Uneven Progress: Recent Trends in Academic Performance Among U.S. School Districts

Kaylee T. Matheny
Marissa E. Thompson
Carrie Townley-Flores
sean f. reardon
Stanford University

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Abstract

We use data from the Stanford Education Data Archive to describe district-level trends in average academic achievement between 2009 and 2018. Though on average school districts' test scores improved by about 0.003 SDs per year, there is significant variation among districts. Additionally, we find that average test score disparities between non-poor and poor students are growing, those between White and Black students are stagnating, and those between White and Hispanic students are shrinking. We find no evidence of achievement-equity synergies or negative tradeoffs: improvements in overall achievement are uncorrelated with trends in achievement gaps. Finally, we find that the strongest predictors of achievement gap trends are the levels and trends in within-district racial and economic segregation and inequality.

Average standardized test scores in the United States have risen since the 1970s, particularly among elementary and middle school students (NCES, 2013). The average 4th grader in 2019, for example, had a mathematics test score that was nearly a standard deviation higher than those of 4th graders in her parents' generation in the 1990s (NCES, 2020). These increases reflect improved educational opportunities: they imply that children growing up today have, on average, more resources and opportunities—in their homes, neighborhoods, preschools, and elementary and middle schools—to learn the math and reading skills measured by standardized tests than did children 50 years ago.

The increase in average test scores is evident for all racial/ethnic groups, though the increases have been larger among Black and Hispanic students than among White students. As a result, the national White-Black and White-Hispanic achievement gaps have narrowed substantially in the last 50 years as well (Reardon et al., 2015). In contrast, the achievement gap between nonpoor and poor students (as measured by free/reduced-price lunch eligibility) has been relatively stable for several decades (NCES, 2020), while the gap between affluent and very poor students (those at the 90th and 10th percentiles of the income distribution, respectively) has widened substantially (Reardon, 2011; but see also Hashim et al., 2020; Reardon, 2020).

On the one hand, the pattern of rising average test scores and narrowing racial/ethnic achievement gaps indicates that increases in overall educational opportunities have been accompanied—at least over the long term—by growing racial equity of opportunities. On the other hand, the same increases in overall educational opportunity have been accompanied by stable or widening economic achievement gaps; economic inequality of educational opportunity has not improved along with overall educational outcomes.

These national trends (as well as state-level trends in the last two decades) in test scores are well-documented by the National Assessment of Educational Progress (NAEP). But what has happened at a more local scale? The U.S. educational system is highly decentralized, with over 13,000 public school districts, each of which has considerable control over staffing, curriculum, instruction, and budget allocation decisions. To what extent are the national trends in average test scores and test score gaps common among school districts? How much do these trends vary and covary? What local and schooling characteristics are associated with local trends in achievement patterns? Are there many districts where scores are improving while gaps are narrowing, or does improvement generally come with increased inequality? Our goal in this paper is to answer these questions, providing a detailed descriptive account of trends in achievement patterns among all school districts in the U.S. Our work here extends the recent work of Atteberry et al (in press) on this topic.

In this article, we first measure recent trends in students' academic performance in every public school district in the United States using ten years of data (2009 to 2018) on third- through eighth-grade math and reading test scores. We show that we are able to measure district-level trends with high reliability. We then describe how these trends vary among school districts and how they differ between socioeconomic and racial/ethnic student subgroups within school districts. Third, we estimate the correlation between trends in overall performance and trends in racial and economic achievement gaps, in order to determine whether increasing overall performance and reducing achievement gaps are synergistic or conflicting processes. Finally, we estimate the correlation of trends in average performance and in racial and economic achievement gaps with local demographic changes and school characteristics. This exploratory

analysis helps identify potential factors to examine further as levers for increasing opportunity and student achievement.

We find that, in the average district, test scores changed very little (increasing by only 0.003 standard deviations (SDs) per year) from 2009 to 2018 (less than one-tenth of a grade level over a decade). The trends vary considerably among districts, however: test scores improved by more than 0.025 SDs per year (roughly three-quarters of a grade level over the study period) in the fastest-improving one-sixth of districts, and declined by 0.020 SDs or more per year (more than half a grade level over the study period) in the one-sixth with the fastest-decreasing performance. Changes in districts' socioeconomic and racial/ethnic composition explain very little of the variation in academic performance trends. Rather, we find that the single strongest predictor of improvement is average test scores at the start of the period. Districts with initially high average levels of educational opportunity experienced the greatest improvement over the study period. As a result, average achievement varied more across districts in later cohorts than earlier cohorts.

We also find that district-level trends in academic performance vary significantly by subgroup. In the average district, scores for both poor and nonpoor students improved, on average, over the study period, but the improvement was greater for nonpoor students, so that the average nonpoor-poor achievement gap widened by 0.005 SDs/year from 2009 to 2018 (an increase of roughly 10% over a decade). The White-Black gap also widened very slightly (by 0.002 SDs/year) in the average district, while the White-Hispanic gap narrowed (by 0.005 SDs/year). The trends in all three gaps varied substantially among districts, however. Moreover, the strongest predictors of increasing achievement gaps are measures of economic inequality and

segregation: achievement gaps have grown most rapidly, on average, in school districts with high and increasing levels of social inequality and school segregation. Our findings, in conjunction with other research, suggest that reducing within-district segregation and inequality may lead to greater equality of educational opportunity.

Background

Improving academic performance has been the focus of major federal education policy in the past 20 years. Both the No Child Left Behind (NCLB) Act and its successor, the Every Child Succeeds Act (ESSA), focus on improving standardized test scores and, importantly, narrowing achievement gaps. In fact, the logic of the laws—holding schools and districts accountable for raising achievement of all racial/ethnic and economic groups to a common level—envisions raising achievement and narrowing achievement gaps as compatible, even synergistic goals. If the goal of improving all student groups' test scores incentivizes schools and districts to focus resources primarily on low-performing students and groups, then test-based accountability systems may increase both average test scores and equity, and school districts that are most effective at raising achievement may also be those most effective at reducing test score gaps. Improving achievement and equity may not be synergistic in practice, however. For example, an accountability system based on test scores may disproportionately discourage or punish schools and teachers of disadvantaged student groups, leading to higher teacher turnover in such places. This might lead to widening achievement gaps, even if overall achievement improves. There may be little synergy or even some tradeoff between allocating resources to increase average achievement and allocating resources to support structurally disadvantaged students'

achievement.

We know little about trends in academic performance and these potential synergies or tradeoffs. The targets of intervention in federal policies have been individual schools and, to some extent, school districts: test scores are reported at the school level; individual schools are targeted for sanctions and improvement based on these scores; and districts are largely responsible for overseeing such improvements. Ironically, however, the standardized testing regime driven by these policies has not been designed to produce comparable measures of academic performance at the school or district level over time. Not only do the tests and proficiency standards vary among states, but they vary within states over time, as tests and proficiency standards and reporting practices change. As a result, after almost 20 years of standardized testing in every public school in the U.S., we lack even basic descriptive information on how average test scores have changed in individual schools and districts.

Prior research on test score trends by race/ethnicity and income

The same is not true at the national or state level. Since 2003, the NAEP assessments have been administered to representative samples of 4th and 8th graders in each state in every other year.[1] The NAEP test score scale has been stable over this time period, making it possible to compare the average achievement of students over time, both nationally and within each state. NAEP regularly produces reports describing the trends, as well as trends for racial/ethnic and economic student groups and trends in the corresponding achievement gaps (NCES, 2018a,

[1] Prior to 2003, NAEP assessments had been administered to nationally-representative samples since the 1970s, and to state-representative samples in a self-selected set of states since 1990.

2018b). These reports show that math and reading scores increased substantially from the 1970s until about 2013, at a rate of roughly 0.05-0.20 SDs/decade in most grades and subjects. The trend has been steeper in math than in reading, and steeper in 4th than in 8th grade, and steeper in 8th grade than in 12th grade. The one exception is 12th grade reading scores, which are roughly the same today as they were in 1970. The trends have flattened since 2013, however. Since then, math and reading scores have declined modestly in most grades and subjects (NCES, 2013, 2018).

The trends in achievement vary considerably among states. The average state's NAEP scores improved by about 0.12 SDs/decade in math and by 0.08 SDs/decade in reading from 2003–2019, but the trends ranged widely. The 10th and 90th percentiles of the math trend distribution were 0.00 and 0.22 SDs/decade, respectively; and -0.01 and 0.18, respectively, in reading. The wide variation in state trends suggests that variation among school districts may be even more pronounced.

The national White-Black and White-Hispanic achievement gaps have also narrowed substantially over the last few decades. Roughly speaking, the gaps declined at a rate of roughly 0.10 SDs/decade during the 1990s and early 2000s. Progress in reducing White-Black gaps has slowed in the last decade, particularly in 8th and 12th grade, but the White-Hispanic gap continued to narrow through 2019. Nonetheless, the gaps remain extremely large—the national White-Black gap was 0.7–0.9 SDs in 2019, depending on test subject and grade; the White-Hispanic gap was 0.50–0.65 SDs. Even if the gaps continue to narrow at 0.10 SDs/decade, they will not be eliminated until the end of the 21st century. Like the trends in average test scores, the trends in racial achievement gaps vary substantially among states. From 2003–2019, the average

state's White-Black gap increased by 0.02 SDs/decade, but the standard deviation of the trend was 0.19 SDs/decade. The average White-Hispanic state trend was -0.04 SDs/decade, with a standard deviation of 0.09 SDs/decade.[2]

The trend in the gap between higher- and lower-income students is somewhat less clear. NAEP data show that the test score gap between students eligible and not eligible for free lunch—an imperfect measure of family income—have remained roughly stable in recent decades, though there have been modest to sizeable increases since the 1980s in the gap between students with college-educated parents and those whose parents have not attended college (NCES, 2020; Reardon et al., 2015). Likewise, Reardon (2011) found that the gap between affluent and very poor students grew substantially for cohorts of students born from the 1970s through the 1990s, though Reardon and Portilla (Reardon & Portilla, 2016) suggest that this trend may have reversed for more recent cohorts, at least with respect to the gap at kindergarten entry. In contrast, several new working papers challenge the Reardon (2011) finding (Hanushek et al., 2020; Hashim et al., 2020), though Reardon (2020) suggests that these papers' methods are flawed.

