Stanford cepa | Center for Education Policy Analysis

CEPA Working Paper No. 15-02

Recent Trends in Socioeconomic and Racial School Readiness Gaps at Kindergarten Entry

AUTHORS

Sean F. Reardon
Stanford University

Ximena A. Portilla
Stanford University

ABSTRACT

Academic achievement gaps between high- and low-income students born in the 1990s were much larger than among cohorts born two decades earlier. During the same period, racial achievement gaps declined. To determine whether these trends have continued in more recent cohorts, we examine trends in school readiness, as indexed by academic achievement and self-regulation, for cohorts born from the early 1990s to the mid-2000s. We use data from nationally-representative samples of kindergarteners (ages 5-6) in 1998 (n=20,220), 2006 (n=6,600), and 2010 (n=16,980) to estimate trends in racial and socioeconomic school readiness gaps. We find that readiness gaps narrowed modestly from 1998-2010, particularly between high- and low-income students and between white and Hispanic students.

VERSION

January 2015

Suggested citation: Reardon, S.F., Portilla, X.A. (2015). Recent Trends in Socioeconomic and Racial School Readiness Gaps at Kindergarten Entry (CEPA Working Paper No.15-02). Retrieved from Stanford Center for Education Policy Analysis: http://cepa.stanford.edu/wp15-02

Recent Trends in Socioeconomic and Racial School Readiness Gaps at Kindergarten Entry

Sean F. Reardon

Ximena A. Portilla

Stanford University

DRAFT: January, 2015

Direct correspondence to sean.reardon@stanford.edu. Ximena A. Portilla's work on this paper was supported by a grant from the Institute of Education Sciences (R305B090016) to Stanford University (Sean F. Reardon, Principal Investigator). We thank Demetra Kalogrides for excellent research assistance. The opinions expressed are ours and do not represent views of the Institute or the U.S. Department of Education. Any errors are our fault.

Recent Trends in Socioeconomic and Racial School Readiness Gaps at Kindergarten Entry

Abstract

In recent decades, academic achievement gaps between high- and low-income students in grades 3-12 have risen, while racial gaps have declined. It is unclear whether trends in school readiness have followed the same pattern. Rising income inequality, income segregation, and socioeconomic disparities in parental investments suggest that school readiness gaps may be rising. Conversely, narrowing disparities in pre-school enrollment and child health insurance coverage suggest they may be declining. Data from nationally-representative samples of kindergarteners (age 5-6) in 1998 (*n*=20,220), 2006 (*n*=6,600), and 2010 (*n*=16,980), are used to estimate trends in racial and economic school readiness gaps. These data show that readiness gaps narrowed modestly from 1998-2010, particularly between high- and low-income students and between white and Hispanic students.

Keywords: school readiness, income gap trends, racial gap trends

Recent Trends in Socioeconomic and Racial School Readiness Gaps at Kindergarten Entry

Racial and socioeconomic disparities in performance on standardized tests of academic achievement are a stubborn feature of the U.S. educational landscape. The white-black and white-Hispanic achievement gaps in both math and reading in grades 4-12 range from roughly 0.50 to 0.85 standard deviations in recent years; the gap in achievement between kindergarten students from high- and low-income families was roughly 1.25 standard deviations in 1998 (Hemphill, Vanneman, & Rahman, 2011; Reardon, 2011; Reardon, Robinson-Cimpian, & Weathers, forthcoming; Vanneman, Hamilton, Baldwin Anderson, & Rahman, 2009). These disparities are present when children enter kindergarten, and persist as children progress through school (Fryer & Levitt, 2006; V. E. Lee & Burkham, 2002; Reardon, 2011).

These academic achievement disparities are not immutable social facts, however. Indeed, they have changed substantially in the last few decades. The white-black and white-Hispanic achievement gaps were considerably larger in the 1970s than they are today; these gaps narrowed sharply in the 1970s and 1980s, before plateauing through much of the 1990s, and then beginning to narrow again in the last 15 years (National Center for Education Statistics, 2013; Reardon, et al., forthcoming). The income achievement gap, in contrast, was considerably smaller in the 1970s than it is today, but grew by roughly 40% between cohorts born in the mid-1970s and the mid-1990s (Reardon, 2011). The causes of these changes are not well understood.

Our goal in this paper is to provide new evidence on very recent trends in these achievement gaps. In particular, we use newly available data to describe the trends in the magnitude of racial and economic achievement and school readiness gaps among kindergarten students from the fall of 1998 to the fall of 2010. Because almost all other evidence on trends in academic achievement gaps is based on tests given to students in grades 3-12, these descriptive analyses fill an important lacuna in the literature.

Moreover, they may help us to better understand several key trends in elementary school achievement gaps. It is important to note, however, that our analyses here are fundamentally *descriptive*, not *explanatory*; we are able to identify patterns of change (and stability) in school readiness gaps, but we do not attempt here to present definitive explanations for these patterns.

Recent Trends in Achievement Gaps

White-black and white-Hispanic academic achievement gaps have been declining for the last decade or more. Over the past 15 years, the gaps in 4th grade math and reading have narrowed by roughly 0.10-0.20 standard deviations, depending on the subject, group, and data source (see Figure 1). Similar, but less pronounced, patterns are evident in 8th grade (Reardon, et al., forthcoming). Nonetheless, although it is clear that racial achievement gaps have narrowed in 4th and 8th grade, it is not clear to what extent this is because gaps are smaller when children first come to kindergarten, or because the gaps now change differently during the early elementary grades. The former would suggest the causes of the declines in grade 4-8 racial gaps cannot be found in changes in opportunities provided by the K-12 educational system; the latter would suggest they might be.

At the same time, the academic achievement gap between children from high- and low-income families has widened considerably—by about 40%—in the last several decades (Reardon, 2011). Reardon argues that because the gap does not appear to grow during the schooling years, the reasons for its increase must be found in trends over time in the size of achievement gaps at kindergarten entry. It is unclear if the income achievement gap at kindergarten entry has changed in the last decade, however. The most recent cohorts in Reardon's data were born in 1992/93 and 2001 (entering kindergarten in 1998 and 2006/07, respectively). The sampling design for these two cohorts were not strictly comparable, however, making estimation of the trend in the income achievement gap difficult. Newly available data, however, provide a nationally-representative sample from the kindergarten class of 2010 (who were

mostly born in 2004/05) that is quite comparable to the sample 1998 kindergarten sample. These data will provide information on whether the income achievement gap has continued to grow in recent cohorts.

Dimensions of School Readiness

The National Education Goals Panel described five dimensions of school readiness: 1) physical well-being and motor development; 2) social and emotional development; 3) approaches to learning; 4) language development; and 5) cognition and general knowledge (Kagan, Moore, & Bredekamp, 1998). Of these, language development and cognition and general knowledge are typically measured using cognitive tests designed to assess children's literacy and language skills, their numeracy and pre-mathematics skills, and their general knowledge. These "academic readiness" skills are a key dimension of school readiness. Early academic achievement scores predict later academic achievement better than do early measures of social-emotional development and behavior (G. J. Duncan et al., 2007), and also predict adult earnings (Chetty et al., 2011).

Nonetheless, although academic readiness at kindergarten entry is critical in predicting school performance in later grades and has long played a dominant role in research on educational and social inequality, other dimensions of readiness, such as social, motor, emotional, and behavioral skills, also affect academic achievement and educational success (Grissmer & Eiseman, 2008). One key area is children's capacity for self-regulation, which includes children's ability to focus and pay attention, control their impulses, communicate their needs, and engage in the learning material (Lewit & Baker, 1995). These self-regulatory abilities have been directly implicated in children's later school success (Blair & Razza, 2007; G. J. Duncan, et al., 2007; McClelland et al., 2007), highlighting the importance of focusing on indicators of school readiness in addition to achievement outcomes.

Self-regulation is a broad, multi-dimensional construct consisting of cognitive and behavioral

processes that allow individuals to maintain optimal levels of emotional, motivational, and cognitive arousal for positive adjustment and adaptation (Blair & Diamond, 2008). Socioeconomic status is positively associated with self-regulatory abilities, both as reported by parents and teachers (Brody & Flor, 1997; Brody, Stoneman, & Flor, 1996) and as measured via laboratory tasks (Crook & Evans, 2014; Evans & Rosenbaum, 2008; Farah et al., 2006; Noble, McCandliss, & Farah, 2007; Noble, Norman, & Farah, 2005; Sarsour et al., 2011). There are also racial differences in patterns of development of self-regulation skills. Both racial and socioeconomic gaps in self-regulatory abilities emerge prior to kindergarten entry (Grissmer & Eiseman, 2008; Hughes, Ensor, Wilson, & Graham, 2009; Magnuson & Duncan, 2014).

Children who lack the attentional and inhibitory control processes necessary to focus on educational material tend to exhibit challenges learning and engaging with classroom activities. These challenges potentially place them at risk for reduced academic achievement as they progress through school (Blair, 2002). An analysis of six longitudinal studies found that children's attentional skills in kindergarten predicted math and reading achievement in third grade, although not as strongly as did early numeracy and literacy skills (G. J. Duncan, et al., 2007). Thus, self-regulation may be seen as a mediator to explain the relation between income and academic achievement (Crook & Evans, 2014; Evans & Rosenbaum, 2008).

Why Might Racial and Socioeconomic School Readiness Gaps Have Changed Since 1998?

