The Impact of Full-day Kindergarten Expansions on Academic Achievement

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Abstract

In the United States, full-day kindergarten has proliferated in the past two decades as states and localities have rapidly expanded their provision of kindergarten in full-day settings. Participation in full-day kindergarten eclipsed half-day in 1995 and now constitutes approximately three-quarters of kindergarten students. In contrast to the existing, limited literature on full-day kindergarten impact, which focuses on participant effects, this study provides the first evidence on the systemic impact of provision by focusing on subsequent student achievement in places that expand full-day kindergarten offerings. Leveraging variation across states and—within one state, across districts—and over time, this research investigates the impact of expansions on mean student achievement, in the third through eighth grades, and on Hispanic-white and black-white test score gaps. Full-day kindergarten contributes to improved overall academic performance in both reading and math in the later grades, but may in fact exacerbate achievement gaps. As full-day kindergarten has evolved from a targeted to near-universal intervention, the findings have important implications for the broader policy discourse around early childhood investments and inequality.

JEL codes: I24, I28, J13

Keywords: early childhood education, kindergarten, instructional time, achievement gaps

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I. INTRODUCTION

This study explores the impact of dramatic full-day kindergarten expansions across states and over time on academic achievement. I couple district-level academic achievement data from the Stanford Education Data Archive with data on full-day kindergarten expansions to investigate the relationship between full-day kindergarten availability and subsequent student achievement and test score gaps. In particular, the project focuses on the systemic impact of providing full-day kindergarten by focusing on subsequent student achievement and racial and ethnic achievement gaps in places that expand full-day kindergarten offerings. By leveraging variation across states and—within one state, across districts—and over time, the research design seeks to isolate the effects of full-day kindergarten expansions on subsequent student achievement and racial/ethnic achievement gaps. This work speaks directly to the impact of state education policies around full-day kindergarten, rapidly changing in the time period of interest, on educational achievement and educational inequality.

The early childhood years have been a focus of policymakers, practitioners, and researchers, particularly as a time to address significant school entry achievement gaps. The early emergence of achievement gaps by race/ethnicity and socioeconomic status has been well-established in the literature (Fryer & Levitt 2004, Fryer & Levitt 2006, Lee & Burkam 2002, Murnane, Willett, Bub & McCartney 2006). Test score gaps by race and socioeconomic status are already large at the beginning of formal schooling and persist throughout the schooling years. These sizable gaps have led policymakers to consider early childhood interventions, and full-day kindergarten in particular has been an area of considerable attention and growth. The number of kindergarteners in full-day settings has increased dramatically over the last two decades, but there is no evidence on the effectiveness of these expansions in improving subsequent student achievement and addressing inequality in early skill development.

This paper contributes new evidence to this conversation by exploring how full-day kindergarten expansions have affected mean student achievement in both reading and math and racial and ethnic test score gaps. The motivating research question is whether or not states that expanded full-day kindergarten experienced corresponding boosts in subsequent student achievement in the third through eight grades, and whether those expansions reduced or exacerbated Hispanic-white and black-white test score gaps. I use the variation across states and over time, in a period of dramatic full-day kindergarten expansions, and find that full-day kindergarten expansions were associated with improved academic performance in both reading and math in later grades. Greater provision of full-day kindergarten appears to have enlarged Hispanic-white and black-white math gaps.

In presenting the evidence on the impact of full-day kindergarten expansions, the paper proceeds as follows. The next section discusses further the rationale for studying this question as well as previous, related research. Section 3 details the study, including the data and empirical strategy. In Section 4, I summarize the results and Section 5 concludes with discussion of the implications of the study findings.

II. STUDY MOTIVATION

Investment in early childhood has gained significant traction in recent years as an efficient and equitable means to compensate for the impoverished developmental environments in which many disadvantaged children grow up (Currie 2001, Heckman 2000, Heckman & Masterov 2007). The developmental literature has coalesced around the notion that children experience declining developmental plasticity and thus early investments—by altering cognitive and social skill development when the brain is most malleable and able to adapt its functioning—are more likely to substantially and permanently affect long-term life chances (Shonkoff & Phillips 2000, Knudsen, Heckman, Cameron & Shonkoff 2006).

There is also a growing body of empirical evidence that early childhood programs reap long-term effects for participants, generating substantial private and social returns that far outweigh the program costs. Long-term evidence from the Abecedarian Project, Perry

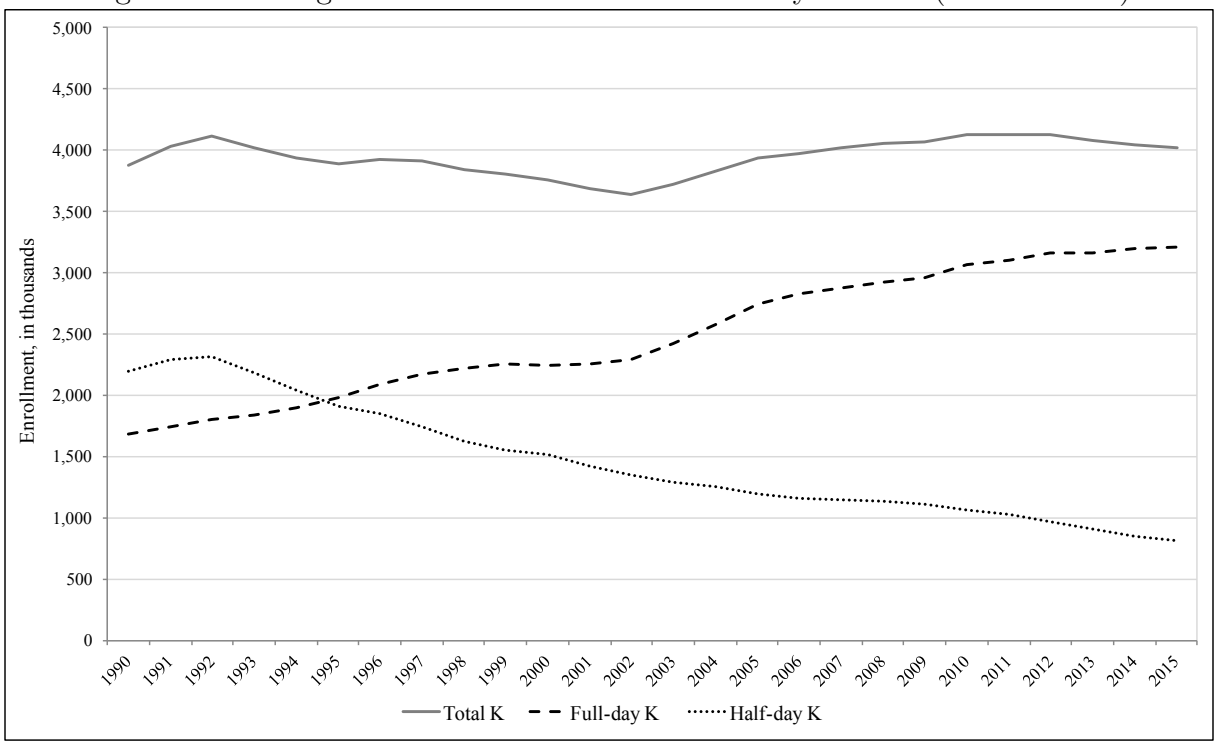
Preschool Project, Head Start, and the Project STAR class-size reduction intervention suggests that interventions in the preschool and early school years can have substantial effects on schooling attainment, labor market success, and other measures of health and well-being into adulthood (Chetty et al. 2011, Deming 2009, Schweinhart, Montie, Xiang, Barnett, Belfield & Nores 2005). Improvements in life chances include better health and higher rates of college-going (Campbell, Conti, Heckman, Moon, Pinto, Pungello & Pan 2014, Dynarski, Hyman & Schanzenbach 2013). While these "existence proofs" have garnered significant attention and focus on the early childhood years, less is known about how to implement programs effectively at scale, whether programs should be targeted or universally provided, and at what age programs are most effective.

