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Changes in the Performance of Students in Charter and District Sectors of U.S. Education: An Analysis of Nationwide Trends

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Abstract

We use a quadratic equation to estimate trends in cohort performances in the charter and district sectors on the National Assessment of Educational Progress in 4th and 8th grade between 2005 and 2017. Data consist of over four million test observations of nationally representative samples of students on seven separate math and reading tests. We estimate unadjusted trends as well as trends adjusted for changes in the demographic composition of the two sectors. Compared to district cohorts, we find steeper upward trends in mean charter performance. Larger sector differentials are observed for African Americans, low SES students, and for students in the Northeast. No significant trend differences are observed for Hispanic and Asian Americans, suburban students and for students in the West. Since students in the two sectors may differ in relevant ways for reasons unrelated to demographic characteristics, inferences about changes in school production factors remain uncertain.

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Introduction

Public education in the United States is divided into two sectors—school district and charter. Schools in both sectors receive most of their funding from governments at the local, state, and federal levels. District schools are governed by school boards or other official governing bodies, while charters are governed by nonprofit organizations authorized by a public agency. The district sector is by far the larger of the two, serving over 94% of all public-school students in 2017. But the charter sector grew from roughly 2% of all public enrollments in 2005 to about 6% in 2017, nearly a three-fold increase (U.S. Department of Education, 2020; Wang, Rathbun, & Musu, 2019).[1]

After 2016, the rate of growth of the charter sector slackened (Lake et al., 2018). Observers have attributed the slowdown to inadequate funding, limited access to appropriate facilities, and increased resistance to charter expansion by school districts, teacher unions and advocacy groups such as the NAACP (Barnum, 2017; Kahlenberg & Potter, 2014; Katayama, 2016; Lake et al., 2018; Moe, 2011; (NAACP, 2017). But the rate of growth could also be adversely affected if trends in student achievement at charter schools are not keeping pace with trends in the district sector. Conversely, the rising political opposition to charters could be a function of greater improvement within the charter sector, stoking fears that it could eventually disrupt district sector operations.

To see whether trends in student achievement at charter and district schools differ, we track changes in the performance of cohorts of a nationally representative sample of students on

[1] We do not discuss the private sector in this paper. The National Assessment of Educational Progress cannot require the participation of private schools in its assessments and it therefore does not have a representative sample of private schools.

seven tests in math and seven tests in reading administered by the National Assessment of Educational Progress (NAEP) to students in 4th and 8th grade between 2005 and 2017.

As its name implies, NAEP is a national report card that informs the public on the progress state and national cohorts of students are making over time. It is widely used to compare student performance across states and to ascertain whether each cohort is learning as much as or more than previous ones. The report card also contains information available to qualified researchers that can be used to estimate national progress in the district and charter sectors with adjustments for demographic characteristics. Our study is the first to make use of this information to assess charter and district progress separately. However, NAEP tests students on only one occasion, so we are unable to estimate student performance levels using a value-added methodology that adjusts for prior levels of student achievement.

We begin by briefly describing the charter sector and summarizing prior research on student achievement in the two sectors. We then describe our data, present our methods, report results, and discuss our findings.

Charters, Districts, and Student Achievement

The first charter school law was enacted in Minnesota in 1990. The law authorized the establishment of a new arrangement for school governance that combined features of the district and the private sectors. Forty-three states followed suit, though each state has its own set of provisions governing charter operations. To operate, a school must first receive a "charter" from a legislatively determined agent: school district, state department of education, mayoral office, state university, or other entity specifically given this authority. With important exceptions, charters, like district schools, must abide by the provisions of the state legal code, and they are

funded primarily by government revenues (Batdorff et al., 2015). But charters differ from district schools in that they are not operated directly by a government entity such as a school district. Instead, charters, like private schools, are operated by nonprofit organizations that have autonomy from certain provisions of a state's legal code. Some nonprofits contract out operational responsibility to a for-profit firm. Most choose their own curriculum and personnel free of numerous, though not all, state restrictions. Unlike many district schools, most charters have not signed collective bargaining agreements with their employees. They are typically funded by states (and, sometimes, districts) according to the size and composition of their enrollment, with extra funds usually available for students in need of special education.

Unlike most district schools, charters do not exclusively serve students living within a defined geographic area. Instead, they recruit students from the surrounding community according to rules that vary from one state to the next. If charters have difficulties persuading students to attend, they are at risk financially. If they receive more applicants than they can accommodate, they usually must admit applicants at random. However, not every applicant will accept admission when they are told the school's policies and procedures (Pondiscio, 2019). Many of the charters that have survived the rigors of building a new school have become quite popular with parents, who are more likely to report satisfaction with their child's school if they attend a school in the charter rather than one in the district sector (Cheng & Peterson, 2017).

But if many charters are popular with parents, it is the conventional wisdom within the research community that charters, on average, do no better than district schools at raising student achievement. Summarizing an extensive review of the literature, Cohodes (2018, p. 3) says, quite frankly, that "the evidence shows, on average, no difference [in achievement] between students who attend a charter and those who attend a traditional public school." There is one exception to

this generalization, she writes. “Urban charter schools serving minority and low-income students that use a no excuses curriculum” have “significant positive impacts on student outcomes (p. 3).” She notes that these “no excuses” schools are concentrated in Boston, New York City, and Washington, D.C., and perhaps some other urban areas. She also notes that the charters operated by the Knowledge Is Power Program (KIPP), a network of schools that follow a “no excuses” curriculum, “produces statistically significant positive test score effects (p. 7).”

In a meta-analysis of 47 charter studies, Betts and Tang (2019) are only slightly more positive in their assessment. Apart from students attending KIPP schools and those attending middle schools, the authors say, “the predicted gains in achievement from attending a charter school are small, typically 0.5 to one percentile point.” But if a student stays in a charter school for six to 12 years, Betts and Tang go on to observe, these small gains might become reasonably substantial. Their meta-analysis also shows that in middle school gains are somewhat higher, 2 percentile points in reading and 3 percentile points in math each year.

In a third review of the literature, Egalite (2020) says that high-quality studies have “revealed statistically significant, large, and educationally-meaningful achievement gains for lottery winners, with particularly dramatic gains observed for disadvantaged students, students of color, and English language learners.” But Egalite also notes that the Center for Research on Education Outcomes (CREDO), an organization that has cast its research net widely across many states, finds, on average, little difference between charter and district schools. However, CREDO shows more positive results for disadvantaged students, those in urban areas, and those in the Northeast, with smaller, if any, charter effects in the West (CREDO, 2013; Egalite, 2020).

Two prior studies that have looked at performance trends in the charter sector. The more extensive CREDO (2013) study compares charter students in sixteen states to students at nearby district schools who have similar demographic characteristics and prior test performance. The study finds relative improvement at charters for each year of the four-year period, 2009 to 2013. The study attributes most of the improvement to replacement of weaker charters by more effective ones. Baude et al. (2020) compare the value-added performances of students in Texas who switch to a charter school with those of students who remain in the original district school. The authors found that in the initial period charter school quality was, on average, lower than that of district schools. With time, the charter sector improved in relative effectiveness between 2001 and 2011. The authors attribute that finding to factors such as closure of lower quality charter schools, entry of higher-quality charters in subsequent years, and internal improvement by charter schools. Changes in the proficiency of students entering the charter sector account for a small portion of relative achievement gains.

In sum, reviews of the charter studies that analyze the two sectors at a single point in time do not find much difference between the charter and district sectors, on average, though they find considerable variation within the charter sector. The two trend studies find greater progress in charters relative to district schools, but the studies are either restricted in their geographic focus or track time trends over only a few years. We expand on this literature by describing and comparing nationwide trends in the charter and district over a twelve-year period.

Data

NAEP is the one reliable source readily available for the study of trends within the charter and district sectors. It administers standardized tests in math and reading to samples of students that are both nationally representative and representative of students in each of the 50 states.[2] Between 2005 and 2017, NAEP administered seven math and seven reading tests to students in the district and charter sectors. We report for the first time a 12-year trend in student performances on the seven math and seven reading tests in the charter and district sectors. Altogether, over four million tests were administered to district students, and approximately 140,000 tests were given to charter students (Appendix Table A).

