Working Paper:

Do the Benefits of Early Childhood Interventions Systematically Fade? Exploring Variation in the Association Between Preschool Participation and Early School Outcomes

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This study is the first to employ rich data from both kindergarten cohorts of the nationally representative Early Childhood Longitudinal Study (ECLS 1998 and 2010) to compare whether the relationship between preschool participation and children's cognitive and behavioral outcomes—both at school entry and through the first years of elementary school—has changed over time. The 12 years between these two kindergarten cohorts were characterized by a heightened understanding of the importance of early childhood in the life course and relatedly, substantial increases in public preschool access. Across both cohorts, preschool participation is positively associated with cognitive outcomes at school entry, and although these associations are substantially smaller, they are still present at the end of first grade. We document negative associations between preschool participation and behavioral outcomes. Notably however, these relationships are far less pronounced for the recent cohort. Finally, across both kindergarten cohorts, we document a particularly large positive association between preschool participation and first grade cognitive outcomes for black children. Implications for both developmental science and policy are discussed.

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DO THE BENEFITS OF EARLY CHILDHOOD INTERVENTIONS SYSTEMATICALLY FADE? EXPLORING VARIATION IN THE ASSOCIATION BETWEEN PRESCHOOL PARTICIPATION AND EARLY SCHOOL OUTCOMES

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Early childhood is a focal point in human development. Researchers have identified this period as one in which significant brain development occurs and children's brains are most influenced by contextual factors, inputs, and stimulation (Shonkoff & Phillips, 2000). Because developmental plasticity declines with age, early childhood is both a promising and critical time to fundamentally improve cognitive and social skill development. During early childhood, the young brain is at its most malleable, so those years constitute a particularly effective time to affect developmental trajectories, and thus long-term life outcomes (Knudsen, Heckman, Cameron, & Shonkoff, 2006).

Moreover, a large and growing body of research has established the impact of preschool participation on immediate and long-term outcomes, corroborating the argument that early childhood presents an opportunity to improve children's developmental trajectories. Short-term gains from participation in preschool on early cognitive skills and school readiness are well documented (Bassok & Loeb, 2015; Loeb, Bridges, Bassok, Fuller, & Rumberger, 2007; Magnuson, Meyers, Ruhm, & Waldfogel, 2004). Increasingly, studies are also finding long-term effects of early childhood program participation on health, educational attainment, risky behaviors, and earnings (Campbell et al., 2014; Deming, 2009; Schweinhart et al., 2005).

A major puzzle in this literature is the rapid "fade-out" of the initial academic benefits of preschool as children progress through the primary grades of schooling and into adolescence (see Claessens, Engel, & Curran, 2014; Gibbs, Ludwig, & Miller, 2011 for reviews). Despite the heightened attention paid to early childhood education in general, and to the issue of fade-out in particular, our understanding of the convergence in outcomes between preschool participants and non-participants remains underdeveloped.

One notable gap is the lack of research examining this issue at a national level using recent data. This limitation is important because the early childhood landscape has changed considerably since 1998, when the first nationally representative study of children entering kindergarten took place. Since that time, enrollment in state-sponsored preschool has increased dramatically, nearly

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doubling since 2000, and the visibility of early childhood education has grown substantially (Barnett, Carolan, Squires, & Brown, 2014). In addition, the period between 1998 and 2010 saw substantial changes to both the kindergarten classroom environment and young children's home environment (Bassok, Latham, & Rorem, 2015; Bassok, Lee, Reardon, & Waldfogel, 2015).

Our study aims to fill this gap. We leverage two large, nationally representative datasets to describe the extent to which the association between preschool participation and children's cognitive and behavioral outcomes fades between kindergarten entry and the end of first grade. In doing so, our study makes two key contributions. First, because the datasets overlap substantially in their content, we provide a consistent examination of whether patterns of fade-out have changed over a period characterized by heightened investment in early education. Duncan and Magnuson's review of the early childhood literature (2013) presents meta-analytic evidence that the initial effects of preschool programs have declined over time. They hypothesize that this decline is driven by changes in the "counterfactual" conditions experienced by non-participating children, noting that over time children have attended preschool at higher rates and their home environments have improved substantially. Our analysis provides a two-wave national test of whether the initial benefits of preschool have continued to decrease in the most recent decade, and also examines whether the *persistence* of effects has diminished over time.

Our paper's second contribution is that it adds to a relatively limited, but growing, literature exploring heterogeneity in fade-out. We examine whether patterns differ across four theoretically-motivated dimensions: (1) characteristics of the preschool experience; (2) child and family demographic characteristics; (3) characteristics of the subsequent schooling environment; and (4) characteristics of the home environment. Understanding how the persistence of preschool effects varies depending on children's contexts is important for identifying strategies for early policy interventions with lasting impact.

Towards that goal, we examine four related research questions:

1. Do children who attended preschool in the year before kindergarten outperform children who did not participate in formal care with respect to cognitive or behavioral outcomes? Do these patterns differ by characteristics of the preschool experience?
2. Are there persistent differences between these two groups by the spring of first grade?
3. Do these patterns differ across demographic groups as defined by race and socio-economic status?

4. Are there differences in patterns of persistence depending on parenting practices and the characteristics of the subsequent kindergarten experience?

We answer each of these questions through analysis of two waves of data, and discuss similarities, differences and potential implications for both developmental science and policy.

Background

Developmental theory provides a number of reasons to anticipate that the initial impacts of preschool participation— as well as their persistence—depend on characteristics of the preschool experience, the child, and notably, on children's experiences in elementary school. We begin by discussing the conceptual foundations for understanding early skill development and its evolution during early childhood. We then present empirical evidence both about the impact of preschool participation generally as well as the extent to which the benefits of preschool vary by preschool characteristics, child characteristics, subsequent schooling experiences and parenting practices.

Theoretical Perspectives on Early Skill Development and Persistence

We rely on bioecological theory as a framework for our study (Bronfenbrenner, 1977, 1979; Bronfenbrenner & Morris, 2006). At the theory's core are the "proximal processes in young children's lives," which are the complex interactions between a child and the people and objects in their immediate environment. Optimal development occurs when children experience consistent and supportive proximal processes over an extended period (Bronfenbrenner & Morris, 2006). However, this theory also posits that the relationship between proximal processes and children's development depends critically on both characteristics of the child and their environment (Tudge, Mokrova, Hatfield, & Karnik, 2009).

In bioecological theory, the Process-Person-Context-Time (PPCT) model posits that there are four interdependent components that together create a dynamic system (Bronfenbrenner & Morris, 2006) with implications for understanding both the initial effects of early childhood interventions and their persistence. Specifically, the PPCT model suggests that preschool and its impacts cannot be studied in isolation, but rather, that it is also important to understand interactions between the preschool experience, child characteristics, and the multiple environments children experience during preschool and in subsequent years.

Duncan and Magnuson (2013) argue that theories of human development from both economics and developmental psychology provide useful lenses for examining the relationship

between preschool participation and children's early skill development. From economics, the cumulative model of human capital acquisition and production (Cunha & Heckman, 2007; Cunha, Heckman, Lochner, & Masterov, 2006; Heckman, 2006) posits that skills produced in one stage of development serve to amplify skill development in a later period. This "dynamic complementarity" implies, for example, that children who experience high-quality kindergarten will benefit more if they also attended a high-quality preschool. This notion of *complementarity* suggests that the benefits of preschool participation may not be just maintained, but even enhanced when followed up by high-quality, enriched environments.

Theories from developmental psychology similarly suggest that the longer-term effects of an early experience depend on the individual child's capabilities as well as the characteristics of both the early experience and the subsequent environmental contexts (Blair & Raver, 2012; Elder, 1998). In contrast to the *cumulative* model of human capital acquisition, developmental models allow for a *compensatory* role of subsequent experiences, in which the benefits of an enriched environment may be most pronounced for children with the *lowest* levels of skills or the most limited prior exposure to enriched environments (Ramey & Ramey, 1998). Compensatory models suggest that high-quality schooling or an enriched home environment after the early childhood years may act as a substitute for the preschool experience.

While complementary and compensatory models yield different predictions about the relationship between preschool experiences, subsequent environments, and the persistence of preschool effects, they both imply variation in preschool persistence depending on the type, quality, and intensity of later experiences.

Empirical Evidence on the Effects of Preschool

Two well-known and oft-cited experiments demonstrate that early childhood programs can yield lasting benefits on outcomes including educational attainment, health, and earnings (Campbell et al., 2012; Schweinhart et al., 2005). It is unclear to what extent, however, the findings from these small, decades-old studies generalize to today's context.

Most of the participants in these studies were extremely low-income, black children for whom compensatory theories of child development would suggest the magnitude of program impact may be particularly large. In addition, the preschool services provided were far more intensive and costly than most large-scale programs today. For instance, most of the children in the Perry Preschool Project experienced two years of preschool care led by a teacher with a Bachelor's

degree who also conducted weekly home visits. The cost of the program was approximately $18,000 dollars per child, compared to the average spending per child in state preschool which was just over $4,000 in 2014 (Barnett, Carolan, Squires, Clarke Brown, & Horowitz, 2015; Schweinhart et al., 2005). Finally, comparison group children in these studies generally stayed home or with relatives. In contrast, over two-thirds of four-year-old children today receive some type of non-relative care (Bassok, 2010).

A large body of evidence has emerged over the past decade that addresses some of the generalizability concerns of the experimental evidence and enhances our understanding of the benefits of early childhood education. For the most part, studies examining the immediate (end-of-program) benefits of preschool participation suggest sizable and important benefits on both reading and mathematics skills (Gormley, Gayer, Phillips, & Dawson, 2005; Weiland & Yoshikawa, 2013; Wong, Cook, Barnett, & Jung, 2008).

Recent studies also suggest these benefits can persist (Deming, 2009; Fitzpatrick, 2008; Ladd, Muschkin, & Dodge, 2014). Notably, Reynolds et al (2011) evaluated the Chicago Child-Parent Centers, which provided comprehensive services to low-income children and families, using a matched control design and estimated that the preschool services produced benefits about seven times greater than their costs. Similarly, Ludwig & Miller (2007) evaluated the long-term effects of the federal Head Start program using a regression discontinuity design and found that participation increased children's educational attainment. Taken together, these studies provide evidence that larger-scale programs can have important short and long-term benefits.

