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Is Full Better than Half?

Examining the Longitudinal Effects of Full-day Kindergarten Attendance

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RAND LABOR AND POPULATION

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Examining the Longitudinal Effects of Full-day Kindergarten Attendance

by

Jill S. Cannon*, Alison Jacknowitz**, and Gary Painter***

Abstract

Kindergarten policy varies widely both across and within states. Over the past decade, a number of states have instituted a full-day kindergarten requirement and a number of others are considering it as a way of increasing educational achievement. Many parents also support full-day kindergarten as a source of child care. This paper uses the Early Child Longitudinal Study-Kindergarten Class of 1998-1999 to evaluate the efficacy of this policy. In ordinary least squares, probit, county fixed effects, and instrumental variables models, we find that there are initial benefits for students and the mothers of students that attend full-day kindergarten, but that these differences largely evaporate by third grade. Contrary to claims by some advocates, attending full-day kindergarten is found to have no additional benefit for students in families with income below the poverty threshold.

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1. INTRODUCTION

As high-stakes testing in education becomes more important and is occurring at earlier junctures in a student's educational experience, the importance of the early educational experience of students in kindergarten also increases. Kindergarten, as the transitional year into formal schooling, can have an important role in laying the groundwork for future school success (Entwisle & Alexander, 1998; Heckman, 2000; Morrow et al., 1998). Many state and local school district decisionmakers are interested in policies that expand kindergarten from half-day to full-day because of perceived benefits for learning. In addition, many parents are also enthusiastic about the full-day option for both educational reasons and because it lessens the need for child care arrangements during the workday.

This support has led to a marked increase in the number of children enrolled in full-day programs over the past three decades. The U.S. Census shows that 60 percent of kindergartners were in full-day classes in 2000 (Education Commission of the States, 2004), compared with about 13 percent in 1970 (Elicker & Mathur, 1997). The decade of the 1990s, in particular, saw an increase in the requirement of full-day offerings in states (Chart 1). At the same time, great variation remains in the full-day program offerings across the country (Table 1). State policies vary from requiring school districts to offer a full-day program (10 states) to states with no formal policy (10 states), with half-day and combinations of half-day and full-day policies in between (Council of Chief State School Officers, 1998).

While students and parents may receive benefits from full-day kindergarten classes, it remains a significant expense for school districts to expand their kindergarten programs. Research, to date, has provided some evidence of the benefits of full-day kindergarten programs, although most of the studies have methodological limitations such as small sample sizes, potential selection biases, and/or have only examined outcomes through first grade. Therefore,

more research is needed to evaluate the efficacy of full-day kindergarten programs when education dollars could instead be spent on numerous other programs designed for improving student achievement. This analysis will examine the education, social, and maternal employment effects of full-day kindergarten compared to half-day kindergarten.¹

Using nationally-representative data from the Early Childhood Longitudinal Study—Kindergarten Class of 1998-1999 (ECLS-K), this research will overcome many of the methodological limitations of previous research first by examining student and parental outcomes through the third grade. Second, due to sufficient sample size, this study is able to test for differential effects of full-day programs by poverty status and by gender, as research suggests possible differences in consequences for these different groups. Finally, this analysis attempts to control for the role parents have in choosing the type of kindergarten program their children attend by estimating both county fixed effects and instrumental variables models. In the latter, we use state variation in kindergarten full-day policies as an instrument for the likelihood that a student will attend a full-day program.

2. THEORY AND BACKGROUND

Teachers, parents, and child development experts cite academic and social reasons why a longer kindergarten day may be beneficial for children. One major reason mentioned is the belief that a longer kindergarten day will help children to be better prepared for first grade and thus future learning (Clark & Kirk, 2000). More classroom time will provide a less rushed schedule and more opportunity for the teacher to work individually with children and spend less time proportionately on large-group or teacher-directed activities (Clark & Kirk, 2000; Elicker & Mathur, 1997; Morrow et al., 1998).

¹ Full-day is also referred to as “all-day,” “whole-day,” or “extended-day” in the literature. Half-day is often referred to as “part-day.”

Furthermore, a longer day is hypothesized to allow more time for the types of child-initiated and process-oriented activities that encourage social and cognitive development. Children learn through play and child-initiated activities, as well as teacher-directed instruction, thus a balance between the two, which a longer day facilitates, is important for development (Bredekamp & Copple, 1997). Morrow et al. (1998) suggest that a longer class would provide better literacy outcomes because of the larger blocks of time for literacy instruction available in a full-day program, as well as more time proportionately than half-day programs. Early childhood theorists such as Piaget and Vygotsky posit that larger blocks of time are necessary for young children to engage in process learning (Morrow et al., 1998). However, child development experts argue that a longer day in itself does not necessarily mean that the additional time is used in a developmentally appropriate manner (Gullo, 1990; Olsen & Zigler, 1988), and therefore could potentially have negative effects, as well, such as encouraging an increasingly academic curriculum and classroom structure not appropriate for younger children.²

In addition to a focus on child outcomes, there is reason to expect that maternal employment would also be affected by the enrollment of a child in a full-day rather than half-day program. Child care literature suggests that availability and price of child care, especially subsidized child care, significantly affects maternal employment (Blau & Robins, 1988; Connelly, 1992; Gelbach, 2002; Karoly et al., 1998; Ribar, 1992). Gelbach (2002) extends this literature by studying the impact of kindergarten enrollment for five year olds because the free kindergarten program substitutes for parental child care expenses. Gelbach (2002) found that

² In addition, the care provided to students in half-day programs during out-of-school time can have ambiguous effects on outcomes compared to children in full-day programs. Research suggests that mothers with higher education levels and socio-economic status, and those providing positive parent-child interactions and secure attachments afford benefits for their children's learning. Alternatively, mothers with low education levels, depression, poor parenting skills or insecure attachments with their children may pose risks to children's school success (see, for example, Huffman et al., 2001, and Werner, 2000).

kindergarten enrollment significantly affected maternal labor market outcomes, increasing labor supply measures by six to 24 percent.

While the effect of full-day kindergarten on maternal employment outcomes has not been empirically tested, extant research on the issue of full-day kindergarten compared to half-day kindergarten has shown several positive student outcomes from the longer school day. Beneficial outcomes cited in previous studies include improved readiness for first grade, improved reading and mathematics achievement in early elementary school, and improved social skills and behavior (Clark & Kirk, 2000). While findings indicate some positive outcomes, studies with no significant differences or mixed results also exist. Further, overall confidence in the early literature is weak, at least in part due to methodological limitations of previous studies.³

More recently research has begun to utilize larger sample sizes in the study of the efficacy of full-day vs. half-day programs. Cryan et al. (1992) studied 8,290 children retrospectively in 27 school districts and 2,899 longitudinally in the state of Ohio to help inform statewide decisionmaking. They found generally positive academic and behavioral outcomes through first grade of full-day kindergarten on average. Children performed better on standardized tests and had fewer grade retentions through first grade, and kindergarten teachers rated full-day children higher on the majority of the fourteen classroom behavior dimensions. Another study in the Philadelphia schools (Weiss & Offenber, 2002, as cited in Brewster & Railsback, 2002) followed 17,600 Philadelphia students into fourth grade and also found positive effects of full-day kindergarten. Full-day students were 26 percent more likely than half-day

³ A review of early research from the 1970s and 1980s found a few positive effects for the full-day program, such as short-term gains in basic academic skills and fewer grade retentions (Puelo, 1988; see Fusaro (1997) for another review). No differences were found for social and emotional development. However, Puelo (1988) notes that methodological weaknesses in these studies as a whole suggests that most of the early research findings are tenuous. Cryan et al. (1992) note that exhaustive literature reviews on kindergarten schedules found that studies “(a) tend to be with small samples or unique populations, (b) generally fail to use rigorous research standards, (c) give almost exclusive priority to academic outcomes, and most important, (d) offer little or no convincing evidence favoring one type of schedule over another” (p. 188).

students to avoid repeating a grade by third grade. They also experienced higher academic achievement scores and better attendance.

A more recent study using a nationally-representative sample of kindergarten children (Walston & West, 2004) examined cognitive gains of public school children in the kindergarten year using ECLS-K data. This study found evidence of positive effects of full-day attendance on math and reading score gains from fall to spring of the kindergarten year, but the analysis did not extend beyond the kindergarten year. Another current study using the same dataset examined academic outcomes through third grade and found that these positive full-day kindergarten effects did not sustain into third grade (Rathbun & West, 2004).

A limitation with these larger-sample studies (as well as with the other studies) is that they fail to account for potential selection bias. Existing studies have not modeled family or school choice of full-day versus half-day kindergarten. Ignoring this element of choice may have led to biased findings in earlier studies. For instance, if parents with high motivation and expectations for their children tend to choose full-day programs, then findings from the study may be recording the fact that these children have different circumstances at home that might account for their achievement, not the full-day program per se.

Finally, several studies have suggested that at-risk children may benefit the most from full-day programs (Clark & Kirk, 2000; Morrow et al., 1998), perhaps because the extra time is especially needed because of poor learning environments at home or in other child care arrangements. According to Rothenberg (1995), two-thirds of full-day kindergarten teachers in 1993 taught in high-poverty areas. Walston & West (2004) note that in the ECLS-K sample of public school children, “63 percent of kindergarten children living below the poverty threshold are enrolled in a full-day program compared with 55 percent that come from households at or above the poverty line” (p. 21). Morrow et al. (1998, p. 8) suggest two reasons to help explain

this: state and federal funding flows to districts with low-income and minority students, which they use for full-day programs, and rural districts use full-day programs to prevent the need for bussing in the middle of the day.

