Does Prekindergarten Improve School Preparation and Performance?

Katherine A. Magnuson
University of Wisconsin—Madison

Christopher Ruhm
University of North Carolina, Greensboro

Jane Waldfogel
Columbia University

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Address for corresponding author:
Katherine Magnuson
University of Wisconsin—Madison
School of Social Work
1350 University Ave.
Madison, WI 53703
kmagnuson@wisc.edu
Phone (608) 263-4812
Fax (608) 263-3836

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Abstract

Prekindergarten programs are expanding rapidly, but to date, 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 increases reading and mathematics skills at school entry, but also increases behavioral problems. By the spring of first grade, effects on academic skills have largely dissipated, but the behavioral effects persist. Larger and longer lasting 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.

Does Prekindergarten Improve School Preparation and Performance?

1. Introduction

The share of U.S. children attending early education programs has risen dramatically in recent years -- 66% of four-year olds were enrolled in a center or school-based preschool program in 2001, up 23 percentage points from thirty years earlier (U.S. 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 et al., 2004; US Department of Education, 2003).

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 -- early education programs sponsored by school districts (Bowman, Donovan and Burns, 2001; Committee on Economic Development, 2002; Wolfe and Scrivner, 2003 U. S. General Accounting Office, 2000a, 2000b; Gilliam and Zigler, 2001). Since 1990, state funding for prekindergarten has increased 250% to approximately $1.9 billion, and now one in seven four-year olds are enrolled in prekindergarten (Education Week, 2002). Thirty-nine states funded prekindergarten in 2000, although only 7 – Connecticut, Georgia, Illinois, Kentucky, Massachusetts, Ohio, and Oklahoma – make substantial per capita investments (Schulman et al., 1999; Ripple et al., 1999; Education Week, 2002).[1] Local school districts also invest in prekindergarten programs independently, although the bulk of this money comes from federal funding (Smith et al., 2003).

[1] The Education Commission of the United States (2003) summarizes state activities in early education.

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. 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?

We use data from the newly available Early Childhood Longitudinal Study – Kindergarten Class of 1998-99 (ECLS-K), a large nationally representative sample of children entering kindergarten in the fall of 1998. 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 ELS-K 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 – 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 of prekindergarten quickly 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 (see Barnett, 1995; Currie, 2001; Karoly et al., 1998; Brooks-Gunn, 2003; Farran, 2000; Ramey and Ramey, 2000; Vandell and Wolfe 2000; Waldfogel, 2002). However, it is not clear whether more typical preschool or prekindergarten programs improve children's cognitive and academic outcomes (Gilliam and 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 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 and Zigler, 2001; NICHD ECCRN, 2002b; NICHD ECCRN and Duncan, 2003).[2] However, these analyses typically control for only a few potential selection factors, raising the possibility that resulting associations are spurious rather than causal (Blau, 2001; Currie & Blau, in press).

[2] The Head Start program has also been extensively studied with non-experimental research designs. However, selection bias is a major problem, given the disadvantaged nature of the Head Start population. Studies most successfully addressing this issue tend to find the most positive and long-lasting academic benefits (e.g. Currie and Thomas, 1995; Garces et. al. 2001).

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. 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, 2002a; Phillips, Mekos, Scarr, McCartney, and Abbott-Shim, 2001), and the data on these indicators suggest that school-based prekindergarten is of relatively high quality (Ripple et al., 1999; Smith et al., 2003).[3]

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 and Gayer's (2003) 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.[4] The results suggest that prekindergarten boosted children's language skills by 0.39 of a standard deviation, with the largest effects for Hispanic and black children who attended full-day programs.[5] An additional study analyzed prekindergarten programs as distinct from other types of preschool or center-based care. Magnuson and colleagues (2004), using data from the ECLS-K, similarly 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 bias due to the differential selection of children into prekindergarten were not thoroughly addressed**.**

[3] For example, 86% of school-based prekindergarten teachers have a four-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.

[4] Part of Oklahoma's universal prekindergarten initiative, Tulsa's program offers part- or full-day early education classes in public schools to any child who turns four by September 1.

[5] 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 behavior adjustment (Rimm-Kaufman et al., 1998; Shonkoff and Phillips, 2000; Carneiro and 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 and Baker, 1995). Furthermore, aggressive behavior and a lack of self-control predict lower academic achievement, although whether these associations are causal remains controversial (Alexander, Entwisle, and Dauber, 1993; Hinshaw, 1992).

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.[6] Non-experimental research by Stipek and colleagues (1998) found that attending a preschool or kindergarten with a basic-skills emphasis was associated with higher levels of problem behavior, compared to programs offering less basic skill instruction and more child-directed learning approaches (Stipek et al., 1998). 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 increase behavior problems.

More general evidence on the link 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 (2003) evaluation of the Tulsa prekindergarten program found no behavioral effects.

[6] Although an experimental evaluation of the model Perry Preschool program indicates no effect on school misbehavior (Schweinhart, Barnes, and Weikart, 1993), 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). However, longer-term follow-ups of children who participated in model programs generally find improved social outcomes (e.g. reductions in crime and teen pregnancy) (Carneiro and Heckman, 2003).

Taken together, the prior literature suggests that early education may increase children's academic skills and possibly misbehavior, but is 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 (Duncan and Gibson, 2000).

