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ABSTRACT

Substantial uncertainty exists about the impact of school quality on the black-white achievement gap. Our results, based on both Texas Schools Project (TSP) administrative data and the Early Childhood Longitudinal Survey (ECLS), differ noticeably from other recent analyses of the black-white achievement gap by providing strong evidence that schools have a substantial effect on the differential. The majority of the expansion of the achievement gap with age occurs between rather than within schools, and specific school and peer factors exert a significant effect on the growth in the achievement gap. Unequal distributions of inexperienced teachers and of racial concentrations in schools can explain all of the increased achievement gap between grades 3 and 8. Moreover, non-random sample attrition for school changers and much higher rates of special education classification and grade retention for blacks appears to lead to a significant understatement of the increase in the achievement gap with age within the ECLS and other data sets.

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Schools, Peers, and the Black-White Achievement Gap

By Eric A. Hanushek and Steven G. Rivkin

Cognitive skills appear strongly correlated with black and white gaps in school attainment and in wages, and this has motivated aggressive policies to raise the quality of education for blacks.[1] The landmark decision in *Brown v Board of Education* that attacked racial segregation of schools was the modern beginning of concerted federal, state, and local actions directed at improving black achievement.[2] Along with subsequent court cases, *Brown* ushered in a profound change in both school and peer characteristics, while contemporaneous increases in school spending, brought on in part by school finance litigation, further raised the resources devoted to black students in the public schools. Nonetheless, racial disparities have been stubbornly resistant to policy, raising the possibility that schools really cannot be effective policy instruments.[3]

Table 1 provides a stark picture of the black-white differences in academic, economic, and social outcomes that have survived the schooling policies of the last decades. Among men and women 20 to 24 years old, blacks are far less likely to complete or be in the process of completing college, far less likely to work, and far more likely to be in prison or other institution. The rates of incarceration and non-employment for young black men paint a particularly dire picture.

These outcomes, combined with the weak and often contradictory statistical evidence on the effects of specific school policies on achievement, raise substantial doubts that schools are an important determinant of achievement inequality.[4] Moreover, recent research generally provides

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[1] O'Neill (1990) and Neal and Johnson (1996) provide evidence on wage differences, and Rivkin (1995) provides evidence on differences in educational attainment and employment.

[2] *Brown v. Board of Education*, 347 U.S. 483 (1954).

[3] Neal (2006) documents black-white gaps in both quantity and quality of schooling and shows evidence that convergence of earlier periods slowed or stopped in the 1980s and 1990s.

[4] Earlier optimism about narrowing gaps (Jencks and Phillips (1998)) largely dissipated with new evidence that the black-white achievement gap stayed constant or even grew during the 1990s (National Center for Education Statistics (2005)). In terms of the specific policies that have been pursued, direct evidence on the benefits of school desegregation remains limited. Review of the evidence surrounding desegregation actions provides limited support for positive achievement effects (Schofield (1995)); Guryan (2004) does, however, find that desegregation reduced the probability of dropping out of high school. Accumulated evidence does not provide strong support for the belief that higher expenditure typically leads to substantial improvements

Table 1. Distribution of 20 to 24 year olds by School Status, Employment Status, Years of Schooling, and Institutionalization Status in 2000 (percentage by Gender and Race)

	Institutionalized	High school dropout		High School Graduate: Attending college		High School Graduate: Not Attending college		College Graduate		Total observations
		Not employed	Employed	Not employed	Employed	Not employed	Employed	Not employed	Employed	
Men										
Blacks	14.1%	10.3%	6.7%	12.7%	13.2%	15.0%	23.3%	1.2%	3.8%	10,459
Whites	2.7%	4.2%	9.5%	13.6%	22.5%	6.3%	29.0%	2.3%	10.0%	53,820
Women										
Blacks	0.9%	10.3%	5.6%	15.6%	20.0%	17.2%	21.3%	2.2%	7.0%	10,728
Whites	0.3%	6.4%	4.7%	13.9%	26.8%	9.8%	19.5%	3.1%	15.5%	50,664

Note: Row percentages add to 100 percent.
Source: Author calculations from Census 2000 Public Use Microdata Sample (PUMS).

additional support for that view. For example, Fryer and Levitt (2004, 2005) find that a substantial racial achievement gap exists at entry to school and increases with age but that the majority of the increase occurs within schools and is not explained by quantifiable school characteristics.[5] Clotfelter, Ladd, and Vigdor (2005) document a large third grade achievement gap in North Carolina that does not increase with schooling. Our past work, on the other hand, highlights substantial achievement impacts of specific peer and teacher inputs whose distributions differ substantially by race, suggesting possible school based explanations of at least a portion of the black-white achievement differences.[6]

We trace the racial achievement gap as it evolves from kindergarten to the end of middle school and are able largely to reconcile the disparate findings. The resolution involves several elements. First, prior analyses have not accurately decomposed changes in the racial gap with age, and correction of this decomposition alters the basic picture. Second, a variety of survey difficulties, non-uniform measurement errors over time, and differential missing test data lead to substantial distortions in the apparent racial achievement gaps that, if uncorrected, mask the true character of racial gaps. Finally, careful attention to differences in and the effects of specific peer and school factors yields a clear explanation of the expansion of the gap with age.

We use data from the Early Childhood Longitudinal Survey (ECLS) – the basis for the Fryer and Levitt work – for analysis through grade 5 and the Texas Schools Project (TSP) panel data for grades 3 through 8. Although the richer and more extensive TSP data offer the clearest picture of school influences, they are not nationally representative and do not provide achievement results in the earliest grades.

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in the quality of instruction, particularly with regard to higher pay for teachers with a masters degree or substantial experience (Hanushek (2003)).

[5] Note that Murnane, Willett, Bub, and McCartney (2005) cannot replicate either the basic school patterns of the achievement gap or the influence of measured family background on the gaps when they go to a different, but in some ways richer, data base. Neal (2006) finds little evidence of a growing gap past entry to school and discounts the role of schools in either creating or ameliorating any gaps.

Differences in the achievement distributions for blacks and whites at school entry complicate comparisons if growth rates differ systematically by initial achievement either due to actual differences in skill acquisition or limitations in the measurement of achievement. Several hypotheses have been offered that suggest that the gap may grow more rapidly for initially high achieving blacks. On the one hand, blacks who excel in the early grades may face the strongest peer pressure against academic success. Alternatively, higher achieving blacks may fall further from the center of their school's achievement distribution and be less likely to participate in an academic program that facilitates continued excellence.[7] Importantly, we consider the effects of test measurement error and regression to the mean on the pattern of racial achievement differences.

Our results differ sharply from the other recent analyses of the black-white achievement gap. First, we find that the majority of the expansion of the achievement gap with age occurs between rather than within schools in both the ECLS and TSP data. The contrast with the findings of Fryer and Levitt (2005) appears to result from a problem with their achievement decomposition. Second, we find that identifiable school factors – the rate of student turnover, the proportion of teachers with little or no experience, and student racial composition – explain much of the growth in the achievement gap between grades 3 and 8 in Texas schools. Unfortunately, the structure of the ECLS does not permit the estimation of the causal effects of these variables for the grades and test instruments in that sample. Nonetheless, the similar race differences in school and peer characteristics in the TSP and ECLS data and the much larger increases in the between-school component of the racial achievement gap in the early ECLS grades suggest the impact of schools is likely to be as large if not larger in the earlier grades.

Importantly, a comparison of the TSP data and the ECLS strongly suggests that nonrandom

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[6] Hanushek, Kain, and Rivkin (2004a) investigate the effects of student mobility, Rivkin, Hanushek, and Kain (2005) investigate the effects of teacher experience, and Hanushek, Kain, and Rivkin (2006) investigate the effects of racial composition.

[7] Fryer and Levitt (2005) consider a related hypothesis through comparing performances of blacks and whites on alternative cognitive tests and suggest that blacks may indeed be doing more poorly on tests of higher

attrition due in large part to student and family mobility leads the ECLS to understate significantly the increase in the achievement gap with age. In addition, the much higher rates of special education classification and grade retention for blacks, particularly for boys, indicates that the select sample of tested students provides an incomplete picture of the academic difficulties experienced by blacks relative to whites in both administrative and survey data.

The next section describes the ECLS and TSP data sets used in this analysis. Section 2 documents changes in the racial achievement gap with age for all blacks and whites and by initial achievement and gender. This section also decomposes the gap into within-and between-school components to illustrate the potential importance of schools in explaining growth in the achievement differential. Section 3 describes the empirical model and estimates of the effects of specific school and peer factors on achievement. The final section summarizes the findings and discusses potential implications for policy.

1. ECLS and TSP Data

This paper employs both the Early Childhood Longitudinal Survey Kindergarten Cohort (ECLS) and Texas Schools Project (TSP) data sets in the investigation of the black-white achievement gap. The ECLS is designed to be a nationally representative sample for grades K-5, and the TSP data contain administrative information on the universe of Texas public school students for grades 3-8. Together these data span the elementary and middle school years, and the stacked panels contained in the TSP data facilitate the estimation of school and peer group effects on achievement.

A. ECLS Data

The ECLS is a survey of the National Center for Education Statistics that is designed to provide extensive information on the early school years. To date six waves of data have been collected, beginning with the base year kindergarten survey in fall 1998. Follow-up surveys were

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order skills. Murnane, Willett, Bub, and McCartney (2005) further question the impact of test content and score calculations on the pattern of achievement gaps.

completed in the spring of kindergarten, the spring of the subsequent academic year and every two years thereafter for all students and in the fall of the year following kindergarten for a much smaller sub-sample. Students remaining with their cohort were thus surveyed twice in kindergarten, once or twice in first grade, in third grade, and in fifth grade. Because the fall survey for the first grade was administered to only a subset of students, we do not use information from that wave.

Importantly, only a sub-sample of students who changed schools was included in the follow-up waves. Given the high mobility rate of blacks and difficulties tracking some movers, this sampling approach potentially contaminates racial achievement comparisons. As we illustrate below, it appears that nonrandom selection into the follow-up waves distorts the black-white comparisons in ways that understate the growth of the achievement gap with age.

Standardized mathematics and reading tests were administered in each of the waves along with child surveys that elicit information on race, ethnicity, family financial circumstances, parental education and employment, and a number of other variables. Information on teacher, school, and student demographics was also collected from schools and teachers each academic year, and sampling weights were provided in order to make the data nationally representative.

A two stage adaptive testing procedure was used to measure achievement. Students first completed a short pretest that sorted them into categories on the basis of the number correct. Students were administered different tests depending upon the pretest score, and test administrators used item response theory algorithms to grade the examinations. Theoretically the tests are vertically scaled such that a given point differential reflects a given difference in knowledge throughout the scale regardless of whether the differential reflects different scores on the same test or results for different grades.

Because of the relatively small sample size, limited and potentially noisy information on family background, and concerns about the possibility of omitted variables bias that cannot be mitigated using the panel data techniques employed in the analysis of the TSP data, we do not use the ECLS data in the estimation of school, peer, and teacher effects. Rather we use the test scores to describe the evolution of the racial achievement gap for this cohort and use the information on teachers and peers to characterize racial differences in the school environment.