Despite the impressive long-term results found in these studies, a recurring pattern is that the short-term benefits, particularly on academic skills, often dissipate in elementary school (Camilli, Vargas, Ryan, & Barnett, 2010; Leak et al., 2012). Notably, results from the national Head Start Impact Study, a large, randomized trial of Head Start participation, showed that at third grade, Head Start participants *did not* systematically outperform their control group peers on *any* of the developmental domains examined (Puma et al., 2012). Many of the gains realized by participants at the end of the program year had eroded as soon as kindergarten or first grade (Puma et al., 2010). This fade-out of test scores has been documented not only in Head Start programs (Currie, Garces, & Thomas, 2000; Deming, 2009; Lee & Loeb, 1995; Ludwig & Miller, 2007), but across a wide range of preschool settings including state pre-kindergarten programs (Lipsey, Hofer, Dong, Farran, & Bilbrey, 2013), and for national samples (Magnuson et al., 2004; Magnuson, Ruhm, & Waldfogel,

2007b).

Heterogeneity in Preschool Effects

Although researchers often focus on measuring the *overall* effects (i.e., average treatment effects) of preschool participation, increasingly there is also interest in understanding treatment heterogeneity. In this paper we consider heterogeneity of effects along four dimensions: (1) the preschool's characteristics; (2) the child's characteristics; (3) the subsequent schooling environment; and (4) the home learning environment. Each has concrete connections to complementary and compensatory models in developmental theory. Below we summarize the existing evidence.

Differences in preschool effects by program characteristics. A large body of research demonstrates the importance of preschool quality in explaining program effects on reading and math outcomes, particularly when quality measures capture proximal process quality (Mashburn et al., 2008; Peisner-Feinberg et al., 2001). In the current study, measures of the proximal quality of preschool classrooms are not available, but we do explore two structural measures—length of the preschool day and program type—which are hypothesized to relate both to proximal quality and to child outcomes.

Attending a program a few hours per week may yield quite different effects than attending full-time (Herry, Maltais, & Thompson, 2007; Reynolds et al., 2014). Research indicates that children who spent more hours per week in center-based care (Loeb et al., 2007) or Head Start (Walters, forthcoming) had higher reading and math test scores at the start of kindergarten, and that this result was most prominent among low-income children. At the same time, a number of studies also found that more hours in preschool settings were associated with increases in behavioral problems (Belsky, 2002; Loeb et al., 2007; Vandell et al., 2010). Although Magnuson, Ruhm & Waldfogel (2007b) found no evidence that patterns of persistence for reading and math scores at third grade varied by length of the preschool day, more evidence on this issue is needed especially given recent experimental evidence about the benefits of full-day kindergarten.

Another set of recent studies has examined whether the effects of preschool depend on program "type," often comparing state pre-kindergarten programs to Head Start programs or other forms of center-based care (Gormley, Phillips, Adelstein, & Shaw, 2010; Henry, Gordon, & Rickman, 2006). Since observable measures of quality in state-funded preschool programs tend to be higher than those in private child care centers (Bassok, Fitzpatrick, Greenberg, & Loeb, 2014), one

plausible hypothesis is that both the initial benefits and their persistence would be more pronounced in these more highly-regulated settings.

Differences in preschool effects by child characteristics. Studies have shown that *on average* children benefit from early childhood program participation. There is evidence, however, that the magnitude of impacts varies across groups, in accordance with predictions from compensatory models. For instance, researchers have found evidence of more pronounced benefits for both reading and math achievement as well as IQ among low-income children (Duncan & Sojourner, 2013; Magnuson, Ruhm, & Waldfogel, 2007a; Weiland & Yoshikawa, 2013) and children with low maternal education (Havnes & Mogstad, 2011; Peisner-Feinberg et al., 2001; Waldfogel, 2002). Studies have similarly shown greater benefits among Hispanic children (Gormley et al., 2005; Loeb et al., 2007), black children (Bassok, 2010), and children with low initial cognitive scores (Zill et al., 2001). Studies that examined the longer-term impacts of preschool also report heterogeneity in persistence with respect to low-stakes math and reading achievement tests as well as high school completion, college attendance and earnings (Cascio & Schanzenbach, 2013; Fitzpatrick, 2008; Garces, Thomas, & Currie, 2002).

Differences in preschool effects by subsequent schooling experiences. In recent years, early childhood advocates have called for preschool to third grade initiatives, which are designed to provide aligned and consistently high-quality care (Bogard & Takanishi, 2005). The premise of these initiatives, in part, is that in order to sustain the benefits of even a high-quality preschool experience, children must have access to high-quality learning experiences in early elementary school as well. There is conflicting evidence, however, on whether these subsequent experiences play a complementary or compensatory role.

A number of studies have found evidence that high-quality subsequent experiences may support the effects of early interventions (Currie & Thomas, 2000; Reynolds, Magnuson, & Ou, 2010). Reynolds, Ou, & Topitzes (2004) found that high-quality elementary schools were an important mediator of the long-term benefits of preschools. Similarly, Zhai, Raver, and Jones (2012) found persistent effects of an intervention in Head Start centers only among children who subsequently attended high-performing schools.

However, counter to the hypothesis that high-quality classrooms foster more persistent preschool benefits, Magnuson, Ruhm, & Waldfogel (2007b) showed that by the spring of third grade, the preschool advantage was actually more persistent for children who attended classrooms

with *larger* class sizes and *lower* levels of reading instruction. Similarly, Bierman et al. (2014) found that the persistent benefits of an intervention delivered in Head Start classrooms on social competence and inattention were more pronounced for children who attended lower-performing kindergarten schools. These findings suggest that children who did not attend preschool may have a chance to "catch up" in higher quality learning environments.

It is important to note that the specific school characteristics used in these studies to characterize the quality of the kindergarten classrooms (e.g., frequency of reading practices) are just a subset of the many early elementary school characteristics that have been shown to matter for learning during the kindergarten year and that may therefore mitigate (or exacerbate) fade-out. We briefly summarize this research.

Structural measures of school quality. A number of studies have demonstrated that children benefit substantially from structural quality features of kindergarten classrooms. For instance, several studies show that children benefit more from full-day settings (Cannon, Jacknowitz, & Painter, 2006; Gibbs, 2014; Lee, Burkam, Ready, Honigman, & Meisels, 2006), and smaller class sizes (Chetty et al., 2011; Dynarski, Hyman, & Schanzenbach, 2013; Krueger & Whitmore, 2001; Nye, Hedges, & Konstantopoulos, 2001). Magnuson et al. (2007a) also found that children benefit when preschool and kindergarten classrooms are located in the same building.

Process measures of the kindergarten environment. In addition to structural features of kindergarten classrooms, we also consider several more proximal measures of the kindergarten learning environment: use of transition practices, time spent on advanced (rather than basic) reading and math content, and frequency of "didactic" forms of instruction (e.g., teacher-led lessons, worksheets, and textbooks).

Using national survey data from kindergarten teachers, Rimm-Kaufman, Pianta, & Cox (2000) showed that many children struggle with the transition to kindergarten. In turn, Schulting, Malone & Dodge (2005) found that the more kindergarten teachers do to explicitly support children in their transition into school, the better their students' academic achievement at the end of the kindergarten year.

Several studies demonstrate the importance of kindergarten curriculum and show that children perform better on assessments of reading and math in kindergarten classrooms that focus on challenging rather than basic math and literacy content (Engel, Claessens, & Finch, 2013; Engel, Claessens, Watts, & Farkas, 2015). The literature examining the effect of pedagogical approaches in

kindergarten is underdeveloped, but existing research suggests that didactic forms of instruction may be associated with higher levels of basic literacy skills but lower levels of motivation (Stipek, Feiler, Daniels, & Milburn, 1995). Counter to expectations, Claessens et al. (2014) found that the benefits of advanced academic content in kindergarten did not differ depending on preschool attendance. However, given the striking increase in both time spent on advanced content and time spent on didactic instruction over the past decade, we hypothesize these moderators may influence preschool effect persistence (Bassok, Latham, et al., 2015).

Differences in preschool effects by subsequent parental investments. Finally, we explore whether the persistence of preschool effects varies based on levels of parental investment both at home and at school. A large body of correlational evidence suggests that home literacy practices are positively related to reading achievement, emergent literacy and language growth (Bus, IJzendoorn, & Pellegrini, 1995; Evans, Shaw, & Bell, 2000; Roberts, Jergens, & Burchinal, 2005; Storch & Whitehurst, 2001). The research on parental involvement in school is mixed, and often struggles to address the potential of "reverse causality" between child outcomes and parental involvement. However, a number of quasi-experimental studies and meta-analyses suggest largely positive impacts on both behavioral and achievement measures (Domina, 2005; Jeynes, 2012; Van Voorhis, Maier, Epstein, & Lloyd, 2013).

It is worth noting that children's out-of-home learning environments and their parents' investments are interrelated. Strong parental investments could complement high-quality early childhood classroom experiences or compensate for poor ones. Parenting practices may also be affected by preschool participation. For instance, Gelber and Isen (2011) use the experimental Head Start Impact Study to demonstrate that parents of children assigned to Head Start increase their investment in and involvement with their children, including more time together, reading, and math activities.

The Current Study

This paper adds to the existing literature in several ways. First, this is the first study to leverage newly-released data from the National Center for Education Statistics' (NCES) Early Childhood Longitudinal Study (ECLS-K 2010) to examine to what extent the association between preschool participation and children's outcomes persist throughout the first two years of elementary school. This dataset is a follow-up to the ECLS-K 1998, which tracked a similar cohort of kindergarteners who entered school nearly two decades ago. The ECLS-K 1998 has been used extensively to

examine a host of questions about the effects of preschool participation both at school entry and beyond (Loeb et al., 2007; Magnuson et al., 2007a, 2007b).

The years between when these two cohorts entered kindergarten were characterized by substantial expansion of early childhood opportunities, heightened focus on improved preschool quality, substantial changes in kindergarten learning environments and improvements in home environments (Bassok, Latham, et al., 2015; Bassok, Lee, et al., 2015). The period may also have been characterized by changes in the experiences of children *not* in preschool (Bassok, Lee, et al., 2015; Duncan & Magnuson, 2013). A growing number of studies demonstrate that preschool program effects depend on the care experiences of the comparison group, with larger preschool benefits observed when compared to informal settings (Feller, Grindal, Miratrix, & Page, 2014; Shager et al., 2012; Zhai, Brooks-Gunn, & Waldfogel, 2014). Given the changing early childhood landscape, it is important to examine questions of fade-out with more recent data and investigate whether patterns uncovered earlier align with those seen today.

Method

This study leverages data from two nationally representative samples of children entering kindergarten in the fall of 1998 and 2010 respectively. The ECLS-K 1998 tracked children through 8th grade, with 7 waves of data collection occurring in fall and spring of kindergarten, fall and spring of first grade, and the spring of grades 3, 5, and 8. Data collection for the 2010 cohort is ongoing, and so far data have been released for fall and spring of both the kindergarten and first grade year.