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 well as academic skills. Third, we better deal with selection effects due to the extensive array of child, family background, school, and classroom characteristics included in our data set, and by 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 of 1998-99, a nationally representative sample of children attending kindergarten in the fall of 1998 that was designed and carried out by the U.S. 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 (for the first time) in the fall of 1998.[7] This sample size reflects the exclusion of 1,848 children for whom information on child care/early education or one of the outcomes was missing and 5,540

[7] The ECLS-K had high completion rates with close to 90% of children and teachers, and 85% of parents participating in the study in the fall of kindergarten. Non-response did not differ by child or family characteristics, except that parents of Asian children were slightly less likely to complete parent interviews due to language barriers (National Center for Education Statistics, 2001).

children for whom data was not collected in the spring of first grade.[8] 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).[9]

3.1 Outcomes

Children's math and reading skills were assessed during one-on-one testing sessions in the fall of kindergarten and the spring of first grade.[10] 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 (National Center for Education Statistics, 2001).

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).[11] Consequently, the scores should be interpreted as children's ability relative to their peers, and can be translated into effect sizes by dividing regression coefficients by 10. The sample analyzed scored

[8]About 13% of those who were excluded in the fall of kindergarten were non-English speaking, and therefore were not administered reading assessments. Just over 40% were missing parent report data and 30% were missing teacher report data. An additional 790 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. Robustness checks performed by adding these children back to the sample did not substantively change any of the results.

[9] 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).

[10] 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.

[11] 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.

slightly above the full sample mean at school entry and during first grade, with average reading scores of 51 and math scores of 52.[12] The 3 percent of children still in kindergarten in the spring of 2000 were classified as having repeated kindergarten (since they should have progressed to first grade in the fall of 1999).

Teacher reports of children's externalizing behavior and self-control measure children's classroom behavior.[13] 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.[14] The final 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.[15] Using these

[12] This partially reflects our exclusion of children who are repeating kindergarten, are not proficient in English or who transferred schools and were not followed up in first grade.
[13] These are adapted from the Social Rating System (SRS, Gresham and Elliot, 1990).
[14] Externalizing behavior is highly negatively correlated with self-control (-0.70, $p<.01$). 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.
[15] 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-

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 can not determine how parents distinguish between different types of programs, with misclassification seeming most likely for preschool and prekindergarten. Our presumption is that programs 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 reassuring piece of evidence is that the prekindergarten enrollment rate of 15% for children in public schools 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%). Because we are interested in understanding the effects of publicly funded programs, we estimate some analyses separately for children attending kindergarten in public schools, and also consider whether effects differ if the prekindergarten program is located in the same school in which the child attends kindergarten.

3.3 Additional Explanatory Variables

Most of our regressions contain exhaustive controls for child, family background, and neighborhood characteristics. These include demographic and family characteristics such as race/ethnicity, age, health status at birth, height, weight, and gender, the household income-to-needs ratio, parental education, region of the country, family structure and size, and language spoken in the home. Appendix Table 1 provides details on all of the covariates.

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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 below.

We also incorporate measures of the child's home environment, using data from surveys of parents in the fall and spring of kindergarten.[16] 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 information on 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).[17]

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 US Bureau of the Census (2001).

Information on one or more background characteristics are lacking for some children.[18] 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

[16] These surveys were primarily conducted with mothers. If the child's mother was unable to complete the interview, another knowledgeable adult in the household did so.

[17] 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.

[18] Rates of missing data are quite low, below 2% for most child and family characteristics.

weight, the two low birthweight variables were recoded to have a value of zero, and a dummy variable indicating missing birthweight data was created.

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 by the number of children under 6 and the average cost of center-based care for four-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.[19]

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 nonparental 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:

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

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.

[19] Values for both variables range from 0 to .08, and the two instruments are highly correlated (r=.68).

Equation (1) does not control for types of care other than prekindergarten, so that $\hat{\beta}$ 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.

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:

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

The difference in outcomes for child *i* in classroom *t* (O_{it}) and the average child in the same classroom *t* ($O_{.t}$) is estimated as a function of their 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 reduce biases related to differences in the classroom environment and in the methods used by teachers to rate students. Biases due to unobserved neighborhood characteristics will also be reduced (since most elementary schools are neighborhood based).

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 instance, 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 (compared to OLS) requires fewer assumptions about the "correct" functional form. Our propensity score analysis proceeds in two steps. First, we estimate a propensity score for each individual 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:

$$(3) \qquad \Pr(\text{prekindergarten}=1 \mid \Sigma X_{ij}, \Sigma \text{State}_j).$$

The propensity score is next used to create a matched control group of children who did not attend prekindergarten. [20] We use a 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 (the area of common support).[21] 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.

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

$$(4) \qquad PREK_{ij} = STEXPEND_j\beta_1 + STENROLL_j\beta_2 + X_{ij}\gamma + S_j\delta + \varepsilon_{ij}.$$

[20] 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.

[21] We use STATA8's shareware psmatch2 program to conduct the propensity score analysis, specify a caliper width of .001, and allow for "replacement" (or the ability for a comparison case to serve as a control more than once).

Because $PREK_{ij}$ is dichotomous, (2) is estimated as a probit model. 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).[22] As detailed below, state prekindergarten expenditures and enrollment predict attendance quite well and are likely to be satisfactory instruments.

5. Descriptive 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., 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. Finally, 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.[23]

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[22] 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.

[23] However, when we restrict the sample to children in public schools, the income-to-need ratios is higher for children attending preschool (3.63) than prekindergarten (3.33). Family poverty is one criterion for Head Start enrollment, so it is no surprise that children attending Head Start had the lowest household income-to-needs ratios.