In this paper, we use data from cohorts of children entering kindergarten in 1998, 2006-07, and 2010 to examine trends in school readiness gaps over a 12-year period. There are a number of reasons to suspect that school readiness gaps might have risen from 1998 to 2010. Income inequality grew moderately over this time period. Among families with children, the 90/10 income ratio grew from an

average of 9.3 in 1993-1998 to an average of 9.8 in 2005-2010.[1] The 1998 kindergarten cohort grew up (from birth to age 5) in a period of strong economic growth; the 2010 cohort spent half of their early childhood in the Great Recession (which officially lasted from December, 2007 to February 2010, but whose effects certainly persisted beyond then). The recession disproportionately affected the employment and earnings of low-income families, and contributed to growing wage inequality. To the extent that larger differences in income lead to larger differences in the educational and developmental opportunities families can provide, such as high-quality child care and pre-school programs, this increase in income inequality may have led to a corresponding increase in school readiness gaps by income.

A number of other factors might be expected to lead to increased achievement gaps, particularly by income. Economic residential segregation grew from 1990-2009 (Bischoff & Reardon, 2014), though racial segregation, particularly segregation of black households, declined from 1990-2010 (B. A. Lee, Iceland, & Farrell, 2014). Given the positive association between neighborhood conditions and children's cognitive development (Brooks-Gunn, Duncan, & Aber, 1997; G. J. Duncan, Brooks Gunn, & Klebanov, 1994; Klebanov, Brooks-Gunn, McCarton, & McCormick, 1998; Leventhal & Brooks-Gunn, 2000), increasing economic segregation might have led to increasing disparities in kindergarten readiness.

The amount of time that parents spent with their children also grew from 1994-2008, but the increase was much greater among college-educated parents than those without a college degree (Ramey & Ramey, 2010). Likewise, average parental spending on children grew substantially from the mid-1990s to the mid-2000s, with the largest increases coming from increased spending on young children and college-age children. High-income families increased their spending over this time period much more than did low-income families (G. J. Duncan & Murnane, 2011; Kornrich & Furstenberg, 2013). Both of these increased disparities may be a result of growing income inequality; higher incomes provide families with more disposable income to invest in children, and may also provide greater opportunity for parents

[1] Author's calculations from Current Population Survey data. Although the 90/10 income ratio averaged 9.8 from 2005-2010, it grew sharply over this period, from 9.4 in 2005 to 10.6 in 2010.

to spend time with their children. These increased disparities in investments in children provide an additional reason to suspect there may have been an increase in the income gap in school readiness.

Despite the recent increases in income inequality, income segregation, and parental investments in children, there are some countervailing trends that might be expected instead to reduce school readiness gaps, or at least to slow their growth. First among these are trends in pre-school enrollment. Historically, white and higher-income children are more likely to attend pre-school than non-white and lower-income children (Magnuson & Duncan, 2014; Magnuson, Meyers, & Waldfogel, 2007). Although pre-school enrollment has increased for both high- and low-income children, the increase has been greater for low-income children, narrowing the income enrollment gap since the early 1990s (Magnuson & Duncan, 2014; Magnuson & Waldfogel, 2012). Magnuson and Waldfogel (2007) argue that the increase in enrollment rates and the decline in the enrollment gap between high- and low-income children is largely due to increases in public funding for pre-school programs over this time period.

The Hispanic-white gap in pre-school enrollment also narrowed over the last two decades, again because Hispanic enrollment rates rose much more rapidly than white enrollment rates. Black and white enrollment rates have been roughly equal, and rising at the same rate, since the 1970s (Magnuson & Waldfogel, 2012). The narrowing of the income and Hispanic-white pre-school enrollment gaps might suggest that the corresponding school readiness gaps have narrowed as well. Moreover, given the evidence that pre-school programs increase school readiness more for low-income and minority children than higher-income children (likely because, in the absence of pre-school, higher-income children may have better access to developmentally-stimulating experiences than low-income students) (Bassok, 2010; Magnuson, Meyers, Ruhm, & Waldfogel, 2004), overall increases in pre-school enrollment rates may reduce school readiness gaps, even if there were no narrowing of the enrollment rate gap.

A second reason to think that school readiness gaps may have narrowed in the last decade is the expansion of publicly funded health insurance for children since 1997. The Children's Health Insurance

Program (CHIP) was signed into law in 1997, expanding public funding for children's health insurance for families with incomes too high to qualify for Medicaid but who cannot afford private health insurance.[2] Between 1997 and 2010, the proportion of uninsured children in the U.S. declined from 14% to 8%.[3] The evidence on whether the expansion of health care coverage for low- to middle-income children during this time period improved health outcomes is mixed, though it does show the expansion reduced child hospitalization and mortality (see Howell & Kenney, 2012). One might expect increased health care coverage to lead to improvements in a range of developmental outcomes. If that is the case, then the expansion of publicly funded children's health insurance since 1997 may have led to narrowed school readiness gaps.

This is far from an exhaustive list of factors that might influence school readiness gaps, but it does suggest that it is not clear whether one should expect the school readiness gaps to have widened or narrowed between 1998 and 2010. To investigate if and how these gaps have changed in that time period, we examine data on children's school readiness from several studies of nationally representative samples of kindergarten students.

Method

Data

We use data from three studies conducted by the National Center for Education Statistics: two Early Childhood Longitudinal Study—Kindergarten Cohort (ECLS-K) studies (which include children who entered kindergarten in fall 1998 and 2010) and the Early Childhood Longitudinal Study—Birth Cohort (ECLS-B) study (which includes children who entered kindergarten in fall 2006 or 2007). These studies are multi-method and multi-informant, providing measures of children's development, school readiness, and

[2] http://www.medicaid.gov/chip/chip-program-information.html. Retrieved December 21, 2014.
[3] http://kff.org/health-reform/issue-brief/childrens-health-coverage-medicaid-chip-and-the-aca/. Retrieved December 21, 2014.

early school experiences. We describe the studies' key features below; various technical reports provide more detail on their design and measures (Snow et al., 2009; Tourangeau et al., 2001; Tourangeau et al., 2013).

To a great extent, the measures used in the ECLS-K studies draw from similar domains to allow for comparison of the characteristics and experiences of these two cohorts who were in kindergarten more than a decade apart. Because the ECLS-K 1998 served as a starting point for designing the ECLS-K 2010 and the kindergarten wave of the ECLS-B, much of their content and data collection procedures are the same or similar. Direct child assessments and items from the teacher and parent surveys were often used or modified directly from ECLS-K 1998. Nonetheless, the variation across the three studies in the scaling and exact content of the measures make an analysis of *trends in average levels* of school readiness problematic (since the school readiness tests are not scaled identically across time, for example). However, an examination of *trends in school readiness gaps* is little compromised by the changes in the content of the measures since we measure gaps relative to the population standard deviation of the measures at each point in time.

Early Childhood Longitudinal Study—Kindergarten Class of 1998-99 (ECLS-K 1998). The ECLS-K 1998 followed a nationally representative sample of roughly 21,400 children from their 1998-99 kindergarten year through eighth grade.[4] We use outcome data from fall and spring of kindergarten collected through direct child assessments, computer-assisted parent interviews, and self-administered teacher surveys.

Early Childhood Longitudinal Study—Kindergarten Class of 2010-11 (ECLS-K 2010). The ECLS-K 2010 study tracks a nationally representative sample of 18,170 children who entered kindergarten in the 2010-11 school year through fifth grade. At the time of writing, data were available from the first two waves of data collection: fall and spring of kindergarten. The data collection procedures for ECLS-K 2010 were the same as in the ECLS-K 1998 study.

[4] Throughout the paper, all sample sizes are rounded in accordance with National Center of Education Statistics guidelines.

Early Childhood Longitudinal Study—Birth Cohort (ECLS-B). The ECLS-B study includes a nationally representative sample of 10,700 children born in the United States in 2001 and followed through kindergarten. We use data from the final wave of the study, collected when the children entered kindergarten. Seventy-five percent of the sample entered kindergarten in 2006 while the remaining 25 percent entered in 2007. Direct assessments were conducted from September 2006 through March 2007 for the kindergarten 2006 wave and October 2007 through March 2008 for the kindergarten 2007 wave. As a result, we only examine gaps at one time point for these children. We do not include teacher- and parent-reported measures from this sample.

Measures

Language screener. The ECLS-K studies made efforts to include children who spoke a language other than English. In the ECLS-K 1998, the Oral Language Development Scale (OLDS) language screener was administered to children who were determined to have a non-English language background. The OLDS consisted of three parts adapted from the Preschool Language Assessment Scale (preLAS 2000; S. Duncan & De Avila, 1998). If children passed this screener, they received the full direct child assessment in English. Children who did not pass were administered a reduced version of the direct assessments. In the event that a child spoke Spanish, he or she was administered an alternate form of the language screener, the Spanish version of the OLDS. If the student passed, he or she was administered a Spanish-translated form of the mathematics assessment. Regardless of their native language, children not meeting the English proficiency threshold were not administered the reading assessment.