NAEP's purpose is to ascertain periodically the levels of performance of cohorts of students in math, reading, and other subjects for each state and for the United States as a whole. The survey does not identify a specific performance with the name or identity of any student, teacher, school, or school district. In fact, no student takes the entire test. Instead, NAEP reports plausible values for overall performance on a test estimated from the sample of questions that were administered to a student. There is thus no incentive for a school or a district to excessively prepare their students for the test in order to maximize performances.

Despite the large number of test observations, NAEP does not conduct a census of student performance, which would require that all students be tested. Instead, it draws representative samples of schools and representative samples of 4th- and 8th-grade students within each of the sampled schools. If a school is unable or unwilling to participate, NAEP substitutes another school with a similar set of student backgrounds and other characteristics. If

[2] Our data come from what is called the Main NAEP to distinguish it from the Long-Term Trend (LTT) NAEP, which tracks achievement levels of nationally representative samples of student cohorts. Samples collected for the LTT NAEP are much smaller, and information on whether the student is attending a charter school is only available for 2008 and 2012. We refer to the "Main NAEP" simply by its acronym, NAEP.

the randomly chosen student at a school is unable or unwilling to participate, a comparable student is tested instead. The data are weighted to reflect the composition of the student population within each state.

The NAEP lens for viewing student achievement, though better than any other available for this purpose, is not the equivalent of a Hubble telescope. For one thing, we cannot be sure that the sample of charter students is nationally representative. Rather, the sample is drawn and weighted to be representative of the total 4th- and 8th-grade public-school population for each state and for the United States as a whole, not to be representative of each sector. To ascertain the representativeness of NAEP observations of charter school performance, we compare the characteristics of the NAEP sample to the characteristics of the census of schools and students conducted by the National Center for Education Statistics (NCES), the other authoritative source for education statistics in the United States. Instead of the sampling procedure used by NAEP, NCES conducts an annual census by asking states and local districts to respond to detailed questionnaires that ask about enrollments, finances, school personnel, and other factors. NCES has gradually introduced procedures that allow it to collect information about schools and students in the charter sector.

NCES, too, is a less-than-perfect data-collection instrument. The information NCES obtains is only as accurate as are the responses to its survey, which may include ambiguous questions open to alternative interpretations. For example, at one time it was not clear whether charter enrollments should be counted as part of district enrollments, whether they should be separately identified, or whether each charter school should be treated as a separate district. The variation in the legal framework for charters across states added to the confusion. Even now, the number of charter schools reported by NCES differs from the number reported by state agencies,

mainly because the definition of a school (as distinct from a campus that is part of another school) is not consistently applied. However, NCES figures for the number of students enrolled in charter schools are not seriously disputed.

Even if both data-collection systems were ideal, one would still expect to see differences between them. For one thing, NCES gathers information on enrollment as of October 15, while NAEP tests students later in the school year. Students may change schools in the meantime. More important, NCES obtains information on all enrolled students, while NCES administers its tests only to a representative sample of students in 4th and 8th grade. Unless the composition of students in these grades is identical to overall school enrollment at each level, the NCES and NAEP estimates of student characteristics will differ. That said, one still expects the NCES and the NAEP data to show similar trends and to be generally consistent with one another.

The overall trends in the NCES and NAEP data are broadly comparable (Table 1). The NCES reports that in 2006 the charter share was 2% of the elementary public-school population; by 2017, the share had expanded to 6%. The charter share of observations in the NAEP math and reading tests shows a similar trend. In 2005, the share of both 4th-grade and 8th-grade students was 1.5%.[3] By 2017, the percentage of 4th-grade students taking the tests had increased to 3.9% and the percentage of 8th-grade students had increased to 5.6%, somewhat higher than in the census of elementary schools..

NCES and NAEP also provide information on the ethnic composition of the charter and district sectors.[4] NCES shows a decline in the White share of the charter sector from 43% in

[3] For NAEP, we use the weighted number of observations.
[4] Both have information on participation in the free and reduced-price lunch program, but the data are reported in such different ways they preclude comparisons.

2001 to 36% in 2011 to 32% in 2018 (Table 1). The percentage of White 4th-grade students participating in NAEP tests shows a similar downward trend—from 42% in 2005 to 36% in 2011 to 34% in 2017. The White share of tested 8th-grade students declines from 39% in 2005 to 31% in 2011 and to 30% in 2017.

NCES reports that the Black share of charter-school elementary enrollment also declines from 33% in the spring of 2001 to 29% in 2011 to 26% in 2018. The Black share of tested 8th-grade students is higher, but it also falls from 37% in 2005 to 32% in 2011 and to 29% in 2017. The Black share of 4th graders in the NAEP testing data is also higher, but it trends up and down over time—from 34% in 2005 to 37% in 2011, then down to 32% in 2017.

NCES reports the Hispanic American share as climbing from 19% in 2001 to 27% in 2011 to 33% in 2018. The Hispanic American share of those tested by NAEP in 4th grade is lower, but it also increases from 19% to 21% between 2005 and 2011 and then to 26% in 2017. Among 8th graders, the Hispanic American share increases from 19% in 2005 to 31% in 2011, where it remains in 2017.[5]

The Asian American share in NCES was 3% in 2001, 3.7% in 2011, and it rose to 4.4% in 2018.[6] The Asian American share of those tested in 8th grade by NAEP climbs steadily upward from 2.8% to 6%. The trends for 4th-grade students show a minor increase from 3.2% to 4.4%.

In sum, both NCES and NAEP data indicate that the charter sector is predominantly non-White, and both show that the non-White share of the total has increased over the course of the 21st century. However, NAEP administers its math and reading tests to a higher percentage of

[5] Since we have no information on the citizenship of those tested, we refer to all participating students as Americans.
[6] We use Asian to identify Asian/Pacific Islander categories in NAEP and NCES.

Black students and a lower percentage of White American and Hispanic American students than NCES reports.

Discrepancies could be a function of a higher share of ethnic differences of students attending charters in 4th and 8th grade than in other grades. Or it could be due to differential procedures used to classify students into ethnic groups, as procedures for classifying students into Black or Hispanic or other categories may differ by district and are open to alternative interpretations. Or it could be that White Americans and Hispanic Americans are under-sampled in the NAEP achievement tests. Given these inconsistencies, it is important to look at trends within ethnic groups as well as the overall trend.

Methodology

Like NAEP, we focus on changes in cohorts of students from one assessment to the next in order to get a sense of the direction in which a sector is heading. In that respect, our study differs from earlier research that compares the relative effectiveness of the charter and district sectors at raising the achievement of individual students in specific places at particular points in time. That is not our purpose here. We do not observe the progress of any one student but rather the changes in performance of one student cohort to the next. We look at these cohort changes in both the district and charter sectors in order to see the trends occurring in each sector and to compare those trends to one another.

Our analysis, like other research on the two sectors, must attend to what is known as the selection problem, the fact that students choose whether to attend schools in the charter or district sector. Since each sector is self-selected, it is not easy to make apples-to-apples comparisons between them. If one sector attracts more proficient students than the other, differences in sector

performance may be due to differential recruitment rather than to any changes in the schools themselves. For example, the charter sector, as it grows, might be attracting an increasingly advantaged group of students. Or, conversely, charters may be attracting more students who are educationally challenged. Many charter schools admit students by a lottery, so it might be thought that there is no opportunity for the charter sector to become more or less selective over time. But lotteries take place only among those who apply to charter schools, and not every student who applies accepts admission. And some charter schools do not receive enough applicants to require a lottery.

Similarly, the demographic composition of the district sector can change both as the result of choices students are making and as the result of demographic change in society. For example, the Hispanic American and Asian American shares of the school-age population increased between 2005 and 2017, while the share of White Americans attending district schools declined. These demographic changes may affect performance levels.