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 again 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) through (4) demonstrate that the addition of covariates reduces the prekindergarten effect by about 60 percent, most of which is due to the inclusion of 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 50^{th} to the 55^{th} percentile for reading and from the 50^{th} to the 54^{th} percentile for math.[24]

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. Effects of these magnitudes imply that prekindergarten is predicted to raise children from the median to the 54^{th} percentile of externalizing behavior, and lower them to the 47^{th} percentile of self-control.

7. Teacher Fixed-Effect, Propensity Score, and IV Estimates

[24] 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.

The OLS estimates, discussed above, suggest that prekindergarten has positive effects on academic outcomes, but negative effects on 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 a positive effect of prekindergarten on children's academic skills and a negative impact on behavior (although the coefficient for self-control is not statistically significant).

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 is matched to the treatment group on the predicted likelihood of attending prekindergarten, and also on all regressors. 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.[25] 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

[25] 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.

OLS analyses, although slightly larger for the academic outcomes.[26] 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. Figure 1 displays how spending on prekindergarten (per child under six years of age) varied in 1998 for the 39 states covered by the ECLS-K.[27] 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 child under age six) 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 presented in Figure 2 closely mirror state spending patterns in 1998.[28]

It is plausible that access to state-funded programs will predict the use of prekindergarten while having no independent effect on child outcomes (other than by influencing enrollment).[29] 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 Table 2). In contrast, the share of children in the state attending

[26] 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, 2003). 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.

[27] We use funding during the 1998-1999 school year because data are unavailable for 1997-1998, the year these children would have attended prekindergarten programs.

[28] The enrollment data differs from that on state spending by also including participation in locally or federally funded prekindergarten.

[29] State spending for prekindergarten programs is a state policy decision and is unlikely to be linked to the characteristics of children and families within a state, and so may be exogenous.

prekindergarten is not uniquely associated with the child's enrollment in prekindergarten.[30] The Chi-square statistic for the joint test of the instruments' significance is 18.94, well above the recommended guideline of 10 (Bound, Jaeger, and Baker, 1995). Finally, as expected, higher state spending is associated with a lower probability of being exclusively in other types of non-parental care or parental care (Appendix Table 2).

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 on reading of 0.86, compared with 0.12 for OLS. Because the effects predicted using IV are much greater (in absolute value) than the OLS estimates, we find no indication that the OLS results are biased upwards.

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.[31]

[30] Prekindergarten enrollment is strongly associated with prekindergarten attendance when state spending is not included in the model.

[31] 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.

Taken together, the four sets of estimates all point to positive effects of prekindergarten on children's 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 et al., 2002). Consequently, we expect that the gains to academic achievement, if any, 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), there may be features of prekindergarten, such as teacher directed basic skill instruction, that 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 (e.g., babysitters or relative 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 effects 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.[32] Head Start is associated with higher levels of

[32] On average children attended prekindergarten for more hours 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

externalizing behavior and lower levels of self-control, but is less strongly related to academic outcomes, whereas care in non-center-based settings has no effect on academic skills, but may be associated with lower levels of problem behaviors.[33]

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 advantages associated with preschool fade over time, lasting only through one or two years of elementary school (Barnett, 1995). This may have important policy implications, since 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 the kindergarten fall results (displayed in the top panel), the positive effects of prekindergarten on 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 effects on classroom behavior persist and actually have increased in size by the spring of first grade – effect sizes are -0.13 for self-control and 0.21 for externalizing behavior.[34]

Children attending early education programs prior to kindergarten are 3 to 6 times more likely than their counterparts to be in center-based care (before or after school) in kindergarten and first

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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.

[33] The uniquely disadvantaged nature of children attending Head Start makes it particularly 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 in the OLS models.

[34] Effects of this magnitude would raise the average first-grader's position in the externalizing distribution from the 50th percentile to the 58th 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.

grade.[35] To test whether this accounts for some of the previously observed negative effects on 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 effects of early education programs on behavior persist, but do not increase over time.[36]

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. 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 and 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 (Karoly et al., 1998; 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 in families receiving welfare during the fall or spring of kindergarten.[37]

[35] 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%.

[36] 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.

[37] Using other specifications of disadvantage (e.g., living in a single parent family) yield similar results.

Consistent with previous research, the estimated effects of prekindergarten and preschool on academic outcomes are slightly larger for disadvantaged children than the general population (Table 5). For example, the effect size of prekindergarten on reading scores at school entry is 0.24 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 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; compare with 0.03 for both outcomes among for the general population (Table 5).[38]

The negative effect of prekindergarten on behavior at school entry is of similar magnitude for disadvantaged children as for the full sample – effect sizes on externalizing behavior are 0.17 to 0.24, compared with 0.18 for the general population. However, the detrimental effects on externalizing behavior appear to be larger by the spring of kindergarten for disadvantaged children – where the effect sizes range from 0.28 to 0.42, compared with 0.21 for the full sample.[39] The average child in poverty or with less-educated parents is in the 52th percentile of the externalizing behavior distribution during the spring of first grade; attending prekindergarten is predicted to raise 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 does it increase the probability that a child will repeat kindergarten (among children of welfare recipients it is predicted to reduce grade retention).

11. Public School Children

[38] Prekindergarten's beneficial effect in reducing grade retention was also significantly larger for children from welfare families.

[39] 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.

