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ABSTRACT

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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.

Keywords: school readiness, socioeconomic 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, 2015; 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., 2015). 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.

In this paper we 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 school readiness gaps, as indexed by academic achievement and self-regulation, 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, and there has been little emphasis on gaps in children's self-regulation, these analyses fill an important lacuna in the literature. Moreover, they indicate whether the trends among birth cohorts from the 1970s to 1990s in the income academic achievement gap documented by Reardon (2011) have persisted among more recent cohorts. Finally, they may help us to better understand the sources of the continuing decline in elementary school racial 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 Academic 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 patterns are evident in 8th grade (Reardon, et al., 2015). 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 arrive in 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 widened considerably—by about 40%—between cohorts born in the 1970s and the 1990s (Reardon, 2011). Reardon argues that because the income achievement 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 for cohorts born after the early 1990s 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 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-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, numeracy and pre-mathematics skills, and general knowledge. These "academic readiness" skills are a key dimension of school readiness. Early academic achievement predicts 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. 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). These processes include children's ability to focus and pay attention, control their impulses, communicate their needs, and engage in the learning material (Lewit & Baker, 1995), processes that have been directly implicated in children's later math and reading achievement (Blair & Razza, 2007; G. J. Duncan, et al., 2007; McClelland et al., 2007). 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 may place them at risk for reduced academic achievement as they progress through school (Blair, 2002).

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). Further, self-regulation has been proposed to function as a mediator to explain the relation between income and academic achievement (Crook & Evans, 2014; Evans & Rosenbaum, 2008). For this reason, this study focuses on indicators of self-regulation in addition to academic achievement outcomes in order to obtain a better current picture of children's school readiness gaps at kindergarten entry, and whether these trends have changed in the period from 1998-2010.

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

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 ratio of the 90th percentile of the income distribution to the 10th percentile grew from an average of 9.3 in 1993-1998 to an average of 9.8 in 2005-2010 (authors' calculations from Current Population Survey data). 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.

Higher income has been shown to improve children's cognitive abilities and social-emotional competence (Dahl & Lochner, 2012; G. J. Duncan, Morris, & Rodrigues, 2011); as a result, rising income inequality may lead to growing disparities in children's cognitive and social-emotional development. The effects of family income on children are likely mediated through the family context (Gershoff, Aber, Raver, & Lennon, 2007). With increased income, parents may invest money and time into their children to provide educational and developmental "inputs" that influence children's developmental outcomes (Becker, 2009). In fact, along with an increase in income inequality, the period from the mid-1990s to the mid-2000s saw a substantial increase in average parental spending on children, with the largest increases coming from increased spending on both young children (ages 0-5) and college-age children. Data from the nationally-representative Consumer Expenditure Surveys show that high-income families increased their spending on children over this time period by roughly 150%, compared to a 60% increase among low-income families (G. J. Duncan & Murnane, 2011; Kornrich & Furstenberg, 2013), with higher-income families spending more money on child care and cognitive

enrichment activities and resources (Kaushal, Magnuson, & Waldfogel, 2011).

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, according to data from the nationally-representative American Time Use Surveys (Guryan, Hurst, & Kearney, 2008; Ramey & Ramey, 2010). Kalil and colleagues (2012) not only showed that a college-education resulted in mothers' greater time investments in children, but that these mothers also adjusted the composition of time spent with their children depending on their developmental stage. Notably, college-educated mothers spent more time in basic care and parent-child play during ages 0-2 when this type of play is most developmentally-appropriate, and transitioned to spending more time in teaching-related activities when children were in preschool (ages 3-5), a developmental stage when time spent in learning activities, such as reading, increase children's school readiness. If these mothers' are spending more time providing greater environmental stimulation and scaffolding their children's activities in developmentally appropriate ways, these parenting behaviors may also promote young children's self-regulatory capacities (Fay-Stammach, Hawes, & Meredith, 2014).

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 to spend time with their children. Together this body of evidence provides an additional reason to suspect there may have been an increase in the income gap in school readiness at kindergarten entry.