B. TSP Data

The TSP data set is a unique stacked panel of school administrative data constructed by the UTD Texas Schools Project. The data we employ track the universe of Texas public elementary students as they progress through school. For each cohort there are over 200,000 students in over 3,000 public schools. Unlike many data sets that sample only small numbers from each school, these data enable us to create accurate measures of peer group characteristics. We use data on four cohorts for grades three (the earliest grade tested) through eight. The most recent cohort attended 8th grade in 2002, while the earliest cohort attended 8th grade in 1999.

The student data contain a limited number of student, family, and program characteristics including race, ethnicity, gender, and eligibility for a free or reduced price lunch (the measure of economic disadvantage). The panel feature of the data, however, is exploited to account implicitly for a more extensive set of background characteristics through the use of a value added framework that controls for prior achievement. Importantly, students who switch schools can be followed as long as they remain in a Texas public school.

Beginning in 1993, the Texas Assessment of Academic Skills (TAAS) was administered each spring to eligible students enrolled in grades three through eight. The tests, labeled criteria referenced tests, evaluate student mastery of grade-specific subject matter. This paper presents results for mathematics. Because the number of questions and average percent right varies across time and grades, test results are standardized to a mean of zero and variance equal to one.

Notice that the persistence of a constant differential in terms of relative score does not imply a constant knowledge gap. If the variance in knowledge grows with age and time in school, as we believe most likely, any deterioration in the relative standing of blacks on the achievement tests would understate the increase in knowledge inequality.

The student database is linked to teacher and school information. The school data contain detailed information on teachers including grade and subject taught, class size, years of experience, highest degree, race, gender, and student population served. Although individual student-teacher matches are not possible, students and teachers are uniquely related to a grade on each campus. Students are assigned the average class size and the distribution of teacher characteristics for teachers in regular classrooms for the appropriate grade, school, subject, and year.

3. The Facts about Racial Achievement Gaps

Beginning with the "Coleman report," *Equality of Educational Opportunity* (Coleman et al. (1966)), test score decompositions have been used to learn about the contribution of schools to the variation in achievement. The logic is simply that school policies mainly affect differences across schools, so a finding that only a small proportion of achievement variance occurs between schools is suggestive of a limited role of schools as opposed to family and other factors that vary both within and between schools. There are of course reasons why this rough logic might fail, [8] but it is a useful starting point for understanding the basic pattern of achievement gaps.

Fryer and Levitt (2004, (2005) report that most of the black-white achievement differences lie within schools, but their approach fails to capture accurately the contributions of the within- and between-school components. Although there is a simple and well-known decomposition of the variance of achievement into between- and within-school components, this calculation does not carry over to consideration of the mean achievement gap. Specifically, except in the special and uninteresting case of identical enrollment shares for blacks and whites across schools, the between-school component of the mean gap does not equal the average overall gap minus average within school gap as captured by the coefficient on an indicator for blacks from a school fixed effect achievement regression. Given the uneven distribution of whites and blacks among schools, this calculation produces erroneous measures of the within- and between- school contributions by

[8] In particular, sorting by families and teachers leads to systematic differences in family and community background among schools that is correlated to school and teacher quality, and differences in the quality of instruction exist within schools (see, for example, Rivkin, Hanushek, and Kain (2005)).

ignoring the implications of the distribution of blacks and whites among schools.

An example illustrates the problem with setting the between-school component equal to the overall gap minus the fixed effect coefficient. Consider a sample of 1,000 schools where all but one is completely segregated. The fixed effect estimator of the "within" component of the achievement gap would come entirely from the single school containing both black and white students. This one school has virtually no effect on the overall gap and no information on the difference between the segregated black and white schools. Nonetheless, if the within school difference in this one school happened to be larger than the overall gap, this approach would imply that the between-school contribution was negative and that differences among schools actually reduced the overall achievement gap.

Equation (1) shows the appropriate weighting of the two components such that the between-school component (first term in brackets) and the within-school component (second term in brackets) adds up to the racial difference in average achievement ($\overline{A}_w - \overline{A}_b$).[9] The first term shows explicitly how differences in the distributions of blacks and whites among schools with different average levels of achievement determines the between-school component, where n_{ds}/n_d is the share of demographic group d in school s.[10]

$$(1) \qquad \overline{A}_w - \overline{A}_b = [\sum_s \frac{n_{ws}}{n_w}\overline{A}_s - \sum_s \frac{n_{bs}}{n_b}\overline{A}_s] + [\left(\frac{1}{n_w} + \frac{1}{n_b}\right)\sum_s (\overline{A}_{ws} - \overline{A}_{bs})\alpha_s(1-\alpha_s)n_s]$$

The second term is a weighted average of black-white achievement differences within each school, where α_s equals the proportion of the black and white students in school s who are black and 1- α_s equals the proportion who are white. Notice that the weight for school s is neither proportional to the school's share of total enrollment of blacks or whites nor its share of enrollment in schools with both blacks and whites. Rather the weight for school s depends non-linearly on both total

[9] The appendix provides a derivation of this decomposition.

[10] n_b is the total number of black students, and n_{bs} is the number of black students in school s, with parallel definitions for white students (w).

enrollment and the distribution by race: schools with higher total enrollment and more equal enrollment shares receive greater weight. Notice that in a decomposition based on equation (1) the within school contribution in the above example with the single integrated school would approach zero, meaning that essentially all of the differential would correctly be attributed to the between-school component.

A. Different Views of Average Black-white Achievement Differences

Table 2 decomposes the black-white achievement gap into within- and between-school components using the sample of students in the ECLS with a complete set of test scores and applying the sampling weights relevant for students who participated in the five waves used in this paper.[11] The top row shows that the overall gap begins at 5.4 points and increases by 2.5 points during kindergarten, 4.4 points during first grade, 5.7 points during grades two and three, and by 1.4 points during grades four and five. Although the gap continues to widen through fifth grade, the pace slows following first grade.

The second row shows that virtually all of the grade-to-grade increases in the overall gap occur between schools. The increase in the between-school component accounts for 12.8 points out of the total increase of 14 points throughout the period. Note that if we instead relied on the black coefficient from a school fixed effect regression in the decomposition, the within-school component would appear to increase by 11 points, accounting for almost 80 percent of the overall gap during this period.[12]

Table 3 reports mean scores for grades 3, 5, and 8 from the TSP data calculated over all test-takers and over those who remain with their initial cohort for all grades.[13] (Note that these

[11] Scores are scaled according to item response theory (IRT), permitting them to be equated across grades. These calculations use the sampling weights from the survey (where the decomposition follows equation 1 based on weighted student counts for each school). Calculations not using the sampling weights are very similar in both magnitude and pattern.

[12] This is very similar to the pattern estimated by Fryer and Levitt.

[13] We do not report all grades, because movement from elementary to junior high or middle school produces a great deal of temporary test volatility in grades 6 and 7 that disappears within a year following the transition.

Table 2. U.S. Average Black-white Math Test Score Gap from ECLS

(average white score minus average black score)

	K (fall)	K (spring)	Grade 1	Grade 3	Grade 5
Overall	5.4	7.9	12.3	18.0	19.4
Between school	4.0	6.2	10.3	15.0	16.8
Within school	1.4	1.8	2.0	3.1	2.6
Race coefficient from regression with school fixed effects	4.5	6.0	8.8	15.8	15.6
Observations					
blacks	1,165	1,276	1,283	1,249	1,249
whites	5,972	6,520	6,535	6,439	6,410

Note: Scores are calculated in ECLS according to Item Response Theory. Averages calculated with sample weights to account for non-random aspects of sampling and attrition.

Table 3. Texas Average Black-white Math Test Score Gap from TSP

	intact cohort			entire sample		
	grade			grade		
	3	5	8	3	5	8
Overall	0.59	0.65	0.70	0.70	0.73	0.76
Between school	0.19	0.25	0.28	0.24	0.27	0.31
Within school	0.39	0.40	0.42	0.46	0.46	0.44
Observations						
blacks	87,941	87,941	87,941	145,282	143,524	142,073
whites	336,948	336,948	336,948	503,835	507,789	497,924

Note: Standardized test scores (mean=0, s.d.=1) from TAAS.

comparisons are calculated in terms of standard deviations, because no IRT scores are available for the Texas tests).[14]

A comparison of the gaps produced by the repeated cross sections (right panel) and the sample of students with a complete set of test observations who progress with their class (left panel) highlights the importance of grade retention, special program assignment, and other factors that determine test taking patterns. The probability of grade retention and of special education classification is higher for those in the lower portion of the achievement distribution, implying that blacks in the complete cohort sample will tend be a more select group than whites in the complete cohort sample. Across grades, the sample of blacks will tend to have been in school longer on average than whites because of grade retention, and this works to narrow the black-white gap when taken as a snapshot at a given grade level. Both the lower 3rd grade test score gap and larger increase in the gap between 3rd and 8th grade for the complete cohort sample can be attributed to these differences in grade retention and special education classification.

In the complete panel sample, the gap rises from 0.59 standard deviations at the end of 3rd grade to 0.65 in 5th grade and to 0.70 in 8th grade. The pattern of achievement gap change is similar to that observed in the ECLS. Not only does the yearly rate of increase diminish with age, but also the between-school component accounts for over 75 percent of the change in the gap between third and eighth grades (0.09 of the 0.11 total increase).

Although the purposeful sorting of families into communities and school districts means that family and community factors contribute to the between school gaps, the patterns observed in Tables 2 and 3 leave open the possibility that school quality differences account for much of the rise in the racial achievement gap during the elementary and middle school years.

B. Differences by Initial Achievement

Tables 2 and 3 show that the growth in the average black-white achievement gap declines

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[14] Murnane, Willett, Bub, and McCartney (2005) suggest that the different units of analysis can affect the results, but we have no way to deal with that issue here.

with age and occurs predominantly between schools, but an important question is whether the changes are similar across the initial achievement distribution. Investigating such heterogeneity is complicated by the fact that test scores measure actual knowledge with error, meaning that the kindergarten or third grade scores are not perfectly correlated with knowledge. If students are categorized by their initial scores and if test measurement errors are uncorrelated over time, those placed in high achievement categories will tend to draw less positive errors in the subsequent year, while those placed in the lower categories will tend to draw more positive errors in the subsequent year. Consequently regression to the mean will account for a portion of the observed difference in test score changes across categories.

Such regression to the mean also complicates black-white comparisons because of differences in the actual initial skill distribution. Table 4 illustrates the general problem using a stylized trivariate distribution of actual skill and measurement error that is randomly distributed and does not differ by race. The top panel reports the assumed distributions of actual skill for blacks and whites, where the distribution for blacks is more concentrated in the lower categories than the distribution for whites. The bottom panel describes the resulting distribution of observed test scores, where P_{ij} is the probability that a student with true ability in category i is observed in category j (e.g., P_{LH} is the probability that someone with low ability will have an observed test score in the high ability category). Comparison of the top and bottom panels shows that the observed test score distributions distort the actual race differences in skill even with the assumption of random measurement error distributions that do not differ by race. A higher proportion of whites than blacks are misclassified into the lowest observed skill category, while the opposite is true for the highest observed skill category. Such systematic misclassification leads to higher expected achievement gains for whites than blacks throughout the distribution as a result of the regression to the mean phenomenon.