The NAEP data provide evidence on the national and state-level trends in average academic performance and achievement gaps. The substantial heterogeneity among state-level trends suggests that local forces shape educational opportunity patterns. However, until recently, we have had no reliable information about trends in achievement or achievement gaps within more local units, such as school districts.[3]

[2] Authors' calculations using NAEP data (NCES, 2020).
[3] The NAEP Trial Urban District Assessment (TUDA) provides trend data for roughly two dozen large urban districts, but these constitute only a small fraction of the 13,000+ school districts in the U.S.

One might think that the state-administered standardized tests required by NCLB and ESSA since the early 2000s would provide information on changes in average achievement within each school district. While it is true that states are required to test all students in grades 3–8 in math and reading each year, and to report summaries of these assessments at the school and district level, in general the tests and reporting systems are not designed to enable the measurement and comparisons of trends in average scores. First, states change the tests they use occasionally, often using a given test for five years or less. As a result, only short-term trends can be measured, unless the test scales are linked over time. Second, most states do not report the average test scores in a school or district; rather they report the percent of students scoring above a state-defined "proficiency" threshold score. But the percent proficient is not a linear function of average test scores; as a result, trends in "percent proficient" are biased measures of trends in average test scores (e.g., Ho, 2008; Yee & Ho, 2015). Third, states have changed their definitions of proficiency often in the last decade (Bandeira de Mello et al., 2019). This also breaks trend measurement. Finally, states use different tests and proficiency thresholds than one another, so comparing trends across states is not possible, even if accurate within-state trends can be obtained. As a result, we lack a basic understanding of whether and how much academic performance has been increasing in each school or district.

A recent study by Atteberry, Bischoff, and Owens (in press), similar to this one, uses SEDA data to describe trends in achievement. Atteberry et al find substantial variation among and within districts in trends from 2009-16. They do not, however, identify the correlates of these trends, so we don't know which kinds of districts have experienced the largest improvements. We extend these analyses, using updated data from 2009-18, and identify trends in

achievement, achievement gaps, and their correlates.

While it might be useful to examine trends in academic performance and achievement gaps at both the district and school level, we focus in this paper on districts as the unit of analysis for three reasons. First, and most importantly, districts control many relevant decisions—staffing, curriculum, instruction, resource allocation—that may shape learning opportunities within and between schools and so may affect trends in average achievement and achievement gaps. As a result, we view school districts as of more substantive interest than schools in an examination of achievement and gap trends.

Second, districts are more stable units of analysis than schools. School attendance zone boundaries may change; student assignment policies (such as school choice policies) and changes in school programs (e.g. the availability of gifted/talented programs) may alter the mix of students attending a given school. Such changes may confound the measurement of trends in average academic achievement. Of course, the mix of students in a district also may change over time, as local demography changes or because of changes in private school enrollment patterns. But between-district transfers are much rarer than between-school, within-district student transfers (Reardon, 2019). Moreover, district composition changes more slowly than school composition, and demographic changes are more easily measured at the district than the school level (because the Census provides demographic data tabulated at the school district, but not the school level).

Finally, SEDA (our source for test score data) does not include data on school-level achievement gaps. Moreover, data on trends in average performance are prone to considerable measurement error in small schools; district-level trend estimates are more reliable. For these

reasons, we focus here on measuring and describing district-level trends in academic achievement and achievement gaps.

Potential causes of local test score trends

The average test scores of students in a given school district in a given year reflect the total set of educational opportunities and resources the students have had, from birth through the time they take the test. These opportunities include experiences and resources in their homes, neighborhoods, preschools, peer groups, and in their schools. So a change in average scores from one cohort of students to another within a district reflects changes in educational opportunities and resources. Broadly put, changes in average scores may result from differences between cohorts in out-of-school experiences—such as changes in family resources, or differences in preschool or neighborhood conditions—or from differences between cohorts in school characteristics, practices, or resources.

Because family socioeconomic characteristics are predictive of academic performance (Sirin, 2005), changes in average family socioeconomic status across cohorts lead to corresponding changes in average test scores. Moreover, achievement gaps are expected to widen/narrow when between group family socioeconomic status disparities widen/narrow.

Likewise, as school conditions that affect academic performance change, so will average test scores. And as between-group differences in school experiences or access to school resources change, achievement gaps will change. This can happen as school segregation patterns change. Indeed, between-school segregation is, along with racial differences in socioeconomic status, the strongest correlate of racial achievement gaps (Reardon, Weathers, Jang, et al.,

2019). Since the 1980s, socioeconomic school segregation has grown substantially (Duncan & Murnane, 2011; Owens et al., 2016). At the same time, even as district, state, and national policies have sought to decrease the level of racial school segregation in the American public school system, racial school segregation has largely remained unchanged (Johnson, 2011; Reardon & Owens, 2014). School segregation has marked consequences for students. For example, income segregation between schools is strongly associated with both socioeconomic and racial/ethnic disparities in test scores (Owens, 2018). Additionally, research shows that neighborhoods with more racial segregation and racial differences in average school poverty rates are associated with greater disparities in performance between White students and their Black and Hispanic peers (Card & Rothstein, 2007; Reardon, Weathers, et al., 2019; Reardon et al., 2015; Reardon, Kalogrides, et al., 2019). Because school segregation may concentrate students differentially in schools with higher or lower levels of educational resources and opportunities, cohorts experiencing higher levels of between-school segregation may have larger achievement gaps than similar, but less-segregated, cohorts (Reardon, Weathers, Fahle, et al., 2019).

Several aspects of schools are of particular interest when studying trends in academic performance. First is school funding: a number of rigorous studies in the last decade have found clear evidence that increases in school funding lead to improved academic achievement and other educational outcomes (see Jackson, 2020 for a detailed review). Second, changes in teaching staff may lead to changes in student achievement. A change in the student/teacher ratio may lead to a change in average achievement, because such a change directly affects the amount of teacher time, focus, and attention available to the average student. Teachers' skills

also shape students' learning. However, because we do not have population-level data on teachers' skills, we focus on several measures of teacher characteristics that are roughly correlated with skills and impact, including teacher experience and rates of teacher absenteeism (Clotfelter et al., 2009, 2010; Miller et al., 2008). Finally, given the emphasis in the last decade on charter schools as way of improving academic outcomes, we might expect that the availability and effectiveness of charter schools would predict changes in average test scores, if charter schools are more effective than traditional public schools (as appears to be the case in some, but not all, places (Abdulkadiroğlu et al., 2011), or if they spur competition that leads traditional public schools to improve (Gilraine et al., 2019).

To the extent that changes in district characteristics lead to changes in average student test scores, differences in these changes between the schools attended by students of different racial/ethnic groups or economic backgrounds will lead to corresponding between-group differences in test score trends, that is, to changes in achievement gaps. For example, if exposure to more experienced teachers leads to higher test scores, then racial disparities in exposure to experienced teachers will lead to increases in achievement gaps.

Research Questions

Our first goal in this paper is to provide a descriptive overview of trends in academic achievement and achievement gaps at the school district level, using population level data from virtually every school district in the country. While NAEP provides detailed information at the state and national level, we know far too little about district-level test score trends, despite the fact that states have administered hundreds of millions of standardized tests over the last

decade. Second, we investigate whether there is, in the current policy realm, a tradeoff between achievement and equity. Here we examine whether improvements in overall achievement are generally experienced equally by all student groups in a district, and how often increasing achievement coincides with narrowing achievement gaps. The answer here helps shed light on whether the current policy regime facilitates a virtuous synergy or a vicious choice between equity and achievement.

Third, we investigate the role of district demographic changes, particularly changes in family socioeconomic conditions and resources, in shaping these trends. How much of the variation in district-level trends is due to such demographic changes? Finally, we examine the correlation of local achievement and achievement gap trends with community and school district characteristics. These analyses do not provide clear causal evidence but can help make clear what factors are associated with achievement and gap trends and may be used to generate hypotheses for future research.

The answers to these questions may have important policy implications. Scholars and practitioners must understand whether increases in district-level opportunity benefit some children more than others, as this has critical implications for how states and districts allocate resources and direct school improvement efforts.

Data and Methods

We use data from several sources. Like Atteberry et al. (in press), we use data from the Stanford Education Data Archive (SEDA) to measure district-level trends in average test scores, though we use more years of data than they do. We use additional data from the Common Core

of Data (CCD), the Civil Rights Data Collection (CRDC), and the American Community Survey (ACS) to construct covariates used in our models.

Stanford Education Data Archive (SEDA)

SEDA is based on 430 million third- through eighth-grade math and reading test scores from spring 2009 to spring 2018 in more than 13,000 geographic public school districts, nearly every school district in the United States (Fahle et al., 2021). SEDA includes district-level estimates of average performance in each district by grade, cohort, and subject, as well as estimates disaggregated by race/ethnicity and socioeconomic status. The test scores are linked to a common scale across states, grades, and years, making comparisons possible across districts in different states and across time. The scores are standardized within grades and subjects relative to the corresponding national student-level test score distribution.

The linking process that was used to compile SEDA is detailed in recent papers (Fahle et al., 2019; Reardon, Kalogrides, & Ho, 2019). Briefly, SEDA is based on the ED*Facts* data files collected by the U.S. Department of Education. These files contain counts of students' test scores—disaggregated by school, year, grade, subject, and subgroup—in each of a set of usually four or five coarse proficiency categories (often labeled something like "Below Basic," "Basic," "Proficient," and "Advanced"). These counts are used to estimate the mean test scores in each district-grade-year-subject cell for all students and for White, Black, and Hispanic students and for economically disadvantaged and non-disadvantaged students separately, using heteroskedastic ordered probit models (Ho & Reardon, 2012; Reardon & Ho, 2015). The estimated means are then scaled to the NAEP scale, using state-year-grade-subject specific NAEP

test score distributions (Reardon, Kalogrides, & Ho, 2019), and then standardized for interpretability. For more detail see Fahle et al. (2021).

In the SEDA data, schools are aggregated to "geographic school districts," each of which contains all traditional public schools, charter schools, and BIE schools within its geographic boundaries. Virtual schools, which enroll fewer than half of one percent of all students, are excluded from SEDA.