Full-day kindergarten as a policy lever has been an area of considerable activity over the past two decades. Table 1 displays features of children's early childhood experiences as measured across two kindergarten cohorts, 1998 and 2010, in the Early Childhood Longitudinal Study (ECLS-K). While full-day kindergarten participation–and provision as measured by principal reports of school-level policy–has increased substantially across the two waves of the ECLS-K, other aspects of the early childhood experience have remained relatively stable, including preschool and Head Start participation and small class size in kindergarten, despite growing interest in the early childhood years more generally.

In the United States, nearly all students attend kindergarten, viewed as a transition year to formal schooling, and at present the vast majority of students in kindergarten are in full-day settings. As depicted in Figure 1, full-day kindergarten eclipsed half-day provision as a proportion of all kindergarten enrollment in 1995 and now constitutes greater than three-quarters of kindergarten enrollment in both private and public schools. While there was brief federal attention on full-day kindergarten in the Obama Administration, the policy activity on full-day kindergarten has all taken place at the local and state levels, with 10 states and DC providing full-day kindergarten at no charge to all children per state statute (Children's Defense Fund, 2014). Several states have made considerable legislative efforts towards full

provision of full-day, including Arizona, Indiana, Ohio, Oregon, and Minnesota. While only 11 states formally define full-day kindergarten in state statute, 24 states specify a funding formula that funds full-day kindergarten at or above the level of first grade (Education Commission of the States, 2012).

Figure 1: Kindergarten Enrollment of Three to Six-year Olds (in thousands)

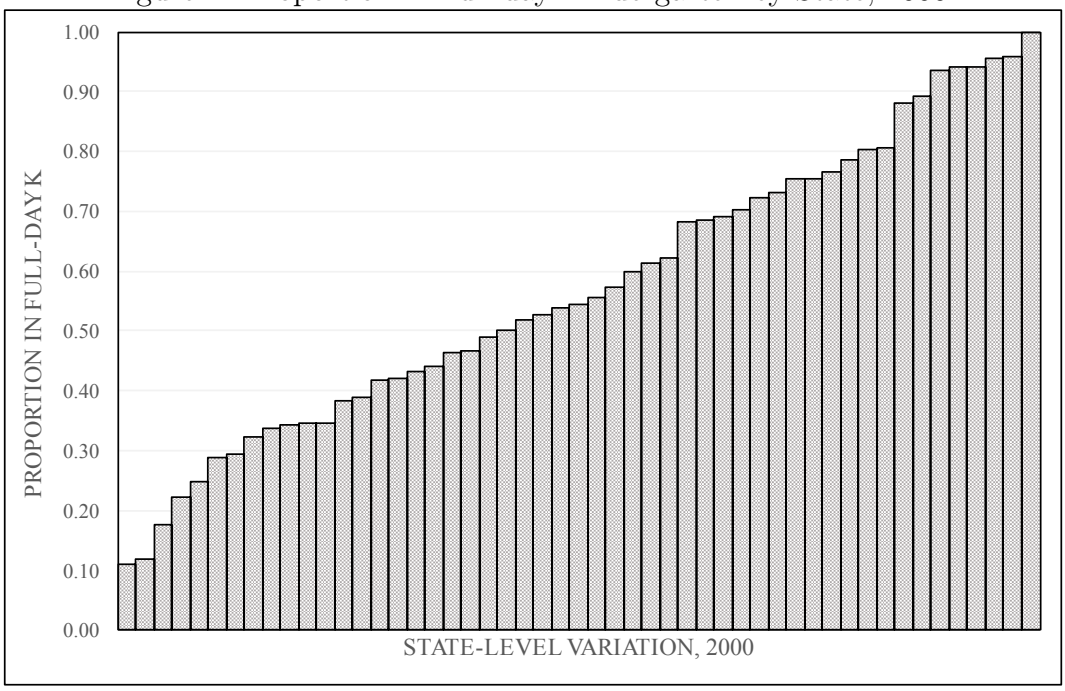


Notes: Three-year moving averages; end points are single years.
Source: U.S. Department of Commerce, Bureau of the Census, CPS October School Enrollment Supplement, 1990-2015.

There is also considerable variation across states over the time period depicted in Figure 1. According to the Current Population Survey (CPS) October School Enrollment Supplement, 37 states were at 40 percent or below in full-day kindergarten enrollment in the 1990s. By 2010, only two states had approximately 40 percent or less of their kindergarten students in full-day settings. Figures 2 and 3 depict the state-level variation in full-day kindergarten in the 2000–01 school year and the 2009–10, the earliest and latest kindergarten cohorts for

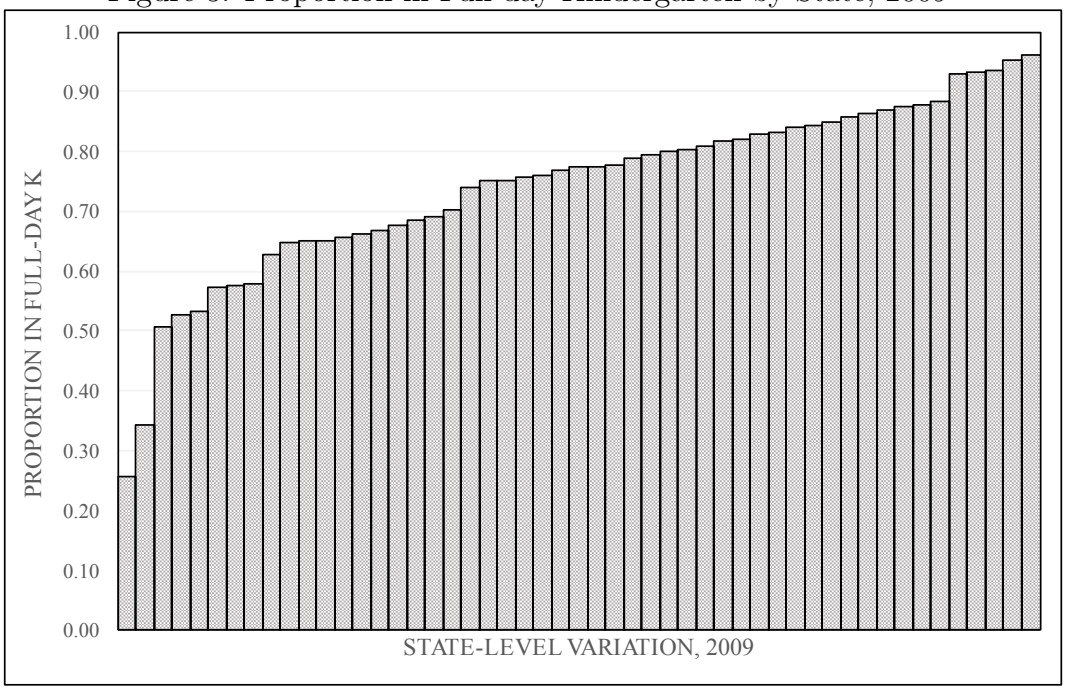
the period of analysis in this study. The figures plot in ascending order the proportion of all kindergarten students in full-day settings for all 50 states and DC, using three-year moving averages.

Figure 2: Proportion in Full-day Kindergarten by State, 2000



Source: CPS October School Enrollment Supplement (Flood, King, Ruggles & Warren 2015).

