IRePP
Stanford University
Institute for Research on Education Policy & Practice

WORKING PAPER # : 2008-01

# The Hispanic-White Achievement Gap in Math and Reading in the Elementary Grades

Sean F. Reardon
Stanford University

Claudia Galindo
Johns Hopkins University

January 2008

The research reported here was funded by the Carnegie Scholars Program of the Carnegie Corporation of New York. Additional research support was provided by the National Task Force on Early Childhood Education for Hispanics and the AERA Research Grants Program. We thank Eugene García and L. Scott Miller for very helpful feedback and suggestions, and Joe Robinson and Tara Beteille for exceedingly good research assistance. All errors remain our own. Address correspondence to Sean F. Reardon, 520 Galvez Mall, #526, Stanford CA 94305-3084, sean.reardon@stanford.edu.

# The Hispanic-White Achievement Gap in Math and Reading in the Elementary Grades


## Abstract

Despite the rapid growth and the substantial diversity of the Hispanic school-age population in the U.S., we have relatively little detailed and systematic knowledge regarding achievement patterns among various Hispanic subgroups, particularly in comparison to the extent of available information on achievement patterns among Black students. In this paper, we provide a detailed descriptive analysis of the development of Hispanic-White math and reading achievement gaps in elementary school, with particular attention to variation in these patterns among Hispanic subgroups. We use kindergarten through fifth grade test score data from a nationally-representative sample of students who were in kindergarten the fall of 1998. We find that Hispanic students, like Black students, enter kindergarten with math and reading skills much lower, on average, than their non-Hispanic White counterparts. The Hispanic-White gaps in math and reading narrow by roughly a third in the first two years of schooling, but remain relatively stable for the next four years. There is considerable heterogeneity in the size and development of achievement gaps among Hispanic subgroups defined by national origin, immigrant generational status, and English language use and proficiency. Students with Mexican and Central American origins, particularly first- and second-generation immigrants, and those not English proficient at the start of kindergarten have the lowest math and reading skill levels at kindergarten entry, but also show the greatest gains relative to non-Hispanic White students in the early years of schooling.

# The Hispanic-White Achievement Gap in Math and Reading in the Elementary Grades

## Introduction

Despite the rapid growth and the substantial diversity of the Hispanic school-age population in the U.S., we have relatively little detailed and systematic knowledge regarding achievement patterns among various Hispanic subgroups, particularly in comparison to the extent of available information on achievement patterns among Black students. This is not to say we have no evidence regarding the achievement of Hispanic students. It is clear from recent cross-sectional national studies that the educational outcomes of Hispanic students in U.S. schools lag, on average, well behind those of non-Hispanic White and Asian students, and in some cases, behind those of non-Hispanic[1] Black students as well (Kao and Thompson 2003; Kohler and Lazarín 2007; Lee and Burkham 2002; Schneider, Martinez, and Owens 2006). Hispanic children have lower levels of school readiness at the start of kindergarten than White and Black children (Duncan and Magnuson 2005; Fryer and Levitt 2004; Reardon 2003; Rumberger and Arellano 2004; Zill, Collins, West, and Hausken 1995). High school completion rates for Hispanic students are substantially lower than either White or Black students (Kaufman, Alt, and Chapman 2001; Padron, Waxman, and Rivera 2002; Perreira, Harris, and Lee 2006). Likewise, Hispanic students are less likely than White students to attend and graduate from college (Cameron and Heckman 2001; Stoops 2004), and more likely to be enrolled in two-year colleges than four-year colleges (Fry 2004).

Nonetheless, most studies of Hispanic students' achievement pattern treat Hispanic students as a single undifferentiated category, typically comparing average achievement patterns of non-Hispanic White students to those of Hispanic students as a whole. Moreover, until recently,

[1] Throughout the remainder of this paper, we use the terms "White," "Black," and "Asian" to denote non-Hispanic members of each respective group.

nationally-representative studies that include sizeable samples of Hispanic students have included data only on 4th graders or students in 8th-12th grade,[2] limiting our knowledge about the development of Hispanic-White achievement gaps during elementary school.

Given the lack of existing evidence describing national patterns of Hispanic students' achievement in the elementary grades, we provide here a detailed descriptive analysis of the development of Hispanic-White math and reading achievement gaps in elementary school, with particular attention to variation in these patterns among Hispanic subgroups. We use kindergarten through fifth grade test score data from a nationally-representative sample of students who were in kindergarten the fall of 1998. While a full accounting of the causes of the observed patterns is certainly necessary, we do not aim in this paper to explain the causes of these gaps nor to suggest or evaluate remedies. Just as in medicine, where epidemiological documentation may stimulate the discovery of a cure, so too in educational research, a detailed description of the development of achievement gaps may lead to a better understanding of their causes and solutions.

The paper proceeds as follows. We begin with a brief review of existing evidence regarding trends and patterns in Hispanic-White achievement gaps in elementary grades, drawing on studies that use nationally-representative samples, or samples from states with large populations of Hispanic students. In the second section of the paper, we describe the data and measures on which we rely for the remainder of the results in the paper. We include here a discussion of methodological and measurement issues involved in assessing the magnitude and development of achievement gaps, since these issues underlie all our subsequent results and discussion. The third section of the paper describes patterns in the development of Hispanic-White math and reading disparities through

[2] Recent nationally-representative studies with sizeable Hispanic student samples include the National Assessment of Educational Progress (NAEP; 4th, 8th, and 12th grades), the National Education Longitudinal Study (NELS; 8th-12th grades), the National Longitudinal Study of Adolescent Health (Add Health; 7th-12th grades), and the Education Longitudinal Study (ELS: 10th-12th grades). The Early Childhood Longitudinal Study—Kindergarten Cohort (ECLS-K), which we use in this paper, is the only recent nationally-representative study with a large Hispanic sample of elementary school students (kindergarten-5th grade).

elementary school; here we report gaps for Hispanic subgroups defined by national origin and immigrant generational status.[3] We also investigate the extent to which these gaps differ among Hispanic subpopulations defined by language use and socioeconomic status. We conclude with a discussion of the implications of our findings.

**1. Educational Achievement Patterns of Hispanic Students**

The best recent data on the size of Hispanic-White achievement gaps in the elementary grades comes from the National Assessment of Educational Progress (NAEP). The so-called "Main-NAEP" assessments have been given to state- and nationally-representative samples of students in grades 4, 8, and 12 roughly every two years since the early 1990's. Figure 1 reports estimates of the size of the Hispanic-White gap in math and reading from 1990-2007 for the nation as a whole and for the four states with the largest proportions of Hispanic students (we report gaps in only 4th- and 8th-grade here, given our focus on elementary grades).[4] Gaps are measured in standard deviation units.

Nationally, in both math and reading, and in both 4th and 8th grade, the Hispanic-White gaps have declined slightly in the last decade, by roughly one tenth of a standard deviation. Nonetheless, the gaps remain large—roughly three-quarters of a standard deviation in each subject and grade.[5]

---

[3] Here we adopt the common definitions of immigrant generational status: first generation immigrants are those born outside the U.S. to non-native parents; second generation immigrants are those born in the U.S. to non-native parents; and third generation immigrants are those born to U.S.-born parents.

[4] Given the large samples of Hispanics in the most recent NAEP assessments, it is possible to estimate average NAEP scores for Mexican-, Cuban-, and Puerto Rican-origin Hispanic students separately. Interestingly, the Hispanic-White achievement gaps do not vary much by national origin: Mexican-, Cuban-, and Puerto-Rican-origin Hispanics have performed, on average, equally well on the 4th- and 8th-grade NAEP math and reading tests from 2003-2007. However, exclusion rates of Hispanic students vary among national-origin subgroups (because states have different exclusion policies and because English proficiency rates vary among subgroups), so it is not clear that these NAEP subgroup comparisons are valid.

[5] Some caution is warranted when comparing Hispanic-White achievement gaps across cohorts or grades. Given the dramatic increase of the Hispanic student population since the early 1990s, the composition of Hispanic students tested in different grades and different years may vary somewhat, and so any comparison across cohorts or grades may be confounded with the changing composition of the Hispanic student population. In addition, changes in the content of the NAEP assessments may confound estimates of changes in the size of achievement gaps (though gap estimates are

The size of the gaps varies among the four states as well; in general, the gaps are larger in California and New York than Texas and Florida. In each state the gaps appear to have generally narrowed somewhat over the last decade, though the smaller state samples render the within-state trend estimates considerably less precise than the national trend estimates (note the much larger 95% confidence intervals on the state-specific estimates).

Figure 1 here

While NAEP data are useful for examining trends over time and differences among states in the magnitude of Hispanic-White achievement gaps, they do not provide a detailed description of how gaps develop as students progress through school—both because NAEP data are only available at a few grade levels and because the NAEP data are based on repeated cross-sections of grade cohorts rather than longitudinal data on cohorts tracked over time. Comparison of the 4th-grade and 8th-grade gaps in Figure 1 suggests that Hispanic-White gaps do not change substantially in the late elementary and middle-school years, though changes in the composition of the cross-sectional grade cohorts over time again potentially complicate such comparisons. Studies with repeated measures of achievement for the same sample of students over time provide the best information on how achievement gaps develop over time.

We identified three studies containing estimated Hispanic-White achievement gaps based on longitudinal test score data from large, representative samples of Hispanic and White elementary school students.[6] First is the Early Childhood Longitudinal Study--Kindergarten Cohort (ECLS-K),

---

arguably less sensitive to changes in the content of the test than are estimates of mean score differences—see the discussion of measurement issues below). Finally, NAEP exclusion rates (the rates at which students identified as English Learners were excluded from the NAEP sample) vary somewhat across years, grades, and test subjects, further complicating comparison of the trends among states. Nonetheless, because NAEP exclusion rates were generally higher in the early years of NAEP than in recent years, the apparent narrowing trend in the NAEP gaps likely underestimates the true narrowing trend.

[6] We do not discuss Hispanic-White gap estimates from other studies for a variety of reasons: some are based on small, local samples (e.g., Bali and Alvarez 2003); some are based on non-representative national samples (e.g., Phillips 2000 estimates Mexican-White gaps using data from the Children of the NLSY study, which includes a sample representative of children born to women who were 14-21 years old and living in the U.S. in 1979, a population that excludes first-

a study of a nationally-representative sample of students who were in kindergarten in the fall of 1998 (National Center for Education Statistics 2001). The ECLS-K sample was tested in math and reading at multiple times from 1998-2004. Fryer and Levitt (2006) report estimated Hispanic-White gaps from kindergarten through third grade using these data. Second is a study using data from five cohorts of North Carolina students in grades 3-8 from 1995-2004 (Clotfelter, Ladd, and Vigdor 2006). The last study uses data from two cohorts of the 1991-1994 Prospects study, one cohort followed from first to third grade, and one followed from third to sixth grade (Borman, Stringfield, and Rachuba 2000). Each of these studies provides repeated estimates of Hispanic-White achievement gaps in math and reading for cohorts of students in elementary school in the last 15 years. Figure 2 reports these estimates.

Figure 2 here

With the exception of the Prospects first-grade cohort, each of these studies generally finds that Hispanic-White gaps in both math and reading narrow somewhat as children progress through elementary school. While there are differences in the sizes of the estimated gaps across studies, these may result from differences in the cohorts of students included and differences in the tests used in each study. The patterns in the Prospects first-grade cohort data are somewhat perplexing; the math gaps widen sharply in first and second grades and then narrow sharply in third; while the reading gaps narrow in first grade, widen in second, and then narrow again in third. Given the general consistency of the gradual narrowing evident in the other studies, it seems likely that the patterns in the Prospects first-grade cohort data are either due to sampling variation or are an artifact of the tests used.

---

generation children and children of parents who immigrated since 1979, and which is overrepresentative of children born to young mothers); and some report gaps in ways not comparable to other studies. (e.g., Murnane, Willett, Bub, and McCartney 2006).

Diversity of the Hispanic Student Population

While the studies described above provide some evidence that Hispanic-White achievement gaps narrow slightly during elementary school, each of the studies treats Hispanic students as a homogenous group. Given the size of the Hispanic student population—one-sixth of the school-age population, and over one-fifth of public elementary school enrollments (National Center for Education Statistics 2002a)—however, a fuller account of Hispanic students' achievement patterns would consider their substantial diversity as well.

The Hispanic student population is diverse along several key dimensions, including national origin, family immigration history (including immigrant generation, context of reception, and length of time in the U.S.), socioeconomic status, and linguistic and cultural characteristics. With regard to national origin, Mexicans are by far the most predominant Hispanic group in the U.S., representing 59% of the Hispanic population. Next in size are Puerto Ricans (10%), Central Americans (including Dominicans) (7%), Cubans (5%), and South Americans (4%) (Guzman 2001; Ramirez 2004). With regard to immigration history, the diversity of the Latino population is reflected in their heterogeneity by nativity and immigrant generational status. About 60% of the Hispanic population is native-born (Ramirez 2004) and two-thirds of Hispanic children are first- or second-generation immigrants, meaning they have at least one foreign-born parents, while one-third have parents born in the U.S. (Hernandez 2006)

With regard to socioeconomic status, the Hispanic population is, in general, economically disadvantaged in comparison to the non-Hispanic U.S. population: Hispanic median family income in 2003 was $33,000, only 69% of White median family income (DeNavas-Walt, Proctor, and Mills 2004). Likewise, 27% of Hispanic children (and 34% of Hispanic immigrant children) lived below the poverty line in 2000, compared to 9% and 32% for native-born White and Black children (Lichter, Qian, and Crowley 2005). Moreover, economic conditions vary substantially across

Hispanics of different national origins. Poverty rates among Dominicans (28%), Mexicans (25%), and Puerto Ricans (24%) are particularly high; but are much lower for Cubans (15%) and South Americans (15%).

The diversity of the Hispanic student population is also evident in their varying levels of proficiency and use of English and Spanish. Nationally, 21% of Hispanics report they speak only English at home, while 41% report that they do not use English at home and do not speak English well. Among school-age children, almost one-third of Hispanics are designated as English Language Learners. Hispanic students are over-represented in Limited English Proficiency programs, particularly in states with large proportions of Hispanic students. In California, for instance, 40% of kindergarten and first-grade students are English language learners (Gándara 1999). Language use and proficiency, however, vary considerably among Hispanic subgroups. Only 43% and 46% of Central American- and Dominican-origin Hispanics are proficient in English, compared to 73% of Puerto Ricans, for example (Hakimzadeh and Cohn 2007; Ramirez 2004). Moreover, English proficiency rates vary substantially with national origin and generational status: first- and second-generation children from Mexico and Central America, for example, have considerably lower English proficiency rates than third-generation children and Puerto Ricans, for example.

The substantial heterogeneity of the Hispanic student population suggests that Hispanic achievement patterns are not well characterized by a single measure of the Hispanic-White gaps. Instead, in this paper, we describe the developmental patterns of achievement gaps for various Hispanic subgroups, in order to identify the populations in most need of improved educational supports.

## 2. Data and Methods

Data

The data for this study come from the Early Childhood Longitudinal Study–Kindergarten Class of 1998-1999 (ECLS-K), sponsored by the National Center for Education Statistics (NCES). The ECLS-K contains data on a nationally-representative sample of roughly 21,400 students from the kindergarten class of 1998-99 (thus, representing a cohort born in roughly 1992-93). Students in the sample were assessed in reading and mathematics skills at six time points during the years 1998-2004 (fall 1998, spring 1999, fall 1999, spring 2000, spring 2002, and spring 2004). In addition to these cognitive developmental measures, the ECLS-K data include information gathered from parents, teachers, and school administrators regarding family, school, community, and student characteristics.

To disaggregate the Hispanic student population, we categorize Hispanic students using four key variables: *national/regional origin*, *immigrant generational status*, *socioeconomic status*, and *language used at home*. We describe the construction of each of these variables below. While the measures of immigrant generational status, national/regional origin, and language proficiency that we construct from information available in the ECLS-K data are not ideal, they are certainly better than data that have previously been available.

