Early Opportunities and Fourth-Grade Success: State Pre-K Funding, Quality, and Access on Student Achievement

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Abstract: To ensure all children can be successful in school and beyond, states have increasingly supported and expanded pre-kindergarten (pre-k) programs aimed at improving student outcomes and reducing disparities. While research has shown generally positive short-term outcomes for specific programs, state design and support for pre-k programs varies widely across the US, making cross-state comparisons difficult. As a means to better inform state policy decisions, this study assesses the relation between structural aspects of pre-k programs on fourth-grade student achievement and gaps across all 50 states. In assessing the relation of ELA achievement with state funding, standards of quality, and scope of access, we find that (1) state funding is associated with both increases in student achievement and reduced gaps, (2) the effect of funding is stronger in states that provide...
targeted pre-k access to low-income/at-risk students, and (3) legislated quality standards only improve overall achievement in states that provide universal access to pre-k. These results help identify how state policy structure may best be used to leverage achievement benefits for pre-k programs and reduce disparities.

**Keywords:** early childhood education; achievement gaps; prekindergarten quality; prekindergarten funding

Oportunidades tempranas y éxito en cuarto grado: Financiación estatal de prekínder, calidad y acceso al rendimiento estudiantil

**Resumen:** Para garantizar que todos los niños puedan tener éxito en la escuela y más allá, los estados han apoyado y ampliado cada vez más los programas de prejardín de infantes destinados a mejorar los resultados de los estudiantes y reducir las disparidades. Si bien la investigación ha mostrado resultados generalmente positivos a corto plazo para programas específicos, el diseño y el apoyo estatal para los programas de prekínder varía ampliamente en los EE. UU., lo que dificulta las comparaciones entre estados. Como un medio para informar mejor las decisiones de política estatal, este estudio evalúa la relación entre los aspectos estructurales de los programas de prekínder en el rendimiento de los estudiantes de cuarto grado y las brechas en los 50 estados. Al evaluar la relación del rendimiento en ELA con el financiamiento estatal, los estándares de calidad y el alcance del acceso, encontramos que (1) el financiamiento estatal está asociado con aumentos en el rendimiento estudiantil y brechas reducidas, (2) el efecto del financiamiento es más fuerte en estados que brindan acceso a prekínder específico para estudiantes de bajos ingresos/en riesgo, y (3) los estándares de calidad legislados solo mejoran el rendimiento general en los estados que brindan acceso universal a prekínder. Estos resultados ayudan a identificar cómo se puede utilizar mejor la estructura de la política estatal para aprovechar los beneficios de logro para los programas de prekínder y reducir las disparidades.

**Palabras clave:** educación de la primera infancia; brechas de logros; calidad de prekínder; financiación de prekínder

Oportunidades iniciais e sucesso na quarta série: Financiamento estadual pré-K, qualidade e acesso ao desempenho do aluno

**Resumo:** Para garantir que todas as crianças possam ter sucesso na escola e fora dela, os estados têm apoiado e ampliado cada vez mais programas de pré-escola (pré-K) visando melhorar os resultados dos alunos e reduzir as disparidades. Embora a pesquisa tenha mostrado resultados de curto prazo geralmente positivos para programas específicos, o design e o suporte do estado para programas pré-K variam muito nos EUA, dificultando as comparações entre estados. Como forma de informar melhor as decisões políticas estaduais, este estudo avalia a relação entre os aspectos estruturais dos programas pré-K no desempenho dos alunos da quarta série e as lacunas em todos os 50 estados. Ao avaliar a relação do desempenho do ELA com o financiamento estatal, padrões de qualidade e escopo de acesso, descobrimos que (1) o financiamento estatal está associado tanto a aumentos no desempenho dos alunos quanto à redução de lacunas, (2) o efeito do financiamento é mais forte em estados que fornecem acesso pré-escolar direcionado a alunos de baixa renda/em risco e (3) padrões de qualidade legislados apenas melhoram o desempenho geral em estados que oferecem acesso universal a pré-escola. Esses resultados ajudam a identificar como a estrutura da política estadual pode ser melhor usada para alavancar os benefícios de conquista para os programas pré-K e reduzir as disparidades.
Early Opportunities and Fourth Grade Success: State Pre-K Funding, Quality, and Access on Student Achievement

As a primary strategy to improve student outcomes and reduce gaps, states across the US have legislated and funded a range of 4-year-old prekindergarten (pre-k) policies aimed at early intervention in education. Research has shown that children attending pre-k programs are more prepared for school, tend to have higher achievement early on and that gains can be more pronounced for historically disadvantaged student groups (see Fischer et al., 2020). However, despite some promising evidence, not all programs are equally effective, and consensus on the uniform and long-term effects of pre-k programs has remained elusive (Phillips et al., 2017).

Much of the difficulty in identifying an association between these programs and student achievement stems from the wide disparities between pre-k policies and programs (Parker et al., 2018). Across the US, state policy varies considerably in terms of program spending, standards of structural quality, and scope of eligibility and access (Meloy et al., 2019). As a result, for states to realize the potential benefits of pre-k interventions, it is imperative to understand how structural pre-k policies impact student outcomes.

This paper thereby aims to assess the impact of state-level policies on primary-school academic outcomes. To do so, we combine state longitudinal data on per-pupil spending, a structural program quality index, and a scope of access indicator (no state-funded access, targeted access, universal access) with fourth-grade student achievement scores from the Stanford Education Data Archive (SEDA). Employing district and year fixed effects models, we explore our main research question: To what extent are state pre-k policies associated with district-level changes in the fourth-grade student achievement and gaps? We estimate the association of funding, quality, and access with lagged fourth grade English Language Arts (ELA) scores over an eight-year period from 2008-9 to 2015-16. Results indicate spending matters, increasing fourth-grade achievement for all students while reducing gaps for Black and Hispanic students. This effect is amplified in states providing targeted pre-k program access. However, results also indicate that structural quality standards are not associated with increased student achievement.

We begin with an overview of the recent research on pre-k programs and their effects on student achievement. We then explore ways in which state policy context has evolved and continues to differ across the US, particularly in terms of funding, quality, and scope of access. Next, we present our data and methodological approach, followed by model results. We conclude by interpreting these results in the context of state policy programming, identifying recommendations for policy development to scale state pre-k programs to provide equitable outcomes for student learning.