A number of other factors might be expected to lead to increased school readiness 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 and educational outcomes (Brooks-Gunn, Duncan, & Aber, 1997; G. J. Duncan, Brooks Gunn, & Klebanov, 1994; Klebanov, Brooks-Gunn, McCarton, & McCormick, 1998; Leventhal & Brooks-Gunn, 2000), and between physical/psychosocial stressors and children's self-regulatory difficulties (Evans & English, 2002; McCoy, 2013; McCoy & Raver, 2014), increasing economic segregation might have led to increasing disparities in kindergarten readiness. New evidence from a randomized housing voucher program is consistent with this, showing that living in a high-poverty neighborhood as a young child negatively affects children's long-term educational outcomes (Chetty, Hendren, & Katz, 2015).

Despite the recent increases in income inequality, parental investments in children, and income segregation, 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, 2015). Magnuson and colleagues (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, 2015). 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 1997 Children's Health Insurance Program (CHIP) law expanded public funding for children's health insurance for families with incomes too high to qualify for Medicaid but who cannot afford private health insurance (<http://www.medicaid.gov/chip/chip-program-information.html>. Retrieved December 21, 2014). Between 1997 and 2010, the proportion of uninsured children in the U.S. declined from 14% to 8% (<http://kff.org/health-reform/issue-brief/childrens-health-coverage-medicaid-chip-and-the-aca/>. Retrieved December 21, 2014.). 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). Limited research on the effects of health insurance expansion on educational outcomes showed that eligibility at birth was related to increased reading scores in 4th and 8th grade (Levine & Schanzenbach, 2009), while expansions when children were already in school improved long-run educational outcomes, such

as high school completion (Cohodes, Grossman, Kleiner, & Lovenheim, 2014). Given this early evidence, 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 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 kindergarten data collection of the ECLS-K 2010 and of the ECLS-B were designed to be comparable to that of the ECLS-K 1998, much of

the content, measures, and data collection procedures of the three studies were 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. Because the assessments were scaled differently in the three studies, however, we standardize the scores within each study before computing school readiness gaps. The gaps are therefore measured 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 21,400 children from their 1998-99 kindergarten year through eighth grade (note that all sample sizes are rounded in accordance with NCES guidelines). 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.

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. Roughly one-third of the ECLS-B sample was not observed in the final wave of the study, due to sample attrition; we use post-stratification weights constructed by NCES to weight the remaining sample so that it is representative of its cohort. Seventy-five

percent of the sample remaining in the study's final wave 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 *preLAS* 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 *preLAS* 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 *preLAS* 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 *preLAS* 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 *preLAS* 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 measures are comparable in the ECLS-K studies, we can examine trends in self-regulatory gaps at kindergarten entry. Nonetheless, since they are reported by teachers and parents, these scales are not standardized in the way that task-based measures are. Teachers and parents in different schools and communities

may assess the same behaviors differently, either because of different norms about readiness or because they may assess children's readiness relative to a reference group they observe in their schools and communities rather than against national norms.

Indeed, Bassok and Rorem (2014) find that kindergarten teachers in schools enrolling high proportions of non-white or poor students are more like to say that children should know their alphabet and have formal math and reading instruction before kindergarten, and should be able to read in kindergarten. Moreover, teachers' school readiness expectations increased from 1998-2010. These differential expectations of school readiness will upwardly bias teacher-reported estimates of readiness gaps and will downwardly bias estimates of trends in children's readiness levels. But the trends in the readiness gaps—which is our focus here—will only be biased if teachers' readiness expectations change differently between 1998 and 2010 in high- and low-poverty or high- and low-minority enrollment schools. Bassok and Rorem (2014) find no consistent evidence of such differential changes. Nonetheless, because of the potential for other differential changes in factors affecting teachers' and parents' reports of children's kindergarten readiness, we suggest that readers interpret the trends based on these measures with caution.

Income and race. Children's primary race/ethnicity and household income were reported by parents during the parent interviews in each study. In each of the datasets, we classified children as Hispanic if their parents indicated they were Hispanic, regardless of how parents reported their race. Children not classified as Hispanic were classified as white, black, Asian, or "other"—a category that included a small percentage of children whose parents reported multiple racial categories. Family income was reported by the parents in the kindergarten year in each study. Income was reported as a continuous variable in the ECLS-K 1998, and as an ordered categorical variable (with 13 or 18 categories, respectively) in the ECLS-B and ECLS-K 2010.

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, who entered straight into first grade, or who were homeschooled ($n= 350$).