*National/Regional Origin.* Based on parent survey responses, we classify students as having national origins in Mexico; Puerto Rico; Cuba; South America, Central America (including the Dominican Republic), or elsewhere. This "Other Hispanic origin" category includes a small and heterogeneous group of students with ancestries in Spain, Brazil, Guyana, or Dominica, for example. It also includes students for whom country of birth information is missing and whose parents defined them as members of an "other Spanish/Hispanic/Latino group" in the question about Hispanic group membership.[7]

[7] Roughly a third of the Hispanic students in the sample are missing information on national/regional origin. Most of these cases occur because the student left the sample prior to first grade, when the parental birthplace questions were included in the survey. However, we focus our analysis on the subsample of Hispanic students who were assessed

*Immigrant Generational status*. We categorize ECLS-K Hispanic students as first-, second-, or third-(plus)-generation based on a set of questions in the kindergarten, first-grade, and third-grade parent survey that indicate where they and their parents were born. Students born outside of the U.S. whose mother (or father, if mother's place of birth is not reported) was born outside of the U.S. are classified as first-generation students (island-born Puerto-Rican students are also defined as first-generation students). Students born in the U.S. and whose mother (or father, if mother's place of birth is not reported) was born outside of the U.S. are classified as second-generation students. Finally, students born to a U.S.-born parent (regardless of where the student was born) are classified as third-(plus)-generation students.[8] Although we define the immigrant generational status of all Hispanic students, we report achievement gaps by generational status only for Mexican-origin students, because cell sizes for other groups are too small.

*Language Used at Home*. Because ECLS-K does not include direct measures of English proficiency for all students, we use as a proxy a measure of the language(s) spoken by the student and his or her parent(s) in their home in the fall of kindergarten.[9] Parents were asked how often each parent speaks Spanish to the child, and how often the child speaks Spanish to each parent. Possible responses for each question were 1) never, 2) sometimes, 3) often, and 4) very often. We averaged the non-missing parent responses to these four questions (coded 1-4; alpha reliability=0.96), and then rounded this average to the nearest whole number, yielding a categorical variable describing the primary language used at home (only English, primarily English, primarily Spanish, or only Spanish).

---

through fifth grade, almost all of whom have non-missing data on immigrant generation and national/regional origin.

[8] Roughly 23% of the total ECLS-K sample (roughly 26% of Hispanic students) cannot be unambiguously categorized as first, second, or third-plus generation. As above, most of this missing data (17% of the total sample) is a result of the fact that the kindergarten parent survey did not ask about the parent's country of birth (it was asked in the first- and third-grade surveys), so we cannot distinguish second- from third-plus generation students among those who left the sample prior to the spring of first grade (about a fifth of the total sample).

[9] For some supplemental analyses at the end of the paper, we construct a simple dichotomous measure of students' English proficiency in kindergarten. We categorize students as oral English proficient (or not) in the Fall of kindergarten based on whether they were given the math assessment in English or Spanish (see note 10, below).

*Socioeconomic Status.* For the ECLS-K, a continuous measure of socioeconomic status was created based on a composite of the student's mother's and father's educational attainment, mother's and father's occupation, and family income (National Center for Education Statistics 2002b). We average the kindergarten and first grade composite measures for each student, and classify students by quintiles of this measure.

## The ECLS-K Math and Reading Assessments

The ECLS-K direct cognitive assessments are individually-administered, oral, untimed, adaptive tests of math and reading skills. The content areas of the tests are based on the NAEP 4th grade content areas, adapted to be age appropriate at each assessment. The assessments were administered by trained ECLS-K assessors, and were scored using a 3-parameter Item Response Theory (IRT) model. Details of the assessments are provided in the ECLS-K psychometric reports (Pollack, Narajian, Rock, Atkins-Burnett, and Hausken 2005a; Pollack, Rock, Weiss, Atkins-Burnett, Tourangeau, West, and Hausken 2005b; Rock and Pollack 2002).

Students were only administered the ECLS-K math assessment if they were proficient in oral English or oral Spanish, and were only administered the ECLS-K reading assessment if they were proficient in oral English.[10] This has implications for our ability to estimate trends in math and reading test scores. In the early waves of the ECLS-K data collection, many Hispanic students (29% of all Hispanic students; including 42% of Mexican-origin students; and 77% of first-generation Mexican-origin students) were not fluent enough in oral English to be assessed in reading (in English). Because the proportion of oral English-proficient Hispanic students grows over time (to 80% by the spring of kindergarten, 90% by the spring of first grade, and 99% by the spring of third

[10] Students took the math assessment in English if either the school reported the student was from a home where English was the primary language or if the student passed the English Oral Language Development Scale (OLDS) assessment given by ECLS-K assessors. Hispanic students otherwise took the test in Spanish.

grade), and because students not proficient in English certainly have lower average reading skills in English than students proficient in oral English, trends in the mean reading scores of those Hispanic students with reading scores are confounded by changes in the population of Hispanic students represented in the sample of students with test scores. There is no such bias in the mean math score estimates (except for Asian students, 22% of whom were not proficient in English at wave 1 and for whom no home language version of the tests were available), because non-English proficient Hispanic students could take the math test in Spanish.

In order to avoid these confounding patterns, we focus here on estimating reading achievement trends only for the subpopulation of students who were proficient in spoken English at the start of kindergarten. Thus, the Hispanic-White reading gaps reported here almost certainly understate the magnitude of the true Hispanic-White reading gaps, since they are based only on the 71% of Hispanic students proficient in oral English in kindergarten. We caution readers to keep this in mind throughout this paper. As a partial assessment of the extent to which this restriction may affect our conclusions, we include some supplemental analyses at the end of the paper to examine the differences in skills between those students in our analytic sample and those excluded because they were not proficient in oral English at the start of schooling.[11]

[11] Finally, it is important to consider the extent to which estimates of the gap may be biased by what is commonly known as 'test bias'—bias that might result if a test does not measure the desired dimension of cognitive skill equally well for both Hispanic and non-Hispanic White students. A math test administered in English, for example, is essentially a test of both math skills and English language proficiency, rather than a pure measure of math skills, and so may underestimate non-English-speaking students' math skills relative to those of White students. Likewise, tests of math or literacy that depend on cultural knowledge less available to Hispanic students than White students (or vice versa) will yield biased estimates of cognitive skill gaps, since the tests confound cognitive skill with cultural knowledge. In assessing the size and development of Hispanic-White achievement differences, then, it is essential to ensure that the tests truly measure the cognitive skill of interest, unconfounded by language or cultural knowledge. In the ECLS-K data, several facts lead us to believe the tests do not suffer from such biases. First, the math tests were administered orally in Spanish to Hispanic students not proficient in oral English, ensuring that the math test performance was not dependent on students' oral English proficiency nor on literacy skills in either English or Spanish. Second, the reading tests were not administered to students not proficient in oral English. This limits the sample and generalizability of the reading estimates, as discussed above, but it ensures that the estimated reading gaps are unbiased with regard to the population of English-proficient students. Third, the developers of the ECLS-K assessments performed a range of differential item functioning (DIF) tests on the assessment items to ensure that there was no item-level bias in the cognitive assessments (for detail, see Pollack et al. 2005a).

Sample and Descriptive Statistics

Table 1 describes the distribution of the complete ECLS-K sample by race/ethnicity, Hispanic national/regional origin, and immigrant generational status. Of note for our purposes here is the large sample of Hispanic students. There are 4,006 Hispanic students in the sample, of whom roughly 2,600 can be categorized by national origin and immigrant generational status. Mexican-origin Hispanics are by far the largest group of Hispanics, and the only group for whom we have adequate sample sizes to reliably disaggregate achievement patterns by immigrant generational status.[12]

Table 1 here

In order to ensure that the trend data we report is not affected by attrition from the ECLS-K sample, we restrict our analyses of achievement gaps to a subsample of the ECLS-K students who were present in the ECLS-K sample at each wave of the study.[13] In addition, we restrict the analyses of reading trends to students who have valid math and reading scores in wave 1 (fall of kindergarten). In the case of the math assessment, these restrictions do not substantially change our conclusions about the trends compared to an analysis that uses all available students at each wave.[14] In the case of the reading assessment, however, the second restriction limits our analyses to students who were proficient in oral English in the fall of kindergarten (71% of all Hispanic students), as noted above. Table 2 reports the total number of students, by subgroup, used in the math and

[12] Note also that the absence of third-generation South and Central American-origin Hispanics in the sample is an artifact of the way national origin and immigrant generation data were collected. Students whose parent(s) reported being born in the U.S. were identified as third-generation students. For these students, national origin was determined by the question regarding group membership (see above), for which South and Central American were not available responses (only Mexican, Cuban, Puerto Rican, and Other were available options). Thus, third-generation students with origins in South or Central American would be coded as Other or Unknown national origin.

[13] We do, however, include students not assessed in the fall of first grade, since at that wave missingness is largely random—by design, only a 30% random subsample of the full ECLS-K sample were assessed in spring of first grade.

[14] In other words, sample attrition does not appear to be systematically related to achievement, once the appropriate ECLS-K weights are applied. However, for some small subgroups, attrition of a small number of non-representative students does appear to affect our gap estimates. We report the gap trends for a constant sample in order to avoid confounding the gap trends with attrition noise.

reading gap analyses. We do not report gap estimates for subgroups smaller than 40 students.

Table 2 here

Measuring Achievement Gaps

In order to compare the magnitude of achievement gaps across different grades/ages, the gaps must be measured in a comparable metric at each point in time. In the ECLS-K study, the cognitive skill of each student *i* in subject *s* (math or reading) at each assessment wave *t*, denoted $\theta_{ist}$, was estimated using an item response theory (IRT) model (Lord and Novick 1968; Pollack et al. 2005a). The $\theta$ scores produced by the IRT model are measured in a common metric (within subjects) across assessment waves (i.e., scores are not normed within grades), meaning that a first-grade student and a fifth grade student with the same $\theta$ have the same skill level. These $\theta$ scores are the basis for our estimates of Hispanic-White achievement gaps.[15]

In general, there are three general types of measures of achievement gaps—differences in mean scores; standardized score differences; and so-called "metric-free" gap measures (Reardon and Robinson 2007). In this paper, we begin by reporting Hispanic-White gaps in different metrics, noting the interpretation of each metric. Throughout the remainder of the paper, however, we report gaps using only standardized score differences, which allows for simple interpretation and comparability with other research. The measures that we use are described below; estimation details

[15] Importantly, we do not rely on the published ECLS-K 'scale scores,' which are estimates of the number of questions a student would have gotten right has she been administered every item on the full K-5 test (no student was administered every item at any wave; the adaptive nature of the test meant that students were asked only the items that were appropriate to their skill level). The scale score is an arbitrary and highly nonlinear monotonic transformation of the $\theta$ score, meaning that conclusions about the patterns of Hispanic-White gaps over time depend substantially on the transformation used (which is a function of the distribution of item difficulties on the test), a point Reardon (2007) demonstrates empirically with regard to Black-White gaps. To see this, consider two individuals who start kindergarten with different $\theta$ scores and who experience the same increase in $\theta$ over time. Because the scale score metric is a nonlinear transformation of the $\theta$ metric, the two students will not, in general, experience the same increases in their scale scores as one another. Thus, inferences about changes in the size of the achievement gap between the two students (or two groups) will differ depending on which metric we use. Although the $\theta$ scores have not been included in the data files provided by NCES in the past, files containing the theta scores are available from NCES upon request (or can be constructed from the published data using the approach shown in Reardon, 2007).

are in Appendix A.

*Mean Score Differences.* The most obvious way of measuring an achievement gap between two groups is to define the gap as the difference in mean test scores of the two groups. If scores are measured in the same metric across grades, then we can, in principle, compare the difference in mean scores at one grade/age with the mean difference at another grade/age. Comparing the magnitude of achievement gaps measured this way, however, requires a test that measures cognitive skill in an interval-scaled metric, so that a difference of one point in mean scores between two groups has the same meaning (i.e., it corresponds to the same size 'gap' in cognitive skills) as a difference of one point in mean scores between two other groups (or the same two groups at another time), regardless of where on the test score metric the group means lie.[16] In general, a well-constructed test can generally be assumed to be ordinal-scaled (higher scores correspond to higher levels of cognitive skill), but the assumption of interval-scaling is harder to justify (Phillips 2000; Reardon 2007). If a test is not interval-scaled, however, the magnitude and meaning of a difference in groups' mean scores will depend on where on the scale the difference lies, rendering inferences about achievement gaps highly dependent on the test metric (see, for example, Reardon 2007; Selzer, Frank, and Bryk 1994). While some of the literature on achievement gaps has relied on (un-standardized) mean differences in test scores (Hanushek and Rivkin 2006; LoGerfo, Nichols, and Reardon 2006; Murnane, Willett, Bub, and McCartney 2006), Reardon (2007) illustrates that analyses based on mean score differences may be very sensitive to the test metric used.

*Standardized Score Differences.* Because of this dependence (and because it is not obvious that the $\theta$ scores—or any test scores—are measured in an interval-scaled metric (see Phillips 2000; Reardon 2007), we also compute standardized score differences, dividing the $\theta$ scores by their

[16] We use the term "interval-scaled" to mean that test scores are a linear function of true (unobservable) cognitive skill (plus random measurement error with mean zero), as opposed to the weaker condition that test scores are a monotonically increasing function of cognitive skill (plus error).

pooled standard deviation at each wave and estimating the Hispanic-White gap at each wave in standard deviation units. These standardized score differences are analogous to effect sizes. They have the advantage of being less sensitive to the metric used to measure the gaps than do mean score differences; in addition, standardized gaps (and their standard errors) are easily computed from published summary data and allow (rough) comparability across different tests. Moreover, standardized gap measures are widely used in the literature (see, for example, Clotfelter, Ladd, and Vigdor 2006; Fryer and Levitt 2004, 2006; Grissmer, Flanagan, and Williamson 1998; Hedges and Nowell 1999; Neal 2005; Phillips, Brooks-Gunn, Duncan, Klebanov, and Crane 1998; Reardon and Galindo 2006), and so have the advantage of comparability with prior work.

Standardized gap measures have three disadvantages, however. First, they do not make clear how test score differences correspond to interpretable differences in specific math and reading skills. Second, standardized gap measures confound changes in the difference in the means of two groups and changes in the variation in test scores within groups. They are therefore measures of *relative* achievement differences—they measure the size of the gap relative to the amount of variation in test scores within each group. If we are interested in *absolute* mean difference, then standardizing may obscure the information we desire. Third, measurement error in test scores will tend to inflate the variance of the test score distributions, meaning that the achievement gaps measured in standard deviation units will be biased toward zero.[17] If the gaps at different grades, ages, or cohorts are measured with tests that have different amounts of measurement error, then the amount of bias will not be the same in each measure of the gap, leading to potentially erroneous inferences regarding patterns or trends in the magnitudes of the gaps over time. If the reliability of the test is known, however, then estimated gaps can be corrected for measurement error.

[17] The standardized gap measures are computed by dividing the mean score difference by the pooled standard deviation of test scores. If test scores contain measurement error; the estimated pooled standard deviation will typically overestimate the within-group standard deviation in true scores, leading to a bias toward zero in the estimated standardized gaps.

*Metric-Free Gap Measures.* Standardized gap measures may be sensitive to the distribution of the test scores—which may be affected by the test metric used (since a non-linear transformation of the test metric will alter the distributions of each group's test scores differently). So-called 'metric-free' measures of achievement gaps, however, rely only on the ordinality of the test metric, requiring no assumption of interval-scaling (Ho and Haertel 2006). One such measure, for example, is the probability that a randomly chosen Hispanic student has a score higher than a randomly chosen White student (denoted $P_{h>w}$); the less overlap there is of the White and Hispanic test score distributions, the lower $P_{h>w}$ will be. A second metric-free measure is what Ho and Haertel refer to as the 'pseudo-effect size'; this is the effect size (or standardized gap measure) that would correspond to $P_{h>w}$ if both groups had standard normal test score distributions (Ho and Haertel 2006).