Estimating Achievement Trends Using Precision-Weighted Random Effects Models

In each district, SEDA includes up to 120 estimates of average test scores, one for each grade-year-subject in the data (6 grades, 10 years, 2 subjects). We pool these observations and use a precision-weighted multilevel model (described below) to estimate each district's average within-grade and -subject trend in test scores over the 2009 to 2018 period. This approach differs from that used by Atteberry et al. (in press), who estimated trends separately in each district-grade-subject. We pool the trend estimates across grades and subjects in order to obtain more reliable estimates of average district trends (the grade- and subject-specific trends can be very noisy). We estimate the trend for the district as a whole, as well as for socioeconomic and racial/ethnic subgroups within each district; in addition, we estimate the trend in socioeconomic and racial/ethnic achievement gaps in each district with sufficient numbers of each subgroup.

The estimated average test score and its standard error for students in district d for year y, grade g, and subject b are designated by $\hat{\mu}_{dygb}$ and $\widehat{\omega}_{dygb}$, respectively. We replace $\hat{\mu}_{dygb}$ with a subgroup-specific estimate or a gap estimate in the relevant models. We define $cohort = year - grade$, so that the $cohort$ variable indicates the spring of the year that a cohort of

students was in kindergarten, following Reardon (2019). Because the data span the years 2009 through 2018 and the grades three to eight, there are 15 cohorts represented in the data, ranging from those entering kindergarten from 2001 to 2015. The test subject is indicated by the binary variable $math$ (1 = math; 0 = reading).

To estimate the trends in achievement, we use versions of the following precision-weighted multilevel model and data from all districts, cohorts, grades, and subjects:

$$\hat{\mu}_{dygb} = \beta_{0d} + \beta_{1d}\left(grade_{dgyb} - 5.5\right) + \beta_{2d}(cohort_{dgyb} - 2008) + \beta_{3d}(math_{dgyb} - .5) + e_{dygb} + \varepsilon_{dygb}$$

$$\beta_{0d} = \gamma_{00} + u_{0d}$$

$$\beta_{1d} = \gamma_{10} + u_{1d}$$

$$\beta_{2d} = \gamma_{20} + u_{2d}$$

$$\beta_{3d} = \gamma_{30} + u_{3d}$$

$$\varepsilon_{dygb} \sim N\left(0, \hat{\omega}^2_{dygb}\right); e_{dygb} \sim N(0, \sigma^2);\ [u_{0d}, u_{1d}, u_{2d}, u_{3d}] \sim MVN(0, \boldsymbol{\tau}). \quad (1)$$

We fit the model via maximum likelihood, using the HLM v7 software. In the estimation, $\hat{\omega}^2_{dygb}$ is treated as a known parameter—the error variance of the estimated mean score $\hat{\mu}_{dygb}$—while both σ^2 and $\boldsymbol{\tau}$ are estimated.

In this model, β_{2d} is the parameter of interest: the pooled average within-grade and -subject (cohort-to-cohort) change in average test scores in standard deviations in district d. A hypothetical trend of 0.01 would imply that, on average, scores in that district increased by 0.01 standard deviations per year over the period from 2008–09 to 2017–18, or 0.09 grade- and subject-specific national student-level standard deviations over the study period. In addition, the matrix $\boldsymbol{\tau}$ is informative: in particular, its diagonal element τ_{22} indicates the variance of trends across districts. Other estimates obtained from this model are the average district-level test

scores, β_{0d}; the estimated within-cohort growth from grades three to eight, β_{1d};[4] and the estimated difference in math and reading scores (within grade and cohort) for the district, β_{3d}.

Adjusting Trends for Demographic Changes

The observed trends in achievement may reflect changes in student demographic characteristics, particularly those related to family economic resources. We estimate demographic-change-adjusted trends by fitting the following modified version of the model above:

$$\hat{\mu}_{dgyb} = \beta_{0d} + \beta_{1d}\left(grade_g - 5.5\right) + \beta_{2d}\left(cohort_{gy} - 2008\right) + \beta_{3d}\left(math_b - .5\right) + (\mathbf{X}_{dy} - \bar{\mathbf{X}})\mathbf{B}_d + e_{dgyb} + \varepsilon_{dgyb}$$

$$\beta_{0d} = \gamma_{00} + \gamma_{01}(SESChange_d) + u_{0d}$$

$$\beta_{1d} = \gamma_{10} + \gamma_{11}(SESChange_d) + u_{1d}$$

$$\beta_{2d} = \gamma_{20} + \gamma_{21}(SESChange_d) + u_{2d}$$

$$\beta_{3d} = \gamma_{30} + \gamma_{31}(SESChange_d) + u_{3d}$$

$$\mathbf{B}_d = \mathbf{\Gamma}_0$$

$$\varepsilon_{dygb} \sim N\left(0, \hat{\omega}^2_{dygb}\right); e_{dygb} \sim N(0, \sigma^2);\ [u_{0d}, u_{1d}, u_{2d}, u_{3d}] \sim MVN(0, \boldsymbol{\tau}). \quad (2)$$

In this model, $\mathbf{X}_{dy}$ is a vector of district-year demographic covariates, including the percent of students classified as economically disadvantaged (from the ED*Facts* data); the proportion eligible for free or reduced-price lunch (from CCD); the average district SES (from ACS); and the proportions in each race/ethnic category (White omitted; from CCD). Each of these variables is group-mean centered. At the district-level we include an estimate of the change in SES from

[4] For more information on estimated within-cohort growth (β_{1d}), see Reardon (2019).

2005–09 to 2014–18. This variable is uncentered, so that the $\gamma_{\cdot 0}$ coefficients describe the average values of the $\beta_{\cdot 0}$ in a district where SES did not change. We include multiple, potentially redundant measures of time-varying SES and changes in SES in the model because we want to account for as much of the variance associated with demographic changes as possible; we are not interested in interpreting the coefficients on $\mathbf{X}$ or the change in SES.

We compute the adjusted trend by adding the residual $\hat{\mu}_{2d}$ to the adjusted average trend, $\hat{\gamma}_{2d}$:

$$\hat{\beta}_{2d} = \hat{\gamma}_{20} + \hat{\mu}_{2d}. \tag{3}$$

The adjusted average trend represents our estimate of the trend we would have observed had there been no change in the socioeconomic and racial makeup of the district during the study period. Moreover, a comparison of τ_{22}^2 (the variance of u_{2d}, obtained from the estimate of the $\boldsymbol{\tau}$ matrix) from Model 1 to Model 2 indicates the proportion of variance in trends that is associated with demographic changes.

Modeling Trends in Achievement and Achievement Gaps

Having obtained estimates of the trend in achievement and achievement gaps in each district (the $\hat{\beta}_{2d}$'s), we fit precision-weighted regression models to estimate the associations of these trends with district covariates. These models are of the following form:

$$\hat{\beta}_{2d} = \mathbf{Z}_d\boldsymbol{\Gamma} + u_d + \varphi_d$$
$$u_d \sim \mathrm{N}(0, \tau_2^2);\ \varphi_d \sim \mathrm{N}(0, \theta_d^2), \tag{4}$$

where $\hat{\beta}_{2d}$ is the estimated (overall, subgroup, or gap) trend in district d, estimated from Model 1 above, and $\mathbf{Z}_d$ is a vector of district-level covariates. For each district characteristics, we include both the average district level of the measure over the study period as well as the change in the measure over the period (for example, we include both a measure of average segregation and the change in segregation in the district from 2008-09 to 2017-18). The parameters of interest are the coefficients in the vector $\mathbf{\Gamma}$, which describe the partial associations of district achievement (or gap) trends and district characteristics. The model includes two error terms, one (u_d) representing the residual of the true trend in achievement, conditional on $\mathbf{Z}_d$, and the other (φ_d) representing the estimation error in $\hat{\beta}_{2d}$ (i.e., $\hat{\beta}_{2d} = \beta_{2d} + \varphi_d$). The error variance is assumed known (it is set to equal the squared standard error of $\hat{\beta}_{2d}$), and the true conditional variance τ_2^2 is estimated. We fit the models via maximum likelihood, using the `–metareg–` command in Stata (Harbord & Higgins, 2008).

Covariates

We use data from a variety of sources to identify demographic, community, and school characteristics. The bulk of these covariates are drawn from the Common Core of Data (CCD), the Civil Rights Data Collection (CRDC), and the American Community Survey (ACS). From the CCD, we obtain district-level economically disadvantaged, free lunch, and racial and ethnic student composition; estimates of segregation; teacher variables, including pupil-teacher ratios and instructional expenditures; and enrollment patterns, including overall district enrollment and charter school enrollment. From the CRDC, we obtain district-level measures of the proportion of teachers in their first two years of teaching, the proportion of teachers absent 10

or more days from school in a given year, and the proportion of certified teachers. From the ACS, we include measures of district-level SES following the approach used by Reardon (2019). We follow the approach of Shores and Steinberg (2019) to construct a measure of intensity of the impacts of the 2008 recession using data from the Bureau of Labor Statistics.

Results

Variation in Trends Among School Districts

We find that over the 2009 to 2018 period, test scores improved annually by 0.003 standard deviations in the typical school district. This translates to roughly one-tenth of a grade level of improvement over ten years.[5] However, trends vary considerably among districts: the standard deviation of the annual trend is 0.025, meaning that over the study period, we estimate that one-sixth of U.S. school districts see improvements of more than three-quarters of a grade level, and one-sixth will have declines in average scores of more than three-fifths of a grade level.[6] Table 1 shows average annual changes in achievement from 2009 to 2018, disaggregated by demographic group.

Table 1 here

There is also considerable variation in trends in group-specific academic performance and in achievement gaps (note the standard deviations of trends shown in Table 1). This

[5] The vertically-equated NAEP scale indicates that the average difference in test scores between 4th and 8th graders is roughly 1.33 standard deviations of the student test score distribution at a given grade. This allows a rough 1:3 conversion of test score standard deviations to approximate "grade levels": the average student's scores improve by one standard deviation over three grades, or one third of a standard deviation per grade.