The datasets were designed, in part, to facilitate comparisons across cohorts. To a large extent, the content and data collection procedures from the new cohort were modeled after the original ECLS-K and, as a result, these datasets provide a unique opportunity to compare the experiences of children in the United States over time.

Participants

The initial ECLS-1998 and ECLS-2010 samples consist of approximately 21,400 and 18,150 children respectively.[1] To facilitate comparison both across waves of data collection and across cohorts, we restrict our sample to first-time kindergarteners with assessment data in the fall and spring of kindergarten as well as the spring of first grade. To account for a change across the two waves in

[1] In keeping with National Center for Education Statistics guidelines, we round all sample sizes to the nearest 50.

how children who were not proficient in English were assessed we limit the sample to students who passed an English language screener.[2]

Since the sample of children who had valid *cognitive* assessments in each wave is substantially larger than the sample who had valid *behavioral* assessments, we construct separate analytic samples for analyzing the cognitive and behavioral outcomes (henceforth the "cognitive" and "behavioral" samples).[3] Our cognitive samples consist of 12,450 and 11,000 children in the 1998 and 2010 cohorts respectively. The behavioral samples consist of 10,090 and 9,050 children.[4]

Our exclusion restrictions have implications for the generalizability of our results.[5] To address this issue, we estimate all analyses using weights developed as part of the ECLS-K studies to account for this non-random selection into sample and attrition. We also conduct multiple imputation using chained equations to avoid the bias that may arise when analyzing complete-case data. Our imputation model accounts for all the covariates that we later include in our analysis (i.e., demographics, preschool participation, kindergarten characteristics, and variables listed in Appendix Table 1), and we impute independent but not dependent variables.[6]

Measures

Preschool experience. During the fall kindergarten data collection, parents were asked detailed questions about the care their children received in the prior year. Specifically, parents were asked to report whether their children attended a "day care center, nursery school, preschool or prekindergarten program" in the year before kindergarten and how many hours per week they attended. We categorize students as having attended "preschool" if they attended any of these

[2] In both ECLS-K cohorts, students were administered an English proficiency screener to determine whether they would be able to take the reading assessment in English. In 1998, students who failed this screener were not assessed in reading, while in 2010 students who failed were administered a reading assessment in Spanish. This change in how assessments were administered only affected a small portion of the sample (N=approx. 350). Importantly, results are robust to the inclusion of these students.

[3] We also run all analyses on a fixed sample of children who have both cognitive and behavioral outcomes. Results, available from the authors, are substantively unchanged.

[4] We excluded children who were not first time kindergartens (~15%) and those who did not pass the English language screener (5-10% across waves, or 1,050 students in 1998 and 350 students in 2010). The bulk of our exclusions, however, are due to children lacking assessment data. Roughly 30-35% of our exclusions are because the child lacked a fall kindergarten assessment. An additional 10% are missing a score at spring of kindergarten, and 30% were missing first grade assessment data.

[5] Notably, but not surprisingly, children excluded from our sample were more likely to come from lower income families and to be Hispanic relative to the analytic sample.

[6] Multiple imputation was conducted using the MI command in Stata, and based on Graham, Olchowski, and Gilreath (2007), 20 imputed datasets were generated.

programs for five or more hours per week.[7] Our definition of preschool is consistent with most studies using the ECLS data to study preschool (e.g., Loeb et al., 2007; Magnuson et al., 2004). In keeping with those studies, we allow for a broad set of classroom-based early childhood education experiences, but exclude Head Start.

Changes in survey design across cohorts make it impossible to construct equivalent Head Start categories across our two datasets. In 1998 parents were asked specific questions about Head Start participation, separately from the set of questions about other forms of preschool participation. They were asked whether their children attended and, if so, the number of hours per week. In contrast, in 2010 there was no longer a separate survey component about Head Start participation. Instead, parents were asked to report whether their child attended any "day care center, nursery school, preschool or prekindergarten program." Then, as a follow up question, they were asked whether any of the time their children spent in these arrangements was spent in Head Start. Therefore, in 2010 we are able to determine whether a child attended *any* Head Start in the year prior to kindergarten, but cannot determine whether Head Start was their primary care provider or how many hours the child went to Head Start.

We construct an indicator variable for whether a child attended *any* amount of Head Start in the year before kindergarten, and include it in all of our models. Doing so allows us to interpret the preschool coefficient as the difference between children who went to any formal preschool arrangement excluding Head Start and those who had no type of formal care arrangement (this includes kids who stay with grandparents, parents, babysitters, etc., along with children in family day care).

Public prekindergarten and center based care. Our measure of preschool participation is broad and may mask what we know to be large quality differences across different types of preschool. In attempting to address this issue, we faced a tradeoff between our overall measure which is broad but consistent across waves, and more disaggregated preschool categories. The items available in the ECLS data to determine preschool type are not perfectly aligned across waves. Further, we cannot determine whether parents are able to accurately distinguish between different types of programs when reporting types of childcare. Regardless, we think it is important to further disaggregate our broad "preschool" category for additional analysis. In particular, we divide our

[7] We exclude children who attended fewer than five hours from the treatment group due to limited exposure, though including them does not substantively change our results.

preschool measure into two mutually exclusive types: "public pre-kindergarten" and "center based care." The way we defined these groups differed across cohorts due to survey changes. In 1998, we classified a child as a "public pre-kindergarten" participant if their parents indicated the child had attended preschool or pre-kindergarten and that it was free. In 2010, parents were explicitly asked whether their child attended a public prekindergarten program, and we follow the parental report. We define "center-based" care to be all preschool programs that are not classified as public pre-kindergartens.

Part-time and full-time care. We construct a measure of preschool intensity by separating our preschool measure into "part-time" and "full-time" care based on the number of hours per week that children attended. Following Magnuson et al. (2007b), we consider 20 hours a week as the cut-off for full-day preschool, and classify children who attended between 5 and 20 hours per week as part-time participants.[8] These categories are mutually exclusive. Children attending multiple care arrangements were classified as in part- or full-time care based on total hours per week across arrangements.

Outcomes. We consider the relationship between children's participation in preschool and their cognitive as well as behavioral outcomes. The cognitive outcomes are drawn from direct assessments of student literacy and math skills, conducted in the fall and spring of kindergarten, and in the spring of first grade. The language and literacy ("reading") assessment was designed to measure basic skills such as letter recognition and print familiarity along with vocabulary and listening comprehension. The math assessment measured conceptual knowledge, procedural knowledge, and problem solving ability. To minimize burden on children, the tests were administered in two parts. First, children took a routing test, which provided a crude estimate of ability. They were then given an easy, medium, or hard test based on their score on the routing test. Scores were equated across children using item response theory (IRT). The reliabilities for these IRT-based assessments were quite high in both 1998 and 2010 (between .93 and .95 for reading and between .92 and .94 for math).

Our behavioral outcomes are drawn from teacher reports of student behavior, specifically externalizing behavior and self-control, in kindergarten and first grade. These measures are adapted from the Social Skills Rating Scale (Gresham & Elliott, 1990) and have high reliability (.90 for

[8] We explored the robustness of our findings to a number of different definitions of "part-time" vs. "full-time," to include using thresholds of 25 and 30 hours per week. We find that our results are strikingly similar regardless of the definition we use.

externalizing behavior, and .79 for self-control in 2010, and .88, .81 in 1998 respectively). The externalizing scale asks how often children argue, fight, get angry, act impulsively, or disturb classroom activities. For this scale, lower scores represent more positive outcomes. The self-control scale asks whether children respect others' property rights, control their temper, accept peer ideas, and respond appropriately to peer pressure. Higher scores represent more positive outcomes for this scale. We standardize both cognitive and behavioral outcomes to have a mean of zero and standard deviation of one. Additional details regarding the psychometric properties of all our outcomes are reported in Rock & Pollack (2002) for the 1998 data and Tourangeau et al. (2014) for the 2010 cohort.

Moderators. We explore interactions between preschool participation and a number of subsequent experiences that we hypothesize may influence children's learning during kindergarten to determine whether these characteristics moderate patterns of fade-out. We focus on three types of potential moderators: structural features of kindergarten, process features of kindergarten, and measures of the home environment. Kindergarten information was collected from teachers, and home environment information was collected from parents, both in the fall of the kindergarten year.

Structural features of kindergarten. The three structural features we consider are length of day, preschool co-location, and class size. We define a "full day" kindergarten classroom to be five or more hours per day, consistent with the existent literature (Gibbs, 2014). We construct an indicator for whether the school principal indicates that the child's elementary school also contains a preschool. Finally, we define a small class to be one with fewer than 20 children following other studies (e.g., Blatchford, Edmonds, & Martin, 2002; Finn & Achilles, 1990), though our analysis is robust to different definitions of "small class."

Process features of Kindergarten. We examine teacher-reported accounts of kindergarten transition practices, didactic instruction, and advanced reading and math content instruction. Kindergarten teachers were asked whether they did each of the following six transition practices: sending information about kindergarten home to parents of preschoolers, visits to the kindergarten classroom for both preschoolers and their parents, shortened school days at the beginning of the kindergarten year, teacher visits to children's homes at the beginning of the kindergarten year, and parent orientation prior to the school year. We construct a kindergarten transition index defined as the proportion of these practices the teachers indicates she used. Our didactic instruction index is the average of three indicators for whether a teacher spends more than 3 hours per day on teacher

directed activities, and whether the teacher uses worksheets or workbooks every day in math and in reading.

We define content as "advanced" if at least 75 percent of kindergarten teachers in 1998 indicated that the topic was not taught in kindergarten and was covered in a later grade. Three reading topics and six math topics meet this criterion. The reading topics include "composing and writing complete sentences," "writing stories with an understandable beginning, middle and end," and "conventional spelling." The math topics include "writing equations to solve word problems," "probability," "reading 3-digit numbers," "writing all numbers between 1 and 100," "place value," and "fractions." We construct indicators for whether a teacher taught each of these topics at least weekly in kindergarten. Our advanced reading content measure is defined as the average of the three indicators for reading topics, and advanced math content is the average of the six indicators for math topics.

Home environment. Our measures of the home environment include indices for home literacy exposure and parental involvement in school. To measure home literacy exposure we construct a two item index that includes indicators for whether a parent either reads or tells stories to their child every day, and whether the child has visited a library in the past month. To measure parental involvement in schools, we take the average of five indicators for whether a parent attended an open house, attended a PTA meeting, attended a parental advisory meeting, volunteered at school, or participated in fundraising.

Control variables. Both ECLS-K datasets contain a rich set of potential covariates. We include many of these in our analysis to account for the possible selection bias associated with child and family characteristics. Specifically, we control for race, socioeconomic status, parental education (both mother's and father's), maternal age, family composition, and whether English is the primary language spoken at home. We also control for region of the country and urbanicity. For a complete list of these controls, which are identical across cohorts, see Appendix Table 1.