Background

Research on Pre-K Outcomes

Researchers and policymakers have long agreed that for children to be successful in school and beyond, it is critical to lay a strong educational foundation during the early years. Across the US, 42 states have established pre-k programs as a means to support positive student outcomes, serving nearly 30% of the nation’s 4-year-olds (Friedman-Krauss et al., 2020). Amongst the many identified
potential benefits of pre-k programs, including socio-emotional growth, school readiness, and reductions in developmental gaps (see Conger et al., 2019; Meloy et al., 2019), interest has grown in identifying how pre-k programs broadly support academic achievement for students. When it comes to academic achievement, however, research has generally shown gains in literacy and numeracy for pre-k participants at school entry, but evidence of a longer-term ‘boost’ for academic achievement further into the primary school years has remained less conclusive. Several studies note a fadeout effect, generally around the third grade, whereby the academic boost of pre-k programs may not be sustained amongst differences in the quality of primary education (Bailey et al., 2017; Heckman, 2006; Hill et al., 2015; Lipsey et al., 2018; Pearman et al., 2020). However, several other studies have demonstrated longer-term sustained effects well into the primary years, that include lower grade repetition, chronic absenteeism, and special education placement rates, and higher high school graduation rates (Bai et al., 2020; McCoy et al., 2017; Phillips et al., 2016; Virginia University Research Consortium on Early Childhood, 2015). In a recent literature synthesis, the Education Commission of the States found that 68% of studies on the association between pre-k participation and long-term academic gains have significant and positive findings for participants (Fischer et al., 2020; see also Barnett and Camill, 2002).

In addition, a secondary goal of pre-k programs is to help reduce gaps in student achievement.¹ Research has often had difficulty separating socioeconomic and linguistic status from historical educational debts associated with race in the US (Ladson-Billings, 2006; Phillips et al., 2017). While there are roughly similar levels of access to pre-k programs and program quality by ethnicity/race (Nores & Barnett, 2014), several studies have noted that pre-k may be comparatively more effective for Hispanic children (Loeb et al., 2005; Magnuson et al., 2006; Weiland & Yoshikawa, 2013), some of whom may benefit from earlier exposure to English language resources as dual learners (Han, 2012; Lipsey et al., 2013; Puma et al., 2012; Reardon & Galindo, 2009). Research on gains for Black students has been less conclusive, with mixed results on academic gains (Gormley et al., 2005; Ladd et al., 2014; Weiland & Yoshikawa, 2013). Some of the difficulty in identifying effects by student race/ethnicity may stem from the level of representation by socioeconomic status. For example, Bassok (2010) found no racial differences in pre-k effects for children living below the poverty line. However, Black children that were above the poverty line did benefit more than their Hispanic or White counterparts from pre-k exposure (Bassok, 2010). Much of the research on subgroup performance and fade-out has emphasized the difficulties in access to comparable primary school learning environments for low-income or minoritized students, which are often situated in under-resourced environments less conducive to maintaining pre-k gains (Bassok, 2010; Lipsey et al., 2013).

Policy Differences and Quality

Differences in pre-k program design, enrollment, and environment have made broad conclusions about the relationship between pre-k exposure and later student achievement elusive (Meloy et al., 2019; Phillips et al., 2017). Pre-k programs are by no means similar across state borders, with the notion of publicly funded pre-k covering a host of programs unique to each state setting, including different funding streams, eligibility criteria, oversight structures, standards, and

¹ The authors would like to acknowledge upfront that deficit-based ideas have been derived from the language and research surrounding achievement gaps. We want no part of that. We would like to note that our choice to examine gaps is not to emphasize differences, but, following Ladson-Billings (2006), to confront the ‘education debt.’ Our goal is to better understand policy options that may help to repay the promise of equal educational opportunity to children that have undoubtedly been saddled with historic, systematic, and structural biases.
moving towards, universal access for all 4
state
Program
instructors
specifically
programs,
at (Barnett,
Structural 2016; Parker et al., 2019).

Programs varies formulae (Barnett & Kasmin, 2016; Parker et al., 2019), but the amount of funding allocated to pre-

Start program and state funding through block grants, general appropriations, and state funding
a combination of federal, state, and local government $13.7 for every dollar spent (García et al. 2020). We also know that pre-

return on investment for high
earn potential to improve the access, experience, and outcomes of pre-k programs across the
US (Meloy et al., 2019). However, given the distal relationship between program structure and
student achievement (Slot, 2018), broad conclusions about structural quality and long-term academic
outcomes are less clear, with researchers calling for further investigation into the relationship
between the two (Camilli et al., 2010; Meloy et al., 2019; Phillips et al., 2017). Given this call, we
focus on three policy-level elements of structural quality: state funding, standards of quality, and
scope of program access.

State Funding

The effects of K-12 school resources such as per-pupil spending and other school inputs on
student outcomes have been extensively studied, though results have been mixed. While some
studies find positive effects of spending on student outcomes (Card & Payne, 2002; Krueger, 2003;
Wenglinsky, 1998), others find little to no effects (Downes et al., 1998; Hanushek, 2003). Recently,
some studies have used more compelling methods to analyze the effects of school finance reforms
and found positive effects of school spending on long-term educational success and labor outcomes
(Candelaria & Shores, 2019; Hyman, 2017; Jackson et al., 2016; Lafortune et al., 2018). Research on
the effects of pre-k spending on student outcomes, however, is quite limited. We know that the
return on investment for high-quality programs targeted at children ages 0-to-5 may be as high as
$13.7 for every dollar spent (García et al. 2020). We also know that pre-k is typically funded through
a combination of federal, state, and local governments, including federal funding from the Head
Start program and state funding through block grants, general appropriations, and state funding
formulae (Barnett & Kasmin, 2016; Parker et al., 2019), but the amount of funding allocated to pre-k
programs varies greatly by state, a few states providing no pre-k state funding (Barnett & Kasmin,
2016; Parker et al., 2019).

Structural Quality Standards

Based on accumulating research on the positive effects of attending high-quality programs
(Barnett, 2010; Fischer et al., 2020), states have further implemented a broad range of standards set
at maintaining structural elements such as low child-to-teacher ratios, certified personnel, full-day
programs, and curriculum supports to ensure positive student outcomes. Studies have shown that
the regulation of higher quality standards is generally associated with improved program processes,
specifically in terms of lower class sizes and pre-service training and professional development for
instructors (Bogard et al., 2008; Hartman et al., 2016; Slot, 2018).

Program Access

A major policy aspect of pre-k deals with the scope of students that are provided access to
state-sponsored programs. States with the most available access are considered to have, or be
moving towards, universal access for all 4-year-old children in the state. Currently, Florida, Georgia,
Oklahoma, and the District of Columbia have universal programs, while Illinois, Iowa, Massachusetts, New York, Vermont, West Virginia, and Wisconsin are working towards universal access (Parker et al., 2018). Still other states provide no funding for pre-k programs, including Idaho, Montana, New Hampshire, South Dakota, North Dakota, and Wyoming. The remaining 35 states provide targeted access, whereby certain student groups such as low-income, at-risk, and/or special needs children are provided access to state-funded programs.

