Does prekindergarten improve school preparation and performance?

By: Katherine A. Magnuson, Christopher Ruhm, and Jane Waldfogel.

Ruhm, C., Magnuson, K.A., and Waldfogel, J. (2007). Does Prekindergarten Improve School Preparation and Performance?" *Economics of Education Review*, Vol. 26(1): 33-51.

Abstract:

Prekindergarten programs are expanding rapidly but evidence on their effects is limited. Using rich data from Early Childhood Longitudinal Study, we estimate the effects of prekindergarten on children's school readiness. We find that prekindergarten is associated with higher reading and mathematics skills at school entry, but also higher levels of behavior problems. By the spring of first grade, estimated effects on academic skills have largely dissipated, but the behavioral effects persist. Larger and longer lasting associations with academic gains are found for disadvantaged children. Finally, we find some evidence that prekindergartens located in public schools do not have adverse effects on behavior problems.

Keywords: Preschool; Child care; School readiness

Article:

1. INTRODUCTION

The share of US children attending early education programs has risen dramatically in recent years–66% of 4-year-olds were enrolled in a center or school-based preschool program in 2001, up 23 percentage points from 30 years earlier (US Bureau of the Census, 1970; US Department of Education, 2003). Yet disadvantaged children remain consistently less likely to attend early education programs. Today, children whose mothers did not complete high school are half as likely to be in center-based care arrangements as those whose mothers are college educated and a similar gap exists between children from low and high income families (Bainbridge Meyers, Tanako, & Waldfogel, 2005).

Concerns that many disadvantaged children are insufficiently prepared to start school have motivated expansions in public funding. To equalize access to high quality early education opportunities, there have been numerous calls for public support for prekindergarten (e.g. Wolfe & Scrivner, 2003). Since 1990, state prekindergarten funding has increased by over 250% and now amounts to $2.54 billion; and recent estimates suggest that 16% of 4-year-olds are now enrolled (Barnett, Hustedt, Robin, & Schulman 2004).[1]

Evidence on how prekindergarten affects school readiness and subsequent educational performance is limited. We know that model early education programs promote academic skills but know much less about typical programs, with data particularly lacking for prekindergarten.

1. *Thirty-nine states funded prekindergarten in 2002, although only 7—Connecticut, Georgia, Illinois, Kentucky, Massachusetts, Ohio, and Oklahoma—make substantial per capita investments (Barnett et al., 2004). Local school districts also invest in prekindergarten programs independently, although the bulk of this money comes from federal funding (Smith, Kleiner, Parsad, Farris, & Green, 2003).*

This paper begins to fill this gap by addressing three specific questions. First, does prekindergarten increase school readiness at kindergarten entry? Second, do the effects persist over time or quickly dissipate? Third, do the results differ for children with disadvantaged family backgrounds?

Answering these questions is important, given evidence that many children enter school without the requisite skills teachers identify as important. In particular, lack of academic skills is identified by teachers as one of the most common obstacles children face when they enter school (Rimm-Kaufman, Pianta, & Cox, 2000). Evidence suggests that children's academic skills at school entry are linked to their later school achievement (Entwisle & Alexander, 1993), and that test scores in the elementary school years are associated with long- run economic outcomes such as employment and earnings (Krueger, 2003). Understanding the effects of prekindergarten is also essential if policy-makers are to make wise decisions as to how to invest public funds.

We use data from the newly available Early Childhood Longitudinal Study–Kindergarten Class of 1998–1999 (ECLS-K), a large nationally representative sample of children entering kindergarten. The ECLS-K collects information on school performance and a rich array of family background, school, early education and child care experiences. We assess school readiness using data on academic skills and classroom behavior from the fall of kindergarten, and the persistence of effects with corresponding information from the spring of first grade.

A significant challenge is to adequately control for differential selection into early education. For example, favorable selection, whereby parents whose children attend prekindergarten possess characteristics that promote high levels of school performance, would result in a spurious positive correlation between preschool and later academic outcomes. Our primary econometric strategy is to use the detailed information available in the ECLSK to account for many potential confounding factors. We also test the robustness of our findings using fixed-effect, propensity score and instrumental variables methods.

Our main results are as follows. (1) Prekindergarten significantly raises math and reading performance at school entry—effect sizes range from 0.10 to 0.12 in the preferred models. (2) Prekindergarten attendance increases aggression and decreases self- control at school entry—with effect sizes of 0.07–0.11. (3) Other types of center-based care have positive effects on academic outcomes and negative impacts on behavior, although these are smaller than for prekindergarten. (4) For most children, the cognitive benefits fade, but the behavioral effects persist. (5) However, there are more lasting cognitive gains for disadvantaged children. (6) Among children attending prekindergarten in the same public school as kindergarten, the higher reading and math skills are not accompanied by increases in behavior problems. These last findings suggest that further expansions of prekindergarten should focus on serving children from disadvantaged backgrounds and programs located in public schools.

2. PRIOR RESEARCH

The benefits from high-quality intensive early education interventions are well documented and include short-term improvements in cognitive development, long-term increases in academic achievement, and reductions in special education placement and grade retention (Waldfogel, 2002; Brooks- Gunn, 2003). However, it is not clear whether more typical preschool or

prekindergarten programs, which vary in the extent to which they offer high- quality early learning environments, improve children's cognitive and academic outcomes (Gilliam & Zigler, 2001). Lacking experiments, researchers typically study naturally occurring variation in early education or center-based care, which often includes an educational component. The bulk of evidence suggests that by providing a cognitively stimulating environment center-based care during the third and fourth year of life enhances academic outcomes at school entry, but that the effects fade over the first year or two of school (Barnett, 1995; Gilliam & Zigler, 2001; Fryer & Levitt, 2004; NICHD ECCRN & Duncan, 2003). However, these analyses typically control for only a few potential selection factors, raising the possibility that resulting associations are spurious rather than causal (Blau & Currie, in press).

Most previous studies combine all types of early education programs into one category, even though the effects may differ depending on program quality or emphasis. Such a general approach may mask variability in specific types of program effects, as early education classrooms vary greatly in quality of and approach to engaging children in academic learning activities (Pianta, LaParo, Payne, Cox, & Bradley, 2002). With the exception of Head Start, few studies consider whether specific types of preschool programs are more or less beneficial than others. Yet child–staff ratios, class sizes, and caregiver education and pay are important determinants of program quality (NICHD ECCRN, 2002; Phillips, Mekos, Scarr, McCartney, & Abott-Shim, 2001), and the data on these indicators suggest that school-based prekindergarten is of relatively high quality (Ripple, Gilliam, Chanana, & Zigler, 1999; Smith et al., 2003).[2] In addition, most states have developed prekindergarten curriculum standards, although few have adopted comprehensive standards and established mechanisms to assure that they are met (Barnett et al., 2004; Schulman, Blank, & Ewen, 1999). Nonetheless, state-funded prekindergartens' increasing attention to developmentally appropriate curriculum suggests that these programs may be of higher educational quality than other preschools or child care centers.

Gilliam and Zigler's (2004) review of 20 state evaluation efforts suggests that most prior studies of prekindergarten are so poorly designed as to raise serious questions about the validity of their findings. One exception is Gormley, Gayer, Phillips, and Dawson's (2004) evaluation of the Tulsa prekindergarten program, which took advantage of the strict age cut-off for entry to compare children attending prekindergarten with those who missed the age cut off. The results suggest that prekindergarten boosted children's academic skills by 0.38–0.74 of a standard deviation, depending on the outcome.[3] An additional study analyzed prekindergarten programs as distinct from other types of preschool or center-based care. Magnuson, Meyers, Ruhm, and Waldfogel (2004), using data from the ECLSK, provide evidence that prekindergarten confers greater academic benefits than other center-based programs, especially for disadvantaged children. However, behavioral outcomes were not considered, and concerns about selection bias into prekindergarten were not thoroughly addressed.

2. *For example, 86% of school-based prekindergarten teachers have a 4-year college degree (Smith et al., 2003), which is more than twice the rate among center-based care program workers (Blau, 2001). Existing data do not indicate whether prekindergarten classrooms have positive social climates.*

3. *Related evidence can be found in Cascio's (2004) analyses of the introduction of public kindergarten programs. She finds that kindergarten attendance is associated with lower levels of grade retention.*

Although cognitive outcomes receive the most attention, school readiness and later school success also depend on classroom behavior (Carneiro & Heckman, 2003). When teachers are asked to describe the key components of school readiness, positive behaviors including enthusiasm, cooperation, following directions, and not disrupting the class are rated more important than specific skills such as naming letters of the alphabet or counting numbers (Lewit & Baker, 1995). Furthermore, aggressive behavior and a lack of self-control predict lower academic achievement, presumably because they reduce the time that children are engaged in learning activities, although whether these associations are causal remains controversial (Duncan, Claussens, & Engel, 2004).

Non-experimental evidence indicates that early and extensive non-maternal child care (particularly center-based care) is associated with higher levels of school behavior problems (Belsky, 2001; NICHD ECCRN, 2003), but evidence is mixed as to whether attending early education programs during the year or two prior to school entry has detrimental effects.[4] In theory a classroom's social climate is unrelated to the amount and type of instruction provided, suggesting that programs may have differential effects on children's behavioral and academic outcomes. Social dimensions of the class interactions, including good peer and teacher–student relationships may be particularly important to understanding children's subsequent behavioral adjustment (Peisner-Feinberg et al., 2001).