Analytic Approach

We use ordinary least squares to estimate the effect of preschool participation on our four outcome variables (reading scores, math scores, externalizing behavior, self-control).[9] For each relationship of

[9] We choose not to employ hierarchical linear modeling (HLM) in this study as our analytic approach leverages, in many cases, cross-classroom and cross-school variation with a focus on estimating average treatment effects, rather than partitioning variation at the levels in which individual children are nested.

interest, we estimate three sets of regressions, one that treats preschool participation as a single construct, one that separates preschool into center based care and public pre-kindergarten, and one that separates preschool into part- and full-time care. These equations take the form:

$$Y_i = \beta_0 + \beta_1 PRESCHOOL_i + \gamma_j \boldsymbol{X}_{ij} + \varepsilon_i \quad (1)$$

$$Y_i = \beta_0 + \beta_1 CENTER_i + \beta_2 PREK_i + \gamma_j \boldsymbol{X}_{ij} + \varepsilon_i \quad (2)$$

$$Y_i = \beta_0 + \beta_1 PART_i + \beta_2 FULL_i + \gamma_j \boldsymbol{X}_{ij} + \varepsilon_i \quad (3)$$

where *Y* is the outcome of interest for individual child *i*, *PRESCHOOL* is an indicator that takes on a value of one if the child's care experience in the year before kindergarten meets the definition of preschool and zero otherwise, and $\boldsymbol{X}$ is a vector of covariates. Included in $\boldsymbol{X}$ is an indicator for whether a child attended a Head Start program, allowing us to interpret the counterfactual as children who did not attend any type of formal care, including Head Start, in the year before kindergarten. All models include heteroskedasticity-robust standard errors clustered at the kindergarten classroom level.

We estimate models (1), (2), and (3) three times for each outcome variable, once each for scores from fall and spring of kindergarten as well as the spring of first grade. These estimates explore the extent to which outcomes converge between preschool participants and children who experienced no formal care, both during the kindergarten year and at the end of first grade. We also run these models separately by demographic subgroups, restricting the regression estimation to students who are black, Hispanic, and low SES.

Next, we explore whether the association between preschool participation and child outcomes during early elementary school differs for children depending on their subsequent experiences. We estimate a separate model for each potential moderator, and define these interaction models as follows:

$$Y_i = \beta_0 + \beta_1 PRESCHOOL_i + \beta_2 Mod_i + \beta_3 PRESCHOOL * Mod_i + \gamma_j \boldsymbol{X}_{ij} + \varepsilon_i \quad (4)$$

where *Y* is the outcome of interest for individual child *i*, *PRESCHOOL* is an indicator that takes on a value of one if the child's care experience in the year before kindergarten meets the definition of preschool and zero otherwise, *Mod* is a measure of child *i*'s subsequent experiences in the kindergarten classroom or at home. *PRESCHOOL*Mod* is the interaction term of preschool and

Additionally, we account for the possibility of correlated errors across individuals by clustering at the kindergarten classroom level to address a primary issue arising from the nested structure of the data.

subsequent experience, and $\boldsymbol{X}$ is a vector of covariates. In equation (4), β_3 is the coefficient of interest, capturing the composite relationship of preschool participation and subsequent experiences.

To the extent that selection into either the initial preschool experience or into subsequent experiences is confounded by unobservable characteristics over and above those included in our vector of covariates, our coefficients may be biased estimates of the impact of preschool or subsequent experiences. That said, our analytic approach and our reliance on the richness of the ECLS datasets to address selection issues are consistent with the observational literature and previous studies employing the ECLS-K data.

Results

The Early Childhood Landscape, 1998 & 2010

We begin by presenting descriptive statistics about our analytic sample, separately across waves, to provide context about changes in the early childhood landscape over the period studied. Table 1 shows the percentage of children who attended preschool, both overall and disaggregated by type (center-based care and public pre-kindergarten) and length of day (part- and full-time). Overall, participation both in preschool and in Head Start was stable over the period examined. In both periods just under 70 percent of first time-kindergarteners were enrolled in *either* preschool or Head Start in the year prior to kindergarten entry. The lack of overall increase is notable in light of the documented expansion of publicly-funded preschool. Indeed, our results show that public pre-k participation nearly doubled from 8 to 15 percent over our study period, while center-based care participation dropped by 8 percentage points. This suggests a sizable shift from private to public preschool without an overall participation increase. We do not see substantial differences over time in usage of full- versus half-day programs.

The remaining columns in Table 1 disaggregate these patterns by demographic subgroups. In both periods, black, Hispanic and low-income children are far less likely to attend (non-Head Start) preschool, particularly part-day programs, than the average child in our sample, which is primarily white and classified as mid- or high-SES. In 2010, for example, 53 percent of the full sample attended preschool in the year before kindergarten compared to 39 percent of black and Hispanic children and 26 percent of children in the bottom SES quintile. Over the period studied, the percentage of black children who enrolled *either* in preschool or in Head Start dropped from 75

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to 67 and, relatedly, for low-SES children there is a five percentage-point drop. This pattern suggests growing disparities in access to formal, classroom experiences for young children.

Table 2 provides analogous information about each cohort's kindergarten experience. The table highlights changes to both the classroom and home environments of kindergarteners across this period. Between 1998 and 2010, full-day kindergarten participation rose from 56 to 80 percent. While all student subgroups experienced growth in full-day kindergarten participation, the increase was particularly pronounced among Hispanic children, from 48 to 83 percent.

Kindergarteners in 2010 were also 14 percentage points more likely to attend kindergarten in a building that also offered preschool, a finding consistent with the expansion of state-funded preschools, which are often located in public schools. On average, there was no change in the proportion of children experiencing a small class size in kindergarten, but among black students there was an increase in this proportion. As shown in previous studies, teachers in 2010 were much more likely to report using didactic practices (e.g., teacher-directed instructions, worksheets, and textbooks) frequently, and also reported teaching more advanced reading and math content than kindergarten teachers did in 1998.

The bottom panel of Table 2 shows changes in parent-reported measures of home reading practices and school involvement. Here too we observe increases overall, and particularly among Black children. Taken together, these results suggest that children's experiences during the kindergarten year have changed significantly across this period.

Preschool Participation and Subsequent Children's Outcomes

To explore the relationships between preschool participation and academic and behavioral outcomes, we estimate the models described in equations (1), (2), and (3). The regression results for academic outcomes are presented in Table 3 (2010) and Table 4 (1998). Tables 5 and 6 present analogous results for behavioral outcomes.

Academic achievement. Consistent with earlier literature leveraging the ECLS-K, children who participated in preschool in the year prior to kindergarten outperform their peers in reading and math skills at kindergarten entry. In both 2010 and 1998 we continue to observe significant, positive associations between preschool participation and children's academic outcomes through the spring of third grade. However, the magnitude of these coefficients is smaller than at kindergarten entry. For instance, in 2010 the association between preschool participation and reading outcomes fell

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from .15 to .07 between fall kindergarten to spring first grade. For math, the pattern is quite similar (.13 to .07).

Disaggregating data by preschool type, in 2010 we observe positive and significant associations between academic outcomes and both center-based care and public pre-k However, the magnitude of the "center" coefficients is larger, and for math the difference between centers and pre-kindergarten is statistically significant. The effects of center based care are also significant through first grade, while the effects of public pre-k are not

Although there were some differences across types of care in 2010, the differences were far more pronounced in 1998. For instance, the center-based care coefficient for reading scores at the start of kindergarten was more than three times as large as the public pre-k coefficient (.21 and .06, respectively). Further, the positive association between preschool participation and math scores in 1998 is driven *entirely* by children in center-based care. This disparity continued through first grade. For example, the coefficients for center-based care in the spring of first grade are .14 and .13 for reading and math respectively. In contrast, for public pre-k the comparable coefficients are *negative* (though insignificant).

We hypothesized that children attending full-day preschool programs would display a greater advantage than children who attended part-day programs. This pattern is not observed either in the 2010 or the 1998 data. At the start of kindergarten, children in both part- and full-time preschool outperform those with no formal preschool experience at kindergarten entry. Indeed, the magnitude of the coefficients is actually slightly larger for children who attended part-time preschools.

Also counter to our hypothesis, in 2010 only the associations between part-time preschool are significantly linked to first grade outcomes (.11 for reading, .10 for math). Among children who attended full-time care, the coefficients are small and insignificant (.03 and .05). For the 1998 cohort there are no differences in first grade outcomes by length of the preschool day.

Behavioral outcomes. As has been documented in prior research, preschool participants in both iterations of the ECLS exhibit more externalizing behavior and less self-control in the fall of kindergarten relative to peers who did not experience any type of formal care (see first column of Tables 5 and 6). We do not find evidence, in either wave, that these patterns differ between centers and public pre-kindergarten programs. However, in both waves we find, as has earlier research, that the negative associations between preschool participation and behavior are driven by children enrolled in full-time programs. In 2010, for example, we see little or no association between *part-time*

preschool and behavioral outcomes. The same is true for the self-control results in 1998. We do find a statistically significant and positive association between part-time preschool and externalizing behaviors in 1998, but the magnitude of this association is dwarfed by the association for full day care (.08 compared to .41). Across both cohorts, there is little evidence of any fade-out with respect to these associations and in some cases the magnitude of the coefficients is somewhat larger (in absolute value) in first grade than at school entry.

While the overall patterns of results are quite similar across waves, the *magnitude* of these relationships is strikingly different. Specifically, the magnitudes of the associations between preschool participation and child outcomes in 1998 are generally less than half the size observed in 1998. For instance, in 2010, preschool participation was associated with a .11 SD increase in externalizing behavior and a .06 SD decrease in self-control. The analogous associations in 1998 were .24 and -.15. For children enrolled in full-time care, the 2010 associations were .20 and -.13, which, again, was roughly half the size of the comparable coefficients for 1998 (.41 and -.29).

Heterogeneity across Demographic Groups

Our first two research questions aimed to assess the *average* relationship between preschool participation and children's academic and behavioral outcomes both at school entry and in the early elementary year. Next we explore whether either the initial association between preschool participation and child outcomes or its persistence varies across groups, focusing in particular on race and socio-economic status. We caution that the standard errors in these analyses are much larger due to reduced sample size and that in some cases the cell sizes for these subgroup analyses may be restricted given our extensive controls and specification of the independent variable(s).

Academic achievement. Among the 2010 cohort, black, Hispanic and low-SES children who attended preschool in the year prior to kindergarten all outperformed their peers in both reading and math at school entry (Table 3). Black children maintained their "preschool advantage" in reading through the end of first grade. In the fall of kindergarten, Black preschool participants scored about .18 standard deviations higher than similar Black children who did not attend any formal care. At the spring of first grade the preschool coefficient was nearly unchanged (.17).