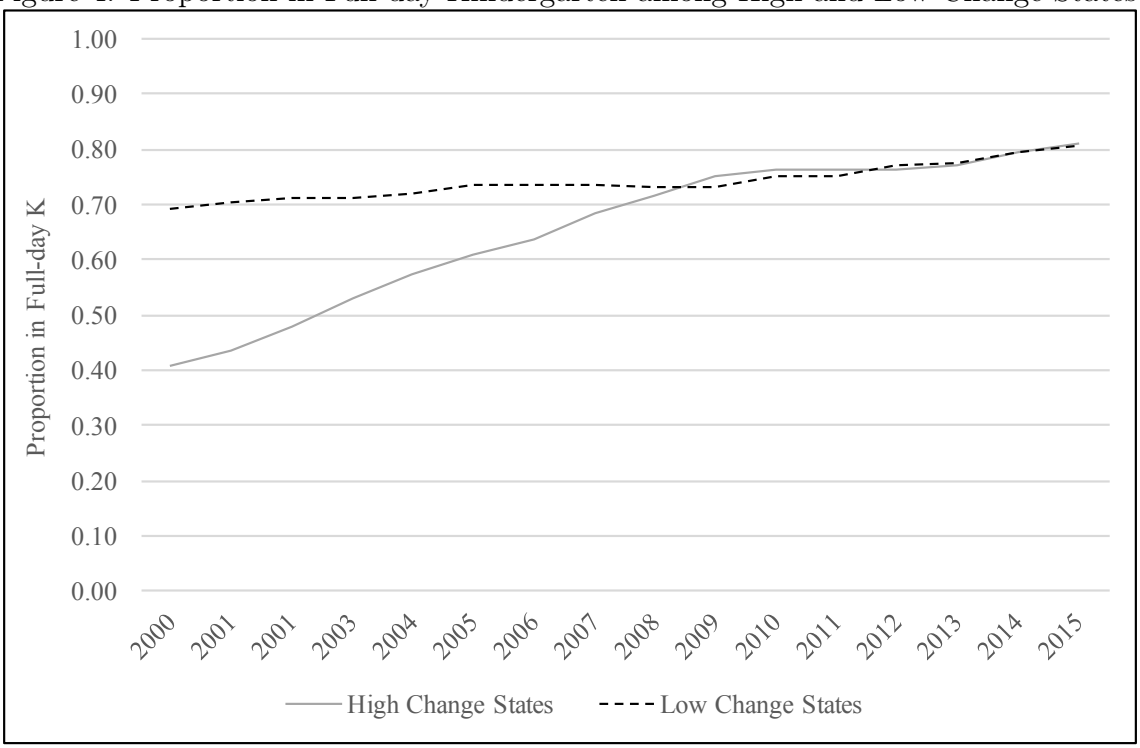
Figure 3: Proportion in Full-day Kindergarten by State, 2009



Source: CPS October School Enrollment Supplement (Flood et al. 2015).

As displayed in Figures 2 and 3, there has been an overall shift to greater provision of full-day kindergarten over time, but it is also the case that at any given point of time, there is considerable variation across states. Appendix Figure A.1 maps the changes from 2000 to 2009 across states, broken into quartiles. The following figures display trends in full-day kindergarten provision among groupings of states. First, Figure 4 displays the trends in full-day kindergarten participation among "high" and "low change" states, as defined by states that were above or below the mean for change in full-day kindergarten participation from 2000 to 2009. The mean percentage-point change in proportion in full-day kindergarten was approximately 17. Twenty-two states fall in the "high change" category. It is clear from this figure that "high change" states are those that lagged behind the national average in their provision of full-day kindergarten in the early part of the period, and that they are in essence catching up over this time period.

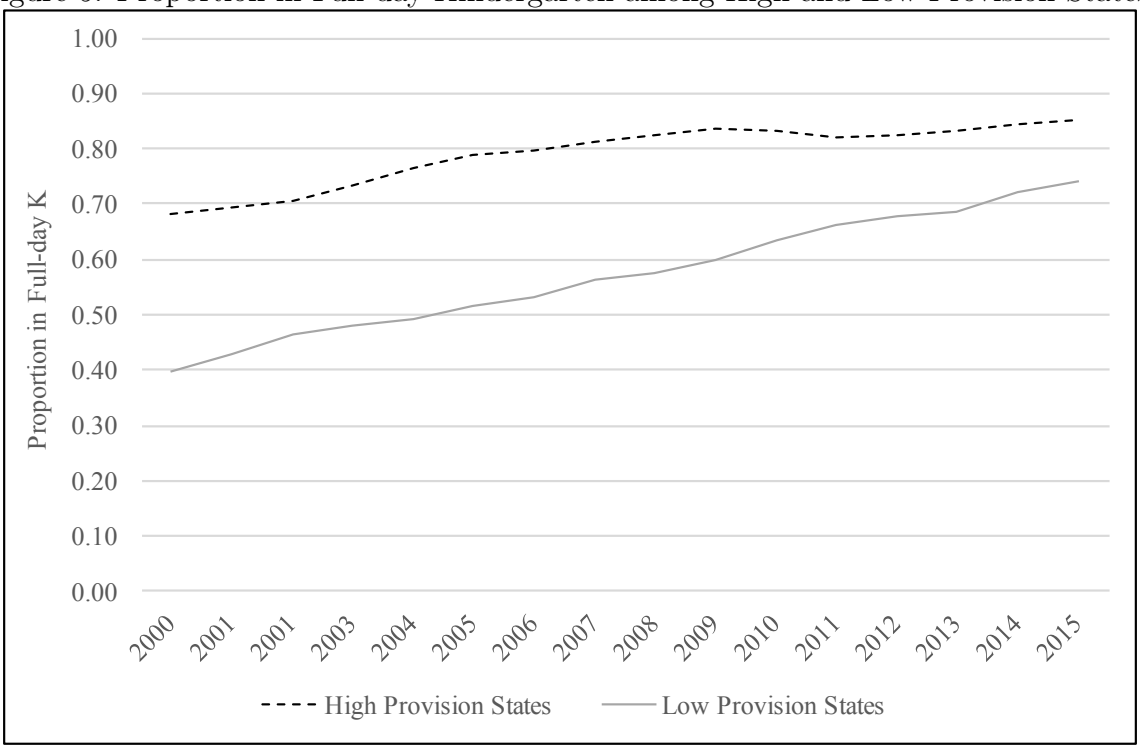
Figure 4: Proportion in Full-day Kindergarten among High and Low Change States



Source: CPS October School Enrollment Supplement (Flood et al. 2015).

In Figure 5, trends for "high" and "low provision" states are provided. "High provision" is defined as those states above the mean for proportion in full-day kindergarten in 2009. The mean participation rate in full-day kindergarten in the 2009-2010 school year was 74 percent. Thirty-one states were above that mean and were classified as "high provision."

Figure 5: Proportion in Full-day Kindergarten among High and Low Provision States



Source: CPS October School Enrollment Supplement (Flood et al. 2015).

Indiana is an example of a state that substantially invested in full-day kindergarten provision in this timeframe. In legislation passed in 2007, the state increased funds available for local school district provision of full-day kindergarten from 8.5 million dollars in the 2006–07 school year to 33.5 million dollars in the 2007–08 school year. Participation increased from approximately 40 percent of kindergarten students in full-day settings to approximately 60 percent in the school year following the legislative action. Indiana previously lagged behind the national average and caught up through these expansions. Appendix Figure A.2 depicts the changes across local school districts in Indiana.