We correct for such changes in the composition of the two sectors by adjusting or controlling for background characteristics known to be associated with student achievement, including a child's socioeconomic status (SES), ethnicity, and gender. We use such adjustments as a tool to ascertain how much progress in each sector may be due to demographic change as distinct from changes in school factors. However, we are unable to control for student test performances in previous years and therefore cannot employ a value-added model that has often been used to estimate charter effectiveness (CREDO, 2013.) We therefore cannot detect ways in which the charter sector might become increasingly selective other than by observing changes in the demographic characteristics of the two sectors. Our comparisons, while suggestive, cannot be

interpreted as definitive evidence that trends observed for either sector are due in part to heightened school quality.

We first report the mean test performance of initial 4th- and 8th-grade cohorts in reading and math in 2005. To equate results across tests, we use the standard deviation (sd) of these cohorts to calculate achievement means in sd for all NAEP math and reading assessments at grade 4 and grade 8 that are administered between 2005 and 2017.[7] We estimate trends in mean performances over time by calculating the distance (in sd) of the test-score distribution for each cohort's performances in each subject and grade level from the means of the initial observations in 2005, which are set to zero. The empirical models are analyzed separately for each grade and subject. In all estimations, we apply the weights NAEP uses to make samples state and nationally representative. Following Reardon (2011) and Hanushek et al. (2020), trends have been estimated with a quadratic function to allow for estimates of nonlinear change. We extract the performance trend of cohorts in math and reading for each year of test administered at each grade level with the following equations:

$$O_{sgi}^{t} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \varepsilon_{sgti}, \text{ where} \quad (1)$$

O is the achievement score for student i, by subject s, testing grade g, and cohort t; The parameters α_1 and α_2 describe the achievement trend, and ε is the error term.

When controls X are added the equation becomes

$$O_{sgi}^{t} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \beta_k X_i + \varepsilon_{sgti} \quad (2)$$

[7] As mentioned, NAEP estimates plausible values of overall test performance of individual students from their performance on the section administered to them. We use the second plausible value NAEP provides. Results are robust to estimating effects with averages of the first five plausible values.

where *X* includes dummies for ethnicity, gender, free and reduced-price lunch status at grades 4 and 8. For 8th-grade students, levels of parental education, computer availability in the home, and the number of books in the home are used as additional controls for student's socioeconomic status (SES). We divide the student into four quartiles of the SES distribution that is estimated by extracting the first principal component from a factor analysis based upon these same variables (Broer, Bai, & Fonseca, 2019; OECD, 2018).[8] We do not include special education or English Language Learner status as controls, because the two sectors may have different definitions of these concepts (Ackerman & Egalite, 2017; Setren, 2015; Winters, Carpenter, & Clayton, 2017). We use the fitted point estimate and standard errors of the start and end points for each model to estimate the overall changes and associated standard error (Feiveson, 1999; Gould, 1996; Oehlert, 1992; Philips & Park, 1988).[9]

All differences between student performance at charter and district schools for each subject at each grade level are assumed to be statistically significant if the differences in the point estimates for each trend exceed the joint standard errors of the two estimates. Other than to indicate a null effect, we do not interpret in the text differences that are not statistically significant.

Because the NAEP tests are linked by subsets of questions asked of students at both 4th and 8th grade, one can estimate the difference in standard deviations between the average performances of 4th- and 8th-grade students. The estimated average difference between 4th- and

[8] In the factor analysis, two variables are included. The first is parent education, which is based upon student reports as to whether the parent with the highest level of educational attainment 1) did not finish high school; 2) graduated from high school; 3) received education beyond high school; or 4) obtained a college degree. The second variable is an index that sums two variables: 1) whether or not a computer is in the home; and 2) a measure of the rank ordering of students' estimates of the number of books in their home (divided into the following four categories: 0–10, 11–25, 26–100, and >100). A separate factor analysis is performed for each assessment.

[9] The calculations are based on the delta method. This method calculates the variance, standard error, and Wald test statistic (z-test) from the nonlinear transformations of the estimated parameter vector from the fitted model.

8th-grade students on NAEP math and reading tests administered in 2005 and 2017 is 1.23 sd. Dividing that number by four yields 0.31 sd, the average amount of learning that takes place each year between grades 4 and 8. We use this metric to interpret observed differences in sd in years of learning. For example, the cohort gain of 8th grade in math for students in charter schools between 2005 and 2017 is 0.34 sd or slightly more than one year's worth of learning.

Because tests at 4th and 8th grade are designed to be on the same scale, we report averages for 4th- and 8th-grade math and reading tests combined, and many of the findings discussed in the text are for the average of the four tests given in the two subjects at both grade levels. We present the information in this way in order to reduce the number of specific results reported in the text to a manageable number. However, these averages mask a number of differences by both test and grade level. When adjusting for background characteristics, we control for parent education and home possessions only in the 8th-grade analyses, because NAEP does not ask 4th-grade students these questions. For more precise understanding of trends over time, the reader is encouraged to examine results more precisely in the tables that present the full set of results by subject and grade level.

Results

We first report average cohort performance levels on NAEP's math and reading assessments in 2005 for both the charter and district sectors. We next show the changes in the mean performance on these tests for all students in each sector both with and without controls for background characteristics. We then examine trends by ethnicity, SES, eligibility for free and reduced-price lunch, region, and locale.

NAEP achievement levels in 2005 and 2017

On average, district schools outperformed charter schools in 2005. In math, the average score for the cohort in 4th grade in district schools was 237 points (Table 2), 5 points or 0.15 standard deviations (sd) higher than the charter average. In reading, the charters trailed districts by 2 points. The district advantage in 8th-grade math in 2005 was 10 points or about 0.28 sd, and in reading it was 5 points. By 2017, most of these differences disappeared, or nearly so. At grade 4, charters still trailed districts by 3 points in math, but in reading they edged above districts by a point. At the 8th-grade level, charters also slipped ahead by a point in reading and secured a tie with districts, on average, in math.

Trends in mean cohort performance

We also observe a disproportionately positive trend for students at charter schools, as compared to those at district schools, when we estimate trends with information on performances on all seven of the NAEP math tests and all seven of the reading tests. As shown in Figure 1, the district trend in 8th-grade math rises modestly in the early portion of the period, only to recede more recently. In reading, the district trend rises, then flattens in the second half of the period. Charter gains in reading are quite linear and rise more steeply than those of students at district schools. The math performances of cohorts at charters rise even more steeply at first but flatten toward the end. It is difficult to interpret these uneven, disparate fluctuations, so in the analysis that follows we focus on the estimated change for the period overall.

The average performance of cohorts of students in the district sector improves modestly over the 2005-17 period. As can be seen in Table 3, the average combined gains in student performances in math and reading at grades 4 and 8 is 0.1 sd. The achievement of students at charter schools improves at a more rapid rate. Overall, the average combined gains for the two

subjects and grade levels is estimated to be 0.24 sd or 0.14 sd greater than the average district gain. Relative gains at charters, as compared to districts, are larger in 8th-grade math (0.24 sd) than in 8th-grade reading (0.11 sd). In 4th grade, the relative gains are 0.1 sd and 0.12 sd for the two subjects, respectively. When background characteristics are controlled, the average student gains for both grades at both levels are estimated to be 0.21 sd at district schools and 0.30 sd at charters, a difference of 0.09 sd or roughly two thirds the size of the uncontrolled estimate (Table 3).[10] That difference is somewhat larger at the 8th-grade level than at the 4th-grade level, a finding consistent with research that reports larger charter impacts in middle schools (Betts & Tang, 2019).

In sum, the upward trend appears to be steeper in the charter sector than in the district one. Roughly one third of the charter gain relative to district schools is attributable to changes in the observed characteristics of the district and charter populations, a suggestion that the charter sector is recruiting a more proficient set of students over time. The remaining two thirds of charters' relative gain could be due to differential changes in school production factors in the two sectors, though unobserved differences in student characteristics cannot be ruled out as an alternative explanation.