However, among both Hispanic and low-income children, already by the spring *of kindergarten* the "preschool advantage" has dissipated and coefficients are no longer statistically different from zero for either subject. For instance, among the low-SES subsample, the fall

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kindergarten coefficients for reading and math were .14 and .16 respectively. By the spring of kindergarten these were .03 and .07, and by spring of first grade .05 and .00.

In some ways, the 1998 results mirror those observed in the 2010 data. For both cohorts, there are positive associations between preschool participation and academic test scores at school entry across all three subgroups. As in the 2010 data, we also see that the relationship between preschool participation and child outcomes is particularly pronounced among Black children. In the spring of first grade, Black children who experienced preschool outperform peers with no formal care experience by .24 in reading and .27 in math. For context, note that among the full 1998 sample, the associations between preschool participation and academic outcomes at spring of kindergarten were only a third as large as for Black children.

In contrast to 2010, however, there are statistically significant positive effects on reading and math through the spring of kindergarten in the 1998 cohort. For instance, in 1998 the spring of kindergarten preschool coefficients for both reading and math among Hispanic children were statistically significant and roughly three quarters their size in the fall of kindergarten (.15 and .12 for reading and math respectively). In 2010, the comparable coefficients were .06 and .05, and not statistically significant. There is a similar pattern among low SES students.

Taken together the results are consistent with the notion that patterns of fade-out have accelerated among black, Hispanic and low-income children. In 1998, black children who had attended preschool were still outperforming their peers with no preschool on a math assessment by .27 of a standard deviation. By 2010, this coefficient dropped to .12 and is no longer statistically significant. For Hispanic and low-income children, we find no evidence of preschool benefits in the spring of first grade for either subject in either wave. However, in the 2010 wave this fade-out occurs more rapidly.

Behavioral outcomes. Recall that for the full population we found preschool participation was associated with worse behavioral outcomes, but that the associations were far more pronounced in 1998 than in 2010. When we disaggregate the analyses by subgroups, the results are somewhat similar, though the large standard errors in these smaller subgroup analyses yield fewer statistically significant coefficients. Again, the most striking finding is that the magnitude of the negative associations between preschool participation and child outcomes are far less pronounced in the more recent wave.

Among black children in 2010, there is no relationship between preschool participation and either externalizing or self-control in the fall of kindergarten (insignificant, 07 and .01). In 1998, these same coefficients were .36 and .28, and were not only statistically significant, but higher than what we observed for the full sample. Among the low-SES sample the patterns are quite similar.

By the spring of first grade for the 2010 cohort, only two of the six relevant preschool coefficients (three subgroups by two outcome measures) are statistically significant. Black children are rated as having significantly higher levels of externalizing behavior (.26), a surprising result giving the lack of an association at any point during the kindergarten year. In addition, Hispanic children are rated as having somewhat lower levels of self-control
(-.14). In comparison, five of six spring of first grade coefficients were significant for the 1998 cohort with effect sizes ranging in size from .20 to .37.

Heterogeneity in Persistence by Subsequent Contexts

The final goal of the current analysis is to examine whether the relationship between preschool participation and child outcomes differs depending on characteristics of the child's subsequent kindergarten classroom or home environment. We present outcomes from the spring of kindergarten since these are most proximate to our measures of the environment.

Structural characteristics of kindergarten. We hypothesized that the persistence of the associations between preschool participation and child outcomes would differ depending on structural characteristics of children's kindergarten experiences (e.g. the length of the kindergarten day, the kindergarten class size). Table 7 presents results from estimating model (4). We regressed outcomes from the spring of kindergarten on indicators of preschool participation, kindergarten quality and the interaction of the two. The coefficient of interest is on the interaction between preschool participation and each measure of the kindergarten classroom.

Panel A of Table 7 shows no evidence of such interactions in the more recent cohort. None of the 12 interactions examined (four outcomes by three kindergarten quality measures) were statistically different from zero. For 1998 the results (presented in Panel B of Table 7) are fairly similar, though we do find modest evidence of interactions between preschool participation and child outcomes. For instance, we find a positive interaction between preschool participation and small kindergarten class size for both reading and math outcomes.

Process characteristics of kindergarten. Panel A of Table 8, which examines the associations between preschool, kindergarten classroom experiences, and child outcomes for the

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2010 cohort, again provides little support for the hypothesis that these subsequent kindergarten characteristics are related to the persistence of preschool effects. Of 16 interactions examined (four outcomes by four kindergarten characteristics) we find only one coefficient that is statistically different from zero. Specifically, we find a positive interaction between teachers' use of advanced reading practices and children's self-control ratings in the spring of kindergarten. The magnitude of this interaction suggests that the negative association between preschool participation and self-control is not present for children who subsequently are exposed to more advanced reading content in kindergarten.

As with the structural measures, there is somewhat more evidence of interactions when we turn to the 1998 data (presented in Panel B of Table 8). Here we find four statistically significant interactions. Again, we see an interaction between preschool participation, exposure to advanced content in kindergarten and children's self-control ratings. Specifically, the negative association between preschool participation and self-control is not present for children who subsequently are exposed to more advanced math content in kindergarten. We also find that the use of kindergarten transition practices moderates the relationship between preschool participation and behavioral outcomes, such that the negative association between preschool participation and both externalizing and self-control is less pronounced if in classrooms where teachers reported more transition practices.

Parental interactions with children. Finally, Table 9 reports findings from models that interact preschool participation with two measures of parental investment, home reading practices and parental investments in school. None of the eight interaction terms examined in 2010 is significant, and only one of eight is significant in 1998. Specifically, in the earlier cohort there is a marginally significant, positive interaction between preschool participation and home-reading practices in the model predicting literacy scores.

Discussion

This study makes several notable contributions to the existing literature. First, we employ two very similar datasets to compare whether either the initial association between preschool participation and child outcomes or the *persistence* of these associations as children proceed through school have changed over time. The datasets span a period characterized by significant increases in public interest and investment in early childhood, so changes in patterns over time were hypothesized.

In many ways, however, the patterns of results we document in 2010 mirror 1998 patterns. For instance, we document positive short-term associations between preschool participation and academic skills in the 2010 data, just as has been reported for the earlier cohort. In doing so, our study suggests that counter to the hypothesis that the relationship between preschool participation and child outcomes has weakened over time, over the 12-year period examined here, this was not the case.

There are several other important similarities across waves. In both cases, the positive associations between preschool participation and academic achievement remain through first grade, though in both waves they are meaningfully smaller in magnitude than they were at school entry. In addition, in both cohorts we find particularly pronounced positive relationships between preschool participation and first grade cognitive outcomes for black children. By demonstrating greater persistence of cognitive benefits among black children in both cohorts, our study adds to the research base suggesting heterogeneous benefits of early interventions (Bassok, 2010).
In both cohorts we also find negative associations between preschool participation and behavioral outcomes, particularly for children enrolled in full-day care. However, one striking divergence is that in the more recent cohort, the associations between preschool participation and behavioral outcomes are much less pronounced. This result is intriguing.

Given the increased investment in early childhood over this period, we expected, but did not see, greater benefits to preschool in the more recent cohort with respect to academic outcomes. However, perhaps the investments in early childhood over this period coupled with the heightened awareness of the importance of social and emotional development did foster changes that supported children's behavioral outcomes.

It is important to note that our analysis focuses on gaps in outcomes between preschool participants and non-participants, and does not address changes in the overall academic or behavioral outcomes of children. Our results indicate that *gaps* in academic outcomes between preschool participants and non-participants remained stable, but does not disentangle if this is because both groups experienced similar increases (or declines) or because both stayed relatively stable. If, for example, the experiences of children who did not attend preschool improved at the same rate as did the preschool experiences, we may not observe changes over time in the preschool advantage on cognitive outcomes.

We further examined whether characteristics of the preschool experience or subsequent kindergarten and home experiences moderate the associations between preschool participation and subsequent child outcomes. Given the large changes over the study period in some of these moderators (e.g. full-day kindergarten), we had anticipated larger changes across cohorts in patterns of moderation. We find limited evidence that subsequent classroom and home contexts were associated with more persistent preschool benefits in 1998, and no evidence of this relationship in 2010. As all children are exposed to improved, more enriching contexts at home and in school, specific moderators may play less of a role in predicting the persistence of preschool advantages. At the same time, our moderation analysis is best characterized as providing little clear evidence of moderation in either wave.

Limitations

The current study advances the literature, but suffers from limitations that are typical in studies that use large, national datasets to make comparisons over time. First, to the extent that our extensive set of controls does not account fully for the endogeneity of preschool participation, type and intensity of preschool participation, and subsequent experiences, we have to be cautious in attributing any of the relationships documented in this study as causal. Rather, we can explore associations in the data, and identify those characteristics of children, preschool participation, and kindergarten experience *associated* with the persistence of early cognitive skill advantages or behavioral disadvantages. We acknowledge there is likely selection—on both observable and unobservable dimensions—into preschool and subsequent kindergarten experiences. That said, the 1998 wave of the ECLS data has been leveraged extensively in the literature to document the effects of preschool participation (Loeb et al., 2007; Magnuson et al., 2007a, 2007b). Our estimates for the earlier wave are consistent with that existing evidence.

A second limitation of the current work is that we are constrained somewhat by differences in data collection between 1998 and 2010. For instance, differences across surveys with respect to how Head Start participation was treated make it impossible for us to examine whether the association between Head Start participation and either initial or later outcomes have changed over time. Although we have done our best to construct very similar "preschool" groups across studies, it is possible that differences in the wording of the Head Start items across surveys could impact our findings. Further, because the test score standardization occurs within sample, we are somewhat

cautious about the comparability of the magnitude of effects for preschool participants across the two waves of survey data.

Relatedly, when exploring heterogeneity in patterns by preschool and kindergarten experiences, we focused on a number of measures that were selected based on their demonstrated relevance in the existing literature as well as their availability in the dataset. However, these measures are only a subset of the preschool or subsequent program characteristics that may be relevant. The ECLS data does not allow us to perfectly capture the type and quality of preschool program children experience. We rely on parent reports of care type even though parents may not accurately distinguish among care types when reporting early childhood experiences. Moreover, a large body of research has demonstrated the importance of engaged and caring child-teacher interactions in predicting gains from preschool participation (Hamre & Pianta, 2006; Mashburn et al., 2008). The ECLS-K datasets have very limited information about children's preschool experiences, and none about the quality of child-teacher interactions.

