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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 and 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

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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 expandido 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 estadual 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.

Palavras-chave: educação infantil; lacunas de realização; qualidade de pré-escola; financiamento pré-escola

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 difficultly 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.

more (Atchison & Diffey, 2018; Camilli et al., 2010). While this makes comparisons and cross-state studies difficult, research has begun to identify how two general indicators of program quality—process quality and structural quality—align with pre-k outcomes. Process quality refers to the direct child experience within pre-k programs, such as "activities and interactions with teachers, peers, and materials" (Slot, 2018, p. 8). Research has shown that elements of process quality, such as teacher-child interactions and supportive instruction benefits student outcomes (Slot, 2018; Weiland, 2016; Yoshikawa et al., 2013). However, for programs to provide a high-quality pre-k experience, structural supports such as student access, adequate funding, lower child-to-teacher ratios, higher staff qualifications, and curriculum standards need to be present (Fischer et al., 2020; Meloy et al., 2019; Slot, 2018; Yoshikawa et al., 2013). As policy-level changes, improvements in structural quality have great 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/ethnically 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).[2] 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.[3] 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.

[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	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Achievement outcome	0.05	0.38	0.19	0.33	-0.39	0.31	-0.30	0.33	0.59	0.28	0.49	0.29
District-year observations	79282		70582		17912		22906		16046		20045	

Independent Variables

Per-Pupil Spending in Pre-K

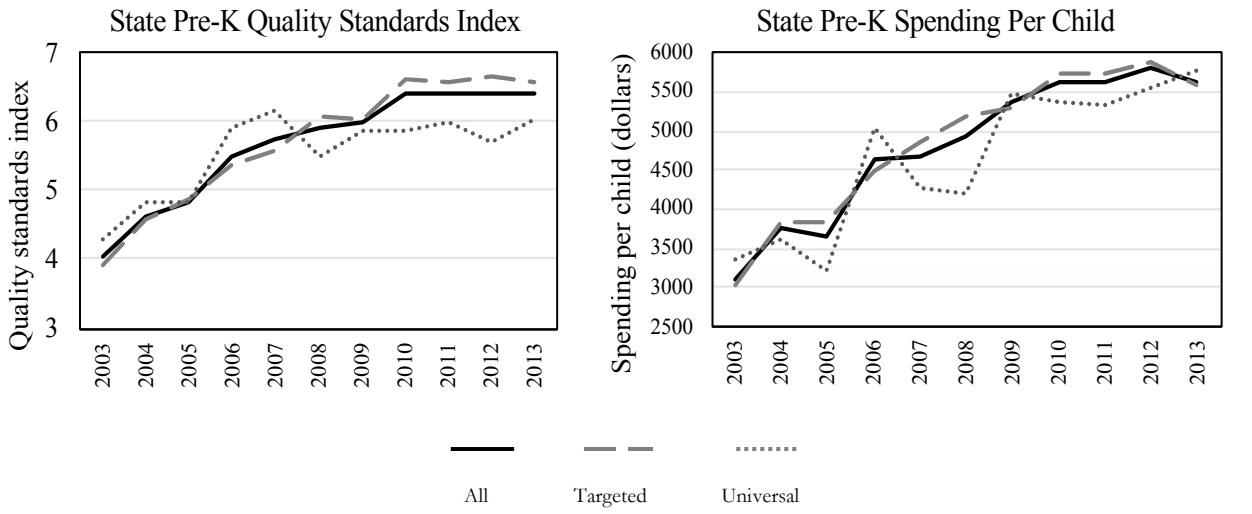
We use total state funds spent per child in pre-k programs based on NIEER reported sources. This may include some additional funds from federal or local sources. However, our measure excludes federal contributions to Head Start. States with no implementation for pre-k programs were assigned a $0 per-pupil 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