Ethnicity

[10]We conduct two robustness checks, which confirm our main analysis. First, we estimate mean effects without controlling for FRL. Results show relative gains of charter (compared to district) cohorts of 0.05 sd and 0.08 sd in 4th-grade math and reading, respectively. For 8th-grade cohorts, the numbers are 0.20 sd and 0.08 sd. Second, we estimate effects with controls for students identified as participating in special education and limited English proficiency programs. With these added controls, relative charter gains are 0.06 sd and 0.09 sd in 4th-grade math and reading, respectively. In 8th grade the relative gains are 0.16 sd and 0.07 sd.

To see whether cohort gains by districts and charters vary by ethnicity, we estimate changes in cohort achievement for four broad ethnic categories—African American, White American, Hispanic American, and Asian American.

African American. In 2005, the average performance of all African Americans who took the 4th-grade math test was the lowest of the four ethnic groups, over 0.93 sd less than the average performances of White Americans and 1.11 sd less than Asian Americans, differences similar to those reported elsewhere (Jencks & Phillips, 1998; Reardon, 2011; Magnuson & Waldfogel, 2008). In 8th grade, the Black-White disparity in math was even larger—1.2 sd. The Black-Asian gap was just as dramatic at the 8th-grade as at the 4th-grade level. In reading, these ethnic gaps were somewhat less—approximately 0.80 standard deviations. It was the size of these gaps that persuaded many states to establish charter schools as an alternative to traditional offerings in the district sector. Perhaps this is one reason African Americans remain the largest ethnic group attending schools in the charter sector. They constitute about 33% of the tested charter school populations between 2005 and 2017.

African Americans are also the ethnic group that shows the steepest increase in average cohort performance at charters, relative to the district sector between 2005 and 2017 (Table 4). In the district sector, the combined average gain by African Americans in both reading and math at both 4th- and 8th-grade levels is 0.14 sd. The gain is roughly the same at both grade levels. In the charter sector, the combined average gains by African American students are more than twice as large—0.33sd. The charter cohort gain in 8th-grade math is a very sizable 0.46 sd, four times larger than in the district sector. In reading it is 0.33 sd. At the 4th-grade level, the average gain for the two subjects is about 0.33 sd, nearly twice the gain in the district sector. Altogether, the

relative gains of the charter sector for the two grades and two subjects combined amount to 0.19 sd or about half a year's worth of additional learning for African American students.

These results do not necessarily show that the quality of schools attended by African Americans in the charter sector are improving at a more rapid rate than those in the district sector. It may be the case that African American students who attend charters are increasingly coming from backgrounds that leave them better prepared for school. To see whether there is observable evidence in our data set for such a shift, we control for family background characteristics. When this is done, we find a 0.17 sd relative improvement among cohorts of African American charter students (as compared to district ones), almost as large as gains of 0.19 sd observed in the uncontrolled estimations (Table 4). In other words, almost none of the gains in test-score performance can be explained by changes in the background characteristics of African American students attending charters. It is quite likely that charters induce a half year's greater improvement relative to district schools in African American achievement over this period, though unobserved changes in background characteristics might contribute to this result. Still, the trends observed here are consistent with studies that show sizable charter impacts on the performance of African American students. The average gains for this ethnic group appear to be generalizable beyond Boston, New York City, and Newark, where experimental studies of relative effectiveness have been undertaken (Cohodes et al, 2013; Dobbie & Fryer, 2013; Hoxby, Muraka, & Kang, 2009; Winters, 2020).

White Americans. White American students account for 35% of the 4th-grade and 32% of the 8th-grade charter school population tested by NAEP over the 12-year period. Steeper gains for cohorts of students at charter schools, relative to those at district schools, are detected (Table 4).

In district schools, the combined average gain in math and reading in 4th and 8th grade between 2005 and 2017 by cohorts of White students comes to 0.1 sd. When adjusted for changes in background characteristics, the change is 0.18 sd. The unadjusted combined average gains over the same period in the same grades and subjects by cohorts of Whites in the charter sector come to 0.22 sd, over twice the 0.10 sd gains observed in the district sector. When adjusted for background characteristics, these gains remain intact (0.24 sd). Relative to the district sector, charter improvement among White Americans in 4th and 8th grade in both subjects combined amounts to 0.12 sd. Half of that gain (0.06 sd) persists after controlling for student background. From this it may be inferred that the differential progress by cohorts of White students at charters is due almost equally to demographic changes and to school production factors, assuming controls for background characteristics capture all selection effects. Note that differential changes that might be attributed to school production factors cannot account for any more than 0.06 standard deviations of the gain for White Americans, little more than a third the size for African Americans (0.17 sd.)

In sum, our findings are consistent with prior research showing fewer achievement benefits in the charter sector for White Americans than for African Americans (CREDO, 2013; Cohodes, 2018). We nonetheless see evidence of improvement in relative school quality within the charter sector for White Americans.

Hispanic Americans. Hispanic American students comprise 24% of charter students tested in 4th grade and 30% of those tested in 8th grade. In contrast to the results for Black students and White students, we find no clear difference in the trends in performance in the district and charter sectors between 2005 and 2017 (Table 4). The average combined performance of Hispanic students in both 4th and 8th grade rose by 0.21sd in both sectors. These

strong gains persist after controlling for background characteristics, emerging as one of the most notable aspects of U.S. education over this time period.

Asian Americans. Much the same can be said for Asian Americans, the smallest ethnic group within the charter sector. They comprised only 4% of the 4th-grade charter students and 5% of the 8th-grade charter students. The advances in performance are higher for this segment of all tested students in both district and charter sector than for the three larger groups (Table 4). Average gains are about a third of a standard deviation, or roughly a year's worth of learning, in both district and charter sectors. Those gains remain essentially unchanged after controlling for background characteristics. There is little difference in changes in performances between the charter and district sectors.

Summary. In sum, the test performances of cohorts of African American and White American students in charters advanced at a steeper rate than cohorts of students in district schools between 2005 and 2017. Among African American students, the cohort gains in charter schools appear to be due mainly to changes in school production factors, while the gains registered by White cohorts appear to be due to both demographic change and school factors. Hispanic Americans are advancing steadily in both sectors, and Asian Americans are leading the way in both sectors, with little difference between them.

Socioeconomic status

Due to data limitations discussed above, we estimate trends in cohort performance by quartiles of the SES distribution only for students in 8th grade. The performance of cohorts of district students in the top SES quartile trends upward by 0.02 sd. in math and 0.09 sd in reading.

(Table 5). When other background characteristics are controlled, the shift upward is slightly steeper—0.4 and 0.13 in the two subjects, respectively. The performance of cohorts of students in the top SES quartile who attend charters climbs at the more rapid rate of 0.27 sd in math and 0.21 sd in reading over the period. The magnitude of the trend at charters remains unchanged when adjustments are made for background characteristics (0.21 sd and 0.22 sd, respectively). Taking the two-subject average, cohorts of charter 8th-grade students in the highest SES quartile are showing a greater gain of 0.13 sd than cohorts of district students.

The differentials between the two sectors are greater for 8th-grade students in the bottom quartile of the SES distribution. In the district sector, the students in the lowest SES quartile climb upward by 0.21 sd in math and 0.24 sd in reading, a larger gain than for the top quartile, which suggests that a modest closing of the SES achievement gap is taking place. At charters, the vertical tilt among the lowest quartile is more precipitous—0.48 sd in math and 0.31 in reading. Estimates are not altered materially when background controls are introduced. When the two subjects are combined, the differential in the trends between the two sectors are 0.17 sd., approximately one-half year's worth of learning. The results are consistent with prior research that shows more positive charter effects for less advantaged students (CREDO, 2013).