There is considerable debate about whether universal programs are better equipped to increase long-term achievement or reduce gaps than targeted programs. The emerging evidence shows that universal pre-k students are at least as well prepared for kindergarten as Head Start attendees (Henry et al., 2006) and low socioeconomic status students in rural areas benefit academically from access to universal programs (Fitzpatrick, 2008). But the larger question of who should have access remains. Some argue that targeted programs allow states to equitably provide access for those who would not otherwise attend pre-k, while universal programs use up limited tax dollars on children whose parents can afford private programs (Fuller, 2007). However, others argue that universal programs are of better overall quality because middle-class parents are more demanding and therefore push for quality increases, benefiting all students through ‘spillover’ effects (Williams, 2019). By definition, universal programs should be more economically and racially/ethically integrated, but it is unclear if targeted pre-k enrollments are better able to reduce long-term achievement gaps, or if universal programs are sufficient to raise overall achievement and reduce gaps.

Given the incomplete understanding of how policies surrounding funding, access, and the structural quality of pre-k programs affect later student outcomes, this paper aims to assess the extent to which state-level pre-k policies are related to later student achievement and gaps, as a means to better identify policy levers for improving student outcomes. Substantial variation in state practices over time enables us to examine a range of pre-k policies at the state level and their association with district-level changes in overall achievement and the racial/ethnic achievement gaps in fourth grade ELA. By constructing a unique state-level dataset on early childhood education policies plus district-level achievement outcomes and confounders, this research poses the main question: Are changes in state-level early childhood education policies associated with district-level changes in the fourth-grade average ELA achievement and gap? We subsequently, propose the following hypotheses:

- Higher state-level pre-k spending will be associated with increased district-level average fourth-grade ELA achievement and lower achievement gaps.
- A higher number of legislated quality standards of pre-k will be associated with increased district-level average achievement and lower achievement gaps.
- Both increased quality standards and spending will be associated with higher district-level average achievement and lower gaps regardless of context (e.g., targeted or universal).

**Methods**

**Data**

We compile data from two sources. First, for academic achievement outcomes, gaps, and school control variables, we use district-level data from SEDA for the period of 2008-09 to 2015-16. The SEDA dataset includes average test scores in ELA based on state standardized tests for nearly all school districts in the United States, as well as academic achievement gaps for Black and Hispanic students (Reardon, Kalogrides, & Ho, 2016). We choose to work with district-level data because previous research has shown that larger differences in achievement scores arise at the district level.
rather than at the state level, given that state-level measures tend to aggregate away important differences between smaller geographic entities within each state (Reardon, Kalogrides, & Shores, 2016). For the purpose of this analysis, we use fourth-grade ELA achievement scores, given they are the most consistent early achievement measure in the dataset and further represent a primary school measure slightly past the typical third-grade “fadeout” period, and thus represent a more conservative measure. We additionally use ELA as our indicator of achievement as it is likely to be a more sensitive measure to the aforementioned gains for dual language learners, although some of the effects of pre-k exposure may not be expressed until later in a student’s development (Han, 2012; Reardon & Galindo, 2009). The SEDA dataset further contains district-level covariates such as enrollment, demographics, and socioeconomic status.

Second, we used State Preschool Yearbooks from the National Institute for Early Education Research (NIEER) to construct two pre-k related measures at the state level. Starting in 2003, these yearly reports contain detailed information on the conditions of state-funded pre-k programs, including an indicator of structural quality and spending per child enrolled. Programs met the following criteria to be considered as state-funded: they were funded and controlled by the state, targeted at children of preschool age, focused primarily on the provision of early childhood education in which children can learn as a group at least twice a week, and differentiated from the state’s system for subsidized care. State supplements to Head Start were also considered if the state substantially increased children’s enrollment and assumed part of the program’s administrative functions. In addition, NIEER provides detailed explanations for each state regarding the context of pre-k. Through this, we categorized states as having (1) no state-funded pre-k, (2) targeted access aimed at specific student subgroups, such as low-income students, or (3) moving towards or providing universal access, whereby all students were eligible for state-funded pre-k. For the purpose of this analysis, NIEER State Preschool Yearbooks for the period 2004-2011 were used to categorize states each year, selected at a five-year lag from the SEDA data given that cohorts passing through a pre-k program would be in the fourth grade by the time of assessment (e.g., a student in pre-k in 2005 would be in the fourth grade in 2010).

Measures

Dependent Variables

Academic Achievement

We use SEDA’s ELA average standardized scores of all fourth-grade students at the district level. SEDA uses raw test scores from the EdFacts data system at the United States Department of Education, which collects aggregated test score data from each state’s standardized testing program from the 2008-09 to 2015-16 school years. SEDA then distributes test scores on a common scale that allows comparability across school districts, states, and years. In addition to overall performance, EdFacts requires states to report information disaggregated by several demographic characteristics, including race/ethnicity, which are also included in the SEDA database (Fahle et al., 2017). For this study, we also report average achievement results for Black, Hispanic, and White students.

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2 We focus on ELA scores for simplicity but note that analyses using fourth-grade mathematics scores demonstrated substantively similar results.

3 This excludes state supplements that minimally improve quality, extend days of service, or increases enrollment.
Achievement Gaps

We use SEDA’s estimation of fourth-grade White-Black and White-Hispanic achievement gaps in ELA. Districts with low numbers of minoritized students were excluded. As described in Reardon and Ho (2015), these achievement gap variables are estimated using the V-statistic, which measures the non-overlap of two distributions. Achievement gaps were calculated only for districts with 20 or more available minority students’ test scores. Thus, from the overall sample of approximately 13,000 districts, the White-Black achievement gap was calculated for approximately 2,600 districts and White-Hispanic achievement gap was calculated for approximately 2,900 districts.

Table 1
Mean and Standard Deviation for Achievement Outcomes

|                      | Achievement scores samples | Achievement gaps samples |
|----------------------|-----------------------------|--------------------------|
|                      | All | White | Black | Hispanic | W-B | W-H |
| Achievement outcome  | M   | SD    | M     | SD       | M   | SD  |
| 0.05                 | 0.3 | 0.19  | 0.3   | 0.3      | 0.3 | 0.3 |
| District-year        | 7928 | 7058  | 17912 | 22906    | 16046 | 20045 |

Independent Variables

Per-Pupil Spending in Pre-K

We use total state funds spent per child in pre-k programs based on NIEER reported sources. This may include some additional funds from federal or local sources. However, our measure excludes federal contributions to Head Start. States with no implementation for pre-k programs were assigned a $0 per-pupil spending, and per-pupil spending was logarithmically transformed. We present the overall funding trends in Figure 1 (See Appendix A for each state by year). These demonstrate that over the 10-year period from 2003 to 2013, mean state spending on pre-k programs increased from $2,561 to $4,629 (a 71% increase when adjusted for inflation), with South Carolina at the low end contributing $1,300 per child, the District of Columbia at the high end contributing $16,853 per child, and 10 states contributing zero funds (See Appendix A).