Because the metric-free measures are essentially measures of the overlap of two distributions, they share the disadvantages of the standardized measures. They do not make clear the concrete differences in skills between two groups; they are measures of relative rather than absolute difference; and they are biased toward zero by measurement error. Unlike the standardized measures, however, which are somewhat sensitive to violations of the interval-scaling assumption, metric-free measures are invariant under any monotonic transformation of the test metric, obviating the need for assumptions about the metric's interval nature. Despite this advantage over standardized gap measures, metric-free measures have not yet been widely used (for recent examples of their use, see Ho and Haertel 2006; Neal 2005; Reardon 2007).

## 3. Results

Measures of Hispanic-White Gaps in Kindergarten Through Fifth Grade

Table 3 shows the estimated Hispanic-White Gaps in math and reading as measured using

each of the metrics described above (mean $\theta$ score differences, standardized score differences, metric-free probabilities, and metric-free pseudo-effect sizes). In addition, because the gap measures (except for the mean score differences) are biased toward zero by measurement error in the ECLS-K tests, we also report gaps adjusted for measurement error, under assumed test reliabilities of 0.70, 0.80, 0.90, and 1.00.[18] We report standard errors for the mean score differences and standardized differences in order to provide some sense of the precision of the difference estimates.[19]

In the fall of kindergarten, there are large math and reading gaps between Hispanic and White students. Although the magnitude of the mean $\theta$ difference is difficult to interpret concretely, the other metrics provide interpretable gap measures. The estimated math gap is between 0.77 and 0.92 standard deviations (depending on the amount of measurement error we assume). The reading gap is about one-third smaller.[20] The 'metric-free' probability measure yields probabilities of 35% and 29%, respectively, that a randomly chosen Hispanic student has a higher math or reading score than a randomly chosen White student in the fall of kindergarten. Finally, note that the pseudo-effect size measures are very similar to the standardized differences, reflecting the fact that the $\theta$ distributions are approximately normal.

The Hispanic-White math gap narrows from kindergarten to fifth grade, regardless of the

[18] Estimated *item-level* reliabilities of the ECLS-K scores range from 0.89-0.96 (Pollack et al. 2005a), and the *test-retest* reliability of the ECLS-K tests is likely somewhere between 0.75 and 0.95 (based on estimates of test-retest reliability of IQ and school readiness tests for children ages 5-10; see Rock and Stenner 2005). Thus, the overall reliability of the tests is likely between 0.70 and 0.90, which means that the estimated standard deviation of true scores is likely 5-15% smaller than the estimated standard deviation of the observed scores. Thus, estimates of the between-group gaps that assume no measurement error will likely underestimate the magnitude of the true gaps by 5-15%. To adjust the gaps for measurement error, we assume classical measurement error in the test. Given an assumed test reliability, we use the reliability to shrink each student's observed test score toward his or her group (Hispanic or White) mean score (see Appendix A). We then compute the Hispanic-White gaps using these shrunken test scores. Reardon (2007) provides a detailed discussion of this approach.

[19] Standard errors for the metric-free measures cannot be computed analytically, but could be computed by bootstrapping. Bootstrapped standard errors for the pseudo-effect sizes would be very similar to those for the standardized difference measures, given the approximate normality of the $\theta$ distributions. We have not gone to the trouble of computing the bootstrapped standard errors however, since we are not interested in making statistical comparisons here.

[20] Our Hispanic-White standardized gap estimates differ slightly from those reported in Fryer and Levitt (2006) because we use different sample selection criteria, adjust our estimates for the date of assessment, and use the assessment-date adjusted pooled standard deviation rather than the sample standard deviation at each wave.

metric used to measure it, though the timing of the narrowing depends somewhat on the metric. In each metric, the gap narrows sharply in kindergarten and first grade, but then flattens. In the mean $\theta$ difference metric, the gap remains flat through fifth grade, while it narrows from third to fifth grade in the other metrics, a reflection of the fact that the standard deviations of the within-group test score distributions increase from third to fifth grade, making the relative gap smaller.

In reading, the Hispanic-White gap also narrows sharply in kindergarten and slightly in first grade, but then remains flat (in the mean $\theta$ difference metric) or widens somewhat (in the other metrics). Here the explanation for the divergence of these trends is also because of the changing standard deviation of test scores, but in this case, the standard deviation narrows from first to third grade. The narrowing of the standard deviation of the theta scores means that a constant difference in theta corresponds to a widening standardized difference.

The disparities in the patterns of the development of the Hispanic-White gaps among different gap measures are not dramatic here, though they do indicate the potential sensitivity of our conclusions to the choice of a test metric. For the reasons outlined above, it is not clear that there is a single 'best' metric, however—each of those we describe has some merit. In the interest of space and parsimony, however, we rely on the standardized difference gap measures throughout the remainder of this paper. These have the advantage of being familiar to many readers, roughly comparable across studies, and yield descriptions of the development of gaps that are nearly identical to those based on metric-free measures.

Standardized Achievement Gaps in Kindergarten through fifth grade

In this section, we describe the estimated math and reading gaps for a variety of subgroups. Specifically, we report estimated gaps, using standardized difference measures, 1) by race/ethnic group; 2) for Hispanics, broken down by country/region of national origin; 3) for Mexican-origin

students, broken down by immigrant generational status; 4) for Hispanics, broken down by language used in the home; and 5) for Hispanics, broken down by socioeconomic quintile. For simplicity, rather than report estimates under a range of assumed test reliabilities, we report estimates here based on the assumption that the test scores contain no measurement error. These estimates can be divided by the square root of any assumed reliability to recover unbiased gap estimates. Moreover, as long as the reliability of the tests is constant across the waves of the test administration, the patterns of development of the gaps are not biased by ignoring measurement error, since all gap estimates will be biased by measurement error in the same direction and by the same proportional amount.

To facilitate presentation of a large amount of data, and because our aims are primarily descriptive, we present the estimated gaps in a series of figures rather than tables (exact gap estimates and their standard errors are provided in detailed tables in Appendix B). In each of Figures 3-12, the vertical axis indicates the size of the achievement gap (the difference in standard deviation units between the average score of students in a given group and the average score of the reference group—generally third-generation non-Hispanic White students. For each comparison group (e.g., Black, Hispanic, Asian, and 'Other' race students in figure 3), the figure shows six estimates of the achievement gap, corresponding to the six waves of ECLS-K assessments: fall kindergarten (FK), spring kindergarten (SK), fall first grade (F1), spring first grade (S1), spring third grade (S3) and spring fifth grade (S5). For each gap, the vertical error bars indicate the 95% confidence interval around the estimate.[21] Finally, for each group, the figure includes a fitted trend line, indicated by the thick solid line. These trends are fitted piecewise linear trend lines, with a change in slope at the end of first grade,[22] so that they indicate the average linear trend in the

[21] The confidence intervals are typically much larger in fall first grade than in other waves, since only a random 30% subsample of the ECLS-K sample was tested at that wave, yielding less precise gap estimates.
[22] We examined a variety of alternative ways of summarizing the trends, including linear, quadratic and cubic trends;

achievement gap during kindergarten and first grade, and the average linear trend in the achievement gap from the end of first grade through fifth grade. We present them to provide a simple visual summary of the developmental trend of the achievement gap for each subgroup. The fitted trend lines do not correspond exactly to the point estimates of the gaps at each assessment wave, but rather they summarize the general trends in the magnitude of the gaps during the two time periods (kindergarten to first grade and first to fifth grade).

*Gaps by Race/Ethnicity.* Figures 3 and 4 show kindergarten through fifth grade trends in the differences in average math (Figure 3) and reading (Figure 4) test scores of Black, Hispanic, Asian, and Other Race students, relative to White students. Most notable here are 1) the steadily increasing Black-White gaps (particularly in math) during the kindergarten through fifth-grade period; and 2) the narrowing of the White-Hispanic gaps during kindergarten and first grade, followed by a period of stability from the end of first grade through fifth grade. At the start of kindergarten, Hispanic and Black students have math and reading scores substantially lower than those of White students (but roughly equal to one another). The average Hispanic and Black students begin kindergarten with math scores three-quarters of a standard deviation lower than those of White students and with reading scores half a standard deviation lower than those of White students. Six years later, however, Hispanic-White gaps have narrowed (by roughly a third), while Black-White gaps have widened (also by roughly a third). Despite this narrowing, the Hispanic-White gap is one-half a standard deviation in math and three-eighths of a standard deviation in reading at the end of fifth grade.

The trends in the Hispanic-White gaps are notable for their rapid narrowing in kindergarten and first grade—the estimated math gap declines from 0.77 to 0.56 standard deviations and the

---

among these, the two-part piecewise linear trend with a change in slope at the end of first grade appeared to fit the trends most parsimoniously. In fitting the trend lines, each wave's estimated gap is weighted by the inverse of its estimated sampling variance.

estimated reading gap declines from 0.52 to 0.29 standard deviations in the roughly 18 months between the fall kindergarten and spring first-grade assessments. In the four years from the spring of first grade through the spring of fifth grade, however, the gaps change very little—narrowing slightly to 0.50 in math and widening slightly to 0.38 in reading. As we will see, this pattern of rapid narrowing at the start of formal schooling followed by relative stability is common to most Hispanic subgroups.

Figures 3 and 4 here

*Achievement Gaps by Hispanic National/Regional Origin*. Figures 5 and 6 describe Hispanic-White achievement gaps disaggregated by Hispanic students' country/region of origin. Several key findings are evident here. First, there is considerable heterogeneity among Hispanic national origin groups in the magnitude of achievement disparities, particularly with regard to math achievement. In math, students of Mexican and Central American origins enter kindergarten with average achievement scores roughly one standard deviation below those of non-Hispanic White students, while students of Cuban, Puerto Rican, and South American origins enter kindergarten with scores roughly half a standard deviation below such White students. In reading, the patterns are similar, though the gaps are only about half the size as in math and vary less among national/regional origin groups. As we noted above, the reading gaps reported here are based only on the sample of Hispanic students proficient in oral English at the start of kindergarten, so the gap estimates are likely smaller here than they would be if we could include all Hispanic students.

Second, there is some heterogeneity among Hispanic national origin groups in the patterns of change of achievement gaps from kindergarten to fifth grade. In general, the achievement gaps narrow for most groups in kindergarten and first grade (though not for Puerto Rican students in math or Cuban-origin students in reading). From the spring of first through fifth grade, however, the patterns are more varied. In math, there is little or no change in the size of the achievement gap

for Mexican and Cuban origin students, a gradual narrowing of the gap for Puerto Rican and South American origin students, and a substantial narrowing of the gap for Central American origin students. In reading, the gaps generally change little for most groups from first through fifth grade, although the reading gap appears to widen slightly for Mexican origin students.

Figures 5 and 6 here

*Achievement Gaps by Immigrant Generational Status***.** In order to examine differences in achievement patterns by Hispanic immigrant generational status, we focus on Mexican origin students, since they are the only national origin group with sizeable samples of first-, second-, and third-plus-generation students. While we would obtain larger sample sizes within each immigrant generation group if we combined all national origin groups in this analysis, an analysis that combined students of similar immigrant generations but of different national origins would potentially confound generational status with the different immigration histories and contexts of different national origin groups.

Figures 7 and 8 illustrate the patterns of math and reading scores for first- (in math only), second-, and third-plus-generation Mexican students. In math, both first- and second-generation Mexican origin students enter kindergarten with average achievement scores roughly 1.1 standard deviations below those of White students. These gaps are very large, much larger, for example, than the Black-White math gaps at the start of kindergarten. Third-generation Mexican students enter kindergarten with math scores 0.46 standard deviations below those of White students. By the spring of first grade, these gaps have narrowed considerably, particularly for first- and second-generation students, who are roughly 0.75 standard deviations below White students at this point. There is relatively little change in the magnitude of the gaps after first grade for any of the groups.

Figures 7 & 8 here

Because our reading gap estimates are based only on the sample of students who were

proficient in oral English in the fall of kindergarten, and because very few Mexican first-generation students were proficient, we are able to estimate reading gaps only for second- and third-plus-generation Mexican origin students. The patterns for these students are similar in reading as in math, though the magnitudes of the gaps are smaller. As in math, the gaps are larger for second-generation students than for third-plus-generation students, they narrow sharply in kindergarten and first grade, and they are relatively stable (widening slightly, in fact) from first to fifth grade.

*Achievement Gaps by Language Use in the Home.* Table 4 reports the distribution of home language category of Hispanic students by country of origin and generational status subgroups. Overall, Hispanic students are equally likely to live in English or Spanish dominant homes; however, the patterns of home language show sharp differences among Hispanic subgroups. Most students of Mexican and Central American origins, particularly the most recent Mexican immigrants, come from families where Spanish is the predominant or only language spoken in the home. Puerto Rican students and students of Other Hispanic origin, in contrast come primarily from homes where English is the predominant or only language spoken in the home.

Table 4 here

Figures 9 and 10 show Hispanic-White achievement gap trends, for Hispanic subgroups defined by language spoken in the students' homes. Two clear patterns are evident. First, students from homes where Spanish is the only or predominant language used enter kindergarten with lower math and reading skills than students from homes where English is the dominant language. Second, the pattern of rapid achievement gains in kindergarten and first grade is most evident for students from homes where Spanish is the only language spoken at home. This pattern is particularly evident in reading. Nonetheless, despite the rapid gains in math and reading of students from homes where Spanish is the predominant language, these students still score well below those of White students and Hispanic students from English-speaking homes by fifth grade.

Figures 9 & 10 here

*Achievement Gap Trends by Students' Initial English Proficiency*. Recall that the reading achievement gap patterns and trends reported above are based on the sample of Hispanic students who were proficient in oral English at the start of kindergarten (about 71% of the total Hispanic sample). In general, the reading gaps between Hispanic and White students are smaller than the math gaps. However, the true reading gap (based on the entire population of Hispanic students, not just the ones proficient in English in kindergarten) is likely larger than that which we describe, since the omitted students would almost certainly have lower reading scores (in English), on average, than those included in the estimates.

In Table 5, we examine this by comparing the kindergarten through fifth grade math score gaps for Hispanic students proficient and not proficient in English in kindergarten. Table 5 clearly indicates that the non-English proficient Hispanic students score considerably worse than the English-proficient students at each wave, though the non-English proficient students gain more in math skills (half a standard deviation), relative to White students, from kindergarten to fifth grade. These gains, however, are not sufficient to make up the substantial initial gaps. In reading, although we cannot observe reading scores for non-English proficient students in kindergarten and first grade, it is clear that by fifth grade, these students still lag over a standard deviation behind non-Hispanic White students and behind Hispanic students who were proficient in English in kindergarten.

Table 5 here

The large gaps between Hispanic students who are not proficient in oral English at the start of kindergarten and non-Hispanic White students are likely not due entirely to differences in English proficiency at the start of schooling. In analyses not shown here, we find that the non-English-proficient students are disproportionately from low-SES homes—72% of those not proficient in

English at the start of schooling are in the lowest SES quintile, and 15% are in the second-lowest SES quintile. Moreover, when we compare the fifth-grade reading scores of the non-English-proficient and English proficient Hispanic students from the lowest SES quintile, we find that roughly a third to a half of the difference in fifth grade reading scores between proficient and non-English-proficient Hispanic students can be accounted for by the lower socioeconomic status of the non-English-proficient students.

*Achievement Gaps by Socioeconomic Status (SES) Quintile.* Table 6 shows the distributions of socioeconomic status, by race/ethnicity and Hispanic students' country of origin and immigrant generational status Overall, Hispanic students come from families with much lower socioeconomic status than White students and similar to those of Black students. Among Hispanics, Central American origin students and Mexican students—particularly first- and second-generation Mexican students—have the lowest average socioeconomic status. Roughly half of these students (and over three-quarters of first-generation Mexican origin students) come from families in the lowest SES quintile. In contrast, Hispanic students of Cuban and South American origin have, on average, the highest SES among Hispanic subgroups, showing a somewhat similar SES distribution as do Whites.