We conducted additional 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.[40] Forty percent of public school children attending prekindergarten did so in the same location as their kindergarten; the proportion was even higher, close to 60%, for poor children.[41] The results of this analysis are summarized in Table 6.

Limiting the sample to children in public schools does not substantially change the estimated effect of prekindergarten on academic preparation.[42] For example, the effect sizes for reading are .18 among public school attendees, compared with .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.

The pattern of effects for behavior problems are different, with the adverse consequences of prekindergarten 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 .05 (not significant) for children attending prekindergarten in the same school but .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

[40] 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 can not distinguish children attending prekindergarten in other public schools from those doing so in non-school or private school settings.

[41] In contrast, only 14% of children enrolled in a nonprekindergarten preschool attended a program located in their public school.

[42] We also find a similar pattern of effects among private school children with one exception. Children who attended preschool programs do not display higher levels of externalizing behavior or lower levels of self control.

out for children's behavior.[43] Alternatively, this association may also reflect higher mobility among children with behavior problems (i.e. well behaved children may change schools relatively infrequently). 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 increases school readiness, as measured by math and reading skills at kindergarten entry, but is also associated with an increase in classroom behavior problems. The effect sizes for academic outcomes (compared to 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 percentiles. Attending a (nonprekindergarten) preschool has similar but smaller effects, yielding effect sizes of about 0.12 for both outcomes. Conversely, prekindergarten and other 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.

The second major finding is that 70 to 80 percent of the cognitive gains of prekindergarten predicted for the typical child 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 over time, 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

[43] 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 percent minority students, indicating benefits to students attending what are typically thought of as low-quality schools.

center-based care during the first two years of formal schooling, which contributes to these negative effects on behavior.

Several qualifications are important for interpreting the negative effects 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 impacts are not a necessary consequence of attending prekindergarten or other early education. With some evidence indicating 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. Second, classroom behavior is not necessarily indicative of problems 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, the long-term implications of these modest increases in problem behaviors are unclear. Research predicting children's school success from behavior at school entry is sparse, but recent work conducted by Duncan and colleagues (2004) suggests that the contribution of early school behavior to later achievement is quite small.[44]

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 effects on behavior are not immediately larger for disadvantaged children but are again longer lasting.

[44] Controlling for a large set of background characteristics included in the ECLS-K, they find that math and reading skills at school entry are far more important determinants of children's academic outcomes in first grade than teachers' reports of behavior.

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, and Garcia Coll, 2001). For example, 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, and Kohen, 2002). Attending a prekindergarten program that provides a cognitively stimulating environment may partially compensate for these deficits (Bradley, Burchinal, and Casey, 2001; Caughy, DiPietro, and Strobino, 1994; Hubbs-Tait et al., 2001).

Our main conclusion is that prekindergarten has few lasting positive effects on advantaged children's skills and persisting adverse effects on their behavior, 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 problem behaviors. These results suggest that the greatest 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 currently in whether state funded prekindergarten programs are delivered in local public schools, which our findings suggest provide the best results, or by providers outside schools.

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References

Alexander, Karl, Doris R. Entwisle, and Susan L. Dauber. 1993. "First Grade Classroom Behavior: Its Short- and Long-term Consequences for School Performance." *Child Development, 64*, 801-814.

Bainbridge, Jay, Marcia Meyers, SakikoTanako, and Jane Waldfogel. 2004. "Who Gets an Early Education? Family Income and the Gaps in Enrollment of 3- to 5-year-olds from 1968-2000." Mimeo, Columbia University School of Social Work.

Barnett, W. Steven. 1995. "Long-term Effects of Early Childhood Programs on Cognitive and School Outcomes." *The Future of Children, 5*, 25-50.

Bates, John E., Denny Marvinney, Timothy Kelly, Kenneth A. Dodge, David S. Bennett, and Gregory S. Pettit.1994). "Child Care History and Kindergarten Adjustment." *Developmental Psychology,* 30, 690-700.

Bellm, Dan, Alice Burton, Marcy Whitebook, Linda Broatch, and Marci P. Young. 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, Jay. 2001. "Emanuel Miller Lecture: Developmental Risks (Still) Associated with Early Child Care." *Journal of Child Psychology & Psychiatry & Allied Disciplines*, 42, 845-859.

Blank, Helen, Karen Schulman, and Danielle Ewen. 1999. *Key Facts: Essential Information about Child Care, Early Education, and School-age Care*. Washington, DC: Children's Defense Fund.

Blau, David. 2001. *The Child Care Problem*. NY, NY: Russell Sage Foundation.

Bowman, Barbara T., M. Suzanne Donovan, and M. Susan Burns, Eds. 2001. *Eager toLearn: Educating our Preschoolers*. Washington, DC: National Academy Press.

Bound, J., David A. Jaeger, and Regina Baker. 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, Robert H., Margaret Burchinal, and Patrick H. Casey. 2001. "Early Intervention: The Moderating Role of the Home Environment." *Applied Developmental Science, 5*, 2-8.

Bradley, Robert H., Robert F. Corwyn, Harriet P. McAdoo, and Cynthia Garcia Coll, 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, Jeanne. 2003. "Do You Believe in Magic? What We Can Expect From Early Childhood Intervention Programs?" *SRCD Social Policy Report, 17, 3*-14Carneiro, Pedro and James J. Heckman. 2003. "Human Capital Policy." In Benjamin W. Friedman (ed) *Inequality in America: What Role for Human Capital Policies?* Cambridge, MA: MIT Press.