Nevertheless, some evidence suggests that social climates and instructional approaches may be linked in classrooms. Non-experimental research by Stipek et al. (1998) found that attending a preschool or kindergarten with a teacher-directed basic-skills curriculum was associated with higher levels of problem behavior, compared with programs offering less basic skill instruction and more child-directed learning approaches. They suggest that teachers' focus on instruction typically leads to negative class climates with higher levels of discipline and less warmth and nurturance, which in turn increases behavior problems.

Evidence on the specific links between prekindergarten and problem behavior is sparse. Gilliam and Zigler's (2004) review found that most state prekindergarten evaluations did not measure behavior outcomes and, among those that did, there was no clear effect. Gormley and Gayer's (2005) evaluation of the Tulsa prekindergarten program found no behavioral effects.

Taken together, the prior literature suggests that early education may increase children's academic skills and possibly misbehavior, but the findings are limited because most experimental studies focus on model programs serving small non-representative samples, whereas larger and more representative studies have typically not adequately addressed the selection biases that may pervade non-experimental designs.

This study addresses five limitations of prior research. First, we examine the effects of different types of early education programs. Second, we consider the impacts on behavior problems as

4. *An experimental evaluation of the model Perry Preschool program indicates the program had no negative effects on school misbehavior and, like several other high-quality programs, had positive long-term effects on social outcomes (e.g. reductions in crime and teen pregnancy) (Carneiro & Heckman, 2003). However, some non-experimental studies find that center-based care in the year prior to kindergarten is associated with higher levels of problem behavior in kindergarten (Bates et al., 1994).*

well as academic skills. Third, we deal with selection effects by using the extensive array of child, family background, school, and classroom characteristics included in our data set as well as using several alternative methods to test the robustness of the findings. Fourth, we analyze whether the differences observed at school entry persist over time or fade out. Fifth, we evaluate whether the impacts differ for disadvantaged children.

3. DATA

Data are from the Early Childhood Longitudinal Study, Kindergarten Cohort, a nationally represen tative sample of children attending kindergarten in the fall of 1998 that was designed and carried out by the US Department of Education. Our information comes from the fall of 1998 (kindergarten) and spring of 2000 (for most children, first grade). The ECLS-K includes academic assessments, child, parent, teacher and school administrator surveys, and observational ratings of school environments. The sample consists of 10,224 children entering kindergarten. This sample size reflects the exclusion of 1848 children for whom information on child care/early education or one of the outcomes was missing and 5540 children for whom data was not collected in the spring of first grade.[5] The latter exclusions partially reflect planned attrition (only half the children changing schools after the fall of kindergarten were retained in the study), as well as lower completion rates among children followed after changing schools (64% compared with 95% for non-movers).[6]

Attrition of children in the ECLS-K study raises concerns about the potential for systematic differences between our longitudinal sample and the original sample. Indeed, comparisons provide some indication that the students included in our sample are on average more advantaged than those excluded. Students in our sample had higher income-to-needs ratios (3.3 vs. 2.6), were less likely to be receiving welfare (10% vs. 15%), were less likely to be black or Hispanic (14% vs. 17% for black and 11% vs. 25% for Hispanic), and had parents with higher levels of education (92% vs. 82% of mothers had achieved a high school degree or higher). Consequently, we should be cautious in generalizing findings as our sample may not be representative of all US kindergartners. We address this issue by considering differential effects for the less advantaged children in our sample. These subgroup analyses provide some indication of the extent to which our results might be biased by the exclusion of some disadvantaged children.[7]

3.1. Outcomes

Children's math and reading skills were assessed during one-on-one testing sessions in the fall of

5. *About 13% of those excluded in the fall of kindergarten were non-English speaking, who were not administered reading assessments. Just over 40% were missing parent report data and 30% were missing teacher report data. An additional 790 children were excluded because they were repeating kindergarten in 1998, or because data for this measure was missing. We also excluded 364 children because the sizes of missing data cells were too small to be included in our first stage IV analyses.*

6. *Overall completion rates were high among those children who were followed through the spring of first grade, with 92% of child assessments, 86% of parent interviews, and 83% teacher interviews completed (National Center for Education Statistics, 2002).*

7.*The ECLS-K study has created analytic weights to handle non-random attrition; however, the weights are not specific to our particular sample. When they were applied in our analyses, they did not substantially change the reported findings.*

kindergarten and the spring of first grade.[8] The assessments were created for the ECLS-K by a team of experts, with some items adapted from existing instruments. The reading test assessed knowledge of letters and word recognition, beginning and ending sounds, vocabulary, and passage comprehension. The math test evaluated understanding of numbers, geometry, and spatial relations. Reported reliabilities for the tests were quite high for all assessments.
The math and reading outcomes are transformations of latent ability scores into standardized *t*-scores that have a mean of 50 and standard deviation of 10 (based on the full sample distribution).[9] Consequently, the scores should be interpreted as children's skill levels relative to their peers, and can be translated into effect sizes by dividing regression coefficients by 10. The sample analyzed scored slightly above the full sample mean at school entry and during first grade, with average reading scores of 51 and math scores of 52. The 3 percent of children still in kindergarten in spring 2000 were classified as having repeated kindergarten (since they should have progressed to first grade by fall 1999).

Teacher reports of children's externalizing behavior and self-control are used to measure classroom behavior (see the Social Rating Scale, Gresham & Elliot, 1990). Externalizing problem behavior refers to aggressive behavior as indicated by a five-item scale measuring how frequently the child fights, argues, gets angry, acts impulsively, or disturbs ongoing activities. Self-control is comprised of four items about how frequently the child respects the property of others, controls their temper, accepts peer ideas for group activities, and appropriately responds to peer pressure.[10] These scale scores were standardized (for the full sample) to have a mean of 0 and a standard deviation of 10 and, as with academic skills, can be translated into effect sizes by dividing regression coefficients by 10.

3.2. Early Child Care and Education

Parental responses to questions about child care in the year prior to kindergarten are used to classify children as having attended a prekindergarten program, other types of center-based care (subsequently referred to as preschool), Head Start, or other non-parental care (care by a relative or non- relative, e.g., nanny or babysitter). To simplify interpretation of the regression coefficients and isolate the effects of prekindergarten, we constructed mutually exclusive groups.[11] Using these categories, 45% of child care was preschool, 17% prekindergarten, 16% exclusively parental care, 12% other types of non-parental care, and 10% Head Start.

We cannot determine how parents distinguish between different types of programs and misclassification seems most likely for preschool and prekindergarten. Our presumption is that programs

8.*Children failing a language screener given to those identified as having a non-English background received a reduced version of the assessments and were excluded from our sample.*

9. *The skills tests were conducted in two-steps. Children were first given common questions. The second set of questions then differed in difficulty, depending on performance in the first step. Because children did not answer the same questions, the scores were calculated using Item Response Theory (IRT), which uses patterns of right, wrong, and missing answers and the difficulty of questions to place each child on a continuous ability scale. The resulting score is an estimate of the number of questions the child would have correctly answered had he or she been asked all available questions.*

10. *Externalizing behavior is negatively correlated with self- control. At school entry, reported frequencies of externalizing behavior were relatively low, with unstandardized means of 1.5, and rates of self-control were high, with unstandardized scores of 3.12. Self-control was positively correlated with reading and math skills and externalizing behavior was negatively correlated with reading and math skills.*

identified as prekindergarten correspond to either school-based programs or publicly funded state prekindergarten initiatives, and are thus more explicitly educational than other types of center-based care. Classification errors seem likely to attenuate the parameter estimates, such that the regression results probably understate the true effects.

One strategy we use for reducing potential classification errors is to estimate models with the sample limited to children attending kindergarten in public schools. We also consider whether the effects differ if the prekindergarten program is located in the same school in which the child attends kindergarten. Classification errors seem less likely in these cases and we are particularly interested in understanding the effects of publicly funded programs, which most often are located in public schools. In this regard, it also noteworthy that the prekindergarten enrollment rate of 15% for children in public schools in our sample is remarkably close to the 14% national estimate recently obtained by Smith et al. (2003). The rate of prekindergarten attendance among children in private schools is much higher (25%) and the nature and funding of these programs is likely to be quite different.