The pattern illustrated in Table 4 invalidates the simple categorization of students on the basis of initial test scores. To overcome this problem, we use a test in a different subject to

Table 4. Simulated Observed and Actual Test Score Distributions for Blacks and Whites (Pij = probability of being actual category i but observed as category j)

Initial Actual Skill Distributions

	Low	Middle	High
Blacks	0.4	0.4	0.2
Whites	0.2	0.4	0.4

Observed Test distribution

Blacks		
	Low	$0.4*P_{LL} + (0.4*P_{ML} + 0.2*P_{HL})$
	Middle	$0.4*P_{MM} + (0.4*P_{LM} + 0.2*P_{HM})$
	High	$0.2*P_{HH} + (0.4*P_{LH} + 0.4*P_{MH})$
Whites		
	Low	$0.2*P_{LL} + (0.4*P_{ML} + 0.4*P_{HL})$
	Middle	$0.4*P_{MM} + (0.2*P_{LM} + 0.4*P_{HM})$
	High	$0.4*P_{HH} + (0.2*P_{LH} + 0.4*P_{MH})$

categorize students by initial mathematics skill level, based on the assumptions of positive correlations across subjects in true skill and of no correlation in the test measurement errors across subjects. This scheme severs the link between initial category and expected difference in the error realizations for the initial and subsequent periods.

Table 5 and Figures 1 and 2 report changes with age in the overall and between-school components of the black-white achievement gap in mathematics for the ECLS and TSP samples, respectively. The ECLS sample is divided into six initial achievement categories on the basis of kindergarten reading scores, and Table 5 shows that the black-white gap increases much more prior to 3rd grade than between 3rd and 5th grade except for the highest category where the gap declines following 1st grade and in the period as a whole.[15] Although the largest increase occurs in the bottom category, the overall increase in the lower five categories does not vary much by initial reading achievement. Finally, the bulk of the overall changes in all categories results from between- rather than within-school changes.

Similar to the national trends from the ECLS for grades K thru 5, Figure 1 shows that growth in the achievement gap for the TSP sample tends to be noticeably larger in the earlier grades (3rd to 5th).[16] However, in contrast to the pattern observed in Table 5, Figure 1 reveals a pronounced ordering in the magnitude of change by initial achievement categories, particularly following 5th grade (solid bars). Between grades 5 and 8 the overall gap increases in only one of the seven bottom categories and by only 0.01 standard deviations, while the gap increases by at least 0.05 standard deviations in all but one of the next six groups and by at least 0.09 standard deviations in the top three groups. For the grade span as whole, the gap increases by at least 0.25 standard deviations in the top three groups, between 0.17 and 0.21 in five of the next 6 groups, and by less than 0.10 in the seven lowest categories.

[15] We use the spring kindergarten rather than the fall kindergarten test to divide students in the ECLS because of the lack of dispersion in the fall kindergarten reading test distribution. The distribution of scores and evolution of the racial achievement gaps by kindergarten reading category are found in Appendix Table a1.
[16] Appendix Table a1 reports the overall and between school gaps for the TSP sample.

Table 5. U.S. Average Black-white Math Test Score Gap by Spring Kindergarten Reading Test Score Category from ECLS

	Spring Kindergarten reading test score category					
	1	2	3	4	5	6
Overall						
kindergarten	2.2	3.6	4.9	6.1	5.4	8.2
1st grade	5.7	6.4	7.8	9.7	13.7	10.4
3rd grade	14.9	12.8	15.1	13.0	15.6	9.4
5th grade	16.8	14.1	15.7	13.3	15.6	6.6
Between School						
kindergarten	2.3	3.0	3.8	5.4	5.3	7.4
1st grade	5.6	5.5	6.2	8.1	13.2	9.2
3rd grade	14.4	10.8	12.8	11.0	14.6	8.6
5th grade	16.1	11.9	13.1	11.0	14.7	6.6
Observations						
blacks	208	412	324	170	65	39
whites	382	1,315	2,078	1,567	562	218

Notes: Students are categorized by kindergarten reading score. Scores are divided into 20 intervals of equal length with results reported for categories with at least 30 blacks. (Because the IRT scaling spans all grades, the top categories are not relevant for kindergarten). Cell sizes fluctuate slightly from grade to grade.

Figure 1. 3rd to 5th Grade and 5th to 8th Grade Changes in the Math Achievement Gap by 3rd Grade Reading Category

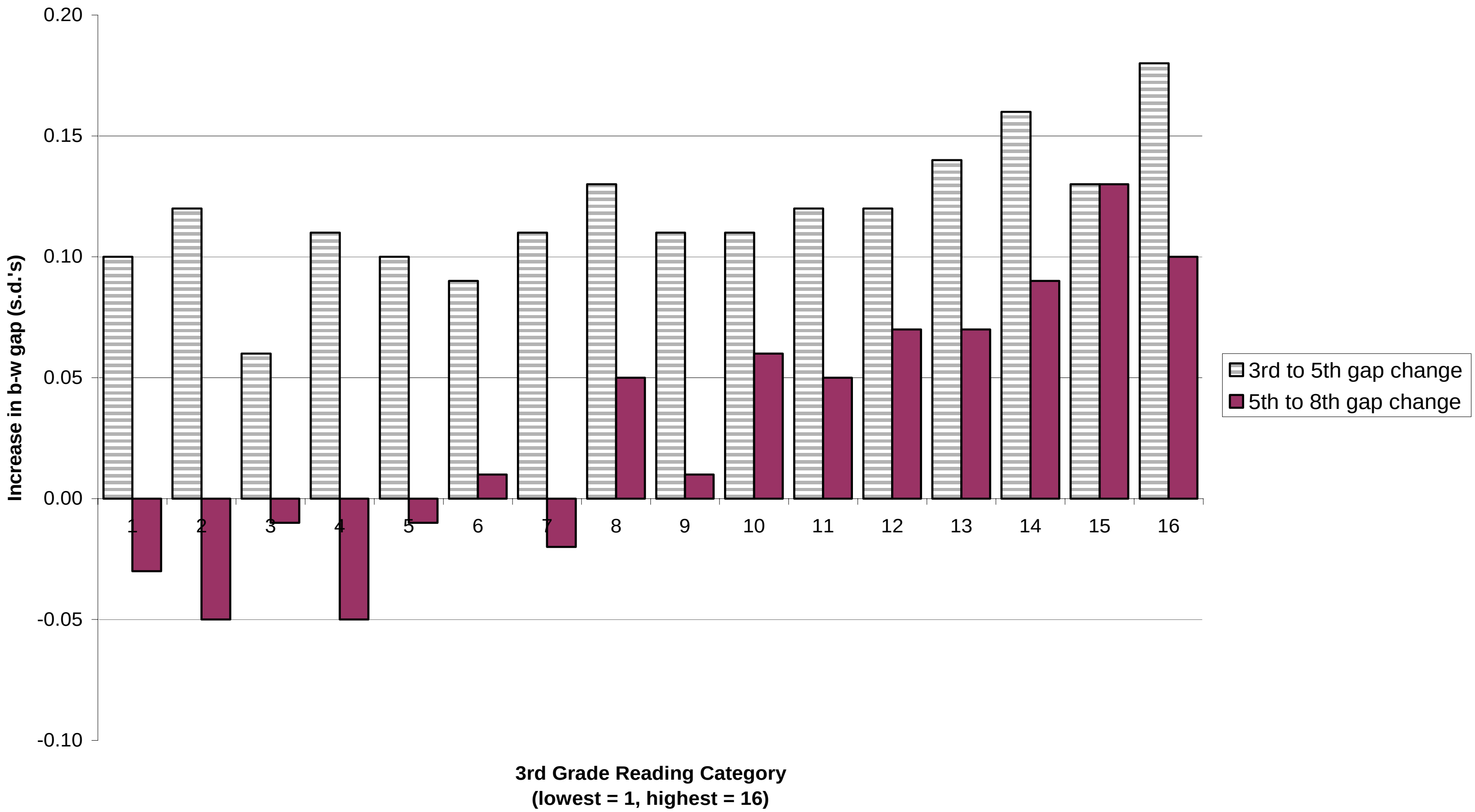
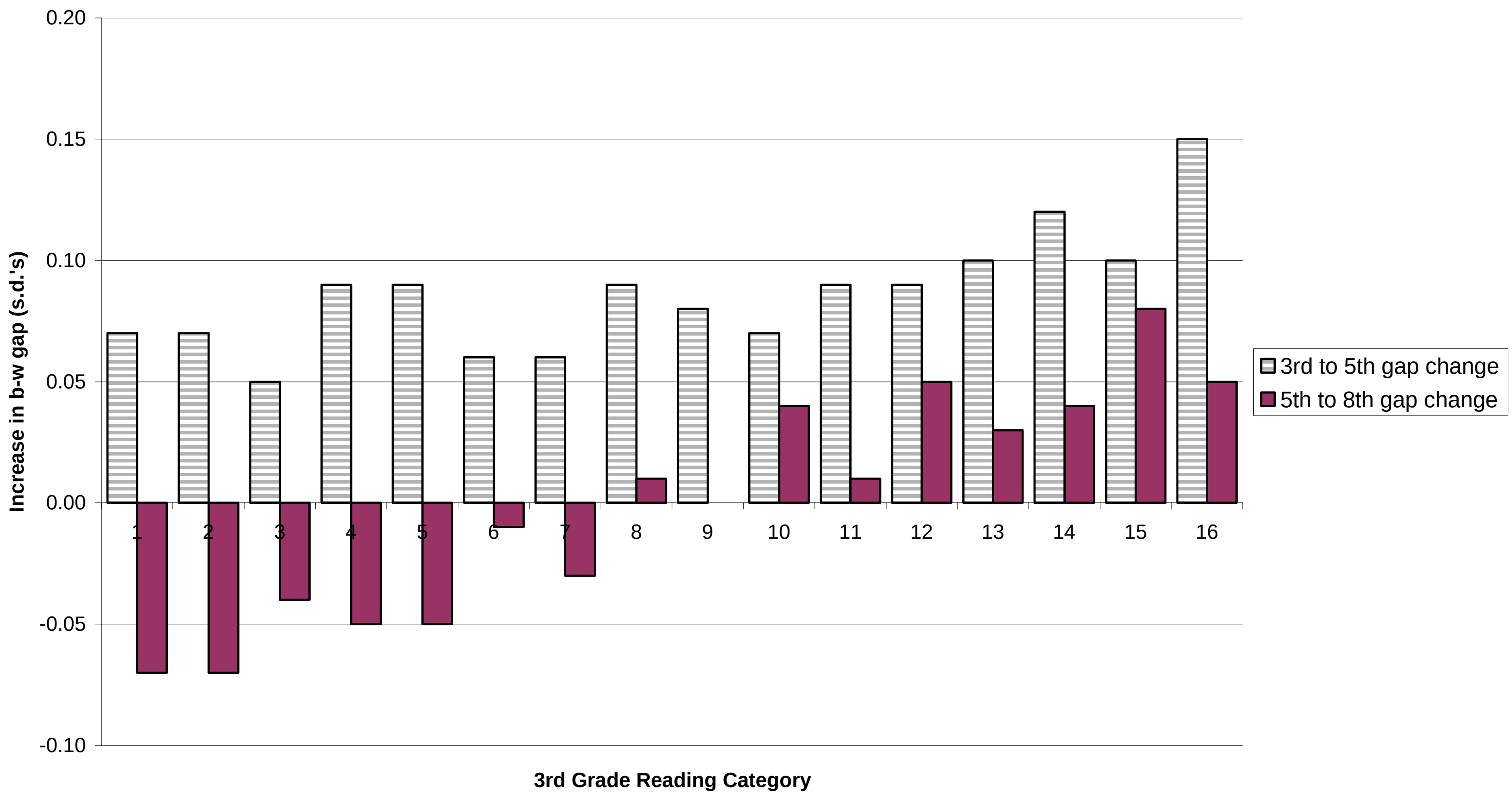