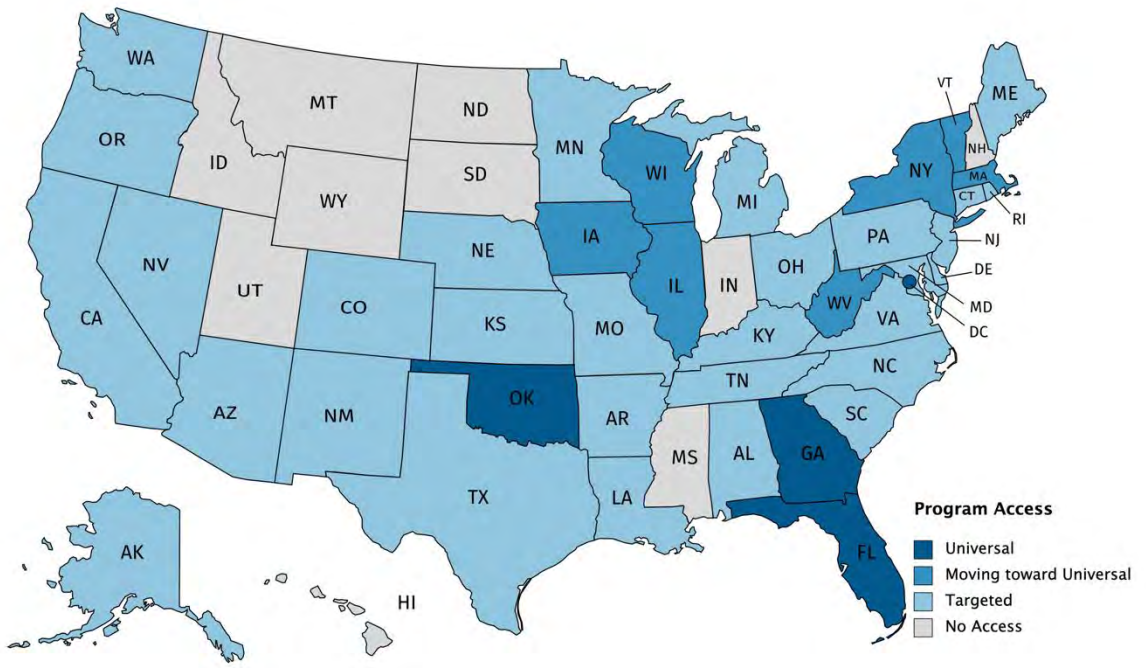


Program Access

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[4]; 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.

[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.

Figure 2
Pre-K Program Access by State



Control Variables

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	0.73	0.28	0.78	0.23	0.49	0.26	0.49	0.27	0.53	0.23	0.54	0.24
Proportion of Black students in 4th grade	0.08	0.17	0.07	0.13	0.29	0.25	0.11	0.16	0.24	0.20	0.12	0.15
Proportion of Hispanic students in 4th grade	0.14	0.21	0.11	0.17	0.18	0.20	0.34	0.27	0.18	0.20	0.28	0.22
Proportion of Asian students in 4th grade	0.02	0.05	0.02	0.05	0.04	0.07	0.04	0.07	0.04	0.07	0.05	0.07
Proportion of Native American students in 4th grade	0.02	0.10	0.01	0.05	0.01	0.02	0.01	0.04	0.01	0.02	0.01	0.04

	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*
Number of White students in 4th grade/100	1.78	3.49	1.94	3.58	4.12	6.29	3.60	5.76	4.56	6.48	4.06	5.98
Number of Black students in 4th grade/100	0.54	3.05	0.55	3.15	2.24	6.09	1.50	5.41	2.33	6.29	1.64	5.65
Number of Hispanic students in 4th grade/100	0.83	5.38	0.83	5.61	2.67	10.84	2.68	9.73	2.88	11.36	2.79	10.26
Number of Asian students in 4th grade/100	0.16	1.17	0.18	1.23	0.56	2.36	0.49	2.12	0.61	2.49	0.55	2.26
Number of Native American students in 4th grade/100	0.04	0.18	0.03	0.17	0.06	0.26	0.07	0.27	0.07	0.28	0.07	0.28
Proportion of free-lunch students in 4th grade	0.41	0.21	0.39	0.20	0.52	0.22	0.47	0.22	0.49	0.21	0.44	0.21
Proportion of Special Education students in district	0.14	0.05	0.14	0.04	0.13	0.04	0.12	0.04	0.13	0.04	0.13	0.04
District-year observations	79282		70582		17912		22906		16046		20045	