Table 6 here

Figures 11 and 12 describe the within-SES quintile Hispanic-White achievement gaps. These figures show the average difference in math and reading scores between Hispanic and non-Hispanic White students who are in the same socioeconomic quintile. Notably, at the start of kindergarten, Hispanic students score roughly a quarter to a third of a standard deviation lower in both math and reading than do non-Hispanic White students of the same SES quintile.[23] By the spring of fifth

[23] In analyses not shown here, we also observe a clear socioeconomic gradient in achievement patterns of Hispanic students. Hispanic students in the lowest SES quintiles start kindergarten with math and reading scores significantly below those of the average White student, though low-SES Hispanic students also make the largest gains relative to White students in kindergarten and first grade.

grade, however, the gaps are typically smaller. In some cases—particularly among students in the lowest SES quintile—Hispanic and non-Hispanic White students' average scores are no different from one another. At higher SES levels, Hispanic students still score slightly below White students, though the gaps are typically 0.1 to 0.2 standard deviations smaller than at the start of kindergarten.

Figures 11 & 12 here

**4. Discussion**

In this paper we provide a detailed descriptive analysis of the development of Hispanic-White achievement gaps in the elementary grades. We further previous research on Hispanic students' education by taking into account variations in these patterns among Hispanic subgroups and by focusing on early ages. While older Latinos' educational disadvantages have been relatively well-documented, we know little about young Latino children's schooling.

Five important findings emerge from this study. First, Hispanic students enter kindergarten with average math and reading skills significantly lower than those of non-Hispanic White students. In the fall of their kindergarten year, Hispanic students' average math scores are three-quarters of a standard deviation below the average scores of non-Hispanic White students. Among the 71% of Hispanic students who are proficient in oral English in the fall of kindergarten, average reading scores are one-half a standard deviation below those of White students. Second, unlike the Black-White test score gaps measured in ECLS-K, which widen steadily from kindergarten through fifth grade, the Hispanic-White achievement gaps narrow during kindergarten and first grade (from 0.77 to 0.56 standard deviations in math and from 0.52 to 0.29 standard deviations in reading). The Hispanic-White gaps change little in the years following first grade, however. By fifth grade, the math gap is still one-half a standard deviation, and the reading gap has widened slightly to three-eighths of standard deviation.

Third, there is considerable variation in math and reading achievement patterns among Hispanic subgroups. Students of Mexican and Central American origins, particularly students whose parents are immigrants to the U.S., enter school with lower math and reading scores than children of Cuban, South American, and other national origins and children of U.S.-born Hispanic parents. Because students of Mexican and Central American origins are, on average, more socioeconomically disadvantaged and less likely to come from homes where English is spoken than other Hispanic students, it is possible that these patterns can be largely explained by socioeconomic and language differences among Hispanic subgroups. The lower socioeconomic status of Mexican and Central American students, and of first- and second-generation Mexican students, may account for the lower math and reading skills of these students when they enter kindergarten.

Fourth, differences among Hispanic subgroups persist through fifth grade, though they become somewhat less pronounced. In fifth grade, Mexican-origin students score a one-quarter to one-half a standard deviation lower than Cuban and Puerto Rican students in on the ECLS-K tests of math and reading, on average.

Fifth, those Hispanic subgroups with lower levels of math and reading skills at kindergarten entry show the most substantial narrowing of achievement gaps over time. By the end of fifth grade, math achievement gaps of Mexican students with foreign-born parents, Hispanic students from Spanish speaking homes, and those Hispanic students from the lowest SES are half of a standard deviation smaller than the corresponding gaps observed at kindergarten entry. In contrast, native-born Mexican students, Hispanic students living in English-speaking homes, and those from the highest SES quintiles show smaller gap reductions over time.

It is worth noting that first- and second-generation Mexican students are the most socioeconomically disadvantaged of the Hispanic subgroups we examine, with average socioeconomic levels far below those of native-born Black students—93% of first-generation

Mexican students and 81% of second-generation Mexican students are in the bottom two SES quintiles, compared to 53% of Black students (see Table 6 above). Nonetheless, despite starting kindergarten with math and reading scores far below those of Black students and even farther below those of White students, first- and second-generation Mexican students make substantial test score gains, relative to Whites and Blacks during elementary school. At the same time, Black students' scores fall, on average, relative to White students' scores, so that by fifth grade, first- and second-generation Mexican students—have average scores considerably higher than those of Black students (compare figures 3 and 4 with figures 7 and 8).

The evidence here is consistent with the hypothesis that at least part of the gains made by Hispanic students in the early grades is due to students' increased English acquisition (both oral and written)—which likely improves test performance on tests given in English (such as the reading test), and increases the opportunity for students to learn in schools where at least some, if not all, of the instruction is in English. The evidence for this comes from several factors. The greatest relative gains in achievement are observed in groups with the lowest levels of home English use and oral English proficiency—Mexican and Central American origin students, particularly those whose parents were born outside the U.S., and those from homes where English is not the predominant language. In addition, the narrowing of the math and reading gaps occurs primarily in the first two years of schooling, when English acquisition is most rapid for these students. Moreover, Hispanic students not proficient in English at the start of kindergarten make much more rapid gains in math scores than do students proficient in English (see Table 5), suggesting that English acquisition may be a factor in their learning process.

On the other hand, some of the rapid progress of Hispanic students in the first two years of schooling may also be due to the use of instructional practices that are particularly effective with English language learners in the first years of schooling. The patterns of rapid gains in learning

among groups with the lowest levels of initial English proficiency could result from the targeting of effective instructional practices on these students in the early elementary grades. Language support programs, for example, are more common in schools with large proportions of recent immigrants and students with low levels of English proficiency. To the extent that such practices are effective in narrowing the achievement gap for English Learners, they may account for some of the rapid narrowing of the gaps in the early grades, when English proficiency is lowest for the students in the ECLS-K sample. After first grade, instructional practices targeted to English Learners may be less common and/or less effective in narrowing the gaps, since by this time most students are reasonably proficient in oral English (over 80% of those not proficient in English in kindergarten are proficient by the end of first grade in the ECLS-K sample).

The ECLS-K data are not particularly well-suited to investigate these two hypotheses in detail. Consequently, an attempt to determine the extent to which, if any, language acquisition and/or instructional practices account for the patterns of achievement is beyond the scope of this article.

A final puzzle remains in the patterns reported here. Black and Hispanic students enter kindergarten with achievement levels equally low relative to White students. Moreover, the socioeconomic background (at least as measured by parental education, occupation, and income) of Black and Hispanic students are roughly equal at the start of kindergarten. Yet the achievement trajectories of Black and Hispanic students are strikingly different in the next six years. Black-White achievement gaps grow while Hispanic-White gaps narrow. Moreover, socioeconomic status explains virtually all of the Black-White gap at kindergarten entry (Fryer and Levitt 2004), but explains much less of the Hispanic-White gap at the same age. However, by fifth grade, socioeconomic status no longer accounts for all of the Black-White gap (Fryer and Levitt 2006), but accounts for the majority of the Hispanic-White gap (see Figures 11-12). The reasons for this

divergence between Black and Hispanic trajectories are beyond the scope of this paper, though several candidate explanations should be explored in future work.

First, the source of the initial achievement gaps at the start of kindergarten my differ for Black and Hispanic students. If Hispanic-White gaps are partly due to low English proficiency (both of children and their parents) limiting children's access to cognitively stimulating materials (in English), while Black-White gaps are primarily due to low-socioeconomic status and its attendant family stressors, then this might explain why Hispanic children show strong gains in the early grades (as they learn English), while Black students fall further behind. Second, the fact that Black and Hispanic students have similar socioeconomic backgrounds and cognitive skills at the start of schooling, on average, but very different average developmental trajectories after the start of schooling, suggests that socioeconomic status is not the only factor that shapes achievement gaps. Differences in the average quality of schools attended by Hispanic, Black, and White students may play an important role in the development of achievement disparities (for Blacks) or their amelioration (for Hispanics). The fact that Hispanic-White gaps narrow following the start of formal schooling suggest that schooling has the potential to remedy at least part of initial achievement gaps. Future research might identify the features of schooling most strongly associated with the reduction of Hispanic-white achievement gaps in the early grades and test ways of improving schools to narrow the gaps further.

**References**

Bali, Valentina A. and R. Michael Alvarez. 2003. "Schools and Educational Outcomes: What Causes the 'Race Gap' in Student Test Scores?" *Social Science Quarterly* 84:485-507.

Borman, Geoffrey D, Sam Stringfield, and Laura Rachuba. 2000. "Advancing Minority High Achievement: National Trends and Promising Programs and Practices." Johns Hopkins University - Center for Social Organization of Schools., Baltimore MD.

Cameron, Stephen and James Heckman. 2001. "The Dynamics of Educational Attainment for Black, Hispanic, and White Males." *Journal of Political Economy* 109:455-499.

Clotfelter, Charles T., Helen F. Ladd, and Jacob L. Vigdor. 2006. "The academic achievement gap in grades three to eight." National Bureau of Economic Research, Cambridge, MA.

DeNavas-Walt, Carmen, Bernadette D. Proctor, and Robert J. Mills. 2004. "Income, Poverty, and Health Insurance Coverage in the United States: 2003." U.S. Census Bureau, Washington, DC.

Duncan, Greg J. and Katharine A. Magnuson. 2005. "Can Family Socioeconomic Resources Account for Racial and Ethnic Test Score Gaps?" *The Future of Children* 15:35-54.

Fry, Richard. 2004. "Hispanic Youth Finishing College: The Role of Selective Pathways." The Pew Hispanic Center, Washington, DC.

Fryer, Roland G. and Stephen D. Levitt. 2004. "Understanding the black-white test score gap in the first two years of school." *The Review of Economics and Statistics* 86:447-464.

—. 2006. "The Black-White Test Score Gap through Third Grade." *American Law and Economics Review* 8:249-281.

Gándara, Patricia. 1999. "Telling stories of success: Cultural capital and the educational mobility of Chicano students." *Latino Studies Journal* 10:38-54.

Grissmer, David W., Ann Flanagan, and Stephanie Williamson. 1998. "Why did the Black-White score gap narrow in the 1970s and 1980s?" Pp. 182-228 in *The Black-White Test Score Gap*, edited by C. Jencks and M. Phillips. Washington, D.C.: Brookings Institution Press.

Guzman, B. 2001. "The Hispanic Population: Census 2000 Brief." U.S. Census Bureau, Washington DC.

Hakimzadeh, Shirin and D'Vera Cohn. 2007. "English Usage Among Hispanics in the United States." The Pew Hispanic Center, Washington, DC.

Hanushek, Eric A. and Steven G. Rivkin. 2006. "School quality and the black-white achievement gap." NBER.

Hedges, Larry V. and Amy Nowell. 1999. "Changes in the black-white gap in achievement test scores." *Sociology of Education* 72:111-135.

Hernandez, Donald J. 2006. "Young Hispanic Children in the U.S.: A Demographic Portrait Based on Census 2000." National Task Force on Early Childhood Education for Hispanics, New York: Foundation for Child Development.

Ho, Andrew D. and Edward H. Haertel. 2006. "Metric-Free Measures of Test Score Trends and Gaps with Policy-Relevant Examples." Center for the Study of Evaluation, National Center for Research on Evaluation, Standards, and Student Testing, Graduate School of Education & Information Studies, Los Angeles, CA.

Kao, Grace and J. Thompson. 2003. "Race and Ethnic Stratification in Educational Achievement and Attainment." *Annual Review of Sociology* 29:417-442.

Kaufman, Phillip, Martha Naomi Alt, and Christopher D. Chapman. 2001. "Dropout Rates in the United States: 2000." U.S. Department of Education; National Center for Educational Statistics Washington, DC.

Kohler, Adriana and Melissa Lazarín. 2007. "Hispanic Education in the United States." National

Council of La Raza, Washington, DC.
Lee, Valerie E. and David T. Burkham. 2002. *Inequality at the Starting Gate: Social Background Differences in Achievement as Children Begin School*. Washington, DC: Economic Policy Institute.
Lichter, Daniel T., Zhenchao Qian, and Martha L. Crowley. 2005. "Poverty and Economic Polarization among America's Minority and Immigrant Children." National Poverty Center.
LoGerfo, Laura, Austin Nichols, and Sean F. Reardon. 2006. "Achievement Gains in Elementary and High School." Urban Institute, Washington, DC.
Lord, F.M. and M.R. Novick. 1968. *Statistical Theory of Mental Test Scores*. Reading, MA: Addison Wesley.
Murnane, Richard J., John B. Willett, Kristen L. Bub, and Kathleen McCartney. 2006. "Understanding trends in the black-white achievement gaps during the first years of school." *Brookings-Wharton Papers on Urban Affairs*.
National Center for Education Statistics. 2001. "ECLS-K, Base Year Public-Use Data File and User's Manual." U.S. Department of Education, Office of Educational Research and Improvement, Washington, DC.
—. 2002a. "Common Core of Data (CCD) Public Elementary and Secondary School Universe Data." Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.
—. 2002b. "User's manual for the ECLS-K First Grade Public-Use Data Files and Electronic Codebook." U.S. Department of Education, Office of Educational Research and Improvement, Washington, DC.
Neal, Derek A. 2005. "Why has Black-White skill convergence stopped?" University of Chicago.
Padron, Yolanda N., Hersh C. Waxman, and Hector H. Rivera. 2002. "Educating Hispanic Students: Obstacles and Avenues to Improve Academic Achievement." University of California, Santa Cruz; Center for Research on Education, Diversity, and Excellence, Santa Cruz, CA.
Perreira, Krista, Kathleen Harris, and Dohoon Lee. 2006. "Making it in America: High School Completion by Immigrant and Native Youth." *Demography* 43:511-536.
Phillips, Meredith. 2000. "Understanding Ethnic Differences in Academic Achievement: Empirical Lessons from National Data." Pp. 103-132 in *Analytic Issues in the Assessment of Student Achievement*, edited by D. W. Grissmer and J. M. Ross. Washington, DC: National Center for Education Statistics, U.S. Department of Education.
Phillips, Meredith, Jeanne Brooks-Gunn, Greg J. Duncan, Pamela Klebanov, and Jonathan Crane. 1998. "Family Background, Parenting Practices, and the Black-White Test Score Gap." Pp. 103-148 in *The Black-White Test Score Gap*, edited by C. Jencks and M. Phillips. Washington, D.C.: Brookings Institution Press.
Pollack, Judith M., Michelle Narajian, Donald A. Rock, Sally Atkins-Burnett, and Elvira Germino Hausken. 2005a. "Early Childhood Longitudinal Study-Kindergarten Class of 1998-99 (ECLS-K), Psychometric Report for the Fifth Grade." U.S. Department of Education, National Center for Education Statistics, Washington, DC.
Pollack, Judith M., Donald A. Rock, Michael J. Weiss, Sally Atkins-Burnett, Karen Tourangeau, Jerry West, and Elvira Germino Hausken. 2005b. "Early Childhood Longitudinal Study-Kindergarten Class of 1998-99 (ECLS-K), Psychometric Report for the Third Grade." U.S. Department of Education, National Center for Education Statistics, Washington, DC.
Ramirez, Roberto R. 2004. "We the people: Hispanics in the United States." U.S. Census Bureau, Washington, DC.
Reardon, Sean F. 2003. "Sources of educational inequality: The growth of racial/ethnic and socioeconomic test score gaps in kindergarten and first grade." Population Research Institute, Pennsylvania State University.