Pre-K Quality Index

Our quality index is built as a composite score of nine indicators that represent the minimum criteria needed for effective pre-k programs as determined by the National Institute for Early Education Research (Friedman-Krauss et al., 2020). It identifies whether a state has a policy in place establishing a standard for: 1) policy requirements of comprehensive early learning standards; 2) teacher degree of at least bachelor’s degree; 3) teacher specialized pre-service training in early childhood; 4) assistant teacher degree of at least Child Development Associate (CDA) or equivalent; 5) teacher annual in-service professional development and training of at least 15 hours; 6) a maximum class size of 20 children; 7) a minimum of 1:10 staff-child ratio; 8) provision for screening/referral and family support services, which must include vision, hearing, health, and at least one family support service; and 9) at least one meal provided per day. Notably, these are structural indicators of policies in place, rather than a measure of the observed quality of a given program. Certain indicators, such as pre-service training, may have a greater impact on student
outcomes in particular situations than, for example, staff-child ratios. Figure 1 shows that the average state quality index, as reported by NIEER, increased by nearly 2 points from 5 to 7 on the nine-point scale for states with programs between 2003-2013.

**Figure 1**  
*Pre-k Quality Standards and State Per-Pupil Spending 2003-2013*

| State Pre-K Quality Standards Index | State Pre-K Spending Per Child |
|-----------------------------------|--------------------------------|
| Quality standards index           | Spending per child (dollars)  |
| 3                                 | 2500                           |
| 4                                 | 3000                           |
| 5                                 | 3500                           |
| 6                                 | 4000                           |
| 7                                 | 4500                           |
| 2003                              | 2004                           |
| 2005                              | 2006                           |
| 2007                              | 2008                           |
| 2009                              | 2010                           |
| 2011                              | 2012                           |
| 2013                              | 2014                           |
| All                               | Targeted                       |
| Universal                         |

**Program Access**

To gain further understanding of how structural quality and state funding and their association with achievement and the achievement gap, we include an index of program access by state. NIEER State Preschool Yearbooks 2003-2013 were used to determine the status of implementation of pre-k programs. As noted above, this variable was coded according to three categories: 1) no state implementation, in the case of states that do not provide any pre-k funding; 2) targeted state implementation, generally in the form of targeted programs for low-income, at-risk, and/or special needs children; and 3) universal implementation, including states moving toward universal implementation and states with universal pre-k, where all 4-year-old children are eligible for and have access to free pre-k. States were coded according to NIEER reports.

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4 The term ‘at-risk’ differs by state but can include students identified as low-income, homeless, in foster care, mobile (having missed a substantial portion of the year or moved multiple times), receiving protective services, receiving forms of state aid, having a history of or exposure to family substance abuse or violence, developmental delays, having parent lacking a high school diploma, having a single or teen parent, migrant status, or English Language Learner status.
Finally, we include a set of socioeconomic and school control variables aggregated at the district level, as reported in SEDA and originating from the Common Core of Data and the American Community Survey. These include racial/ethnic proportions and number of students in fourth grade, proportion of free-lunch students in fourth grade, proportion of special education students in the district, proportion of English learners in the district, and total number of teachers. See Appendix B for time-varying characteristics of the sample.

Table 3
Mean and Standard Deviation for District Covariates

|                                      | Achievement scores samples |                             | Achievement gaps samples |
|---------------------------------------|-----------------------------|-----------------------------|--------------------------|
|                                       | All | White | Black | Hispanic | W-B | W-H |
|                                       | M SD | M SD | M SD | M SD | M SD | M SD |
| Proportion of White students in 4th grade | 0.7 0.2 | 0.7 0.2 | 0.4 0.2 | 0.49 0.27 | 0.5 0.2 | 0.5 0.2 |
|                                       | 3 8 | 8 3 | 9 6 | 3 3 | 4 4 | 4 4 |
| Proportion of Black students in 4th grade | 0.0 0.1 | 0.0 0.1 | 0.2 0.2 | 0.11 0.16 | 0.2 0.2 | 0.1 0.1 |
|                                       | 8 7 | 7 3 | 9 5 | 4 0 | 2 5 | 2 5 |
| Proportion of Hispanic students in 4th grade | 0.1 0.2 | 0.1 0.1 | 0.1 0.2 | 0.34 0.27 | 0.1 0.2 | 0.2 0.2 |
|                                       | 4 1 | 1 7 | 8 0 | 8 0 | 8 2 | 8 2 |
| Proportion of Asian students in 4th grade | 0.0 0.0 | 0.0 0.0 | 0.0 0.0 | 0.04 0.07 | 0.0 0.0 | 0.0 0.0 |
|                                       | 2 5 | 2 5 | 4 7 | 4 7 | 5 7 | 5 7 |
| Proportion of Native American students in 4th grade | 0.0 0.1 | 0.0 0.0 | 0.0 0.0 | 0.01 0.04 | 0.0 0.0 | 0.0 0.0 |
|                                       | 2 0 | 1 5 | 1 2 | 1 2 | 1 4 | 1 4 |
Empirical Strategy

To assess the effect of state-level pre-k policies on academic achievement scores and racial achievement gaps, we employ a district and year fixed effects regression model. In this model, state-level variation in pre-k quality index and per-pupil spending in pre-k programs are regressed on academic achievement outcomes, while holding constant any time-invariant unobserved district characteristics and any year-specific effect, as well as observed district-level characteristics. Given the inclusion of fixed effects, states with no variation over time in the main independent variables were excluded from the analyses. The proposed estimation model is represented by the following equation:

\[
ACH_{dst} = \beta_0 + \beta_1 PREK_{st} + \beta_2 CON_{dst} + \delta + \gamma + \varepsilon_{dst}
\]

Where \(ACH_{dst}\) represents a given academic achievement outcome (i.e., achievement score and racial/ethnic achievement gap in ELA) for district \(d\) in state \(s\) at year \(t\). \(PREK_{st}\) captures state-level pre-k-related variables at the time fourth-grade students were at pre-k, including pre-k quality index and per-pupil spending in pre-k programs. \(CON_{dst}\) is a set of control variables that captures observed and time-variant demographic and socioeconomic characteristics for district \(d\) in state \(s\) at year \(t\). The terms \(\delta\) and \(\gamma\) represent year and district fixed effects, respectively, so that comparisons are within district-year cells. The estimated effect of each pre-k indicator on a given achievement outcome is represented by the OLS estimate of \(\beta_1\). Given the possibility of state-level shocks, we cluster standard errors at the state level.