Cascio, Elizabeth. 2004. Schooling Attainment and the Introduction of Human Capital into Public Schools." Mimeo University of California, Davis.

Caughy, Margaret O., Janet A. DiPietro, and Donna St.robino. 1994. "Day Care Participation as a Protective Factor in the Cognitive Development of Low-income Children." *Child Development*, *65*, 457-471.

Comittee for Economic Development. 2002. *Preschool for All: Investing in a Productive and Just Society*. New York: Committee for Economic Development.

Currie, Janet. 2001. "Early Childhood Intervention Programs: What Do We Know?" *Journal of Economic Perspectives*, 15, 213-38. Currie, Janet and David Blau. In press. "Preschool, Day Care and After School: Who's Minding the Kids." *Handbook of Economics of Education*.

Currie, Janet, and Duncan Thomas. 1995. "Does Head Start Make a Difference?" *American Economic Review, 85*, 341-364.

Currie, Janet, and Duncan Thomas. 2000. "School Quality and the Longer-term Effects of Head Start." *Journal of Human Resources*, *35*, 755-774.

Duncan, Greg, Amy Claessens, and Mimi Engel. 2004. "The Contribution of Hard Skills and Socio-emotional Behavior to School Readiness." Mimeo, Northwestern Unversity.

Duncan, Greg, and Christina Gibson. 2000. "Selection and Attrition in the NICHD Child Care Study's Analyses of the Impacts of Child Care Quality on Child Outcomes." Mimeo, Northwestern University.

Education Commission of the United States. 2003. *State funded Prekindergarten Programs*. Retrieved December 19, 2003, from http://www.ecs.org/dbsearches/EarlyLearning_Reports.htm

Education Week. 2002. "Quality Counts 2002: Building Blocks for Success." *Education Week, 21*17, January 10. Retrieved on June 27, 2003 from, http://www.edweek.org/sreports/qc02/templates/article.cfm?slug=17exec.h21

Farran, Dale C. 2000. "Another decade of intervention for children who are low-income or disabled: What do we know now?" In Jack Shonkoff and Samuel Meisels (Eds)., *Handbook of Early Childhood Intervention, Second edition* (pp. 510-548). New York: Cambridge University Press.

Garces, Eliana, Duncan Thomas, and Janet Currie. 2002. "Longer-term Effects of Head Start." *American Economic Review*, *92*, 999-1012.

Gilliam, William S. and Edward Zigler. 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, William S. and Edward Zigler. 2004. "State Efforts to Evaluate the Effects of Prekindergarten: 1977 to 2003." Mimeo, Yale University.

Gresham, Frank M. and Stephen N. Eliot (1990). *Elementary Scale A ("How Often?")*. Circle Pines, MN: American Guidance Service, Inc.

Gormley, William and Thomas Gayer. 2003. "Promoting School Readiness in Tulsa: An Evaluation of Tulsa's Pre-K Program." Mimeo, Georgetown University.

Hinshaw, Stephen P. 1992. "Externalizing Behavior Problems and Academic Underachievement in Childhood and Adolescence: Causal Relationships and Underlying Mechanisms." *Psychological Bulletin*, 111, 127-125.

Hubbs-Tait, Laura, Anne M. Culp, Erron Huey, Rex Culp, Huei-Juang Starost and Charles Hare. 2002. "Relation of Head Start Attendance to Children's Cognitive and Social Outcomes: Moderation by Family Risk." *Early Childhood Research Quarterly*, *17*, 539-558.

Karoly, Lynn A., Peter W. Greenwood, Susan S. Everingham, Jill Houbé, M. Rebecca Kilburn, C. Peter Rydell, Mathew Sanders, and James Chiesa. 1998. *Investing In Our Children: What We*

Do and Don't Know About the Costs and Benefits of Early Childhood Interventions. Santa Monica, CA: RAND.

Lewit, Eugene M., and Linda S. Baker. 1995. "School Readiness." *The Future of Children*, 2, 128-139.

Linver, Miriam R., Jeanne Brooks-Gunn., and Dafna E. Kohen. 2002. "Family Processes as Pathways from Income to Young Children's Development." *Developmental Psychology*, *5,* 719-734.

Magnuson, Katherine A., Marcia Meyers, Christopher Ruhm, and Jane Waldfogel. (2004). "Inequality in Preschool Education and School Readiness." *American Educational Research Journal*, 41, 115-157

Murphy, Kevin M., and Robert H. Topel. 1985. Estimation and Inference in Two-Step Econometric Models. *Journal of Business & Economic Statistics*, 3, 370-379.

National Center for Education Statistics (2001). *User's Manual for the ECLS-K Base Year Public-Use User's Manual.* Washington, DC: U.S. Department of Education , Office of Educational Research and Improvement.

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: U.S. Department of Education , Office of Educational Research and Improvement.

NICHD Early Child Care Research Network. 2002a. "Child Care Structure> Process> Outcome: Direct and Indirect Effects of Child-Care Quality on Young Children's Development." *Psychological Science*, *13*,199-206.

NICHD Early Child Care Research Network. 2003. "Does Amount of Time Spent in Child Care Predict Socioemotional Adjustment during the Transition to Kindergarten?" *Child Development*, 74, 976-1005.

NICHD Early Child Care Research Network. 2002b. "Early Child Care and Children's Development Prior to School Entry: Results from NICHD study of Early Child Care." *American Educational Research Journal*, *39*, 133-164.