—. 2007. "Thirteen ways of looking at the black-white test score gap."
Reardon, Sean F. and Claudia Galindo. 2006. "Patterns of Hispanic Students' Math and English Literacy Test Scores in the Early Elementary Grades." National Task Force on Early Childhood Education for Hispanics.
Reardon, Sean F. and Joseph Robinson. 2007. "Patterns and Trends in Racial/Ethnic and Socioeconomic Academic Achievement Gaps." in *Handbook of Research in Education Finance and Policy*, edited by H. Ladd and E. Fiske.
Rock, Donald A. and Judith M. Pollack. 2002. "Early Childhood Longitudinal Study-Kindergarten Class of 1998-99 (ECLS-K), Psychometric Report for Kindergarten Through First Grade." U.S. Department of Education, National Center for Education Statistics, Washington, DC.
Rock, Donald A. and A. Jackson Stenner. 2005. "Assessment Issues in the Testing of Children at School Entry." *The Future of Children* 15:15-34.
Rumberger, Russell and Brenda Arellano. 2004. "Understanding and Addressing the California Latino Achievement Gap in Early Elementary School." University of California Linguistic Minority Research Institute, University of California, Santa Barbara, Santa Barbara, CA.
Schneider, Barbara, Sylvia Martinez, and Ann Owens. 2006. "Barriers to Educational Opportunities for Hispanics in the United States." in *Hispanics and the Future of America*, edited by M. Tienda and F. Mitchell. Washington, DC: The National Academies Press.
Selzer, Michael H., Ken A. Frank, and Anthony S. Bryk. 1994. "The metric matters: the sensitivity of conclusions about growth in student achievement to choice of metric." *Educational Evaluation and Policy Analysis* 16:41-49.
Stata Corporation. 2005. "Stata." College Station, TX: Stata Corporation.
Stoops, Nicole. 2004. "Educational Attainment in the United States: 2003." US. Census Bureau, Washington, DC.
Zill, Nicholas, Mary Collins, Jerry West, and Elvie Germino Hausken. 1995. "Approaching Kindergarten: A Look at preschoolers in the United States." U.S. Department of Education, Office of Educational Research and Improvement, Washington, DC.

**Table 1: ECLS-K Sample Sizes, by Race, Hispanic National Origin, and Immigrant Generational Status**

| | Immigrant Generation | | | | |
|---|---|---|---|---|---|
| **Race / National Origin** | 1st | 2nd | 3rd (plus) | Unknown | Total |
| White, Not Hispanic | 87 | 511 | 8,675 | 2,386 | 11,659 |
| Hispanic, any Race | 279 | 1,574 | 1,106 | 1,047 | 4,006 |
| Mexican Origin | 174 | 991 | 518 | 32 | 1,715 |
| Cuban Origin | 11 | 58 | 25 | 3 | 97 |
| Puerto Rican Origin | 19 | 97 | 120 | 7 | 243 |
| Central American Origin | 27 | 234 | 0 | 9 | 270 |
| South American Origin | 29 | 115 | 0 | 3 | 147 |
| Other Hispanic Origin | 10 | 63 | 99 | 10 | 182 |
| National Origin Unknown | 9 | 16 | 344 | 983 | 1,352 |
| Black, Not Hispanic | 30 | 149 | 1,921 | 1,105 | 3,205 |
| Asian | 150 | 642 | 104 | 455 | 1,351 |
| Other Race | 25 | 191 | 667 | 253 | 1,136 |
| Race/Ethnicity Unknown | 0 | 8 | 7 | 37 | 52 |
| **Total** | **571** | **3,075** | **12,480** | **5,283** | **21,409** |

**Table 2: ECLS-K Analytic Sample Sizes, by Race, Hispanic National Origin, and Mexican Immigrant Generational Status**

| | Analytic Sample Size | |
|---|---|---|
| **Race / National Origin** | Math | Reading |
| White, Not Hispanic, 3rd generation | 5,119 | 5,115 |
| Hispanic, any Race | 1,871 | 1,303 |
| Mexican Origin | 1,045 | 612 |
| Mexican, 1st generation | 77 | 14 |
| Mexican, 2nd generation | 662 | 308 |
| Mexican, 3rd generation | 295 | 284 |
| Mexican, Unknown generation | 11 | 6 |
| Cuban Origin | 58 | 47 |
| Puerto Rican Origin | 119 | 109 |
| Central American Origin | 174 | 100 |
| South American Origin | 87 | 73 |
| Other Hispanic Origin | 101 | 97 |
| National Origin Unknown | 287 | 265 |
| Black, Not Hispanic, 3rd generation | 894 | 894 |
| Asian | 489 | 489 |
| Other Race | 538 | 538 |
| **Total** | **8,911** | **8,339** |

**Table 3: Hispanic-White Math and Reading Test Score Gaps, Kindergarten through Fifth Grade, by Gap Measure and Wave**

| | Math | | | | | Reading | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fall K | Spring K | Spring 1st | Spring 3rd | Spring 5th | Fall K | Spring K | Spring 1st | Spring 3rd | Spring 5th |
| Mean $\theta$ score differences | | | | | | | | | | |
| | -0.36 | -0.31 | -0.23 | -0.22 | -0.22 | -0.25 | -0.16 | -0.13 | -0.12 | -0.13 |
| | (0.03) | (0.03) | (0.02) | (0.02) | (0.02) | (0.03) | (0.03) | (0.03) | (0.02) | (0.02) |
| Standardized differences | | | | | | | | | | |
| ($r$=.7) | -0.92 | -0.80 | -0.67 | -0.68 | -0.60 | -0.61 | -0.41 | -0.35 | -0.43 | -0.45 |
| | (0.07) | (0.07) | (0.06) | (0.06) | (0.06) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) |
| ($r$=.8) | -0.86 | -0.75 | -0.63 | -0.64 | -0.56 | -0.57 | -0.38 | -0.32 | -0.40 | -0.42 |
| | (0.07) | (0.07) | (0.06) | (0.06) | (0.06) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) |
| ($r$=.9) | -0.81 | -0.71 | -0.59 | -0.60 | -0.53 | -0.54 | -0.36 | -0.31 | -0.38 | -0.40 |
| | (0.07) | (0.07) | (0.06) | (0.06) | (0.06) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) |
| ($r$=1.0) | -0.77 | -0.67 | -0.56 | -0.57 | -0.50 | -0.51 | -0.34 | -0.29 | -0.36 | -0.38 |
| | (0.06) | (0.06) | (0.05) | (0.05) | (0.05) | (0.06) | (0.06) | (0.06) | (0.06) | (0.06) |
| Metric-free probabilities | | | | | | | | | | |
| ($r$=.7) | 0.26 | 0.28 | 0.31 | 0.31 | 0.33 | 0.32 | 0.38 | 0.39 | 0.37 | 0.36 |
| ($r$=.8) | 0.27 | 0.30 | 0.32 | 0.32 | 0.34 | 0.33 | 0.39 | 0.40 | 0.38 | 0.37 |
| ($r$=.9) | 0.28 | 0.31 | 0.33 | 0.33 | 0.35 | 0.34 | 0.40 | 0.41 | 0.39 | 0.38 |
| ($r$=1.0) | 0.29 | 0.32 | 0.34 | 0.34 | 0.36 | 0.35 | 0.41 | 0.42 | 0.40 | 0.39 |
| Metric-free pseudo-effect sizes | | | | | | | | | | |
| ($r$=.7) | -0.92 | -0.81 | -0.72 | -0.69 | -0.61 | -0.66 | -0.42 | -0.39 | -0.48 | -0.52 |
| ($r$=.8) | -0.86 | -0.75 | -0.67 | -0.64 | -0.57 | -0.62 | -0.39 | -0.36 | -0.43 | -0.47 |
| ($r$=.9) | -0.81 | -0.71 | -0.63 | -0.61 | -0.54 | -0.59 | -0.36 | -0.32 | -0.39 | -0.43 |
| ($r$=1.0) | -0.77 | -0.67 | -0.60 | -0.57 | -0.51 | -0.56 | -0.34 | -0.30 | -0.36 | -0.39 |

Standard errors in parentheses. See text for detailed description of gap measures. N=8,911 (math); N= 8,339 (reading).

**Table 4: Home Language Use, by National Origin, and Mexican Immigrant Generational Status, Hispanics**

| National Origin / Mexican Immigrant Generational Status | Language Spoken in Home | | | |
|---|---|---|---|---|
| | Only English | Predominantly English | Predominantly Spanish | Only Spanish |
| Mexican Origin | 24.0 | 19.2 | 20.7 | 36.0 |
| Mexican, 1st generation | 4.7 | 0.0 | 15.0 | 80.4 |
| Mexican, 2nd generation | 11.9 | 13.3 | 25.1 | 49.7 |
| Mexican, 3rd generation | 51.0 | 34.2 | 10.7 | 4.1 |
| Mexican, Unknown gen. | -- | -- | -- | -- |
| Cuban Origin | 7.8 | 26.3 | 30.6 | 35.3 |
| Puerto Rican Origin | 38.5 | 26.4 | 20.6 | 14.5 |
| Central American Origin | 23.5 | 11.2 | 21.2 | 44.1 |
| South American Origin | 10.2 | 28.8 | 34.0 | 27.0 |
| Other Hispanic Origin | 59.7 | 18.4 | 8.9 | 13.0 |
| National Origin Unknown | 61.7 | 21.0 | 10.5 | 6.9 |
| **Total Hispanic, any Race** | 31.8 | 19.8 | 19.3 | 29.1 |

Note: percentages are weighted by ECLS-K longitudinal weight *c1_6fc0*, and include only students in the longitudinal sample and with valid math scores in wave 1. Percentages not reported for Mexican, Unknown generation group due to small sample size.

**Table 5: ECLS-K Standardized Math and Reading Achievement Gaps, by Kindergarten English Proficiency and Wave**

| | Subject / Wave | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Math | | | | | | Reading | |
| **Subgroup / Sample** | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th | Spring 3rd | Spring 5th |
| **Hispanic** | | | | | | | | |
| English Proficient, Fall K | -0.518 | -0.450 | -0.350 | -0.403 | -0.403 | -0.349 | -0.359 | -0.372 |
| | (0.060) | (0.060) | (0.102) | (0.054) | (0.057) | (0.056) | (0.064) | (0.062) |
| Not English Proficient, Fall K | -1.394 | -1.239 | -1.143 | -0.964 | -0.991 | -0.884 | -1.140 | -1.088 |
| | (0.067) | (0.067) | (0.104) | (0.062) | (0.062) | (0.063) | (0.061) | (0.055) |

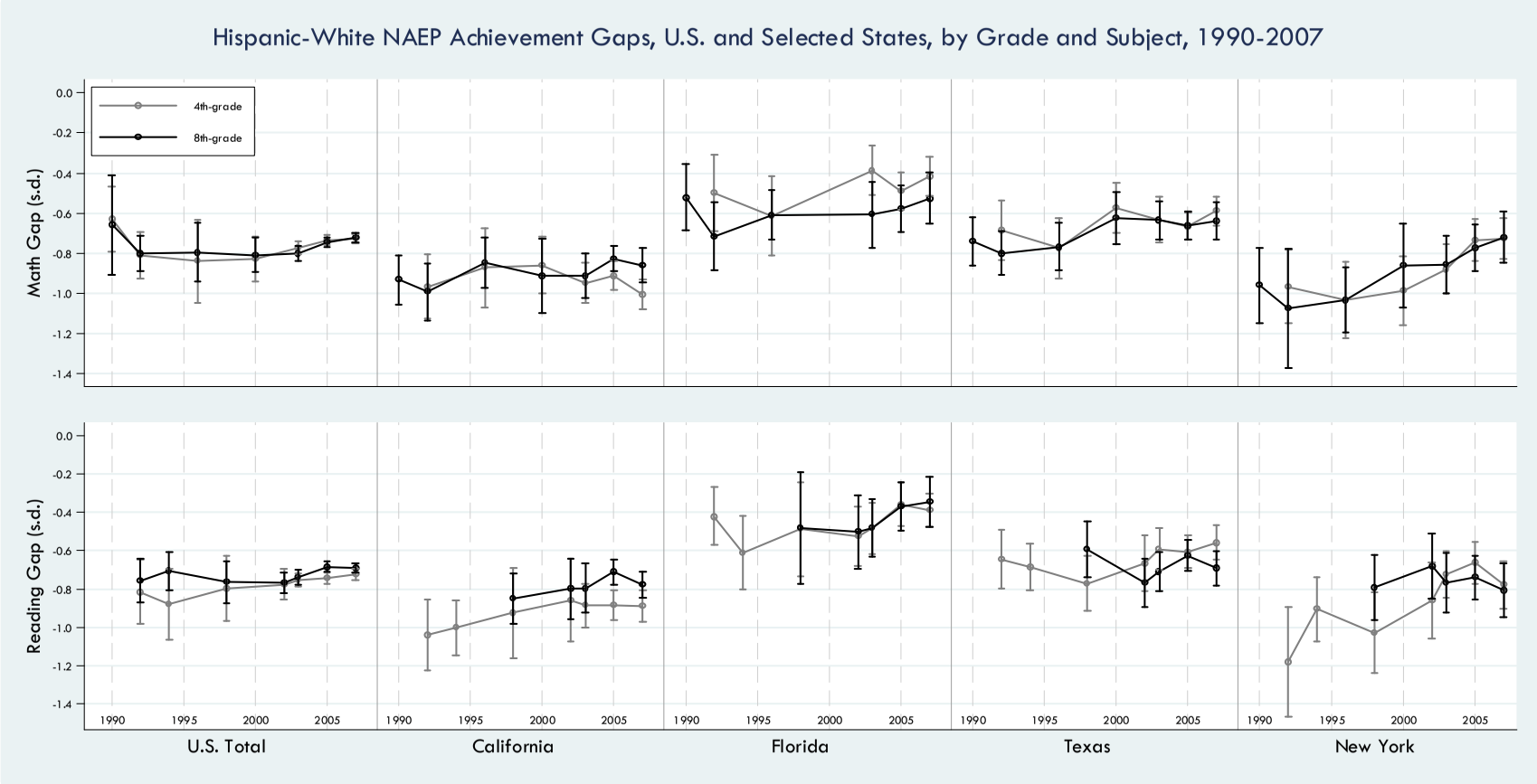
Notes: "Not English Proficient, Fall K" indicates the student does not have a valid reading score at wave 1, but the student has a valid longitudinal weight (c1_6fc0). "English Proficient, Fall K" indicates the student has both a valid reading score at wave 1 and a valid longitudinal weight. Assessment waves are: FK=Fall 1998 assessment; SK=Spring 1999 assessment; F1=Fall 1999 assessment; S1=Spring 2000 assessment; S3=Spring 2002 assessment; S5=Spring 2004 assessment. Achievement gaps are relative to 3rd-generation non-Hispanic White students in the sample at each assessment wave. Survey design corrected standard errors are in parentheses.