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:

$$ACH_{dst} = \beta_0 + \beta_1 PREK_{st-5} + \beta_2 CON_{dst} + \delta + \gamma + \varepsilon_{dst}$$

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*. $PREK_{st-5}$ 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 δ and γ 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 β_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).[5] 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

[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	
	All	All	All	White	Black	Hispanic	W-B	W-H
	(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)
Spending per child (logged)	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				Achievement gap	
	All	White	Black	Hispanic	W-B	W-H
	(1)	(2)	(3)	(4)	(5)	(6)
Quality standards x partial	-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	12.86	11.74	0.03	1.47	4.79	1.67
(p-value)	(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	0.73	2.03	1.50	4.42	1.34	0.99
(p-value)	(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, *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

	Quality standards index								Spending per child							
	2004	2005	2006	2007	2008	2009	2010	2011	2004	2005	2006	2007	2008	2009	2010	2011
Alabama	7.0	8.0	9.0	9.0	9.0	9.0	9.0	9.0	6465	3386	5883	6931	4415	5134	4544	5680
Alaska	0.0	0.0	0.0	0.0	0.0	0.0	9.0	9.0	0	0	0	0	0	0	8500	6855
Arizona	4.0	3.0	3.0	3.0	3.0	3.0	2.0	0.0	2432	2283	2296	2379	2316	2247	1093	0
Arkansas	9.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	4996	4711	7769	7194	7979	8399	8388	8126
California	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3317	3218	3341	3486	3607	3681	5571	5428
Colorado	3.0	3.0	3.0	4.0	5.0	5.0	5.0	5.0	2864	3078	3056	3194	3353	3572	3757	3623
Connecticut	3.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	7371	8069	8918	9577	9393	10303	10441	10565
Delaware	6.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	5287	5816	6261	6745	6795	6795	6795	6795
District of Columbia	6.0	0.0	7.0	8.0	0.0	7.0	5.5	4.5	8876	0	9445	0	0	11605	11457	11668
Florida	0.0	0.0	3.0	3.0	3.0	2.0	2.0	2.0	0	0	2163	2335	2500	2448	2514	2422
Georgia	5.0	7.0	7.0	7.0	7.0	7.0	8.0	9.0	3824	3899	3978	4114	4249	4239	4212	4299
Illinois	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	2905	2980	3298	3322	3372	3438	3371	3449
Iowa	4.0	4.0	4.0	5.0	6.5	6.5	6.5	6.0	2925	3178	8269	8966	4932	4054	3749	3945
Kansas	3.0	3.0	3.0	3.0	7.0	7.0	7.0	7.0	1721	1686	2554	2596	2843	3026	2490	2640
Kentucky	6.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	3916	3697	3652	4637	4860	4941	6290	6718
Louisiana	6.0	6.3	7.0	6.7	7.0	7.7	8.0	8.0	3922	4535	5012	5275	5997	5403	4804	4768
Maine	3.0	3.0	4.0	4.0	5.0	5.0	6.0	6.0	4097	4406	3469	3575	3281	2901	3835	4555
Maryland	7.0	7.0	7.0	7.0	8.0	8.0	8.0	8.0	4067	721	4663	6132	8558	8304	9645	9846
Massachusetts	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5221	5484	3959	3998	3811	5994	3895	3691
Michigan	4.0	4.0	6.0	6.0	8.0	7.0	7.0	7.0	3306	3366	3934	4167	4230	4286	4405	4453
Minnesota	7.0	7.0	7.0	7.0	8.0	8.0	8.0	8.0	6672	6929	7203	7251	8310	9994	7301	7475
Missouri	4.0	5.0	6.0	6.0	6.0	7.0	8.0	8.0	2198	2254	2632	2540	2757	2880	3051	3085
Nebraska	5.0	5.0	7.0	7.0	7.0	6.0	6.0	6.0	5455	1963	7418	6888	6748	5184	2070	2656
Nevada	3.0	3.0	6.0	6.0	6.0	6.0	6.0	6.0	3686	2767	3116	3322	3130	2973	2710	3297
New Jersey	6.0	6.5	6.7	6.7	6.7	7.3	7.3	7.3	8739	9305	9854	10494	10989	11205	11578	11669
New Mexico	3.0	3.0	3.5	5.5	8.0	7.0	7.0	7.0	1765	2576	2269	2975	3056	3355	3412	3561
New York	5.5	4.5	5.5	6.0	5.0	5.0	5.0	7.0	3430	3625	3512	3454	3948	3668	3503	3685
North Carolina	8.0	8.0	9.0	9.0	9.0	9.0	9.0	9.0	4819	4058	3892	7401	6954	7713	7824	7910
Ohio	5.0	4.0	3.0	3.0	3.0	3.0	2.0	2.0	4514	6325	2345	2515	7260	6904	3902	3942
Oklahoma	7.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	2368	2517	6167	6731	7484	7853	7855	7690
Oregon	5.0	6.0	6.0	6.0	7.0	7.0	7.0	7.0	6525	7624	7932	7853	8337	8020	8435	8454
Pennsylvania	2.0	2.7	3.7	5.0	5.3	5.0	5.0	5.0	0	2954	5080	5519	6252	5711	5924	5193
Rhode Island	0.0	0.0	0.0	0.0	0.0	0.0	9.0	9.0	0	0	0	0	0	0	9127	9127