Limitations

Before proceeding, we note several limitations to our strategy and scope. First, a major concern about the validity of our estimations is variable bias, whereby unobserved district, state, and national-level characteristics may be simultaneously correlated with pre-k variables and subsequent
academic achievement outcomes. For instance, districts with high levels of poverty are more likely to have lower academic achievement scores and at the same time may belong to states that first adopted policies towards the expansion and high quality of pre-k programs. States with fewer financial resources and lower scores may emphasize quality standards in lieu of economic investments. Second and related, significant shifts in overall pre-k funding, quality, and enrollment may coincide with other environmental changes impacting achievement, such as employment and housing stability during the Great Recession (Evans et al., 2019; Frone, 2018). The Great Recession led to considerable long-term reductions in pre-k funding, at roughly $1 billion a year overall, and many states (e.g., Arkansas, California, North Carolina, and Pennsylvania) enacted large enrollment cuts to adjust for budgetary shortfalls (Garver, 2020; Leachman et al., 2015). Third, the focus on average effects may mask significant heterogeneity in the scope of eligibility, funding, and access to pre-k services. For example, several districts are known to have additional tax and enrollment supports for pre-k programs that are not captured in our data (Garver, 2021). Fourth, as noted above, we do not observe process quality in our data, given standardized national-level measurements are not available. Research has shown that process quality may systematically vary across racial/ethnic groups—and be specifically detrimental to minoritized children—in terms of elements such as treatment, discipline, and curricular relevance (Nxumalo & Adair, 2019; Tobin, 2005), and may therefore contribute to differences in later student achievement metrics.

While we cannot control for these issues fully, the two sets of fixed effects included in the models absorb some of the unobserved heterogeneity likely to bias estimations. The use of district-level control variables and fixed effects by district and year help to mitigate potential sources of omitted variable bias, particularly those related to time-invariant and district-specific aspects, such as differences in district funding. However, this strategy does not entirely rule out this type of bias. Thus, we further assess whether the effect of quality standards and spending vary by program access (i.e., targeted and universal state programs). Finally, robustness checks with multiple alternative specifications were run (e.g., state fixed effects), with little substantive differences across iterations.

**Results**

**Do Pre-K Policies Affect Academic Achievement?**

In Table 4 we begin by presenting results of the effects of pre-k policies on future students’ academic achievement outcomes. Column 1 shows the simplest specification, where only state pre-k variables are included in the model. Column 2 adds district-level control variables. Finally, columns 3 and 4 add fixed effects by district and year, respectively, to control for unobserved time-invariant district and year-specific effects.

Table 4 shows several trends. First, consistent throughout all specifications, increased state-level per-pupil pre-k spending is significantly associated with higher increased fourth grade ELA achievement. After accounting for year-specific effects, unobserved time-invariant district characteristics, and observed time-varying district characteristics, we found that a 10% increase in lagged pre-k per-pupil spending increases fourth grade ELA scores by 0.0076 standard deviations, a statistically significant result. Second, the pre-k quality index is negatively associated with fourth-grade ELA average achievement. In the fully controlled model, we estimate that for each one-point increase in the pre-k quality index, ELA scores decrease by 0.0054 standard deviations—although this is not a statistically significant reduction. Overall, increasing state pre-k spending is associated

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5 For an overview of the state % of children enrolled in state-sponsored pre-k or Head Start by year, see Appendix C.
with increasing ELA test scores several years later but increasing state-level traditional measures of quality in pre-k are not related to significant differences in later ELA achievement.

**Do Pre-K Policies Affect Achievement Gaps?**

Next, we turn to the separate analyses for Black, Hispanic, and White students as well as Black and Hispanic achievement gaps, shown in models 7 and 8 in Table 4. First, after accounting for district characteristics and fixed effects by year and district, increasing state per-pupil pre-k spending is significantly associated with increasing average fourth-grade ELA achievement separately for Black, Hispanic, and White students and a decreasing ELA White-Black achievement gap. The decreased White-Black achievement gap is the result of an accelerated rate of growth for Black students.

Second, while increases in the pre-k quality standards index are not significantly associated with lower achievement for Hispanic or White students, they are associated with a reduction in Black student achievement and a larger White-Black achievement gap. Here, the increase in the gap is largely attributable to the reduction in achievement for Black students, rather than an increase in achievement for White students.

**Does the Effect of Pre-K Policies Vary by Context?**

To better understand the relationship between pre-k policies and achievement, Table 5 reports full fixed effects models with indicators for quality and spending interacted with state-level access policy (targeted or universal). Beginning with quality standards, Table 5 demonstrates that quality standards have a negative relationship with general student achievement in targeted states, but a positive relationship in universal states. However, when looking at racial/ethnic subgroups, we see that quality standards only affect White student achievement at a statistically significant level. The increase in White student achievement in universal states may thereby account for the observed increase in both White-Black and White-Hispanic achievement gaps in universal states as well.

Moving to spending, we see that increased per-pupil spending on pre-k programs is associated with a considerable increase in student achievement in targeted states. This effect holds racial/ethnic subgroups. We further see that for targeted states, there is a slight reduction in White-Hispanic achievement gaps, meaning that even though both Hispanic and White students increase their achievement with increased targeted pre-k spending, the gains for Hispanic students are proportionally greater. Turning to universal states, we only observe a statistically significant increase in Black student achievement with increased per-pupil spending, but also see a reduction for both White-Black and White-Hispanic achievement gaps.
Table 4
Lagged State Pre-K Indicators and ELA Achievement Scores and Race/Ethnic Achievement Gap, 2009-2016

|                  | Achievement score |                |                | Achievement by race/ethnicity |                |                | Achievement gap |
|------------------|-------------------|----------------|----------------|-------------------------------|----------------|----------------|-----------------|
|                  | (1)               | (2)            | (3)            | (4)                          | (5)            | (6)            | (7)             | (8)             |
| Quality standards| -0.0065           | -0.0063        | -0.0054        | -0.0038                      | -0.0100*       | -0.0082        | 0.0101**        | 0.0043          |
|                  | (0.0047)          | (0.0048)       | (0.0048)       | (0.0048)                     | (0.0058)       | (0.0070)       | (0.0038)        | (0.0049)        |
| Quality standards| 0.0076***         | 0.0075***      | 0.0076***      | 0.0071***                    | 0.0052**       | 0.0092**       | -0.0041*        | -0.0072***      |
|                  | (0.0024)          | (0.0023)       | (0.0024)       | (0.0025)                     | (0.0021)       | (0.0036)       | (0.0020)        | (0.0022)        |
| R-squared        | 0.8208            | 0.8220         | 0.8240         | 0.7537                       | 0.7248         | 0.7769         | 0.6401          | 0.6621          |
| District-year observations | 79,282           | 79,282         | 72,262         | 64,348                       | 16,568         | 21,628         | 15,030          | 18,804          |
| Year fixed effects | Yes              | Yes            | Yes            | Yes                          | Yes            | Yes            | Yes             | Yes             |
| District fixed effects | Yes              | Yes            | Yes            | Yes                          | Yes            | Yes            | Yes             | Yes             |
| Time-varying controls | No               | Yes            | Yes            | Yes                          | Yes            | Yes            | Yes             | Yes             |