**Table 6: Proportion in Each Socioeconomic Quintile, by Race, Hispanic National Origin, and Mexican Immigrant Generational Status**

| Race / National Origin / Mexican Immigrant Generational Status | SES Quintile | | | | |
|---|---|---|---|---|---|
| | 1 (low) | 2 | 3 | 4 | 5 (high) |
| **White, Not Hispanic, 3rd+ Generation** | 8.2 | 16.5 | 22.4 | 22.9 | 30.0 |
| **Hispanic, any Race** | 35.8 | 24.5 | 17.7 | 13.4 | 8.6 |
| Mexican Origin | 42.6 | 26.2 | 14.6 | 10.3 | 6.2 |
| Mexican, 1st generation | 66.9 | 26.3 | 4.9 | 0.0 | 1.9 |
| Mexican, 2nd generation | 53.0 | 28.4 | 9.4 | 6.6 | 2.6 |
| Mexican, 3rd generation | 17.6 | 22.5 | 26.5 | 19.4 | 14.0 |
| Mexican, Unknown generation | -- | -- | -- | -- | -- |
| Cuban Origin | 14.1 | 4.8 | 36.6 | 17.6 | 27.0 |
| Puerto Rican Origin | 17.5 | 24.4 | 27.5 | 21.7 | 8.8 |
| Central American Origin | 45.8 | 23.4 | 12.7 | 7.7 | 10.4 |
| South American Origin | 9.9 | 41.1 | 14.2 | 15.3 | 19.5 |
| Other Hispanic Origin | 35.7 | 15.2 | 25.0 | 13.4 | 10.8 |
| National Origin Unknown | 17.0 | 19.3 | 25.7 | 27.1 | 10.9 |
| **Black, Not Hispanic, 3rd+ Generation** | 33.1 | 23.3 | 24.4 | 14.8 | 4.4 |
| **Asian, Any Generation** | 18.5 | 12.9 | 16.5 | 17.7 | 34.4 |
| **Other Race, Any Generation** | 18.0 | 21.6 | 29.3 | 14.1 | 17.0 |
| **Total** | 18.3 | 19.3 | 21.9 | 19.2 | 21.4 |

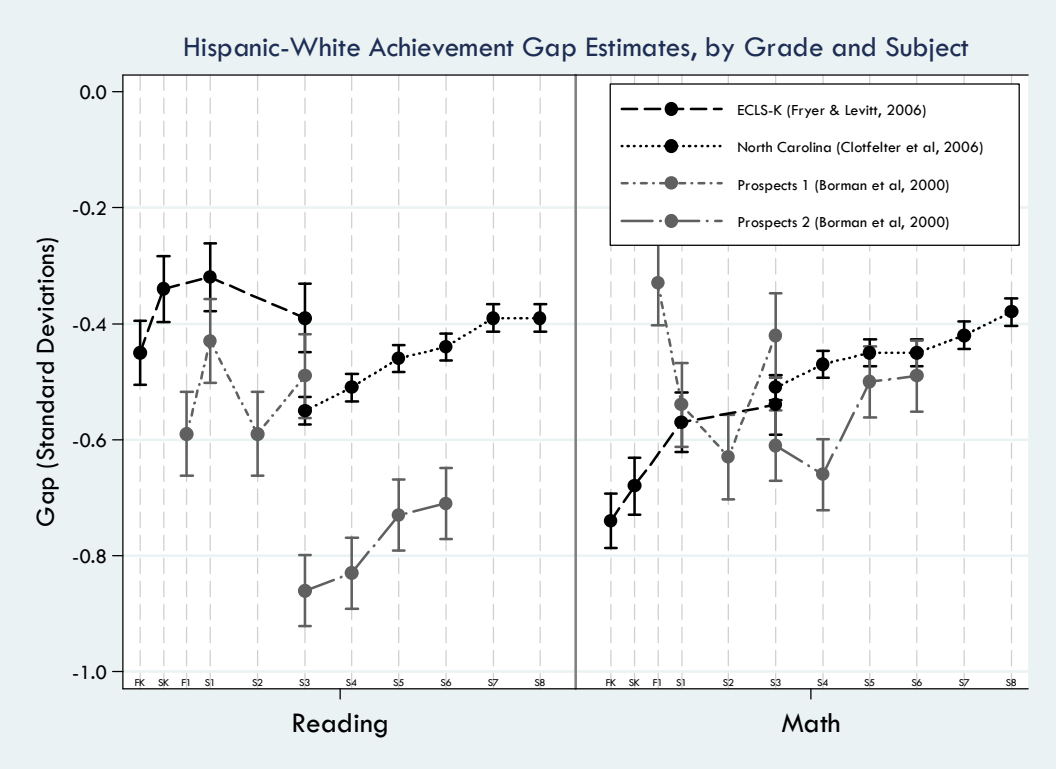
Note: percentages are weighted by ECLS-K longitudinal weight *c1_6fc0*, and include only students in the longitudinal sample and with valid math scores in wave 1. Percentages not reported for Mexican, Unknown generation group due to small sample size.

**Figure 1**




Source: Authors' tabulations of NAEP data, obtained at http://nces.ed.gov/nationsreportcard/nde/. Note: Hispanic-White gaps are measured in pooled standard deviation units (raw gaps are divided by the appropriate national grade- and subject-specific pooled Hispanic-White standard deviation). Error bars indicate 95% confidence intervals.

**Figure 2**




Note: Error bars indicate 95% confidence intervals. Gap estimates and standard errors obtained from respective studies. Borman et al (2000) do not report standard errors, so we estimate them using information on the Hispanic and White sample sizes under the assumption that the within-group test score standard deviations are equal for Hispanic and White students at each wave. These estimates do not account for clustering of students within schools, and so are likely too small. We include them only to provide a rough sense of the precision of each of the estimates.