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 original sample, 7,000 of whom who remained in the study at kindergarten entry) in the ECLS-B. We use the ECLS-B post-stratification weights to adjust for sample attrition. Nonetheless, the attrition in ECLS-B makes the estimates from that study less certain than those from the ECLS-K studies, which have no sample attrition because the samples were drawn in fall of kindergarten.

Multiple imputation. Multiple imputation was conducted using the `–mi–` commands in Stata 13.0, using chained equations and 20 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 all the math, reading, and self-regulation measures administered during kindergarten and first grade (when available). The ECLS-K 1998 imputation model also included the OLDS English proficiency screener score, while the ECLS-K 2010 imputation model included the EBRS English proficiency screener score. The ECLS-B imputation model included a variable to designate whether children entered kindergarten in 2006 or 2007, and pre-kindergarten measures of school readiness administered in 2005 when the children were four.

Computing school readiness gaps. Although the assessments in the three studies were designed to measure the same domains and used many of the same items, the tests were scaled differently (though a future release of the ECLS-K 2010 data is planned which will include scores equated to the ECLS-K 1998 scale). We therefore standardize the readiness measures within each wave of each study before computing school readiness gaps in each study and wave.

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 the difference in average scores between children at the 90th and 10th percentiles of the family income distribution, using the method described by Reardon (2011). This “90/10 income achievement gap” measure is conceptually very similar to estimating the difference in average scores between children in the 1st and 5th income quintiles. Because income is reported categorically in two of the studies (in categories that do not correspond neatly to income quintiles), we cannot identify each child’s income quintile and so cannot readily compute the between-quintile difference in average scores. The 90/10 income achievement gap can, however, be estimated accurately from ordered income data using the cubic regression method described by Reardon (2011). We also compute the 50/10 and 90/50 income gaps for each readiness measure.

To compute the racial 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). The regression coefficients from this model represent the racial school readiness gaps. In estimating

both income and race gaps, we use the appropriate sample weights and paired jackknife replication in Stata 13.0 in order to produce correct standard errors.

Reliability disattenuation. Although standardizing the outcome scores solves the primary problems of the comparability of gaps measured with different instruments, measurement error in outcome scores will tend to inflate the variance of the test score distributions, thereby biasing the estimated gaps toward zero. Measurement error in the income measure will further attenuate the income gap estimates. In order to correct gap estimates and standard errors for measurement error, we multiply each gap estimate and standard error 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 scales their standard errors appropriately), and eliminates any bias in the trend that may arise from differential reliability of the tests.

Statistical significance of changes in readiness gaps. Because the 1998 and 2010 ECLS-K studies have very similar sampling designs and use very similar (or identical) measures, a comparison of the gaps in the two ECLS-K studies provides the best test of whether racial and socioeconomic school readiness gaps have changed. We computed 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. We do not formally test for

changes between 1998 and 2005/06 or 2005/06 and 2010 because of concerns that the ECLS-B sampling design was not similar enough to the ECLS-K designs to allow for strict comparability. We do however, report the gaps in all three waves below.

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 0.39 standard deviations, respectively. The change in the math gap is marginally significant ($p=0.08$). Given the size of the standard errors of the estimates (0.035 and 0.029, respectively), 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% ($p < .05$). 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 ($p < .05$), 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 ($p < .05$). 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 0.13 standard deviations ($p < .001$) in math and 0.21 standard deviations ($p < .001$) in reading from 1998-2010. These correspond to reductions of 10% and 17%, respectively. 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 ($p < .05$); the estimates are too imprecise to determine how much of the reduction is due to changes in the 90/50 gap. 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., 2015). 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 (0.06 to 0.08 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 0.07 standard deviations in the 1998 cohort and by 0.12 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. The evidence regarding trends in gaps in other measures of school readiness are less clear. Racial gaps in teacher-reported measures of self-control and approaches to learning declined by 30-50%. We find no evidence, however, that income gaps in these dimensions of readiness changed significantly.

How meaningful are these changes? The income achievement gaps in kindergarten entry math and reading declined at the rate of 0.008 and 0.014 standard deviations per year, respectively, over the 1998-2010 period. To put this in context, Reardon (2011) found that the 90/10 income achievement gap grew by roughly 0.020 standard deviations per year among cohorts born in the mid-1970s to those born in the early 1990s. So the rate of decline in the kindergarten readiness 90/10 income gaps appears to be somewhere between 40 and 70% 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 60-110 years for them to be completely eliminated. The rate of decline in the white-Hispanic and white-black math gaps are similar in magnitude.