In the ECLS-K 2010, all children, regardless of home language, were administered the language screener as the first component of the direct cognitive assessment. The screener consisted of two tasks from the *pre*LAS 2000 (S. Duncan & De Avila, 1998). All children also received the first section of the reading assessment referred to as the English Basic Reading Skills (EBRS) section regardless of their home

language or performance on the *pre*LAS tasks. The reading assessment ended after this first section if a child's home language was not English and he or she did not score at least 16 (out of 20) points on the combined *pre*LAS and EBRS assessments. Spanish speakers who did not pass were administered a short reading assessment in Spanish (Spanish Basic Reading Skills), as well as a translated mathematics assessment. Those children whose home language was neither English nor Spanish and did not pass the *pre*LAS and EBRS were not administered any of the remaining cognitive assessments after the EBRS.

The ECLS-B used Spanish translations of measures for Spanish-speakers who did not pass an English fluency screening measure. A Spanish *pre*LAS was given to assess the language skills of non-English speakers who spoke Spanish. A translated mathematics assessment was administered as well as a Spanish Peabody Picture Vocabulary Test (Dunn & Dunn, 1997).

Even though the studies excluded some children from the assessments, we imputed all children's outcome scores using the method described below to make maximum use of the data. Nonetheless, we do not report trends in white-Hispanic reading gaps because differences in screening procedures render comparisons invalid. Imputed scores for students not administered the reading assessment are used in the computation of the income reading gaps, but the results are robust to the exclusion of these students as well. Because all Spanish-speaking students were administered the math test in all three studies, we do report white-Hispanic math gap trends.

Reading achievement. Reading assessments used in all studies measured basic reading skills such as print familiarity, letter recognition, beginning and ending sounds, rhyming sounds, word recognition, and receptive vocabulary. Reading comprehension items targeted initial understanding, developing interpretation, personal reflection, and demonstrating critical stance.

Mathematics achievement. Mathematics assessments used in all studies measured conceptual knowledge, procedural knowledge, and problem solving through items related to number sense, number properties, operations, geometry and spatial sense, data analysis, statistics, probability, patterns, algebra,

and functions.

Self-control. The self-control scales used in the ECLS-K 1998 describe children's ability to control their behavior. Items completed by teachers assessed children's ability to respect the property rights of others, control their tempers, accept peer ideas for group activities, and respond appropriately to pressure from peers (Gresham & Elliott, 1990b). The items reported by parents included both positive and negatively worded behaviors, such as "the frequency with which a child fights, argues, throws tantrums, or gets angry" (adapted from Gresham & Elliott, 1990b). All items were rated on a 1 to 4 scale from "never" to "very often."

Parents and teachers completed a similar scale in the ECLS-K 2010 study; the scale included some items taken verbatim from the Social Skills Rating System (SSRS; Gresham & Elliott, 1990b), some modified from the original items, and some measuring the same kinds of behaviors captured in the SSRS but using wording developed specifically for the ECLS studies.

Approaches to learning. This scale measured behaviors that affect children's ability to benefit from the learning environment. Teachers rated children's attentiveness, task persistence, eagerness to learn, learning independence, flexibility, and organization (adapted from Gresham & Elliott, 1990a). Parents rated how often children showed eagerness to learn, interest in a variety of things, creativity, persistence, concentration, and responsibility (adapted from Gresham & Elliott, 1990a). All items were rated on a 1 to 4 scale from "never" to "very often". The scales were similar across the ECLS-K studies, though teachers answered one extra item.

Because the self-control and approaches to learning scales are comparable in the ECLS-K studies, we can examine trends in self-regulatory gaps at kindergarten entry. Nonetheless, since they come from teacher and parent reports, these scales are not standardized in the way that task-based measures are. Thus, we interpret the trends based on these measures with caution.

Income and race. Children's race and household income were reported by parents during the

parent interviews in each study.

Data Analysis

Sample restrictions. We restrict the sample to first-time kindergarteners because of our interest in assessing kindergarten readiness gaps. In the ECLS-K studies, we dropped from the sample children whose parents reported they were repeating kindergarten (850 children in the 1998 cohort; 840 in the 2010 cohort). Among students whose parents did not answer the question on kindergarten repetition, we dropped children born prior to June 1 in 1992 or 2004 (who would have been at least 6.25 years old by September 1 of 1998 or 2010). Although some of these children may have been first-time kindergarteners whose parents "redshirted" them (delayed their kindergarten entry for a year beyond when they were initially eligible), redshirting is very uncommon among children born this early in the calendar year (Bassok & Reardon, 2013), so it is very likely that these children (260 in the 1998 cohort; 210 in the 2010 cohort) were repeating kindergarten. Children born after May 1992 or 2004 whose parents did not answer the question about repeating were included, although it was not clear whether they were redshirters or repeaters. Very few children were included for this reason (*n*= 110 in 1998; *n*= 50 in 2010).

In the ECLS-B, this restriction was straightforward since parents reported on the year children entered kindergarten. We dropped children who were not enrolled in school in 2006 or 2007, entered straight into first grade, were homeschooled, or were missing data (*n*= 4,100).

We also dropped cases for whom race or gender information was missing. We dropped 80 children from the 1998 cohort (missing race: *n*= 70; missing gender: *n*= less than 10), and 150 from the 2010 cohort (missing race: *n*= 80; missing gender: *n*= 70). In the ECLS-B, we dropped fewer than 50 missing cases for race and none for gender.

These restrictions resulted in a final sample size of 20,220 children (of an original sample of

21,400) in the ECLS-K 1998; 16,980 children (of an original sample of 18,170) in the ECLS-K 2010; and 6,600 children (of 10,700) in the ECLS-B. Most children missing from the ECLS-B were dropped because they did not participate in the final wave of data collection.

Multiple imputation. Multiple imputation was conducted using the –mi– commands in Stata 12.0, using chained equations and five iterations. The imputation model for all three studies used a regression model that included child age, gender, race, income, and a socioeconomic status (SES) composite included in the datasets. The imputation models also included measures of school readiness and performance, though the variables included differed slightly across datasets due to differences in the study designs. The ECLS-K 1998 imputation model also included the OLDS English proficiency screener score, outcome variables in kindergarten fall and spring, as well as first grade fall and spring. The ECLS-K 2010 imputation model included the EBRS English proficiency screener score and outcome variables in fall and spring kindergarten. The ECLS-B imputation model included a variable to designate whether children entered kindergarten in 2006 or 2007, and outcome variables in 2005, 2006, and 2007.

Computing school readiness gaps. While the ECLS-K 2010 is designed to allow for cross-cohort comparison with the ECLS-K 1998, it is currently not possible to compare average test scores across time because the tests are scaled differently (a future release of the ECLS-K 2010 data will include scores equated to the ECLS-K 1998 scale). Nonetheless, we can compute cross-sectional school readiness gaps in each study and wave, by standardizing the readiness measures within each wave of each study.

To standardize the outcome scores within each study and wave, we fit, for each outcome variable Y, the regression model

$$Y_i = \beta_0 + \beta_1(AGE_i) + e_i, e_i \sim N(0, \sigma^2),$$

using the appropriate sample weights. This yields an estimate of the age-adjusted variance in the outcome scores, $\hat{\sigma}^2$, and an estimated residual, $\hat{e}_i$, for each child. Dividing the residual by the root mean squared error yields the age-adjusted standardized outcome score for each child

$$\hat{Y}_i^* = \frac{\hat{e}_i}{\hat{\sigma}}.$$

By construction, the $\hat{Y}_i^*$'s have a mean of 0 and a standard deviation of 1 when weighted by the appropriate child-level sample weight. For ECLS-K 1998, we used the child weight at kindergarten spring when standardizing both the fall and spring scores because children not assessed in fall do not have sample weights in fall. For ECLS-K 2010, we used the only available child-level weight—the spring kindergarten weight. The ECLS-B calculations applied the first time kindergartener weight to account for whether children entered kindergarten in 2006 or 2007.

To compute income gaps in school readiness, we estimate Reardon's (2011) 90/10 income gap for each measure. This is interpreted as the difference in the average scores of children whose families are at the 90th percentile of the income distribution and children whose families are at the 10th percentile. We similarly compute the 50/10 and 90/50 income gaps for each measure. We use the methods described by Reardon (2011), using the appropriate sample weights and paired jackknife replication in Stata 12.0 in order to produce correct standard errors.

To compute the race school readiness gaps, we regress the standardized outcome score ($\hat{Y}_i^*$) on a vector of indicator variables for the racial groups (white is the reference group), using the appropriate sample weights. The regression coefficients from this model represent the racial school readiness gaps; we obtain standard errors using paired jackknife replication.

Reliability disattenuation. Although standardizing the outcome scores solves the primary problems of the comparability of gaps measured with different instruments and in non-interval scale metrics, measurement error in outcome scores will tend to inflate the variance of the test score distributions, thereby inflating σ^2 and biasing the estimated gaps toward zero. In addition, measurement error in the income measure will further attenuate the income gap estimates. In order to correct gap estimates for measurement error, we multiply each gap estimate by

$$\frac{1}{\sqrt{r_i \cdot r_g}}$$

where r_i is the reliability of the instrument and r_g is the reliability of the gap (income or race). We use $r_g = 0.86$ for income reliability (Marquis, Marquis, & Polich, 1986; Reardon, 2011) and $r_g = 1$ for race reliability (assuming race is measured without error). For r_i we use instrument reliabilities as reported in the ECLS technical reports (Snow, et al., 2009; Tourangeau, et al., 2001; Tourangeau, et al., 2013). Table 1 provides information regarding the reliability of the instruments used in each of the studies. This reliability disattenuation yields estimates of the true gaps, and eliminates any bias in the trend that may arise from differential reliability of the tests.