Figure 2. Between School Changes in the Math Achievement Gap by 3rd Grade Reading Category



Similar to the pattern observed in the ECLS sample, Figure 2 shows that between-school changes account for the bulk of the overall changes observed between 3rd and 5th grade in Texas across the initial reading achievement distribution. However, following 5th grade there is a marked divergence in the impacts of the between-school component by 3rd grade reading category. The between-school gap actually declined in each of the bottom seven categories, and in six of the seven this decline leads to a reduction in the overall differential despite offsetting changes in the within-school component in most. In contrast, the between-school gap does not fall in any of the remaining groups and tends to move in the same direction as the within-school changes. Consequently the overall gap increases for students in the upper reading achievement categories, though as previously noted the magnitude of the gap expansion following 5th grade tends to be much smaller than the changes observed between grades 3 and 5.

C. Differences by Gender

The recent widening of the gender gap in high school and college completion, which is particularly pronounced for blacks, raises the possibility of a gender differential in the evolution of the elementary school achievement gap. Appendix Tables a2 and a3 report overall gender differences for the ECLS and TSP samples, respectively, and Appendix Tables a4 and a5 report gender differences by initial reading achievement.

The tables provide little or no evidence of differential patterns by gender, and particularly no evidence of a sharp drop in the relative achievement of black boys during these grades. This holds across the initial reading achievement distribution and for both total changes and the within-and between-school components.

D. Nonrandom attrition and test taking

Nonrandom attrition from the samples of students with test results potentially complicates the measurement of the black-white achievement gap including differences by gender in both the ECLS and TSP data. Nonrandom sampling in follow-up surveys, race differences in special education classification and grade retention, and other sources of missing test data have the potential to distort achievement comparisons and understate academic difficulties experienced by many students (as previously shown in Table 3).

The high rate of school transfers for blacks elevates the importance of sampling a representative set of movers in the ECLS, and the test score pattern observed in Appendix Table a6 for students who remain in the sample for all five waves raises doubts that the ECLS succeeded in procuring a 50 percent random sub-sample of movers in the follow-up surveys.[17] In contrast to white movers whose average scores are slightly lower than those of stayers, blacks who move between first and third grade score significantly higher on average than non-movers and those who switch schools in other periods. This achievement pattern seems particularly unlikely, because the 2000 U.S. Census shows that average income, mother's education, and the probability of living in a two parent household were far lower for black children 6 to 8 years old who switched residences within the previous year than for black children who did not move.[18] The ECLS pattern also differs markedly from the pattern observed for public school switchers in Texas (see Appendix Table a7) and suggests that its included black movers are a biased sample of all blacks who switched schools during these grades. Moreover, the sampled black movers tend to realize substantial academic gains with age relative to other blacks, in sharp contrast both to the whites in the ECLS and to Texas movers who tend to lose ground relative to non-movers.

The apparent ECLS sampling difficulties highlight the value of being able to track school switchers with administrative data, but such tracking does not insulate the TSP data from all causes of nonrandom selection. As Texas public school students age the racial gap in remaining on grade and having a test widens, particularly for boys. A substantially higher percentage of black than white boys is retained in grade each year, and the race differential in the proportion of boys excused from test taking due to special education classification exceeds ten percentage points (Appendix

[17] The intent was to movers whose first language was English at a rate of 50 percent and other movers at a slightly higher rate.

Table a8). Those excused from the test or retained score far lower on average than other students in the previous year (see Appendix Table a9), meaning that the attrition from the test sample almost certainly attenuates estimates of the achievement gap and its growth with age.

Clearly the test data provide only a partial measure of academic progress, and we attempt to provide a more complete picture by describing the special education and retention patterns for the entire elementary and middle school experience. Table 6 describes the joint distributions of special education classification and retention by race and gender for grades K thru 8. Both retention and special education classification are considerably higher for blacks, particularly for boys. By middle school over one quarter of black boys receive special services, almost twice the rate for white boys or black girls. In addition, the high failure rates, concentrated in grades one and seven, highlight the lack of academic progress for many black boys.

In sum, the test score patterns and rates of special education and retention depict a sizeable deficiency in academic progress for black girls and an even larger deficit for black boys. Although the largest increases in the test score gap occur in the early school years, the nonrandom selection out of the test sample would appear to lower the observed growth in the gap in later grades from what it would be in the absence of such attrition. Moreover, the high rates of retention in the early grades mean that many can quit school legally close to the beginning or even prior to the start of high school, raising doubts that surveys of high school students provide a valid comparison of the academic progress of blacks and whites.

4. School and Peer Effects on Achievement Gaps

A key issue is the extent to which specific teacher and school variables account for the growth in the achievement gap during the school years. Although some recent studies including Fryer and Levitt (2004) have not found that observed school factors account for much if any of the growth in the achievement gap, these results are inconsistent with other research that highlights the

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[18] From the 2000 Census data, within state movers come, for example, from families with a single parent 60 percent of the time and 18 percent have less than a high school education. For nonmovers, the comparable

Table 6. Distribution of Texas Public School Students by Special Education and Grade Retention Status, by Race, Gender, and Grade

	Grade							
	1	2	3	4	5	6	7	8
Boys								
Blacks								
1. Not retained/not special education	78.9%	80.9%	77.8%	75.5%	73.4%	71.4%	70.1%	72.5%
2. Not retained/special education	8.2%	14.6%	18.4%	22.7%	25.3%	25.6%	25.1%	25.2%
3. Retained/not special education	10.2%	3.5%	2.9%	1.4%	0.9%	2.4%	3.9%	1.7%
4. Retained/special education	2.8%	1.0%	0.9%	0.4%	0.5%	0.6%	0.9%	0.6%
Whites								
1. Not retained/not special education	80.5%	83.0%	81.4%	11.2%	80.9%	80.9%	80.6%	82.0%
2. Not retained/special education	10.7%	14.8%	16.9%	18.0%	18.3%	17.6%	17.2%	16.7%
3. Retained/not special education	0.2%	1.4%	1.1%	0.5%	0.5%	1.1%	1.7%	0.9%
4. Retained/special education	2.6%	0.7%	0.7%	0.3%	0.3%	0.4%	0.5%	0.4%
Girls								
Blacks								
1. Not retained/not special education	86.9%	90.0%	88.1%	87.0%	85.4%	84.3%	83.6%	85.3%
2. Not retained/special education	4.1%	7.2%	9.2%	11.8%	13.7%	14.1%	13.8%	13.3%
3. Retained/not special education	7.7%	2.6%	2.3%	1.0%	0.6%	1.3%	2.4%	1.1%
4. Retained/special education	1.3%	0.5%	0.5%	0.2%	0.2%	0.3%	0.3%	0.3%
Whites								
1. Not retained/not special education	88.5%	90.5%	89.6%	89.6%	89.6%	89.7%	89.6%	90.6%
2. Not retained/special education	5.8%	8.0%	9.2%	9.8%	9.9%	9.6%	9.1%	8.6%
3. Retained/not special education	4.3%	1.1%	0.9%	0.4%	0.3%	0.6%	1.0%	0.6%
4. Retained/special education	1.4%	0.4%	0.4%	0.2%	0.2%	0.2%	0.2%	0.2%

significant effects of specific school and peer factors that clearly differ by race.

Our primary goal here is to assess whether schools have a discernible impact on the growth of the racial achievement gap. At any grade, the white-black gap in average achievement ($\Delta\overline{A}$) can be written in terms of underlying mean characteristics ($\overline{X}$) of whites (w) and blacks (b), the impacts of these (β) on achievement, and a stochastic term (ε) such as:

$$
\begin{aligned}
\Delta\overline{A} &= \overline{A}_w - \overline{A}_b \\
&= \overline{X}_w\beta_w - \overline{X}_b\beta_b + (\overline{\varepsilon}_w - \overline{\varepsilon}_b) \\
&= (\overline{X}_w - \overline{X}_b)\beta_w + (\beta_w - \beta_b)\overline{X}_b + (\overline{\varepsilon}_w - \overline{\varepsilon}_b)
\end{aligned}
\tag{2}
$$

If $\overline{X}_i$ and $\beta_i, i \in \{w,b\}$, are vectors of the mean characteristics affecting achievement and their respective impacts on achievement, the white-black achievement gap can be decomposed into a weighted difference in mean characteristics and a weighted difference in achievement impact parameters along with mean stochastic terms, as shown in the last line of Equation (2). Assuming that the expected value of the mean errors is zero, equation (2) highlights the fact that racial differences in both characteristics and parameters contribute to the evolution of the achievement gap. Importantly, if $\beta_w \neq \beta_b$, achievement gaps can change over time even if blacks and whites face the same average inputs within schools.

We pursue a conservative estimation strategy that concentrates on that portion of the achievement variance that can be credibly related to the causal influence of specific school factors previously shown to be significant determinants of achievement and that are distributed differently by race. Consequently we ignore other factors such as school leadership that are likely distributed more favorably for whites than blacks. Further, because the ECLS data offer virtually no chance of identifying the causal impact of any of the school factors, we limit our analysis just to the Texas data. This is unfortunate because the Texas analysis begins with grade 3 and thus does not include the earlier grades where there are larger changes in achievement gaps.

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figures are 40 percent and 12 percent, respectively.

A. Empirical Model

A wide range of studies have sought to relate various schooling factors to student outcomes, but they have had mixed success, especially when viewed from the perspective of causal influences (see Hanushek (2003)). The central problem in modeling the impact of teacher and school variables is the non-randomness and interdependence of the allocation of students and teachers among schools. Both school resources and racial composition, for example, are the outcomes of decisions made by families, school officials, legislators, and in some cases judges, and these are likely to interrelate with a range of factors that directly and indirectly influence achievement.

Equation (3), a specialized version of the general achievement relationships depicted in equation (2), highlights the key identification issues that must be addressed in the absence of random assignment. Here achievement (A) for student i in grade G and school s_{iG} is modeled as a function of student, family, teacher, and peer factors:

(3) $$A_{iG} = \alpha_{iG} + \phi F_{iG} + \delta T_{iGs_{iG}} + \lambda P_{iGs_G} + \rho S_{iGs_{iG}} + e_{iG}$$

where *P* is a vector of peer variables in grade G, *T* is a vector of teacher variables, *S* is a vector of nonteacher school factors (such as class size), *F* is a vector of student and family background variables, *α* is an individual intercept specific to grade G, and *e* is a stochastic term capturing other unmeasured influences.