3. DATA

The primary data source is the Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999. Information on state kindergarten policies is primarily from the *Key State Education Policies on K-12 Education* (Council of Chief State School Officers, 1998). Data on job market characteristics at the county and state level are from the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages program, BLS Local Area Unemployment Statistics program, and Robert Moffitt's Welfare Benefits Database at Johns Hopkins University.⁴

ECLS-K

The ECLS-K is a longitudinal data set collected by the National Center of Education Statistics (NCES). The original sample of approximately 22,000 children from about 1,000 kindergarten programs was designed to be nationally representative of kindergartners during the 1998-1999 academic year with over samples of Asians and children in private schools. The ECLS-K employed a multi-stage sampling plan with the primary sampling unit (PSU) being the county or a group of counties. The second sampling unit was the schools within sampled PSUs and the final sampling unit was children within schools. The sample is designed to support separate estimates by type of school child attends (i.e., public or private), race/ethnicity, and socio-economic status. To date, information has been collected from children, parents, teachers, and school administrators during the fall and spring of the kindergarten year, the fall and spring

⁴ Web sites for these sources are <ftp://ftp.bls.gov/pub/special.requests/cew/>, <http://www.bls.gov/lau/home.htm>, and www.econ.jhu.edu/People/Moffitt/DataSets.html, respectively.

of first grade, and the spring of third grade.^{5,6}

The ECLS-K was designed to support research on a range of topics regarding the kindergarten experience; hence, these data are quite rich. Data are available about the child, the household the child resides in, and the classroom and school the child attends. Pertinent to this paper, information on what type of kindergarten program the child attended was collected in the fall and spring of kindergarten. Teachers taught a full-day kindergarten class, a half-day morning kindergarten class, or half-day afternoon kindergarten class.

The ECLS-K also contains information on a rich set of outcomes that may be influenced by the type of kindergarten program a child participated in. Test scores for reading, mathematics, and general studies are administered during each wave of the survey.⁷ In addition, information on whether a child was retained at any grade is available. Data are collected from parents and teachers to measure the behavior of the child. Finally, mothers are asked about their employment status.

Analysis Sample

The baseline analysis sample is comprised of 8,540 children meeting the following criteria for inclusion with the number of observations dropped per criterion in parentheses.⁸ First, those with positive values for survey weights in all four of the waves of interest (the fall and spring kindergarten, spring first grade, and spring third grade waves) were included

⁵ For additional information, user's guides are available from NCES at <http://nces.ed.gov/ecls/KinderDataInformation.asp>.

⁶ According to the NCES (2004) the number of children who participated in the base year, first grade, and third grade data collections is 13,698, which represents 60 percent of children sampled for the base year. When comparing children with parent information in all four rounds of data collection to those without, we find that attriters are significantly more likely ($p < .05$) to be in full-day classes, minority, younger at kindergarten entry age, in a single-parent family and a household with more children, have parents who read to them less often, attend a school that is public and urban, and have lower fall kindergarten standardized math and reading scores. They are significantly less likely to be in a rural school. No significant differences were found by gender.

⁷ The general studies examination is not administered in the third grade wave of data collection.

⁸ The number of observations dropped for each criterion for inclusion depends upon the order in which the criteria are implemented. Therefore, if observations are dropped in a different order the number of records dropped for each criterion may be different.

(10,411).^{9,10} Second, only children who were first-time kindergartners were included in the sample (461). Next, only students in a regular-type of kindergarten class were included (1,436).¹¹ Fourth, only those children in the same type of kindergarten program throughout the year were included (149). Fifth, only those with values for state and county identifiers were included (78). Finally, observations were only included if they had non-missing values for all of the independent variables included in the respective models (334) with the exception of maternal and paternal education, household income, and religiosity.¹² For the first three variables we imputed values and for religiosity we included a dummy variable indicating a missing value.¹³

While only children with positive weights in all four waves were included in the baseline analysis sample, this does not ensure that children have non-missing values for each of the outcome variables in each wave of the survey. Hence, an analysis sample is generated for each of the six outcomes examined: math achievement scores, reading achievement scores, internal behavior problems, external behavior problems, grade retention, and maternal full-time employment status. The samples sizes for the six outcome samples are the following: math achievement scores (7,772), reading achievement scores (7,407), internal behavior problems

⁹ We do not use data from the fall of first grade because information was only collected on a sub-sample of the sample.

¹⁰ For all analyses, the weight C1_5FP0 is used. If C1_5FP0 is zero, then parent interview data are not available for all four rounds of data collection involving the full sample.

¹¹ Regular kindergarten class is defined as a one-year kindergarten class primarily for five year olds prior to first grade. Kindergarten classes that are not considered regular include those that are part of a two-year program, include children from multiple grades, are not graded, or are transitional. A transitional classroom is for children not ready for kindergarten or those who have attended kindergarten but are not ready for first grade.

¹² To assess how the observations excluded due to missing information (i.e., state and county identifiers and independent variables) differ from those without missing information, we compared the means of these two groups for the following variables: full-day status, female, non-Hispanic Black, Hispanic, other race, how often parent reads books to child, age at entry into kindergarten, number of children in household, single-parent family, public school, urban, and rural. Of these variables tested, the only one statistically different at a five percent level using a two-tailed test is public school.

¹³ To impute paternal education, maternal education, and household income best-subset regression was used. Imputations for maternal education are based on the following variables: non-Hispanic Black, Hispanic, other race, paternal education, single-parent family, and household below poverty threshold. To impute paternal education the following variables are used: non-Hispanic Black, Hispanic, other race, paternal education, single-parent family, household below poverty threshold, and maternal foreign-born status. Finally, maternal education, urban, non-Hispanic Black, Hispanic, other race, single-parent family, maternal foreign-born status, maternal full-time employment, and maternal part-time employment are used to impute the log of household income.

(5,949), external behavior problems (6,108), grade retention (8,406) and maternal full-time employment status (7,781).

From Table 2, several key points emerge that are relevant to the analyses. First, variation exists among children who are attending different types of kindergarten programs. Fifty-three percent of children in the sample attend full-day kindergarten programs. Second, almost half of the children in the sample are females. Finally, approximately 19 percent of the children are in households below the poverty threshold.

4. EMPIRICAL STRATEGY

OLS and Probit Regression Models

To test the effect of attending a full-day kindergarten program relative to a half-day kindergarten program on five of the six outcomes of interest, we estimate ordinary least squares (OLS) and probit regression models as shown in Equation 1.

$$Y_{ijk} = \alpha_0 + \alpha_1 FD_{ijk} + \alpha_2 CH_{ijk} + \alpha_3 HH_{ijk} + \alpha_4 SC_{ijk} + \varepsilon_i + \nu_j + \omega_k \quad [1]$$

In Equation 1, Y represents the dependent variables; FD is whether the child attended full-day kindergarten; CH is a vector of child-level characteristics; HH is a vector of household characteristics; and SC is a vector of school and teacher characteristics. The unit of analysis, i , is the child. The index for the household is j and k indexes the school. ε is the error term associated with the child, ν is the error term associated with the household, and ω is the error term associated with the school. OLS regression models are estimated when examining the math and reading test scores. Probit models are estimated for the two behavioral outcomes and grade retention.

Dependent Variables

This paper estimates the effect of attending a full-day kindergarten program on five child outcome variables (math test scores, reading test scores, internal behavior problems, external

behavior problems, and grade retention) at three points in time as well as over time. Specifically, we estimate the effect of full-day kindergarten on all outcomes in the spring of kindergarten, the spring of first grade, and the spring of third grade. The one exception is grade retention, which is measured once in third grade.

For the math and reading test scores, gain scores are constructed to examine the effects of full-day kindergarten on gains in math and reading achievement. These gain scores are calculated by subtracting the fall kindergarten test score from a more recent score of interest. Gain scores are generated for math and reading between fall kindergarten and spring kindergarten, fall kindergarten and spring first grade, and fall kindergarten and spring third grade.

The first two outcome variables represent academic achievement. They are math and reading scaled-test scores.¹⁴ Because achievement tests used a two-stage assessment approach, all children did not take the same exam. Hence, the ECLS-K computed scaled-test scores based on the full set of test items using Item Response Theory (IRT). For easier interpretation of results, these math and reading scaled-test scores are standardized based on a mean of zero and a standard deviation of one.

The second two outcome variables capture children's behavioral problems. The first variable is a binary variable indicating whether the child exhibits internal behavior problems, on average, often or very often as reported by teachers on an internalizing behavior scale.¹⁵ The second variable is binary variable indicating whether a child exhibits external behavior problems,

¹⁴ In kindergarten and first grade, math examinations test children's abilities on the following subjects: numbers and shapes, relative size, ordinality and sequence, addition and subtraction, and multiplication and division. In third grade, students are also asked about place values and rates and measurements. The reading examinations test kindergartners and first-graders on letter recognition, beginning sounds, ending sounds, sight words, and words in context. In third grade, literal reference, extrapolation, and evaluation skills are also tested.

¹⁵ The internalizing behavior scale asks the teacher a series of questions about the frequency of the following four behaviors: presence of anxiety, loneliness, low self-esteem, and sadness. To each of the questions the teacher could report the frequency of the behavior as: never, sometimes, often, or very often. The internalizing behavior scale score is the mean of the teacher's ratings.

on average, often or very often as reported by teachers on an externalizing behavior scale.¹⁶ The final academic outcome variable is grade retention. It is a binary variable indicating whether the child was retained at any grade between kindergarten and third grade.

Full-day Kindergarten

The primary independent variable in the analysis is whether the child is attending a full-day kindergarten program versus a half-day one. We categorize those who attended either morning or afternoon half-day classes as half-day because there is little reason to believe there is any difference between attending either type of half-day program (empirical tests confirm this assumption). Students who attended full-day programs are classified as full day, and those students who changed the type of program were omitted.