[6] We calculate this as follows: two thirds of districts' trends fall within +/- 1 standard deviation of the average trend (so between -0.022 and +0.028). We multiple by 9 years, and then convert to approximate grade levels by multiplying by 3. This yields a range from -0.60 to +0.75 grade levels. One sixth of districts have changes less than -0.60 and one-sixth have changes greater than 0.75.

variation is visualized in the right side of Figure 1, which plots the district-level trends in one group's achievement against another. There is both wide variation in group achievement trends (evident in the range of district trends along the axes) and in gap trends (evident in the dispersion of the data around the 45-degree line; in districts on the 45-degree line, gaps are unchanging; districts above or below the line have widening or narrowing gaps, respectively).

Figure 1 here

The within-district test score disparity between poor children and their non-poor peers grew by an average of 0.005 standard deviations among the roughly 10,000 districts with enough poor and non-poor students to report disparities. This is largely driven by the high average achievement gains of non-poor students on the order of 0.008 standard deviations annually. Average gains for poor students, however, were not as high, with average district-level increases of 0.003 standard deviations annually. This means that between 2009 and 2018, the average district-level disparity between poor and non-poor children has grown by roughly one-seventh of a grade level.

For White and Black students, the patterns are slightly different. From 2009 to 2018, average district-level test scores for White students improved by 0.003 standard deviations (0.009 grade levels) per year. Among the roughly 4,000 districts with enough Black and White students to report disparities in test scores, the average district's Black students improved by 0.001 standard deviations (0.003 grade levels) per year. This results in a gap that does not change much, by only about 0.002 standard deviations (0.006 grade levels) per year, roughly one-twentieth of a grade level over the study period. In the average district, then, the White-Black disparity barely changed over the last decade.

While socioeconomic disparities have widened and White-Black disparities have been stagnant, on average, the White-Hispanic disparity has narrowed. In districts with enough White and Hispanic students to report disparities, the test scores of White students improved by 0.004 SDs annually while those of Hispanic students grew by an average of 0.009 SDs annually. This resulted in a disparity trend of -0.005 SDs (-0.015 grade levels) per year, or about one-seventh of a grade level over the study period.

While all subgroups are improving in the average district, there are clear differences in the provision of educational opportunity over time. This has resulted in increasing disparities between non-poor and poor students, stagnant disparities between White and Black students, and decreasing disparities between White and Hispanic students.

Achievement-Equity Tradeoff?

Incentives for improving overall educational opportunities may be at odds with incentives for equitably improving educational opportunities or providing more resources to students with greater need. Subgroup trends are strongly and positively correlated (see Table 1). That is, in districts where one group experiences increasing educational opportunity, so does the other group, on average. In general, the correlations between overall trends and trends in White-Black, White-Hispanic, and nonpoor-poor achievement disparities are weak and positive, ranging from 0.04 to 0.10 (See Appendix Table 2). This suggests that there has been no systematic synergy between achievement and equity over the last decade.

Figure 1 displays the relationships between trends in the performance of different student groups. Each of the three panels shows information for a different pair of student

groups (White-Black, White-Hispanic, and nonpoor-poor). The righthand figure in each panel plots the trend in one group's achievement against the trend in the other group's achievement (i.e., comparing the trends for White students vs. Black students). Each district is represented by a bubble. The scatterplot is divided into six regions: in districts in regions A and B, both student groups' scores improved over time; in regions D and E, both groups' scores declined; in C and F, one group's scores improved while the other's declined. Achievement gaps narrowed for districts above the 45-degree line (in regions A, F, and E), and widened for those below the line (regions B, C, and D).

To the extent that there is a synergy between improving achievement and narrowing achievement gaps, we would expect to see most districts fall in regions A (improving achievement accompanied by narrowing gaps) or D (declining achievement accompanied by widening gaps). To the extent there is a tradeoff, we would expect more districts in regions B and E. The figure suggests that in general, achievement gains or losses are common to all student groups in a district (there is a high correlation between group trends, evident in the scatter and reported in Table 1). But there is no systematic relationship between trends in achievement and trends in achievement gaps: districts where achievement is growing are generally just as likely to fall in region A as in D; and districts where achievement is falling are just as likely to fall in B as in E.

Variation Across the Twenty Largest Districts

To illustrate the extent of the variation in trends, we show the variation in unadjusted trends across the twenty school districts with the highest enrollment in the United States in

Figure 2. The trends in achievement and gaps vary widely across school districts. Average test scores in Philadelphia declined by approximately 0.025 SDs/year (0.075 grade levels/year, or two-thirds of a grade level over the 9-year study period), while scores in San Diego improved by 0.029 SDs/year (0.087 grade levels/year, or more than three-quarters of a grade level over 9 years).

Figure 2 here

Achievement gap trends also vary widely among the 20 largest districts. The district where socioeconomic disparities have narrowed the fastest is Dallas ISD, where the nonpoor-poor gap has declined at a rate of 0.029 SDs per year (0.087 grade levels/year, or more than three-quarters of a grade level over 9 years). Conversely, inequality is growing rapidly in Fairfax County, where the socioeconomic gap has grown faster than Dallas's has shrunk. In some districts, improving achievement is accompanied by narrowing achievement gaps: in Los Angeles Unified School District, the White-Hispanic gap has narrowed modestly while overall achievement has improved substantially. In other places, the opposite is true: in Philadelphia, not only have average scores declined substantially, but the White-Black and White-Hispanic gaps have widened significantly at the same time. The data indicate that even among large school districts, the patterns of change in academic achievement and achievement gaps vary widely.

Demographic Changes and Neighborhood and District Characteristics

To determine how much of the variation in district-level achievement trends are attributable to demographic changes, we calculated adjusted trends as described in Equations 2

and 3. The demographic adjustments changed the underlying trends very little. Indeed, the inclusion of covariates in Model 2 reduced the variance of the trends by less than 1%. Thus, although districts' average achievement—and therefore, by our argument, educational opportunity—is strongly associated with socioeconomic and demographic characteristics, virtually all of the variation in trends in achievement over time is independent of demographic changes.

Our regression models in Appendix Table 3 show that districts with higher average achievement from the outset experienced greater improvement over the study period (correlation = 0.20, $p < .001$). As a result, average achievement varied more across districts in later cohorts than in earlier cohorts, with an 18% increase in between-district variation for the 2015 cohort (the cohort of children in kindergarten in Spring 2015, whom we observe in third grade in 2018) compared to the 2001 cohort (those who were kindergarteners in 2001, and observed in our data in eighth grade in 2009). However, characteristics of school districts (size, staffing, expenditures, charter enrollments) and changes in these characteristics explain only about 3% of the variation in overall trends in educational opportunity. Holding constant the other variables in the models, districts with declining enrollment and districts with declining shares of structurally disadvantaged students tend to experience greater improvement, as do districts with increasing per pupil instructional expenditures and increasing charter school enrollment. Districts with higher or increasing percentages of novice teachers and districts where students have higher or increasing rates of exposure to teacher absences experienced greater declines over time. However, changes in most district policies and characteristics had little predictive power in understanding patterns of educational opportunity across districts. The

full set of variables in the model together account for only 12% of the variation in achievement trends, leaving much to be explained.

Correlates of Trends in Achievement Gaps

We first examine the bivariate correlations between district characteristics and group-specific trends in achievement. Figure 3 illustrates these bivariate correlations graphically. To make this figure, we did the following: we first tested whether each covariate was significantly associated with the relevant achievement gap; for those covariates, we then estimated the bivariate association of the covariate with each of the two groups' trends separately, and tested whether those associations were significant. Figure 3 plots these pairs of bivariate regression coefficients, with symbols indicating whether the coefficients were significant predictors of one or both groups' trends. Because each of the covariates are standardized, the lengths of the lines indicate the relative strength of the associations. The direction of each line indicates—using the same region labels as in Figure 1—the sign of the associations between the covariate and each groups' achievement trends and the achievement gap.

Figure 3 here

For example, in the bottom panel, the longest line is labeled "Residential Segregation (Wht-Hsp)." The line points down into region D of the graph, indicating that residential segregation is associated with a) a trend of widening White-Hispanic achievement gaps; b) declining White achievement; and c) even more rapidly declining Hispanic achievement. In other words, both White and Hispanic achievement tend to decline in more residentially segregated school districts, but the associated declines in achievement are stronger for Hispanic

achievement than White achievement, meaning that the White-Hispanic gap tends to widen in more segregated districts. Likewise, measures in region B are associated with increasing disparities because they advantage White students the most. Those in region C are associated with improving trends for White students and declining trends for Black students. Section D includes measures that are associated with declining trends for both groups.

One of the key findings evident in Figure 3 is that achievement gaps tend to widen the most in places where average school or residential segregation is higher or increasing. Indeed, economic school segregation (measured as the difference in two groups' exposure to poor schoolmates), is associated with positive trends for White or non-poor students but negative trends for Black and Hispanic students (and not related to trends for poor students). White-Black differences in exposure to novice teachers, and increases in these differences, are associated with increasing White-Black achievement gaps. Specifically, these factors are linked to increasing trends for White students and declining trends for Black students.

Table 2 reports the estimates from multivariate regression models predicting the trends in achievement gaps. We focus here on the district characteristics associated with at least two of the three types of achievement gap trends. First, places with high and increasing SES tend to have growing achievement gaps. Moreover, racial achievement gaps have increased more, on average, in districts where between-group SES disparities are growing.

Changes in school segregation—specifically changes in the between-group difference in the average proportion of poor students in the schools of each student group—is consistently associated with achievement gap trends. In districts where Black, Hispanic, and poor students are increasingly concentrated in high poverty schools relative to their White and nonpoor peers,

achievement gaps have increased as well, on average. Places with large and increasing enrollment also experienced widening achievement gaps over the study period. Places that increased per pupil instructional expenditures also experienced increased equity between White and Black students. Finally, in districts where Black and poor students were in schools with more novice teachers White and nonpoor students, achievement gaps widened, on average.

Table 2 here

Discussion

Overall, in the decade following the Great Recession, school districts' standardized test scores have improved, albeit at a very modest pace compared with the rate of improvement over the prior few decades. At the same time, the White-Black achievement gap has been relatively stable in the average district; the White-Hispanic gap has declined moderately; and the nonpoor-poor gap has widened modestly. These average changes in average achievement and achievement gaps in the last decades are generally small in comparison to the sharp increases in achievement and sharp reduction in racial achievement gaps that occurred in the decades prior.