3.3. Additional explanatory variables

Most of our regressions contain exhaustive controls for child, family background, and neighborhood characteristics.[12] We also incorporate measures of the child's home environment, using data from surveys of parents in the fall and spring of kindergarten. These include controls for a diverse set of home and family resources and parenting practices that may be related to early Child care, education experiences, academic skills, and behaviors. The learning environment is proxied by activities such as reading books and singing songs, children's participation in structured activities outside of the home, their use of home computers, and the number of books in the home. There are also indicators of parental expectations of the child's educational attainment, attitudes about the importance of particular skills, family members' involvement in the child's schooling, parental responses to questions about the warmth and affection of the relationship with their child, the frequency of physical discipline, a composite measure of the parental depressive symptoms, and several measures of the regularity of the family routines (like eating meals together).[13]

11. *Children experiencing prekindergarten and other non-parental care were placed in the prekindergarten category. Those with preschool and other non-parental care were put in the preschool group. Children in Head Start and other non-parental care were coded as having attended Head Start. Those with both Head Start and other center-based care (preschool or prekindergarten) were categorized according to the type of care where they spent the greatest number of hours per week. Approximately 34% of children in prekindergarten, 35% in preschool, and 41 % in Head Start were also in other non-parental care arrangements. Overlap between preschool or prekindergarten and Head Start was much lower. Only 7% of children who attended prekindergarten and 5% in preschool were also in Head Start. The results of models estimated with non-exclusive child care categories are nearly identical to those reported in the tables.*

12. *These include demographic and family characteristics such as race/ethnicity, age, birth weight, height, weight, gender, the household income-to-needs ratio, parental education, region of the country, family structure and size, and language spoken in the home. Details on the covariates are available from the authors.*

13. *Most family characteristics are measured during kindergarten and so could be influenced by prekindergarten (or other preschool) attendance. This problem is usually likely to be minor (e.g. parents are unlikely to base meal routines on the availability of prekindergarten) but some components of the home learning environment could be shaped by the early education experiences. For instance, prekindergarten teachers may instruct parents to read frequently to their children or provide information about the availability of structured activities such as art classes. The inclusion of these covariates may therefore absorb a portion of the effects of prekindergarten (or preschool). Generally, this seems likely to lead us to understate any positive impacts of prekindergarten but to overestimate any negative effects.*

The effects of neighborhood and state characteristics are captured through a neighborhood composite quality index (based on information about the prevalence of crime, abandoned buildings, drugs, and safe places for children to play in the neighborhood), as well as the log of state per capita income and state public spending on welfare and education programs in 1998. Data for the state variables are from the US Census Bureau (2001).[14]

One strategy employed below to test the robustness of the results is to estimate instrumental variables (IV) models using two measures of access to state prekindergarten as instruments. The first divides state prekindergarten spending (from Blank, Schulman, & Ewen, 1999) by the number of children under 6 and the average cost of center-based care for 4-year-olds. The second directly estimates the number of children in the state attending prekindergarten in public schools divided by the number of children under 6 in the state. Estimates of the number of children attending prekindergarten were taken from the National Center for Educational Statistics Common Core of Data.[15]

4. METHODS

Conceptually, outcomes for child i living in state j (O_{ij}) are "produced" by inputs such as the non- market "leisure" time of parents, purchased inputs like educational resources provided in the home, and non-parental child care provided prior to school entry. We do not attempt to determine the structural parameters of this child production function. Instead, most models estimate the reduced-form association between experiences in the year prior to kindergarten and early school outcomes, after controlling for a comprehensive set of explanatory variables.

The basic regression equation is

$$O_{ij} = PREK_{ij}ß + X_{ij}\gamma + S_j\delta + \varepsilon_{ij}, \quad (1)$$

where outcomes are measured in the fall of kindergarten and spring of the first grade, PREK is a dummy variable for prekindergarten attendance, *X* is a set of child, family, and neighborhood characteristics, *S* is vector of state characteristics, and ε is a regression disturbance term. Because schools were the primary sampling unit in the survey, all analyses provide robust standard errors corrected for the non-independence of observations within schools.[16]

Eq. (1) does not control for types of care other than prekindergarten, so that $\hat{ß}$ captures differences between children attending prekindergarten and those experiencing all other type of care (including exclusively parental care). However, we also estimate models that add controls for preschool, Head Start, and other non-parental care; these examine the effects of prekindergarten (and other forms of care) relative to children cared for only by parents.

14. *Information on one or more background characteristics are lacking for some children. To retain these cases, the relevant regressors are set to zero and dummy variables were created to denote the presence of missing values. For example, for children missing data on parental reports of birth weight, the two low birthweight variables were recoded to have a value of zero, and a dummy variable indicating missing birthweight data was created. Rates of missing data are quite low, below 2% for most child and family characteristics.*

15. *Values for both variables range from 0 to 0.08, and the two instruments are highly correlated (r = 0.68). The NCES Common Core of Data is available online at http://nces.ed.gov/ccd/.*

16. *Reported results are robust to clustering at the state level.*

One regression strategy is to include a sufficiently rich set of covariates that the error term in (1) is orthogonal to O_{ij}. A potential concern is that even our extensive set of controls may not fully account for the selection into prekindergarten. For this reason, we also present results from teacher fixed-effect, propensity score, and instrumental variable analyses.

The teacher-fixed effect estimates reduce bias from characteristics common to children within the same kindergarten classroom. These models are equivalent to estimating:

$$O_{it} - O_{.t} = (PREK_{it} - PREK_{.t})ß + (X_{it} - X_{.t})\gamma + \varepsilon_{it}. \quad (2)$$

The difference in outcomes for child i in classroom t (Oit) and the average child in the same classroom t ($O_{.t}$) is estimated as a function of prekindergarten attendance and the full set of measured child and family covariates. Because state characteristics are the same for children within a classroom, they are automatically controlled for and not included in the model. The fixed-effect models are also likely to decrease biases related to differences in the classroom environments and unobserved neighborhood characteristics (since most elementary schools are neighborhood based) as well as biases that might arise from teachers using differing standards of behavior to rate students (for a discussion of this see Finn & Pannozzo, 2004).

Even holding constant a large set of observed characteristics or comparing children within the same classroom may fail to appropriately estimate prekindergarten effects, if the prekindergarten children differ greatly from comparison children. For example, OLS estimates may be biased if there is insufficient overlap in prekindergarten and other children's distribution of observed characteristics, and thus the regression models are forced to extrapolate beyond the data. OLS models also impose assumptions about the linearity and additivity of regressors that are difficult to test with many covariates.

Selecting an appropriate comparison group through propensity score matching offers an alternative way to obtain comparable samples and requires fewer assumptions than OLS about the "correct" functional form. Our propensity score analysis proceeds in two steps. First, we estimate a propensity score for each individual, defined as the conditional probability (from a probit model) of attending prekindergarten given the full set of covariates and dummy variables for the child's state of residence or

$$Pr\left(prekindergarten = 1 | \sum X_{ij}, \sum State_j\right). \quad (3)$$

The propensity score is next used to create a matched control group of children who did not attend prekindergarten.[17] We use the nearest- neighbor matching technique and limit the sample to children for whom there is sufficient overlap in propensity scores between the prekindergarten and comparison group (caliper width, 0.001, with replacement). If the matching process proceeds correctly, the treatment and control children will have similar measured characteristics and the effects of prekindergarten can be estimated by comparing the matched groups' means. Because

17. *We include state dummy indicators because they improve our overall prediction of propensity scores, and the balance in covariates across the prekindergarten and comparison groups.*

propensity score techniques match cases on measured characteristics, unobserved differences between prekindergarten and other children remain a possible source of bias in these analyses.

Our third test of robustness involves instrumental variable (IV) models where, as mentioned, the adjusted level of state spending on prekindergarten, STEXPEND, and the fraction of young children attending public prekindergarten, STENROLL, are used as instruments. The first-stage equation is

$$PREK_{ij} = STEXPEND_j ß_1 + STENROLL_j ß_2 + X_{ij}\gamma + S_j\delta + \varepsilon_{ij}. \quad (4)$$

Because $PREK_{ij}$ is dichotomous, (4) is estimated as a probit model.[18] The second stage is then estimated by OLS, with Huber–White robust standard errors adjusted for the clustering of data at the school level and with additional correction for the two-stage estimation process using the procedures discussed in Murphy and Topel (1985).[19] As detailed below, state prekindergarten expenditures and enrollment predict attendance quite well and are likely to be satisfactory instruments.

5. DESCRIPITVE STATISTICS

Table 1 provides the means and standard errors for all outcomes for the full sample and for subsamples stratified by the type of care in the year prior to kindergarten. Children who attended prekindergarten or preschool have the highest test scores, followed by those exclusively in parental care or receiving other types of non-parental care (e.g., relative care or babysitters); Head Start enrollees have the lowest scores in math and reading. Children exclusively in parental care have the highest levels of self-control and lowest levels of externalizing behavior. Children who attended prekindergarten or preschool were least likely to repeat kindergarten.

The sample characteristics summarized in the bottom panel of Table 1 suggest that differing family backgrounds may account for some of the disparities in the outcomes. For example, children experiencing prekindergarten or preschool come from high income families, which is not surprising given the high rates of attendance by private school children.