A. Prior Research

A growing body of work has established the importance of kindergarten, both the quality of kindergarten environments and the skills children demonstrate in the kindergarten year, for later life outcomes (Chetty, Friedman, Hilger, Saez, Schanzenbach & Yagan 2011, Duncan

et al. 2006). Recent work has also used the plausibly exogenous timing of kindergarten availability to estimate impact. Cascio (2009) relies on the varied timing of state kindergarten grants to school districts to estimate the long-term effects of kindergarten availability. She finds effects for white children in the form of lower likelihood to drop out of high school and lower institutionalization rates as adults. She does not find similar effects for blacks–though black children experienced similar increases in public kindergarten enrollment–which is likely due to the crowd out of other early childhood interventions available to disadvantaged populations (Cascio 2009). Dhuey (2011) similarly exploits variation in public kindergarten expansions, though she uses significant increases in kindergarten availability within a state for identification. She finds that Hispanic children and those who live in immigrant households, are of low socioeconomic status, and do not speak English experience benefits from the availability of kindergarten with lower likelihood of being below grade for age and higher wages as adults (Dhuey 2011).

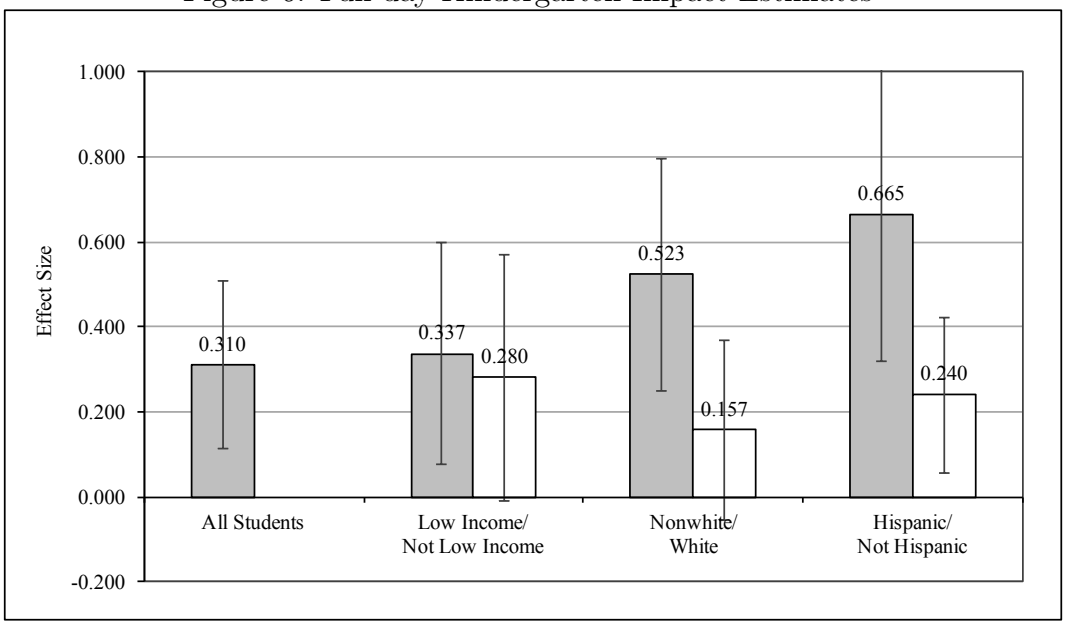
Using Project STAR data, researchers find that kindergarten test scores are highly correlated with important, long-term outcomes including college attendance, adult earnings, home ownership, and retirement savings (Chetty et al. 2011). They find that kindergarten intensity, as operationalized by small class size, predicts college attendance. In addition, kindergarten quality measured by teacher experience and peer ability relates to college attendance and higher earnings. While they observe fade out of kindergarten quality effects in test scores, the positive effects on sociocognitive measures remain (Chetty et al. 2011). Fitzpatrick, Grissmer, and Hastedt (2011) capitalize on quasi-randomness in dates of test administration to estimate gains to schooling over the course of the kindergarten and first-grade years. They find that one year of schooling corresponds to 1.2 standard deviations (sd) on reading tests and 0.9 sd on math tests in those early grades, over and above the normal developmental growth children are experiencing in that timeframe.

Despite its popularity, there is a very small literature on the impact of full-day kindergarten, largely lacking in rigor and increasingly dated for application to current contexts.

Importantly, in this literature full-day kindergarten is compared to half-day kindergarten, rather than no kindergarten attendance at all in contrast to the broader evidence on preschool participation. The existing literature on full-day kindergarten takes two forms: studies using nationally representative data and district- and school-level evaluations. In observational studies using the 1998 ECLS-K, researchers found significant differences between full- and half-day kindergarteners on literacy and mathematics assessments at the end of the kindergarten year (Cannon et al. 2006, DeCicca 2007, Lee et al. 2006, Votruba-Drzal et al. 2008). These full-day kindergarten advantages—as measured by test scores—are somewhat persistent into first grade (Cannon et al. 2006, DeCicca 2007), but not longer present in third grade (Cannon et al. 2006, Votruba-Drzal et al. 2008) or fifth grade (Votruba-Drzal et al. 2008). Additional smaller-scale evaluations mirror the ECLS-K findings (Hall-Kenyon, Bingham & Korth 2009, Zvoch, Reynolds & Parker 2008). In general, findings suggest some positive associations in the early schooling years, but these studies are now dated and remain subject to concerns about selection bias in student assignment to—or school or district provision of—full-day kindergarten.

Experimental results, based on student-level data from districts that used lottery assignment to full- and half-day kindergarten settings, suggest that full-day kindergarten has a sizable, positive effect (0.31 s.d.) on end-of-kindergarten literacy skills (Gibbs 2014). These effects are notably larger in magnitude than those found in the prior, observational literature. Figure 7 summarizes the study results. In particular, Hispanic students benefitted greatly from assignment to and participation in full-day kindergarten as compared to their peers in half-day kindergarten settings. Notably, this study only includes early literacy outcomes and could not explore mathematics.

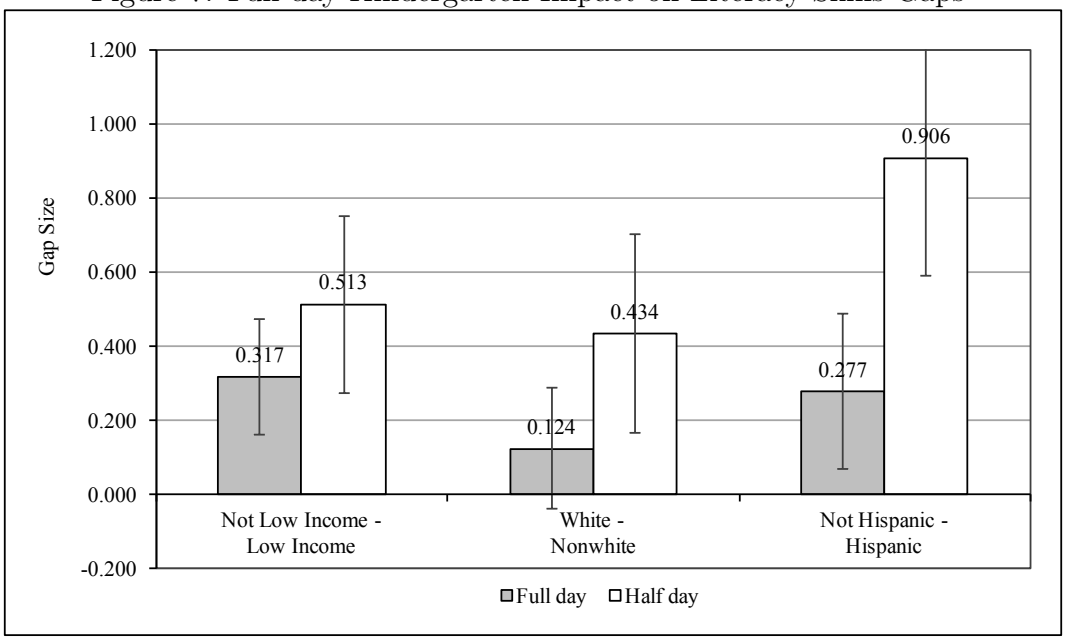
Figure 6: Full-day Kindergarten Impact Estimates



Source: Gibbs (2014).