	Quality standards index								Spending per child							
	2004	2005	2006	2007	2008	2009	2010	2011	2004	2005	2006	2007	2008	2009	2010	2011
South Carolina	7.0	7.0	7.0	7.0	7.0	6.0	6.0	6.5	1467	1575	3219	2702	2134	3409	3244	2934
Tennessee	7.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	4573	3333	4061	5295	5578	5763	5688	5853
Texas	2.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2746	2707	2653	2836	3581	3790	3686	3761
Vermont	5.0	6.5	6.5	6.5	6.5	4.5	4.0	4.0	1197	2488	2439	2577	3290	3467	3980	3272
Virginia	4.0	4.0	6.0	6.0	6.0	7.0	6.0	6.0	3090	5456	5375	5633	5639	6284	6288	5892
Washington	5.0	5.0	5.0	8.0	8.0	8.0	8.0	8.0	4640	6120	6600	6010	7046	6890	6817	6780
West Virginia	4.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	5032	6829	7758	6724	7778	8743	9413	9136
Wisconsin	3.5	5.0	5.0	5.0	5.5	5.5	5.5	5.5	4138	4167	4590	4665	4737	4725	5038	5424
Total	4.1	4.4	4.8	5.0	5.3	5.2	5.3	5.4	3243	3489	3995	4181	4552	4639	4543	4552

Note: non-sponsored states whose pre-k indicators are zero over the sample period are not included in the table: Hawaii, Idaho, Indiana, Mississippi, Montana, New Hampshire, North Dakota, South Dakota, Utah, and Wyoming.

Appendix B

Appendix Table B

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

	2009		2010		2011		2012		2013		2014		2015	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	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

% of state 4-year-old enrollment in pre-k programs

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	9	8	7	8	8	7	7	8
Connecticut	7	8	8	8	8	9	8	8	8
Delaware	9	10	9	9	9	8	7	5	8
Florida		10	10	9	9	9	9	9	10
Georgia	9	9	8	7	7	7	7	7	7
Hawaii	9	10	10	9	10	11	10	11	10
Idaho		12	12	12	11	11	10	10	9
Illinois	10	11	11	10	11	11	11	11	12
Indiana		8	9	8	9	8	9	10	9
Iowa	10	11	11	11	11	9	9	20	9
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	16	15	14	14
Maine	14	15	13	12	13	14	12	12	11
Maryland	8	8	6	6	7	7	8	6	6
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
Missouri	11	11	12	11	12	11	11	11	11
Montana		22	23	22	20	20	19	19	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	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	9	10	10	10	10	10	11
North Carolina	10	10	10	9	9	9	8	9	9
North Dakota		24	24	25	22	23	21	19	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
South Carolina	10	11	10	11	10	20	10	10	10
South Dakota		19	20	20	20	20	20	19	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
Vermont	8	10	11	10	10	9	9	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	20	21	21	22	23	24
Wisconsin	9	10	10	9	9	9	9	9	9
Wyoming		17	18	16	15	13	14	13	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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