Additional Independent Variables

Many variables affect a child's school achievement and behavior, including home environment and school-related factors. To rule out other factors as causes of the child outcomes of interest, this analysis controls for three groups of variables measured during the child's kindergarten year: child characteristics, household characteristics, and school characteristics.¹⁷ All of these variables are listed in Table 2 along with their weighted means.

Child characteristics included are: female, age in months at kindergarten entry, race (dummy variables for non-Hispanic Black, Hispanic, and Other), home language is non-English, and presence of a disability in kindergarten. In addition, fall kindergarten achievement scores are included as a control variable for all regressions with a dependent variable of math or reading scores. Including the initial score as an independent variable is a strong control for unobservable

¹⁶ The externalizing behavior scale asks the teacher to rate students on the frequency of the following five behaviors: arguing, fighting, getting angry, acting impulsively, and disturbing ongoing activities. To each of the questions the teacher could report the frequency of the behavior as: never, sometimes, often, or very often. The externalizing behavior scale score is the mean of the teacher's ratings.

¹⁷ Parents' religious attendance and status as a child in non-parental care in kindergarten were asked in first grade.

household and student characteristics affecting achievement and thus controls for a child's starting point.^{18,19} The household characteristics included in the regression models are the following: number of children in the household, single-parent family, log of household income, maternal education (dummy variables for high school graduate, some college, college graduate), paternal education (dummy variables for high school graduate, some college, college graduate), parents' attendance at religious services (dummy variables for several times a month or more, several times a year, and missing response), participation in non-parental care the year before kindergarten, and participation in non-parental care during the kindergarten year. As part of these household characteristics, we also include some variables that capture parents' expectations for their children's scholarly accomplishments. Variables include number of books in the child's home, frequency that the parents read books to child, how often parents play games with child, and the highest educational degree parent expects for child. The final group of explanatory variables is school characteristics which include: public school, school size, kindergarten class size, location (dummy variables for urban and rural), and the number of years the classroom teacher has taught kindergarten.²⁰

While almost all of the aforementioned explanatory variables are measured in the kindergarten year, we also include three variables that capture change in a child's household and school environment that may influence one of the outcome variables. These variables are changes in household structure status between waves, moves to different schools between waves, and changes in income between waves. Household structure changes represent a change in the

¹⁸ Initial behavioral scores are not included as a control variable in regressions with dependent variables capturing children's behavioral problems as NCES (2004) notes that teachers may perceive the questions differently at different times; therefore, these scores should not be used as change scores.

¹⁹ Models that also accounted for the dates of assessments were estimated and results were not qualitatively different than those presented.

²⁰ Models in Table 4 were also estimated without school-level controls and are similar to those presented with two minor differences. The coefficient on full-day is no longer statistically significant at the 10 percent level in models examining first grade math and gain scores in math between kindergarten and first grade.

number of parents living in the household. The change in income is measured as a percentage change in income between survey waves. Analyses that examine first grade outcomes or gains between kindergarten and first grade include changes in these variables between spring kindergarten and spring first grade. Similarly, analyses investigating third grade outcomes or gains between first and third grades capture changes in these three variables between spring first grade and spring third grade. Weighted means for these variables can be found in Table A.1.

Controlling for Potential Selection Bias

As discussed earlier, the estimation described above does not account for potential selection bias. For instance, parents with high motivation and expectations for their children may choose to send their children to full-day programs (i.e., positive selection). Because the theoretical direction of selection is ambiguous, another plausible scenario is that parents who do not have time to spend with their kids or resources to spend on tutors tend to enroll their children in full-day kindergarten programs (i.e., negative selection). For both cases of selection, OLS and probit regressions estimates of full-day kindergarten may be capturing the fact that these children have different unobservable circumstances at home that might account for their achievement or behavioral problems. Table 2 demonstrates statistically significant differences among observable characteristics between those children attending full-day and half-day kindergarten programs, suggesting that selection may occur. For example, children who attend full-day kindergarten programs are more likely to be non-Hispanic Black, speak English as a home language, live in a single-parent household, have fewer books at home, have parents who attend religious services several times a month or more, attend a private school, and attend a school in an urban or rural area.

We first explore this potential selection by dividing the sample into poor and non-poor. To the extent that poor children are more likely to be offered full-day programs, or are more

likely to utilize full-day programs, then we may observe differential effects by poverty status. In addition, the rhetoric of the move to increase full-day offerings is sometimes driven by concerns for the at-risk population, often characterized by poverty status. Next, we also divide the sample into boys and girls because they may mature at different rates, and because parents may respond differently by gender in selecting the type of kindergarten program.

We then estimate models with county fixed effects and instrumental variables models to address selection on unobservables that may be present. Including fixed effects controls for the role of county level policies that may influence parental choice of type of program or the actual choices available to the parent. The fixed effects also control for other unobservables that may influence student educational or social outcomes.²¹ We note, however, that using county level fixed effects will not control for all unobservable school level variables that may influence parental choice within a district. For example, if higher quality kindergarten teachers are more likely to be present in full-day classrooms, then we would expect the full-day kindergarten coefficient to be biased upwards

Next, we estimate instrumental variables models to address this selection. Using state variation in policies on full-day kindergarten programs as an instrument for the likelihood that a student will attend a full-day program, this analysis is able to address the fact that parents play a role in choosing the type of kindergarten program their children attend. Specifically, a variable representing state policy on the availability of full-day kindergarten at the school district-level, hereafter called state full-day policy, is used as an instrument. From the five state policies on the

²¹ Alternatively, we could have used school district level fixed effects to control for unobservable characteristics about the school district that affect achievement and full-day participation. However, we believe that the county level more fully captures the choices that parents have available for kindergarten such as private schools offering full-day kindergarten. Further, we estimate the models using district level fixed effects for public school students and the results are similar to those using county level fixed effects.

provision of kindergarten listed in Table 1, the state full-day policy variable is generated.²²

States that have the policy that districts must offer full-day kindergarten or full- and half-day kindergarten are coded as one. The remainder of the states with either no policy or policies that districts must offer half-day kindergarten or full- or half-day kindergarten is assigned the value of zero for the instrument. Table A.2 lists each state's policy, the value for the instrument, and the percent of children in the state attending a full-day kindergarten program.

Equation 2 illustrates the full-day participation equation that is part of the two-stage least squares (2SLS) models estimated with the state full-day policy instrument.

$$FD_{ijk} = \alpha_0 + \alpha_1 SP_{ijk} + \alpha_2 CH_{ijk} + \alpha_3 HH_{ijk} + \alpha_4 SC_{ijk} + \varepsilon_i + \nu_j + \omega_k \quad [2]$$

In Equation 2, *FD* is whether the child attended full-day kindergarten; *SP* is the state full-day policy instrument; *CH* is a vector of child-level characteristics; *HH* is a vector of household characteristics; and *SC* is a vector of school characteristics. Similar to the OLS and probit equations, the unit of analysis, *i*, is the child, *j* indexes the household, and *k* indexes the school. ε is the error term associated with the child, ν is the error term associated with the household, and ω is the error term associated with the school.

The validity of this approach rests upon whether the instrument, state full-day policy, meets the following criteria. First, the instrument, state full-day policy, must be highly correlated with participation in a full-day kindergarten program. This is shown to be true in Table 3. The coefficient on the instrument was a strong positive predictor of full-day attendance and was always significant at the 1 percent level. Other positive influences on full-day attendance were age at school entry, non-Hispanic Black, and whether the school was in an

²² The information on relevant state kindergarten policies for the 1998-1999 academic year are extracted from a survey conducted of states by the Council of Chief State School Officers, *Key State Education Policies on K-12 Education* (Council of Chief State School Officers, 1998). Through searches of state kindergarten laws and policies, the information on these policies in the CCSSO publication was verified. If clear discrepancies between CCSSO and other sources were found, the CCSSO data were changed to match the state laws and policies. Discrepancies were found in North Dakota, Rhode Island, South Carolina, South Dakota, Texas, and Washington.

urban or rural school district. Speaking languages other than English in the home, having a higher household income, attending a public school, and having a more experienced teacher lowered the probability that someone attended a full-day program. Finally, most household characteristics were not related to full-day attendance, perhaps suggesting that parental choice may not be a large issue.

Second, the instrument must not be correlated with unobservable factors that affect the outcome variables of interest. If it is the case that parents choose the state they live in based on the state's kindergarten policy, then this second condition is violated. The state policy also must be exogenous to the selection mechanism (Besley & Case, 2000). Because there has been an increase in the number of states requiring full-day kindergarten, it may be the case that the policy instrument is endogenous as state policies may reflect constituent desires. For example, parents who wish to send their children to full-day kindergarten to foster their educational achievement may have lobbied state policymakers to pass legislation requiring districts to offer it. However, in looking at K-12 expenditures in 1998, we find that states without full-day requirements spent significantly more than those in our instrument. Given the mixed results from these two tests, the instrumental variables results should be viewed with caution.

Maternal Labor Force Participation

The final outcome analyzed in this paper is the likelihood that a mother will work. As mentioned previously, research has established a connection between maternal labor force participation and a child's enrollment in kindergarten (Gelbach, 2002). To our knowledge, no one has investigated the impact of a full-day kindergarten program on maternal labor force participation when compared to a half-day program. Consistent with the literature on child care availability, we would expect the mothers of children who attend full-day kindergarten to have higher labor force participation than those with children in half-day programs. In addition, we

are interested in finding out whether any labor force advantage that mothers of students in full-day programs may have had persists over time.²³

To estimate the effect of full-day kindergarten participation on maternal employment, we estimate a recursive bivariate probit model.²⁴ The primary difference between this model and the instrumental variables model estimated in Equations 1 and 2 is that in the recursive bivariate probit the equations and the error terms are jointly estimated. Similar to the instrumental variable models, this model is identified by state kindergarten policy. Because parents who work or want to work may lobby for full-day kindergarten, state policy may be endogenous and results from the recursive bivariate probit should be interpreted with caution.