In this context, Hispanic students were the only sizable, non-white student subgroup, and the effects are important in that they nearly close the Hispanic-non-Hispanic literacy skills gap by the end of the kindergarten year, as depicted in Figure 7. The present study allows for further investigation of the role of full-day kindergarten in addressing early schooling race/ethnicity achievement gaps.

Figure 7: Full-day Kindergarten Impact on Literacy Skills Gaps



Source: Gibbs (2014).

B. The Current Study

To more fully understand the relationship between kindergarten policies and inequality, this study seeks to answer the following questions: Do full-day kindergarten expansions impact subsequent student achievement? Do full-day kindergarten expansions affect racial and ethnic achievement gaps? This study complements and extends the existing literature in a few ways. First, the research design relies on a quasi-experimental approach, leveraging differential exposure to kindergarten policy changes by geography and over time, to generate plausibly causal estimates of program impact. In addition, this work uses newly available data sources to explore these questions in more current policy contexts with a focus on the policy relevant outcomes of subsequent student achievement and achievement gaps. The study includes reading and math outcomes as well as Hispanic-white and black-white test score gaps. Moreover, the investigation pertains to the systemic impact of full-day kindergarten, rather than focusing on the participant level effects, generating policy-relevant estimates of the impact of expansions. No work to date has leveraged the dramatic changes in full-day kindergarten policy in the 2000s to look at these outcomes of interest, and to

specifically connect to implications for inequality.

III. EMPIRICAL APPROACH

This study investigates the impact of full-day kindergarten policy changes using cross-state and over-time variation, and in the case of Indiana, cross-district and over-time variation. Importantly, there is considerable variation in state and local policy governing the provision and availability of full-day kindergarten during the time period of study with several states implementing policies to immediately or over time scale up to full provision of full-day kindergarten.

A. Data

This study relies on the Current Population Survey (CPS) October School Enrollment Supplement for full-day kindergarten data and the Stanford Education Data Archive (SEDA) for student achievement data (Flood et al. 2015, Reardon et al. 2016). The analysis of these data in tandem allow for the application of quasi-experimental approaches to explore the impact of greater full-day kindergarten availability on subsequent student achievement. In particular, the achievement data in third through eighth grades (from the 2008–09 through the 2012–13 school years) map on to ten kindergarten cohorts, entering in 2000 through the fall of 2009, in the full-day kindergarten expansions data. Importantly, this time period corresponds to dramatic increases in full-day kindergarten availability across the country with significant variation in expansions across states. A critical component of this research project is the data on full-day kindergarten expansions. The national data set with observations for each state in each year, available from 1989–2015, was compiled from the CPS and contains weighted, three-year moving averages of full-day kindergarten participation.

The SEDA data contain district-level means in reading and math in third through eight grades for five spring testing cycles (2009 to 2013, reflecting the 2008–09 through 2012–13 school years). These means are measured in standard deviation units. These data also include measures for district-level Hispanic-white and black-white achievement gaps in reading and math, also standardized, in the same years. Table 2 reports summary statistics for these

two data sources, overall and disaggregated for "high" and "low change" and "high" and "low provision" states. For brevity, the table only includes third grade test scores. The proportion of kindergarten students in full-day settings increases on average by 17-percentage points. Test scores are increasing over time, and are generally higher in "high change" states throughout the timeframe of interest. It is also notable that "high provision" states have lower test scores on average than "low provision" states which is consistent with negative selection in which places adopt full-day kindergarten as a means to address low performance.

SEDA data are equated to NAEP and facilitate analysis across grades three through eight, and in both reading and math. Moreover, the data provide information on inequality of test score outcomes by measuring within district racial and ethnic achievement gaps. Within Indiana, these data allow for district-level analysis matched with full-day kindergarten provision data from the Indiana Department of Education. Because these data contain information on full-day kindergarten enrollment in the 2006–07 and 2007–08 school years, they map onto SEDA data for third grade achievement in 2010 and 2011, fourth grade achievement in 2011 and 2012, and fifth grade achievement in 2012 and 2013.

B. Estimation Strategy

This study employs a quasi-experimental approach to coupling the full-day kindergarten expansion and student achievement data, leveraging variation in the provision of full-day kindergarten across states and over time. The basic ordinary least squares (OLS) model for assessing the impact of full-day kindergarten expansions on subsequent achievement is:

$$Y_{ist} = \beta_0 + \beta_1 FullDayK_{st} + \gamma_s + \lambda_t + \varepsilon_{ist} \quad (1)$$

where Y is the academic achievement outcome for local school district i in state s in year t. *FullDayK* is the treatment variable, which measures the proportion of kindergarten students in full-day settings in a particular state and year, resulting in an intention-to-treat estimate (β_1). The state and year fixed effects are represented by γ and λ respectively. Standard errors

are heteroskedasticity-robust, clustered at the school district level. Additional specifications also include time-varying state characteristics and pre-K provision variables to account for other factors that could be changing at the state level over the same timeframe that may influence student achievement.

Similar analyses are conducted within Indiana, leveraging variation across school district and over time:

$$Y_{it} = \alpha_0 + \alpha_1 FullDayK_{it} + \delta_i + \theta_t + \mu_{it} \tag{2}$$

where Y is the academic achievement outcome for local school district i in year t. *FullDayK* is the treatment variable, which measures the proportion of kindergarten students in full-day settings in a particular school district and year, again resulting in an intention-to-treat estimate of the impact of full-day kindergarten expansions (a_1). The school district and year fixed effects are represented by δ and θ respectively. Standard errors are heteroskedasticity-robust.