Notes: State pre-k indicators are lagged by five years. Control variables include racial/ethnic proportions and number of students in fourth grade, proportion of free-lunch students in fourth grade, and proportion of Special Education students in the district. Column 1 and 2 include all states available in the dataset. Columns 3-8 exclude states categorized as non-sponsored. Robust standard errors in parentheses are clustered by state. * p < 0.10, ** p < 0.05, *** p < 0.01.
Table 5
Lagged State Pre-K Indicators and ELA Achievement Scores and Race/Ethnic Achievement Gap, by Access

|                                | Achievement score | Achieve  ment gap |
|--------------------------------|-------------------|------------------|
|                                | All   | White | Black | Hispanic | All | White | Black |
| Quality standards x partial    |       |       |       |          | (1) | (2)   | (3)   |
|                                |       |       |       |          | (4) | (5)   | (6)   |
| Quality standards x moving/universal | -0.0094** | -0.0081* | -0.0099 | -0.0100 | 0.0069 | 0.0028 |
|                                |       |       |       |          | (0.0045) | (0.0043) | (0.0068) | (0.0079) | (0.0052) | (0.0056) |
| Quality standards x moving/universal | 0.0157*** | 0.0181*** | -0.0112 | 0.0008 | 0.0237*** | 0.0128** |
|                                |       |       |       |          | (0.0048) | (0.0058) | (0.0069) | (0.0056) | (0.0051) | (0.0054) |
| F-test partial = moving/universal (p-value) | 12.86 | 11.74 | 0.03 | 1.47 | 4.79 | 1.67 |
|                                |       |       |       |          | (0.001) | (0.001) | (0.872) | (0.233) | (0.035) | (0.204) |
| Spending per child x partial   | 0.0095*** | 0.0095*** | 0.0070** | 0.0120*** | -0.0031 | -0.0065** |
|                                |       |       |       |          | (0.0021) | (0.0018) | (0.0028) | (0.0038) | (0.0030) | (0.0028) |
| Spending per child x moving/universal | 0.0017 | -0.0024 | 0.0028* | 0.0027 | -0.0076*** | -0.0098*** |
|                                |       |       |       |          | (0.0089) | (0.0082) | (0.0017) | (0.0023) | (0.0015) | (0.0018) |
| F-test partial = moving/universal (p-value) | 0.73 | 2.03 | 1.50 | 4.42 | 1.34 | 0.99 |
|                                |       |       |       |          | (0.398) | (0.163) | (0.228) | (0.042) | (0.255) | (0.326) |
| R-squared                      | 0.8244 | 0.7543 | 0.7248 | 0.7770 | 0.6404 | 0.6622 |
| District-year observations      | 72,262 | 64,348 | 16,568 | 21,628 | 15,030 | 18,804 |
| Year fixed effects             | Yes   | Yes   | Yes   | Yes     | Yes   | Yes   |
| District fixed effects         | Yes   | Yes   | Yes   | Yes     | Yes   | Yes   |
| Time-varying controls          | Yes   | Yes   | Yes   | Yes     | Yes   | Yes   |

Notes: State pre-K indicators are lagged by five years. Control variables include racial/ethnic proportions and number of students in fourth grade, proportion of free-lunch students in fourth grade, and proportion of Special Education students in the district. All columns exclude states categorized as non-sponsored. Robust standard errors in parentheses are clustered by state. * p < 0.10, ** p < 0.05, *** p < 0.01.
Discussion

There is little doubt that the expansion of pre-k programs has been largely beneficial to children across the US (Fischer et al., 2020; Gormley et al., 2005; Lipsey et al., 2013). However, the tremendous variation across states in the implementation of early childhood education policy has left policymakers to seek the best way of designing and executing these programs. As noted by Meloy et al. (2019, p. 1) “…the issue is not whether preschool “works,” but how to design and implement programs that ensure public preschool investments consistently deliver on their promise.” Given these considerations, we have sought to identify structural aspects of pre-k policy that may improve later student achievement and reduce racial/ethnic gaps. Our analysis shows that (1) state funding is associated with both increases in student achievement and reduction gaps, (2) the effect of funding is stronger in states that provide targeted pre-k access to low-income/at-risk students, (3) legislated quality standards mainly impact achievement for White students and increase gaps in states that provide universal access to all children. Below, we investigate these results further and provide policy recommendations.

Our most consistent result dealt with funding, mainly noting the broad increase in general student achievement, increases across racial/ethnic subgroups, and a reduction in racial/ethnic gaps. In general, cohorts exposed to higher funded pre-k programs demonstrated significant increases in ELA achievement in the fourth grade, \( \text{ceteris paribus} \). Supporting the adage that ‘money matters,’ this finding supports the notion that spending does matter in pre-k (Johnson & Jackson, 2019).

However, when looking at the scope of access, we saw that this association was most pronounced in states providing targeted access. In universal access states, only Black students increased achievement in a significant manner, echoing the results of Bassok (2010), that pre-k benefits all racial/ethnic subgroups under the poverty line, but additionally benefits Black students that are not living in poverty. Given that most targeted states fund pre-k for low-income, at-risk, or minoritized students, our results suggest that a well-funded pre-k program aimed at historically disadvantaged students is most effective in attaining the broader goals of improved student achievement and a reduction in educational disparities.

Turning to standards of structural quality, we find what appear to be counterintuitive results. While we would be hard-pressed to argue that establishing standards for elements such as educator credentials and minimum class sizes would be detrimental to student outcomes (see: Slot, 2018), we find that quality standards are at best associated with no change in achievement, and at worst associated with increases in achievement gaps. While these results require further investigation, the inverse relationship between quality standards and Black student achievement may speak to a highly problematic mismatch between the implementation of structural quality and beneficial supports for Black children in pre-k (Gutiérrez & Rogoff, 2003; Tobin, 2005). Indeed, when disaggregating by access, we find that quality standards are mainly a lever on White student achievement, having the largest effect in universal states. As such, policy mandated quality standards tend to not support—or even worse may harm—low-income/at-risk/minoritized student achievement. Three speculative interpretations may follow, each requiring further inquiry. One interpretation is that legislated quality standards may be adopted in lieu of adequate pre-k funding or appropriate oversight, and thereby may not be carried out with the fidelity intended. In short, quality standards may be more of a policy symbol than policy action (Rosen, 2009). A second interpretation is that, as noted above, pre-k process quality has often shown to systematically vary across racial/ethnic groups, often to the disadvantage of minoritized groups (Nxumalo & Adair, 2019; Tobin, 2005). It is possible then that legislated structural quality standards may serve to intensify certain detrimental practices by, for example, restricting highly contextual and/or culturally relevant approaches in areas such as...
discipline or curriculum. A third interpretation is that high funding exceeds the criteria legislated qualitatively. Minimum standards for pre-k teacher credentials may, simply, not be equivalent to the ability to recruit and retain a motivated and quality pre-k teacher (Barnett, 2003). Quality standards may therefore not be meaningfully independent of funding, or may only function above a threshold of funding. This later notion may help explain why quality standards only improved White student achievement in the universal context, but more research is needed to investigate these notions. Overall, our results suggest that providing adequate funding targeted toward historically disadvantaged children may provide broad benefits to all students while reducing educational disparities.