The motivation behind estimating such a model is the following. First, it is likely that full-day kindergarten participation is endogenous to maternal employment decisions. Therefore, estimating a single-equation probit model with full-day kindergarten participation included as an explanatory variable is not appropriate. Estimating a recursive bivariate probit model allows full-day kindergarten participation to be instrumented for and included as an explanatory variable. Second, both full-day kindergarten and maternal employment are binary. Lastly, the recursive bivariate probit model tests the correlation between the error terms in the two equations after controlling for the included variables; thus, providing information on whether the unobservable factors affecting full-day kindergarten participation and maternal employment decisions are related.²⁵

²³ In this analysis, the labor force participation variable is dichotomous for self-reported maternal full-time employment status. Full-time status is reported as working 35 or more hours per week. Questions on maternal employment status were only administered during the fall of the kindergarten year and not the spring, thus we use the fall value for the kindergarten year.

²⁴ See Greene (2000) for more information on recursive bivariate probit models.

²⁵ Additional independent variables are included in the estimation of mother's decision to work full-time beyond those that are used in the estimation of academic and social outcomes to capture characteristics of the job market that the mother resides in. These variables include the annual county unemployment rate, average annual county wage, and the maximum state Temporary Assistance for Needy Families (TANF) benefit for a family of four.

Finally, all regression analyses are weighted using weights accompanying the ECLS-K data set.²⁶ In addition, standard errors are clustered at the teacher level because multiple children located within the same classroom are included in the analysis sample and are likely to be correlated.²⁷

5. RESULTS

Baseline Model

The main results for the paper are presented in Table 4 in summary form, with an exemplar of the results for all control variables (kindergarten year) in Table A.3. The first column presents the results estimated by OLS and probit for the continuous and dichotomous variables, respectively, for the set of academic and behavioral outcome variables described above.²⁸ As shown in Table A.3, the control variables have the signs consistent with past literature on educational attainment. Higher socioeconomic status, higher age at kindergarten entry, living in a two parent home, and possessing a better educational environment in the home lead to better outcomes at the end of kindergarten. On the other hand, students who possess disabilities or are African-American have lower outcomes than do other students at the end of kindergarten.²⁹ Also as expected, higher achievement scores in the fall leads to higher scores in the spring of the kindergarten year.³⁰

The first set of outcome variables concerns the academic performance of the student at the end of kindergarten. For both reading and math achievement, attending a full-day

²⁶ OLS and probit models in Table 4 were estimated without sample weights, and the results were similar with the exception that first grade math and kindergarten-first grade math gain scores are significant and third grade external behavior problems is insignificant.

²⁷ OLS and probit regressions in Table 4 were estimated with clustering at the school level and the results are qualitatively similar to those obtained when clustering at the teacher level.

²⁸ The marginal effects for continuous variables are the changes in probabilities calculated at the means of the independent variables and marginal effects for dummy variables are calculated as the discrete change in probability as dummy variables go from 0 to 1.

²⁹ The same basic pattern of results for the control variables is replicated in both first and third grade.

³⁰ The importance of these baseline scores declines monotonically over time, but remains significant in third grade.

kindergarten predicts significantly higher test scores. Specifically, the results imply that reading scores increase by .145 standard deviations, and math scores increase by .119 standard deviations. On the other hand, attending a full-day program does not affect the likelihood of exhibiting frequent internal behavior problems, and significantly predicts more frequent external behavioral problems (2.3 percentage points). The finding of a negative behavior effect in conjunction with a positive academic effect is not necessarily contradictory. Psychological research suggests that behavior problems independent from attention problems are not related to student achievement (Rabiner et al., 2000, 2004). The behavior problem variable used in this analysis does not include assessments of student attention. Thus, it possible that the same students experience both positive academic benefits and negative behavioral problems, or it could be the case that some students receive the positive academic benefits and others exhibit the larger behavioral problems.

By the end of first grade, the estimated effect of attending a full-day kindergarten had been cut in half for math scores (significant at the 10 percent level), and had been eliminated entirely for reading scores. Further, the estimated effects on math scores become insignificant by third grade. The relationship between full-day attendance in kindergarten and external behavioral problems, while insignificant in first grade, is significant in third grade. Also observed in third grade is no impact of full-day kindergarten attendance on the likelihood that a student is retained by third grade. Finally, we observe that attending a full-day kindergarten is significantly related to greater gain scores during kindergarten for both reading and math scores, is significantly related to greater math gain scores from kindergarten to first grade, but unrelated to increases in gain scores for reading or math by third grade.

Differences by Poverty Status

We next compare estimates of the impact of full-day attendance on the set of outcomes stratified by poverty status because part of the rationale for offering full-day kindergarten is to benefit those who are considered “at-risk” (Clark & Kirk, 2000; Karweit, 1992).³¹ The evidence in Table 5 suggests that there is no clear benefit for poor students over non-poor students when attending full-day kindergarten programs. In all academic outcomes, the effect sizes for poor students were smaller or equal to the effect sizes for the non-poor students. Specifically, the coefficient on math scores in kindergarten is significantly higher for non-poor students. At the same time, attending a full-day kindergarten program has larger adverse effects on the external behavioral problems of poor students. The results suggest that the higher incidence of behavioral problems in the long term is confined to students below the poverty line. Thus, it is fair to conclude that poor children do not receive a greater benefit from full-kindergarten programs.

Fixed Effects

As noted above in the methods discussion, there may be reason to be concerned about the role of selection on unobservable characteristics into full-day programs. At the same time, the theoretical direction of selection on the estimates is ambiguous as those whose parents have the highest motivation for education may be placed into full-day programs or those who have the worst home environments may be placed into full-day programs. We first attempt to control for this type of selection by introducing county level fixed effects. We only display results for the math and reading scores because the inclusion of the fixed effects in the probit model required the exclusion of large portions of the sample. As is evidenced in Table 6, the inclusion of the fixed effects in the whole sample does not change the kindergarten or the first grade results. The only coefficients to change are the coefficients on math scores in third grade, suggesting that

³¹ In addition, stratification of the sample by poverty status and gender allows for testing the role that selection bias may play in increasing the odds that particular groups are placed in full day programs.

students who attend a full-day kindergarten have lower scores in math than their half-day peers. In results not shown, we estimated a sample that dropped private school students and found that the coefficient on math scores was again insignificant. This may suggest that there is selection into private schools that can affect our full sample results.

Instrumental Variables

Next, we estimate an instrumental variable model using state policy requiring districts to offer full-day programs as an instrument (Table 7 presents the second stage estimates of the models). Comparing the estimates from Table 4 with the IV estimates in kindergarten, there is little change. The coefficients on reading and math scores and external behavioral problems are not statistically different from each other.

The basic pattern of results remains similar for the students at the end of first grade. As with the OLS estimates, the coefficient on reading scores is insignificant and the math test scores declines by about half, but is insignificant in the IV estimates. As with the probit estimates, the coefficient on external behavioral problems gets smaller as students move from kindergarten to first grade.³² Unlike the probit estimates, the estimate of the impact of attending full-day kindergarten on retention by third grade is positive and significant. The coefficient on math scores in third grade is also significant after not being significant in the first grade.

Finally, the instrumental variables estimates in Table 7 and Table 4 for the gain scores are similar. There are significant gains during kindergarten for both math and reading scores. By first grade, the impact of full-day attendance on gain scores is insignificant. Again we observe that, in third grade, the estimate on gain scores for math is positive. The latter results for third grade gains in math scores is the lone difference from the OLS results.

³² OLS and probit models produce very similar results; hence, we are comfortable comparing 2SLS and probit findings.

Overall, the pattern of results for IV models as well as the fixed effects models gives us some confidence that the findings are robust across model specifications, and across models that deal with potential selection biases in various ways. This is important because no single model specification is likely to be free from all forms of selection bias. While the fixed effects models deal with unobservables at the county level, there may still be school level or family level unobservables that are unaccounted for. The results from the IV models should be viewed with caution because the state policy variable that is used as an instrument may be influenced by parents who are making the choice of kindergarten program for their students to attend. The only difference across models is in the math scores in third grade in the fixed effects models and IV models, but future research is needed as the children age in the ECLS-K to discover if the finding is simply spurious.

Mother's Labor Force Participation

As mentioned earlier, many parents are in favor of full-day kindergarten because it lessens the need for child care. Thus one would expect higher labor force attachment among mothers whose children attend full-day kindergarten. Using a recursive bivariate probit model to estimate the likelihood that a mother will work full-time if the child attends full-day kindergarten in combination with the likelihood that the parent will send her child to a full-day program, we find consistent support that mothers are more likely to work full-time in the kindergarten year if their students attend full-day kindergarten (see Table 8).³³ These effect sizes are not statistically significant in first and third grade, suggesting that there may not be any longer term impact on early labor force attachment for these mothers. As might be expected due to child care cost

³³ As expected, the unemployment rate is negatively related to the probability that a mother would work. The coefficient on the welfare benefit is not statistically significant, and the coefficient on the average wage, although significant, is quite small (-0.00001)

issues, there is a larger positive impact on the labor force participation rates for the poor than the non-poor. Again, this effect disappears after kindergarten.

Additional Analyses

A number of additional analyses were conducted to test the robustness of results discussed above. First, we re-estimated the models in kindergarten and first grade with additional observations that were available in those years, but were not available in third grade. Results were unchanged with the exception that the marginal effect for third grade external behavior problems was no longer significant. We also re-estimated the models including first and third grade school level variables such as class size. While this lowered the sample size, the same pattern of results remains.