NICHD Early Child Care Research Network, and Greg Duncan. 2003. "Modeling the Impacts of Child Care Quality on Children's Preschool Cognitive Development." *Child Development, 74*, 1454-1475.

Peisner-Feinberg, Ellen S., Margaret R. Burchinal, Richard M. Clifford, Mary L. Culkin, Carollee Howes, Sharon Lynn Kagan, and Noreen Yazejian. 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, Deborah, Debra Mekos, Sandra Scarr, Kathleen McCartney, and Martha Abott-Shim. (2001). Within and Beyond the Classroom Door: Assessing Quality in Child Care Centers. *Early Childhood Research Quarterly*, 15, 475-496.

Ramey, Sharon L., and Craig T. Ramey. 2000. "The Effects of Early Childhood Experiences on Developmental Competence." In Sheldon Danziger and Jane Waldfogel (Eds.) *Securing the future: Investing in children from birth to college* pp 122-150. New York: Russell Sage Foundation.

Rimm-Kaufman, Sara E., Robert C. Pianta, and Martha J. Cox. 2000. "Teachers' Judgements of Problems in the Transition to Kindergarten." *Early Childhood Research Quarterly*, 15, 147-166.

Ripple, Carol H., William S. Gilliam, Chanana, N., and Edward Zigler 1999. "Will Fifty Cooks Spoil the Broth?" *American Psychologist*, *54*, 327-343.

Schweinhart, Lawrence J., Helen V. Barnes, and David Weikart. 1993. *Significant Benefits: The High/Scope Perry Preschool Study Through Age 27*. Ypsilanti, MI: High/Scope Press.

Schulman, Karen, Helen Blank, and Danielle Ewen. 1999. *Seeds of Success: State Prekindergarten Initiatives 1998-1999*. Washington, DC: Children's Defense Fund.

Shonkoff, Jack P., and Deborah A. Phillips. Eds.2000. *From Neurons to Neighborhoods: The Science of Early Childhood Development*. Washington, DC: National Academy Press.

Smith, Timothy, Anne Kleiner, Basmat Parsad, Elizabeth Farris, and Bernard Green. 2003. *Prekindergarten in U.S. Public Schools*. U.S. Department of Education, National Center for Education Statistics: Washington, DC.

Stipek, Deborah J., Rachelle Feiler, Patricia Byler, Rosaleen Ryan, Sharon Milburn, and Julie M. Salmon. 1998. "Good Beginnings: What Difference Does the Program Make in Preparing Young Children for School?" *Journal of Applied Developmental Psychology*, 19, 41-66.

Takanishi, Ruby and Patrick H. DeLeon. 1994. "A Head Start for the 21st Century." *American Psychologist*, *49*, 120-122.

U.S. Bureau of the Census 1970. School Enrollment: Social and Economic Characteristics of Students, October 1969. *Current population reports, P-20 Series*. Washington, DC: U.S. 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

U.S. Department of Education, National Center for Education Statistics NCES. 2003. *The condition of education*. Washington, DC: U.S. Government Printing Office. Retrieved June 27, 2003, from http://nces.ed.gov/programs/coe/2002/pdf/01_2002.pdf

US General Accounting Office. 2000a. *Preschool education: Federal investment for low-income children significant but effectiveness unclear*. Washington, DC: United States General Accounting Office. Retrieved June 27, 2003, from, http://www.gao.gov/new.items/he00083t.pdf

US General Accounting Office. 2000b. *Title I preschool education: More children served, but gauging the effect on school readiness difficult*. Washington, DC: United States General Accounting Office. Retrieved June 27, 2003, from, http://www.gao.gov/new.items/he00171.pdf

Vandell, Deborah L., and Barbara Wolfe. 2000. "Child Care Quality: Does It Matter and Does It Need to be Improved?" Institute for Research on Poverty Special Report, University of Wisconsin at Madison, November, 20.

Waldfogel, Jane. 2002. "Child Care, Women's Employment and Child Outcomes." *Journal of Population Economics, 15*, 527-548.

Wolfe, Barbara, and Scott Scrivner. 2003. “Providing Universal Preschool for Four-year olds.” In Belle Sawhill (Ed.), *One-percent for the Kids: New policies, brighter futures for America’s children* (pp. 113-135). Washington, DC: Brookings

Table 1: Selected Sample Characteristics and Mean Child Outcomes, by Child Care Arrangements in the Year Prior to Kindergarten

Outcomes	All	Prekin-dergarten	Other Preschool	Other Nonparental 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	-.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	1,722	4,649	1,216	914	1,621

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 Appendix Table 1 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 & Family Environment			X	X			X	X
Neighborhood & State Characteristics				X				X
R-squared	.01	.28	.35	.35	.01	.30	.36	.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 & Family Environment			X	X			X	X
Neighborhood & State Characteristics				X				X
R-squared	.00	.09	.11	.11	.00	.05	.15	.15

Notes: * p-value<.05; ** p-value<.01. The sample size for all analyses is 10,224. See Appendix Table 1 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	.95**
	(.43)	(.39)	(.46)	(.41)
Instrumental Variables	8.63**	3.58	-1.57	6.85*
	(2.66)	(2.43)	(3.50)	(2.91)

Notes: * p-value<.05; ** p-value<.01. The sample size for all analyses is 10,224. 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 2,386 teachers. 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.