Statistical significance of changes in readiness gaps. In order to assess whether the estimated 1998-2010 changes in gaps are different than zero, we computed the standard error of the changes in two ways. First, because the 1998 and 2010 ECLS-K students are highly comparable to one another in terms in sampling, timing of assessments, and measurement instruments, we compute the standard error of the difference between the 1998 and 2010 gaps and conduct *t*-tests to determine if we can reject the null hypothesis that the gap is unchanged from 1998 to 2010. Second, in order to use all three studies to estimate the trend in the gap, we fit weighted least squares regression models of the form

$$\hat{\delta}_t = \gamma_0 + \gamma_1(Year_t) + \omega_t, \qquad \omega_t \sim N\left(0, var\left(\hat{\delta}_t\right)\right).$$

These models estimate the linear trend in the gap across the three time points, weighting each gap estimate by the precision with which it is estimated. The coefficient γ_1 indicates the average change in the gap per year from 1998-2010. Significance tests indicate whether the trend was statistically different than a slope of zero. Note, however, that the significance test here has relatively low power to detect trends, given that the regression model is based on only three observations, and that any deviation from linearity (either because of true nonlinearity in trends or because of differences in the study and instrument designs between the ECLS-B and ECLS-K studies) will tend to increase the standard errors and

reduce statistical power. The comparisons between the ECLS-K studies may provide a cleaner test than the linear trend models of whether there have been statistically significant changes in school readiness gaps over the 12 year period.

Results

Sample Descriptive Statistics

Table 1 present descriptive statistics (e.g., means, standard deviations, scale, and number of items) for the imputed samples from the three ECLS studies.

Trends in Racial School Readiness Gaps

Table 2 reports the white-black school readiness gaps computed from the three ECLS studies. First, note that the estimated gaps in math and reading skills declined by roughly 0.08 standard deviations from 1998 to 2010. These are relatively small changes but are not trivial in comparison to the size of the gaps in 1998, which were 0.63 and 0.40 standard deviations, respectively. The change in the math gap is marginally significant (p=0.07). Given the size of the standard errors of the estimates (0.044 and 0.056, respectively), however, the 95% confidence intervals for the estimated changes are relatively wide. In short, the estimates are too imprecise to tell us much about whether the trend is flat or declining, though it is clear that the gaps are not increasing at any meaningful rate.

Second, note that the teacher-reported measures of school readiness show substantial declines in the white-black gaps in self-control and approaches to learning. On both measures, the gaps declined by roughly 30% ($p < .01$). The parent measures of self-control and approaches to learning show a very different pattern: the gaps are smaller (in some cases not significantly different than zero) and do not show statistically significant changes. Nonetheless, the parent reports should be interpreted with the most caution, as parents likely differ widely in how they rate their children's school readiness.

Table 3 reports the white-Hispanic school readiness gaps. Here, note that the estimated gap in

math skills declined by roughly 0.11 standard deviations from 1998 to 2010 ($p < .05$). Again, this relatively modest change is not trivial in comparison to the size of the gap in 1998, which was 0.78 standard deviations. Table 3 does not include estimates of the white-Hispanic reading gap from the ECLS-K 1998 or the ECLS-B studies, given the differences in the reading test screening criteria in those studies. As a result, we cannot estimate the trend in the white-Hispanic school readiness gap from these data.

As with the white-black gaps, the teacher-reported measures of school readiness show substantial declines (40-50% declines from 1998 to 2010) in the white-Hispanic gaps in self-control and approaches to learning. Only the change in the approaches to learning measure is statistically significant ($p < .01$), however. Again, the parent measures of self-control and approaches to learning show a very different pattern: in both cases the estimated gaps increase from 1998 to 2010; the increase in the parent-reported gap in self-control is statistically significant. As above, we put less credence in these parent-reported measures, given the many potential confounding factors that may affect how parents rate their own children's school readiness.

Trends in Socioeconomic School Readiness Gaps

Table 4 reports the gaps in school readiness between children whose family incomes are at the 90th and 10th percentile of the family income distribution. These income achievement gaps have declined by 0.11 standard deviations ($p < .05$) in math and 0.19 standard deviations ($p < .001$) in reading from 1998-2010. These correspond to reductions of 8% and 15%, respectively. This rate of narrowing (roughly 7-12% per decade) is roughly half the 20% per decade rate at which the income achievement gap grew between the cohorts born in the mid-1970s and the mid-1990s (Reardon, 2011). None of the teacher- or parent-reported school readiness gap measures showed a significant change from 1998 to 2010.

Table 5 decomposes the changes in the math and reading income achievement gaps into components representing a) the gap between children from low- and middle-income families (the "50/10

income achievement gap" and b) the gap between children from middle- and high-income families (the "90/50 income achievement gap"). The point estimates here suggest that at least some of the reduction in the 90/10 math gap is attributable to a reduction in the 90/50 gap ($p < .10$); the estimates are too imprecise to indicate how much of the reduction is due to changes in the 50/10 gap, however. In contrast, the point estimates indicate that at least some of the reduction in the 90/10 reading gap is due to a decrease in the 50/10 gap ($p < .05$) and suggest that at least some is due to a decrease in the 90/50 gap ($p < .10$). Again, the estimates are too imprecise to further quantify the relative contribution of each component to the change in the 90/10 gaps.

Because there were no significant changes in the measures of the 90/10 self-control and approaches to learning income school readiness gaps, we do not include estimates of the trends in their 50/10 and 90/50 components in Table 5.

Changes in Math and Reading Gaps from Fall to Spring of Kindergarten

In both the 1998 and 2010 ECLS-K studies, children were assessed in math and reading skills in both the fall and spring of their kindergarten year. The two assessments allow us to determine whether achievement gaps narrow or widen during the kindergarten year, and whether these patterns changed between the two cohorts. Figure 2 illustrates the gaps in fall and spring of kindergarten for both the 1998 and 2010 cohorts (detailed estimates are in Appendix Table A1).

It is clear from Figure 2 that there is no evidence that the change in racial or socioeconomic achievement gaps from fall to spring of kindergarten year was different for the 2010 cohort than for the 1998 cohort. The 90/10 income achievement gaps in both math and reading narrowed from fall to spring by 0.10-0.14 standard deviations in both cohorts (the narrowing income achievement gap in kindergarten in the 1998 cohort has been described elsewhere; see Reardon, 2011; Reardon, et al., forthcoming). The difference between cohorts in the fall-spring change in gaps was small and not statistically significant (see

Table A1).

The estimated white-black gaps in math and reading increase very slightly (0.05 standard deviations) from fall to spring, but these increases are not statistically significant, and do not differ between cohorts. The white-Hispanic gap in math declined from fall to spring of kindergarten by 0.10 standard deviations in the 1998 cohort and by 0.14 standard deviations in the 2010 cohort; the difference between the two cohorts in the rate of decline was not statistically significant. In sum, Figure 2 shows that the reduction in school readiness gaps evident between the 1998 and 2010 cohorts appears to have persisted through the end of kindergarten.

Discussion

Data from three large, nationally representative samples of kindergarten students indicate that on standardized tests, socioeconomic and–to some extent–racial school readiness gaps in school readiness have narrowed over the last dozen years (see Figure 3 for summary of these trends). The declines in socioeconomic gaps and in white-Hispanic gaps in academic skills at kindergarten entry are moderately large and statistically significant; the estimated declines in white-black math and reading gaps are somewhat smaller, and are not statistically significant in reading and are only marginally significant in math.

Our estimates suggest that the 90/10 income achievement gap in math skills at kindergarten entry declined at a rate of 0.010 standard deviations per year over the 1998-2010 period; the reading gap declined at a rate of 0.016 standard deviations per year. To put this in context, Reardon (2011) found that the 90/10 income achievement gap grew by roughly 0.35-0.40 standard deviations from cohorts born in the mid-1970s to those born in the early 1990s, a growth rate of roughly 0.020 standard deviations per year. So the rate of decline in the kindergarten readiness 90/10 income gaps appears to be somewhere between 50 and 80% as rapid as the rate of increase in the gap in the prior two decades. Looked at this

way, the rate of decline from 1998 to 2010 is not trivial. Nonetheless, the gaps were roughly 1.25 standard deviations in 1998; at the rates the gaps declined in the last 12 years, it will take another 65-110 years for them to be completely eliminated.

The rate of decline in the white-Hispanic math gap is similar in magnitude. The gap at kindergarten entry was 0.78 standard deviations in 1998; it declined by an average rate of 0.011 standard deviations per year between 1998 and 2010; at that rate, the gap will be eliminated in another 60 years. Although the white-black school readiness gap trends are not statistically significant, the point estimates imply a decline of only 0.007 standard deviations per year.