Because boys and girls may mature at different rates, we next compare the impact of full-day attendance on the full set of outcomes for boys and girls separately.³⁴ Despite this possibility suggested in the literature, we do not find significant differences in the importance of full-day attendance by gender. In kindergarten, both girls and boys benefited academically from full-day programs, but they also had a significantly higher likelihood of external behavioral problems (3.9 percentage points for boys and 0.9 percentage points for girls). After kindergarten, the results are very similar to those in Table 4, and do not differ by gender.

Next, we restricted the sample to students who attended public schools only because they would be most likely affected by state policies. In these models, we found that the results in Tables 4, 6, and 7 are driven by the students in public schools, and that there was very little effect of full-day attendance for private school students. While there are no academic benefits for public school students by third grade, the increase in math scores for students that attend full-

³⁴ Some have found in the school readiness literature that boys may benefit from being older upon entering kindergarten (Crosser, 1991), suggesting different rates of maturity between boys and girls. Therefore, it is plausible that girls may be more ready to learn in a full day setting, and thereby receive a higher benefit from a full day program.

day kindergarten does persist through first grade. Lastly, as mentioned previously, the only significant difference between the models with public schools only and the full sample was in the fixed effects models for third grade math scores.

In our final robustness test, we stratified the sample by whether the mother worked full time while the child was in kindergarten. It may be the case that those mothers who do not work are able to supplement the education of the students, and that full-day attendance may be less important for this sample. Alternatively, if children reside in poor home environments, then there would be no benefit for these children from greater maternal time. The results suggest that neither possibility dominates the other as we found no significant differences in results by mother's work status.

6. CONCLUSIONS AND DISCUSSION

As school districts consider implementing full-day kindergarten programs more broadly, little empirical research exists to determine whether full-day programs enhance the educational outcomes of students and the labor market outcomes of their parents. What research does exist has typically been limited methodologically by focusing on single sites or has not followed students much beyond their kindergarten year. This paper is able to overcome these past limitations by using the ECLS-K data and investigating outcomes through a student's third grade year. In addition, this study deals with the possible selection bias of parents choosing full-day programs for their students using fixed effects models, instrumental variables models, and recursive bivariate probit models for labor force participation.

The results of the analysis suggest that attending a full-day kindergarten program increases the academic performance of students in both math (.12 standard deviations) and reading (.15 standard deviations) by the spring of the kindergarten year. These small effects largely disappear by first grade, and are eliminated by third grade. The analysis also finds no

effect of full-day attendance on the likelihood that a student will exhibit internal behavioral problems, and a small, positive probability of exhibiting external behavioral problems in kindergarten and the third grade. The results also demonstrate that there is no additional benefit, on average, for children whose household income is below the poverty line when they attend full-day kindergarten compared to the non-poor. Finally, the results suggest that mothers who have students in full-day programs are more likely to work than mothers with children in a half-day program, but that this effect is likely confined to kindergarten.

Further analyses were conducted using county fixed effects and instrumental variables. In the fixed effects' models, the results confirm that all the advantage that a student attending full-day kindergarten may have is gone by third grade, and the students who attend full day may have lower third grade math test scores and lower gains in math scores between kindergarten and third grade. The results from the IV models also do not differ much from the OLS results in kindergarten and first grade, although there are differences in third grade retention and in third grade math scores. The similarity of results across model specifications provides confidence in the overall conclusion of the study that the academic benefits erode quickly over time. The fact that the fixed effects and IV models are so similar to the OLS results suggests one of two things, but, at present, we cannot distinguish between the two hypotheses. Either the theoretical ambiguity surrounding the direction of selection is such that the two effects cancel each other out, or there is little selection in the choice of kindergarten programs by parents.

In sum, there is little evidence that the positive impact of attending a full-day kindergarten program persists beyond first grade. Given the cost of these programs, it calls into question the practice of requiring school districts to offer such programs. It very well may be the case that there are better uses for scarce school district monies, but future research is needed to determine the most effective use of those monies. For example, a recent report by the Education

Commission of the States (2005, p. 7) suggests that many school districts use Title 1 funding to support full-day kindergarten for low-income students, rather than using these funds for alternative uses.

There are two potentially important caveats that may temper the above conclusion. The first is that we estimate a reduced form model of the effects of full-day kindergarten on outcomes of interest and there are many mechanisms through which full-day kindergarten attendance compared to half-day kindergarten influences outcomes, including how half-day kindergartners spend their out-of-school time, participation in the National School Lunch Program, and income from maternal employment. Further, the direction of these mechanisms may be ambiguous. For example, children who attend full-day kindergarten programs are more likely to have mothers who work full time. To the extent that these school environments are better than alternative child care arrangements that may be funded by the public sector, then it could be the case that full-day programs are cost-beneficial. On the other hand, it may be the case that full-day kindergarten deprives some children of maternal care, which may be better than that received at the school. Because there are so many mechanisms through which full-day kindergarten attendance compared to half-day attendance could influence outcomes and the directions of these effects can be ambiguous, future research is necessary to disentangle the mechanisms through which full-day kindergarten influences outcomes and to determine whether full-day kindergarten is cost-beneficial.

The second caveat to consider is that it may be the case that full-day programs are beneficial, but that these benefits erode for the students who are disadvantaged. In a study of black-white test scores gaps, Fryer and Levitt (2004) find that the gaps widen over time, which they hypothesize may be due to worse out of school environments for minorities. It could be the case that a similar mechanism exists in our sample. It is also possible that disadvantaged

students experience lower quality kindergarten through third grade relative to their more advantaged counterparts, which is not captured in this analysis. Again, more research is needed to determine if either of these hypotheses is an accurate depiction of what is occurring.

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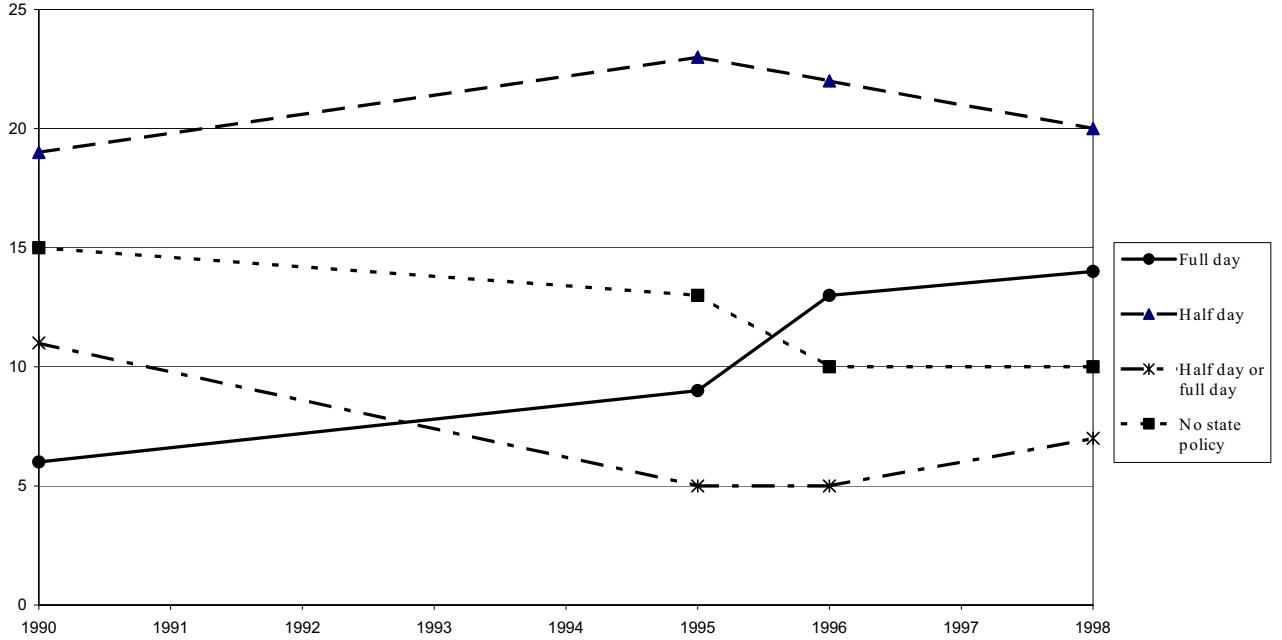
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CHARTS

Chart 1: State Kindergarten Policy Trends 1990-1998



Note: States with a full-day or a full-day and half-day policy are combined into full day.

Source: Council of Chief State School Officers

TABLES

Table 1: State Kindergarten Policies 1998-1999 School Year

Full-Day Policy¹ (N=10)	Half-Day Policy² (N=20)	No State Policy³ (N=10)
Alabama	Arizona	Alaska
Arkansas	California	Colorado
District of Columbia	Connecticut	Idaho
Florida	Delaware	Kansas
Georgia	Indiana	Maine
Hawaii	Kentucky	Michigan
Louisiana	Maryland	New Hampshire
Mississippi	Massachusetts	New Jersey
North Carolina	Montana	New York
West Virginia	Nebraska	South Dakota
	Nevada	
	New Mexico	
	Oklahoma	
	Oregon	
	Pennsylvania	
	Tennessee	
	Utah	
	Washington	
	Wisconsin	
	Wyoming	
Half-Day and Full-Day Policy⁴ (N=3)	Half-Day or Full-Day Policy⁵ (N=8)	
South Carolina	Illinois	
Vermont	Iowa	
Virginia	Minnesota	
	Missouri	
	North Dakota	
	Ohio	
	Rhode Island	
	Texas	

¹State requires districts to offer full-day kindergarten programs.

²State requires districts to offer half-day kindergarten programs.