**Figure 3**

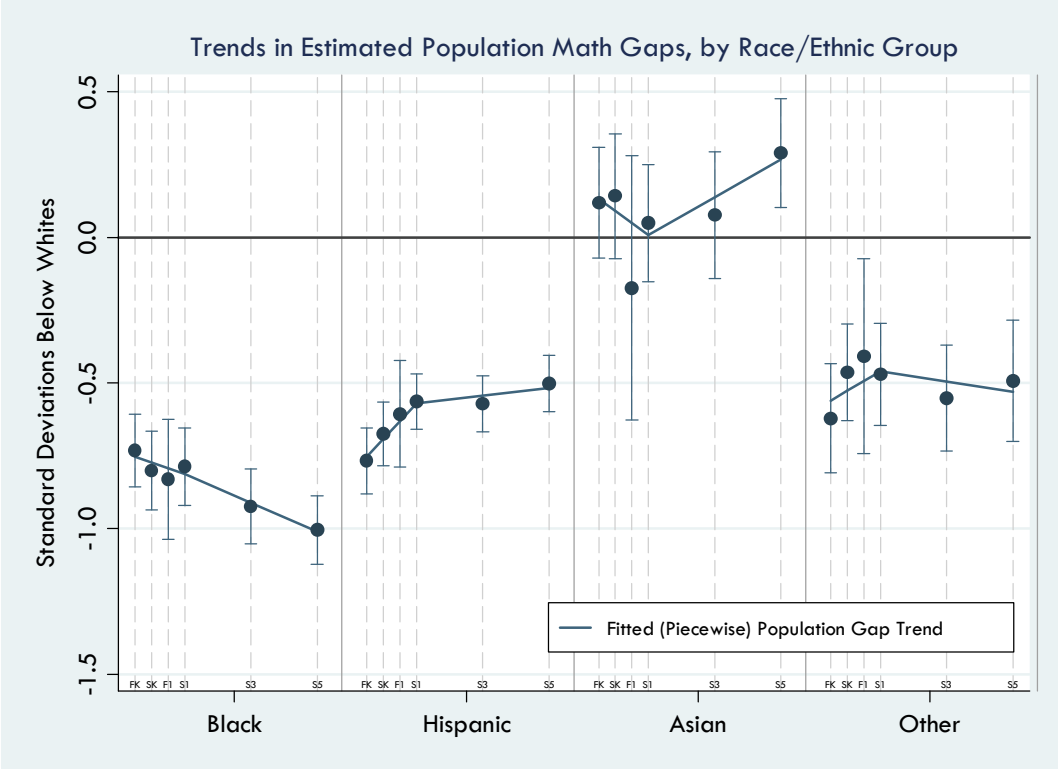



**Figure 4**

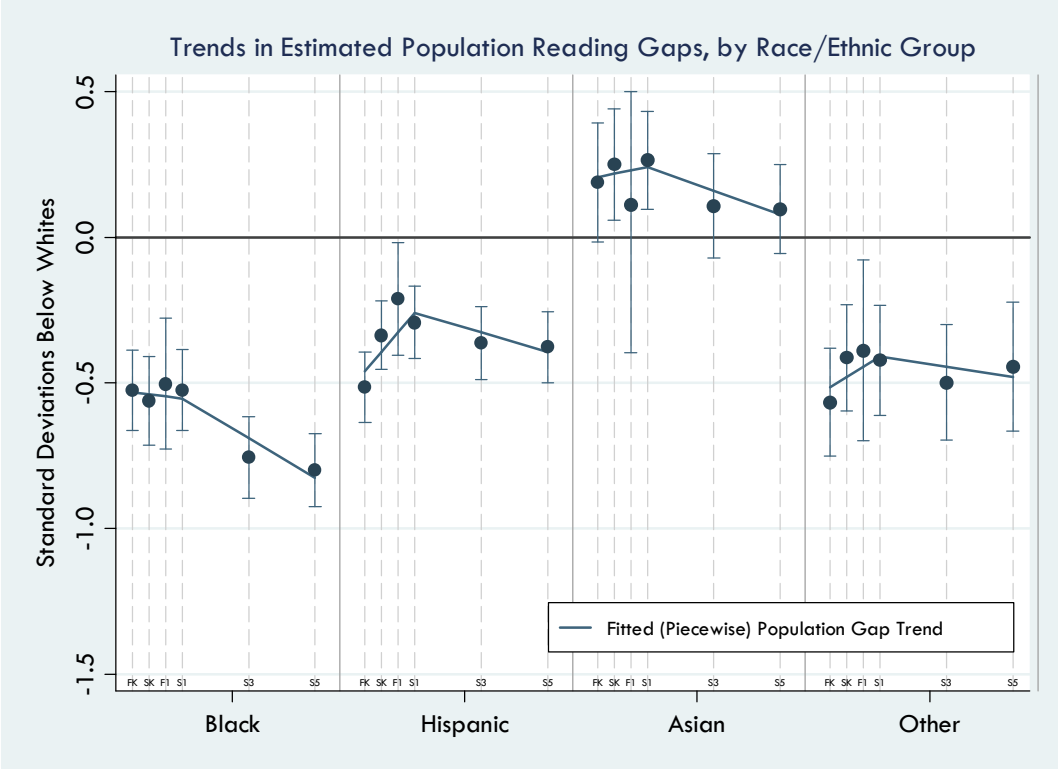


**Figure 5**

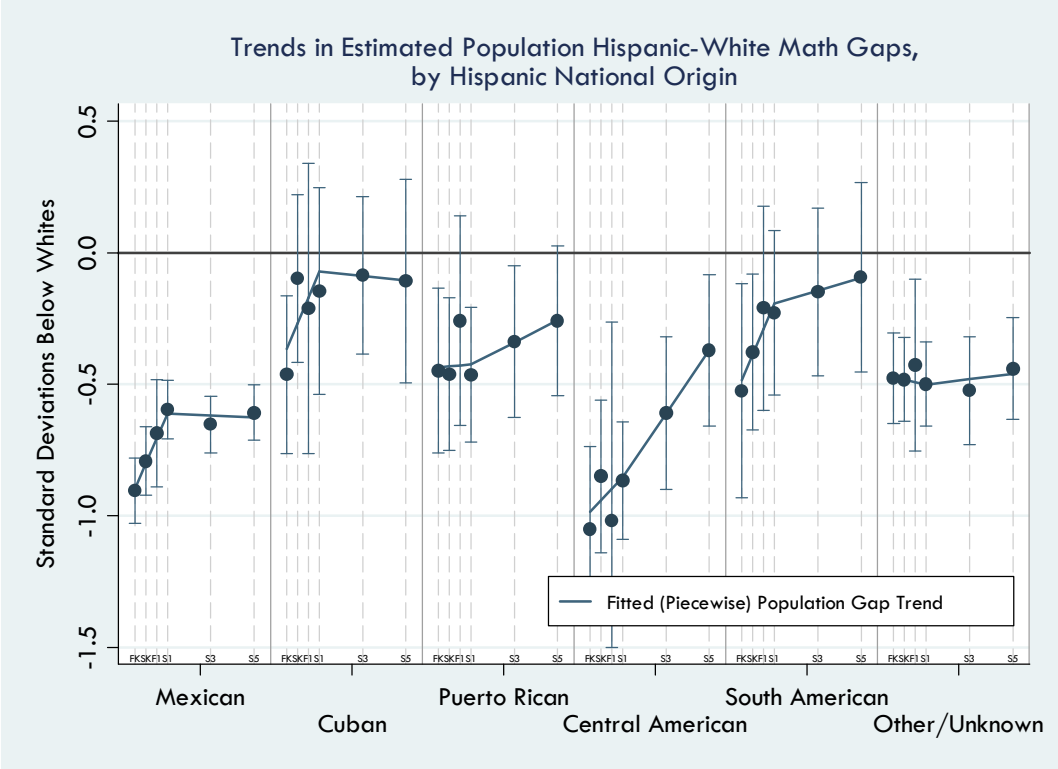



**Figure 6**

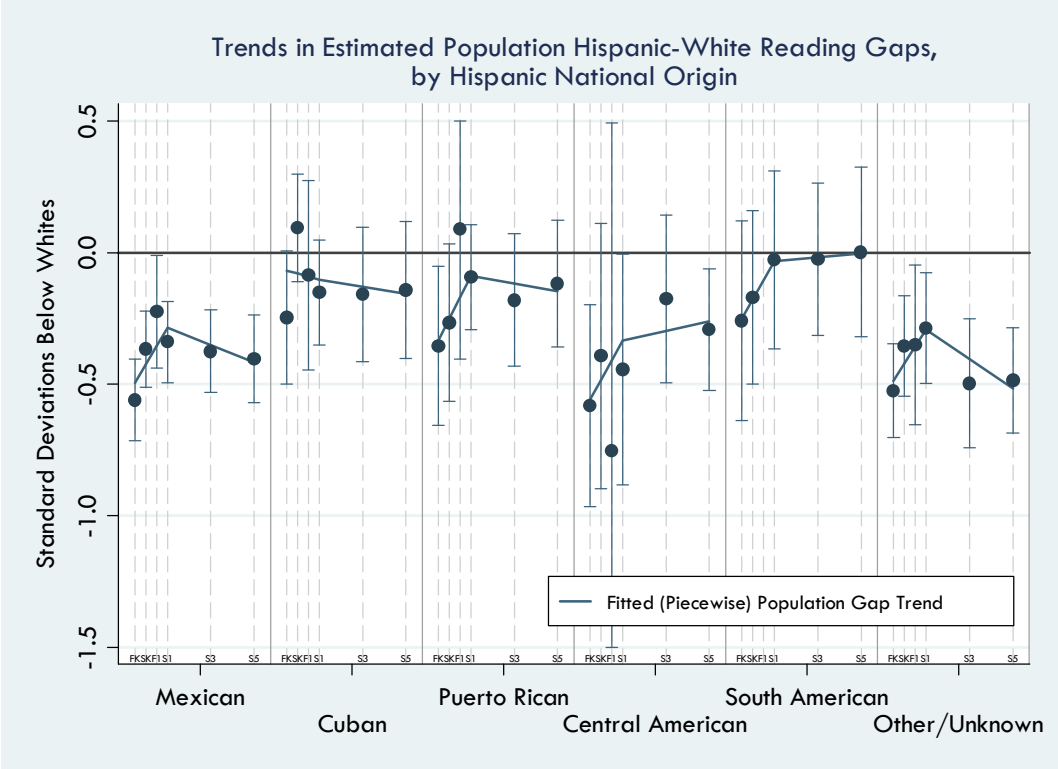


**Figure 7**

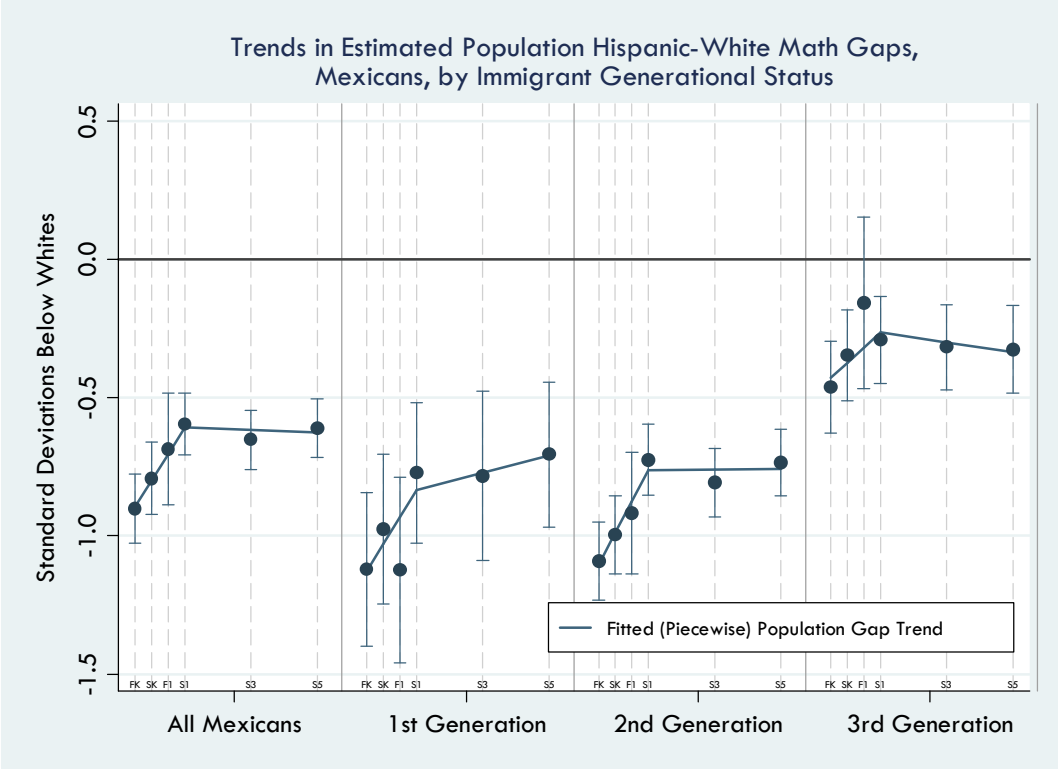



**Figure 8**

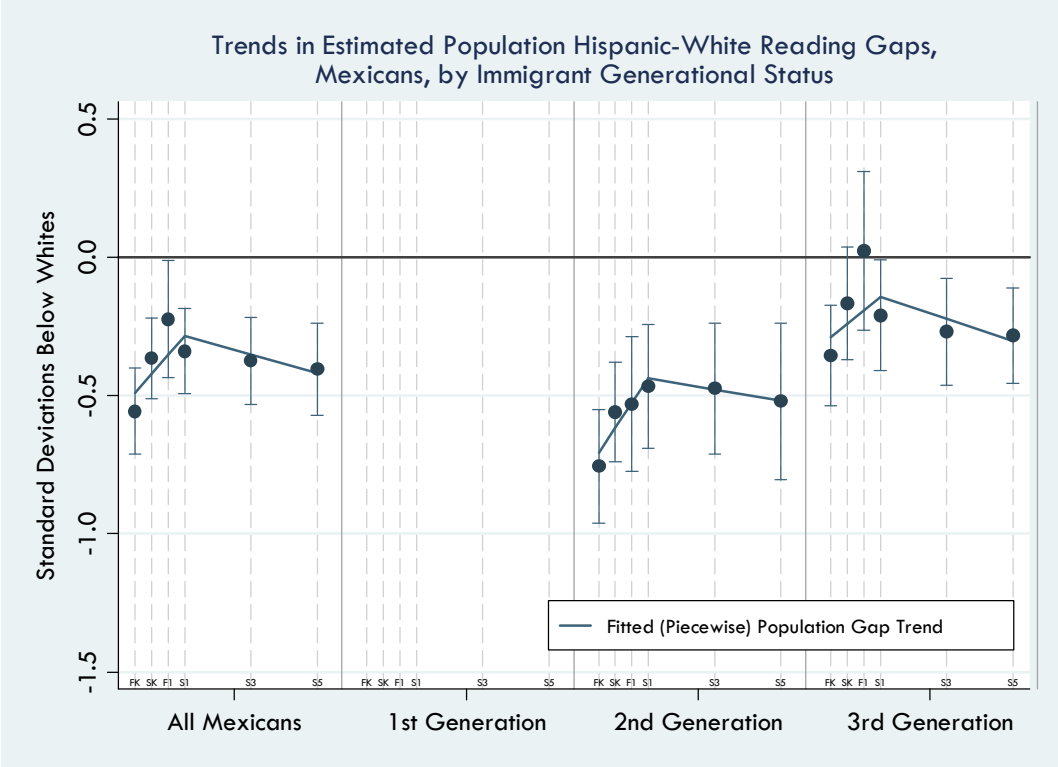


**Figure 9**

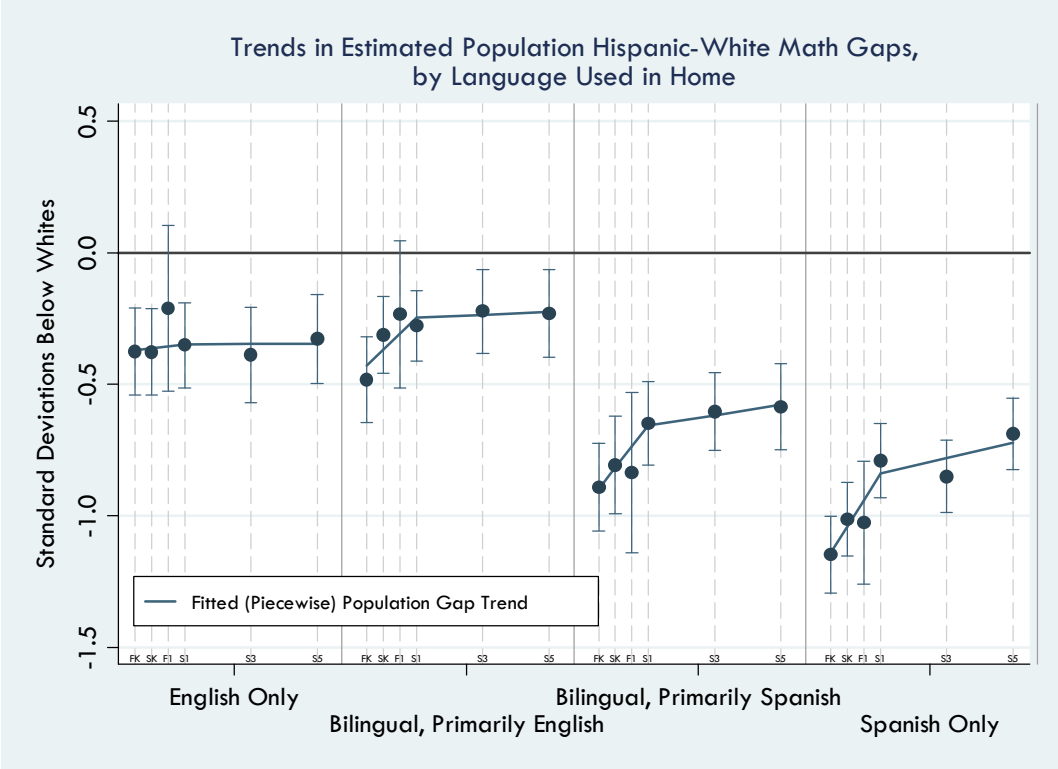



**Figure 10**

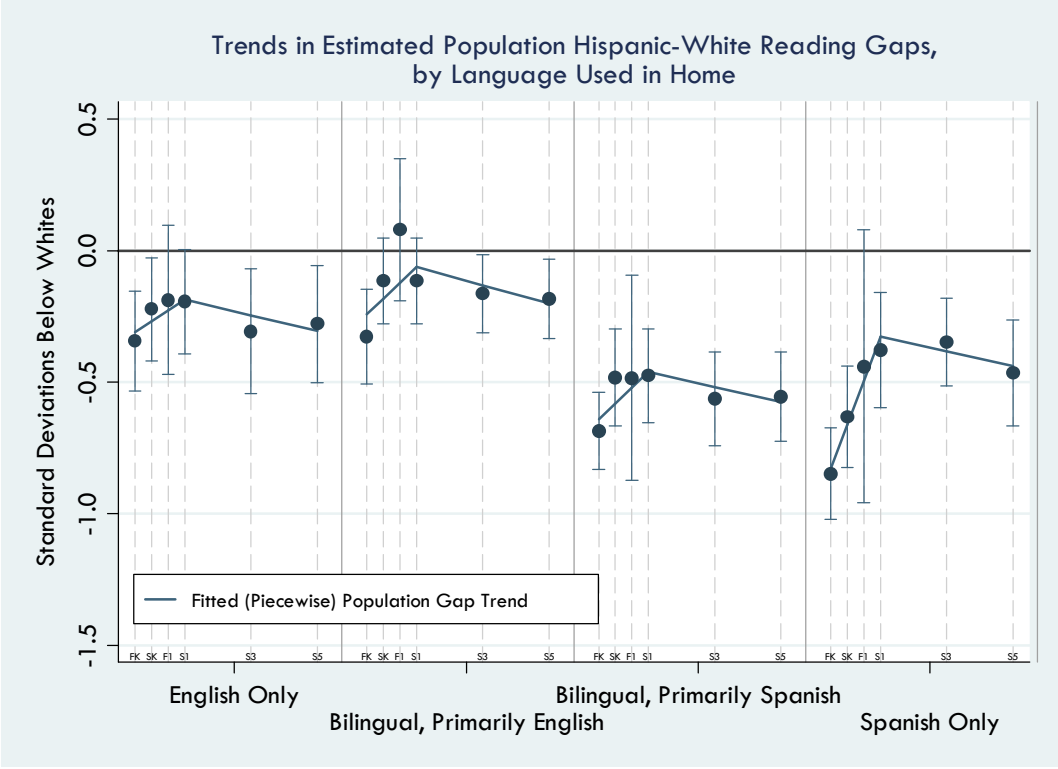


**Figure 11**

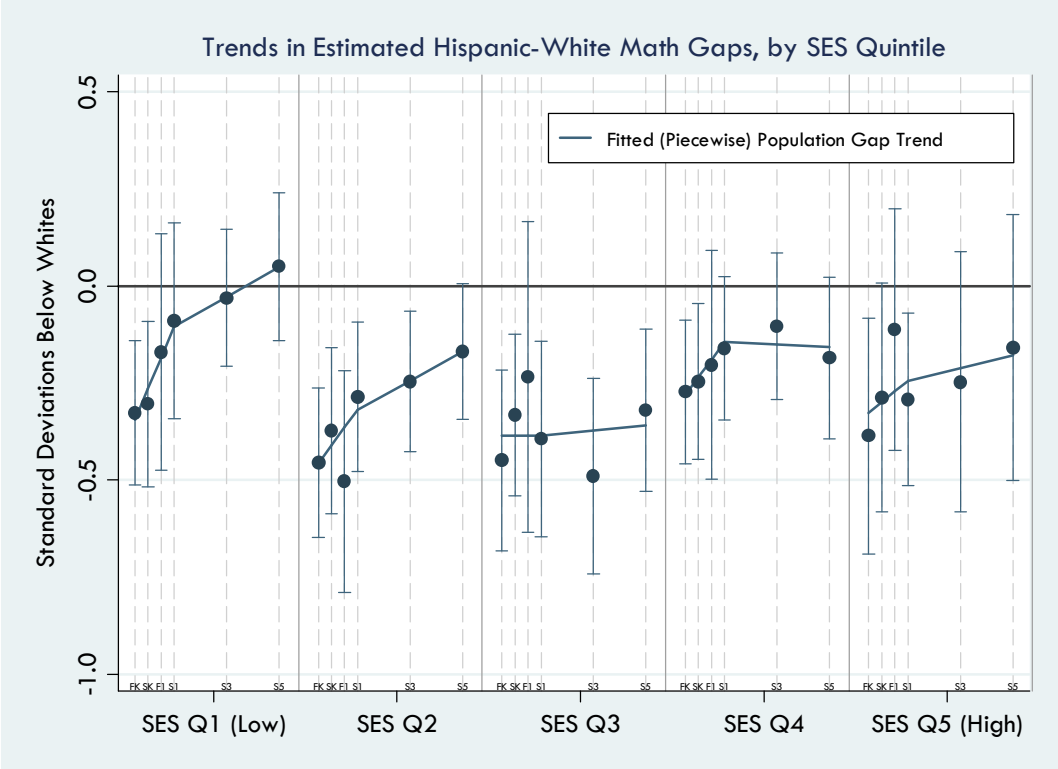
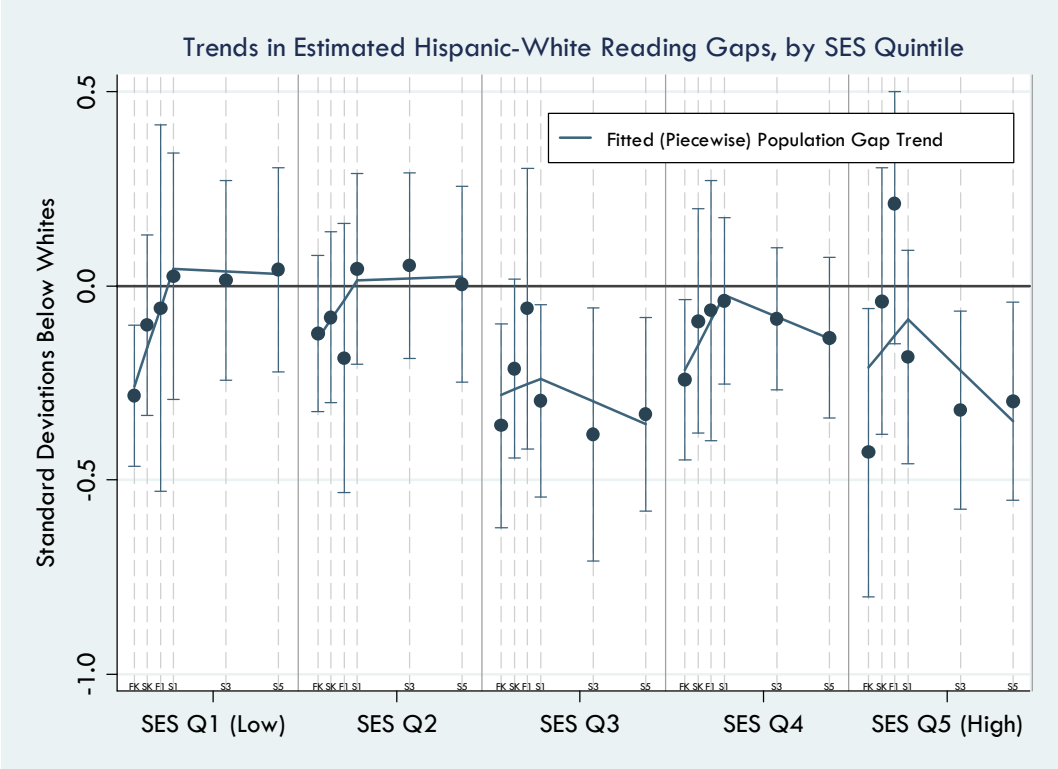



**Figure 12**



**Appendix A: Estimation of Achievement Gaps**

Let $\theta_{ist}$ denote the observed test score in subject *s* at wave *t* for student *i*. Let **G** be a vector of dummy variables indicating group or subgroup (with non-Hispanic Whites the omitted group). Let $T_{it}$ indicate the assessment date for student *i* at wave *t*. We estimate three types of gaps using the $\theta$ scores.

*Mean* θ *Score Differences*: For each subject *s* and wave *t*, we estimate the vector of gaps $\Delta_{st}$ between each Hispanic subgroup and non-Hispanic Whites by fitting (via weighted least squares, using the ECLS-K child longitudinal weight, *c1_6fc0*) the model

$$\theta_{ist} = \beta_0 + \beta_1 T_{it} + \mathbf{G}_{ist}\mathbf{\Delta}_{st} + \varepsilon_{ist} . \qquad [A1]$$

The vector $\hat{\mathbf{\Delta}}_{st}$ contains the estimated gaps in subject *s* at wave *t* between each group or subgroup and non-Hispanic Whites. We compute standard errors adjusted for the complex sampling design of ECLS-K, using the `-svy-` commands in the Stata statistical software package (Stata Corporation 2005).

*Standardized mean differences*. We first estimate each student's true $\theta$ score in each subject *s* and wave *t*, given an assumed reliability *r* (we assume reliabilities ranging from 0.7 to 1.0) Assuming classical measurement error, the Bayesian shrinkage estimator of $\theta_{ist}$ is given by

$$\theta^*_{ist} = \left(1 - \sqrt{r}\right)\bar{\theta}^i_{st} + \left(\sqrt{r}\right)\theta_{ist} , \qquad [A2]$$

where $\bar{\theta}^i_{st}$ is the mean $\theta$ for student *i*'s race/ethnic group (White, Black, Hispanic, Asian, other) in subject *s* at wave *t*. The resulting $\theta^*_{ist}$ will have smaller within-group variance than $\theta_{ist}$ (essentially we are subtracting of the proportion of the variance that is assumed to be due to measurement error) but the same group means.