Figure 1: State Prekindergarten Spending (per five year old) in 1998, by State

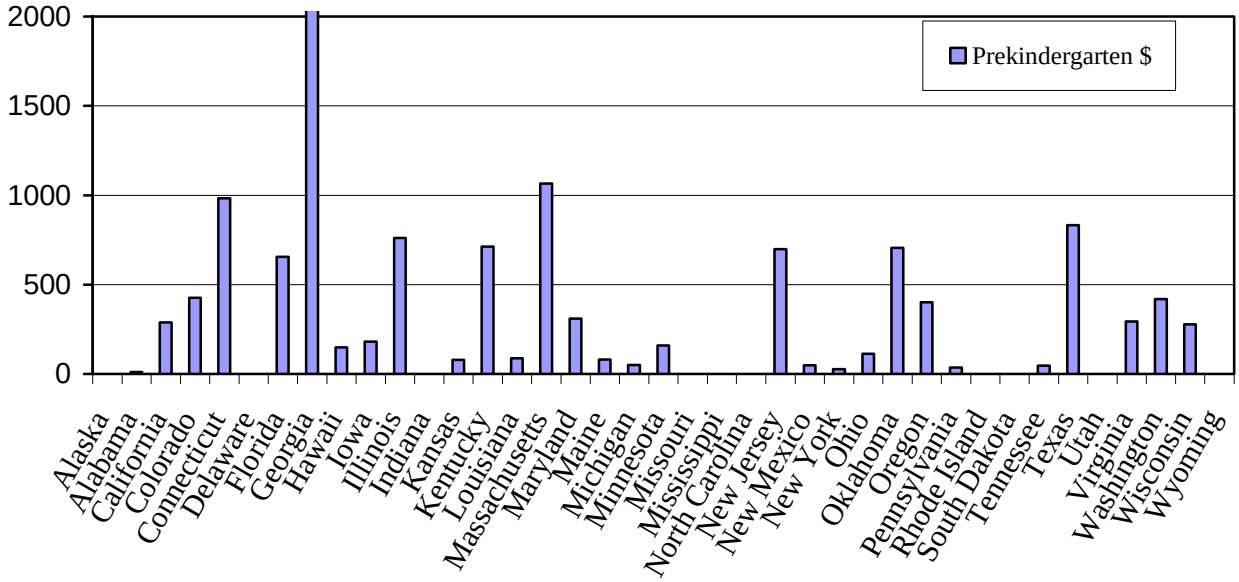

Figure 2: State Prekindergarten Enrollment Rates in 1997, by State

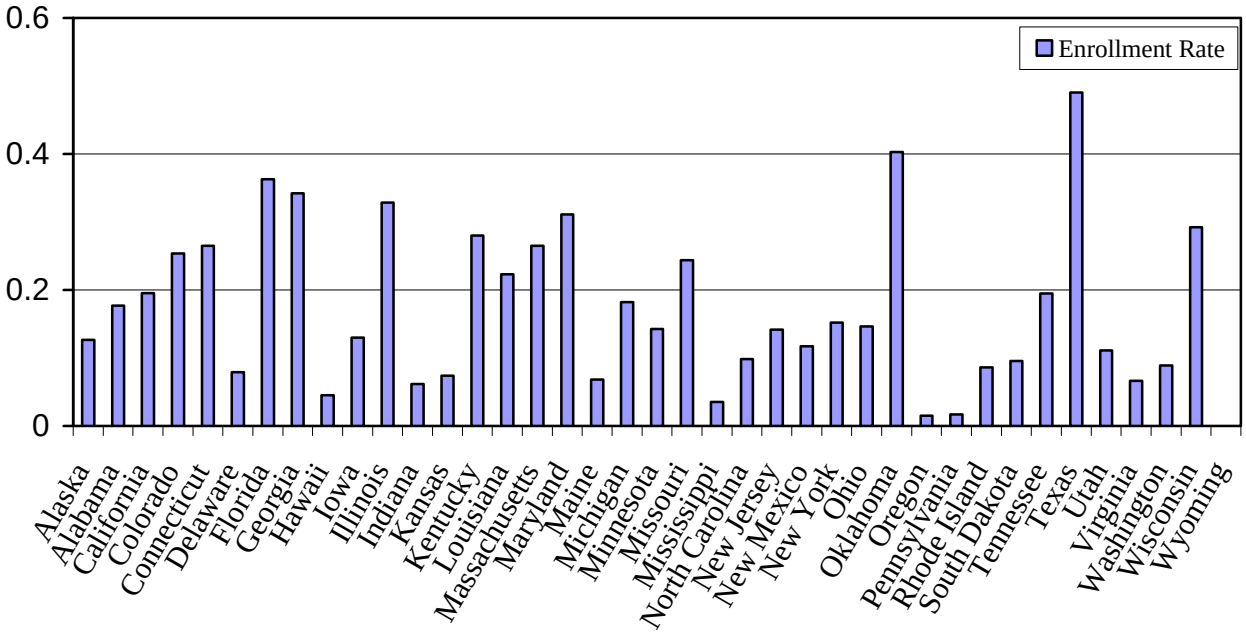

Table 4: OLS Estimates of the Effects of Prekindergarten on Child Outcomes, Controlling for other types of Child Care, Kindergarten Fall and First Grade Spring

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<.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.

Table 5: OLS Estimates for Disadvantaged Children, Kindergarten Fall

	Children of Parents with Low Education or in Poverty (N=2,328)					Children of Welfare Recipients (N=1,033)				
	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<.05; ** p-value<.01. All estimates include a full set of covariates (corresponding to model 4, Table 1). See notes to Tables 2 through 4. Parents with "low education" include those not completing high school.