18. *Estimating these models with 2SLS yields similar results for the effects of prekindergarten on reading and math skills, but the effects differ slightly for children's behavior outcomes. For example, prekindergarten effects on children's externalizing behavior are about half of the size of those reported in Table 3. Because the 2SLS models result in predicted values of less than 0, we present results from the two-stage probit models. In addition, results from two-stage probit models conducted using only one instrument (either enrollment or expenditures) do not differ from results reported in Table 3.*

19. *The spending variable takes the same value for all children in a given state. Correcting for this would probably increase the IV standard errors. We have not done so since we are primarily using the IV models to detect the direction of any bias in the OLS estimates. Ideally, we would have also included other types of care in our IV models. However, it is difficult to find good instruments for other types of child care (e.g., preschool). We did consider using federal spending on child subsidies. However, such funding is based on a formula largely determined by the number of low-income children within a state (i.e. the number qualifying for free or reduced-price lunch), the state's prior level of spending on child care for welfare recipients, and their ability to match and draw down federal funds (Gish, 2002). Consequently, the variation across states is much smaller than for prekindergarten and more likely to be driven by error in measuring either the number of poor children or the cost of care per child.*

6. DOES PREKINDERGARTEN IMPROVE SCHOOL READINESS?

Table 2 presents results from the basic OLS models examining academic and behavioral outcomes in the fall of kindergarten as a function of prekindergarten attendance, with increasing controls included for potential selection effects. Absent other controls, model 1 shows that prekindergarten is positively and strongly associated with reading and mathematics skills—children experiencing prekindergarten have reading (math) scores 3.09 (2.36) points higher than other children. Models 2–4 demonstrate that adding covariates reduces the associations between academic skills and prekindergarten by about 60%, mostly by including demographic characteristics.

We focus below on the results of the most comprehensive specification (model 4), which includes controls for many family, neighborhood, and state conditions and is likely to best account for potential selection factors. In this case, prekindergarten attendance predicts a statistically significant 1.20 higher reading score and 0.95 higher math score, corresponding to effect sizes of 0.12 and 0.10. This represents about one more question answered correctly and would move the median child from the 50th to the 55th percentile for reading and from the 50th to the 54th percentile for math.[20]

In contrast, prekindergarten is associated with an increase in externalizing (aggressive) behavior and insignificantly lower levels of self-control. The addition of covariates has virtually no effect on the estimates for externalizing behavior (effect sizes are about 0.11 in all four models) and increases the negative associations with self-control–to an effect size of —0.07 in model 4. Estimated effects of these magnitudes imply that prekindergarten is predicted to raise children from the median to the 54th percentile of externalizing behavior, and lower them to the 47th percentile of self-control.

7. TEACHER FIXED-EFFECT, PROPENSITY SCORE, AND IV ESTIMATES

The OLS estimates, discussed above, suggest that prekindergarten is positively associated with academic outcomes, but negatively correlated with good classroom behavior. The exceptionally rich set of controls for potential confounding factors and small changes in estimated effects observed when adding more covariates (beyond the basic demographic variables) increases our confidence that these results may indicate causal relationships. Nevertheless, we address the possibility that some sources of selection bias remain by conducting further analyses with three alternative specifications—fixed-effect, propensity score and IV models—the results of which are presented in Table 3. For ease of comparison, the first row of the table repeats the preferred OLS estimates (from model 4 in Table 2).

The second row of Table 3 presents findings for the teacher fixed-effects models. These estimates are consistently smaller than the basic OLS estimates, but still suggest prekindgarten is

20. *Percentile changes were calculated by converting the standardized scores into percentile scores using the cumulative distribution function (cdf), determining the corresponding position in the cdf, and then adding the estimated effect size of prekindergarten. The resulting value was translated back into a percentile using the cdf.*

Table 1
Selected sample characteristics and mean child outcomes, by child care arrangements in the year prior to kindergarten

Outcomes	All	Prekindergarten	Other preschool	Other non-parental care	Head start	Parental care only
Math test score						
Fall kindergarten	52.02	53.99	53.90	50.11	45.64	49.96
	(0.09)	(0.22)	(0.13)	(0.27)	(0.27)	(0.23)
Spring first grade	51.78	52.77	53.25	50.71	46.37	50.76
	(0.09)	(0.20)	(0.12)	(0.25)	(0.31)	(0.23)
Reading test score						
Fall kindergarten	51.24	53.82	53.05	48.83	45.11	49.02
	(0.09)	(0.24)	(0.14)	(0.27)	(0.25)	(0.24)
Spring first grade	51.82	53.07	53.10	50.70	46.81	50.76
	(0.09)	(0.19)	(0.12)	(0.25)	(0.30)	(0.23)
Self control score						
Fall kindergarten	0.93	0.58	1.15	1.53	−1.69	1.77
	(0.10)	(0.24)	(0.15)	(0.27)	(0.32)	(0.23)
Spring first grade	0.34	0.15	0.64	0.80	−2.86	1.27
	(0.10)	(0.24)	(0.14)	(0.28)	(0.33)	(0.24)
Externalizing behavior score						
Fall kindergarten	−0.59	0.32	−0.46	−1.98	1.35	−2.02
	(0.09)	(0.24)	(0.14)	(0.25)	(0.32)	(0.22)
Spring first grade	−0.18	0.15	−0.33	−0.84	2.50	−1.65
	(0.10)	(0.24)	(0.15)	(0.26)	(0.34)	(0.23)
Retained in kindergarten	3%	2%	3%	5%	5%	4%
	(0.17)	(0.37)	(0.23)	(0.60)	(0.65)	(0.47)
Demographic characteristics						
Black	14%	18%	8%	12%	39%	10%
	(0.34)	(0.94)	(0.40)	(0.93)	(1.50)	(0.74)
Hispanic	11%	11%	9%	15%	15%	15%
	(0.31)	(0.75)	(0.41)	(1.01)	(1.09)	(0.88)
Asian	4%	3%	5%	5%	2%	4%
	(0.20)	(0.43)	(0.31)	(0.63)	(0.47)	(0.50)
Boy	50%	49%	51%	49%	47%	52%
	(0.51)	(1.21)	(0.73)	(1.43)	(1.65)	(1.24)
Child age	5.71	5.73	5.73	5.70	5.70	5.70
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Income-to-needs	3.31	3.94	3.92	2.94	1.26	2.46
	(0.04)	(0.10)	(0.05)	(0.08)	(0.03)	(0.06)
Sample size	10,224	1722	4649	1216	914	1621

Notes: Data are for children in the ELCS-K study. Math and reading skills are standardized scores (mean = 50, SD = 10). Behavior outcomes are standardized scores (mean = 0, SD = 10). See Table A17 for definitions of sample characteristics. The table shows sample means of the specified variable, with standard errors in parentheses.

Table 2
OLS estimates of the effects of prekindergarten on academic outcomes and classroom behavior during kindergarten fall

	Reading				Math			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Prekindergarten	3.09**	1.72**	1.24**	1.20**	2.36**	1.36**	0.99**	0.95**
	(0.31)	(0.24)	(0.22)	(0.22)	(0.30)	(0.21)	(0.21)	(0.21)
Demographics		X	X	X		X	X	X
Home and family environment			X	X			X	X
Neighborhood and state characteristics				X				X
R^2	0.01	0.28	0.35	0.35	0.01	0.30	0.36	0.36
	Self control				Externalizing			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Prekindergarten	−0.42	−0.62*	−0.68*	−0.71*	1.10**	1.08**	1.08**	1.11**
	(0.31)	(0.31)	(0.30)	(0.30)	(0.28)	(0.27)	(0.27)	(0.27)
Demographics		X	X	X		X	X	X
Home and family environment			X	X			X	X
Neighborhood and state characteristics				X				X
R^2	0.00	0.09	0.11	0.11	0.00	0.05	0.15	0.15

Notes: *p-value < 0.05; **p-value < 0.01. The sample size for all analyses is 10,224. See Table A1 for details on the covariates. The coefficients represent the average difference between children in prekindergarten and those experiencing any other type of care in the year before kindergarten. Models have robust standard errors clustered at the school level. Dividing the coefficients by 10 gives effect sizes.

Table 3
OLS, teacher fixed-effect, propensity score, and IV estimates of the effects of prekindergarten on child outcomes, kindergarten fall

Estimation technique	Reading	Math	Self-control	Externalizing
OLS	1.20**	0.95**	−0.71**	1.11**
	(0.31)	(0.21)	(0.30)	(0.21)
Teacher fixed-effects	0.83**	0.68**	−0.42	0.84**
	(0.25)	(0.25)	(0.27)	(0.29)
Propensity score	1.36**	1.50**	−0.63	0.95**
	(0.43)	(0.39)	(0.46)	(0.41)
Instrumental variables	8.63**	3.58	−1.57	6.85*
	(2.66)	(2.43)	(3.50)	(2.91)

Notes: *p-value < 0.05; **p-value < 0.01. The sample size for OLS, Fixed-Effect, and IV analyses is 10,224. The sample size for the propensity score models is 10,183 (41 prekindergarten children were not included for lack of common support). Models include the same covariates (child and family demographics, the home environment, neighborhood environment, and state characteristics) as model 4 of Table 2. The teacher fixed effects have 2386 teachers (an average of 6 children per teacher). The IV estimates instrument prekindergarten attendance by state's prekindergarten spending and enrollment, as detailed in the text. IV standard errors have been corrected for the two-stage estimation, and propensity score standard errors were calculated by bootstrapping with 150 repetitions. Dividing coefficients by 10 yields effect sizes. See notes to Table 2.

positively associated with children's academic skills and their poor behavior (although the coefficient for self-control is not statistically significant).[21]

Results of the propensity score analysis are displayed in the third row of the table. The goal of this approach is to construct a comparison sample that matches the treatment group both in their likelihood of attending prekindergarten but also on all covariates. Consequently, one key step is to ensure that the observable characteristics of the comparison group (created in the first step) do not differ from those of the prekindergarten treatment group. Our check for such balance confirmed that there were no differences in the mean level of covariates across the two groups.[22] Satisfied that our matching resulted in an appropriate comparison group, we continued to the second stage of the propensity score analysis. Mean comparisons of the outcomes are remarkably similar to those from the OLS analyses, although slightly larger for the academic outcomes.[23] This suggests that our OLS results were not biased by using an inappropriate comparison group.