Similarly, we may not capture the particular kindergarten curricula, pedagogical approaches or teacher characteristics that play a role in the subsequent persistence or convergence of preschool effects.It is certainly possible that characteristics of preschool programs and subsequent schooling and home experiences *do* moderate the relationship between preschool participation and child outcomes, but that we are not picking up the relevant dimensions of quality with our measures.

Finally, it is also worth noting that while we treat parent behaviors as a moderator of preschool impact, these practices may have been present prior to preschool participation or may be correlated with other early investment behaviors.

Conclusions

Early childhood programs are lauded as powerful, cost-effective, and equity enhancing investments (Bassok & Loeb, 2015; Cunha & Heckman, 2010; Shonkoff & Phillips, 2000). President Obama cited the long-term impacts of high-quality early childhood interventions in his 2013 and 2014 State of the Union addresses and at a 2014 White House Summit on early childhood. Although a large body of research suggests that early childhood interventions indeed have significant impacts on both short- and long-term outcomes, researchers, policy-makers, and practitioners struggle to reconcile that evidence with the observed fade-out of preschool effects. Recently, two experimental studies showed that the benefits from *large-scale* preschool programs dissipate quickly (Lipsey et al., 2013; Puma et al., 2012) and have brought this issue of fade-out to the fore.

The current study aimed to shed light on these issues using newly-available data. Specifically, we as: (1) Do children who attend preschool outperform their peers as they progress through elementary school? And (2) Do these patterns depend on observable characteristics of the child, the preschool program or the subsequent kindergarten experiences and parenting practices?

We demonstrate that both initial effects and the persistence of those effects to the spring of first grade are remarkably consistent across cohorts. We also find encouraging evidence that black children are still outperforming their peers through first grade. In addition, the behavioral disadvantages associated with preschool participation appear to have diminished for more recent cohorts.

One popular hypothesis is that characteristics of subsequent schooling might play a role in sustaining preschool effects (Currie & Thomas, 2000; Reynolds et al., 2010). We explore this matter systematically and do not find consistent evidence to support an important role for the moderators we test. Given increased focus on alignment initiatives and concerted effort to improve kindergarten settings on those dimensions, we see an important role for research that more precisely measures the quality of early grades experiences to identify kindergarten classroom features that play either compensatory or complementary roles with early childhood program participation. Moreover**,** as kindergarten settings are increasingly adopting common standards and becoming more academic to meet performance expectations in the early grades, it will be important for researchers to carefully examine the implications of those changes for children's learning as well as their behavior.

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Table 1. Preschool and Head Start Participation by subgroup

	All students		Black		Hispanic		Low SES	
	1998	2010	1998	2010	1998	2010	1998	2010
Preschool	0.55	0.53	0.42	0.39	0.41	0.39	0.26	0.26
Center based care	0.46	0.38	0.28	0.21	0.30	0.22	0.15	0.12
Public pre-k	0.08	0.15	0.14	0.18	0.11	0.17	0.11	0.15
Part time	0.29	0.26	0.10	0.08	0.20	0.18	0.10	0.11
Full time	0.26	0.27	0.32	0.30	0.21	0.21	0.16	0.16
Head Start	0.14	0.14	0.33	0.28	0.20	0.20	0.32	0.26
N	12450	11000	1800	1350	1500	2550	1650	1950

Note. Preschool and Head Start are mutually exclusive; students who attended both are classified as Head Start students. Survey items for determining Head Start participation are not identical across waves and so groups may not be directly comparable. Part time care is defined as less than 20 hours per week. These descriptive statistics refer to the "cognitive" sample described in text. Sample sizes rounded to nearest 50 as per NCES requirements.

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Table 2. Kindergarten classroom features and home environment by subgroup

	All students		Black		Hispanic		Low SES		Preschool		Head Start		No formal care	
	1998	2010	1998	2010	1998	2010	1998	2010	1998	2010	1998	2010	1998	2010
Structural features of Kindergarten														
Full day (>=5 hours)	0.56	0.80	0.81	0.93	0.48	0.83	0.65	0.89	0.56	0.78	0.67	0.86	0.51	0.79
Pre-K class in building	0.37	0.51	0.51	0.54	0.37	0.54	0.41	0.53	0.38	0.52	0.34	0.49	0.34	0.49
Small class size (< 20)	0.38	0.39	0.36	0.43	0.34	0.34	0.39	0.37	0.38	0.40	0.41	0.39	0.37	0.39
Process features of Kindergarten														
Transition practices index	0.53	0.51	0.46	0.49	0.49	0.46	0.49	0.48	0.54	0.52	0.49	0.50	0.52	0.50
Didactic instruction	0.24	0.42	0.31	0.47	0.22	0.47	0.27	0.48	0.23	0.41	0.29	0.47	0.23	0.41
Advanced literacy content	0.40	0.71	0.47	0.76	0.45	0.74	0.41	0.72	0.41	0.70	0.41	0.72	0.38	0.72
Advanced math content	0.21	0.32	0.22	0.34	0.22	0.32	0.21	0.31	0.21	0.33	0.22	0.32	0.20	0.33
Home environment														
Home reading practices	0.54	0.61	0.46	0.60	0.49	0.54	0.41	0.51	0.57	0.64	0.48	0.58	0.52	0.58
Parental involvement	0.46	0.52	0.37	0.49	0.43	0.48	0.31	0.40	0.50	0.56	0.35	0.47	0.44	0.48
N	12450	11000	1800	1350	1500	2550	1650	1950	7050	6000	1750	1450	5350	5000

Note. Preschool: Center based care or public pre-k. Part time: less than 20 hours per week. No formal care means student did not attend any type of formal early childhood care including center based, public pre-k, or Head Start. Didactic instruction includes time spent in teacher directed activities along with the use of workbooks and textbooks. Advanced literacy and math content was determined based on frequency of exposure to content that was taught in <25% of kindergarten classes in 1998. Transition practices include 6 items asked of teachers in fall of kindergarten. Home reading practices include reading books/telling stories every day and visiting a library in the past month. Parental involvement contains 5 items such as does a parent volunteer at school, attend PTA meetings, etc. Survey items for determining Head Start participation are not identical across waves and so groups may not be directly comparable. These descriptive statistics refer to the "cognitive" sample described in text. Sample sizes rounded to nearest 50 as per NCES requirements.

Table 3. Coefficients and standard errors from regressions of academic measures on preschool participation, 2010 cohort.

	All students			Black			Hispanic			Low SES		
	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st
Reading												
Preschool	0.15***	0.08**	0.07*	0.18**	0.14*	0.17*	0.11**	0.06	0.05	0.14***	0.03	0.05
	(0.03)	(0.03)	(0.03)	(0.06)	(0.07)	(0.08)	(0.04)	(0.05)	(0.06)	(0.04)	(0.05)	(0.06)
Center based care	0.16***	0.09**	0.08**	0.11	0.07	0.16	0.16**	0.09	0.09	0.15*	0.02	0.03
	(0.03)	(0.03)	(0.03)	(0.07)	(0.09)	(0.09)	(0.05)	(0.06)	(0.07)	(0.06)	(0.07)	(0.09)
Public pre-k	0.11***	0.06*	0.05	0.26**	0.23*	0.18	0.04	0.02	-0.00	0.13*	0.05	0.08
	(0.03)	(0.03)	(0.04)	(0.09)	(0.09)	(0.10)	(0.05)	(0.06)	(0.07)	(0.06)	(0.07)	(0.08)
Part time care	0.19***	**0.13*** **	**0.11*** **	0.22*	0.20	0.21	0.09	0.07	0.09	0.19**	0.11	0.16
	(0.03)	**(0.03)**	**(0.03)**	(0.10)	(0.11)	(0.11)	(0.06)	(0.07)	(0.07)	(0.06)	(0.08)	(0.09)
Full time care	0.16***	**0.05**	**0.03**	0.24***	0.18*	0.20*	0.18**	0.09	0.02	0.16**	-0.00	0.01
	(0.03)	**(0.03)**	**(0.03)**	(0.07)	(0.08)	(0.08)	(0.06)	(0.07)	(0.07)	(0.06)	(0.07)	(0.08)
Math												
Preschool	0.13***	0.06**	0.07*	0.19**	0.14*	0.12	0.11*	0.05	0.08	0.16**	0.07	0.00
	(0.02)	(0.02)	(0.03)	(0.06)	(0.07)	(0.07)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)
Center based care	**0.16*** **	**0.08** **	0.08**	0.19**	0.14	0.08	0.15*	0.07	0.12	0.13	0.03	-0.08
	(0.03)	**(0.03)**	(0.03)	(0.07)	(0.08)	(0.08)	(0.06)	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)
Public pre-k	**0.08** **	**0.02**	0.04	0.18*	0.14	0.16	0.06	0.03	0.05	0.18*	0.11	0.08
	(0.03)	**(0.03)**	(0.03)	(0.08)	(0.09)	(0.10)	(0.06)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)
Part time care	0.17***	0.08**	0.10***	0.26**	0.13	0.12	0.14*	0.05	0.14*	0.19**	0.10	0.12
	(0.03)	(0.03)	(0.03)	(0.10)	(0.12)	(0.11)	(0.06)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)
Full time care	0.15***	0.06*	0.05	0.25***	0.19*	0.15	0.14*	0.08	0.05	0.19**	0.08	-0.07
	(0.03)	(0.03)	(0.03)	(0.07)	(0.08)	(0.08)	(0.06)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)
Approx N	11100			1350			2550			2000		

Note. Outcomes have been standardized to have mean 0 and SD 1. All estimates control for a rich set of covariates including student gender, race, SES, area of residence, and family composition. Estimates are weighted to be nationally representative of students entering kindergarten in 2010. Sample sizes are rounded to the nearest 50 as per NCES requirements. * p<.05 ** p<.01 *** p<.001. Bolded sets of coefficients are statistically different from each other at the .05 level.

Table 4. Coefficients and standard errors from regressions of academic measures on preschool participation, 1998 cohort.