It is also 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.

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 the opposite; 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, 2015). 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, 2015; 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.

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

Domains/Scales	Scale	# Items	Kindergarten Fall			Kindergarten Spring		
			<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α
<u>ECLS-K: 1998</u>								
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
<i>Approximate N</i>			20,220					
<u>ECLS-B (kindergarten waves)</u>								
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			
<i>Approximate N</i>			6,600					
<u>ECLS-K: 2010</u>								
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
<i>Approximate N</i>			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

School Readiness Measure	White-Black Gap			Change in Gap (1998-2010)	
	1998	2006/2007	2010	Change	Percent Change
Math score	0.626 (0.035)	0.569 (0.057)	0.547 (0.029)	-0.079 † (0.046)	-12.6%
Reading score	0.394 (0.041)	0.313 (0.056)	0.319 (0.040)	-0.075 (0.057)	-19.0%
Self-control (teacher-reported)	0.440 (0.040)		0.322 (0.036)	-0.118 * (0.054)	-26.8%
Self-control (parent-reported)	0.023 (0.040)		-0.011 (0.048)	-0.034 (0.062)	-149.3%
Approaches to learning (teacher-reported)	0.377 (0.032)		0.270 (0.030)	-0.107 * (0.044)	-28.4%
Approaches to learning (parent-reported)	0.203 (0.037)		0.154 (0.038)	-0.049 (0.053)	-24.3%

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.
 † $p < .10$; * $p < .05$.

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

School Readiness Measure	White-Hispanic Gap			Change in Gap (1998-2010)	
	1998	2006/2007	2010	Change	Percent Change
Math score	0.783 (0.035)	0.578 (0.050)	0.672 (0.033)	-0.110 * (0.048)	-14.1%
Reading score			0.559 (0.034)		
Self-control (teacher-reported)	0.149 (0.031)		0.090 (0.039)	-0.058 (0.049)	-39.3%
Self-control (parent-reported)	0.021 (0.028)		0.124 (0.033)	0.103 * (0.044)	497.6%
Approaches to learning (teacher-reported)	0.221 (0.030)		0.109 (0.031)	-0.112 * (0.044)	-50.7%
Approaches to learning (parent-reported)	0.343 (0.035)		0.376 (0.032)	0.033 (0.047)	9.6%

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.
 * $p < .05$.

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

School Readiness Measure	90/10 Income Gap			Change in Gap (1998-2010)	
	1998	2006/2007	2010	Change	Percent Change
Math score	1.301 (0.036)	1.161 (0.050)	1.173 (0.033)	-0.128 *** (0.033)	-9.8%
Reading score	1.265 (0.044)	0.994 (0.068)	1.057 (0.033)	-0.209 *** (0.055)	-16.5%
Self-control (teacher-reported)	0.507 (0.037)		0.523 (0.036)	0.016 (0.052)	3.1%
Self-control (parent-reported)	0.474 (0.033)		0.463 (0.031)	-0.011 (0.046)	-2.3%
Approaches to learning (teacher-reported)	0.641 (0.028)		0.580 (0.038)	-0.061 (0.047)	-9.6%
Approaches to learning (parent-reported)	0.481 (0.052)		0.511 (0.037)	0.030 (0.063)	6.3%

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.

*** $p < .001$.

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

School Readiness Measure	Income Gap			Change in Gap (1998-2010)	
	1998	2006/2007	2010	Change	Percent Change
<u>50/10 Income Gap</u>					
Math score	0.620 (0.036)	0.403 (0.041)	0.565 (0.032)	-0.055 (0.048)	-8.9%
Reading score	0.617 (0.046)	0.352 (0.058)	0.481 (0.028)	-0.135 * (0.053)	-21.9%
<u>90/50 Income Gap</u>					
Math score	0.681 (0.030)	0.758 (0.049)	0.608 (0.030)	-0.073 † (0.043)	-10.7%
Reading score	0.649 (0.035)	0.642 (0.067)	0.575 (0.033)	-0.073 (0.048)	-11.3%

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.

† $p < .10$; * $p < .05$.