We next compute the assessment-date adjusted pooled within-race/ethnic group standard

deviation of test scores at each wave and test subject. For both Hispanic and White students separately, we fit via weighted least squares a set of models (for both math and reading, and at each of the six waves) of the form

$$\theta^*_{ist} = \beta_0 + \beta_1 T_{it} + \varepsilon_{ist} \ . \qquad [A3]$$

From each of these models, we obtain, for both Hispanics and non-Hispanic Whites, an estimate of the measurement error- and assessment date-adjusted standard deviation of test score *s* at wave *t*. We compute the estimated pooled standard deviation for each test subject at each wave, $\hat{\sigma}_{st}$, as the square root of the average of the squares of the Hispanic and non-Hispanic White subject- and wave-specific standard deviations. We next standardize the test scores by de-meaning them and dividing by the estimated pooled standard deviation:

$$\theta'^*_{ist} = \frac{\left(\theta^*_{ist} - \overline{\theta}^*_{st}\right)}{\hat{\sigma}^*_{st}}. \qquad [A4]$$

To estimate the standardized gaps, we refit [A1] using the reliability-adjusted standardized test score $\theta'^*_{ixt}$:

$$\theta'^*_{ist} = \beta'^*_0 + \beta'^*_1 T_{it} + \mathbf{G}_{ist}\boldsymbol{\Delta}'^*_{st} + \varepsilon'^*_{ist}. \qquad [A5]$$

As above, the vector $\hat{\boldsymbol{\Delta}}'^*_{st}$ contains the estimated gaps in subject *s* at wave *t* between each group or subgroup and non-Hispanic Whites, adjusted for measurement error, though here all between-group differences in test scores are expressed in terms of measurement-error-adjusted pooled standard deviations.

*Metric-free measures.* Let $F_{hst}(\theta)$ and $F_{wst}(\theta)$ indicate the cumulative density functions of the Hispanic and non-Hispanic White measurement error-corrected test score distributions, respectively, in subject *s* at wave *t*. Define $H_{st}[F_{hst}(\theta)] = F_{wst}(\theta)$. That is, let $H_{st}$ be the function that maps percentiles of the Hispanic distribution of scores in subject *s* at wave *t* onto percentiles of the

corresponding non-Hispanic White distribution. Then the probability that a randomly chosen Hispanic student has a score in subject *s* at wave *t* that is higher than that of a randomly chosen non-Hispanic student is given by

$$P_{h>w(st)} = \int_0^1 H_{st}(x)dx\,. \qquad [A6]$$

We plot $H_{st}$ and compute the integral in [A6] numerically via interpolation. $P_{g>w(st)}$ is computed similarly for any Hispanic subgroup *g*. Finally, Ho & Haertel's (2006) pseudo-effect size is computed as

$$\delta_{st} = \sqrt{2}\Phi^{-1}\left(P_{h>w(st)}\right), \qquad [A7]$$

where $\Phi^{-1}$ is the inverse cumulative normal density function.

## Appendix B: Detailed Achievement Gap Tables

### Table B1: Estimated Standardized Math and Reading Achievement Gaps, by Race and Wave

| | Math | | | | | |
|---|---|---|---|---|---|---|
| Race | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| Hispanic | -0.768 | -0.675 | -0.606 | -0.564 | -0.571 | -0.502 |
| | (0.057) | (0.056) | (0.094) | (0.048) | (0.049) | (0.049) |
| Black | -0.733 | -0.802 | -0.830 | -0.788 | -0.925 | -1.005 |
| | (0.064) | (0.069) | (0.105) | (0.068) | (0.066) | (0.060) |
| Asian | 0.118 | 0.141 | -0.173 | 0.049 | 0.077 | 0.289 |
| | (0.097) | (0.109) | (0.232) | (0.103) | (0.111) | (0.095) |
| Other | -0.622 | -0.464 | -0.408 | -0.471 | -0.552 | -0.493 |
| | (0.096) | (0.085) | (0.171) | (0.090) | (0.093) | (0.106) |
| | Reading | | | | | |
| Race | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| Hispanic | -0.515 | -0.336 | -0.212 | -0.293 | -0.364 | -0.377 |
| | (0.062) | (0.060) | (0.099) | (0.063) | (0.064) | (0.062) |
| Black | -0.525 | -0.562 | -0.503 | -0.526 | -0.756 | -0.801 |
| | (0.071) | (0.078) | (0.115) | (0.071) | (0.072) | (0.064) |
| Asian | 0.188 | 0.251 | 0.111 | 0.264 | 0.108 | 0.097 |
| | (0.104) | (0.097) | (0.258) | (0.086) | (0.092) | (0.078) |
| Other | -0.567 | -0.414 | -0.388 | -0.422 | -0.499 | -0.445 |
| | (0.095) | (0.093) | (0.158) | (0.096) | (0.101) | (0.113) |

Notes: Samples includes students with both a valid math/reading score (respectively) at wave 1 and a valid longitudinal weight *c1_6fc0*. Each estimate is the estimated achievement gap relative to third-generation non-Hispanic White students. Survey design corrected standard errors are in parentheses.

**Table B2: Estimated Standardized Hispanic-White Math and Reading Achievement Gaps, by Hispanic National Origin and Wave**

| | Math | | | | | |
|---|---|---|---|---|---|---|
| Hispanic National Origin | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| Mexican | -0.905 | -0.793 | -0.685 | -0.597 | -0.653 | -0.607 |
| | (0.063) | (0.066) | (0.104) | (0.057) | (0.055) | (0.054) |
| Cuban | -0.463 | -0.098 | -0.213 | -0.146 | -0.086 | -0.108 |
| | (0.153) | (0.163) | (0.281) | (0.200) | (0.152) | (0.197) |
| Puerto Rican | -0.448 | -0.461 | -0.259 | -0.464 | -0.338 | -0.259 |
| | (0.160) | (0.149) | (0.203) | (0.130) | (0.146) | (0.145) |
| Central American | -1.050 | -0.850 | -1.019 | -0.865 | -0.609 | -0.371 |
| | (0.160) | (0.148) | (0.385) | (0.114) | (0.148) | (0.147) |
| South American | -0.525 | -0.378 | -0.210 | -0.229 | -0.149 | -0.093 |
| | (0.208) | (0.151) | (0.198) | (0.160) | (0.162) | (0.184) |
| Hispanic origin unknown | -0.477 | -0.481 | -0.427 | -0.499 | -0.524 | -0.440 |
| | (0.088) | (0.081) | (0.167) | (0.082) | (0.105) | (0.099) |
| | Reading | | | | | |
| Hispanic National Origin | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| Mexican | -0.560 | -0.367 | -0.224 | -0.340 | -0.374 | -0.403 |
| | (0.079) | (0.074) | (0.109) | (0.079) | (0.080) | (0.085) |
| Cuban | -0.247 | 0.094 | -0.086 | -0.151 | -0.158 | -0.142 |
| | (0.129) | (0.104) | (0.184) | (0.102) | (0.130) | (0.133) |
| Puerto Rican | -0.355 | -0.266 | 0.088 | -0.093 | -0.180 | -0.118 |
| | (0.154) | (0.153) | (0.252) | (0.102) | (0.128) | (0.123) |
| Central American | -0.582 | -0.393 | -0.754 | -0.444 | -0.176 | -0.293 |
| | (0.195) | (0.257) | (0.635) | (0.223) | (0.163) | (0.118) |
| South American | -0.259 | -0.170 | 0.706 | -0.029 | -0.026 | 0.003 |
| | (0.193) | (0.169) | (0.447) | (0.172) | (0.147) | (0.165) |
| Hispanic origin unknown | -0.525 | -0.355 | -0.351 | -0.287 | -0.497 | -0.485 |
| | (0.091) | (0.097) | (0.155) | (0.107) | (0.125) | (0.103) |

Notes: Sample includes students with both a valid math/reading score (respectively) at wave 1 and a valid longitudinal weight *c1_6fc0*. Each estimate is the estimated achievement gap relative to third-generation non-Hispanic White students. Survey design corrected standard errors are in parentheses.

**Table B3: Estimated Standardized Hispanic-White Math and Reading Achievement Gaps, by Immigrant Generational Status and Wave, Mexicans**

| | Math | | | | | |
|---|---|---|---|---|---|---|
| Mexican Generational Status | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| Mexican, 1st Generation | -1.122 | -0.976 | -1.124 | -0.773 | -0.783 | -0.706 |
| | (0.142) | (0.138) | (0.171) | (0.130) | (0.157) | (0.134) |
| Mexican, 2nd Generation | -1.091 | -0.997 | -0.918 | -0.726 | -0.808 | -0.735 |
| | (0.072) | (0.072) | (0.112) | (0.066) | (0.063) | (0.061) |
| Mexican, 3rd Generation | -0.463 | -0.347 | -0.158 | -0.291 | -0.318 | -0.325 |
| | (0.085) | (0.083) | (0.158) | (0.080) | (0.079) | (0.080) |
| Mexican, 2nd/3rd Generation | -1.751 | -1.209 | 1.146 | -1.138 | -0.912 | -1.152 |
| | (0.299) | (0.273) | (0.066) | (0.166) | (0.157) | (0.287) |
| Mexican, Generation unknown | -0.675 | -0.753 | 0.553 | -0.622 | -0.832 | -1.033 |
| | (0.421) | (0.347) | (0.053) | (0.052) | (0.236) | (0.107) |
| | Reading | | | | | |
| Mexican Generational Status | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| Mexican, 1st Generation | -0.890 | -0.927 | -0.293 | -0.683 | -0.698 | -0.681 |
| | (0.330) | (0.255) | (0.150) | (0.226) | (0.234) | (0.162) |
| Mexican, 2nd Generation | -0.757 | -0.561 | -0.531 | -0.467 | -0.475 | -0.521 |
| | (0.105) | (0.092) | (0.125) | (0.115) | (0.121) | (0.145) |
| Mexican, 3rd Generation | -0.356 | -0.167 | 0.023 | -0.210 | -0.269 | -0.283 |
| | (0.093) | (0.104) | (0.146) | (0.102) | (0.099) | (0.088) |
| Mexican, 2nd/3rd Generation | -0.542 | -0.233 | 2.033 | -0.280 | -0.482 | -0.752 |
| | (0.320) | (0.253) | (0.077) | (0.226) | (0.259) | (0.207) |
| Mexican, Generation unknown | -0.822 | 0.003 | -0.483 | 0.062 | -0.043 | 0.564 |
| | (0.033) | (0.064) | (0.054) | (0.043) | (0.034) | (0.065) |

Notes: Sample includes students with both a valid math/reading score (resepctively) at wave 1 and a valid longitudinal weight *c1_6fc0*. Each estimate is the estimated achievement gap relative to third-generation non-Hispanic White students. Survey design corrected standard errors are in parentheses.

**Table B4: Estimated Standardized Hispanic-White Math and Reading Achievement Gaps, by Language Used in Home and Wave**

| | Math | | | | | |
|---|---|---|---|---|---|---|
| Language Used in Home | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| English | -0.375 | -0.376 | -0.211 | -0.352 | -0.388 | -0.327 |
| | (0.084) | (0.084) | (0.161) | (0.083) | (0.093) | (0.086) |
| Mostly English | -0.483 | -0.313 | -0.234 | -0.278 | -0.223 | -0.231 |
| | (0.083) | (0.074) | (0.142) | (0.069) | (0.081) | (0.085) |
| Mostly Spanish | -0.892 | -0.807 | -0.836 | -0.649 | -0.603 | -0.586 |
| | (0.085) | (0.095) | (0.155) | (0.081) | (0.076) | (0.084) |
| Spanish | -1.148 | -1.014 | -1.027 | -0.791 | -0.851 | -0.689 |
| | (0.074) | (0.072) | (0.119) | (0.072) | (0.070) | (0.070) |
| | Reading | | | | | |
| Language Used in Home | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| English | -0.344 | -0.223 | -0.188 | -0.194 | -0.306 | -0.279 |
| | (0.097) | (0.100) | (0.145) | (0.101) | (0.121) | (0.113) |
| Mostly English | -0.326 | -0.115 | 0.079 | -0.114 | -0.164 | -0.184 |
| | (0.092) | (0.083) | (0.138) | (0.083) | (0.076) | (0.077) |
| Mostly Spanish | -0.685 | -0.482 | -0.484 | -0.475 | -0.563 | -0.555 |
| | (0.075) | (0.094) | (0.199) | (0.091) | (0.091) | (0.086) |
| Spanish | -0.848 | -0.632 | -0.440 | -0.377 | -0.347 | -0.465 |
| | (0.088) | (0.099) | (0.265) | (0.111) | (0.085) | (0.103) |

Notes: Sample includes students with a valid math/reading score (respectively) at wave 1, a valid longitudinal weight *c1_6fc0*, and valid information about the language spoken at home. Each estimate is the estimated achievement gap relative to third-generation non-Hispanic White students. Survey design corrected standard errors are in parentheses.

**Table B5: Estimated Standardized Within-SES Quintile Math and Reading Achievement Gaps, by Wave**

| | Math | | | | | |
|---|---|---|---|---|---|---|
| Socioeconomic Quintile | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| SES Quintile 1 | -0.327 | -0.304 | -0.170 | -0.090 | -0.031 | 0.050 |
| | (0.095) | (0.109) | (0.156) | (0.129) | (0.090) | (0.097) |
| SES Quintile 2 | -0.455 | -0.373 | -0.504 | -0.286 | -0.246 | -0.169 |
| | (0.098) | (0.109) | (0.146) | (0.098) | (0.092) | (0.089) |
| SES Quintile 3 | -0.450 | -0.332 | -0.235 | -0.395 | -0.490 | -0.320 |
| | (0.119) | (0.106) | (0.204) | (0.129) | (0.129) | (0.107) |
| SES Quintile 4 | -0.273 | -0.246 | -0.203 | -0.161 | -0.104 | -0.186 |
| | (0.095) | (0.103) | (0.150) | (0.094) | (0.096) | (0.106) |
| SES Quintile 5 | -0.387 | -0.287 | -0.112 | -0.292 | -0.248 | -0.159 |
| | (0.155) | (0.150) | (0.159) | (0.114) | (0.171) | (0.175) |
| | Reading | | | | | |
| Socioeconomic Quintile | Fall K | Spring K | Fall 1st | Spring 1st | Spring 3rd | Spring 5th |
| SES Quintile 1 | -0.283 | -0.101 | -0.058 | 0.025 | 0.014 | 0.041 |
| | (0.093) | (0.118) | (0.241) | (0.162) | (0.131) | (0.134) |
| SES Quintile 2 | -0.123 | -0.081 | -0.186 | 0.043 | 0.052 | 0.005 |
| | (0.102) | (0.112) | (0.177) | (0.125) | (0.122) | (0.129) |
| SES Quintile 3 | -0.361 | -0.213 | -0.059 | -0.296 | -0.383 | -0.331 |
| | (0.134) | (0.118) | (0.184) | (0.126) | (0.167) | (0.127) |
| SES Quintile 4 | -0.241 | -0.091 | -0.064 | -0.039 | -0.084 | -0.134 |
| | (0.105) | (0.147) | (0.171) | (0.109) | (0.093) | (0.105) |
| SES Quintile 5 | -0.429 | -0.040 | 0.211 | -0.184 | -0.320 | -0.298 |
| | (0.189) | (0.175) | (0.184) | (0.140) | (0.130) | (0.130) |

Notes: Sample includes students with both a valid math/reading score (respectively) at wave 1 and a valid longitudinal weight *c1_6fc0*. Each estimate is the estimated achievement gap relative to third-generation non-Hispanic White students of the same socioeconomic quintile. Survey design corrected standard errors are in parentheses.

Institute for Research on Education Policy & Practice
Stanford University
520 Galvez Mall, 5th Floor
Stanford, CA 94305-3084

T 650-736-1258
F 650-723-9931
irepp@suse.stanford.edu
www.irepp.net