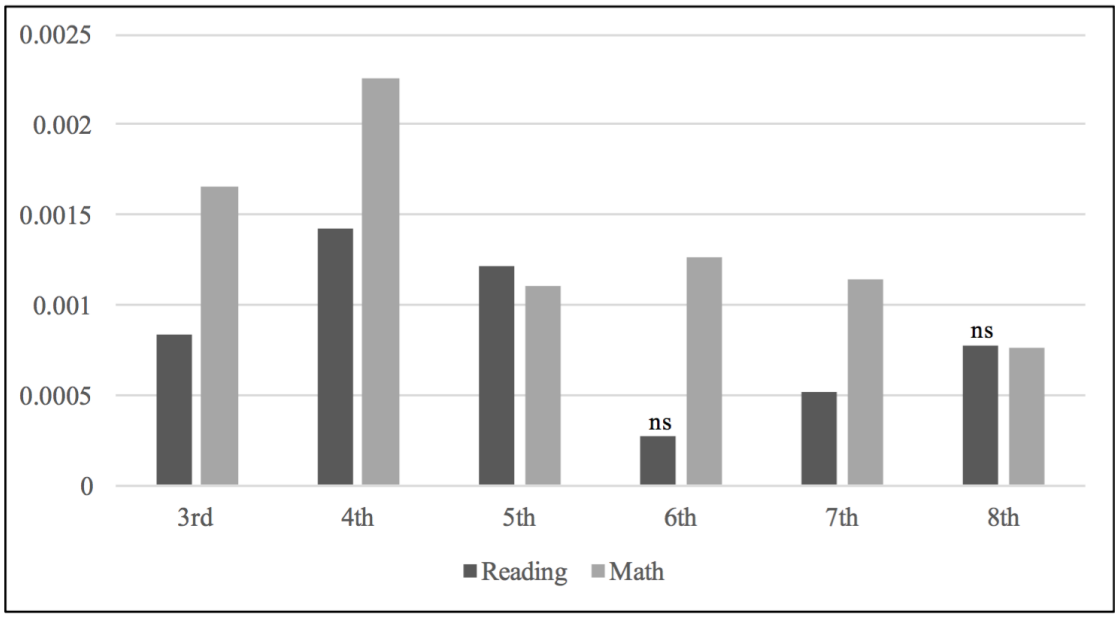
IV. RESULTS

As described in the empirical strategy, I present results from the OLS models for student achievement outcomes, math and reading, in Table 3. Each column in each panel presents the results of a separate regression. The treatment variable is the continuous full-day kindergarten participation rate (0-100) and the outcomes are standardized test scores. The effect sizes correspond to a 1-percentage point increase in full-day kindergarten provision. The average annual increase is 2-percentage points and over the timeframe of interest, 17-percentage points. All models include school and year fixed effects and robust standard errors clustered at the local school district level. The columns display results of the baseline specification, and with time-varying state characteristics and pre-K controls respectively. The results are remarkably robust to the inclusion of additional controls.

Full-day kindergarten is associated with higher subsequent performance in both reading and math. Figure 8 provides the results broken out by grade level. For third grade students,

the boost in reading is 0.08 sd and in math 0.17 sd. The prior literature has been somewhat constrained in looking at math outcomes, so we have previously known very little about the relationship between full-day kindergarten participation and math skill development. The point estimates do shrink at the higher grade levels, but suggest persistence of effects well beyond the kindergarten year. Importantly, these estimates are measures of the policy impact, rather than participant-level effects as the prior literature has estimated.

Figure 8: Impact of Expansions on Subsequent Academic Achievement, by Grade Level

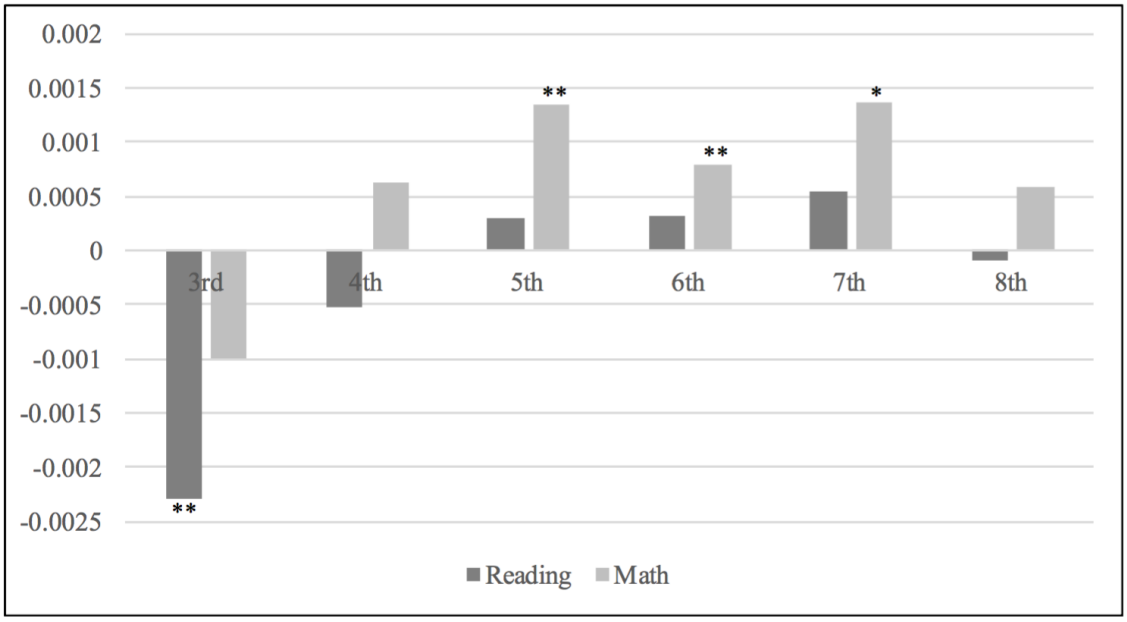


Notes: Test score outcomes are measured in standard deviation units. All estimates are statistically different from zero unless otherwise indicated by "ns."

Table 4 presents results in looking at Hispanic-white test score gaps. These models are limited to the school districts in which there is data on a sufficient number of Hispanic and white students to report a test score gap in any particular grade, subject, and year. Results suggest that full-day kindergarten expansions are associated with a widening of the Hispanic-white test score gap in both reading and math. Figure 9 presents these same results broken out by grade level. Interestingly, there is some suggestive evidence of a decrease in the third grade reading skills gaps (-0.23 sd), but mixed evidence overall. The results for math, at the higher grades in particular, indicate that greater full-day kindergarten provision may be

associated with worsening Hispanic-white test score gaps.

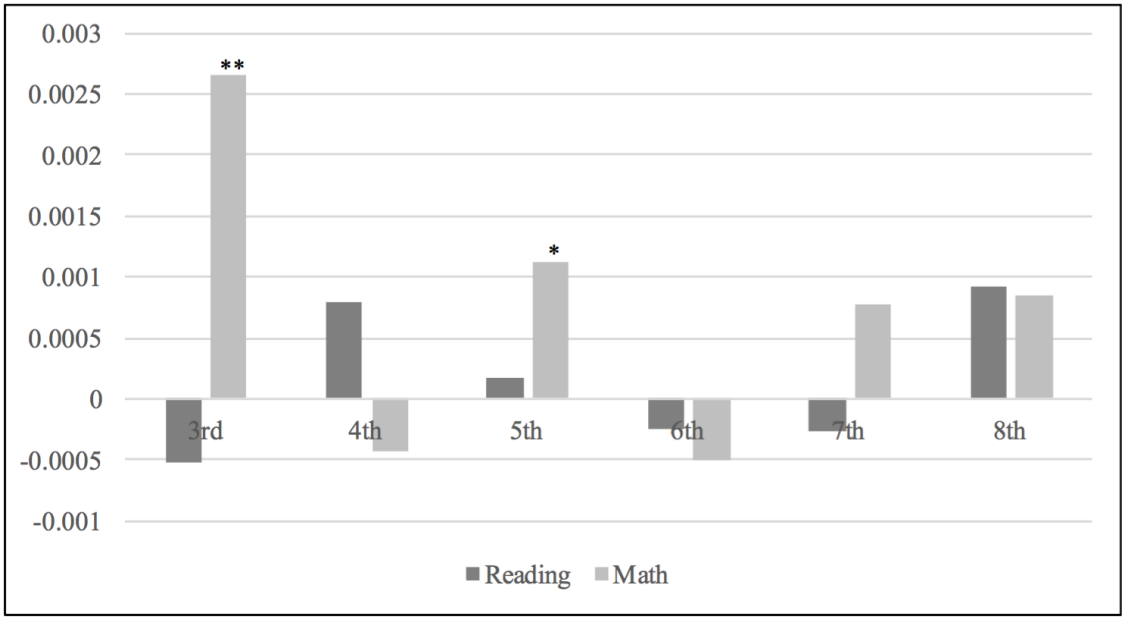
Figure 9: Impact of Expansions on Hispanic-White Achievement Gaps, by Grade Level



Notes: Test score outcomes are measured in standard deviation units. * ($p<0.05$) ** ($p<0.01$)

Table 5 presents the results for black-white test score gaps. Again, these models are constrained to the school districts for which there is sufficient data to construct a test score gap measure for that grade, subject, year combination. There is no systematic evidence of a relationship between full-day kindergarten expansions and black-white test score gaps, but the grade level disaggregation, depicted in Figure 10, suggests some exacerbation of math test score gaps in third and fifth grades.