But these patterns are far from uniform. We find that there is substantial variation in these trends among school districts. In the one-sixth of districts with the greatest increases in achievement, average test scores have increased by more than three-quarters of a grade level since 2009. In the one-sixth of districts with the greatest declines, average scores have declined by more than three-fifths of a grade level. Very little of this variation among districts is attributable to measured demographic changes: we observe the same degree of variability in achievement trends among districts with no demographic change.

Moreover, the variation in average achievement trends is not random. Average achievement has improved more in districts with higher average test scores in 2009. As a result, the between-district variation in average test scores has grown from 2009 to 2018. Achievement has improved more in districts where per pupil spending has increased, where the proportion of novice teachers has declined, where the teacher absenteeism rate has declined, and where the proportion of students in charter schools has increased. These patterns should not be taken as clear evidence that school funding, teacher experience and engagement, and charter schools are *causes* of improved average achievement, however. There may be other causal factors—factors correlated with school funding, teacher characteristics, and charter schooling that we are not able to measure in this study—that drive the associations we describe here. We caution the reader that the associations described here are descriptive and are by themselves insufficient evidence on which to make strong causal claims.

There is also wide variation among school districts in achievement gap trends. Racial/ethnic and economic achievement gaps are narrowing in some districts but widening rapidly in others. The strongest correlates of achievement gap trends are factors related to school resources and economic and racial inequality and segregation. Districts spending more per pupil on instruction also have shrinking academic disparities. On average, the achievement gap between nonpoor and poor students has grown faster in districts with increasing school segregation between non-poor and poor students. Likewise, White-Black and White-Hispanic test score gaps are growing fastest, on average, in districts where school segregation is high and growing over time and in districts where racial economic disparities are growing over time. For example, in districts with little or no White-Black segregation, both White and Black students'

test scores improved very modestly (increasing at a rate of 0.0014 SDs/year for White students and 0.0026 for Black students) from 2009 to 2018. But in the 25% most segregated districts (the top quartile), White students' test scores have improved more rapidly (at an average rate of +0.0059 SDs/year, or 0.15 grade levels over the 9-year period) and Black students' scores have declined (at an average rate of -0.0018 SDs/year, or 0.05 grade levels over the 9-year period). Again, these patterns do not provide evidence of a causal relationship between segregation and growing achievement gaps, but they are broadly consistent with other research showing that segregation is related to unequal educational opportunities and unequal educational outcomes.

In the 1990s and early 2000s, racial achievement gaps in 4th and 8th grade narrowed significantly, at the same time as average achievement improved substantially. Both trends have slowed or stagnated in the last decade. These patterns indicate that achievement and equity are not incompatible goals, at least at a national level. But neither are they necessarily synergistic. Indeed, we find only very weak correlations between local trends in achievement and local trends in racial and economic achievement gaps. There are many communities in the U.S. where improving achievement is accompanied by narrowing achievement gaps; but there are just as many where the opposite is true. Our district-level analysis provides an existence proof that it is possible to improve achievement for all groups and reduce achievement gaps at the same time.

While we do not have definitive evidence regarding the best way to achieve this, our analysis points to several common factors associated with both improving achievement and narrowing achievement gaps: higher expenditures, fewer novice teachers, fewer absent teachers, and lower levels of racial and economic inequality and segregation. In other words, districts with more resources—and more equitably distributed resources—tend to be the

districts where both achievement and equity are improving the most. A focus on policies to improve school districts along these dimensions may lead to improvements in both achievement and equity.

As we note above, one limitation of our study is that it is descriptive, so does not provide clear causal evidence. Nonetheless, our findings are broadly consistent with existing research. Rigorous research clearly shows that school funding leads to improved learning opportunities and achievement (Jackson, 2020). A wide range of research shows that novice teachers are less effective than more experienced teachers, and that teacher absenteeism has negative impacts on students (Clotfelter et al., 2009, 2010; Miller et al., 2008). Finally, research on the effects of school segregation makes clear that it is harmful for low-income and minority students, in part because it concentrates Black, Hispanic, and poor students in high-poverty and under-resourced schools (Guryan, 2001; Johnson & Nazaryan, 2019; Reardon, Weathers, Jang, et al., 2019).

There is much more to be learned about how to improve both average achievement and equity in America's schools. Our models account for, at best, only one-eighth of the variation in trends among districts, indicating that there are many other factors at work. It would be useful to use the SEDA data to identify districts that have shown rapid improvements along both dimensions (and similar districts that have not), and then to conduct case studies of these districts. Such work could lead to new insights and hypotheses to inform future research and education policy.

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Table 1. Descriptive Statistics of Trends in Changing Average Achievement at the District Level

	Full Sample						Analytic Sample		
	Mean	SD	Obs.	Reliability	Trend-Trend Correlation		Mean	SDs	Obs.
Trends by Subgroup									
All Students	0.003	0.025	12,165	0.907	n/a		0.003	0.024	11,813
Poor Students	0.004	0.025	11,162	0.870	n/a		0.003	0.024	9,437
Non-Poor Students	0.008	0.025	10,955	0.868	n/a		0.008	0.024	9,437
Black Students	0.001	0.025	4,239	0.747	n/a		0.001	0.025	3,960
Hispanic Students	0.009	0.026	6,245	0.774	n/a		0.009	0.025	5,639
White Students	0.004	0.024	11,564	0.882	n/a	WBG Sample	0.003	0.021	3,960
						WHG Sample	0.004	0.021	5,639
Trends in Test Score Gaps									
NonPoor-Poor	0.005	0.016	9,799	0.724	0.790		0.005	0.016	9,437
White-Black	0.002	0.019	4,130	0.717	0.748		0.002	0.018	3,960
White-Hispanic	-0.005	0.018	5,863	0.699	0.774		-0.005	0.018	5,639

Note: Trend-Trend correlation indicates the correlation between the two gap trends (i.e. the correlation between the white and black trends)

Table 2. Explaining Variation in Trends in Achievement Disparities

	NonPoor-Poor		White-Black		White-Hispanic	
Average Gap						
Average Gap (Subgroup A - Subgroup B)	0.002		0.013	***	-0.002	
	(0.001)		(0.002)		(0.002)	
Demographics						
Recession Index	0.000		-0.000		0.000	
	(0.000)		(0.000)		(0.000)	
Urban	0.000		0.002	*	-0.001	
	(0.001)		(0.001)		(0.001)	
Rural	0.001		-0.001		-0.000	
	(0.000)		(0.001)		(0.001)	
% (B) Enrollment	-0.004		0.006		-0.012	**
	(0.017)		(0.004)		(0.004)	
Change in % (B) Enrollment	0.618	***	0.142		0.097	
	(0.131)		(0.144)		(0.116)	
Difference in % (B) and % (A)			-0.005		0.004	
			(0.002)		(0.002)	
Change in the Difference in % (B) and % (A)			-0.089		-0.026	
			(0.069)		(0.059)	
SES (B)	0.001	*	-0.003	**	-0.001	
	(0.000)		(0.001)		(0.001)	
Change in SES (B)	0.008	***	0.010		0.012	**
	(0.002)		(0.006)		(0.004)	
Difference in SES (A - B)			-0.004	**	-0.001	
			(0.001)		(0.001)	
Change in the Difference in SES (A - B)			0.015	*	0.023	***
			(0.007)		(0.006)	
Segregation						
% Poor in Average (B) Student's School	0.001		0.000		0.000	
	(0.018)		(0.003)		(0.003)	
Change in % Poor in Average (B) Student's School	-0.559	***	0.107	***	-0.014	
	(0.135)		(0.029)		(0.026)	
Difference in Poor Student Exposure (B - A)	0.007		0.019	*	0.029	***
	(0.009)		(0.008)		(0.008)	
Change in the Difference in Poor Student Exposure (B - A)	0.426	***	0.233	**	0.426	***
	(0.057)		(0.077)		(0.081)	
District and School Characteristics						
% (B) Enrolled in Charter Schools	0.010	*	0.007		-0.006	
	(0.004)		(0.005)		(0.005)	
Change in % (B) Enrolled in Charter Schools	-0.151	***	-0.062		-0.072	
	(0.036)		(0.056)		(0.047)	
Difference in the % Charter Enrollment (A - B)	0.012		0.022	**	-0.006	
	(0.006)		(0.008)		(0.008)	
Change in the Difference in % Charter Enrollment (A - B)	-0.071	*	0.052		-0.003	
	(0.034)		(0.055)		(0.055)	
Enrollment Grades 3-8 (ln)	-0.000		0.002	***	0.002	***
	(0.000)		(0.000)		(0.000)	
Change in Enrollment Grades 3-8 (ln)	0.054	***	0.062	**	0.074	***
	(0.010)		(0.021)		(0.016)	
Average Per-Pupil Expenditures (ln)	-0.001		0.001		0.005	***
	(0.001)		(0.002)		(0.001)	
Change in Per-Pupil Expenditures (ln)	-0.020		-0.063	**	-0.029	
	(0.011)		(0.022)		(0.017)	
Student-Teacher Ratio in Average (B) Student's School	0.000		0.000	*	0.000	
	(0.000)		(0.000)		(0.000)	
Change in Student-Teacher Ratio in Average (B) Student's School	0.000		-0.000		0.000	
	(0.000)		(0.000)		(0.000)	
Difference in the Student-Teacher Ratio (B - A)	0.000		0.001	**	0.000	
	(0.000)		(0.000)		(0.000)	
Change in the Difference in the Student-Teacher Ratio (B - A)	-0.000		-0.001		0.000	
	(0.000)		(0.001)		(0.000)	
Exposure to Certified Teachers (B)	0.010	*	0.001		0.001	
	(0.005)		(0.008)		(0.007)	
Change in Exposure to Certified Teachers (B)	0.040	**	-0.003		-0.006	
	(0.015)		(0.024)		(0.023)	
Difference in Exposure to Certified Teachers (A - B)	0.010		0.004		0.021	
	(0.010)		(0.019)		(0.020)	
Change in the Difference in Exposure to Certified Teachers (A - B)	0.070	*	0.022		0.091	
	(0.032)		(0.056)		(0.057)	
Exposure to Novice Teachers (B)	-0.012	***	-0.018	**	-0.003	
	(0.003)		(0.006)		(0.005)	
Change in Exposure to Novice Teachers (B)	0.006		-0.013		-0.016	
	(0.012)		(0.021)		(0.017)	
Difference in Exposure to Novice Teachers (B - A)	0.039	*	0.041		0.011	
	(0.017)		(0.024)		(0.025)	
Change in the Difference in Exposure to Novice Teachers (B - A)	0.182	***	0.091		0.076	
	(0.048)		(0.073)		(0.075)	
Exposure to Absent Teachers (B)	-0.004	*	-0.005		-0.002	
	(0.002)		(0.003)		(0.002)	
Change in Exposure to Absent Teachers (B)	-0.010		-0.006		-0.002	
	(0.006)		(0.010)		(0.008)	
Difference in Exposure to Absent Teachers (B - A)	0.024	*	0.042	*	0.031	
	(0.012)		(0.017)		(0.019)	
Change in the Difference in Exposure to Absent Teachers (B - A)	0.043		0.103	*	0.104	
	(0.034)		(0.053)		(0.063)	
Constant	0.005	***	0.003	***	-0.005	***
	(0.000)		(0.000)		(0.000)	
Adj. R-squ	5.28%		10.03%		6.65%	
Observations	9437		3960		5639	