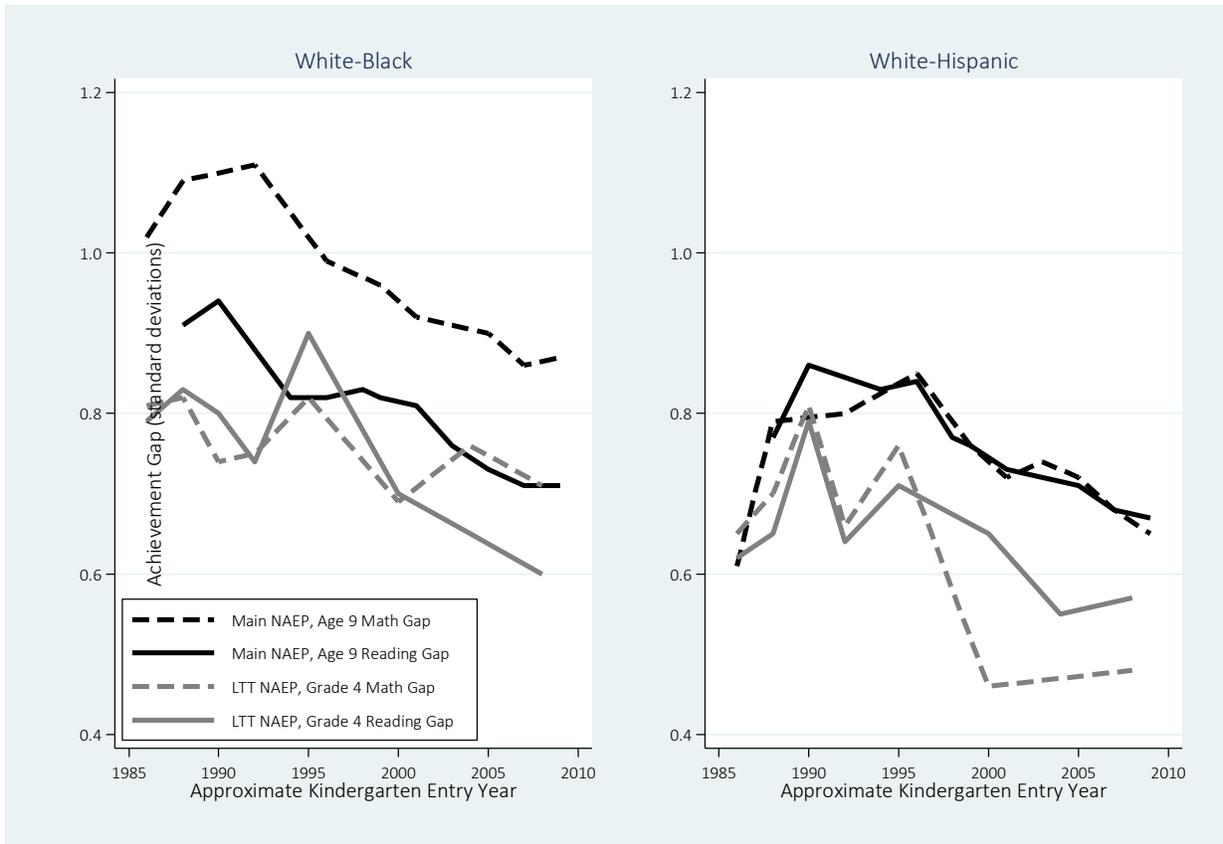


Figure 1. Trends in Academic Achievement Gaps, Age 9.

Note: Gap estimates are based on data reported in Reardon, Robinson-Cimpian, & Weathers (2015).