Table 6: OLS Estimates for Public School Children by Location, Kindergarten Fall

	All Public School Children (N=7,963)				Children of Parents with Low Education or in Poverty (N=2,190)			
	Reading	Math	Self Control	Externalizing	Reading	Math	Self Control	Externalizing
Prekindergarten in same school	1.75**	1.52**	0.03	0.53	2.64**	2.33**	-0.48	0.66
	(0.49)	(0.47)	(0.63)	(0.58)	(0.78)	(0.74)	(0.87)	(0.90)
Prekindergarten not in same school	1.73**	1.58**	-1.39**	2.01**	2.01*	1.90*	-2.45*	3.66**
	(0.40)	(0.36)	(0.49)	(0.44)	(0.86)	(0.82)	(1.14)	(1.12)
Preschool	1.04**	1.11**	-1.19**	1.73**	1.18*	1.58**	-1.76**	2.14**
	(0.28)	(0.27)	(0.33)	(0.31)	(0.49)	(0.51)	(0.66)	(0.61)
Head Start	-0.17	0.25	0.53	-0.99*	0.49	0.77	0.59	-0.77
	(0.33)	(0.33)	(0.42)	(0.39)	(0.56)	(0.61)	(0.78)	(0.72)
Other	-0.35	-0.15	-1.09*	1.22**	0.15	0.80	-1.62*	1.78**
	(0.35)	(0.36)	(0.46)	(0.44)	(0.49)	(0.53)	(0.66)	(0.63)

Notes: * p-value<.05; ** p-value<.01. All estimates include a full set of covariates (corresponding to model 4, Table 1). See notes to Tables 2 through 4.

Appendix Table 1: Definitions, Additional Details, and Notes about Covariates Used in Analyses

Constructs and Variables	Definition, Details, and Notes
	Demographic Characteristics
Child characteristics	
Child age	Continuous variable. Child age in months (specific to timing of assessment).
Child gender	Dummy variable
Birth weight	2 dummy variables for: < 1500 grams, 1500-2500 grams.
Child weight	Average of two interviewer assessed measurements in lbs.
Child height	Average of two interviewer assessed measurements in inches.
Race and ethnicity	Black, Hispanic, Native American, Asian. (4 dummy variables).
Parental reports of family characteristics	
# of children in household	Ordinal variable. Ranges from 1 to 11.
Family structure	Single parent (one biological parent), blended family (one biological and one non-biological parent), adopted or foster parents (3 dummy variables).
City vs. Rural residency	Locality is city or town (2 dummy variables).
Region of country	North, South, Midwest (3 dummy variables).
Early maternal employment	Mother ever employed between child's birth and entry into kindergarten (dummy variable).
Father and mother's education	Less than high school degree through advanced post-graduate degree (6 dummy variables for each parent).
English only spoken in home	Mother never vs. ever speaks foreign language to child (dummy variable).
Father's & Mother's employment status	Full-time (35 or more hours per week), part-time work (fewer than 35 hours per week), or no work (2 dummy variables for each parent).
Use of WIC	Mother or child ever participated in Women, Infants and Children nutritional supplement program (dummy variable).
Household income-to-needs ratio	Household income vs. federal poverty level (9 dummy variables).
	Home and Family Environment Variables
Parental reports of educational expectations, kindergarten fall	
Educational expectations	Parental Expectations for Child's education (4 dummy variables)
Importance of skills	Importance of skills: counting, sharing, communication, drawing, knowledge of letters (5 variables)

Appendix Table 1 Continued

Parental reports of home learning activities, kindergarten fall	
Choice of home location	Parents chose home location for current school (dummy variable).
Home learning activities	Frequency of 7 activities: building things, teaching about nature, playing sports, doing art, doing chores, singing songs, playing games..
# of children's books in home	Ordinal variable. Ranges from 0 to 200.
# of music tapes, CDs, or records in home	Ordinal variable. Ranges from 0 to 100.
Reading outside of school	Frequency of child looking at picture books/reading outside of school (2 variables).
Family member school involvement, kindergarten fall	
Attendance or participation in school activities	Attendance since beginning of school year at PTA meetings, open houses, parent groups, parent advisory meetings; volunteered at school, participated in school fundraiser (6 dummy variables).
Parental reports of parent-child relationship, kindergarten spring	
Parenting stress and depression composites	Two continuous variables (averages of 8 and 12 items). Higher scores indicate more stress, depression.
Spanking	Parent spanked child in last week (dummy variable).
Parental reports of family routines, structured activities, and learning opportunities, kindergarten spring	
Eating Habits.	Days per week family usually eats meals together, at regular time (4 variables).
Family has computer	Dummy variable.
T.V	Number of hours child watches TV on weekdays.
Reading, visiting educational settings outside of school	Frequency of child looking at picture books/reading outside of school, visiting zoo, library, museum, concert (6 variables).
Other non-school activities	Child has ever taken lessons or participated in performing arts or organized clubs outside of school (7 dummy variables).
Parental reports of neighborhood quality, kindergarten spring	
Neighborhood quality composite	Mean of 6 items asking about neighborhood problems.

Appendix Table 2: Probit Estimates of Marginal Effects of State Prekindergarten Expenditures and Prekindergarten Enrollment on Type of Care in the Year Prior to Kindergarten

	Prekinder-garten	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*

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 four 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 for joint test that effects of expenditures and enrollment are equal to 0.