Income (eligibility for free or reduced-price lunch)

Charter students are more likely to qualify for free and reduced-price lunch status than their counterparts at district schools (U.S. Department of Education, 2018). In the analysis of trends in average cohort performance, we control for student eligibility for participation in the

free or reduced-price lunch program (FRL), as eligibility depends mainly on a student's household income. But the indicator is not without its hazards, especially for trend analyses (Chingos, 2016; Domina et al., 2018). Between 2005 and 2017, eligibility for the subsidy was broadened to include those with higher incomes, and, in recent years, all students in some school districts with a high incidence of poverty were declared eligible. As a result, changes in student performance for both those eligible and ineligible for FRL are not consistent over time. Instead, those not eligible for the government subsidy are steadily becoming a more income-exclusive segment of the population. Likewise, a broader income group is becoming eligible for assistance as time goes by. Because our findings may be contaminated by changes in eligibility rules, we place less weight on these results than on the others we report.

Among students from the higher income (FRL ineligible) families, cohorts in district schools performed 0.24 sd higher in 2017 than in 2005 on the combined reading and math tests administered in 4th and 8th grade (Table 6). In charters, the gain was 0.35 sd. over this period, a modest 0.11 difference. Among those of lower income who were eligible for FRL, the average gain was 0.16 sd in districts and 0.31 sd in charters, a difference of 0.15 sd.

Given the changing definitions of eligibility for participation in the FRL program over this period, these results should be interpreted cautiously.

Region

To see whether charter improvement rates vary by regions of the country, we divide the United States into four regions, as defined by the U.S. Census—Northeast, Midwest, South, and West. We find the largest cohort improvements at charters, relative to district schools, in the

Northeast, somewhat less differential cohort gains at charters in the Midwest and the South, and little or no difference in the cohort gains at district and charter schools in the West.

Northeast. In the northeastern region, cohorts of students in district schools improved, on average, by only 0.05 sd over the period on the combined math and reading tests at the two grade levels (Table 7). At charters, cohorts scored, on average, 0.19 sd higher in 2017 than in 2005 on the two tests at the two grade levels.

The differences are considerably larger when changes in student background are taken into account. When that adjustment is made, performance improvement by charter cohorts in the Northeast comes to 0.38 sd, a gain of over a year's worth of learning. That is considerably larger than the 0.13 sd higher rate of improvement evident in district schools of the Northeast when estimates are adjusted for background characteristics. The difference between the two sectors amounts to 0.24 sd or about two thirds of a year's worth of learning. The adjusted relative gains at charter schools are larger for 8th-grade students than for the 4th-grade students.

Midwest. In the Midwest, combined average gains in performance of cohorts of charter students in 4th and 8th grade is estimated to be 0.25 sd, as compared to 0.08 sd in the district sector (Table 7). After adjusting for changes in background characteristics, charter gains remain essentially unaltered (0.28 sd), suggesting that most of the charter gains are likely due to elevated school quality, not to the selectivity with which students are recruited to the charters. District schools register a gain of 0.17 sd once adjustments are made for changes in student background characteristics.

South. The pattern of results in the South resembles that in the Midwest. The combined performance of charter students in 4th- and 8th-grade math and reading improve by an average

of 0.19 sd. When adjusted for background characteristics, the estimate of student performance improvement (0.25) is somewhat higher, an indication that the gains may be due to enhanced school quality. However, there are only modest charter gains of 0.07 relative to district schools in the South, which show an improvement of 0.19 sd in both subjects at both grade levels after adjustments for background characteristics. In other words, the district schools in the South show larger gains than in either the Northeast or Midwest, but southern charters nonetheless improve at a marginally higher rate.

West. When statistically adjusted for background characteristics, district schools in the West show average gains of 0.28 in student performance in math and reading at both grade levels, higher than in any other region of the country. When the same statistical adjustments are made for students attending charter schools, the gains in the West are 0.25, just short of those registered in the district sector.

Although our findings are tracking trends over time, they are broadly consistent with studies of charters at single points in time, which also show the most clearly positive impacts of charters on students living in the Northeast (Cohodes et al, 2013; Dobbie & Fryer, 2013; Hoxby, Muraka, & Kang, 2009; Winters, 2020). Other studies show neutral to negative results in the West (CREDO, 2009; 2014).

Locale

NAEP allows for the analysis of changes in student performance by the type of community in which a school is located. Since the locale variable in NAEP is consistent with U.S. Bureau of the Census definitions of localities only since 2007, we track these trends over a

10-year rather than a 12-year period. Cities are defined as the principal city within any urbanized area. Suburban areas are those communities outside the principal city within an urbanized area. Small towns and rural areas do not lie within an urbanized area or an urban cluster. We find larger relative gains for students in charters located in cities than for those in suburban charters (Table 8).

Cities. Charters are primarily an urban phenomenon. Sixty-five percent of charter students tested by NAEP attend schools located in cities at the core of urban areas. Between 2007 and 2017, the combined improvement in both subjects and at both grade levels of students attending urban schools in the charter sector, relative to those in the district sector, is, on average, 0.15 sd. When background characteristics are controlled, relative charter gains are just 0.08 sd, which may imply that half the gains are due to greater selectivity in the charter sector and half to elevated school quality.

Suburbs. Twenty percent of the tested students live in suburbs, communities outside the core of urban areas. In these suburbs, combined relative gains at charters over the period were 0.08 sd in both subjects and grade levels, but once background characteristics are controlled, no differences are observed when subjects and grade levels are combined. But there is a sharp contrast by grade level in suburbia. The upward trend for charter students is less than the one for district students at the 4th-grade level, but the opposite is true at the 8th-grade level when demographic controls are introduced. This result may be due to the better controls for SES available for 8th-grade students. But it may also be due to differential school quality in the two sectors at the two grade levels.

Towns and rural areas. Only 12% of the students tested by NAEP live in towns and rural areas outside urbanized areas. While public opinion polls show more limited support for charter

in rural areas than in urban areas (Shakeel & Henderson, 2019), the scholarly data on student performance at rural charter schools are thin. Given the limited number of NAEP observations for student performance at charters in towns and rural areas, we cannot fill in this gap.

Summary. The inconsistent results for students at suburban schools resemble the neutral to negative findings reported by impact research (CREDO, 2013; Gleason et al., 2010). However, the trends for charters in urban areas are less than might be expected, given the charter impacts for urban charters in some prior research (Abdulkadiroğlu et al., 2017; Angrist et al., 2013).

Discussion

In this, the first comparative assessment of changes in student achievement of cohorts of students within the charter and district school sectors between 2005 and 2017, we find that in both sectors average cohort performances in math and reading in 4th and 8th grade improve over the period. However, the gains by cohorts of charter students are approximately twice as large as those registered by cohorts in the district sector. About one third of this difference can be explained by changes in the background characteristics of students within each sector, a signal perhaps that charters strengthened their capacity to recruit more proficient students. The other two thirds of the difference in trend lines for the two sectors may tentatively be attributed to enhanced charter performance relative to that of district schools if one assumes that changes in student composition are fully captured by changes in demographic characteristics. Our finding is consistent with a Texas study and a 16-state CREDO study, both of which identify relative school productivity gains in the charter sector, which are attributed largely to replacement of weaker charters with more productive ones (Baude et al., 2020; CREDO, 2013).

Our study is limited in several ways. Although we adjust for student demographic characteristics when estimating sector effects, we are unable to control for prior student achievement. Further, we are unable to identify the moderating impacts of specific factors on trends in the charter sector, such as school size, teacher-pupil ratio, per pupil expenditure, years of operation, type of charter authorizer, charter sector experience within a state, share of charters in networks (rather than a standalone operation) or a host of other potential moderating variables. Those worthy topics we leave for further research.

We nonetheless conclude that the rate of relative improvement in the charter sector is likely due both to increasing selectivity and to enhanced charter performance is consistent with expectations. A sector would not become increasingly attractive to a better-prepared clientele if it was not improving its offerings. Consider transistor radios and television sets, the classic examples of a disruptive innovation (Christensen et al., 2011). Initially, the product was of low quality, and the clientele consisted largely of those who perceived no reasonable alternative. As product developers enhanced the devices, their market share increased and broadened to include more prosperous customers, eventually driving the makers of the vacuum tube devices out of business. The dynamics of the education market can be expected to take much longer than the transistor market, since it is a less competitive market. But selectivity and quality are likely to reinforce one another. Certainly, one would not expect the charter sector to become increasingly selective if the quality of educational services were declining.