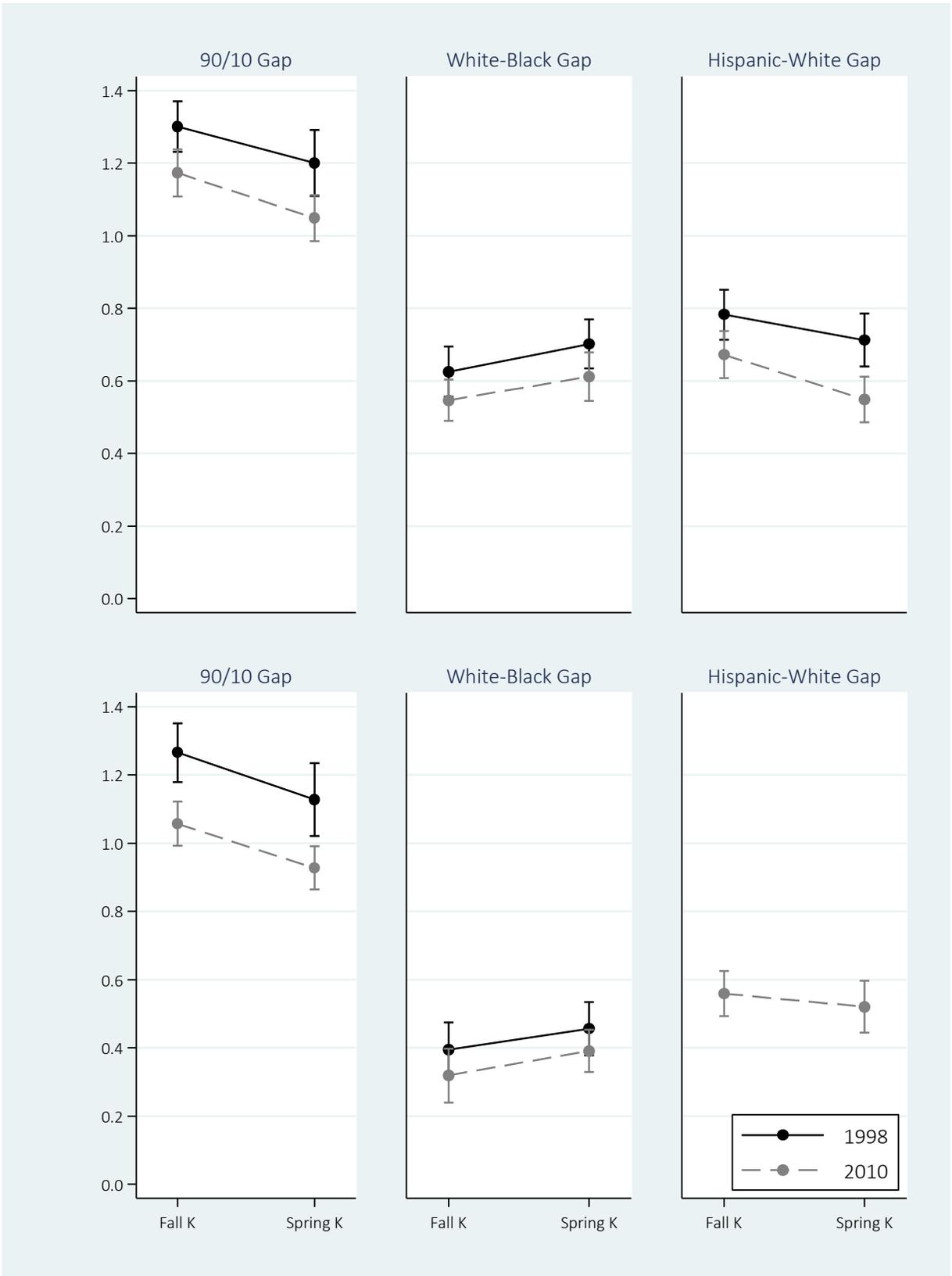


Figure 2. Fall and Spring Kindergarten Achievement Gaps, 1998 and 2010 cohorts.

