A Matter of Time?

Impact of Statewide Full-day Kindergarten Expansions on Later Academic Skills and Maternal Employment

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Abstract

In this paper, I leverage variation in response to a statewide full-day kindergarten policy to explore the effects of full-day kindergarten expansions on student academic performance—as measured by school-level standardized test scores—in first and third grade and on women's labor force participation, measured by county-level employment statistics. The policy change, enacted through 2007 legislation, dramatically increased state grant funding availability for the provision of full-day kindergarten, from 8.5 million dollars in the 2006–2007 academic year to 33.5 million dollars in the 2007–2008 academic year. Because the increased funding generated differential responses across schools in full-day kindergarten enrollment rates, I use a triple-differences framework to exploit variation in exposure to full-day kindergarten by geography, time, and cohort, generating intention-to-treat estimates of the impact of the full-day kindergarten expansions. With various specifications of treatment exposure, I find no evidence of full-day kindergarten effects on subsequent student achievement, but suggestive evidence of increases in maternal employment.

1 Introduction

The early childhood years have garnered much policy interest as a critical developmental period and opportunity for early intervention, potentially remediating cognitive and noncognitive skill gaps prior to formal schooling and generating high returns on investment in the form of private and social benefits over the life cycle. Several papers have established the early emergence of achievement gaps by race/ethnicity and socioeconomic status (Fryer & Levitt 2004, Fryer & Levitt 2006, Lee & Burkam 2002, Murnane, Willett, Bub & McCartney 2006, Princiotta, Flanagan & Germino Hausken 2006). While there is some dispute about the magnitude of these gaps—and whether and how they can be explained by student characteristics and family background—there is consistent evidence that test-score gaps by race and socioeconomic status are already sizable at the end of the kindergarten year. In addition, these gaps persist and grow throughout the primary grades.

In 2007, the Indiana General Assembly significantly increased state grant funds for the provision of full-day kindergarten, from $8.5 million in the 2006-07 school year to $33.5 million for the 2007-08 school year. The legislation sought to improve access to and availability of full-day kindergarten statewide with grants targeted directly to school districts and funding amounts determined based on kindergarten enrollments. This policy change corresponded to increases in provision and enrollment across the state. According to administrative data, full-day kindergarten enrollment in Indiana rose 20 percentage points from 2006-07, before the legislation, to 2007-08, the first year after the funding increase (Lovell et al., 2009). In addition, the number of school corporations providing full-day to the vast majority of their students (i.e., more than 80 percent) increased by 26 percentage points.

The existing literature on full-day kindergarten impact relies largely on the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) to estimate effects for participants. These studies have generally found significant differences between full- and half-day kindergarten students on measures of literacy and numeracy at the end of the kindergarten year (Cannon, Jacknowitz, & Painter 2006; Lee, Burkam, Ready, Hinigman, & Meisels 2006; Votruba-Drzal, Li-Grining, & Maldonado-Carreño 2008; DeCicca 2007). However, these full-day advantages, as measured by cognitive skills, fade out rapidly over the first grade year and are no longer detectable in third grade (Cannon et al 2006; Votruba-Drzal et al. 2008) or fifth grade (Votruba-Drzal et al. 2008). This literature is limited in its ability to address differential selection by schools and districts into offering full-day kindergarten and differential selection by children and families into full-day kindergarten attendance. Moreover, the data pre-date large expansions across the United States in both the provision of full-day kindergarten and the availability of pre-kindergarten programming.

Recent experimental and quasi-experimental evidence finds sizable effects of full-day kindergarten participation on early literacy skills, particularly for disadvantaged students, but does not speak to the persistence of these effects or the broader systemic effects of offering full-day kindergarten (Gibbs 2012).

Additionally, this study investigates the causal impact of full-day kindergarten availability and participation on women's labor market attachment, a largely unexplored outcome of such full-day kindergarten expansions. Because full-day kindergarten constitutes a wealth transfer to parents in the form of subsidized childcare, and provides approximately three additional hours of public schooling relative to half-day kindergarten, mothers may be made more available for labor market participation as a result of the policy. Additionally, they may avoid a disruption in their labor force participation caused by the different schedule of half-day kindergarten relative to publicly provided preschool, such as Head Start, in the prior year and first grade in the following year. This project leverages the same policy expansion to provide new, quasi-experimental evidence on the impact of full-day kindergarten provision on female labor force participation.

Notably, the state level has been the site of much of the policy conversation and action on full-day kindergarten, and this paper is the first to consider systemic impact with intention-to-treat estimates, rather than participant outcomes. Capitalizing on variation across schools and counties in response to the full-day kindergarten policy change, I explore the impact of full-day kindergarten on first and third grade academic skills to answer the question of whether greater provision of full-day kindergarten results in increased levels of achievement in the providing schools. I also estimate the impact of full-day kindergarten on women's employment at the county level. I use triple-difference estimators to assess the impact of the full-day kindergarten legislation on these outcomes of interest. Importantly, I leverage cross-time, cross-cohort, and cross-geography variation in exposure to full-day kindergarten to assess the effect of this sweeping statewide reform. I specify the full-day kindergarten exposure variable in different ways to allow for non-linearities in the effect of full-day kindergarten enrollment. Findings suggest that full-day kindergarten does not affect subsequent academic achievement in the early adopting, or high-implementing, schools, but is associated with greater female labor force participation at the time of expansions.