³State does not have a statewide policy - local education agencies determine.

⁴State requires districts to offer full-day and half-day kindergarten programs.

⁵State requires districts to offer full-day or half-day kindergarten programs.

Source: CCSSO (1998); Confirmed by searches of state education department web sites, findlaw.com, and personal communication with state department of education staff.

Table 2: Baseline Sample Descriptive Characteristics

	All Children		Full-Day Only		Half-Day Only	
	Mean	Std Err	Mean	Std Err	Mean	Std Err
Sample size	8,540		4,487		4,053	
Attended full-day kindergarten	0.530	(0.007)				
Independent Variables						
Child Characteristics						
Fall K math score - standardized	-0.068	(0.014)	-0.059	(0.019)	-0.079	(0.019)
Fall K reading score - standardized	-0.053	(0.013)	-0.027*	(0.019)	-0.082	(0.019)
Female	0.494	(0.007)	0.493	(0.010)	0.496	(0.010)
Age at kindergarten entry (months)	65.767	(0.054)	66.065*	(0.072)	65.432	(0.080)
Race - Non-Hispanic Black (omitted is White)	0.165	(0.006)	0.247*	(0.009)	0.071	(0.006)
Race - Hispanic	0.184	(0.006)	0.147*	(0.007)	0.225	(0.009)
Race - Other	0.070	(0.003)	0.071	(0.004)	0.068	(0.005)
Home language is non-English	0.109	(0.004)	0.086*	(0.005)	0.135	(0.007)
Disability in kindergarten	0.115	(0.005)	0.125*	(0.007)	0.105	(0.006)
Household Characteristics						
Number of children in household	2.455	(0.016)	2.448	(0.023)	2.463	(0.022)
Single-parent family	0.226	(0.006)	0.264*	(0.009)	0.182	(0.008)
Household income (in log dollars)	10.512	(0.013)	10.437*	(0.017)	10.596	(0.019)
Household income below poverty threshold	0.195	(0.006)	0.224*	(0.009)	0.162	(0.008)
Mother graduated from high school	0.305	(0.007)	0.320*	(0.009)	0.289	(0.010)
Mother attended some college	0.340	(0.007)	0.330	(0.009)	0.351	(0.010)
Mother graduated from college	0.216	(0.005)	0.209	(0.007)	0.225	(0.008)
Father graduated from high school	0.259	(0.006)	0.254	(0.008)	0.265	(0.009)
Father attended some college	0.347	(0.007)	0.352	(0.009)	0.342	(0.010)
Father graduated from college	0.215	(0.005)	0.196*	(0.007)	0.237	(0.008)
Number of books in child's home	73.026	(0.791)	68.251*	(1.045)	78.403	(1.195)
How often parent reads books to child (Four categories from 1=not at all to 4=every day)	3.233	(0.011)	3.198*	(0.016)	3.272	(0.016)
How often parent plays games with child (Four categories from 1=not at all to 4=every day)	2.775	(0.012)	2.777	(0.016)	2.772	(0.017)
Highest degree parent expects for child (Six categories from 1=less than high school diploma to 6=Ph.D., M.D. or other higher degree)	4.097	(0.016)	4.117	(0.022)	4.074	(0.023)
Parents attend religious services several times a month or more (omitted is no religious attendance)	0.577	(0.007)	0.599*	(0.010)	0.554	(0.010)
Parents attend religious services several times a year	0.219	(0.006)	0.220	(0.008)	0.217	0.0083
Parents' religious attendance is missing	0.002	(0.001)	0.002	(0.001)	0.002	(0.001)
Child in non-parental care year before kindergarten	0.820	(0.006)	0.830	(0.007)	0.809	(0.008)
Child in non-parental care in kindergarten year	0.514	(0.007)	0.505	(0.010)	0.525	(0.010)
School Characteristics						
Public school	0.865	(0.004)	0.831*	(0.006)	0.904	(0.005)
School size (Five categories from 1=0-149 students to 5=750 students and above)	3.434	(0.016)	3.423	(0.022)	3.446	(0.022)
Kindergarten class size	20.874	(0.068)	21.565*	(0.090)	20.095	(0.099)
Location - Urban (omitted is suburban)	0.386	(0.007)	0.422*	(0.009)	0.346	(0.010)
Location - Rural	0.195	(0.006)	0.227*	(0.008)	0.160	(0.008)
Years teacher has taught kindergarten	9.225	(0.112)	8.742*	(0.142)	9.768	(0.174)

Table 2: Baseline Sample Descriptive Characteristics (continued)

	All Children		Full-Day Only		Half-Day Only	
	Mean	Std Err	Mean	Std Err	Mean	Std Err
Sample size	8,540		4,487		4,053	
Dependent Variables						
Academic - Math						
Spring kindergarten math score - standardized	-0.068	(0.014)	-0.020*	(0.020)	-0.122	(0.020)
Spring first grade math score - standardized	-0.056	(0.014)	-0.065	(0.019)	-0.046	(0.021)
Spring third grade math score - standardized	-0.051	(0.015)	-0.089*	(0.021)	-0.008	(0.021)
Fall K to Spring K math gain score - standardized	-0.026	(0.014)	0.040*	(0.020)	-0.103	(0.020)
Spring K to Spring 1st math gain score - standardized	-0.028	(0.014)	-0.050	(0.020)	-0.004	(0.021)
Spring 1st to Spring 3rd math gain score - standardized	-0.030	(0.015)	-0.097*	(0.021)	0.046	(0.021)
Academic - Reading						
Spring kindergarten reading score - standardized	-0.044	(0.014)	0.023*	(0.020)	-0.123	(0.020)
Spring first grade reading score - standardized	-0.049	(0.015)	-0.054	(0.020)	-0.043	(0.021)
Spring third grade reading score - standardized	-0.047	(0.015)	-0.077*	(0.021)	-0.012	(0.022)
Fall K to Spring K reading gain score - standardized	-0.013	(0.014)	0.072*	(0.020)	-0.112	(0.020)
Spring K to Spring 1st reading gain score - standardized	-0.035	(0.016)	-0.077*	(0.021)	0.014	(0.023)
Spring 1st to Spring 3rd reading gain score - standardized	-0.039	(0.016)	-0.128*	(0.021)	0.067	(0.023)
Retention						
Child retained by third grade	0.089	(0.004)	0.098*	(0.006)	0.078	(0.006)
Behaviors						
Spring K internal behavior problems	0.023	(0.002)	0.025	(0.004)	0.021	(0.003)
Spring K external behavior problems	0.061	(0.004)	0.083*	(0.007)	0.036	(0.004)
Spring 1st internal behavior problems	0.029	(0.003)	0.027	(0.004)	0.032	(0.005)
Spring 1st external behavior problems	0.063	(0.004)	0.073*	(0.006)	0.051	(0.005)
Spring 3rd internal behavior problems	0.031	(0.003)	0.037*	(0.004)	0.025	(0.003)
Spring 3rd external behavior problems	0.047	(0.003)	0.057*	(0.005)	0.037	(0.004)
Mother's Employment Status						
Fall K - mother works full-time	0.468	(0.007)	0.511*	(0.010)	0.420	(0.010)
Spring 1st - mother works full-time	0.491	(0.007)	0.528*	(0.010)	0.449	(0.010)
Spring 3rd - mother works full-time	0.517	(0.007)	0.549*	(0.010)	0.482	(0.010)

Note: All means are weighted.

* significant at 5%

**Table 3: First Stage Instrumental Variable Results
Spring Kindergarten Math Scores**

	Estimate	Std Err
Full-day policy instrument	0.556**	(0.012)
Child Characteristics		
Fall math score - standardized	0.015*	(0.007)
Female	0.012	(0.012)
Age at kindergarten entry (months)	0.007**	(0.002)
Race - Non-Hispanic Black (omitted is White)	0.100**	(0.021)
Race - Hispanic	0.011	(0.024)
Race - Other	0.035	(0.022)
Home language is non-English	-0.061*	(0.029)
Disability in kindergarten	0.031	(0.020)
Household Characteristics		
Number of children in household	-0.002	(0.006)
Single-parent family	-0.009	(0.018)
Household income (in log dollars)	-0.021*	(0.010)
Mother graduated from high school	-0.004	(0.025)
Mother attended some college	0.006	(0.027)
Mother graduated from college	0.021	(0.030)
Father graduated from high school	0.003	(0.024)
Father attended some college	-0.005	(0.024)
Father graduated from college	-0.042	(0.027)
Number of books in child's home	-0.000*	(0.000)
How often parent reads books to child (Four categories from 1=not at all to 4=every day)	-0.011	(0.009)
How often parent plays games with child (Four categories from 1=not at all to 4=every day)	0.001	(0.008)
Highest degree parent expects for child (Six categories from 1=less than high school diploma to 6=Ph.D., M.D. or other higher degree)	0.007	(0.006)
Parents attend religious services several times a month or more (omitted is no religious attendance)	0.009	(0.016)
Parents attend religious services several times a year	0.018	(0.019)
Parents' religious attendance is missing	-0.035	(0.129)
Child in non-parental care year before kindergarten	0.032+	(0.018)
Child in non-parental care in kindergarten year	-0.059**	(0.013)
School Characteristics		
Public school	-0.171**	(0.018)
School size (Five categories from 1=0-149 students to 5=750 students and above)	-0.038**	(0.006)
Kindergarten class size	0.017**	(0.001)
Location - Urban (Omitted is suburban)	0.121**	(0.014)
Location - Rural	0.185**	(0.018)
Years teacher has taught kindergarten	-0.003**	(0.001)

Notes: Standard errors are adjusted to account for multiple children in the same classroom.
All estimates are weighted.