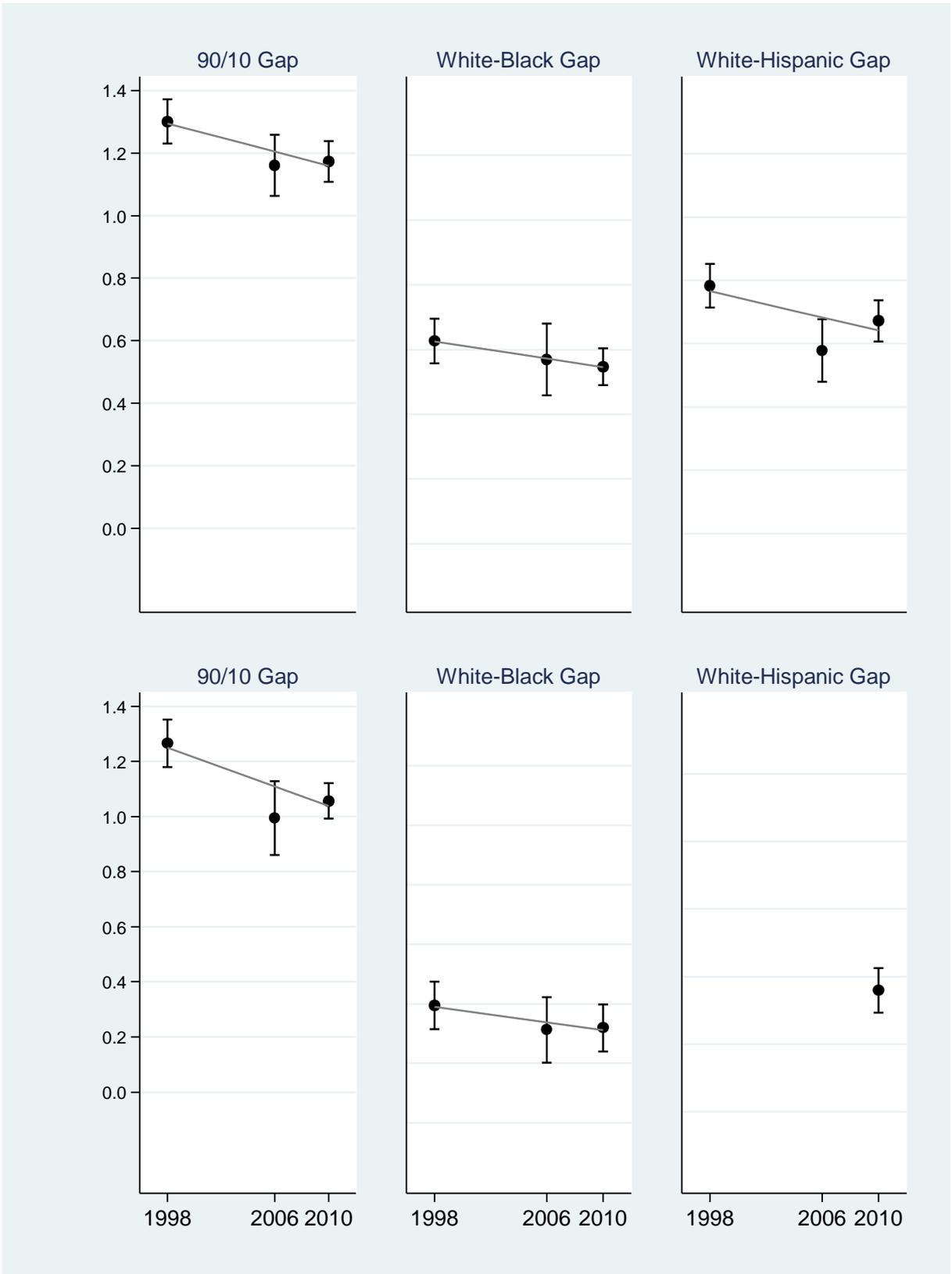


Figure 3. Math and Reading Kindergarten Readiness Gaps, 1998-2010.

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
<u>90/10 Income Gap</u>									
Math	1.301 (0.036)	1.201 (0.047)	-0.100 † (0.059)	1.173 (0.033)	1.049 (0.032)	-0.124 ** (0.047)	-0.128 ** (0.049)	-0.152 ** (0.057)	-0.024 (0.075)
Reading	1.265 (0.044)	1.128 (0.055)	-0.138 * (0.070)	1.057 (0.033)	0.928 (0.032)	-0.129 ** (0.046)	-0.209 *** (0.055)	-0.200 ** (0.063)	0.009 (0.084)
<u>White-Black Gap</u>									
Math	0.626 (0.035)	0.702 (0.034)	0.076 (0.049)	0.547 (0.029)	0.612 (0.034)	0.065 (0.045)	-0.079 † (0.046)	-0.090 † (0.049)	-0.011 (0.067)
Reading	0.394 (0.041)	0.456 (0.040)	0.062 (0.057)	0.319 (0.040)	0.391 (0.032)	0.072 (0.051)	-0.075 (0.057)	-0.065 (0.051)	0.010 (0.077)
<u>White-Hispanic Gap</u>									
Math	0.783 (0.035)	0.713 (0.037)	-0.070 (0.051)	0.672 (0.033)	0.549 (0.032)	-0.123 ** (0.046)	-0.110 * (0.048)	-0.164 *** (0.049)	-0.053 (0.069)
Reading				0.559 (0.034)	0.520 (0.039)	-0.039 (0.051)			

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.

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.