If all variables in *T*, *P*, and *S* were uncorrelated with α and *e,* OLS would yield unbiased estimates of *δ*, *λ,* and *ρ* (the basic parameters needed to estimate the contribution of the schooling component in equation 2). But as noted above, the complications inherent in the determination of peer and school characteristics bolstered by prior empirical evidence strongly suggest that typically available controls do not account adequately for potentially confounding factors.

Because the pattern of school, teacher, and peer effects is so inextricably bound up in the selection of schools by families and school personnel, we focus on the variations in key school inputs that occur within schools over time to identify the fundamental school related parameters of interest. In particular, we exploit the stacked panel nature of our data to eliminate the first order factors that thwart identification of the school parameters.

Our basic estimation includes full sets of school-by-grade and school attendance zone-by-year fixed effects in order to isolate exogenous variation in racial composition, teacher experience, student turnover, and other school inputs. School attendance zones are defined by middle schools, meaning that there can be more than one elementary school in each zone.[19] These attendance zone-by-year fixed effects remove in a very general way all variation over time in neighborhood and local economic conditions that likely affect mobility patterns including such things as the introduction of new race-related school policies or the myriad changes documented to occur in "transitional neighborhoods." An economic shock that reduces neighborhood employment and income would not bias the estimates; nor would a shock to local school finances or the quality of the local school board, because each of these would affect all grades in a school. The school-by-grade fixed effects also account for the possibility that achievement trends vary systematically with changes in teacher experience, peer turnover, or school racial composition as students age.

These fixed effects do not control for any school decisions on classroom placement that might be related to race or student background. For this analysis, we measure teacher and peer variables at the grade rather than classroom level, avoiding the complication introduced by the selective placement of students into classrooms.[20]

In this framework, the remaining variation comes both from mobility induced changes and

[19] It was not computationally feasible to include separate school–by-year fixed effects, but the fact that the attendance zone-by-year fixed effects have little impact on the middle school estimates when school-by-grade fixed effects are included indicates that this is highly unlikely to exert a meaningful impact on the results.

[20] While alternative approaches for dealing with classroom placement would be possible, our data do not support classroom specific analysis. Clotfelter, Ladd, and Vigdor (2003) find significant variations in the racial composition of classrooms by district, school, classroom, and academic track in middle school but much less so in primary school. They do not address implications for student performance, but given that the school-by-year and school-by-grade fixed effects account for any persistent placements for a grade and year-to-year school wide changes, such within-school differences should have minimal effect on the estimates in this paper.

from persistent cohort-to-cohort differences within schools. Importantly, neither mobility nor cohort differences are purely random, and evidence indicates the mobility affects both movers and other students in the destination school. Moreover, the evidence shows that movers tend to have lower prior achievement, indicating that determinants of learning in prior periods were less conducive to achievement. Finally, and most important, we know that there are dramatic differences in the level and pattern of mobility by race (Hanushek, Kain, and Rivkin (2004a)). Therefore, we include indicators for both family initiated and structural moves and control for student differences (captured by α) that may be related to racial composition and student and teacher turnover.

One central concern is that the cumulative nature of knowledge acquisition induces bias whenever school parameters are estimated solely from contemporaneous information. Consider Equation (4), which recognizes that the individual heterogeneity, α, is a function of prior school and family variables, peer composition in previous grades, and unobserved "ability," γ.[21]

$$(4)\ \alpha_{iG} = \phi\sum_{g=1}^{G-1}\theta^{G-g}F_{ig} + \delta\sum_{g=1}^{G-1}\theta^{G-g}T_{igs_{ig}} + \lambda\sum_{g=1}^{G-1}\theta^{G-g}P_{igs_{ig}} + \rho\sum_{g=1}^{G-1}\theta^{G-g}S_{igs_{ig}} + (\gamma_i + \sum_{g=1}^{G-1}\theta^{G-g}\gamma_i)$$

This formulation captures the possibility that family, teacher, and peer interactions in grades prior to G establish the knowledge base for learning during grade G and therefore affect achievement at the end of grade G. In a very general manner, the effects of prior period variables are assumed to decline exponentially as a function of time from the present at a constant rate (1-θ), where $0 \le \theta \le 1$.[22]

[21] Boardman and Murnane (1979) and Todd and Wolpin (2003) also highlight the importance of unobserved ability and the cumulative nature of learning.

[22] At the extreme of θ =0, past inputs are not relevant for current achievement, i.e., having a good fourth grade teacher does not have any implications for math achievement at the end of the fifth grade. On the other hand, θ =1 implies no depreciation of the influence of past inputs, i.e., that the impact of a good fourth grade teacher on 4th grade achievement equals her impact on 5th grade achievement and achievement in all future grades. For convenience, we assume that the effects of prior variables decay at the same rate, although this is not essential for the development below.

The term γ captures student differences that remain constant during the schooling years including early childhood influences, prenatal care, heredity, and other systematic factors. Notice that our formulation is learning-based in that the value of γ affects the quantity of skills and knowledge acquired at each grade, and these increments to achievement are subject to depreciation. This explicitly permits the affects of ability on achievement to increase with age.[23]

Equation (4) includes a mixture of time invariant and time varying individual differences that could potentially bias estimates of racial composition effects. Panel data on student achievement permit dealing directly with the most severe problems. We estimate specifications that include lagged achievement as an independent variable.[24] Prior work using the Texas administrative data shows that first differenced specifications that account for student fixed effects and also include school-by-grade fixed effects produce estimates that are very similar to those produced by specifications with school-by-grade and school-by-year fixed effects[25]. Therefore we use lagged achievement alone to account for unobserved heterogeneity.

B. Baseline Results

Although the analysis considers commonly studied school factors such as class size, teacher education and average experience, it focuses more on the effects of student turnover, racial composition, and initial teacher experience. These latter factors have been identified in our prior work and that of others as systematic determinants of school achievement and their distributions in

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[23] The exact formulation and interpretation depends, however, on the measurement of achievement. If measured with vertically integrated tests, differences in γ would contribute to a widening of the skill distribution over time as long as θ were not equal to zero. On the other hand, if skills were measured in distributional terms (as we do here with standardized scores), the complicated final term in parentheses could be replaced with γ_i, because ability induced differences in relative achievement would remain constant over time.

[24] We employ this specification because models that use test score gain as the dependent variable or include student fixed effects without also including lagged achievement as a control impose unrealistic assumptions on the learning process. Rivkin (2005) compares a number of common, education production function specifications.

[25] Computational limits preclude the estimation of models that include student, school by grade, and school by year fixed effects.

some cases likely impacts differ substantially by race.[26] Preliminary work showed no systematic effect of teacher post-graduate schooling and that the small effect of average experience was driven by gains made in the early years of teaching (which we consider below).

Table 7 reports estimates from lagged achievement models with just observables and with school-by-grade and school-by-year fixed effects, each separately based on elementary and middle school samples where effects are allowed to vary by race. The regressions are based on a total of 1,448,458 observations, but, because of the dimensionality of the problem, the estimates are obtained by first aggregating the student level observations to school-grade-race-year cells and weighting the observations by the number of students in the cell.[27] All specifications include average lagged test score, the proportions of those eligible for a subsidized lunch, classified as special needs, female, black, and having a family initiated school change, and indicators for the first grade offered in a school and grade-by-year. Preliminary work showed that proportions of students who were Hispanic and Asian were not significantly related to achievement of blacks and whites and that exclusion of these variables had virtually no effect on the remaining estimates. Absolute values of t-statistics based on robust standard errors clustered by school are reported.

The estimates for both the elementary and middle school samples show that the inclusion of the fixed effects has its largest impact on the racial composition coefficients, highlighting the importance of controlling for the myriad factors related to the systematic sorting of teachers and students among schools. These include both unobserved determinants of learning and differences in the extent to which the curriculum focuses on tested material. Henceforth we concentrate on the

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[26] Hanushek, Kain, and Rivkin (2004a) demonstrate that both individual moves and overall school mobility rates have a direct impact on student performance and differ dramatically between black and white students. Rivkin, Hanushek, and Kain (2005) finds that teacher experience is important in the first two years of a teaching career (but not thereafter) and that class size has small effects in earlier grades. These patterns are consistent with a number of other high-quality recent works including Rockoff (2004), Boyd et al. (2005), and Kane, Rockoff, and Staiger (2006). Hanushek, Kain, and Rivkin (2006) find increased concentration of black students has a particularly deleterious effect on black achievement. This finding is consistent with Guryan (2004), Angrist and Lang (2004), and Hanushek and Raymond (2005).

[27] Only black and white nonHispanic students who remain with their cohort and have nonmissing test scores for grades three through eight are included in the sample, and a small number of observations are excluded

Table 7. Estimated Effects of School and Student Characteristics on Mathematics Achievement, Texas Public Schools

	elementary school		middle school	
		Attendance zone-by-year and campus-by-grade fixed effects		'Attendance zone-by-year and campus-by-grade fixed effects
Black Students				
proportion students new to school	-0.097	-0.098	-0.237	-0.124
	(2.07)	(2.10)	(4.60)	(2.29)
proportion students black	-0.037	-0.107	-0.096	-0.163
	(1.65)	(3.30)	(3.38)	(4.12)
Teacher Experience				
proportion 0 years	-0.133	-0.154	-0.049	-0.069
	(3.47)	(4.76)	(2.33)	(2.97)
proportion 1 year	-0.015	-0.011	-0.042	-0.046
	(0.50)	(0.39)	(1.44)	(2.37)
White Students				
proportion students new to school	-0.064	-0.110	-0.099	-0.092
	(2.90)	(4.24)	(3.46)	(2.46)
proportion students black	-0.007	-0.027	-0.009	-0.077
	(0.34)	(1.00)	(0.45)	(2.08)
Teacher Experience				
proportion 0 years	-0.086	-0.084	-0.026	-0.042
	(7.52)	(6.34)	(2.66)	(3.31)
proportion 1 year	-0.043	-0.034	-0.021	-0.012
	(3.83)	(2.75)	(2.10)	(1.26)
Observations[a]	34,680		20,933	

Notes: absolute value of t statistics computed from robust std errors controlling for grouping by school in parenthesis. All specifications include black and female dummies, indicators for, subsidized lunch eligibility, special education participation, and a nonstructural move (all fully interacted with black), and a full set of grade-by-year variables.

a. Observations refer to cells that aggregate the 1,446,458 individual student observations into school-grade-year-race aggregates of all variables.

fixed effects specifications.

The estimation results provide strong evidence that higher levels of student turnover negatively affect achievement and that the impact is comparable for both blacks and whites and across schooling levels. This mobility externality is consistent with educator concerns about maintaining a coherent instructional program in the face of high student mobility and is particularly important given the prevalence of high turnover schools for low income and black students (Hanushek, Kain, and Rivkin (2004a)). Ten percent higher student turnover in a school (approximately one standard deviation change across schools) results in approximately a 0.01 standard deviation lower annual growth in achievement.