	All students			Black			Hispanic			Low SES		
	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st
Reading												
Preschool	0.18***	0.11***	0.10***	0.24***	0.24***	0.24**	0.20***	0.15*	0.08	0.16***	0.08*	0.09
	(0.02)	(0.02)	(0.03)	(0.06)	(0.06)	(0.08)	(0.05)	(0.06)	(0.07)	(0.04)	(0.04)	(0.06)
Center based care	**0.21*** **	**0.15*** **	**0.14*** **	0.26***	0.26***	**0.31*** **	**0.26*** **	**0.21** **	**0.15***	**0.22*** **	**0.15***	0.15
	(0.02)	**(0.02)**	**(0.03)**	(0.07)	(0.07)	**(0.09)**	**(0.06)**	**(0.07)**	**(0.07)**	**(0.05)**	**(0.06)**	(0.08)
Public pre-k	**0.06***	**-0.01**	**-0.08**	0.22**	0.21**	**0.12**	**0.08**	**0.03**	**-0.08**	**0.08**	**0.00**	0.01
	(0.03)	**(0.04)**	**(0.05)**	(0.07)	(0.07)	**(0.10)**	**(0.08)**	**(0.08)**	**(0.10)**	**(0.05)**	**(0.06)**	(0.09)
Part time care	0.19***	0.12***	0.11***	0.21*	0.21*	0.12	0.20***	0.15*	0.05	0.16**	0.06	0.07
	(0.03)	(0.03)	(0.03)	(0.10)	(0.09)	(0.11)	(0.06)	(0.07)	(0.08)	(0.05)	(0.06)	(0.08)
Full time care	0.17***	0.11***	0.09**	0.25***	0.26***	0.28***	0.21**	0.16*	0.11	0.17***	0.11*	0.11
	(0.02)	(0.03)	(0.03)	(0.06)	(0.06)	(0.08)	(0.07)	(0.07)	(0.08)	(0.04)	(0.05)	(0.08)
Math												
Preschool	0.17***	0.14***	0.10***	0.21***	0.27***	0.27***	0.16**	0.12*	0.08	0.17***	0.12*	0.10
	(0.02)	(0.02)	(0.03)	(0.05)	(0.06)	(0.07)	(0.05)	(0.05)	(0.06)	(0.04)	(0.05)	(0.07)
Center based care	**0.20*** **	**0.17*** **	**0.13*** **	0.23***	0.28***	0.30***	**0.22*** **	**0.21*** **	0.11	0.20***	0.17***	0.17*
	(0.02)	**(0.02)**	**(0.03)**	(0.05)	(0.06)	(0.07)	**(0.06)**	**(0.06)**	(0.07)	(0.05)	(0.05)	(0.08)
Public pre-k	**0.03**	**0.02**	**-0.05**	0.18***	0.27***	0.21*	**0.01**	**-0.05**	0.01	0.14**	0.06	0.00
	(0.03)	**(0.04)**	**(0.05)**	(0.05)	(0.07)	(0.09)	**(0.07)**	**(0.07)**	(0.09)	(0.05)	(0.06)	(0.08)
Part time care	0.18***	0.13***	0.10***	0.17*	0.25**	0.24*	0.17**	0.15*	0.13	0.19***	0.08	0.13
	(0.02)	(0.02)	(0.03)	(0.07)	(0.08)	(0.10)	(0.06)	(0.06)	(0.08)	(0.05)	(0.06)	(0.08)
Full time care	0.16***	0.15***	0.09**	0.23***	0.29***	0.28***	0.15*	0.10	0.04	0.17***	0.15**	0.08
	(0.02)	(0.02)	(0.03)	(0.05)	(0.06)	(0.07)	(0.06)	(0.06)	(0.07)	(0.04)	(0.05)	(0.08)
Approx N	12450			1800			1550			2450		

Note. Outcomes have been standardized to have mean 0 and SD 1. All estimates control for a rich set of covariates including student gender, race, SES, area of residence, and family composition. Estimates are weighted to be nationally representative of students entering kindergarten in 1998. Sample sizes are rounded to the nearest 50 as per NCES requirements. * p<.05 ** p<.01 *** p<.001. Bolded sets of coefficients are statistically different from each other at the .05 level.

Table 5. Coefficients and standard errors from regressions of behavioral measures on preschool participation, 2010 cohort.

	All students			Black			Hispanic			Low SES		
	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st
Externalizing												
Preschool	0.11***	0.14***	0.10***	0.07	0.05	0.26**	0.14*	0.15*	0.10	0.11	0.18*	0.09
	(0.03)	(0.03)	(0.03)	(0.11)	(0.10)	(0.10)	(0.06)	(0.06)	(0.06)	(0.08)	(0.08)	(0.08)
Center based care	0.10***	0.15***	0.10***	0.13	0.10	0.17	0.13	0.18*	0.13	0.17	0.23*	0.15
	(0.03)	(0.03)	(0.03)	(0.13)	(0.12)	(0.12)	(0.07)	(0.07)	(0.08)	(0.11)	(0.11)	(0.10)
Public pre-k	0.11**	0.12**	0.10*	0.00	-0.01	0.36**	0.15	0.11	0.05	0.06	0.15	0.03
	(0.04)	(0.04)	(0.04)	(0.14)	(0.13)	(0.13)	(0.08)	(0.07)	(0.07)	(0.10)	(0.09)	(0.10)
Part time care	**0.05**	**0.07***	**0.02**	0.28	0.21	0.41*	0.11	0.16*	0.03	0.07	0.16	**-0.06**
	(0.03)	**(0.03)**	**(0.03)**	(0.17)	(0.17)	(0.17)	(0.08)	(0.07)	(0.07)	(0.10)	(0.09)	**(0.10)**
Full time care	**0.20*****	**0.27*****	**0.21*****	0.03	0.02	0.26*	0.26**	0.25***	0.20**	0.18	0.26**	**0.20***
	(0.03)	**(0.03)**	**(0.04)**	(0.11)	(0.10)	(0.11)	(0.08)	(0.07)	(0.07)	(0.11)	(0.09)	**(0.10)**
Self-control												
Preschool	-0.06*	-0.10***	-0.11***	0.01	0.01	-0.14	-0.12*	-0.15*	-0.14*	-0.11	-0.19**	-0.09
	(0.03)	(0.03)	(0.03)	(0.10)	(0.10)	(0.10)	(0.06)	(0.06)	(0.07)	(0.08)	(0.07)	(0.08)
Center based care	-0.07*	-0.10***	-0.10***	-0.02	0.03	-0.08	-0.15*	-0.19**	-0.15	-0.15	-0.19*	-0.15
	(0.03)	(0.03)	(0.03)	(0.11)	(0.12)	(0.12)	(0.07)	(0.07)	(0.08)	(0.10)	(0.09)	(0.10)
Public pre-k	-0.06	-0.10*	-0.13**	0.04	-0.01	-0.20	-0.08	-0.11	-0.13	-0.07	-0.18*	-0.04
	(0.04)	(0.04)	(0.04)	(0.13)	(0.13)	(0.12)	(0.08)	(0.08)	(0.08)	(0.10)	(0.09)	(0.10)
Part time care	**-0.02**	**-0.04**	**-0.04**	-0.14	-0.15	-0.24	-0.09	-0.19*	**-0.01**	-0.03	-0.15	0.01
	(0.03)	**(0.03)**	**(0.03)**	(0.17)	(0.18)	(0.15)	(0.08)	(0.08)	**(0.08)**	(0.10)	(0.10)	(0.11)
Full time care	**-0.13****	**-0.19*****	**-0.21*****	0.05	0.06	-0.12	-0.22**	-0.22**	**-0.31*****	-0.19	-0.28**	-0.17
	(0.04)	**(0.04)**	**(0.04)**	(0.11)	(0.11)	(0.10)	(0.08)	(0.08)	**(0.08)**	(0.11)	(0.09)	(0.09)
Approx N		9050			1100			1950			1600	

Note. Outcomes have been standardized to have mean 0 and SD 1. All estimates control for a rich set of covariates including student gender, race, SES, area of residence, and family composition. Estimates are weighted to be nationally representative of students entering kindergarten in 2010. Sample sizes are rounded to the nearest 50 as per NCES requirements. * p<.05 ** p<.01 *** p<.001. Bolded sets of coefficients are statistically different from each other at the .05 level.

Table 6. Coefficients and standard errors from regressions of behavioral measures on preschool participation, 1998 cohort

	All students			Black			Hispanic			Low SES		
	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st	Fall K	Spring K	Spring 1st
Externalizing												
Preschool	0.24***	0.23***	0.18***	0.36***	0.34***	0.37***	0.25***	0.30***	0.22**	0.25***	0.23**	0.20*
	(0.02)	(0.02)	(0.03)	(0.09)	(0.09)	(0.10)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.08)
Center based care	0.24***	0.23***	0.17***	**0.45*** **	0.40***	0.38***	0.31***	0.32***	0.25**	0.23**	0.22**	0.16*
	(0.03)	(0.03)	(0.03)	**(0.10)**	(0.10)	(0.11)	(0.08)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)
Public pre-k	0.21***	0.22***	0.24***	**0.23***	0.25*	0.35**	0.13	0.26**	0.17	0.28**	0.25*	0.24*
	(0.05)	(0.04)	(0.06)	**(0.11)**	(0.11)	(0.13)	(0.10)	(0.10)	(0.13)	(0.09)	(0.10)	(0.12)
Part time care	**0.08****	**0.08****	**0.04**	**0.13**	**0.07**	0.27	0.20*	0.31***	0.12	0.17	0.14	**0.02**
	(0.03)	**(0.03)**	**(0.03)**	**(0.12)**	**(0.11)**	(0.15)	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	**(0.09)**
Full time care	**0.41*****	**0.40*****	**0.34*****	**0.44*****	**0.42*****	0.40***	0.31***	0.30***	0.32**	0.32***	0.30***	**0.31****
	(0.03)	**(0.03)**	**(0.04)**	**(0.09)**	**(0.10)**	(0.10)	(0.08)	(0.09)	(0.10)	(0.08)	(0.08)	**(0.10)**
Self-control												
Preschool	-0.15***	-0.15***	-0.14***	-0.28**	-0.29**	-0.21*	-0.17*	-0.17*	-0.22*	-0.16*	-0.13*	-0.14
	(0.03)	(0.03)	(0.03)	(0.09)	(0.09)	(0.10)	(0.07)	(0.08)	(0.09)	(0.07)	(0.06)	(0.08)
Center based care	-0.16***	-0.15***	-0.14***	**-0.37*****	**-0.38*****	-0.23*	-0.21**	-0.19*	-0.17	-0.15	-0.12	-0.08
	(0.03)	(0.03)	(0.03)	**(0.09)**	**(0.10)**	(0.11)	(0.08)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)
Public pre-k	-0.13**	-0.15***	-0.13**	**-0.14**	**-0.17**	-0.19	-0.09	-0.13	-0.32*	-0.16	-0.14	-0.21
	(0.05)	(0.04)	(0.05)	**(0.10)**	**(0.11)**	(0.11)	(0.10)	(0.10)	(0.14)	(0.09)	(0.08)	(0.12)
Part time care	**-0.03**	**-0.02**	**-0.02**	**-0.12**	**-0.01**	**0.02**	-0.09	-0.12	-0.14	-0.05	**0.00**	-0.00
	(0.03)	**(0.03)**	**(0.03)**	**(0.11)**	**(0.11)**	**(0.14)**	(0.09)	(0.09)	(0.10)	(0.09)	**(0.08)**	(0.10)
Full time care	**-0.29*****	**-0.30*****	**-0.27*****	**-0.33*****	**-0.39*****	**-0.28****	-0.25**	-0.22*	-0.28*	-0.24**	**-0.22****	-0.22*
	(0.03)	**(0.03)**	**(0.04)**	**(0.09)**	**(0.10)**	**(0.10)**	(0.08)	(0.09)	(0.11)	(0.08)	**(0.08)**	(0.09)
Approx N	10900			1500			1250			2100		

Note. Outcomes have been standardized to have mean 0 and SD 1. All estimates control for a rich set of covariates including student gender, race, SES, area of residence, and family composition. Estimates are weighted to be nationally representative of students entering kindergarten in 1998. Sample sizes are rounded to the nearest 50 as per NCES requirements. * p<.05 ** p<.01 *** p<.001. Bolded sets of coefficients are statistically different from each other at the .05 level.