+ significant at 10%

* significant at 5%

** significant at 1%

**Table 4: Effects of Full-Day Kindergarten Attendance
OLS and Probit Results for All Students**

	Marginal Effect ¹	Std Err
Spring Kindergarten		
Math Scores - standardized (n=7,772)	0.119**	(0.020)
Reading Scores - standardized (n=7,407)	0.145**	(0.020)
Internal Problem Behaviors ² (n=5,949)	0.003	(0.003)
External Problem Behaviors ³ (n=6,108)	0.023**	(0.006)
Spring First Grade		
Math Scores - standardized (n=7,772)	0.045+	(0.024)
Reading Scores - standardized (n=7,407)	0.007	(0.026)
Internal Problem Behaviors (n=5,949)	-0.001	(0.004)
External Problem Behaviors (n=6,108)	0.011	(0.007)
Spring Third Grade		
Math Scores - standardized (n=7,772)	0.018	(0.024)
Reading Scores - standardized (n=7,407)	-0.032	(0.027)
Internal Problem Behaviors (n=5,949)	0.002	(0.005)
External Problem Behaviors (n=6,108)	0.014*	(0.006)
Retained by third grade (n=8,406)	0.012	(0.008)
Gain Scores		
Math Fall K to Spring K (n=7,772)	0.211**	(0.035)
Math Fall K to Spring First (n=7,772)	0.064+	(0.034)
Math Fall K to Spring Third (n=7,772)	0.024	(0.032)
Reading Fall K to Spring K (n=7,407)	0.256**	(0.036)
Reading Fall K to Spring First (n=7,407)	0.009	(0.034)
Reading Fall K to Spring Third (n=7,407)	-0.039	(0.033)

¹OLS coefficients are reported for math and reading outcomes. Probit marginal effects are reported for behavior and retention outcomes.

²Child exhibits internal behavior problems often or very often. The categorical variable for missing observations for parents' religious attendance was dropped from this regression because it perfectly predicted failure.

³Child exhibits external behavior problems often or very often. The categorical variable for missing observations for parents' religious attendance was dropped from this regression because it perfectly predicted failure.

Notes: Standard errors are adjusted to account for multiple children in the same classroom. All estimates are weighted. Regressions include independent variables listed in Tables 2 and A.1 unless otherwise noted.

+ significant at 10%

* significant at 5%

** significant at 1%

**Table 5: Effects of Full-Day Kindergarten Attendance
OLS and Probit Results By Poverty Status**

	Poor		Non-Poor	
	Marginal Eff. ¹	Std Err	Marginal Eff. ¹	Std Err
Spring Kindergarten				
Math Scores - standardized (n=1,104 and 6,668)	0.051	(0.040)	0.130**	(0.022)
Reading Scores - standardized (n=915 and 6,492)	0.140**	(0.042)	0.145**	(0.022)
Internal Problem Behaviors ² (n=761 and 5,188)	0.006	(0.005)	0.000	(0.003)
External Problem Behaviors ³ (n=797 and 5,311)	0.088**	(0.024)	0.013**	(0.005)
Spring First Grade				
Math Scores - standardized (n=1,104 and 6,668)	0.023	(0.055)	0.047+	(0.026)
Reading Scores - standardized (n=915 and 6,492)	-0.027	(0.064)	0.010	(0.027)
Internal Problem Behaviors ² (n=761 and 5,188)	0.022*	(0.010)	-0.005	(0.004)
External Problem Behaviors ³ (n=797 and 5,311)	0.020	(0.024)	0.011	(0.007)
Spring Third Grade				
Math Scores - standardized (n=1,104 and 6,668)	0.045	(0.064)	0.012	(0.025)
Reading Scores - standardized (n=915 and 6,492)	-0.020	(0.082)	-0.031	(0.027)
Internal Problem Behaviors ² (n=761 and 5,188)	0.018+	(0.011)	-0.001	(0.005)
External Problem Behaviors ³ (n=797 and 5,311)	0.047**	(0.014)	0.007	(0.005)
Retained by third grade ⁴ (n=1,260 and 7,146)	0.050*	(0.025)	0.006	(0.007)
Gain Scores				
Math Fall K to Spring K (n=1,104 and 6,668)	0.091	(0.071)	0.231**	(0.038)
Math Fall K to Spring First (n=1,104 and 6,668)	0.033	(0.078)	0.067+	(0.036)
Math Fall K to Spring Third (n=1,104 and 6,668)	0.060	(0.085)	0.015	(0.033)
Reading Fall K to Spring K (n=915 and 6,492)	0.246**	(0.073)	0.254**	(0.038)
Reading Fall K to Spring First (n=915 and 6,492)	-0.036	(0.085)	0.014	(0.036)
Reading Fall K to Spring Third (n=915 and 6,492)	-0.024	(0.100)	-0.038	(0.033)

¹OLS coefficients are reported for math and reading outcomes. Probit marginal effects are reported for behavior and retention outcomes.

²Child exhibits internal behavior problems often or very often. The categorical variables for home language and missing observations for parents' religious attendance were dropped from this regression because they perfectly predicted failure.

³Child exhibits external behavior problems often or very often. The categorical variables for home language and missing observations for parents' religious attendance were dropped from this regression because they perfectly predicted failure.

⁴The categorical variable for missing observations for parents' religious attendance was dropped from this regression because it perfectly predicted failure.

Notes: Bold results are significantly different at 5% between the two groups. Standard errors are adjusted to account for multiple children in the same classroom. All estimates are weighted. Regressions include independent variables listed in Tables 2 and A.1 unless otherwise noted.

+ significant at 10%

* significant at 5%

** significant at 1%

**Table 6: Effects of Full-Day Kindergarten Attendance
Fixed Effects Results for All Students**

	Marginal Effect ¹	Std Err
Spring Kindergarten		
Math Scores - standardized (n=7,772)	0.094**	(0.028)
Reading Scores - standardized (n=7,407)	0.193**	(0.030)
Spring First Grade		
Math Scores - standardized (n=7,772)	-0.010	(0.034)
Reading Scores - standardized (n=7,407)	0.026	(0.038)
Spring Third Grade		
Math Scores - standardized (n=7,772)	-0.086**	(0.032)
Reading Scores - standardized (n=7,407)	-0.052	(0.038)
Gain Scores		
Math Fall K to Spring K (n=7,772)	0.166**	(0.050)
Math Fall K to Spring First (n=7,772)	-0.014	(0.048)
Math Fall K to Spring Third (n=7,772)	-0.114**	(0.042)
Reading Fall K to Spring K (n=7,407)	0.339**	(0.052)
Reading Fall K to Spring First (n=7,407)	0.035	(0.050)
Reading Fall K to Spring Third (n=7,407)	-0.063	(0.047)

¹OLS coefficients are reported for math and reading outcomes.

Notes: Standard errors are adjusted to account for multiple children in the same classroom. All estimates are weighted. Regressions include independent variables listed in Tables 2 and A.1 unless otherwise noted.

+ significant at 10%

* significant at 5%

** significant at 1%

**Table 7: Effects of Full-Day Kindergarten Attendance
Second Stage IV Results for All Students**

	Coefficient	Std Err
Spring Kindergarten		
Math Scores - standardized (n=7,772)	0.115**	(0.043)
Reading Scores - standardized (n=7,407)	0.188**	(0.047)
Internal Problem Behaviors ¹ (n=5,949)	0.000	(0.009)
External Problem Behaviors ² (n=6,108)	0.066**	(0.022)
Spring First Grade		
Math Scores - standardized (n=7,772)	0.068	(0.051)
Reading Scores - standardized (n=7,407)	0.057	(0.054)
Internal Problem Behaviors (n=5,949)	0.006	(0.012)
External Problem Behaviors (n=6,108)	0.037+	(0.022)
Spring Third Grade		
Math Scores - standardized (n=7,772)	0.150**	(0.053)
Reading Scores - standardized (n=7,407)	0.049	(0.058)
Internal Problem Behaviors (n=5,949)	0.000	(0.014)
External Problem Behaviors (n=6,108)	0.025	(0.017)
Retained by third grade (n=8,406)	0.084**	(0.022)
Gain Scores		
Math Fall K to Spring K (n=7,772)	0.203**	(0.076)
Math Fall K to Spring First (n=7,772)	0.096	(0.072)
Math Fall K to Spring Third (n=7,772)	0.198**	(0.071)
Reading Fall K to Spring K (n=7,407)	0.331**	(0.084)
Reading Fall K to Spring First (n=7,407)	0.076	(0.071)
Reading Fall K to Spring Third (n=7,407)	0.059	(0.070)

¹Child exhibits internal behavior problems often or very often.

²Child exhibits external behavior problems often or very often.

Notes: Standard errors are adjusted to account for multiple children in the same classroom. All estimates are weighted. Regressions include independent variables listed in Tables 2 and A.1.

+ significant at 10%

* significant at 5%

** significant at 1%

**Table 8: Effects of Full-Day Kindergarten Attendance
Recursive Bivariate Probit Results For Mother Working Full-time Outcome
Marginal Effects**

	All Students	Poverty Status¹	
	<u>All</u> (n=7,781)	<u>Poor</u> (n=1,130)	<u>Non-Poor</u> (n=6,651)
Fall Kindergarten			
Mother works full-time	0.173**	0.224*	0.159**
Spring First Grade			
Mother works full-time	0.060	0.043	0.044
Spring Third Grade			
Mother works full-time	0.068	0.134	0.026

¹The categorical variable for missing observations for parents' religious attendance was dropped from the poverty regressions because it perfectly predicted failure.

Notes: All estimates are weighted. Regressions include independent variables listed in Tables 2 and A.1 except for household income and with the addition of wage, unemployment, and welfare payment variables.