The more rapid rate of progress by student cohorts in the charter than in the district sector may help to explain rising opposition to charters by school districts, district superintendents, and district teacher organizations. When a sector of the economy begins to lose market share, those working within the sector typically seek government action to curb losses. As the automobile

industry in the United States lost market share to rapidly improving companies abroad, demands for tariffs and trade restrictions escalated. Much the same may be happening in contemporary school politics.

The relative rate of improvement at charters as compared to district schools is greatest for cohorts of African American students. Our results are thus consistent with experimental studies, which have generally found strong positive effects on African American students (Abdulkadiroğlu et al., 2011; Cohodes et al, 2013; Curto & Fryer, 2014; Dobbie & Fryer, 2013; Hoxby, Muraka, & Kang, 2009; Winters, 2020).

We also find gains over time for cohorts of White American students. Although the gains are less than those for Black cohorts, the finding points in a different direction than results from prior research, which generally find neutral to negative charter effects on White students (CREDO, 2013; Gleason et al., 2010). We see no relative improvement in cohort progress in the charter sector for Hispanic Americans and Asian Americans.

Cohort gains at charter schools relative to district schools is substantially higher for students from the lowest SES quartile of the distribution than for those from higher SES quartiles. This finding is generally consistent with research on charter effects, which for the most part report more positive results for disadvantaged students than for those from higher SES backgrounds (CREDO; 2015; Walters, 2018).

Charters enjoy the largest relative advantage among students attending schools in the Northeast, a finding consistent with a large number of experimental studies that find positive charter impacts on students in New York City, Boston, Newark, and Washington, D.C. (Abdulkadiroğlu et al., 2011; Cohodes et al, 2013; Curto & Fryer, 2014; Dobbie & Fryer, 2013;

Hoxby, Muraka, & Kang, 2009; Winters, 2020). We find a smaller but still positive relative advantage in the rate of improvement in the Midwest and South but no difference in improvement rates between the two sectors in the West. The last finding is consistent with the quite mixed set of findings from studies of charters in the mountain and Pacific Coast states (CREDO, 2009; 2014).

The regional variation in improvement gains is difficult to reconcile with the slow growth of charter schools in the Northeast and the continued quite rapid growth in the mountain states of the West (Cheng & Peterson, 2017). It appears that charters are expanding the most where they have the least to offer, and vice versa. The irony may once again be explained by the differential threat charters pose to district schools in various parts of the country. Where charters are improving at a more rapid rate than district schools, the districts are more likely to mobilize their considerable political resources in opposition. But where charters are improving at a rate that poses less of a threat to the district sector, charter expansion is ignored by the district sector, especially if student enrollment is rising more generally.

Sixty-five percent of charter students are enrolled in schools located within big cities. Here we find steady gains by students in charters relative to district schools. Meanwhile, differences between charter and district schools in suburbia are smaller and inconsistent, depending on grade level. Those findings resemble results from prior research, which generally finds more positive charter impacts in urban than in suburban areas (Abdulkadiroğlu et al., 2017; Angrist et al., 2010, 2012; 2013).

Given the rising achievement levels at charter schools, it is unlikely that the slowdown in the sector's growth rate is due to declining productivity. It is more likely that political resistance to charters is increasing as both the management and labor sides of the district sector become

increasingly concerned that charters might prove to be as disruptive an innovation as the transistor.

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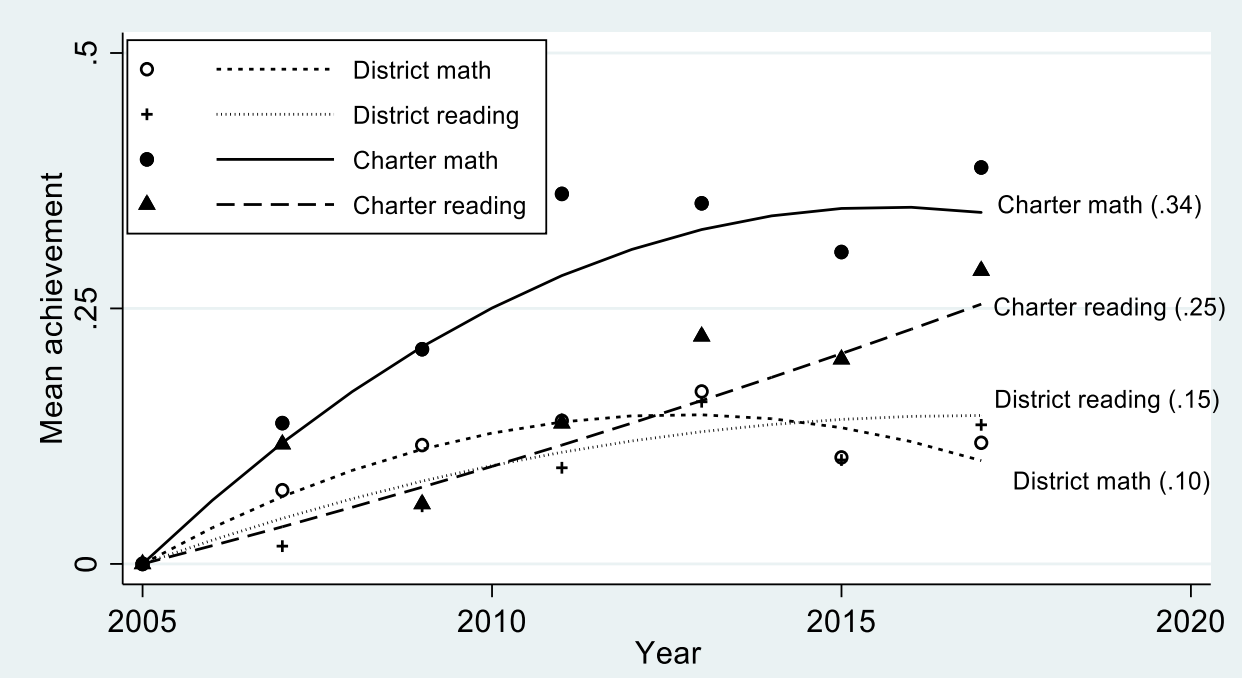

Figure 1. Estimated changes in average student performance on NAEP by school sector and subject, grade 8: Years 2005–17

Note. Estimated changes in student performance are differences in standard deviations (sd) between mean performance level in year test was administered and initial test year, which is set at zero. The lines represent a quadratic fit. Magnitude of the estimated change in average performance is displayed in parentheses at end of each line. Estimated mean performance level for each year is indicated by notation displayed in legend.

SOURCE: U.S. Department of Education, National Center for Education Statistics, 2005–2017 Main NAEP.

Table 1. Share of enrollment in charter sector in NAEP and NCES

Ethnicity	Survey	Grade	2001	2005	2006	2007	2009	2011	2013	2015	2017	2018
All	NCES				2.1			3.6	4.6	5.4	6	
	NAEP	4		1.6		2.1	2.4	2.9	4	4.8	3.9	
		8		1.5		1.8	2.7	2.9	3.6	5.3	5.6	
Black	NCES		33.2					28.9				25.8
	NAEP	4		33.9		38	38.6	37.2	34.9	27.7	31.9	
		8		36.7		36.6	28	31.9	33.3	27.2	28.6	
White	NCES		42.7					36.2				32.1
	NAEP	4		42		38.7	33.7	36.3	30.9	37.1	34.4	
		8		38.9		34.7	34.1	31.2	30.4	29.9	30.3	
Hispanic	NCES		19.4					27.3				33.1
	NAEP	4		19.1		17.8	23	21.1	26.3	28.6	25.6	
		8		18.7		22.5	31.5	31.1	29.1	34.7	32.1	
Asian	NCES		2.9					3.7				4.4
	NAEP	4		3.2		2.7	3.1	3.2	4.2	4.3	4.4	
		8		2.8		3.7	3.7	3.9	4.7	5.2	6	

Note: The table displays share of enrollment in percentage in charter sector as a proportion of public sector in NAEP and NCES. NAEP estimates use survey weights. NCES data combine elementary and secondary grades.