Funding for prekindergarten and enrollment varied greatly across states in the late 1990s. We take advantage of this by using state spending and enrollment as instruments for prekindergarten participation. (Details of these instruments are available from the authors). We calculate spending on prekindergarten (per poor child under 6 years of age) in 1998 for the 39 states covered by the ECLSK (data for 1997 are not available). Some states (e.g., Connecticut, Georgia, New Jersey, and Massachusetts) were making substantial investments in prekindergarten, but at least 10 states had no spending at all. In constructing our instrument, we divide state prekindergarten expenditures (per poor child under age 6) by the average cost of center-based care in the state. This provides a measure of the proportion of poor children with access to publicly funded kindergarten. Patterns of prekindergarten enrollment in public schools during 1997 closely mirror state spending patterns in 1998.

It is plausible that access to state-funded programs–based on state policy decisions—will predict the use of prekindergarten while having no independent effect on child outcomes (other than by influencing enrollment). The probit results from the first stage confirm that state spending significantly predicts children's participation: a 10 percentage point increase in the proportion of children with access to a slot in a state increases the probability of prekindergarten attendance by a highly significant 1.26 percentage points, from the base rate of 17% (see Appendix A). In contrast, the share of children in the state attending prekindergarten is not uniquely associated

21. *All kindergarteners in a sampled school were eligible to be included in the study. The study goal was to assess 24 children per school and all children had an equal probability of being sampled with two exceptions. First, twins were sampled as a unit. Second, Asians and Pacific Islanders were over sampled. In our sample, on average there are 14 students per school, and 6 per classroom.*

22. *In addition, we used a Hotelling T^2 test for the joint equality of covariate means, conducted for bins of both 10 and 25, which further verified balance on the covariates across the prekindergarten and comparison group.*

23. *An alternative approach is to use one-to-one matching without replacement in the first step of the analysis, and then regress the outcomes on prekindergarten attendance and all matching variables using the predicted propensity scores as analytic weights for the comparison group (see Hill, Waldfogel, & Brooks-Gunn, 2002). Using this approach, the pattern of estimates did not differ from those reported in Table 3, although the coefficients were slightly smaller. For example, the estimated effect of prekindergarten was 1.03 rather than 1.36.*

with the child's enrollment in prekindergarten holding constant state funding, which is not surprising given they are highly correlated.[24]

The IV estimates of prekindergarten effects always have the same sign but are much larger than the corresponding OLS effects (Table 3). For example, the IV model suggests an effect size for reading of 0.86, compared with 0.12 for OLS. However, a potential concern with using spending as an instrument is that states investing money in prekindergarten may also spend heavily on other programs benefiting children. If so, the instrument could be correlated with the regression error term leading to biased IV estimates. The OLS and IV estimates shown in Table 3 control for two state characteristics—per capita income and spending on education and public welfare. We tested the sensitivity of our IV estimates to the inclusion of other state policies and characteristics, by estimating models with additional state level covariates including proxies for generosity of the welfare system (TANF benefit levels and rules, Medicaid spending) and the state's political climate (e.g., the percent of representatives in the House and Senate that are Democrats, percent of state population that is female, elderly, or black). Our findings were robust to these specification changes. [25]

Table 4
OLS estimates of the effects of prekindergarten on child outcomes, controlling for other types of child care, kindergarten fall and first grade spring

Year before	Reading	Math	Self-control	Externalizing	Held back
Kindergarten fall					
Prekindergarten	1.82**	1.66**	−1.17**	1.88**	—
	(0.30)	(0.29)	(0.39)	(0.35)	
Preschool	1.16**	1.17**	−0.79*	1.38**	—
	(0.25)	(0.25)	(0.31)	(0.28)	
Head start	−0.48	−0.30	−0.93*	1.12**	—
	(0.33)	(0.35)	(0.45)	(0.42)	
Other non-parental	−0.22	0.27	0.74	−1.15**	
	(0.31)	(0.30)	(0.40)	(0.36)	
First grade spring					
Prekindergarten	0.27	0.28	−1.31**	2.13**	−0.42
	(0.27)	(0.27)	(0.38)	(0.36)	(0.68)
Preschool	0.18	0.32	−1.06**	1.42**	−0.49
	(0.23)	(0.23)	(0.30)	(0.28)	(0.55)
Head Start	−0.48	−0.59	−1.44**	1.44**	−0.64
	(0.38)	(0.38)	(0.45)	(0.42)	(0.84)
Other non-parental	−0.12	0.07	0.38	−0.28	0.91
	(0.30)	(0.29)	(0.37)	(0.35)	(0.86)

Notes: *p-value < .05; **p-value < 0.01. See notes on Tables 2 and 3. All models include the full set of covariates, corresponding to (model 4, Table 2). "Held Back" is a dichotomous variable set to 100 (zero) for individuals who are (are not) retained in kindergarten.

24. *The x2 statistic for the joint test of the instruments' significance is 18.94, well above the recommended guideline of 10 suggesting that weak instruments are not a problem in this analysis (Bound, Jaeger, & Baker, 1995). As expected, higher state spending is associated with a lower probability of being exclusively in other types of non-parental care or parental care (see Appendix A). Finally, an overidentification test confirms the validity of the instruments for children's reading, math and self- control outcomes. It suggests that these instruments may be less valid for children's externalizing behavior.*

25. *For example, IV estimates in models that controlled for the average level of welfare benefits yielded effect sizes of 0.73 for reading and 0.79 for externalizing behavior.*

Because we cannot rule out that other unmeasured state characteristics are spuriously biasing our IV results, we use to these estimates to indicate the possible direction of bias in the OLS models, rather than to offer precise estimates of prekindergarten effects. Given that the IV effect sizes are much greater (in absolute value) than those obtained using OLS, we find no indication of an upwards bias in the latter.

Taken together, the four sets of estimates all point to positive effects of prekindergarten on reading and math skills, as well as adverse consequences for children's behavior at school entry.

8. Prekindergarten versus other child care arrangements

Like prekindergarten, preschools, Head Start, and many center-based child care programs incorporate learning activities to promote academic skills and enhance school readiness. However, structural indicators (such as levels of teacher education) suggest that prekindergarten programs, particularly those in public schools, are typically of higher quality (Bellm, Burton, Whitebook, Broatch, & Young, 2002). Consequently, we expect that any gains to academic achievement from other types of programs will be smaller than for prekindergarten. The patterns for behavior are less obvious. Although high-quality care is associated with lower levels of problem behavior (Peisner-Feinberg et al., 2001), some features of some prekindergartens, such as teacher directed basic skill instruction, may result in less positive social climates and more behavior problems.

Table 4 displays the findings of models that separately measure participation in prekindergarten, preschool, Head Start, and other non-parental care; children receiving only parental care are the reference group. For all academic outcomes, the results support a "dose–response" relationship whereby prekindergarten yields larger benefits than preschool–prekindergarten effect sizes for reading and math are 0.18 and 0. 17, compared to 0.12 for other types of preschool. We obtain a similar dose–response pattern for behavior but, in this case, with prekindergarten having larger adverse associations than other types of center-based care. The effect size of prekindergarten is –0.12 for self- control and 0.19 for externalizing behavior as compared with -0.08 and 0.14, respectively for other types of preschool.[26] Head Start is associated with higher levels of externalizing behavior and lower levels of self-control, but is less strongly related to academic outcomes, whereas care in noncenter-based settings has no association with academic skills, but predicts lower levels of problem behaviors. The uniquely disadvantaged nature of Head Start children makes it difficult to find a comparable control group. We attempted to measure Head Start effects with propensity score methods but were unable to construct a comparison group with similar background characteristics, perhaps indicating that selection biases remain for Head Start children in the OLS models.

9. Do the effects of prekindergarten persist?

Our results indicate that prekindergarten boosts children's reading and math scores at school entry, but also increases classroom misbehavior. Prior research has found that the early academic

26. *On average children attended prekindergarten for more hours per week than preschool (23 vs. 20). However, the predicted effects of prekindergarten remain larger when comparing children in similar hours of care. More generally, longer hours of prekindergarten were associated with larger positive benefits for academics and negative effects on behavior. Longer preschool hours were also associated with larger behavioral, but not academic effects.*

advantages associated with preschool fade over time as other children catch up, lasting only through 1 or 2 years of elementary school (Barnett, 1995). This may have important policy implications, because the case for using public funds to invest in early education is weakened if the academic gains are only temporary. We address this issue in the lower panel of Table 4, by presenting estimates for outcomes measured in the spring of the first grade (2000). Compared to kindergarten fall (results displayed in the top panel), the positive associations of prekindergarten with academic outcomes have largely dissipated—effect sizes are about 0.03 for reading and math, nearly one fifth as large as those obtained in the fall of kindergarten. In contrast, the negative associations with classroom behavior persist and actually have increased by the spring of first grade–effect sizes are -0.13 for self-control and 0.21 for externalizing behavior. [27]

Children attending early education programs prior to kindergarten are 3–6 times more likely than their counterparts to be in center-based care (before or after school) in kindergarten and first grade. [28] To test whether this accounts for some of the previously observed negative associations with behavior, we estimated models that added covariates for attending center-based care in kindergarten and first grade. Doing so reduced the effect size of prekindergarten from 0.21 to 0.18 for externalizing behavior, and from -0.14 to -0.11 for self-control, suggesting that the adverse associations of early education programs with good behavior persist, but do not increase over time. [29]

Evidence that prekindergarten raises academic achievement (although possibly only temporarily) while having persistent negative effects on classroom behavior suggests possible trade-offs between the two effects for at least some children. In evaluating this tradeoff, it is worth noting that all three types of formal education are associated with lower probabilities that the child will be held back in kindergarten, suggesting that the gains in academic achievement may be more consequential for this outcome. However, with such a small share (3%) of children being retained, the estimates are small and statistically insignificant, thus further research is called for.