Figure 10: Impact of Expansions on Black-White Achievement Gaps, by Grade Level



Notes: Test score outcomes are measured in standard deviation units. * ($p<0.05$) ** ($p<0.01$)

Finally, similar analyses are conducted within Indiana, leveraging expansions in full-day kindergarten provision from 2006–07 to 2007-08. These results–for mean achievement and racial/ethnic test score gaps–are presented in Table 5. The results largely mirror those seen nationwide with overall improvements in reading and math achievement. The black-white test score gap in reading also widens in accordance with full-day kindergarten expansions.

V. DISCUSSION

This study provides important new evidence on the impact of full-day kindergarten from a systemic perspective. While there is a limited body of work on the impact of full-day kindergarten on participants, this work sheds light on a different question – that of the policy impact of expanding full-day kindergarten on overall student achievement and on Hispanic-white and black-white test score gaps. In addition, the SEDA data makes it possible to explore later grades performance in both reading and math. The evidence suggests that full-day kindergarten expansions correspond to improved academic performance overall, in both reading and math and in persistent ways.

The evidence on how these expansions have affected inequality is more mixed. The findings suggest that, particularly in math, greater full-day kindergarten provision may widen Hispanic-white and black-white achievement gaps. This pattern is in some ways consistent with the demographic changes in the composition of full-day kindergarten students as more white and higher SES students have participated over time, and as expansions have been most pronounced in more advantaged areas. To the extent full-day kindergarten raises the performance of all students, greater provision could exacerbate gaps. When a beneficial intervention is provided to more advantaged populations, and was previously targeted at disadvantaged populations, performance gaps may increase. In addition, full-day kindergarten may serve a complementary, rather than compensatory, role–particularly for math skill development–which could contribute to widening gaps.

In considering full-day kindergarten policy, it is critical to understand the net policy effect in addition to the direct impact on participants. This evidence contributes to our improved understanding of the return on these early schooling investments and the implications for inequality. Moreover, these findings can inform our consideration of full-day kindergarten expansions and targeted versus universal provision of early interventions.

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Tables

Table 1: Early Childhood Experiences, 1998 & 2010 Kindergarten Cohorts

	All children		Black		Hispanic		Low SES	
	1998	2010	1998	2010	1998	2010	1998	2010
Preschool	0.55	0.53	0.42	0.39	0.41	0.39	0.26	0.26
Head Start	0.14	0.14	0.33	0.28	0.20	0.20	0.32	0.26
Full-day K (≥ 5 hours)	**0.56**	**0.80**	**0.81**	**0.93**	**0.48**	**0.83**	**0.65**	**0.89**
Small K class size (<20)	0.38	0.39	0.36	0.43	0.34	0.34	0.39	0.37
Approx N	12450	11000	1800	1350	1500	2550	1650	1950

Notes: Preschool and Head Start are mutually exclusive. Sample sizes, referring to the paper's analytic sample, rounded to nearest 50 as per National Center for Education Statistics (NCES) data-use requirements.
Source: ECLS-K 1998 and 2010 cohorts; adapted from Table 1 in Bassok, Gibbs & Latham (2015).

Table 2: Summary Statistics

	All	High Change	Low Change	High Provision	Low Provision
Full-day K Provision					
2000-2001 Proportion in Full-day K	0.570	0.410	0.691	0.682	0.396
	(.240)	(.149)	(.225)	(.220)	(.150)
2009-2010 Proportion in Full-day K	0.742	0.753	0.733	0.835	0.598
	(.146)	(.132)	(.158)	(.062)	(.120)
Mean Test Scores					
2009 3rd Grade Reading Test Scores	0.097	0.120	0.079	0.070	0.128
	(.366)	(.348)	(.378)	(.351)	(.382)
2010 3rd Grade Reading Test Scores	0.095	0.133	0.081	0.062	0.134
	(.370)	(.350)	(.385)	(.359)	(.380)
2011 3rd Grade Reading Test Scores	0.098	0.119	0.083	0.063	0.141
	(.372)	(.348)	(.389)	(.359)	(.384)
2012 3rd Grade Reading Test Scores	0.109	0.144	0.082	0.080	0.143
	(.378)	(.349)	(.396)	(.368)	(.387)
2013 3rd Grade Reading Test Scores	0.155	0.165	0.077	0.094	0.140
	(.390)	(.370)	(.401)	(.377)	(.404)
2009 3rd Grade Math Test Scores	0.064	0.125	0.018	0.035	0.097
	(.402)	(.385)	(.409)	(.384)	(.420)
2010 3rd Grade Math Test Scores	0.075	0.128	0.035	0.042	0.113
	(.399)	(.386)	(.403)	(.383)	(.413)
2011 3rd Grade Math Test Scores	0.084	0.138	0.043	0.051	0.124
	(.403)	(.386)	(.411)	(.388)	(.418)
2012 3rd Grade Math Test Scores	0.115	0.179	0.066	0.093	0.141
	(.410)	(.392)	(.417)	(.391)	(.431)
2013 3rd Grade Math Test Scores	0.136	0.221	0.070	0.125	0.149
	(.421)	(.408)	(.418)	(.401)	(.443)

Notes. Test scores are measured in standard deviation units. "High change" states are defined as those above the mean difference (>0.17) in proportion of students in full-day K from 2000–2001 to 2009–2010. "High provision" states are defined as those above the mean proportion (>0.74) of students in full-day K in 2009–2010.

Table 3: Impact of Expansions on Subsequent Academic Achievement

	(1)	(2)	(3)
Panel A. Reading			
Full-day K Participation (0-100)	0.004**	0.004**	0.003**
	(.000)	(.000)	(.000)
Observations	322,202	322,202	322,047
Panel B. Math			
Full-day K Participation (0-100)	0.004**	0.004**	0.004**
	(.000)	(.000)	(.000)
Observations	314,345	314,345	314,190
State Fixed Effects	x	x	x
Year Fixed Effects	x	x	x
State Demographic Controls		x	
State Pre-K Controls			x

Notes. Each column in each panel represents a separate OLS regression with heteroskedasticity-robust standard errors in parentheses, clustered on local school district. The dependent variables are test score outcomes in standard deviation units.
* ($p<0.05$) ** ($p<0.01$)

Table 4: Impact of Expansions on Hispanic-White Achievement Gaps

	(1)	(2)	(3)
Panel A. Reading			
Full-day K Participation (0-100)	0.001**	0.001**	0.001**
	(.000)	(.000)	(.000)
Observations	71,774	71,774	71,714
Panel B. Math			
Full-day K Participation (0-100)	0.0004*	0.001**	0.0004*
	(.000)	(.000)	(.000)
Observations	68,484	68,484	68,423
State Fixed Effects	x	x	x
Year Fixed Effects	x	x	x
State Demographic Controls		x	
State Pre-K Controls			x

Notes. Each column in each panel represents a separate OLS regression with heteroskedasticity-robust standard errors in parentheses, clustered on local school district. The dependent variables are test score gaps in standard deviation units.
* ($p<0.05$) ** ($p<0.01$)