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### Appendix A

#### Appendix Table A

*Mean for State Pre-K Indicators - By State and Year*

| State          | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | Spending per child |
|----------------|------|------|------|------|------|------|------|------|-------------------|
| Alabama        | 7.0  | 8.0  | 9.0  | 9.0  | 9.0  | 9.0  | 9.0  | 9.0  | 6465              |
| Alaska         | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 9.0  | 9.0  | 0                 |
| Arizona        | 4.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 4996              |
| Arkansas       | 9.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 5287              |
| California     | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 3317              |
| Colorado       | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 2864              |
| Connecticut    | 3.0  | 4.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 7371              |
| Delaware       | 6.0  | 7.0  | 7.0  | 7.0  | 7.0  | 7.0  | 7.0  | 7.0  | 5287              |
| District of Columbia | 6.0 | 7.0 | 8.0 | 7.0 | 7.0 | 7.0 | 5.5 | 4.5 | 8876 |
| Florida        | 0.0  | 0.0  | 3.0  | 3.0  | 3.0  | 2.0  | 2.0  | 2.0  | 0                 |
| Georgia        | 5.0  | 7.0  | 7.0  | 7.0  | 7.0  | 7.0  | 8.0  | 9.0  | 3824              |
| Illinois       | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 2905              |
| Iowa           | 4.0  | 4.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 2925              |
| Kansas         | 3.0  | 3.0  | 3.0  | 3.0  | 3.0  | 3.0  | 3.0  | 3.0  | 1721              |
| Kentucky       | 6.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 3916              |
| Louisiana      | 6.0  | 6.3  | 7.0  | 6.7  | 7.0  | 7.7  | 8.0  | 8.0  | 3922              |
| Maine          | 3.0  | 3.0  | 4.0  | 4.0  | 4.0  | 5.0  | 5.0  | 6.0  | 4097              |
| Maryland       | 7.0  | 7.0  | 7.0  | 7.0  | 8.0  | 8.0  | 8.0  | 8.0  | 4067              |
| Massachusetts  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5221              |
| Michigan       | 4.0  | 4.0  | 6.0  | 6.0  | 6.0  | 8.0  | 7.0  | 7.0  | 3306              |
| Minnesota      | 7.0  | 7.0  | 7.0  | 7.0  | 8.0  | 8.0  | 8.0  | 8.0  | 6672              |
| Missouri       | 4.0  | 5.0  | 6.0  | 6.0  | 6.0  | 7.0  | 8.0  | 8.0  | 2198              |
| Nebraska       | 5.0  | 5.0  | 7.0  | 7.0  | 7.0  | 6.0  | 6.0  | 6.0  | 5455              |
| Nevada         | 3.0  | 3.0  | 6.0  | 6.0  | 6.0  | 6.0  | 6.0  | 6.0  | 3686              |
| New Jersey     | 6.0  | 6.5  | 6.7  | 6.7  | 6.7  | 7.3  | 7.3  | 7.3  | 8739              |
| New Mexico     | 3.0  | 3.0  | 3.5  | 5.5  | 8.0  | 7.0  | 7.0  | 7.0  | 1765              |
| New York       | 5.5  | 4.5  | 5.5  | 6.0  | 5.0  | 5.0  | 5.0  | 5.0  | 3430              |
| North Carolina | 8.0  | 8.0  | 9.0  | 9.0  | 9.0  | 9.0  | 9.0  | 9.0  | 4819              |
| Ohio           | 5.0  | 4.0  | 3.0  | 3.0  | 3.0  | 3.0  | 2.0  | 2.0  | 4514              |
| Oklahoma       | 7.0  | 7.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 8.0  | 2368              |
| Oregon         | 5.0  | 6.0  | 6.0  | 6.0  | 7.0  | 7.0  | 7.0  | 7.0  | 6525              |
| Pennsylvania   | 2.0  | 2.7  | 3.7  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 0                 |
| Rhode Island   | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 9.0  | 9.0  | 0                 |

*Note: The table continues with the states and years as provided in the original document.*
## Appendix Table B

*Mean and Standard Deviations for Time-Varying District Controls - All students sample, by year*

|                     | 2009 Mean | 2009 SD | 2010 Mean | 2010 SD | 2011 Mean | 2011 SD | 2012 Mean | 2012 SD | 2013 Mean | 2013 SD | 2014 Mean | 2014 SD | 2015 Mean | 2015 SD |
|---------------------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|
| Proportion of White students in 4th grade | 0.74 0.28 | 0.74 0.28 | 0.73 0.28 | 0.72 0.28 | 0.72 0.28 | 0.74 0.27 | 0.71 0.29 |
| Proportion of Black students in 4th grade | 0.09 0.16 | 0.08 0.16 | 0.08 0.16 | 0.08 0.16 | 0.08 0.15 | 0.08 0.17 | 0.08 0.16 |
| Proportion of Hispanic students in 4th grade | 0.13 0.21 | 0.13 0.21 | 0.14 0.21 | 0.15 0.22 | 0.16 0.22 | 0.13 0.19 | 0.16 0.23 |
| Proportion of Asian students in 4th grade | 0.02 0.05 | 0.03 0.05 | 0.02 0.05 | 0.02 0.05 | 0.02 0.05 | 0.02 0.05 | 0.02 0.05 |
| Proportion of Native American students in 4th grade | 0.02 0.10 | 0.02 0.10 | 0.02 0.10 | 0.02 0.09 | 0.02 0.09 | 0.02 0.10 | 0.02 0.10 |
| Number of White students in 4th grade/100 | 1.81 3.59 | 1.80 3.58 | 1.78 3.57 | 1.77 3.60 | 1.83 3.75 | 1.75 3.59 | 1.76 3.44 |
| Number of Black students in 4th grade/100 | 0.59 3.88 | 0.59 3.85 | 0.57 3.90 | 0.56 3.78 | 0.57 3.67 | 0.58 3.87 | 0.56 2.99 |
| Number of Hispanic students in 4th grade/100 | 0.80 6.08 | 0.83 6.10 | 0.88 6.39 | 0.92 6.34 | 0.98 6.50 | 0.76 5.39 | 1.02 5.95 |
| Number of Asian students in 4th grade/100 | 0.18 1.64 | 0.19 1.75 | 0.18 1.60 | 0.18 1.61 | 0.20 1.71 | 0.14 1.70 | 0.19 1.23 |
| Number of Native American students in 4th grade/100 | 0.04 0.19 | 0.04 0.20 | 0.04 0.19 | 0.04 0.18 | 0.04 0.19 | 0.04 0.20 | 0.04 0.19 |
| Proportion of free-lunch students in 4th grade | 0.35 0.21 | 0.39 0.21 | 0.40 0.21 | 0.40 0.21 | 0.43 0.21 | 0.43 0.21 | 0.46 0.21 |
| Proportion of Special Education students in district | 0.13 0.06 | 0.14 0.05 | 0.14 0.05 | 0.14 0.05 | 0.13 0.04 | 0.14 0.04 | 0.13 0.04 |
| Proportion of English Learners in district | 0.05 0.09 | 0.05 0.10 | 0.03 0.06 | 0.05 0.09 | 0.05 0.09 | 0.03 0.06 | 0.05 0.10 |
| Total number of teachers/100 | 2.84 10.87 | 2.79 10.56 | 2.71 10.25 | 2.73 10.08 | 2.82 10.04 | 2.68 10.07 | 2.51 7.76 |
| District-year observations | 9640 | 9756 | 9756 | 9776 | 9007 | 8039 | 8213 |
### Appendix C