Having a higher proportion of teachers with little or no experience also adversely affects achievement,, and the costs are substantially higher for blacks and for elementary school students.[28] The coefficients show that having a new teacher reduces achievement by 0.15 and 0.08 standard deviations for blacks and whites respectively from what it would be with a teacher with at least two years of prior experience. The negative impacts of new teachers at middle school are roughly half as large as these.

Consistent with other recent work on racial composition, the negative effect of a higher proportion of black is highly significant for blacks and much larger for blacks than for whites.[29] In contrast to teacher experience, the magnitude of the proportion black effect on black students increases with age: a 10 percentage point increase in percentage black reduces achievement by roughly 0.011 standard deviations in elementary school and by 0.016 standard deviations in middle school. For whites, racial composition is insignificant at the elementary level, and the comparable

because of missing information on teachers Preliminary work showed that the school-by-grade fixed effect estimates produced from the cell means were virtually identical to those produced by the student level data.

[28] The underlying cause of the larger impact of new teachers on black students cannot be addressed with our data. It could reflect that new teachers on average have more difficulty reaching black students or, similar to Lazear (2001), that the return to experience is disproportionately higher in schools attended by blacks, perhaps because of higher levels of disruption (for which new teachers are less prepared).

[29] The differential effect of racial composition is consistent with the findings of Guryan (2004), Angrist and Lang (2004), and Hanushek, Kain, and Rivkin (2006).

middle school impact for a ten percent change in the percentage of schoolmates who are black is 0.008 standard deviations.

The fixed effect specifications use exogenous variation across cohorts and grades within schools to quantify the importance of between school differences in teacher and peer characteristics in explaining the racial achievement gap. Purposeful student and teacher sorting among schools complicates efforts to isolate credible between-school variation that can be used to identify causal effects of specific factors. Importantly, the fixed effects approach assumes that estimates based on the within-school variation accurately reflect the effects of between school differences. The assumption is potentially problematic in the case of racial composition, where between-school differences in percent black might be expected to reflect far greater differences in social environment or other influences on learning. However, prior work finds little or no evidence of nonlinearities in the effect of school proportion black on achievement and, more importantly, finds that coefficients identified from non-movers are very similar in magnitude to coefficients identified from a sample of school switchers (Hanushek, Kain, and Rivkin (2006)).

The impact of these teacher and peer characteristics on the racial achievement gap depends of course on racial differences in their distributions. Table 8 illustrates the pronounced differences in the share of teachers with little or no experience, in student turnover, and in student racial composition in both the ECLS and TSP data.[30] Black students are 4-5 percent more likely to have a new teacher and also attend schools with a 4-5 percent higher rate of student turnover (percent new to the school each year).[31] As is well known, even with dramatic improvement after *Brown*, blacks remain far more likely than whites to attend school with a high black enrollment share (Welch and Light (1987), Clotfelter (2004), Rivkin and Welch (2006)). In Texas public schools there is a 28

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30 Although class size is also frequently mentioned for consideration in the early grades, there are virtually no racial differences in average class size in either the ECLS or TSP data.

31 These differences for teacher experience are consistent with teacher mobility patterns and are frequently related to teacher preferences. Schools with higher student turnover and minority enrollment tend to have a higher proportion of inexperienced teachers (Greenberg and McCall (1974), Murnane (1981), Lankford, Loeb, and Wyckoff (2002), Hanushek, Kain, and Rivkin (2004b)).

Table 8. Black-white Differences in Teacher and Peer Characteristics for ECLS and TSP Samples

	United States (3rd grade) [ECLS]			Texas (3rd-8th grade) [TSP]		
	Blacks	Whites	B-W	Blacks	Whites	B-W
proportion students new to school	0.170	0.130	0.040	0.226	0.181	0.045
teacher experience						
proportion 0 years	0.079	0.039	0.040	0.095	0.069	0.026
proportion 1 year	0.086	0.050	0.036	0.082	0.067	0.015
proportion students black				0.361	0.090	0.271
Proportion of students in schools where;						
0% students are black	0.002	0.087	-0.085			
0-5% of students are black	0.034	0.544	-0.510			
5-10% of students are black	0.023	0.100	-0.077			
10-25% of students are black	0.190	0.171	0.019			
>25% of students are black	0.750	0.098	0.652			

percentage point differential in average black enrollment share, and the ECLS data also provide clear evidence that blacks are much more likely to attend schools with high black enrollment shares.[32]

Together the estimates reported in Table 7 and racial gaps in characteristics described in Table 8 raise the possibility that these three characteristics account for a substantial portion of the growth in the racial achievement gap. To quantify the impact of these factors, we simulate the contributions of the differential incidence of each variable to the annual and cumulative achievement gaps with a framework based on equations 2-4. Table 9 describes annual and cumulative impacts on achievement gaps obtained by multiplying the coefficients by the changes in characteristics for whites and blacks necessary to eliminate average race differences in these variables.[33] All variable effects are assumed to be constant across grades within elementary and middle schools and to depreciate exponentially at an annual rate of 30 percent (one minus the coefficient on lagged test score, $\hat{\theta}$). Notice that a constant racial difference in a factor and constant effect for all grades (e.g., student turnover) contributes to an increase in the achievement gap with age because the simulation captures the cumulative nature of knowledge acquisition.

Not surprisingly given the size of the black-white differential, the simulation in Table 9 shows that school proportion black accounts for a much larger share of the growth in the gap than student turnover and teacher experience. Together the latter two cumulatively account for roughly 0.02 standard deviations or about 19 percent of the increase in the achievement gap between grades 3 and 8. On the other hand, the black concentration in schools attended by blacks accounts for almost 0.1 standard deviations or roughly 83.9 percent of the increase in the gap between 3rd and 8th

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[32] The racial composition information in the ECLS data set aggregates all students in schools with 25 percent or more black students into a single category, even though 75 percent of black students in the sample fall in this top category. See Table 8.

[33] The simulated changes in turnover, racial composition and teacher experience for blacks and whites are proportional to the black and white enrollment shares, respectively.. Elementary school estimates are used for grades 4 and 5, and middle school estimates are used for grades 6-8. In Texas, 80 percent of middle schools include grade six, while the remainder place grade six in elementary schools. These proportions do not differ by race. For simplicity, our simulation assumes that all grade six students attend middle school.

Table 9. Impact of Equalizing Teacher Experience, Student Turnover, and Student Proportion Black on the White-Black Achievement Gap between 3rd and 8th Grade

(negative impacts indicate reduction in white-black achievement gap)

	Elementary schools (grades 3-5)		Middle schools (grades 6-8)		Total (grades 3-8)	
	Annual Impact[a]	Cumulative Impact[b]	Annual Impact[c]	Cumulative Impact[b]	Cumulative Impact[b]	Percent of increase in gap[d]
proportion students new to school	-0.004	-0.007	-0.005	-0.012	-0.015	12.6%
proportion students black	-0.028	-0.048	-0.036	-0.080	-0.096	83.9%
Teacher Experience						
proportion 0 years	-0.003	-0.006	-0.002	-0.004	-0.006	5.0%
proportion 1 year	0.000	0.000	-0.001	-0.001	-0.001	1.2%
Total	**-0.036**	**-0.062**	**-0.044**	**-0.097**	**-0.118**	**102.8%**

Notes:
a. Calculated from coefficients in Table 7, column 2.
b. Calculated with depreciation $(1-\theta)=0.3$.
c. Calculated from coefficients in Table 7, column 4.
d. The achievement gap in Texas increases by 0.115 standard deviations between grade 3 and 8.

grade. The unequal distributions of these three characteristics account for all of the growth in the overall achievement gap, providing strong support for the belief that deficiencies related to the school experience inhibit the academic progress of blacks vis-à-vis whites during these grades.

The similarly large black-white differences in teacher experience, student turnover, and proportion black observed in the ECLS data – in combination with the much more rapid growth in the achievement gap in the early grades – strongly suggests that the impact of school quality differences is at least as large if not larger in the early elementary grades.[34]

The simulation does rely on the assumption of a linear effect of proportion black on achievement. This constitutes an important assumption given the magnitude of the black-white difference in average school proportion black. Although nonlinearities cannot be ruled out, other research using the TSP data finds little or no evidence of nonlinear effects up to a quartic in school proportion black (Hanushek, Kain, and Rivkin (2006)).

B. Differences by initial achievement

In considering the pattern of changes in the racial achievement gap over time, we observed that the largest changes were found for students at the higher end of the initial skill distribution. Differences in either the black-white gaps in the characteristics or variable effects by initial skill could produce such a pattern.

Appendix Table a10 provides little or no evidence of systematic differences by initial skill grouping in the racial disparities in teacher experience, student turnover, student racial composition, or other school or peer characteristics such as peer average 3rd grade mathematics achievement. Thus it does not appear that the pattern of differences in school or peer characteristics accounts for the higher growth in the achievement gap at the higher end of the initial reading test distribution.

To test formally for systematic parameter differences by initial achievement, we divide students into two groups – those in one of the top four categories (high scorers) and the rest – and re-estimate the prior models allowing for differential impacts.[35] Table 10 reports regression results for models that fully interact the school variables with the indicators for black and high scorers. These estimates show that the effects of the proportion of teachers with no prior experience are systematically smaller for blacks and whites with higher 3rd grade reading scores, while the adverse effect of a higher proportion black is larger for blacks in higher reading categories. These findings hold across elementary and middle schools. In combination with the large racial difference in school proportion black, these estimates suggest that the differential impact of racial concentration contributes to the higher growth in the black-white gap for students in the upper portion of the 3rd grade reading distribution.

5. Conclusions

By any measure, black-white differences in schooling outcomes are a matter of enormous concern. The early progress toward racial convergence that followed *Brown v. Board of Education* and the civil rights legislation of the 1960s has slowed if not stopped over the past two decades (Neal (2006)). The implications of this slowdown for earnings inequality and the economic well-being of blacks have been magnified by the substantial increase in the return to skill experienced over the past 30 years.

The differences in measured skills between blacks and whites are enormous. By age 17, the average black student is performing at around the 20th percentile of the white distribution.[36] This performance feeds directly into further schooling and into the labor market, continuing the cycle of inequality.

Our work concentrates, however, on achievement differences in elementary and middle

[34] Note, however, that the direct estimates of these factors on early achievement by Murnane, Willett, Bub, and McCartney (2005) does not show their importance for achievement. They further suggest that racial composition is simply a proxy for SES.

[35] Preliminary estimates stratified the data into even finer categories. While these results fluctuated from category to category, the overall pattern was also present there.

[36] See data on the National Assessment of Educational Progress, or NAEP (National Center for Education Statistics (2005)).