Table 5: Impact of Expansions on Black-White Achievement Gaps

	(1)	(2)	(3)
Panel A. Reading			
Full-day K Participation (0-100)	0.0001	0.0003	0.000
	(.000)	(.000)	(.000)
Observations	60,924	60,924	60,889
Panel B. Math			
Full-day K Participation (0-100)	0.0002	0.0002	0.000
	(.000)	(.000)	(.000)
Observations	59,536	59,536	59,501
State Fixed Effects	x	x	x
Year Fixed Effects	x	x	x
State Demographic Controls		x	
State Pre-K Controls			x

Notes. Each column in each panel represents a separate OLS regression with heteroskedasticity-robust standard errors in parentheses, clustered on local school district. The dependent variables are test score gaps in standard deviation units.
* ($p<0.05$) ** ($p<0.01$)

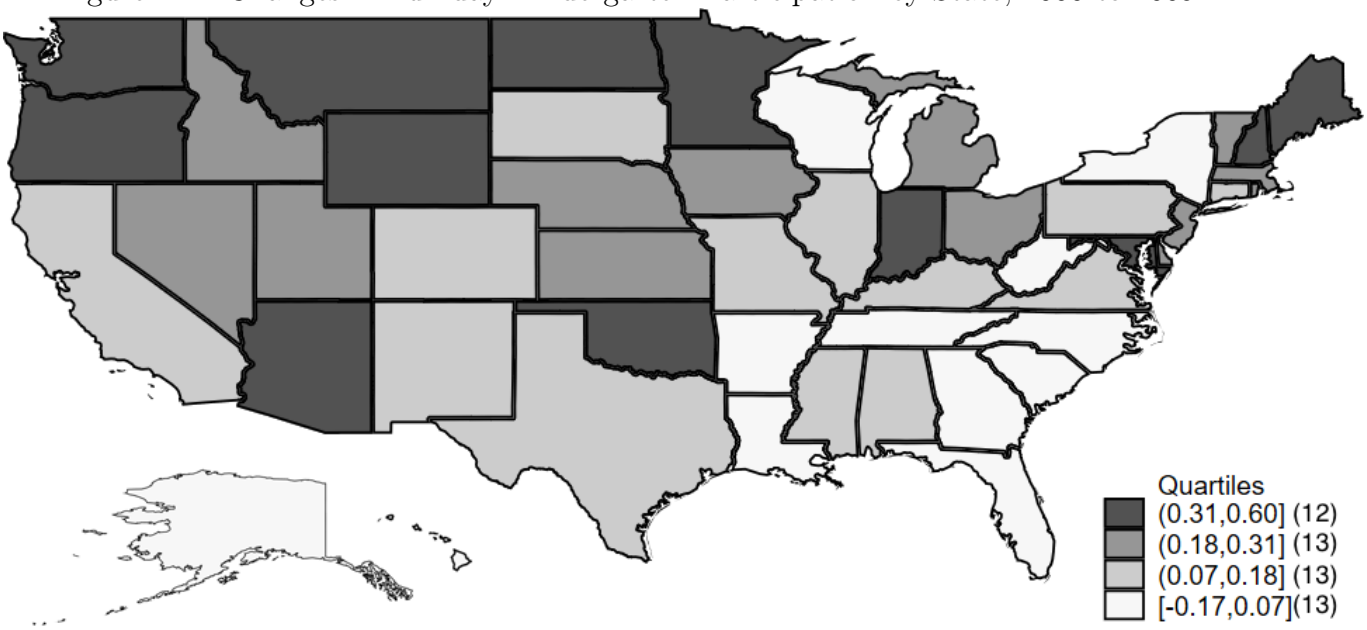
Table 6: Impact of Indiana Expansions on Subsequent Student Achievement

	Test Score Mean	Hispanic-White Gap	Black-White Gap
Panel A. Reading			
Full-day K Participation (0-100)	0.001**	0.0004	0.001*
	(.000)	(.001)	(.001)
Observations	1,834	483	279
Panel B. Math			
Full-day K Participation (0-100)	0.001**	0.001	-0.001
	(.000)	(.001)	(.001)
Observations	1,835	506	288
School District Fixed Effects	x	x	x
Year Fixed Effects	x	x	x

Notes. Each column in each panel represents a separate OLS regression with heteroskedasticity-robust standard errors in parentheses. The dependent variables are test score outcomes in standard deviation units.
* ($p<0.05$) ** ($p<0.01$)

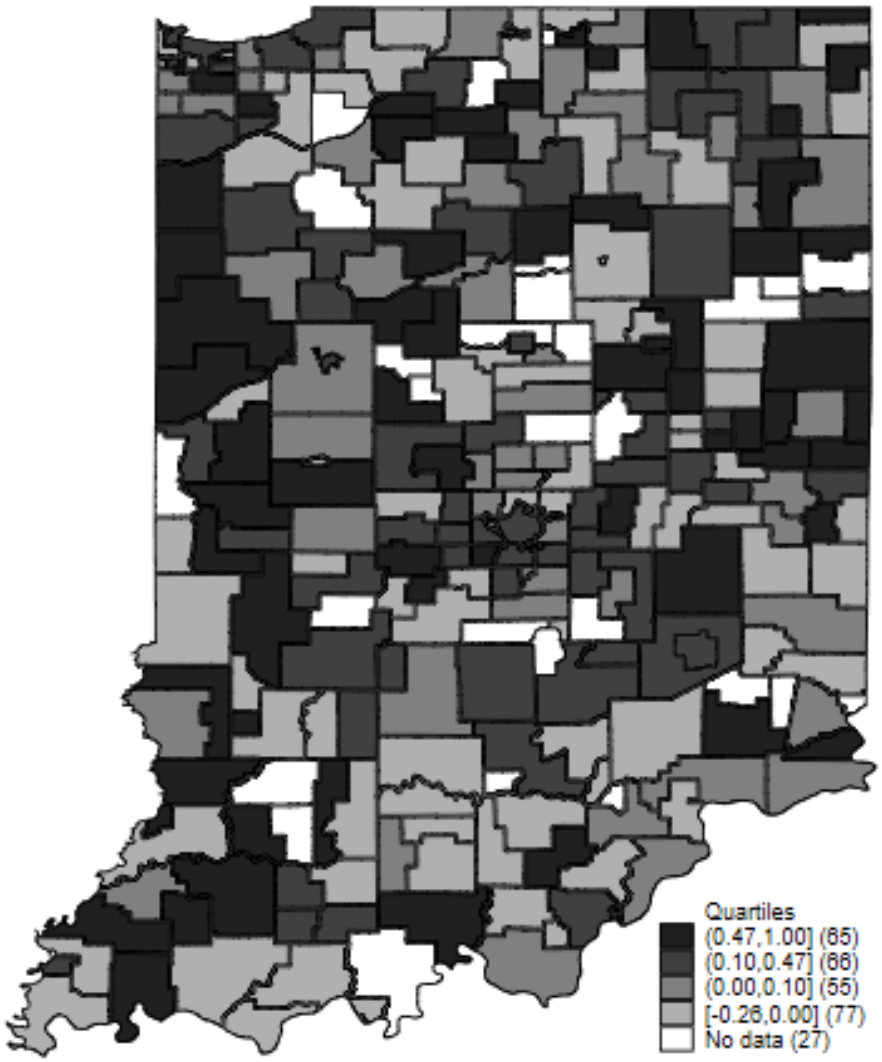
Appendix

Figure A.1: Changes in Full-day Kindergarten Participation by State, 2000 to 2009



Source: CPS October School Enrollment Supplement (Flood et al. 2015).

Figure A.2: Changes in Full-day Kindergarten Participation by Indiana School District, 2006–07 to 2007–08



Source: Indiana Department of Education.