Sources: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," 2000–01 and 2017–18. See *Digest of Education Statistics 2019,* table 216.30., See *Digest of Education Statistics 2014, 2015, 2016, 2017, 2018,* and *2019,* table 216.20., and 2005-17 Main NAEP.

Table 2. NAEP scale scores by school sector

		2005				2017			
Grade	Subject	District	Charter	Difference	(sd)	District	Charter	Difference	(sd)
4	Math	237	232	5*	0.15	239	236	3	0.09
		(29)	(29)	(29)		(32)	(32)	(32)	
	Reading	217	216	2	0.06	221	222	-1	-0.03
		(36)	(36)	(36)		(38)	(37)	(38)	
8	Math	278	268	10**	0.28	282	282	0	0
		(36)	(37)	(36)		(39)	(39)	(39)	
	Reading	260	255	5*	0.14	265	266	-1	-0.03
		(35)	(36)	(35)		(36)	(35)	(36)	

Note: Difference displays the district sector advantage in achievement over charter sector. Standard deviations are in parentheses. Columns headed by sd display the district sector advantage in standard deviations. It was estimated by dividing the district sector advantage by the average standard deviation of sectors and subjects for each year and grade. *p <0.05, **p<0.01, ***p<0.001.

Source: U.S. Department of Education, National Center for Education Statistics, 2005-2017 Main NAEP.

Table 3. Estimated changes in average student performance on NAEP, 2005–17, by sector (in standard deviations)

Grade	Subject	District	Charter	Difference	District	Charter	Difference
4	Math	0.076	0.172	0.096	0.169	0.214	0.045
		(0.003)	(0.019)		(0.003)	(0.018)	
	Reading	0.084	0.209	0.125	0.189	0.262	0.073
		(0.003)	(0.018)		(0.003)	(0.018)	
8	Math	0.101	0.344	0.243	0.218	0.415	0.197
		(0.003)	(0.018)		(0.003)	(0.019)	
	Reading	0.145	0.254	0.109	0.267	0.327	0.060
		(0.003)	(0.018)		(0.003)	(0.018)	
	Average	0.102	0.245	0.143	0.211	0.305	0.094
	Controls	No	No	No	Yes	Yes	Yes

Note: The table displays mean cohort change in student performance in standard deviations (s.d.) by subject, grade, and sector between 2005 and 2017. The s.d. is the estimated change over the period 2005–17. Estimates are obtained from a quadratic fit. Standard errors are in parentheses. The two rightmost columns report the difference between changes in achievement in charter and district sectors. Models with controls include dummies for gender, eligiblity for free and reduced-price lunch, and for those in 8th grade, the socioeconomic status of student background.
Source: U.S. Department of Education, National Center for Education Statistics, 2005-17 Main NAEP.

Table 4. Estimated changes in average student performance on NAEP, 2005–17, by sector and ethnicity (in standard deviations)

Grade	Subject	District	Charter	Difference	District	Charter	Difference
African American							
4	Math	0.12	0.265	0.145	0.179	0.317	0.138
		(0.007)	(0.030)		(0.007)	(0.030)	
	Reading	0.156	0.277	0.121	0.212	0.328	0.116
		(0.007)	(0.030)		(0.007)	(0.030)	
8	Math	0.113	0.462	0.349	0.22	0.518	0.298
		(0.007)	(0.029)		(0.008)	(0.030)	
	Reading	0.177	0.327	0.150	0.298	0.423	0.125
		(0.007)	(0.027)		(0.007)	(0.028)	
	Average	0.142	0.333	0.191	0.227	0.397	0.169
White American							
4	Math	0.076	0.082	0.006	0.164	0.144	-0.020
		(0.004)	(0.032)		(0.004)	(0.033)	
	Reading	0.099	0.187	0.088	0.184	0.236	0.052
		(0.004)	(0.031)		(0.004)	(0.032)	
8	Math	0.1	0.375	0.275	0.161	0.353	0.192
		(0.004)	(0.033)		(0.003)	(0.036)	
	Reading	0.139	0.242	0.103	0.208	0.237	0.029
		(0.004)	(0.032)		(0.004)	(0.034)	
	Average	0.104	0.222	0.118	0.179	0.243	0.063
	Controls	No	No	No	Yes	Yes	Yes

Table 4 (Cont'd). Estimated changes in average student performance on the NAEP, 2005–17, by sector and ethnicity (in standard deviations)

Grade	Subject	District	Charter	Difference	District	Charter	Difference
Hispanic American							
4	Math	0.173	0.195	0.022	0.193	0.236	0.043
		(0.007)	(0.047)		(0.007)	(0.047)	
	Reading	0.166	0.227	0.061	0.196	0.296	0.100
		(0.007)	(0.042)		(0.007)	(0.041)	
8	Math	0.225	0.171	-0.054	0.264	0.203	-0.061
		(0.007)	(0.042)		(0.008)	(0.046)	
	Reading	0.291	0.264	-0.027	0.332	0.267	-0.065
		(0.007)	(0.042)		(0.008)	(0.045)	
	Average	0.214	0.214	0.001	0.246	0.251	0.004
Asian American							
4	Math	0.238	0.305	0.067	0.268	0.397	0.129
		(0.013)	(0.099)		(0.013)	(0.102)	
	Reading	0.276	0.224	-0.052	0.319	0.265	-0.054
		(0.013)	(0.107)		(0.012)	(0.107)	
8	Math	0.398	0.476	0.078	0.451	0.521	0.070
		(0.014)	(0.090)		(0.014)	(0.084)	
	Reading	0.352	0.324	-0.028	0.423	0.262	-0.161
		(0.014)	(0.089)		(0.014)	(0.089)	
	Average	0.316	0.332	0.016	0.365	0.361	-0.004
	Controls	No	No	No	Yes	Yes	Yes

Note and Source: See Table 3.

Table 5. Estimated changes in student performance on NAEP, 2005–17, by sector and SES, grade 8

SES quartile	Subject	District	Charter	Difference	District	Charter	Difference
Top	Math	0.017	0.274	0.257	0.045	0.212	0.167
		(0.006)	(0.038)		(0.006)	(0.036)	
	Reading	0.092	0.212	0.120	0.132	0.220	0.088
		(0.006)	(0.037)		(0.006)	(0.036)	
	Average	0.055	0.243	0.189	0.089	0.216	0.128
Second	Math	0.007	0.338	0.331	0.043	0.273	0.230
		(0.007)	(0.045)		(0.007)	(0.043)	
	Reading	0.079	0.165	0.086	0.106	0.139	0.033
		(0.007)	(0.045)		(0.007)	(0.044)	
	Average	0.043	0.252	0.209	0.075	0.206	0.132
Third	Math	0.073	0.282	0.209	0.087	0.286	0.199
		(0.009)	(0.057)		(0.008)	(0.053)	
	Reading	0.108	0.166	0.058	0.130	0.180	0.050
		(0.009)	(0.053)		(0.008)	(0.049)	
	Average	0.091	0.224	0.134	0.109	0.233	0.125
Bottom	Math	0.212	0.483	0.271	0.211	0.490	0.279
		(0.005)	(0.034)		(0.005)	(0.032)	
	Reading	0.245	0.310	0.065	0.238	0.311	0.073
		(0.005)	(0.032)		(0.005)	(0.030)	
	Average	0.229	0.397	0.168	0.225	0.401	0.176
	Controls	No	No	No	Yes	Yes	Yes

Note and Source: See Table 3.