Table 10. Impact of Student Characteristics on Achievement by 3rd Grade Reading Category

	elementary school		middle school	
proportion students new to school				
whites in low test score group	-0.085	(2.48)	-0.114	(2.84)
whites in high test score group	-0.109	(4.71)	-0.093	(2.90)
blacks in low test score group	-0.139	(2.65)	-0.179	(3.11)
blacks in high test score group	-0.088	(1.79)	-0.127	(2.66)
proportion students black				
whites in low test score group	-0.052	(1.65)	-0.107	(2.73)
whites in high test score group	-0.019	(0.77)	-0.078	(2.20)
blacks in low test score group	-0.066	(1.93)	-0.148	(3.63)
blacks in high test score group	-0.142	(4.84)	-0.202	(5.03)
proportion of teachers with 0 yrs experience				
whites in low test score group	-0.138	(7.19)	-0.060	(3.75)
whites in high test score group	-0.054	(4.48)	-0.032	(2.91)
blacks in low test score group	-0.121	(3.98)	-0.087	(3.59)
blacks in high test score group	-0.180	(3.91)	-0.043	(1.90)
proportion of teachers with 1 yr experience				
whites in low test score group	-0.050	(2.72)	-0.031	(1.91)
whites in high test score group	-0.017	(1.51)	-0.001	(0.44)
blacks in low test score group	-0.062	(1.96)	-0.048	(2.10)
blacks in high test score group	0.069	(2.61)	-0.040	(1.91)
observations	59,901		38,007	

Notes: students in top four reading categories classified as high; absolute value of t statistics computed from robust standard errors controlling for grouping by school in parenthesis. Estimation uses the exhaustive set of school-year-grade-race-initial achievement cells. All specifications include achool-by grade and attendance zone-by-year fixed effects, female and black, and high initial achievement dummies, and indicators for, subsidized lunch eligibility, special education participation, and nonstructural moves (fully interacted with black), and grade-by-year fixed effects.

school, building upon several recent studies on the determinants of early achievement gaps.[37] In contrast to doubts raised by a number of authors concerning the importance of schools, our work finds that differences in school quality play a fundamental role in the growth of achievement differences with age. Decompositions of achievement differences into between- and within-school components show that changes occurring between schools account for a preponderance of the increase with age, particularly prior to 5th grade. After 5th grade, further increases in racial achievement differences are concentrated among students with higher levels of initial achievement. Finally, although there is little or no evidence of gender differences in either the average growth in the black-white gap or changes by initial achievement, the much lower test taking rates of black boys indicates that the achievement comparisons do not capture the educational difficulties of many black boys, particularly those at the lower end of the initial achievement distribution.[38]

The substantial contribution of changes in achievement gaps between schools is consistent with an important role for schools, and we find that the imbalanced racial distribution of specific characteristics of teachers and peers – ones previously found to have significant effects on achievement – can account for all of the growth in the achievement gap following third grade.[39] Specifically, differences in school mobility rates, in the prevalence of beginning teachers, and in the racial composition of schools combine to exacerbate early racial achievement gaps.

The analysis also finds systematic differences in effects by initial achievement. Having a

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[37] Fryer and Levitt (2004, (2005) and Murnane, Willett, Bub, and McCartney (2005) have addressed the early time period of racial achievement, and both have raised questions about whether or not schooling plays a role in achievement. In a larger set of papers, James Heckman argues that early investments are much more productive than later schooling investments and discounts any significant role for schools; see, among others, Cunha, Heckman, Lochner, and Masterov (2006), Heckman (2006). This paper does not discount the potential importance of early learning deficits but instead is best thought of as providing more balance in terms of changes that are possible after students enter schooling.

[38] The low rates of test taking for blacks and to a lesser extent whites among those who participate in all five waves in the ECLS sample raise the possibility that the reported growth in achievement differences understates the actual increase during the early elementary school years.

[39] These findings differ from those of Fryer and Levitt (2004), Murnane, Willett, Bub, and McCartney (2005) and others who do not focus on those variables for which there exist large differences by race and strong evidence that they are important determinants of achievement. Murnane et al. find that racial composition appears to be a simple proxy for SES and that initial teacher experience has no impact, but they are unable to claim that they have credibly identified causal impacts.

teacher with no prior experience appears more costly for students with lower initial achievement, while the adverse effect on blacks of a higher proportion black appears to rise with initial achievement and to explain a portion of the more rapid increase in the racial achievement gap among those with higher initial achievement.[40]

All in all, the central finding is that school quality plays an important role in the determination of achievement and racial achievement differences. Indeed, the impact of schools is almost certainly much larger than we show here: As Rivkin, Hanushek, and Kain (2005) indicate, easily quantifiable variables do not explain the bulk of the variance in teacher and school quality. Our analytical strategy focuses entirely on identifying causal impacts, and thus a portion of the systematic influences of schools is undoubtedly ignored because we could not ensure that any relationships observed is truly causal.[41]

Nonetheless, implications for policy remain uncertain. Perhaps the most easily identified policies focus on reducing the share of teachers with little or no experience in schools with large minority enrollment shares. However, because a substantial portion of the current appears to result from the preferences of teachers, the solutions are far from clear (Hanushek, Kain, and Rivkin (2004a)). Similarly, the high turnover of students in schools attended by blacks in part results from the high mobility of black students – itself potentially caused by larger economic issues.

Of course the largest contribution to the achievement gap comes from the strong relationship between achievement and proportion black for blacks in the Texas public schools. Yet again implications for policy are unclear. As Rivkin and Welch (2006) report, housing patterns

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[40] Our data do not permit disentangling the possible avenues for the teacher experience effects. It may be that teachers improve more in their teaching of lower achieving students for whom learning comes less easily, it may be that students tend to be more disruptive in schools with more lower achievers and that an important component of the return to experience is learning to manage disruption, or it may be low achievers are much more likely to attend schools that struggle to find teachers skilled in the teaching of mathematics. We are unable to unravel these possibilities.

[41] One example is the possible importance of the race match of students and teachers. Ehrenberg and Brewer (1995), Dee (2004), and Hanushek, Kain, O'Brien, and Rivkin (2005) find that black students do better when matched with a black teacher. However, because we cannot investigate classroom linkages here, we cannot pursue this element of schools.

account for the bulk of school segregation, and court decisions limit inter-district desegregation programs. In addition, our sample covers a period without much systematic desegregation activity, and the relationship between achievement and racial composition might depend upon both programmatic and historical factors that determine school attendance patterns in a given district. Moreover, racial composition effects may vary by the intensity of desegregation efforts. Consequently, any newly designed active initiatives to increase substantially black exposure to whites might produce a different relationship between achievement and racial composition.

We conclude that, although we identify specific school and peer factors that systematically affect racial achievement gaps, policy directed at just these factors is unlikely to be very successful. Instead, a broader set of policies aimed at improving the quality of schools attended by blacks – such as improving teacher quality – will be required. In addition, the large gaps at school entry highlight the importance of developing effective early childhood interventions.

Appendix

This appendix develops the decomposition presented in equation (1). We begin by expressing the average achievement for blacks (and whites) as equal to the weighted average of school average achievement for the respective group d:

$$\bar{A}_w - \bar{A}_b = \sum_s \frac{n_{ws}}{n_w}\bar{A}_{ws} - \sum_s \frac{n_{bs}}{n_b}\bar{A}_{bs}$$

Addition and subtraction of the overall school average achievement of all blacks and whites $\bar{A}_s$ from each term yields

$$\bar{A}_w - \bar{A}_b = \sum_s \left[\frac{n_{ws}}{n_w}\bar{A}_s + \frac{n_{ws}}{n_w}\left[\bar{A}_{ws} - \bar{A}_s\right]\right] - \sum_s \left[\frac{n_{bs}}{n_b}\bar{A}_s + \frac{n_{bs}}{n_b}\left[\bar{A}_{bs} - \bar{A}_s\right]\right]$$

Reorganizing terms produces between and within school components.

$$\bar{A}_w - \bar{A}_b = \sum_s \left[\frac{n_{ws}}{n_w}\bar{A}_s - \frac{n_{bs}}{n_b}\bar{A}_s\right] + \sum_s \left[\frac{n_{ws}}{n_w}\left[\bar{A}_{ws} - \bar{A}_s\right] - \frac{n_{bs}}{n_b}\left[\bar{A}_{bs} - \bar{A}_s\right]\right]$$

Expressing the school average achievement components $\bar{A}_s$ in the second summation term equal to the weighted average of the average achievement levels of blacks and whites in the school yields

$$\bar{A}_w - \bar{A}_b = \sum_s \left[\frac{n_{ws}}{n_w}\bar{A}_s - \frac{n_{bs}}{n_b}\bar{A}_s\right] + \sum_s \left[\frac{n_{ws}}{n_w}\left[\bar{A}_{ws} - \left(\frac{n_{ws}}{n_s}\bar{A}_{ws} + \frac{n_{bs}}{n_s}\bar{A}_{bs}\right)\right] - \frac{n_{bs}}{n_b}\left[\bar{A}_{bs} - \left(\frac{n_{ws}}{n_s}\bar{A}_{ws} + \frac{n_{bs}}{n_s}\bar{A}_{bs}\right)\right]\right]$$

Next, each term in brackets in the second summation term can be simplified by multiplying the denominators and numerators by n_s where necessary. Then the $1/n_w$ and $1/n_b$ terms can be moved outside the summation yielding

$$\bar{A}_w - \bar{A}_b = [\sum_s \frac{n_{ws}}{n_w}\bar{A}_s - \sum_s \frac{n_{bs}}{n_b}\bar{A}_s] + [\left(\frac{1}{n_w} + \frac{1}{n_b}\right)\sum_s (\bar{A}_{ws} - \bar{A}_{bs})\alpha_s(1-\alpha_s)n_s]$$

Appendix Table a1. Texas Black-white Math Test Score Gap by 3rd Grade Reading Test Score Category (students with complete observations)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Overall																
3rd grade	0.51	0.49	0.43	0.41	0.37	0.41	0.35	0.32	0.30	0.30	0.27	0.24	0.22	0.21	0.18	0.16
5th grade	0.61	0.61	0.49	0.52	0.47	0.50	0.46	0.45	0.41	0.41	0.39	0.36	0.36	0.37	0.31	0.34
8th grade	0.58	0.56	0.48	0.47	0.46	0.51	0.44	0.50	0.42	0.47	0.44	0.43	0.43	0.46	0.44	0.44
Between School																
3rd grade	0.41	0.37	0.32	0.27	0.24	0.29	0.22	0.18	0.16	0.16	0.12	0.10	0.09	0.09	0.07	0.05
5th grade	0.48	0.44	0.37	0.36	0.33	0.35	0.28	0.27	0.24	0.23	0.21	0.19	0.19	0.21	0.17	0.20
8th grade	0.41	0.37	0.33	0.31	0.28	0.34	0.25	0.28	0.24	0.27	0.22	0.24	0.22	0.25	0.25	0.25
blacks	1,464	1,895	1,472	2,254	3,063	2,528	3,574	5,838	4,131	4,525	7,957	9,809	7,215	9,996	11,518	6,092
whites	1,481	2,082	1,852	2,738	4,246	3,665	6,156	10,776	8,367	10,333	21,083	31,009	29,399	51,422	82,721	61,935
Overall change																
3rd to 5th	0.10	0.12	0.06	0.11	0.10	0.09	0.11	0.13	0.11	0.11	0.12	0.12	0.14	0.16	0.13	0.18
5th to 8th	-0.03	-0.05	-0.01	-0.05	-0.01	0.01	-0.02	0.05	0.01	0.06	0.05	0.07	0.07	0.09	0.13	0.10
Change in between school																
3rd to 5th	0.07	0.07	0.05	0.09	0.09	0.06	0.06	0.09	0.08	0.07	0.09	0.09	0.10	0.12	0.10	0.15
5th to 8th	-0.07	-0.07	-0.04	-0.05	-0.05	-0.01	-0.03	0.01	0.00	0.04	0.01	0.05	0.03	0.04	0.08	0.05

Source: Author calculations from TSP data.