It is useful to compare the trends in the white-Hispanic and white-black gaps at kindergarten entry to the trends in the same gaps in fourth grade for the same cohorts. Figure 1 shows that white-black and white-Hispanic math and reading fourth-grade (or age 9) gaps declined by roughly 0.15 standard deviations between the cohorts born in 1993 and 2005, corresponding to a rate of decline of about 0.012 standard deviations per year, similar to the rate of change of the white-Hispanic kindergarten entry gap and 50% larger than the rate of change of the white-black kindergarten entry gaps. That is, the achievement gaps in 4th grade declined at roughly the same rate as, or moderately faster than, the kindergarten entry gaps. This suggests that the primary source of the reduction in racial achievement gaps in 4th grade (evident in Figure 1) is a reduction in school readiness gaps, not a reduction in the rate at which gaps change between kindergarten and fourth grade. The finding that the racial gaps change at the same rate during kindergarten in the 2010 and 1998 cohorts provides some corroborating support for this conclusion. Nonetheless, this conclusion should be understood as tentative, however, given the considerable uncertainty in the estimated rates of change of the kindergarten entry gaps. Fortunately, both the ECLS-K 1998 and 2010 studies will have followed students through elementary school; once the grades 1-3 data from the 2010 cohort are available, it will be possible to test more rigorously whether racial and socioeconomic achievement gaps develop similarly as children progress through school in 1998

and 2010 kindergarten cohorts.

The evidence regarding trends in gaps in other measures of school readiness are less clear. Teacher-reported measures of self-control and approaches to learning indicate that racial gaps in these dimensions of school readiness declined substantially; three of four estimates show gaps declined by 30-50%. We find no evidence, however, that income gaps in these dimensions of readiness changed significantly. Parent-reported measures of self-control and approaches to learning show a significant change in only one of six estimated trends (the white-Hispanic gap in self-control, as reported by parents, increased between 1998 and 2010). Both teacher- and parent-reported measures of school readiness suffer from the fact that they are not standardized; teachers, and especially parents, have a limited reference group against which to compare a child's readiness and behavior; as a result, the estimated gaps may be both unreliable and biased. Racial and socioeconomic segregation of schools, neighborhoods, and social networks will likely bias gap estimates based on teacher and parent reports toward 0, to the extent that teachers and parents use the readiness of other children they observe as reference groups against which to calibrate their assessments. The bias will likely be larger for parent-reported gaps than teacher-reported gaps, given that parents likely calibrate their assessments against more homogeneous reference groups than do teachers. This is consistent with the results evident in Tables 2-4, which generally show that parent-reported gaps are smaller than teacher-reported gaps.

In some ways, the findings here are surprising, particularly the declines in the income gap in school readiness. Given the sharp increase in the income achievement gap in the prior two decades (Reardon, 2011), as well as the continued increases in income inequality, income segregation, and income gaps in parental investments in children (Bischoff & Reardon, 2014; G. J. Duncan & Murnane, 2011; Kornrich & Furstenberg, 2013; Piketty & Saez, 2013; Ramey & Ramey, 2010), one might have suspected that the income gap in school readiness would have grown as well. But the data here indicate it has not grown; it has instead declined.

The most obvious candidate explanation for this decline is perhaps the changes in pre-school enrollment patterns over this time period. Both the income gap and the white-Hispanic gap in pre-school enrollment rates declined since the early 1990s; the white-black gap in pre-school enrollment was unchanged over the same period (Magnuson & Duncan, 2014; Magnuson & Waldfogel, 2012). These trends are consistent with our finding here that the income and white-Hispanic school readiness gaps declined significantly, while the white-black gap declined less (and not at a rate distinguishable from zero at conventional levels of significance). Of course, the correlation of pre-school enrollment gap trends and school readiness gap trends does not prove the first caused the second, but it does suggest that further investigation of pre-school enrollment trends as a possible primary cause of the narrowing readiness gaps would be informative. We have also suggested above that increases in child health insurance rates among the near-poor may have played a role in these improvements. Another category of explanation might be cultural changes in parenting practices that have increased low-income children's exposure to cognitively stimulating activities at home. An investigation of these possible causes is beyond the scope of this paper, however.

The decline in academic school readiness gaps is a positive trend from an equity perspective. It is not clear, however, to what extent the gaps have narrowed because of improvements in school readiness among low-income and black and Hispanic children, or due to declines in readiness among higher-income and white children. It would be hard to consider it an improvement if readiness gaps have narrowed because of lowered readiness among high-income and white children and stagnant readiness among low-income and minority children. At present, the ECLS-K data do not enable us to compare absolute levels of readiness, because the 1998 and 2010 assessments are not scaled similarly; such a comparison will be possible, however, when NCES releases equated versions of the scores.

Until then, several pieces of evidence lead us to suspect that readiness gaps have narrowed because of more rapid gains in readiness among low-income and non-white students rather than because

of decline or stagnation of high-income and white students' readiness. A number of factors associated with school readiness—including pre-school enrollment, parental spending on children, parental time spent with children, and child health insurance—have increased for all racial groups and among children from all family income levels; many of them have increased more rapidly for minority and low-income children than for others (Kornrich & Furstenberg, 2013; Magnuson & Duncan, 2014; Magnuson & Waldfogel, 2012; Ramey & Ramey, 2010). These trends would suggest increases in absolute levels of school readiness; there is nothing in these trends to suggest declines in readiness among any subgroup.

Fourth-grade NAEP data also provide a hint of what the trends in school readiness levels might be. NAEP data indicate that the narrowing of the white-black and white-Hispanic gaps evident in Figure 1 is not due to any decline in white students' test scores. Indeed, average NAEP scores have increased since the 1990s among white, black, and Hispanic students, but they have increased faster among black and Hispanic students than among white students (Hemphill, et al., 2011; Vanneman, et al., 2009). In other words, the declines in racial achievement gaps in 4th grade are not the result of declines or stagnation in white students' scores. Although NAEP does not collect detailed information on family income, average scores for both poor (free-lunch eligible) students and non-poor students have increased in the last two decades, suggesting that any narrowing of the income achievement gap is likewise not the result of declining scores among high-income students.

In sum, it appears that despite widening income inequality, increasing income segregation, and growing disparities in parental spending on children, disparities in school readiness narrowed from 1998 to 2010. This was likely due to relatively rapid increases in overall school readiness levels among poor and Hispanic children, coupled with less rapid increases in readiness among higher-income and white children, though this remains to be confirmed once the appropriate data become available. It will be important for future research to identify the forces that have led to these improvements in school readiness and reductions in readiness gaps, so that they may be sustained.

References

Bassok, D. (2010). Do Black and Hispanic Children Benefit More from Preschool Centers? Understanding the Differential Effects of Preschool across Racial Groups. *Child Development, 81*(6), 1828-1845.

Bassok, D., & Reardon, S. F. (2013). Academic Redshirting" in Kindergarten: Prevalence, Patterns, and Implications. *Educational Evaluation and Policy Analysis, 35*(3), 283-297.

Bischoff, K., & Reardon, S. F. (2014). Residential Segregation by Income, 1970-2009. In J. Logan (Ed.), *Diversity and Disparities: America Enters a New Century*. New York: The Russell Sage Foundation.

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist, 57*(2), 111.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and psychopathology, 20*(03), 899-911.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child development, 78*(2), 647-663.

Brody, G. H., & Flor, D. L. (1997). Maternal psychological functioning, family processes, and child adjustment in rural, single-parent, African American families. *Developmental psychology, 33*(6), 1000.

Brody, G. H., Stoneman, Z., & Flor, D. (1996). Parental religiosity, family processes, and youth competence in rural, two-parent African American families. *Developmental psychology, 32*(4), 696.

Brooks-Gunn, J., Duncan, G. J., & Aber, J. L. (Eds.). (1997). *Neighborhood poverty: Context and consequences for children* (Vol. 1). New York: Russell Sage Foundation.

Chetty, R., Friedman, J. N., Hilger, N., Saez, E., Schanzenbach, D. W., & Yagen, D. (2011). How does your kindergarten classroom affect your earnings? Evidence from project STAR. *Quarterly Journal of Economics, 126*(4), 1593-1660.

Crook, S. R., & Evans, G. W. (2014). The Role of Planning Skills in the Income–Achievement Gap. *Child development, 85*(2), 405-411.

Duncan, G. J., Brooks Gunn, J., & Klebanov, P. K. (1994). Economic deprivation and early childhood development. *Child Development, 65*(2), 296-318.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., . . . Brooks-Gunn, J. (2007). School readiness and later achievement. *Developmental psychology, 43*(6), 1428.

Duncan, G. J., & Murnane, R. (Eds.). (2011). *Whither Opportunity? Rising Inequality and the Uncertain Life Chances of Low-Income Children*. New York: Russell Sage Foundation.

Duncan, S., & De Avila, E. (1998). PreLAS 2000. *Monterey, CA: CTB/McGraw-Hill*.

Dunn, L. M., & Dunn, L. M. (1997). *Peabody Picture Vocabulary Test* (3rd ed.). Circle Pines, MN: American Guidance Service, Inc.

Evans, G. W., & Rosenbaum, J. (2008). Self-regulation and the income-achievement gap. *Early Childhood Research Quarterly, 23*(4), 504-514.

Farah, M. J., Shera, D. M., Savage, J. H., Betancourt, L., Giannetta, J. M., Brodsky, N. L., . . . Hurt, H. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain research, 1110*(1), 166-174.

Fryer, R. G., & Levitt, S. D. (2006). The Black-White Test Score Gap through Third Grade. *American Law and Economics Review, 8*(2), 249-281.

Gresham, F. M., & Elliott, S. N. (1990a). Social Skills Rating Scale: Elementary Scale A ("How often?"). Circle Pines, MN: American Guidance Services: Inc.

Gresham, F. M., & Elliott, S. N. (1990b). *Social skills rating system: Manual*: American Guidance Service.