Table 6. Estimated changes in average student performance on NAEP, 2005–17, by sector and free and reduced-price lunch (FRL) status (in standard deviations)

Grade	Subject	District	Charter	Difference
High income (Ineligible for FRL)				
4	Math	0.231	0.231	0.000
		(0.004)	(0.029)	
	Reading	0.217	0.281	0.064
		(0.004)	(0.028)	
8	Math	0.246	0.529	0.283
		(0.004)	(0.029)	
	Reading	0.259	0.345	0.086
		(0.004)	(0.028)	
	Average	0.238	0.347	0.108
Low income (Eligible for FRL)				
4	Math	0.123	0.26	0.137
		(0.004)	(0.026)	
	Reading	0.153	0.268	0.115
		(0.004)	(0.026)	
8	Math	0.157	0.35	0.193
		(0.004)	(0.025)	
	Reading	0.215	0.358	0.143
		(0.004)	(0.025)	
	Average	0.162	0.309	0.147

Note and Source: See Table 3.

Table 7. Estimated changes in average student performance on NAEP, 2005–17, by region and sector (in standard deviations)

Region	Grade	Subject	District	Charter	Difference	District	Charter	Difference
Northeast	4	Math	-0.039	0.173	0.212	0.037	0.289	0.252
			(0.007)	(0.057)		(0.006)	(0.055)	
		Reading	0.048	0.087	0.039	0.129	0.263	0.134
			(0.007)	(0.064)		(0.006)	(0.062)	
	8	Math	0.104	0.423	0.319	0.172	0.566	0.394
			(0.007)	(0.062)		(0.007)	(0.065)	
		Reading	0.089	0.084	-0.005	0.195	0.389	0.194
			(0.007)	(0.067)		(0.007)	(0.072)	
		Average	0.051	0.192	0.141	0.133	0.377	0.244
Midwest	4	Math	0.068	0.177	0.109	0.149	0.147	-0.002
			(0.006)	(0.041)		(0.005)	(0.038)	
		Reading	0.047	0.202	0.155	0.14	0.191	0.051
			(0.006)	(0.040)		(0.006)	(0.037)	
	8	Math	0.096	0.412	0.316	0.172	0.495	0.323
			(0.006)	(0.046)		(0.006)	(0.044)	
		Reading	0.11	0.225	0.115	0.196	0.278	0.082
			(0.006)	(0.041)		(0.006)	(0.039)	
		Average	0.080	0.254	0.174	0.164	0.278	0.114
South	4	Math	0.125	0.125	0.000	0.195	0.217	0.022
			(0.005)	(0.033)		(0.004)	(0.030)	
		Reading	0.088	0.188	0.100	0.186	0.273	0.087
			(0.005)	(0.032)		(0.004)	(0.030)	
	8	Math	0.071	0.278	0.207	0.153	0.256	0.103
			(0.005)	(0.026)		(0.005)	(0.025)	
		Reading	0.128	0.172	0.044	0.215	0.264	0.049
			(0.005)	(0.025)		(0.005)	(0.024)	
		Average	0.103	0.191	0.088	0.187	0.253	0.065
West	4	Math	0.091	0.082	-0.009	0.194	0.153	-0.041
			(0.006)	(0.036)		(0.005)	(0.035)	
		Reading	0.146	0.183	0.037	0.246	0.272	0.026
			(0.006)	(0.033)		(0.005)	(0.033)	
	8	Math	0.168	0.218	0.050	0.278	0.258	-0.020
			(0.006)	(0.035)		(0.006)	(0.037)	
		Reading	0.262	0.294	0.032	0.38	0.302	-0.078
			(0.006)	(0.034)		(0.006)	(0.036)	
		Average	0.167	0.194	0.028	0.275	0.246	-0.028
		Controls	No	No	No	Yes	Yes	Yes

Note and Source: See Table 3.

Table 8. Estimated changes in average student performance on NAEP, 2007–17, by sector and locale (in standard deviations)

Locale	Grade	Subject	District	Charter	Difference	District	Charter	Difference
City	4	Math	0.03	0.258	0.228	0.075	0.221	0.146
			(0.005)	(0.025)		(0.005)	(0.024)	
		Reading	0.059	0.342	0.283	0.121	0.318	0.197
			(0.005)	(0.023)		(0.005)	(0.022)	
	8	Math	0.081	0.17	0.089	0.132	0.163	0.031
			(0.006)	(0.021)		(0.005)	(0.021)	
		Reading	0.165	0.167	0.002	0.23	0.158	-0.072
			(0.005)	(0.022)		(0.005)	(0.021)	
		Average	0.084	0.234	0.151	0.140	0.215	0.076
Suburb	4	Math	0.014	-0.011	-0.025	0.117	0.019	-0.098
			(0.006)	(0.038)		(0.005)	(0.036)	
		Reading	0.054	0.082	0.028	0.169	0.104	-0.065
			(0.006)	(0.035)		(0.005)	(0.034)	
	8	Math	0.042	0.213	0.171	0.129	0.223	0.094
			(0.006)	(0.040)		(0.006)	(0.038)	
		Reading	0.135	0.289	0.154	0.23	0.296	0.066
			(0.006)	(0.045)		(0.005)	(0.044)	
		Average	0.061	0.143	0.082	0.161	0.161	-0.001
Town & rural	4	Math	0.001	0.075	0.074	0.102	0.022	-0.080
			(0.005)	(0.052)		(0.005)	(0.049)	
		Reading	-0.015	0.168	0.183	0.09	0.201	0.111
			(0.005)	(0.050)		(0.005)	(0.049)	
	8	Math	-0.045	0.267	0.312	0.05	0.327	0.277
			(0.005)	(0.044)		(0.005)	(0.043)	
		Reading	0.029	0.176	0.147	0.131	0.24	0.109
			(0.005)	(0.044)		(0.005)	(0.043)	
		Average	-0.008	0.172	0.179	0.093	0.198	0.104
		Controls	No	No	No	Yes	Yes	Yes

Note and Source: See Table 3.

Appendix Table A. Unweighted observations by school sector on NAEP, 2005–17

		District		Charter	
Category	Grade	Math	Reading	Math	Reading
Levels	4	1,162,970	1,165,740	33,420	33,790
	8	1,038,770	1,034,670	34,930	34,630
Gender					
Male	4	570,770	575,310	16,910	17,050
Female		592,200	590,430	16,500	16,740
Male	8	511,790	512,100	17,710	17,770
Female		526,980	522,570	17,220	16,870
Ethnicity					
White	4	638,100	644,890	10,680	10,920
Hispanic		192,710	193,290	13,270	13,340
Black		220,240	214,650	6,980	7,030
Asian		56,560	57,140	1,480	1,490
White	8	591,290	592,610	9,590	9,500
Hispanic		173,430	172,030	14,010	13,810
Black		178,330	175,150	8,520	8,470
Asian		51,570	50,750	1,840	1,860
SES quartiles					
Top	8	221,150	6,860	220,800	6,920
Second		219,550	8,450	219,400	8,320
Third		221,470	6,540	221,340	6,380
Bottom		220,620	7,390	220,340	7,370
FRL					
Ineligible	4	542,040	548,760	12,960	13,300
Free & reduced		595,120	591,400	19,180	19,180
Ineligible	8	535,120	535,690	12,830	12,880
Free & reduced		483,660	479,110	20,390	19,990

Appendix Table A (Cont'd). Unweighted observations by school sector on NAEP, 2005–17

		District		Charter	
Category	Grade	Math	Reading	Math	Reading
Region					
Northeast	4	192,650	193,770	3,030	3,060
Midwest		254,740	256,650	6,380	6,420
South		408,240	405,140	13,680	13,810
West		294,700	297,580	10,330	10,490
Northeast	8	174,110	173,940	3,130	3,080
Midwest		234,170	233,310	5,100	5,100
South		359,810	356,960	15,690	15,500
West		261,290	261,220	11,010	10,960
Locale					
City	4	339,450	339,810	19,430	19,630
Suburb		278,190	280,970	6,890	7,030
Town & rural		373,940	379,710	4,720	4,840
City	8	286,670	285,050	21,830	21,550
Suburb		240,780	240,460	6,040	6,050
Town & rural		352,690	352,820	4,680	4,690

Note: Information on locale is available since 2007. Information on SES is derived from student-reported parents' education level, number of books, and computer at home.
Source: See Table 3.