10. Disadvantaged children

Prior studies suggest that early education programs have larger effects for economically disadvantaged populations, primarily because these children come from homes with lower quality learning environments (Peisner-Feinberg et al., 2001; Waldfogel, 2002). We consider this issue using two definitions of economic disadvantage. The first defines disadvantage broadly to include children in poverty (income-to-needs ratio of less than one) or whose mother or father who did not complete high school. The second, more narrow, definition consists of children

27. *Effects of this magnitude would raise the average firstgrader's position in the externalizing distribution from the 50th to the 58th percentile and lower the child from the 50th to the 45th percentile on the self-control distribution. Negative effects on children's behavior are still apparent for Head Start.*

28. *The rates of center-based care in kindergarten, by type of care children were in the prior year, are as follows: prekindergarten 29%; preschool 29%; Head Start 5%; other non-parental care 10%; parental care 5%. In the spring of first grade: prekindergarten 25%; preschool 22%; Head Start 9%; other non- parental care 12%; parental care 7%.*

29. *Coefficients for center-based care in kindergarten and first grade indicate large negative effects on behavior—the effect sizes of center-based care on externalizing behavior are 1.47 in kindergarten and 1.69 in first grade.*

Table 5
OLS estimates for disadvantaged children, kindergarten fall and first grade spring

	Children of parents with low education or in poverty ($N = 2328$)					Children of welfare recipients ($N = 1033$)				
	Reading	Math	Self-control	Externalizing	Held back	Reading	Math	Self-control	Externalizing	Held back
	Kindergarten fall					*Kindergarten fall*				
Prekindergarten	2.37**	1.96**	−1.79*	2.40**	—	2.80**	2.02*	−1.87	1.69	—
	(0.60)	(0.59)	(0.76)	(0.76)		(0.93)	(0.83)	(1.11)	(1.34)	
Preschool	1.47**	1.76**	−1.65*	1.90**	—	1.51*	1.49*	−1.11	0.46	—
	(0.48)	(0.50)	(0.64)	(0.60)		(0.70)	(0.74)	(0.93)	(1.00)	
Head Start	0.25	0.82	−1.60*	1.62*	—	0.59	0.16	−1.19	−0.30	—
	(0.48)	(0.52)	(0.66)	(0.63)		(0.71)	(0.74)	(0.91)	(1.04)	
Other non-parental	0.49	0.71	0.41	−0.88	—	−0.24	−0.77	−0.73	−0.07	—
	(0.55)	(0.60)	(0.77)	(0.71)		(0.86)	(0.88)	(1.25)	(1.20)	
	First grade spring					*First grade spring*				
Prekindergarten	0.62	1.25	−0.95	2.76**	−1.45	1.88	2.00*	−1.37	4.15**	−5.93**
	(0.67)	(0.64)	(0.79)	(0.82)	(1.49)	(1.07)	(1.00)	(1.44)	(1.55)	(2.17)
Preschool	0.34	0.75	−1.13	1.96**	−1.13	0.31	1.25	−0.87	0.59	−2.73
	(0.55)	(0.51)	(0.63)	(0.61)	(1.12)	(0.94)	(0.92)	(1.01)	(1.00)	(2.17)
Head Start	−0.14	0.28	−1.03	1.71**	−0.18	−0.26	0.39	−0.37	0.75	−2.49
	(0.62)	(0.58)	(0.65)	(0.65)	(1.52)	(1.00)	(0.94)	(0.98)	(1.03)	(2.37)
Other non-parental	0.51	0.85	0.57	0.44	2.39	−1.39	−0.16	1.19	0.16	2.85
	(0.63)	(0.63)	(0.73)	(0.72)	(2.04)	(1.14)	(1.07)	(1.15)	(1.31)	(3.45)

Notes: *p-value < 0.05; **p-value < 0.01. All estimates include a full set of covariates (corresponding to model 4, Table 1). See notes to Tables 2–4. Parents with "low education" include those not completing high school.

in families receiving welfare during the fall or spring of kindergarten. (Other specifications of disadvantage, e.g., single parent family, yield similar results). As detailed below, both groups of disadvantaged children have lower levels of achievement and self-control and higher levels of aggression than their more advantaged peers.

Consistent with previous research, the estimated effects of prekindergarten and preschool on academic outcomes are slightly larger for disadvantaged children than the full sample (Table 5). For example, prekindergarten is associated with 0.24 higher reading scores at school entry for disadvantaged children (using the broader definition), compared with 0.18 for the full sample. To put this in perspective, the average disadvantaged child (in poverty or with a less educated parent) scored at the 33rd percentile in reading; attending prekindergarten would raise their predicted performance to the 44th percentile. The estimated effects of prekindergarten on disadvantaged children's academic outcomes also last longer. In the spring of the first grade, the effect sizes for the two disadvantaged groups are 0.13 and 0.20 for math, and 0.06 and 0.19 for reading; in comparison to 0.03 for both outcomes among the general population (Table 5).

The association of prekindergarten with misbehavior at school entry is of a similar magnitude for disadvantaged children and the full sample—effect sizes on externalizing behavior are 0.17–0.24, compared with 0.18 for the general population. However, prekindergarten' s correlation with externalizing behavior is larger by the spring of first grade for disadvantaged children—with effect sizes ranging from 0.28 to 0.42, compared with 0.21 for the full sample.[30]

30. *The effect sizes for prekindergarten fall modestly when controls are added for subsequent center-based care in the fall of kindergarten and spring of first grade.*

Table 6
OLS estimates for public school children by location, kindergarten fall

	All public school children ($N = 7963$)				Children of parents with low education or in poverty ($N = 2190$)			
	Reading	Math	Self-control	Externalizing	Reading	Math	Self-control	Externalizing
Prekindergarten in same school	1.75** (0.49)	1.52** (0.47)	0.03 (0.63)	0.53 (0.58)	2.64** (0.78)	2.33** (0.74)	−0.48 (0.87)	0.66 (0.90)
Prekindergarten not in same school	1.73** (0.40)	1.58** (0.36)	−1.39** (0.49)	2.01** (0.44)	2.01* (0.86)	1.90* (0.82)	−2.45* (1.14)	3.66** (1.12)
Preschool	1.04** (0.28)	1.11** (0.27)	−1.19** (0.33)	1.73** (0.31)	1.18* (0.49)	1.58** (0.51)	−1.76** (0.66)	2.14** (0.61)
Head Start	−0.17 (0.33)	0.25 (0.33)	0.53 (0.42)	−0.99* (0.39)	0.49 (0.56)	0.77 (0.61)	0.59 (0.78)	−0.77 (0.72)
Other	−0.35 (0.35)	−0.15 (0.36)	−1.09* (0.46)	1.22** (0.44)	0.15 (0.49)	0.80 (0.53)	−1.62* (0.66)	1.78** (0.63)

Notes: *p-value<0.05; **p-value<0.01. All estimates include a full set of covariates (corresponding to model 4, Table 1). See notes to Tables 2–4.

The average child in poverty or with less-educated parents is in the 52nd percentile of the externalizing behavior distribution during the spring of first grade; attending prekindergarten is predicted to shift their score to the 68th percentile. On the other hand, prekindergarten does not appear to differentially affect self-control in the spring of the first grade, nor is it associated with an increase in the probability that a child will repeat kindergarten. Among children of welfare recipients it is predicted to reduce grade retention.[31]

11. PUBLIC SCHOOL CHILDREN

We conducted additional regression analyses restricting our sample to public school children, since this population is much more likely than private school students to have attended publicly funded prekindergarten. We further distinguish prekindergarten provided in the child's (public) school from that obtained elsewhere.[32] Forty percent of public school children attending pre-kindergarten did so in the same location as their kindergarten; the proportion was even higher, close to 60%, for poor children. The results from this analysis are summarized in Table 6.

Limiting the sample to children in public schools does not substantially change the estimated effects of prekindergarten on academic preparation. For example, the effect sizes for reading are 0.18 among public school attendees, compared with 0.19 for the full sample. Nor do the estimates differ according to where the prekindergarten program was located, although there is some indication that school-based programs may yield slightly higher benefits for poor children.