Table 7. Structural features of kindergarten as moderators of preschool participation, Spring K Outcomes

Panel A. 2010

	Reading	Math	Extern	Self-Control
Preschool	0.06	0.10+	0.12*	-0.08
	(0.05)	(0.05)	(0.05)	(0.05)
Full-day	0.11*	0.14**	0.17***	-0.13*
	(0.04)	(0.04)	(0.05)	(0.05)
Preschool * Full-day	0.01	-0.05	0.01	-0.00
	(0.05)	(0.05)	(0.05)	(0.06)
Preschool	0.10**	0.08*	0.16***	-0.12***
	(0.03)	(0.03)	(0.03)	(0.04)
Pre-k class in same building	0.05+	0.02	0.07*	-0.08*
	(0.03)	(0.03)	(0.04)	(0.04)
Preschool * Same building	-0.05	-0.05	-0.06	0.07
	(0.04)	(0.05)	(0.05)	(0.05)
Preschool	0.09**	0.07*	0.13***	-0.08*
	(0.03)	(0.03)	(0.03)	(0.03)
Small class	-0.05	-0.04	0.04	-0.01
	(0.03)	(0.03)	(0.04)	(0.04)
Preschool * Small class	-0.05	-0.03	-0.02	-0.01
	(0.05)	(0.05)	(0.04)	(0.05)

Panel B. 1998

	Reading	Math	Extern	Self-Control
Preschool	0.09**	0.11***	0.18***	-0.11**
	(0.03)	(0.03)	(0.03)	(0.03)
Full-day	0.19***	0.14***	0.12***	-0.07
	(0.04)	(0.03)	(0.04)	(0.04)
Preschool * Full-day	0.03	0.04	0.07	-0.06
	(0.04)	(0.04)	(0.04)	(0.05)
Preschool	0.11***	0.14***	0.20***	-0.11***
	(0.03)	(0.02)	(0.03)	(0.03)
Pre-k class in same building	0.00	-0.02	-0.02	0.01
	(0.04)	(0.03)	(0.04)	(0.04)
Preschool * Same building	0.01	-0.00	0.05	-0.09+
	(0.04)	(0.04)	(0.05)	(0.05)
Preschool	0.08**	0.11***	0.21***	-0.12***
	(0.03)	(0.03)	(0.03)	(0.03)
Small class	-0.06+	-0.06+	0.02	-0.03
	(0.03)	(0.03)	(0.04)	(0.04)
Preschool * Small class	0.08*	0.08+	0.03	-0.06
	(0.04)	(0.04)	(0.04)	(0.05)

Note. "Extern" means externalizing behavior. All estimates control for a rich set of covariates including student gender, race, SES, area of residence, and family composition. Estimates are weighted to be nationally representative of students entering kindergarten in 2010 (Panel A) and 1998 (Panel B). Sample sizes are rounded to the nearest 50 as per NCES requirements. * p<.05 ** p<.01 *** p<.001.

Table 8. Process features of kindergarten as moderators of preschool participation, Spring K Outcomes

Panel A. 2010

	Reading	Math	Extern	Self-Control
Preschool	0.07	0.06	0.20**	-0.13+
	(0.07)	(0.07)	(0.08)	(0.08)
Transition practices index	0.00	0.05	-0.00	0.09
	(0.09)	(0.09)	(0.10)	(0.11)
Preschool * Transition practices	0.00	0.00	-0.15	0.09
	(0.13)	(0.13)	(0.14)	(0.14)
Preschool	0.08*	0.07+	0.10**	-0.06+
	(0.04)	(0.04)	(0.04)	(0.04)
Didactic instruction	0.04	0.03	-0.04	0.03
	(0.05)	(0.05)	(0.05)	(0.06)
Preschool * Didactic instruction	-0.01	-0.02	0.06	-0.06
	(0.06)	(0.06)	(0.07)	(0.07)
Preschool	0.08	0.04	0.11+	-0.19**
	(0.05)	(0.05)	(0.06)	(0.06)
Advanced reading content	0.21***	0.14**	-0.10+	0.01
	(0.05)	(0.05)	(0.06)	(0.07)
Preschool * Advanced reading	-0.00	0.03	0.02	0.15+
	(0.07)	(0.07)	(0.08)	(0.08)
Preschool	0.03	0.04	0.14***	-0.12**
	(0.04)	(0.04)	(0.04)	(0.04)
Advanced math content	0.11	0.27***	-0.05	0.02
	(0.07)	(0.07)	(0.07)	(0.07)
Preschool * Advanced math	0.13	0.05	-0.05	0.12
	(0.09)	(0.09)	(0.09)	(0.09)

Panel B. 1998

	Reading	Math	Extern	Self-Control
Preschool	0.14*	0.20***	0.45***	-0.28***
	(0.06)	(0.06)	(0.07)	(0.07)
Transition practices index	0.04	0.11	0.30***	-0.24*
	(0.08)	(0.08)	(0.09)	(0.10)
Preschool * Transition practices	-0.04	-0.12	-0.44***	0.25*
	(0.10)	(0.10)	(0.12)	(0.12)
Preschool	0.09***	0.11***	0.20***	-0.15***
	(0.03)	(0.02)	(0.03)	(0.03)
Didactic instruction	0.12*	0.08+	-0.00	-0.07
	(0.05)	(0.04)	(0.05)	(0.06)
Preschool * Didactic instruction	0.09	0.10+	0.08	0.05
	(0.06)	(0.06)	(0.07)	(0.07)
Preschool	0.13***	0.14***	0.22***	-0.18***
	(0.03)	(0.03)	(0.03)	(0.03)
Advanced reading content	0.36***	0.19***	-0.05	0.09+
	(0.04)	(0.04)	(0.05)	(0.06)
Preschool * Advanced reading	-0.04	-0.00	-0.00	0.10
	(0.06)	(0.05)	(0.06)	(0.06)
Preschool	0.08**	0.11***	0.25***	-0.19***
	(0.03)	(0.03)	(0.03)	(0.03)
Advanced math content	0.35***	0.34***	0.10	0.00
	(0.08)	(0.07)	(0.09)	(0.10)
Preschool * Advanced math	0.14	0.11	-0.14	0.25*
	(0.11)	(0.09)	(0.11)	(0.11)

Note. "Extern" means externalizing behavior. All estimates control for a rich set of covariates including student gender, race, SES, area of residence, and family composition. Estimates are weighted to be nationally representative of students entering kindergarten in 2010 (Panel A) and 1998 (Panel B). Sample sizes are rounded to the nearest 50 as per NCES requirements. * p<.05 ** p<.01 *** p<.001.

Table 9. Interactions between preschool attendance and home environment, Kindergarten outcomes

Panel A. 2010

	Reading	Math	Extern	Self-Control
Preschool	0.07	0.10*	0.13**	-0.09+
	(0.05)	(0.04)	(0.05)	(0.05)
Home reading practices	0.17***	0.13**	-0.06	0.05
	(0.04)	(0.04)	(0.05)	(0.05)
Preschool * Home reading	0.00	-0.06	-0.02	0.01
	(0.06)	(0.06)	(0.06)	(0.06)
Preschool	0.09	0.12*	0.12*	-0.11+
	(0.05)	(0.06)	(0.06)	(0.06)
Parent involvement	0.24***	0.28***	-0.11+	0.10
	(0.07)	(0.07)	(0.07)	(0.07)
Preschool * Parent involvement	-0.04	-0.13	0.02	0.03
	(0.09)	(0.09)	(0.10)	(0.10)

Panel B. 1998

	Reading	Math	Extern	Self-Control
Preschool	0.07*	0.12***	0.25***	-0.17***
	(0.03)	(0.03)	(0.04)	(0.04)
Home reading practices	0.12***	0.08*	-0.07+	0.07+
	(0.03)	(0.03)	(0.04)	(0.04)
Preschool * Home reading	0.09+	0.04	-0.07	0.04
	(0.05)	(0.05)	(0.05)	(0.05)
Preschool	0.13**	0.13**	0.26***	-0.13**
	(0.04)	(0.04)	(0.05)	(0.05)
Parent involvement	0.34***	0.34***	-0.27***	0.35***
	(0.06)	(0.05)	(0.07)	(0.06)
Preschool * Parent involvement	-0.04	0.01	-0.08	-0.04
	(0.08)	(0.07)	(0.09)	(0.08)

Note. "Extern" means externalizing behavior. All estimates control for a rich set of covariates including student gender, race, SES, area of residence, and family composition. Estimates are weighted to be nationally representative of students entering kindergarten in 2010 (Panel A) and 1998 (Panel B). Sample sizes are rounded to the nearest 50 as per NCES requirements. * p<.05 ** p<.01 *** p<.001.

Table A1. List of control variables included in analysis

Variable	How variable is coded	Reference group (if any)
Gender	1 = male	Female
Race	Separate indicators for Black, Hispanic, Asian, other	White
Socioeconomic status	Indicators for SES quintiles 1-4	Quintile 5 (Highest SES)
Region of residence	Northeast, Midwest, South	West
Urbanicity	City, suburb	Rural
Low birthweight	< 5.5 pounds	
Premature birth	3-7 weeks, more than 7 weeks	< 3 weeks
Number of places child has lived	continuous	
Maternal education	Indicators for HS graduate, graduate degree	Some college or bachelor's degree
Paternal education	Indicators for HS graduate, graduate degree	Some college or bachelor's degree
Mother's age in fall of kindergarten	< 25, between 25 and 35, between 35 and 45	> 45
Language spoken at home	Indicator for only English spoken at home	At least one other language spoken
Family type	Indicators for single parent, one biological parent, two adopted parents	Two biological parents
Number of grandparents that have close relationship with child	continuous	
Number of household members younger than 18	continuous	
Number of household members 18 or older	continuous	