Notes: (A) refers to Non-Poor, White, and White students, respectively. (B) refers to Poor, Black, and Hispanic students, respectively. Standard errors in parentheses. * p<0.05 ** p<0.01 *** p<0.001

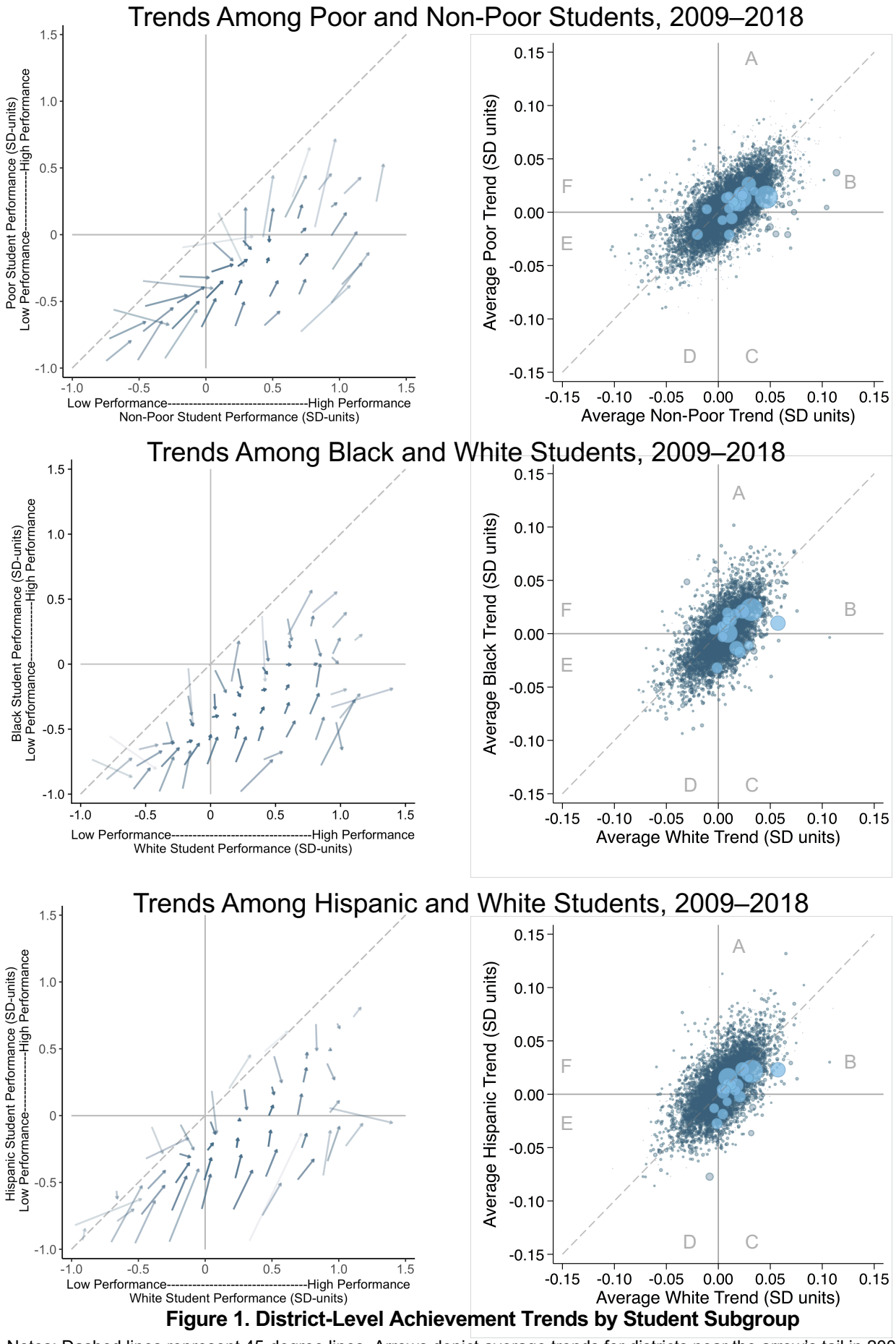


Figure 1. District-Level Achievement Trends by Student Subgroup

Notes: Dashed lines represent 45-degree lines. Arrows depict average trends for districts near the arrow's tail in 2009. Darker arrows represent more students. Performance is measured in SD units above and below national average. Blue circles represent 20 largest school districts. Trends measure the average change in performance per year in SD units.

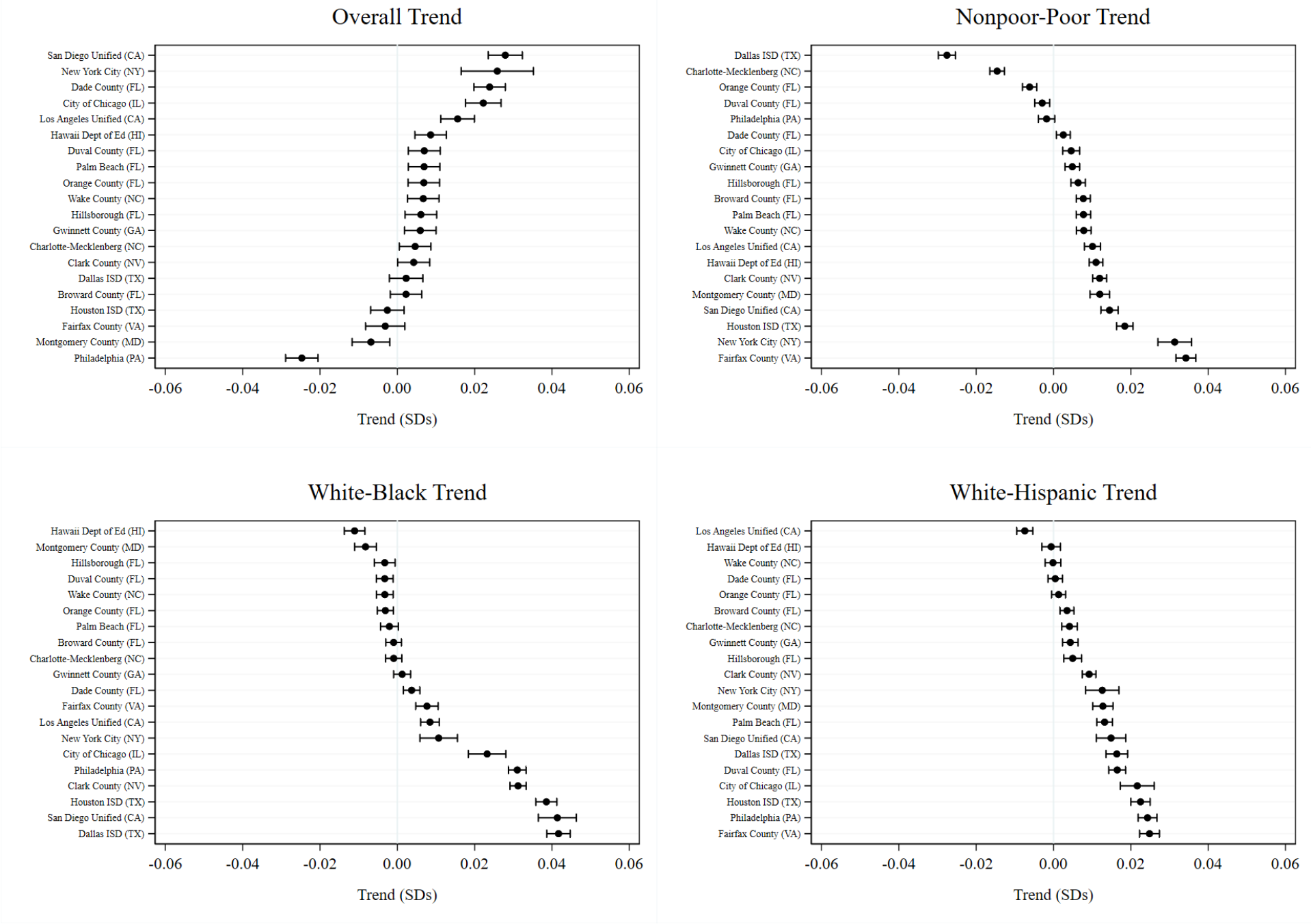
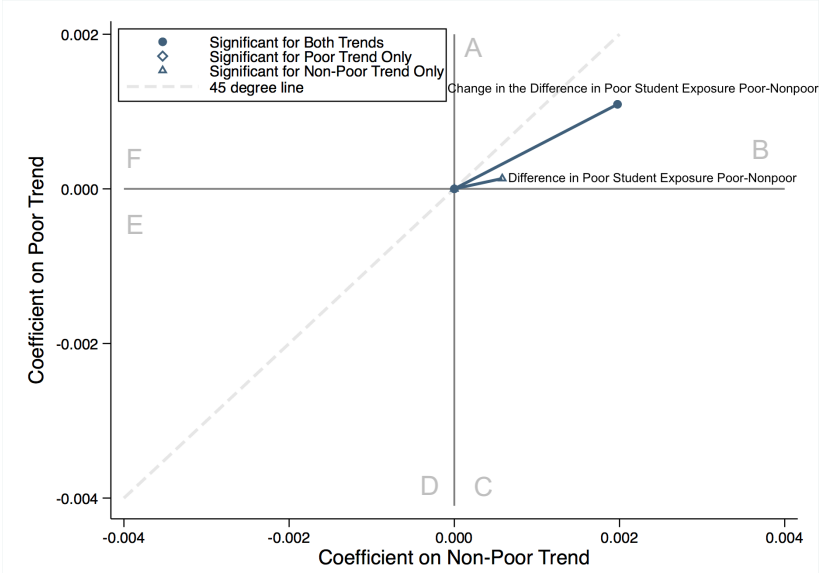
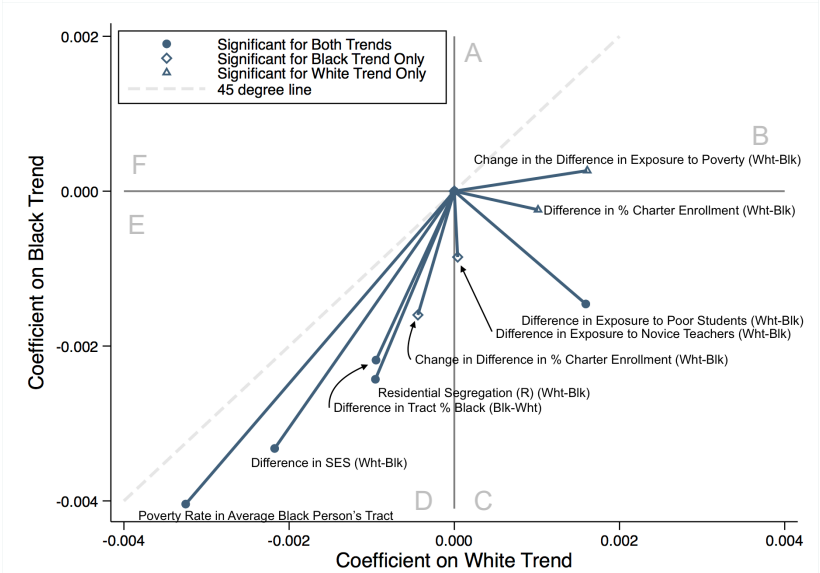