**Appendix Table C**

| State            | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|------------------|------|------|------|------|------|------|------|------|------|
| Alabama          | 17   | 18   | 17   | 16   | 16   | 15   | 15   | 16   | 16   |
| Alaska           |      | 16   | 16   | 13   | 15   | 16   | 13   | 13   | 13   |
| Arizona          | 11   | 14   | 13   | 12   | 13   | 12   | 10   | 12   | 13   |
| Arkansas         | 17   | 17   | 18   | 15   | 15   | 14   | 13   | 13   | 13   |
| California       | 11   | 12   | 11   | 10   | 11   | 11   | 11   | 11   | 12   |
| Colorado         | 9.5  | 9.5  | 8.5  | 8.5  | 8.5  | 7.5  | 7.5  | 8.5  | 8.5  |
| Connecticut      | 7.5  | 8    | 8    | 8    | 8    | 9    | 8    | 8    | 8    |
| Delaware         | 9    | 10   | 9    | 9    | 9    | 8    | 7    | 5    | 8    |
| Florida          | 10   | 10   | 10   | 9    | 9    | 9    | 9    | 9    | 10   |
| Georgia          | 9.5  | 8    | 7.5  | 7.5  | 7.5  | 7    | 7    | 7    | 7    |
| Hawaii           | 9    | 10   | 10   | 10   | 11   | 10   | 11   | 10   | 10   |
| Idaho            |      | 12   | 12   | 11   | 11   | 10   | 10   | 10   | 9    |
| Illinois         | 10   | 11   | 11   | 10   | 11   | 11   | 11   | 11   | 12   |
| Indiana          | 8    | 9    | 8    | 9    | 8    | 9    | 10   | 9    | 10   |
| Iowa             | 10   | 11   | 11   | 11   | 9    | 9    | 20   | 9    | 20   |
| Kansas           | 9    | 10   | 10   | 10   | 9    | 7    | 8    | 9    | 8    |
| Kentucky         | 17   | 18   | 17   | 16   | 17   | 16   | 16   | 16   | 16   |
| Louisiana        | 16   | 16   | 17   | 14   | 16   | 15   | 14   | 14   | 14   |
| Maine            | 14   | 15   | 13   | 12   | 13   | 14   | 12   | 12   | 11   |
| Maryland         | 8    | 8    | 6    | 6    | 8    | 8    | 8    | 8    | 8    |
| Massachusetts    | 8    | 8    | 8    | 7    | 8    | 8    | 8    | 8    | 8    |
| Michigan         | 12   | 14   | 14   | 14   | 17   | 16   | 15   | 16   | 6    |
| Minnesota        | 8    | 9    | 9    | 8    | 9    | 8    | 8    | 8    | 8    |
| Mississippi      | 38   | 38   | 36   | 36   | 36   | 35   | 34   | 36   | 34   |
| Missouri         | 11   | 11   | 12   | 11   | 12   | 11   | 11   | 11   | 11   |
| Montana          | 22   | 23   | 22   | 20   | 20   | 19   | 19   | 20   | 20   |
| Nebraska         | 11   | 11   | 11   | 10   | 10   | 10   | 10   | 10   | 10   |
| Nevada           | 6    | 4    | 5    | 5    | 5    | 5    | 4    | 4    | 5    |
| New Hampshire    | 5    | 6    | 5    | 5    | 5    | 5    | 6    | 5    | 7    |
| New Jersey       | 6    | 7    | 6    | 6    | 6    | 6    | 6    | 7    | 7    |
| New Mexico       | 15   | 18   | 19   | 18   | 17   | 16   | 14   | 15   | 16   |
| New York         | 10   | 10   | 10   | 9    | 10   | 10   | 10   | 10   | 11   |
| North Carolina   | 10   | 10   | 10   | 9    | 9    | 8    | 9    | 9    | 9    |
| North Dakota     | 24   | 24   | 25   | 22   | 23   | 21   | 19   | 24   | 24   |
| Ohio             | 13   | 13   | 13   | 13   | 13   | 12   | 12   | 13   | 13   |
| Oklahoma         | 15   | 18   | 18   | 16   | 17   | 16   | 16   | 15   | 15   |
| Oregon           | 12   | 11   | 11   | 10   | 13   | 14   | 9    | 9    | 9    |
| Pennsylvania     | 10   | 11   | 11   | 11   | 13   | 13   | 11   | 11   | 11   |
| Rhode Island     | 16   | 15   | 10   | 12   | 14   | 10   | 11   | 10   | 10   |
| South Carolina   | 10   | 11   | 10   | 11   | 10   | 20   | 10   | 10   | 10   |
| South Dakota     | 19   | 20   | 20   | 20   | 20   | 20   | 19   | 18   | 18   |
| Tennessee        | 13   | 14   | 14   | 13   | 12   | 12   | 12   | 12   | 12   |
| Texas            | 10   | 11   | 10   | 9    | 10   | 9    | 9    | 9    | 10   |
| Utah             | 9    | 9    | 8    | 8    | 8    | 7    | 8    | 8    | 8    |
| Vermont          | 8    | 10   | 11   | 10   | 9    | 9    | 10   | 10   | 10   |
| Virginia         | 8    | 8    | 7    | 7    | 7    | 7    | 7    | 7    | 8    |
| Washington       | 8    | 9    | 9    | 9    | 9    | 9    | 9    | 9    | 9    |
| West Virginia    | 19   | 20   | 20   | 21   | 21   | 22   | 23   | 24   | 24   |
| Wisconsin        | 9    | 10   | 10   | 9    | 9    | 9    | 9    | 9    | 9    |
| Wyoming          | 17   | 18   | 16   | 15   | 13   | 14   | 13   | 12   | 12   |

Note: Displayed are the percentage of 4-year-old children enrolled in a state pre-k program, pre-k special education, or Head Start. Adapted from NIEER Yearbooks, 2003-2011.
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