31. *On average disadvantaged children had lower levels of self- control, scoring on average at 43rd percentile in the spring of first grade, and were more likely to be held back than their more advantaged peers (5% vs. 3%).*

32. *Unfortunately, if the prekindergarten was not located in the same school in which the child attends kindergarten we do not know where the program was located. Therefore, we cannot distinguish children attending prekindergarten in other public schools from those doing so in non-school or private school settings.*

The pattern of effects for behavior problems are different, with the adverse consequences of pre-kindergarten appearing to be concentrated among public school children not attending programs in the same schools as kindergarten. For externalizing behavior, we find effects sizes of 0.05 (not significant) for children attending prekindergarten in the same school but 0.20 for children doing so in a different location. The pattern is similar for self-control and even more pronounced for both outcomes among children in poverty. One likely explanation is that school based prekindergarten programs are typically of higher quality than prekindergarten programs located elsewhere (Bellm et al., 2002) and may also be more closely aligned with kindergarten classrooms in terms of the expectations they set for children's behavior. [33]

Alternatively, this association may also reflect higher mobility among children with behavior problems (i.e. well-behaved children may change schools relatively infrequently) or that problem behaviors are created by transitioning from one school setting to another, although the latter explanation would suggest that differences in behavior would diminish overtime, which we do not find. Nevertheless, the evidence that children attending prekindergarten programs in public schools do not appear to have increased behavior problems suggests that school-based programs may be particularly beneficial.

12. DISCUSSION AND POLICY IMPLICATIONS

This analysis suggests that prekindergarten is associated with increases in math and reading skills at kindergarten entry, but also with increases in classroom behavior problems. The effect sizes for academic outcomes (compared with parent-only care) are 0.18 for reading and 0.17 for math, which would move the average child from the 50th to the 57th percentile. Attending a (non-prekindergarten) preschool has similar, but smaller effects, yielding effect sizes of about 0.12 for both outcomes. Conversely, prekindergarten and preschool attendance is predicted to raise externalizing behavior problems (the effect sizes are 0.19 and 0.14) and reduce self-control (effect sizes are —0.12 and —0.08). We tested for potential bias in our basic OLS estimates by using teacher fixed-effect, propensity score matching, and instrumental variable analyses. The qualitative pattern of results was robust across these alternatives approaches to controlling for unobserved heterogeneity. Nevertheless, as with any non-experimental study, our results do not prove that the estimated associations are causal.

The second major finding is that 70–80% of the cognitive gains of prekindergarten predicted for the typical child in our sample have faded out by the spring of the first grade (leaving effect sizes of 0.03 for reading and math). In contrast, the correlation with problem behaviors persists, suggesting that the early socialization of aggressive behavior and lack of self-control may be lasting—prekindergarten effect sizes are about —0.14 for self-control and 0.23 for externalizing behavior in the spring of first grade. Children attending preschool or prekindergarten are also more likely to attend center-based care during the first two years of formal schooling, which contributes to these negative effects on behavior.

We also caution that our sample is not representative of all kindergarteners in that children in our sample are more advantaged. Given that we estimate larger effects for

33. *The same pattern of effects was found when limiting our sample to public school children residing in cities or attending schools with more than 50% minority students, indicating there are also benefits to students attending prekindergarten in what are typically thought of as low-quality schools.*

disadvantaged children, it is likely that our findings might understate the average population effect.

Several qualifications are important for interpreting the negative associations observed for children's behavior. First, behavior problems were not apparent among children attending prekindergarten in the same school as kindergarten (or among private school children attending preschool), suggesting that such adverse associations are not a necessary consequence of prekindergarten or other early education. With some evidence indicating that prekindergarten programs located in public schools may be of relatively high quality, further exploration of which dimensions of preschool quality are associated with children's behavior is necessary. We need to learn more about happens inside the "black box" of prekindergarten, and more specifically the types of social interactions and processes that lead to elevated levels of aggressive behavior and lower levels of self-control (Fabes, Hanish, & Martin, 2003). Second, classroom behavior is not necessarily indicative of problem behavior in other settings; for instance, children attending prekindergarten might not exhibit higher levels of aggression at home. Third, absolute levels of aggressive behavior were typically quite low and levels of self-control usually quite high, in this study, even for children attending prekindergarten.

Finally, and perhaps most importantly, the longterm implications of these modest increases in problem behaviors are unclear. Research on externalizing behavior suggests that aggressive behavior decreases over the early school years, as most children develop self-regulation skills, and that slightly elevated aggression during early childhood often does not translate into problematic trajectories of chronic distruptive behavior in middle childhood (NICHD ECCRN, 2004). Research predicting children's school success from behavior at school entry is sparse, but recent work conducted by Duncan et al. (2004) with the ECLS-K suggests that the independent contribution of early aggressive behavior and self-control to later achievement is quite small. Moreover, despite negative effects on behavior, our data hint that children attending prekindergarten may be less likely to be held back in kindergarten. Future research should consider how prekindergarten affects other dimensions of classroom behaviors, such as their task persistence and attentiveness, which may be more closely linked to children's learning (Duncan et al., 2004; Finn & Pannozzo, 2004).

Our reliance on teacher reports of students' behavior raises concerns about the comparative standard used by teachers in rating behavior, and whether some of the apparent negative impacts of prekindergarten might be an artifact of class compositional effects (Finn & Pannozzo, 2004). The teacher-fixed effects analyses, which compare children within the same classroom, make this doubtful. We find that prekindgarten children are rated higher on aggressive behavior than their classmates, although not significantly lower on self-control. However, we recommend that future research be conducted with observational measures of children's behavior.

The initial benefits of prekindergarten and preschool on reading and math scores are particularly large for disadvantaged children, and they exhibit greater persistence than for the full sample. The adverse associations with behavior are not immediately larger for disadvantaged children but are again longer lasting.

Children from disadvantaged backgrounds might receive the largest academic benefits from participating in early education programs because they are less likely to experience home environments that facilitate early learning (Bradley, Corwyn, McAdoo, & Garcia Coll, 2001). On average they have fewer books at home, spend less time reading with their parents, and have less stimulating verbal interactions with them than children from middle-class households (Linver, Brooks-Gunn, & Kohen, 2002). Attending a prekindergarten program that provides a cognitively stimulating environment may partially compensate for these deficits (Bradley, Burchinal, & Casey, 2001). While it is beyond the scope of this paper to estimate the extent to which increasing prekindergarten enrollment will reduce school readiness gaps between more or less advantaged children, we caution that incremental changes may have small to modest effects (Magnuson & Waldfogel, 2005).

Although this study contributes to our understanding of how early childhood education influences school outcomes, some important questions remain unanswered. Without measures of preschool and prekindergarten characteristics and observations of classroom processes we cannot assess how children's outcomes were shaped by differing dimensions of program quality. In addition, other dimensions of children's preschool and prekindergarten experiences (like the number of hours in non- parental care, the age they entered care, and the continuity in preschool arrangements) may also be important to understanding children's outcomes. Finally, although we consider how effects differ for disadvantaged children, other dimensions of children's and family background as well as subsequent schooling experiences may moderate the estimated program effects at school entry as well as the persistence of effects over time.

Our main conclusion is that prekindergarten has few lasting positive effects on advantaged children's skills by first grade and persisting adverse effects on aggression and self-control, but yields larger benefits for disadvantaged children. Among children attending prekindergarten in the same public school as kindergarten, reading and math achievement is increased without an apparent rise in misbehavior. These results suggest that the greatest potential return to public investments in early education may be obtained by increasing disadvantaged children's enrollment in prekindergarten and by expanding programs located in local public schools. Currently, most state-funding initiatives do target at-risk children, but funding falls far short of providing all eligible children with access to these programs (Ripple et al., 1999). There is also variation in whether state-funded prekindergarten programs are delivered in local public schools, which our findings suggest provide the best results, or by suppliers outside schools.

ACKNOWLEDGEMENTS
This research was supported by a grant from the Russell Sage Foundation's Social Inequality program. We are grateful to Elizabeth Cascio, Janet Currie, Eric Wanner, and participants at the May 2003 Social Inequality conference for helpful comments. We would also like to thank Marcia Meyers and Dan Rosenbaum for many helpful discussions. Additional funding support was provided by the John D. and Catherine T. MacArthur Foundation, NICHD, and NSF.

APPENDIX A
For Probit estimation of marginal effects of state prekindergarten expenditures and prekindergarten enrollment on type of care in the year prior to kindergarten see Table A1.

Table A1

Probit estimates of marginal effects of state prekindergarten expenditures and prekindergarten enrollment on type of care in the year prior to kindergarten

	Prekindergarten	Preschool	Head start	Other non-parental care	Parental care
Prekindergarten expenditures	1.26**	−0.64	−0.07	−0.73*	−0.81*
	(0.39)	(0.56)	(0.15)	(0.33)	(0.37)
Prekindergarten enrollment	0.40	−0.65	0.33*	0.18	−0.12
	(0.38)	(0.53)	(0.14)	(0.25)	(0.31)
F-test	18.94**	5.28	5.94	5.45	8.24*

Findings presented in Column 1 replicate the first stage of the IV analysis. All analyses includes the full set of covariates. Expenditure data is for 1998, and enrollment data is for 1997. Raw expenditures are divided by the number of poor children in the state under age 6 and the average cost of full-time child care for a 4-year-old child in the state. Enrollment is the number of children enrolled in prekindergarten divided by the number of poor children under age 6 in the state. Mean level of expenditures is .012, mean level of enrollment .034. The *F*-test statistic is for a joint test that effects of expenditures and enrollment are equal to 0.