Grissmer, D., & Eiseman, E. (2008). Can gaps in the quality of early environments and noncognitive skills help explain persisting black-white achievement gaps? *Steady Gains and Stalled Progress: Inequality and the Black-White Test Score Gap. Russell Sage Foundation: New York*, 139-180.

Hemphill, F. C., Vanneman, A., & Rahman, T. (2011). Achievement Gaps: How Hispanic and White Students in Public Schools Perform in Mathematics and Reading on the National Assessment of Educational Progress. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Howell, E. M., & Kenney, G. M. (2012). The impact of the Medicaid/CHIP expansions on children a synthesis of the evidence. *Medical Care Research and Review, 69*(4), 372-396.

Hughes, C., Ensor, R., Wilson, A., & Graham, A. (2009). Tracking executive function across the transition to school: A latent variable approach. *Developmental Neuropsychology, 35*(1), 20-36.

Kagan, S. L., Moore, E., & Bredekamp, S. (1998). *Reconsidering Children's Early Development and Learning Toward Common Views and Vocabulary: National Education Goals Panel*: DIANE Publishing.

Klebanov, P. K., Brooks-Gunn, J., McCarton, C., & McCormick, M. C. (1998). The contribution of neighborhood and family income to developmental test scores over the first three years of life. *Child Development, 69*(5), 1420-1436.

Kornrich, S., & Furstenberg, F. (2013). Investing in Children: Changes in Parental Spending on Children, 1972–2007. *Demography, 50*(1), 1-23. doi: 10.1007/s13524-012-0146-4

Lee, B. A., Iceland, J., & Farrell, C. R. (2014). Is Ethnoracial Residential Integration on the Rise? Evidence from Metropolitan and Micropolitan America Since 1980. In J. Logan (Ed.), *Diversity and Disparities: America Enters a New Century*. New York: The Russell Sage Foundation.

Lee, V. E., & Burkham, D. T. (2002). *Inequality at the Starting Gate: Social Background Differences in Achievement as Children Begin School*. Washington, DC: Economic Policy Institute.

Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: The effects of neighborhood residence on child and adolescent outcomes. *Psychological Bulletin, 126*(2), 309-337.

Lewit, E. M., & Baker, L. S. (1995). School readiness. *The future of children*, 128-139.

Magnuson, K. A., & Duncan, G. J. (2014). *Can Early Childhood Interventions Decrease Inequality of Economic Opportunity?* Paper presented at the Federal Reserve Bank of Boston Conference, Inequality of Economic Opportunity in the United States, Federal Reserve Bank of Boston.

Magnuson, K. A., Meyers, M. K., Ruhm, C. J., & Waldfogel, J. (2004). Inequality in preschool education and school readiness. *American educational research journal, 41*(1), 115-157.

Magnuson, K. A., Meyers, M. K., & Waldfogel, J. (2007). Public funding and enrollment in formal child care in the 1990s. *Social Service Review, 81*(1), 47-83.

Magnuson, K. A., & Waldfogel, J. (2012). *The Role of Early Childhood Education in Changing Income-Related Gaps in Achievement*.

Marquis, K. H., Marquis, M. S., & Polich, J. M. (1986). Response bias and reliability in sensitive topic surveys. *Journal of the American Statistical Association, 81*(394), 381-389.

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental psychology, 43*(4), 947.

National Center for Education Statistics. (2013). The Nation's Report Card: Trends in Academic Progress 2012. Washington, DC: Institute of Education Sciences, U.S. Department of Education.

Noble, K. G., McCandliss, B. D., & Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Developmental science, 10*(4), 464-480.

Noble, K. G., Norman, M. F., & Farah, M. J. (2005). Neurocognitive correlates of socioeconomic status in kindergarten children. *Developmental science, 8*(1), 74-87.

Piketty, T., & Saez, E. (2013). Income Inequality in the United States, 1913-1998 (Tables and figures updated to 2012) Retrieved 24 January, 2014, from http://www.econ.berkeley.edu/~saez/TabFig2008.xls

Ramey, G., & Ramey, V. A. (2010). The rug rat race. *Brookings Papers on Economic Activity*(Spring), 129-176.

Reardon, S. F. (2011). The widening socioeconomic status achievement gap: New evidence and possible explanations. In R. J. Murnane & G. J. Duncan (Eds.), *Whither Opportunity? Rising Inequality and the Uncertain Life Chances of Low-Income Children*. New York: Russell Sage Foundation.

Reardon, S. F., Robinson-Cimpian, J. P., & Weathers, E. S. (forthcoming). Patterns and Trends in Racial/Ethnic and Socioeconomic Academic Achievement Gaps. In H. Ladd & M. Goertz (Eds.), *Handbook of Research in Education Finance and Policy* (Second ed.): Lawrence Erlbaum.

Sarsour, K., Sheridan, M., Jutte, D., Nuru-Jeter, A., Hinshaw, S., & Boyce, W. T. (2011). Family socioeconomic status and child executive functions: the roles of language, home environment, and single parenthood. *Journal of the International Neuropsychological Society, 17*(01), 120-132.

Snow, K., Derecho, A., Wheeless, S., Lennon, J., Rosen, J., Rogers, J., . . . Einaudi, P. (2009). Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), kindergarten 2006 and 2007 data file user's manual (2010-010). *Washington, DC: National Center for Education Statistics, Institute of Education Sciences, US Department of Education*.

Tourangeau, K., Burke, J., Lê, T., Wan, S., Weant, M., Nord, C., . . . Walston, J. (2001). *User's Manual for the ECLS-K Restricted-Use Base Year Data Files and Electronic Codebook (2000-079)*. Washington, DC: National Center for Education Statistics, U.S. Department of Education.

Tourangeau, K., Nord, C., Lê, T., Sorongon, A. G., Hagedorn, M. C., Daly, P., & Najaran, M. (2013). *Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011): User's Manual for the ECLS-K:2011 Kindergarten Data File and Electronic Codebook (2013-061)*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Vanneman, A., Hamilton, L., Baldwin Anderson, J., & Rahman, T. (2009). Achievement Gaps: How Black and White Students in Public Schools Perform in Mathematics and Reading on the National Assessment of Educational Progress. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Table 1. Descriptive Statistics, Demographics, and School Readiness Measures

			Kindergarten Fall			Kindergarten Spring		
Domains/Scales	Scale	# Items	*M*	*SD*	α	*M*	*SD*	α
ECLS-K: 1998								
Age at kindergarten entry (years)			5.67	0.34				
Female (%)			49.54					
Hispanic (%)			17.79					
Black (%)			15.04					
White (%)			55.42					
Median income (rounded to nearest $1,000)			$ 40,000					
Direct child assessment scores								
Math achievement (t-score)	0-90		50.17	10.17	0.92	50.51	9.93	0.94
Reading achievement (t-score)	0-90		49.30	10.85	0.93	50.03	10.32	0.95
Teacher reported readiness scores								
Self-control	1-4	4	3.08	0.62	0.79	3.17	0.63	0.80
Approaches to learning	1-4	6	2.97	0.68	0.89	3.11	0.69	0.89
Parent reported readiness scores								
Self-control	1-4	5	2.84	0.52	0.74	2.88	0.51	0.75
Approaches to learning	1-4	6	3.11	0.49	0.68	3.12	0.49	0.69
Approximate N			20,220					
ECLS-B (kindergarten waves)								
Age at kindergarten entry			5.68	0.36				
Female (%)			49.20					
Hispanic (%)			20.47					
Black (%)			15.67					
White (%)			40.34					
Median income ($1,000s)			$ 44,000					
Direct child assessment scores								
Math achievement (theta score)			0.83	0.67	0.92			
Reading achievement (theta score)			0.86	0.67	0.92			
Approximate N			6,600					
ECLS-K: 2010								
Age at kindergarten entry			5.67	0.34				
Female (%)			49.35					
Hispanic (%)			25.05					
Black (%)			12.91					
White (%)			47.26					
Median income ($1,000s)			$ 47,000					
Direct child assessment scores								
Math achievement (IRT theta score)	-6 - +6		-0.51	0.95	0.92	0.44	0.77	0.94
Reading achievement (IRT theta score)	-6 - +6		-0.57	0.89	0.95	0.49	0.77	0.95
Teacher reported readiness scores								
Self-control	1-4	4	3.08	0.63	0.81	3.17	0.64	0.82
Approaches to learning	1-4	7	2.95	0.68	0.91	3.09	0.70	0.91
Parent reported readiness scores								
Self-control	1-4	5	2.89	0.53	0.73	2.95	0.51	0.72
Approaches to learning	1-4	6	3.18	0.48	0.70	3.13	0.50	0.72
Approximate N			16,980					

Notes. α = Cronbach's alpha. All descriptive statistics based on the full sample, using multiply imputed data; reliabilities were obtained from the ECLSK and ECLSB technical reports (Snow et al., 2009; Tourangeau et al., 2001; Tourangeau et al., 2013). Note that scales of the direct assessments and the teacher- and parent-reported readiness measures are not comparable across studies. They are, however, comparable between the spring and fall assessments within a study, with the exception of the math and reading assessments in the ECLS-K 1998 study (which are based on scores standardized within assessment wave).