Figure 2. Achievement Trends and Trends in Disparities for the Twenty Largest Districts by Enrollment

Notes: Trends measure the average change in performance per year in standard deviations, standardized to student performance in 2009. The Overall Trend reported here is the unadjusted trend from Equation 1. Each plot shows the 20 largest geographic school districts by enrollment.





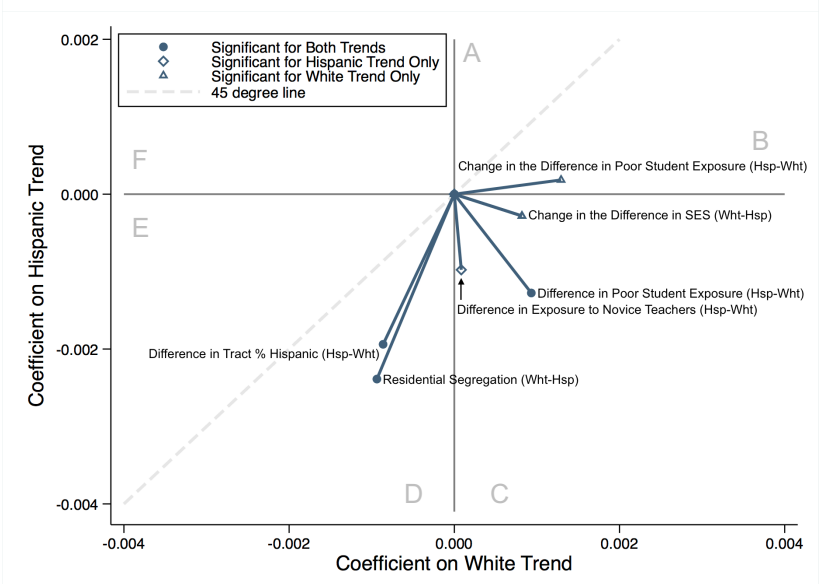


Figure 3. Factors Associated with Equity and Performance in Trends

Note: All coefficients are standardized. All coefficients are significantly different across trends $p < .05$.