REFERENCES

Bainbridge, J., Meyers, M., Tanako, S., & Waldfogel, J. (2005). Who gets an early education? Family income and the gaps in enrollment of 3- to 5-year-olds from 1968–2000. Social Science Quarterly, 86(3), 724–745.

Barnett, W. S. (1995). Long-term effects of early childhood programs on cognitive and school outcomes. The Future of Children, 5, 25–50.

Barnett, W. S., Hustedt, J. T., Robin, K. B., & Schulman, K. L. (2004). The state of preschool: 2004 state preschool yearbook. New Brunswick, NJ: NIEER.

Bates, J. E., Marvinney, D., Kelly, T., Dodge, K. A., Bennett, D. S., & Pettit, G. S. (1994). Child care history and kindergarten adjustment. Developmental Psychology, 30, 690–700.

Bellm, D., Burton, A., Whitebook, M., Broatch, L., & Young, M. P. (2002). Inside the pre-K classroom: A study of staffing and stability in state -funded prekindergarten programs. Washington, DC: Center for Child Care Workforce.

Belsky, J. (2001). Emanuel Miller lecture: Developmental risks (still) associated with early child care. Journal of Child Psychology & Psychiatry & Allied Disciplines, 42, 845–859.

Blank, H., Schulman, K., & Ewen, D. (1999). Keyfacts: Essential information about child care, early education, and school-age care. Washington, DC: Children's Defense Fund.

Blau, D. (2001). The child care problem. New York: Russell Sage Foundation.

Blau, D., & Currie, J. (in press). Who's minding the kids? Preschool, day care and after school. In W. Finnis & E. Hanushek (Eds.), Handbook of Economics of Education. New York: North-Holland.

Bound, J., Jaeger, D. A., & Baker, R. (1995). Problems with instrumental variables estimation when the correlation between the instruments and the endogeneous explanatory variable is weak. Journal of the American Statistical Association, 90, 443–450.

Bradley, R. H., Burchinal, M., & Casey, P. H. (2001). Early intervention: The moderating role of the home environment. Applied Developmental Science, 5, 2–8.

Bradley, R. H., Corwyn, R. F., McAdoo, H. P., & Garcia Coll, C. (2001). The home environments of children in the United States part I: Variations by age, ethnicity, and poverty status. Child Development, 72, 1844–1867.

Brooks-Gunn, J. (2003). Do you believe in magic? What we can expect from early childhood intervention programs? SRCD Social Policy Report, 17, 3–14.

Carneiro, P., & Heckman, J. J. (2003). Human capital policy. In B. W. Friedman (Ed.), Inequality in America: What role for human capital policies? (pp. 77–239). Cambridge, MA: MIT Press.

Cascio, E. (2004). Schooling attainment and the introduction of human capital into public schools. Mimeo. Davis: University of California.

Duncan, G., Claussens, A., & Engel, M. (2004). The contribution of hard skills and socio-emotional behavior to school readiness. Mimeo. Northwestern University.

Entwisle, D., & Alexander, K. L. (1993). Entry into school: The beginning school transition and educational stratification in the United States. Annual Review of Sociology, 19, 401–423.

Fabes, R. A., Hanish, L. D., & Martin, C. L. (2003). Children at play: The role of peers in understanding the effects of child care. Child Development, 74, 1039–1043.

Finn, J. D., & Pannozzo, G. M. (2004). Classroom organization and student behavior in kindergarten. Journal of Educational Research, 98, 79–92.

Fryer, R. G., & Levitt, S. (2004). Understanding the black-White test score gap in the first two years of school. Review of Economics and Statistics, 86, 447–464.

Gilliam, W. S., & Zigler, E. (2001). A critical meta-analysis of all evaluations of state-funded preschool from 1977 to 1998: Implications for policy, service delivery and program evaluation. Early Childhood Research Quarterly, 15, 441–473.
Gilliam, W. S., & Zigler, E. (2004). State efforts to evaluate the effects of prekindergarten: 1977–2003. Mimeo. Yale University.
Gish, M. (2002). Child care: Funding and spending under federal block grants. Washington, DC: Congressional Research Service, The Library of Congress.
Gormley, W., & Gayer, T. (2005). Promoting school readiness in Tulsa: An evaluation of Tulsa's pre-K program. Journal of Human Resources, XL, 553–558.
Gormley W. T., Jr., Gayer, T., Phillips, D. & Dawson, B. (2004). The effects of universal pre-K on cognitive development. Mimeo. Georgetown University.
Gresham, F. M., & Elliot, S. N. (1990). Elementary scale A ("how often?"). Circle Pines, MN: American Guidance Service, Inc.
Hill, J., Waldfogel, J., & Brooks-Gunn, J. (2002). Differential effects of high-quality care. Journal of Policy Analysis and Management, 21, 601–627.
Krueger, A. (2003). Economic considerations and class size. Economic Journal, 113, 34–63.
Lewit, E. M., & Baker, L. S. (1995). School readiness. The Future of Children, 2, 128–139.
Linver, M. R., Brooks-Gunn, J., & Kohen, D. E. (2002). Family processes as pathways from income to young children's development. Developmental Psychology, 5, 719–734.
Magnuson, K. A., Meyers, M., Ruhm, C., & Waldfogel, J. (2004). Inequality in preschool education and school readiness. American Educational Research Journal, 41, 115–157.
Magnuson, K. A., & Waldfogel, J. (2005). Early childhood care and education: Effects on racial and ethnic test score gaps. Future of Children, 15, 169–196.
Murphy, K. M., & Topel, R. H. (1985). Estimation and inference in two-step econometric models. Journal of Business & Economic Statistics, 3, 370–379.
National Center for Education Statistics. (2002). User's manual for the ECLS-K first grade public use data files and electronic code book. Washington, DC: US Department of Education.
NICHD ECCRN. (2002). Child care structure >process> outcome: Direct and indirect effects of child-care quality on young children's development. Psychological Science, 13, 199–206.
NICHD ECCRN. (2003). Does amount of time spent in child care predict socioemotional adjustment during the transition to kindergarten? Child Development, 74, 976–1005.
NICHD ECCRN. (2004). Trajectories of physical aggression from toddlerhood to middle childhood. Monographs of the Society for Research in Child Development, 69 vii–129.
NICHD ECCRN, Duncan, G. (2003). Modeling the impacts of child care quality on children's preschool cognitive development. Child Development, 74, 1454–1475.
Peisner-Feinberg, E. S., Burchinal, M. R., Clifford, R. M., Culkin, M. L., Howes, C., Kagan, S. L., et al. (2001). The relation of preschool child-care quality to children's cognitive and social development trajectories through second grade. Child Development, 723, 1534–1553.
Phillips, D., Mekos, D., Scarr, S., McCartney, K., & Abott-Shim, M. (2001). Within and beyond the classroom door: Assessing quality in child care centers. Early Childhood Research Quarterly, 15, 475–496.
Pianta, R. C., LaParo, K. M., Payne, C., Cox, M. J., & Bradley, R. (2002). The relation of kindergarten classroom environment to teacher, family, and school characteristics and child outcomes. The Elementary School Journal, 102, 225–238.

Rimm-Kaufman, S. E., Pianta, R. C., & Cox, M. J. (2000). Teachers' judgements of problems in the transition to kindergarten. Early Childhood Research Quarterly, 15, 147–166.
Ripple, C. H., Gilliam, W. S., Chanana, N., & Zigler, E. (1999). Will fifty cooks spoil the broth? American Psychologist, 54, 327–343.
Schulman, K., Blank, H., & Ewen, D. (1999). Seeds of Success: State Prekindergarten Initiatives 1998–1999. Washington, DC: Children's Defense Fund.
Smith, T., Kleiner, A., Parsad, B., Farris, E., & Green, B. (2003). Prekindergarten in US Public Schools. Washington, DC: US Department of Education, National Center for Education Statistics.
Stipek, D. J., Feiler, R., Byler, P., Ryan, R., Milburn, S., & Salmon, J. M. (1998). Good beginnings: What difference does the program make in preparing young children for school? Journal of Applied Developmental Psychology, 19, 41–66.
US Bureau of the Census. (1970). School enrollment: Social and economic characteristics of students, October 1969. Current population reports. Washington, DC: US Bureau of the Census.
US Census Bureau. (2001). State estimates for people under age five in Poverty for US: 1998. Retrieved January 14, 2003 from http://www.census.gov/hhes/www/saipe/stcty/e98_00.htm
US Department of Education. (2003). The condition of education. Washington, DC: National Center for Education Statistics NCES.
Waldfogel, J. (2002). Child care, women's employment and child outcomes. Journal of Population Economics, 15, 527–548.
Wolfe, B., & Scrivner, S. (2003). Providing universal preschool for four-year olds. In B. Sawhill (Ed.), One -percent for the kids: New policies, brighter futures for America's children (pp. 113–135). Washington, DC: Brookings.