Table 2. White-Black School Readiness Gaps at Kindergarten Entry, First-Time Kindergarteners, 1998-2010

	White-Black Gap			Change in Gap (1998-2010)		
School Readiness Measure	1998	2006/07	2010	Change	Percent Change	Average Annual Change
Math score	0.626	0.559	0.546	-0.079 †	-12.7%	-0.007 †
	(0.034)	(0.056)	(0.028)	(0.044)		(0.001)
Reading score	0.396	0.325	0.319	-0.077	-19.4%	-0.007
	(0.040)	(0.053)	(0.039)	(0.056)		(0.001)
Self-control (teacher-reported)	0.442		0.315	-0.127 **	-28.8%	-0.011 **
	(0.035)		(0.032)	(0.048)		(0.004)
Self-control (parent-reported)	0.026		-0.017	-0.043	-163.8%	-0.004
	(0.035)		(0.040)	(0.053)		(0.004)
Approaches to learning (teacher-reported)	0.382		0.264	-0.117 **	-30.8%	-0.010 **
	(0.031)		(0.028)	(0.042)		(0.003)
Approaches to learning (parent-reported)	0.200		0.154	-0.046	-23.1%	-0.004
	(0.031)		(0.034)	(0.046)		(0.004)

Source: Authors' tabulations from Early Childhood Longitudinal Studies (ECLS-K 1998; ECLS-B; and ECLS-K 2010). All gaps are measured in population standard deviation units. Standard errors in parentheses. † $p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

Table 3. White-Hispanic School Readiness Gaps at Kindergarten Entry, First-Time Kindergarteners, 1998-2010

	White-Hispanic Gap			Change in Gap (1998-2010)		
School Readiness Measure	1998	2006/07	2010	Change	Percent Change	Average Annual Change
Math score	0.784	0.578	0.670	-0.114 *	-14.5%	-0.011
	(0.034)	(0.048)	(0.032)	(0.046)		(0.009)
Reading score			0.559			
			(0.033)			
Self-control (teacher-reported)	0.150		0.090	-0.061	-40.2%	-0.005
	(0.027)		(0.035)	(0.044)		(0.004)
Self-control (parent-reported)	0.021		0.118	0.096 **	452.6%	0.008 **
	(0.024)		(0.029)	(0.037)		(0.003)
Approaches to learning (teacher-reported)	0.223		0.107	-0.116 **	-52.0%	-0.010 **
	(0.028)		(0.030)	(0.041)		(0.003)
Approaches to learning (parent-reported)	0.341		0.370	0.028	8.3%	0.002
	(0.030)		(0.027)	(0.040)		(0.003)

Source: Authors' tabulations from Early Childhood Longitudinal Studies (ECLS-K 1998; ECLS-B; and ECLS-K 2010). All gaps are measured in population standard deviation units. Standard errors in parentheses. † $p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

Table 4. Income (90/10) School Readiness Gaps at Kindergarten Entry, First-Time Kindergarteners, 1998-2010

	90/10 Income Gap			Change in Gap (1998-2010)		
School Readiness Measure	1998	2006/07	2010	Change	Percent Change	Average Annual Change
Math score	1.298	1.157	1.192	-0.106 *	-8.2%	-0.010
	(0.031)	(0.040)	(0.033)	(0.045)		(0.006)
Reading score	1.262	1.001	1.072	-0.190 ***	-15.1%	-0.016
	(0.039)	(0.062)	(0.030)	(0.049)		(0.008)
Self-control (teacher-reported)	0.504		0.554	0.050	10.0%	0.004
	(0.032)		(0.034)	(0.047)		(0.004)
Self-control (parent-reported)	0.474		0.473	-0.001	-0.1%	0.000
	(0.026)		(0.031)	(0.040)		(0.003)
Approaches to learning (teacher-reported)	0.642		0.592	-0.050	-7.8%	-0.004
	(0.026)		(0.038)	(0.046)		(0.004)
Approaches to learning (parent-reported)	0.477		0.507	0.030	6.2%	0.002
	(0.042)		(0.030)	(0.051)		(0.004)

Source: Authors' tabulations from Early Childhood Longitudinal Studies (ECLS-K 1998; ECLS-B; and ECLS-K 2010). All gaps are measured in population standard deviation units. Standard errors in parentheses. † $p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

Table 5. Income (50/10, 90/50) School Readiness Gaps at Kindergarten Entry, First-Time Kindergarteners, 1998-2010

	Income Gap			Change in Gap (1998-2010)		
School Readiness Measure	1998	2006/07	2010	Change	Percent Change	Average Annual Change
50/10 Income Gap						
Math score	0.619	0.407	0.582	-0.036	-5.9%	-0.006
	(0.031)	(0.037)	(0.031)	(0.044)		(0.016)
Reading score	0.611	0.357	0.506	-0.105 *	-17.2%	-0.009
	(0.039)	(0.053)	(0.029)	(0.049)		(0.013)
90/50 Income Gap						
Math score	0.680	0.750	0.610	-0.070 †	-10.3%	-0.005
	(0.027)	(0.042)	(0.028)	(0.039)		(0.008)
Reading score	0.652	0.644	0.567	-0.085 †	-13.0%	-0.007
	(0.032)	(0.057)	(0.031)	(0.044)		(0.003)

Source: Authors' tabulations from Early Childhood Longitudinal Studies (ECLS-K 1998; ECLS-B; and ECLS-K 2010). All gaps are measured in population standard deviation units. Standard errors in parentheses. † $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

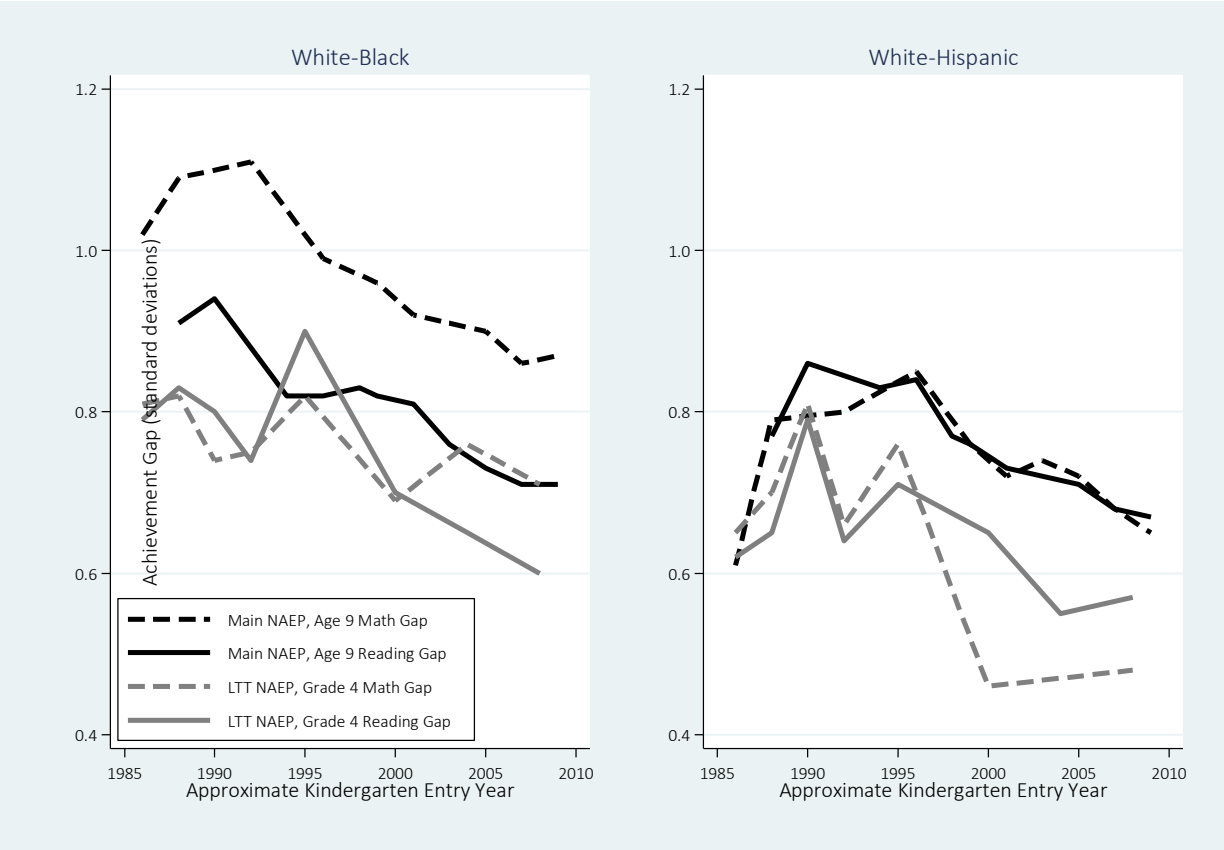

Figure 1. Trends in Academic Achievement Gaps, Age 9.
Note: Gap estimates are based on data reported in Reardon, Robinson-Cimpian, & Weathers (forthcoming).