+ significant at 10%

* significant at 5%

** significant at 1%

APPENDIX

**Table A.1: Sample Descriptive Characteristics
First and Third Grade Variables**

	All Children		Full-Day Only		Half-Day Only	
	Mean	Std Err	Mean	Std Err	Mean	Std Err
Sample size	8,540		4,487		4,053	
First Grade Characteristics						
Income change between Spring kindergarten and Spring first grade (percentage)	0.007	(0.002)	0.005	(0.002)	0.009	(0.003)
Number of parents in household changed between Spring kindergarten and Spring first grade	0.082	(0.005)	0.093*	(0.007)	0.070	(0.006)
Child changed schools between Spring kindergarten and Spring first grade	0.243	(0.008)	0.243	(0.010)	0.243	(0.011)
Third Grade Characteristics						
Income change between Spring first grade and Spring third grade (percentage)	0.011	(0.001)	0.012	(0.001)	0.010	(0.001)
Number of parents in household changed between Spring first grade and Spring third grade	0.108	(0.005)	0.116	(0.007)	0.098	(0.006)
Child changed schools between Spring first grade and Spring third grade	0.313	(0.007)	0.333*	(0.010)	0.291	(0.010)

Note: All means are weighted.

* significant at 5%

Table A.2: Kindergarten Policies by State

State	State Policy	Number of Students in Sample	Mean Attending Full-Day in State
Coded as a full-day policy for instrument			
Alabama	Full-day ¹	260	99.8%
Florida	Full-day	365	96.0%
Georgia	Full-day	183	91.5%
Hawaii	Full-day	112	100.0%
Louisiana	Full-day	257	100.0%
Mississippi	Full-day	126	100.0%
North Carolina	Full-day	249	98.6%
Virginia	Half and Full ²	59	100.0%
Coded as not a full-day policy for instrument			
Arizona	Half-day ³	117	63.4%
California	Half-day	1,085	16.2%
Connecticut	Half-day	101	49.5%
Delaware	Half-day	69	2.3%
Indiana	Half-day	200	31.1%
Kentucky	Half-day	130	76.9%
Maryland	Half-day	118	29.7%
Massachusetts	Half-day	226	24.5%
New Mexico	Half-day	30	5.8%
Oklahoma	Half-day	83	4.8%
Oregon	Half-day	39	100.0%
Pennsylvania	Half-day	506	31.1%
Tennessee	Half-day	202	75.9%
Utah	Half-day	97	6.4%
Washington	Half-day	63	38.9%
Wisconsin	Half-day	300	60.0%
Wyoming	Half-day	87	2.8%
Illinois	Half or Full ⁴	448	46.7%
Iowa	Half or Full	265	65.2%
Minnesota	Half or Full	114	5.9%
Missouri	Half or Full	296	80.4%
Ohio	Half or Full	319	33.0%
Rhode Island	Half or Full	76	3.9%
Texas	Half or Full	514	76.1%
Alaska	None ⁵	66	49.9%
Colorado	None	153	26.8%
Kansas	None	154	13.1%
Maine	None	202	27.7%
Michigan	None	308	20.1%
New Jersey	None	177	44.2%
New York	None	324	63.2%
South Dakota	None	60	100.0%

Table A.2: Kindergarten Policies by State (continued)

State	State Policy	Number of Students in Sample	Mean Attending Full-Day in State
Not included in sample			
Arkansas	Full-day	0	
District of Columbia	Full-day	0	
West Virginia	Full-day	0	
South Carolina	Half and Full	0	
Vermont	Half and Full	0	
Montana	Half-day	0	
Nebraska	Half-day	0	
Nevada	Half-day	0	
North Dakota	Half or Full	0	
Idaho	None	0	
New Hampshire	None	0	

¹State requires districts to offer full-day kindergarten programs.

²State requires districts to offer half-day and full-day kindergarten programs.

³State requires districts to offer half-day kindergarten programs.

⁴State requires districts to offer half-day or full-day kindergarten programs.

⁵State does not have a statewide policy - local education agencies determine.

Note: Mean attending full -day is weighted.

Source: CCSSO (1998); Confirmed by searches of state education department web sites, findlaw.com, and personal communication with state department of education staff.

Table A.3: OLS and Probit Estimates for Spring Kindergarten Outcomes

	Standardized Math Scale Score ¹	Standardized Reading Scale Score ¹	Internal Behavior Problems ²	External Behavior Problems ³
Sample size	7,772	7,407	5,949	6,108
Child attended full-day kindergarten	.119** (0.020)	0.145** (0.020)	0.003 (0.003)	0.023** (0.006)
Child Characteristics				
Fall score - standardized	0.772** (0.013)	0.796** (0.014)	N/A	N/A
Female	-.041* (0.016)	0.026+ (0.016)	-.000 (0.003)	-.028** (0.006)
Age at kindergarten entry (months)	.012** (0.002)	.005* (0.002)	0 (0.000)	-.001 (0.001)
Race - Non-Hispanic Black (omitted is White)	-0.162** (0.029)	-0.102** (0.034)	.002 (0.007)	.025* (0.014)
Race - Hispanic	-.018 (0.027)	0.047 (0.031)	-.002 (0.004)	0.009 (0.012)
Race - Other	-.068* (0.028)	0.024 (0.033)	0.001 (0.006)	0.011 (0.014)
Home language is non-English	-.046 (0.035)	0.047 (0.037)	-.003 (0.005)	-.033** (0.005)
Disability in kindergarten	-.110** (0.026)	-0.105** (0.026)	.012* (0.007)	.032** (0.013)
Household Characteristics				
Number of children in household	0.001 (0.008)	-0.004 (0.008)	-.002 (0.001)	-.000 (0.003)
Single-parent family	-0.053* (0.024)	-0.038 (0.024)	0.002 (0.004)	0.005 (0.009)
Household income (in log dollars)	0.007 (0.013)	0.018 (0.012)	-.004* (0.002)	-.009* (0.004)
Mother graduated from high school	0.045 (0.037)	0.086** (0.031)	-.008 (0.005)	0.005 (0.010)
Mother attended some college	0.068+ (0.040)	0.082* (0.034)	-.005 (0.006)	0.002 (0.011)
Mother graduated from college	.085+ (0.047)	0.101** (0.037)	-.009 (0.005)	-.004 (0.012)
Father graduated from high school	0.016 (0.031)	-0.027 (0.031)	0.006 (0.008)	-.001 (0.010)
Father attended some college	0.032 (0.031)	-0.002 (0.032)	0.008 (0.008)	-.001 (0.011)
Father graduated from college	0.049 (0.038)	-0.015 (0.038)	0.013 (0.012)	-.008 (0.011)
Number of books in child's home	0.000* (0.000)	-0.000 (0.000)	-.000* (0.000)	-.000 (0.000)
How often parent reads books to child (Four categories from 1=not at all to 4=every day)	-.002 (0.012)	0.022+ (0.011)	0 (0.002)	-.007+ (0.004)
How often parent plays games with child (Four categories from 1=not at all to 4=every day)	0.007 (0.010)	-0.006 (0.010)	-.002 (0.002)	-.003 (0.004)

Table A.3: OLS and Probit Estimates for Spring Kindergarten Outcomes (continued)

	Standardized Math Scale Score ¹	Standardized Reading Scale Score ¹	Internal Behavior Problems ²	External Behavior Problems ³
Highest degree parent expects for child (Six categories from 1=less than high school diploma to 6=Ph.D., M.D. or other higher degree)	.017* (0.008)	0.005 (0.008)	0.001 (0.002)	-.003 (0.003)
Parents attend religious services several times a month or more (omitted is no religious attendance)	0.001 (0.021)	0.021 (0.022)	-.008* (0.004)	-.008 (0.008)
Parents attend religious services several times a year	0.019 (0.024)	0.01 (0.024)	-.001 (0.004)	0.005 (0.009)
Parents' religious attendance is missing	-0.157 (0.111)	0.142 (0.158)	N/A N/A	N/A N/A
Child was in non-parental care year before kindergarten	-0.001 (0.024)	-0.027 (0.024)	0.003 (0.004)	.026** (0.005)
Child was in non-parental care in kindergarten year	-.039* (0.019)	-0.011 (0.018)	-.005+ (0.003)	.011+ (0.006)
School Characteristics				
Public school	-0.016 (0.028)	0.008 (0.030)	0.004 (0.004)	-.001 (0.009)
School size (Five categories from 1=0-149 students to 5=750 students and above)	-0.010 (0.009)	0.016+ (0.009)	0 (0.001)	0.004 (0.003)
Kindergarten class size	-0.001 (0.002)	-0.004+ (0.002)	-.001* (0.000)	-.000 (0.001)
Location - Urban (Omitted is suburban)	0.012 (0.023)	-0.018 (0.023)	-.007* (0.003)	-.004 (0.007)
Location - Rural	-0.007 (0.024)	-0.026 (0.025)	-.005 (0.004)	-.002 (0.008)
Years teacher has taught kindergarten	-0.001 (0.001)	0.001 (0.001)	-.001** (0.000)	-.001+ (0.000)
Constant	-1.047** (0.219)	-0.644** (0.198)		
R-squared	0.69	0.69		

¹OLS coefficients are listed for this outcome.

²Child exhibits internal behavior problems often or very often. Probit marginal effects are listed for this outcome. The categorical variable for missing observations for parents' religious attendance was dropped from this regression because it perfectly predicted failure.

³Child exhibits external behavior problems often or very often. Probit marginal effects are listed for this outcome. The categorical variable for missing observations for parents' religious attendance was dropped from this regression because it perfectly predicted failure.

Notes: Standard errors are in parentheses and are adjusted to account for multiple children in the same school. All estimates are weighted.

+ significant at 10%

* significant at 5%

** significant at 1%