Appendix Table a2. U.S. Black-white Math Test Score Gap by Gender (unweighted data)

	boys					girls				
grade	fall k	spring k	1	3	5	fall k	spring k	1	3	5
overall	6.3	8.6	13.8	20.0	20.4	5.8	8.1	12.1	18.9	19.9
between school	5.0	7.0	11.2	16.0	16.8	4.7	6.3	9.6	14.9	16.0
within school	1.2	1.5	2.6	4.0	3.6	1.1	1.8	2.5	4.0	4.0
blacks	587	646	648	623	631	578	630	635	626	618
whites	3,026	3,326	3,328	3,258	3,247	2,946	3,194	3,207	3,181	3,163

Source: Author calculations from ECLS data.

Appendix Table a3. Texas Public School Black-white Math Test Score gap by Gender (TAAS standardized test scores)

	boys			girls		
grade	3	5	8	3	5	8
overall	0.60	0.66	0.71	0.57	0.64	0.70
between school	0.19	0.25	0.28	0.19	0.25	0.29
within school	0.41	0.41	0.43	0.38	0.39	0.41
blacks		40,163			47,711	
whites		166,267			170,431	

Source: Author calculations from TSP data.

Appendix Table a4. U.S. Black-white Math Test Score Gap by Gender and Spring Kindergarten Reading Test Score Category

	boys					girls				
	1	2	3	4	5	1	2	3	4	5
Overall										
kindergarten	2.3	4.0	5.4	7.1	3.9	1.7	2.8	4.3	5.0	6.2
1st grade	5.7	6.9	10.1	11.1	12.6	5.2	5.4	5.7	8.3	14.0
3rd grade	15.4	13.9	16.0	14.5	13.6	12.5	10.5	13.9	11.6	16.4
5th grade	16.9	14.9	15.9	14.2	16.2	15.0	12.2	15.3	12.5	15.0
Between School										
kindergarten	2.4	3.5	4.2	7.0	4.0	1.8	2.5	3.9	4.3	6.0
1st grade	5.6	6.3	8.3	10.3	12.4	5.2	4.5	5.3	7.0	13.7
3rd grade	14.7	12.7	14.5	13.0	13.0	12.3	9.2	12.3	9.9	16.4
5th grade	16.8	13.4	14.2	12.5	15.9	14.4	10.4	13.5	11.0	15.0
blacks	123	208	149	85	25	85	204	175	85	40
whites	266	756	1,000	776	251	116	559	1,078	791	311

Source: Author calculations from ECLS data.

Appendix Table a5. Texas Black-white Math Test Score Gap by Gender and 3rd Grade Reading Test Score Category (intact cohort)

	reading test score group															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Boys																
Overall																
3rd grade	0.50	0.51	0.41	0.43	0.38	0.41	0.34	0.31	0.33	0.30	0.25	0.25	0.20	0.21	0.19	0.16
5th grade	0.58	0.57	0.43	0.43	0.40	0.46	0.42	0.41	0.37	0.38	0.37	0.34	0.34	0.34	0.30	0.34
8th grade	0.61	0.61	0.49	0.43	0.40	0.49	0.42	0.45	0.40	0.43	0.43	0.42	0.42	0.44	0.43	0.44
Between																
3rd grade	0.43	0.41	0.32	0.31	0.27	0.32	0.23	0.18	0.20	0.19	0.13	0.12	0.08	0.09	0.09	0.06
5th grade	0.48	0.46	0.37	0.32	0.35	0.34	0.30	0.27	0.24	0.26	0.22	0.19	0.20	0.20	0.17	0.20
8th grade	0.49	0.47	0.35	0.32	0.29	0.35	0.27	0.29	0.24	0.27	0.23	0.24	0.23	0.25	0.25	0.25
blacks	781	960	788	1,171	1,559	1,223	1,804	2,911	1,980	2,156	3,696	4,365	3,119	4,136	4,594	2,361
whites	891	1,215	1,081	1,587	2,433	2,085	3,487	6,046	4,521	5,578	11,143	16,015	14,802	24,835	38,339	27,540
2. Girls																
Overall																
3rd grade	0.48	0.44	0.42	0.36	0.31	0.38	0.34	0.32	0.26	0.27	0.26	0.21	0.21	0.20	0.17	0.15
5th grade	0.61	0.62	0.52	0.58	0.50	0.50	0.47	0.47	0.42	0.42	0.39	0.37	0.36	0.39	0.32	0.34
8th grade	0.54	0.52	0.46	0.50	0.49	0.51	0.45	0.52	0.43	0.49	0.43	0.44	0.41	0.47	0.45	0.42
Between																
3rd grade	0.47	0.39	0.36	0.29	0.25	0.29	0.24	0.20	0.16	0.17	0.13	0.09	0.09	0.09	0.07	0.05
5th grade	0.49	0.47	0.40	0.44	0.35	0.40	0.31	0.29	0.28	0.24	0.23	0.21	0.21	0.23	0.19	0.21
8th grade	0.44	0.35	0.31	0.36	0.31	0.37	0.27	0.30	0.25	0.27	0.23	0.24	0.23	0.26	0.25	0.25
blacks	679	932	684	1,080	1,502	1,303	1,765	2,925	2,149	2,369	4,251	5,437	4,093	5,857	6,916	3,728
whites	589	867	769	1,150	1,806	1,577	2,661	4,720	3,841	4,742	9,920	14,967	14,568	26,556	44,337	34,356

Source: Author calculations from TSP data.

Appendix Table a6. Average Mathematics Test Score by Mobility, Race, and Grade in ECLS for Students Who Participate in all Five Survey Waves (weighted by sampling weights)

	Grade					
	fall K	spring K	spring 1st	spring 3rd	spring 5th	number
Blacks						
no school change	19.3	27.9	48.5	77.8	97.5	702
moves between K and first grade	18.9	27.0	49.2	77.3	95.2	76
moves between first and third grade	20.4	29.1	50.8	83.5	106.4	106
moves between third and fifth grade	18.8	27.2	48.0	77.8	95.3	169
Whites						
no school change	25.3	36.3	62.0	97.7	118.5	4,085
moves between K and first grade	24.2	34.9	62.0	96.4	116.7	295
moves between first and third grade	23.9	34.6	60.2	96.6	117.2	487
moves between third and fifth grade	24.5	35.9	60.3	96.0	117.0	738

Source: Author calculations from ECLS data.

Appendix Table a7. Average Mathematics Test Score by Mobility, Race, and Grade in Texas

	Grade					
	3	4	5	6	7	8
Blacks						
no school change	-0.19	-0.21	-0.26	-0.20	-0.24	-0.31
moves to another Texas public school between 3rd and 8th grade	-0.34	-0.46	-0.50	-0.45	-0.49	-0.48
Leaves the Texas public schools between 3rd and 8th grade	-0.82	-0.85	-0.93	-0.98	-0.97	-0.86
Whites						
no school change	0.42	0.42	0.40	0.44	0.45	0.41
moves to another Texas public school between 3rd and 8th grade	0.25	0.18	0.18	0.21	0.22	0.22
Leaves the Texas public schools between 3rd and 8th grade	0.04	0.00	-0.07	-0.09	-0.10	-0.01

Source: Author calculations from TSP data

Appendix Table a8. Distribution of Texas Public School Students by Test and Grade Retention Status, by Race, Gender, and Grade

	Grade					Grade				
	4	5	6	7	8	4	5	6	7	8
			blacks					**whites**		
girls										
has test score	88.2%	89.3%	88.6%	89.3%	87.8%	93.3%	94.3%	94.1%	94.0%	92.5%
no test score:										
special education	8.4%	9.1%	9.2%	7.5%	7.5%	4.1%	4.1%	4.1%	3.7%	4.0%
other	2.5%	1.0%	1.1%	1.6%	3.9%	2.2%	1.2%	1.2%	1.5%	3.0%
Retained in grade	0.8%	0.6%	1.1%	1.6%	0.8%	0.4%	0.4%	0.5%	0.8%	0.5%
boys										
has test score	80.3%	81.2%	79.9%	80.8%	79.1%	90.3%	91.2%	90.6%	90.5%	88.9%
no test score:										
special education	15.9%	16.8%	16.8%	14.4%	14.3%	7.0%	7.0%	7.0%	6.4%	7.1%
other	2.7%	1.1%	1.4%	1.8%	5.2%	2.1%	1.2%	1.3%	1.6%	3.2%
Retained in grade	1.2%	0.9%	2.0%	3.1%	1.7%	0.6%	0.6%	1.1%	1.6%	1.0%

Source: Author calculations from TSP data

Appendix Table a9. Average Mathematics Test Score by Test and Grade Retention Status in the Subsequent Year

	Grade					Grade				
	3	4	5	6	7	3	4	5	6	7
			blacks					**whites**		
girls										
has test score	-0.31	-0.36	-0.39	-0.30	-0.30	0.31	0.29	0.28	0.35	0.39
no test score										
special education	-1.90	-2.12	-2.23	-2.22	-2.10	-1.37	-1.69	-1.87	-1.72	-1.62
other	-0.70	-0.83	-0.82	-0.85	-0.86	0.13	0.11	0.10	0.09	0.02
retained	-1.68	-1.59	-1.65	-1.65	-1.48	-1.04	-1.15	-1.07	-0.96	-0.96
boys										
has test score	-0.38	-0.38	-0.45	-0.41	-0.41	0.31	0.31	0.28	0.32	0.34
no test score										
special education	-1.84	-2.03	-2.20	-2.20	-2.07	-1.15	-1.51	-1.63	-1.65	-1.61
other	-0.78	-0.80	-0.90	-1.07	-1.12	0.13	0.15	0.09	-0.01	-0.16
retained	-1.66	-1.55	-1.61	-1.60	-1.55	-0.92	-0.97	-0.86	-0.98	-1.01

Source: Author calculations from TSP data.

Appendix Table A10. Racial Gap (black minus white) in Peer and School characteristics by 3rd Grade Reading Test Category

	reading test score group															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Peer Variables																
proportion new to school	0.049	0.039	0.032	0.030	0.038	0.036	0.036	0.035	0.033	0.035	0.036	0.036	0.038	0.038	0.041	0.042
proportion Black	0.35	0.32	0.29	0.30	0.30	0.30	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.29	0.30
teacher experience																
proportion 0 years	0.047	0.029	0.027	0.025	0.025	0.023	0.021	0.026	0.021	0.021	0.023	0.023	0.022	0.025	0.024	0.028
proportion 1 year	0.013	0.019	0.013	0.009	0.008	0.012	0.012	0.012	0.012	0.011	0.012	0.015	0.013	0.014	0.015	0.015

Source: Author calculations from TSP data.

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