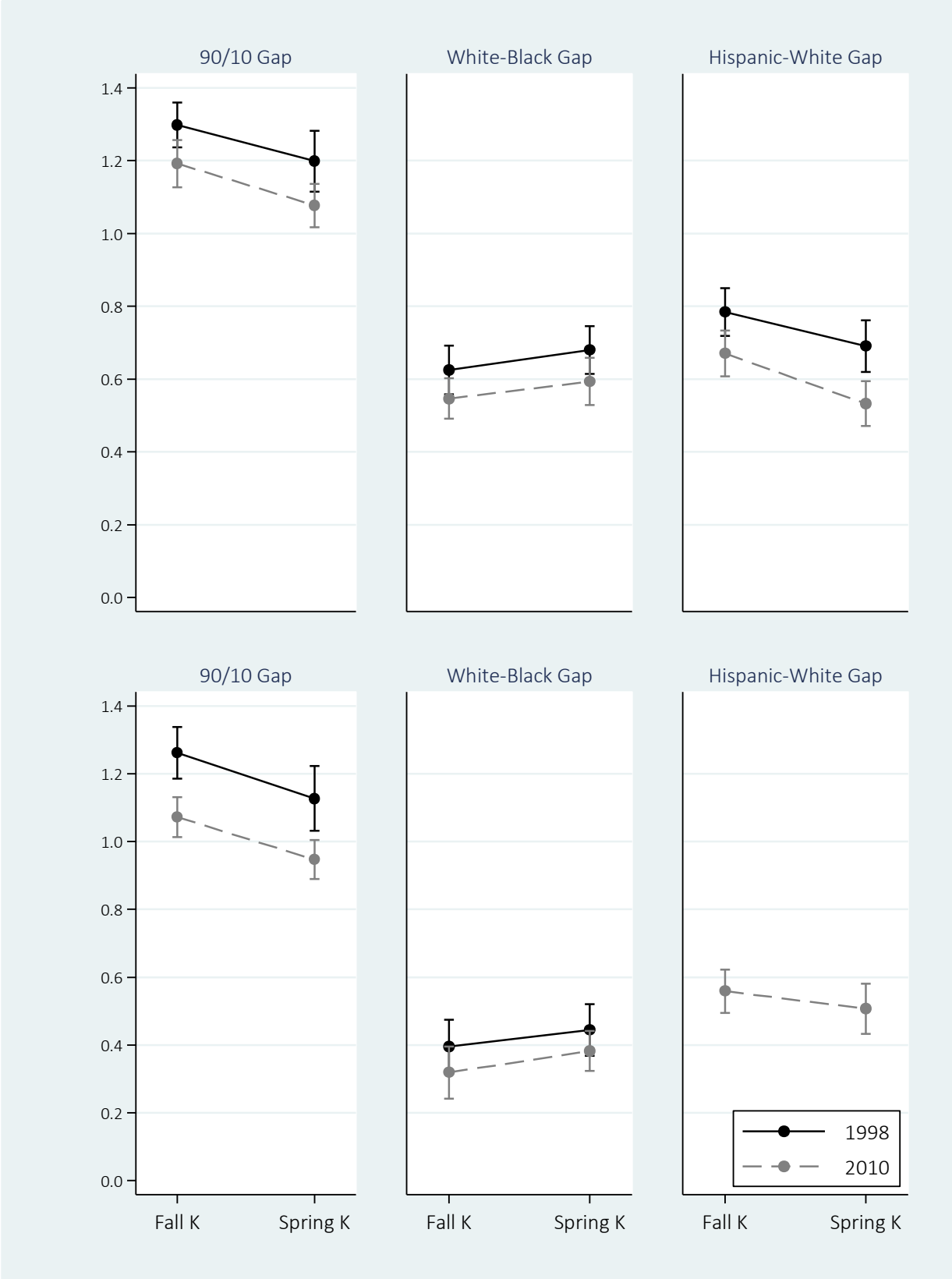

Figure 2. Fall and Spring Kindergarten Achievement Gaps, 1998 and 2010 cohorts.

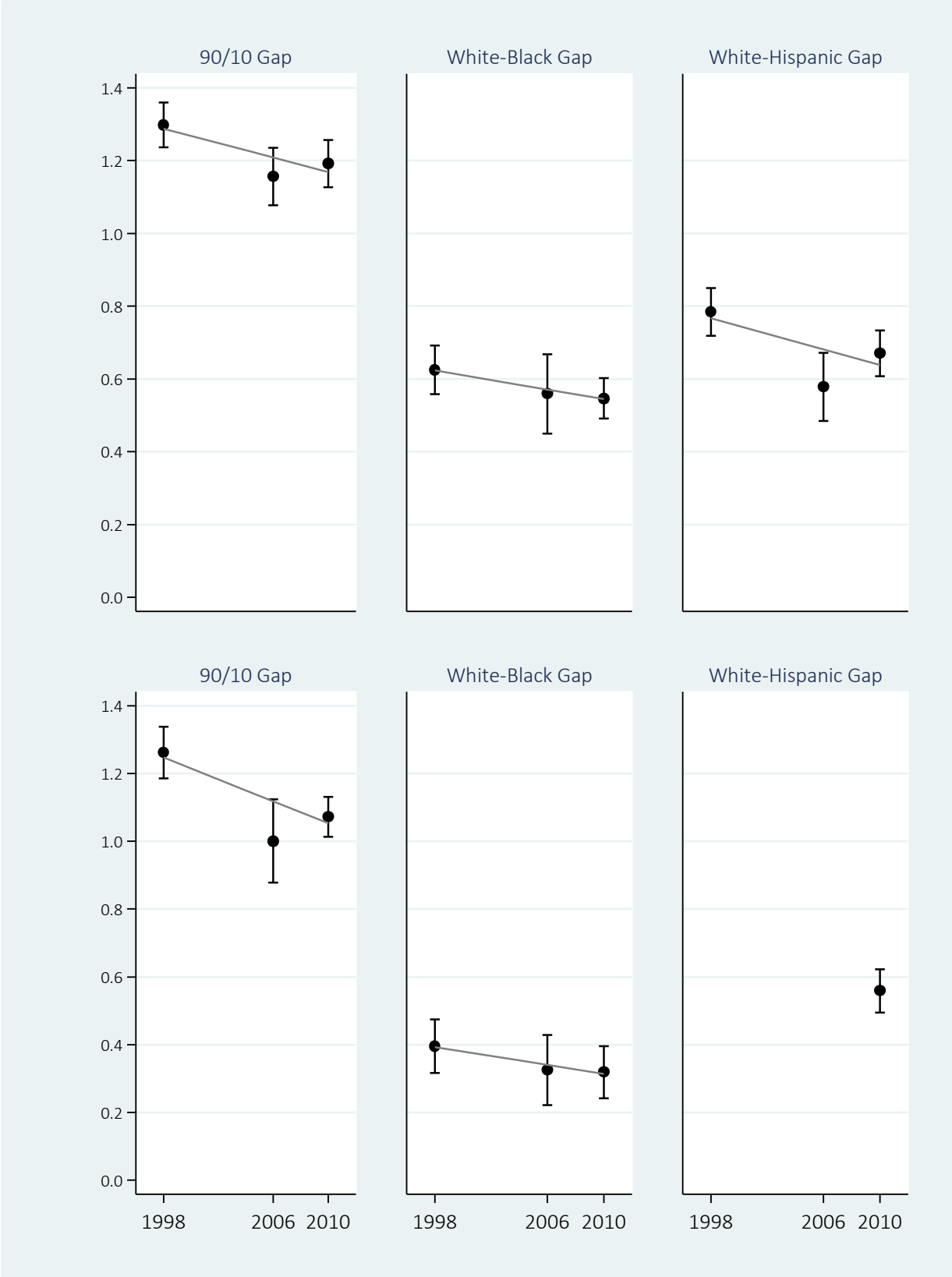

Figure 3. Math and Reading Kindergarten Readiness Gaps, 1998-2010.

Table A1: Math and Reading Gap Estimates, Fall and Spring Kindergarten, 1998 and 2010 Cohorts

	1998 Cohort			2010 Cohort			Between-Cohort Difference		
	Fall K	Spring K	Fall-Spring Change	Fall K	Spring K	Fall-Spring Change	Fall K	Spring K	Fall-Spring Change
90/10 Income Gap									
Math	1.298	1.198	-0.100 †	1.192	1.077	-0.115 *	-0.106 *	-0.121 *	-0.015
	(0.031)	(0.043)	(0.053)	(0.033)	(0.030)	(0.045)	(0.045)	(0.052)	(0.069)
Reading	1.262	1.127	-0.135 *	1.072	0.947	-0.125 **	-0.190 ***	-0.180 **	0.010
	(0.039)	(0.049)	(0.063)	(0.030)	(0.029)	(0.042)	(0.049)	(0.057)	(0.075)
White-Black Gap									
Math	0.626	0.680	0.055	0.546	0.593	0.047	-0.079 †	-0.087 †	-0.008
	(0.034)	(0.033)	(0.048)	(0.028)	(0.033)	(0.043)	(0.044)	(0.047)	(0.065)
Reading	0.396	0.444	0.048	0.319	0.383	0.064	-0.077	-0.061	0.016
	(0.040)	(0.039)	(0.056)	(0.039)	(0.030)	(0.050)	(0.056)	(0.049)	(0.075)
White-Hispanic Gap									
Math	0.784	0.691	-0.093 †	0.670	0.532	-0.138 **	-0.114 *	-0.159 ***	-0.045
	(0.034)	(0.036)	(0.049)	(0.032)	(0.031)	(0.045)	(0.046)	(0.048)	(0.067)
Reading				0.559	0.507	-0.052			
				(0.033)	(0.038)	(0.050)			

Source: Authors' tabulations from Early Childhood Longitudinal Studies (ECLS-K 1998 and ECLS-K 2010). All gaps are measured in population standard deviation units. Standard errors in parentheses. † p <.10; *p <.05; **p <.01; ***p <.001.