Appendix Table 1. Descriptive Statistics of Covariates

	Mean	SD	Min.	Max.	Obs.
Average Achievement or Gap					
Average Performance	0.02	0.33	-1.64	1.25	11,813
Average NonPoor-Poor Gap	0.48	0.16	-0.09	1.51	9,437
Average White-Black Gap	0.54	0.20	-0.09	1.60	3,960
Average White-Hispanic Gap	0.39	0.19	-0.30	1.36	5,639
Demographics					
Recession Index	0.01	1.00	-15.40	7.11	11,838
Urban	0.07	0.25	0.00	1.00	11,838
Rural	0.51	0.50	0.00	1.00	11,838
% Poor Enrollment	0.50	0.22	0.00	1.00	11,813
Change in % Poor Enrollment	0.01	0.01	-0.12	0.11	11,813
% Asian Enrollment	0.02	0.05	0.00	0.74	11,813
Change in % Asian Enrollment	0.00	0.00	-0.03	0.03	11,813
% Black Enrollment	0.07	0.16	0.00	1.00	11,832
Change in % Black Enrollment	-0.00	0.00	-0.04	0.04	11,832
Difference in % Black and % White	-0.44	0.41	-0.98	0.97	3,960
Change in the Difference in % Black and % White	0.01	0.01	-0.05	0.08	3,960
% Hispanic Enrollment	0.14	0.21	0.00	1.00	11,831
Change in % Hispanic Enrollment	0.00	0.01	-0.07	0.06	11,831
Difference in % Hispanic and % White	-0.44	0.45	-0.97	0.99	5,639
Change in the Difference in % Hispanic and % White	0.01	0.01	-0.07	0.12	5,639
District SES	0.12	0.85	-4.27	2.64	11,813
Change in District SES	-0.05	0.10	-0.62	0.61	11,813
District SES Black	-1.64	1.09	-5.96	1.45	3,960
Change in District SES Black	-0.01	0.12	-0.76	0.59	3,960
Difference in District SES White-Black	2.00	0.71	-0.36	4.79	3,960
Change in the Difference in District SES White-Black	-0.05	0.10	-0.66	0.76	3,960
District SES Hispanic	-0.64	0.66	-4.47	1.82	5,639
Change in District SES Hispanic	-0.09	0.12	-0.85	0.68	5,639
Difference in District SES White-Hispanic	1.11	0.36	-0.35	4.32	5,639
Change in the Difference in District SES White-Hispanic	0.05	0.08	-0.42	0.60	5,639
Segregation					
% Poor in Average Poor Student's School	0.50	0.20	0.02	0.98	9,437
Change in % Poor in Average Poor Student's School	0.01	0.01	-0.06	0.07	9,437
Difference in Poor Student Exposure Poor-NonPoor	0.03	0.06	0.00	0.51	9,437
Change in the Difference in Poor Stu Exposure Poor-NonPoor	0.00	0.01	-0.05	0.09	9,437
% Poor in Average Black Student's School	0.53	0.22	0.00	1.00	3,960
Change in % Poor in Average Black Student's School	0.01	0.01	-0.06	0.07	3,960
Difference in Poor Student Exposure Black-White	0.04	0.06	-0.14	0.57	3,960
Change in the Difference in Poor Student Exposure Black-White	-0.00	0.00	-0.06	0.04	3,960
% Poor in Average Hispanic Student's School	0.50	0.22	0.00	1.00	5,639
Change in % Poor in Average Hispanic Student's School	0.01	0.01	-0.08	0.07	5,639
Difference in Poor Student Exposure Hispanic-White	0.03	0.05	-0.09	0.50	5,639
Change in the Difference in Poor Student Exposure Hispanic-White	-0.00	0.00	-0.05	0.03	5,639
District and Schoolool Characteristics					
% Enrolled in Charter Schools	0.01	0.06	0.00	0.98	11,813
Change in % Enrolled in Charter Schools	0.00	0.01	-0.07	0.21	11,813
Enrollment Grades 3-8 (ln)	6.42	1.39	2.04	12.96	11,838
Change in Enrollment Grades 3-8 (ln)	-0.00	0.03	-0.36	0.35	11,838
Average PP Expenditures (ln)	8.79	0.30	4.81	10.03	11,838
Change in PP Expenditures (ln)	0.02	0.02	-0.92	0.36	11,838
Student-Teacher Ratio in Average Student's School	15.31	9.44	3.68	688.79	11,813
Change in Student-Teacher Ratio in Average Student's School	0.04	2.91	-285.42	75.48	11,813
Exposure to Certified Teachers (Average Student)	0.98	0.05	0.10	1.26	11,813
Change in Exposure to Certified Teachers (Average Student)	-0.00	0.02	-0.32	0.17	11,813
Exposure to Novice Teachers (Average Student)	0.10	0.07	-0.56	1.07	11,813
Change in Exposure to Novice Teachers (Average Student)	0.00	0.02	-0.19	0.24	11,813
Exposure to Absent Teachers (Average Student)	0.24	0.15	-0.71	1.10	11,813
Change in Exposure to Absent Teachers (Average Student)	0.00	0.04	-0.27	0.38	11,813
% Poor Enrolled in Charter Schools	0.01	0.06	0.00	1.00	9,437
Change in % Poor Enrolled in Charter Schools	0.00	0.01	-0.08	0.11	9,437
Difference in the % Charter Enrollment (NonPoor-Poor)	0.00	0.04	-0.48	0.73	9,437
Change in Difference in % Charter (NonPoor-Poor)	0.00	0.01	-0.12	0.17	9,437
Student-Teacher Ratio in Average Poor Student's School	15.71	8.04	4.82	676.45	9,437
Change in Student-Teacher Ratio in Average Poor Student's School	0.02	2.99	-280.20	47.77	9,437
Difference in the Student-Teacher Ratio Poor-NonPoor	-0.16	2.76	-186.39	33.11	9,437
Change in the Difference in the Student-Teacher Ratio Poor-NonPoor	0.00	1.19	-80.38	78.99	9,437
Exposure to Certified Teachers (Poor)	0.98	0.05	0.10	1.24	9,437
Change in Exposure to Certified Teachers (Poor)	-0.00	0.02	-0.32	0.18	9,437
Difference in Exposure to Certified Teachers (NonPoor-Poor)	0.00	0.02	-0.45	0.74	9,437
Change in the Difference in Exposure to Certified Teachers (NonPoor-Poor)	-0.00	0.01	-0.15	0.32	9,437
Exposure to Novice Teachers (Poor)	0.10	0.07	-0.21	0.85	9,437
Change in Exposure to Novice Teachers (Poor)	0.00	0.02	-0.18	0.15	9,437
Difference in Exposure to Novice Teachers (Poor-NonPoor)	0.00	0.02	-0.46	0.55	9,437
Change in the Difference in Exposure to Novice Teachers (Poor-NonPoor)	0.00	0.01	-0.22	0.10	9,437
Exposure to Absent Teachers (Poor)	0.25	0.14	-0.65	1.13	9,437
Change in Exposure to Absent Teachers (Poor)	0.00	0.04	-0.25	0.27	9,437
Difference in Exposure to Absent Teachers (Poor-NonPoor)	0.00	0.02	-0.48	0.76	9,437
Change in the Difference in Exposure to Absent Teachers (Poor-NonPoor)	0.00	0.01	-0.23	0.20	9,437
% Black Enrolled in Charter Schools	0.03	0.09	0.00	0.95	3,960
Change in % Black Enrolled in Charter Schools	0.00	0.01	-0.08	0.12	3,960
Difference in the % Charter Enrollment (White-Black)	-0.00	0.06	-0.80	0.73	3,960
Change in Difference in % Charter Enrollment (White-Black)	0.00	0.01	-0.09	0.10	3,960
Student-Teacher Ratio in Average Black Student's School	16.44	11.30	8.43	627.08	3,960
Change in Student-Teacher Ratio in Average Black Student's School	0.02	4.37	-259.32	79.99	3,960
Difference in the Student-Teacher Ratio Black-White	-0.19	2.11	-101.34	47.32	3,960
Change in the Difference in the Student-Teacher Ratio Black-White	0.02	0.88	-8.79	42.89	3,960
Exposure to Certified Teachers (Black)	0.98	0.05	0.10	1.31	3,960
Change in Exposure to Certified Teachers (Black)	-0.00	0.02	-0.32	0.16	3,960
Difference in Exposure to Certified Teachers (White-Black)	0.00	0.02	-0.32	0.42	3,960
Change in the Difference in Exposure to Certified Teachers (White-Black)	-0.00	0.01	-0.16	0.08	3,960
Exposure to Novice Teachers (Black)	0.10	0.07	-0.06	0.71	3,960
Change in Exposure to Novice Teachers (Black)	0.00	0.02	-0.16	0.15	3,960
Difference in Exposure to Novice Teachers (Black-White)	0.00	0.02	-0.22	0.17	3,960
Change in the Difference in Exposure to Novice Teachers (Black-White)	0.00	0.01	-0.04	0.08	3,960
Exposure to Absent Teachers (Black)	0.29	0.13	-0.10	0.82	3,960
Change in Exposure to Absent Teachers (Black)	0.00	0.04	-0.22	0.15	3,960
Difference in Exposure to Absent Teachers (Black-White)	0.00	0.02	-0.32	0.34	3,960
Change in the Difference in Exposure to Absent Teachers (Black-White)	0.00	0.01	-0.07	0.19	3,960
% Hispanic Enrolled in Charter Schools	0.02	0.06	0.00	0.97	5,639
Change in % Hispanic Enrolled in Charter Schools	0.00	0.01	-0.08	0.15	5,639
Difference in the % Charter Enrollment (White-Hispanic)	0.01	0.04	-0.53	0.69	5,639
Change in Difference in % Charter Enrollment (White-Hispanic)	0.00	0.01	-0.05	0.11	5,639
Student-Teacher Ratio in Average Hispanic Student's School	16.38	5.86	8.44	262.79	5,639
Change in Student-Teacher Ratio in Average Hispanic Student's School	0.07	0.79	-15.41	34.98	5,639
Difference in the Student-Teacher Ratio Hispanic-White	-0.28	9.31	-692.64	18.79	5,639
Change in the Difference in the Student-Teacher Ratio Hispanic-White	0.05	3.94	-18.88	294.17	5,639
Exposure to Certified Teachers (Hispanic)	0.98	0.05	0.10	1.25	5,639
Change in Exposure to Certified Teachers (Hispanic)	-0.00	0.01	-0.23	0.17	5,639
Difference in Exposure to Certified Teachers (White-Hispanic)	-0.00	0.02	-0.31	0.65	5,639
Change in the Difference in Exposure to Certified Teachers (White-Hispanic)	-0.00	0.01	-0.26	0.10	5,639
Exposure to Novice Teachers (Hispanic)	0.10	0.07	-0.09	0.71	5,639
Change in Exposure to Novice Teachers (Hispanic)	0.00	0.02	-0.17	0.16	5,639
Difference in Exposure to Novice Teachers (Hispanic-White)	0.00	0.01	-0.20	0.15	5,639
Change in the Difference in Exposure to Novice Teachers (Hispanic-White)	0.00	0.00	-0.05	0.11	5,639
Exposure to Absent Teachers (Hispanic)	0.27	0.13	-0.62	1.12	5,639
Change in Exposure to Absent Teachers (Hispanic)	0.00	0.04	-0.27	0.36	5,639
Difference in Exposure to Absent Teachers (Hispanic-White)	0.00	0.02	-0.19	0.17	5,639
Change in the Difference in Exposure to Absent Teachers (Hispanic-White)	-0.00	0.01	-0.05	0.04	5,639

Appendix Table 2. Correlations Between Overall Trends and Trends in Achievement Disparities

	Overall Trend	NonPoor-Poor Trend	White-Black Trend	White-Hispanic Trend
Overall Trend	1			
NonPoor-Poor Trend	0.043	1		
White-Black Trend	0.080	0.316	1	
White-Hispanic Trend	0.098	0.303	0.374	1

Appendix Table 3. Accounting for Variation in the Overall Trend

	M1		M2		M3		M4	
Average Performance	0.014	***					0.018	***
	(0.001)						(0.001)	
Recession Index			0.002	***			0.001	***
			(0.000)				(0.000)	
Urban			-0.002	*			-0.002	
			(0.001)				(0.001)	
Rural			0.002	***			0.001	*
			(0.001)				(0.001)	
District SES			0.001				-0.000	
			(0.001)				(0.001)	
Change in District SES			0.013	***			0.008	**
			(0.002)				(0.002)	
% Poor Students			-0.012	***			-0.000	
			(0.002)				(0.003)	
Change in % Poor Students			-0.151	***			-0.132	***
			(0.018)				(0.018)	
% Asian Enrollment			0.040	***			0.043	***
			(0.006)				(0.006)	
Change in % Asian Enrollment			0.163				0.118	
			(0.113)				(0.111)	
% Black Enrollment			-0.003				0.005	**
			(0.002)				(0.002)	
Change in % Black Enrollment			-0.535	***			-0.625	***
			(0.068)				(0.067)	
% Hispanic Enrollment			0.011	***			0.016	***
			(0.001)				(0.001)	
Change in % Hispanic Enrollment			-0.491	***			-0.428	***
			(0.043)				(0.042)	
% Charter School Enrollment					-0.000		0.004	
					(0.005)		(0.005)	
Change in % Charter School Enrollment					0.086	*	0.095	*
					(0.041)		(0.039)	
Enrollment Grades 3-8 (ln)					0.000		-0.001	***
					(0.000)		(0.000)	
Change in Enrollment Grades 3-8 (ln)					0.018		-0.035	***
					(0.010)		(0.010)	
Average PP Expenditures (ln)					-0.009	***	-0.014	***
					(0.001)		(0.001)	
Change in PP Expenditures (ln)					0.075	***	0.044	***
					(0.011)		(0.011)	
Pupil-Teacher Ratio in Average Student's School					0.000	*	0.000	*
					(0.000)		(0.000)	
Change in Pupil-Teacher Ratio in Average Student's School					0.000		0.000	
					(0.000)		(0.000)	
% Teaching Staff with Certification (Average Student)					0.006		-0.008	
					(0.005)		(0.005)	
Change in % Teaching Staff with Certification (Average Student)					0.014		-0.008	
					(0.018)		(0.017)	
Exposure to Novice Teachers (Average Student)					-0.034	***	-0.021	***
					(0.004)		(0.004)	
Change in Exposure to Novice Teachers (Average Student)					-0.118	***	-0.082	***
					(0.013)		(0.012)	
Exposure to Absent Teachers (Average Student)					-0.015	***	-0.009	***
					(0.002)		(0.002)	
Change in Exposure to Absent Teachers (Average Student)					-0.040	***	-0.031	***
					(0.007)		(0.007)	
Constant	0.003	***	0.003	***	0.003	***	0.003	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Adj. R-squ	0.040		0.074		0.030		0.119	
Observations	11813		11813		11813		11813	

Notes: This table presents descriptive statistics showing the relationship between different predictors and the average annual change in achievement in standard deviations. All covariates are mean-centered. * p<0.05, ** p<0.01, *** p<0.001

Appendix Table 4. Adjusted R-squared values from models predicting variation in trends.

	Overall Trend	Adjusted Trend	NonPoor-Poor Gap Trend	White-Black Gap Trend	White-Hispanic Gap Trend
Average Achievement or Gap	3.95%	2.92%	0.52%	4.10%	0.71%
Demographic Covariates	7.40%	0.33%	2.05%	2.75%	2.04%
Segregation Covariates			2.74%	5.60%	4.40%
District/School Covariates	2.99%	3.16%	2.21%	6.13%	4.74%
All Covariates	11.87%	6.66%	5.28%	10.03%	6.65%
Observations	11,813	11,034	9,437	3,960	5,639

Notes: Full regression models in Table 2 (for subgroup models) and Online Supplement Table 2 (for overall trend model).