2 Study Background

Nearly all students who attend school outside the home participate in kindergarten in the United States and nearly three-quarters of students in kindergarten are in full-day settings (Walston & West 2004). As displayed in Figure 1, less than 20 percent of kindergarten

students were in full-day settings in 1970. Full-day kindergarten enrollment exceeded half-day participation for the first time in 1995 and by the 2000-01 academic year, approximately 60 percent of kindergarteners were in full-day classrooms. Of the 3.5 million kindergarten students enrolled in 2010, over 2.5 million attended full-day kindergarten.

Figure 1: Kindergarten Enrollment Among 5-year-olds (in thousands)
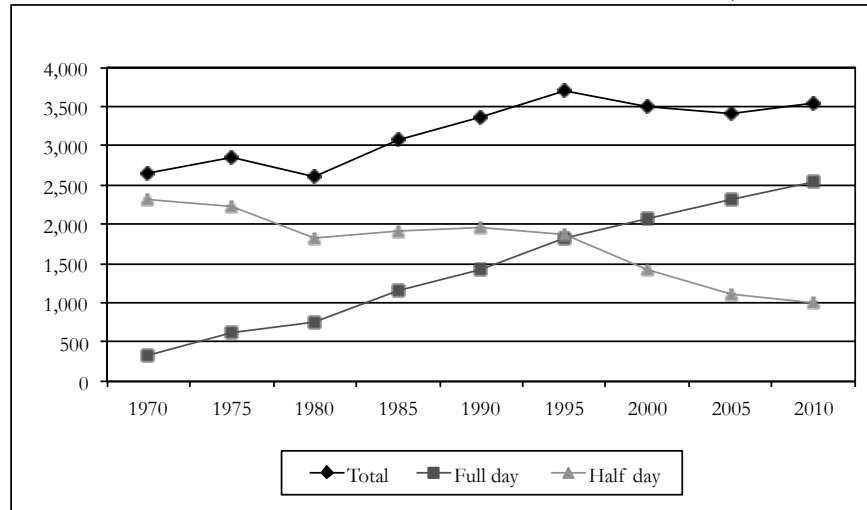
Source: U.S. Census Bureau, Current Population Survey, October School Enrollment Supplement.

States are also considering full-day kindergarten policies and expansions, with Minnesota providing full-day kindergarten for all kindergarten students in the 2014–15 academic year and Kansas considering legislation to do the same. According to the Children's Defense Fund, ten states and Washington, D.C. provided full-day kindergarten at no charge to all children in 2013. In only 16 states is kindergarten attendance mandatory though, so seven of those ten states have both required full-day kindergarten provision and mandatory kindergarten attendance.

2.1   Motivation

Full-day kindergarten provision is rapidly expanding in the United States, but many districts and states are constrained by tight budgets in funding full-day kindergarten at the levels and for the number of children that they would like. Moreover, other early childhood investments may reap larger returns. The case for full-day kindergarten has been made almost entirely on the educational benefits to participants of these programs, but labor force implications are clearly an important consideration in assessing the cost-effectiveness of such policies. In

addition, understanding the longer-term impact on overall school and district performance is crucial to fully capturing program effects. The finding that full-day kindergarten affects later academic achievement or women's labor force attachment—as the existing literature suggests—would constitute an important consideration for policymakers faced with tradeoffs in program provision. Moreover, full-day kindergarten may constitute a relatively cost-effective way to enhance student achievement and incentivize labor force participation as the marginal cost of expanding childcare subsidies or publicly provided preschool generally exceeds the marginal cost associated with expanding half-day kindergarten to full-day.

This study improves upon the existing literature in a few ways. First, the research design leverages the availability of state funding for full-day kindergarten and the resulting expansions in provision as plausibly exogenous changes to estimate the effect of full-day kindergarten. Thus, this work complements the existing work which uses nationally representative data by using more limited samples, but an identification strategy that reasonably addresses the selection problem. In addition, the policy change took place in 2007, so the study employs more recent data than that on which much of the existing work relies.

Previous work in this vein certainly establishes the plausibility of full-day kindergarten impact on maternal employment, and in fact, the only existing paper on full-day kindergarten and this outcome finds positive effects on maternal labor supply (Cannon, Jacknowitz & Painter 2006). With a more current policy context, quasi-experimental approaches, and more nuanced outcome measures, the work represents an important extension and contribution to our collective understanding of the impact of childcare on women's employment. By adding maternal labor market outcomes to the conversation on full-day kindergarten and relatedly, incorporating full-day kindergarten into our broader discourse around childcare, this work could affect the way policymakers think about how best to incentivize and support labor force participation among mothers.

2.2   Prior Research

The existing literature on full-day kindergarten takes two forms: observational studies using nationally representative data and district- and school-level evaluations. In observational studies using the ECLS-K, researchers have found significant differences between full- and half-day kindergarten students 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 failed to persist, however, over the first-grade year. In one study, marginally significant differences were found in the spring of first grade (Cannon et al. 2006). DeCicca (2007) found significant differences in mathematics and

reading in the fall of first grade, but only for white children, which faded but continued to be significant in spring literacy performance. No significant differences were found between full- and half-day kindergarten students in the ECLS-K in third grade (Cannon et al. 2006, Votruba-Drzal et al. 2008) or fifth grade (Votruba-Drzal et al. 2008).

Additional smaller-scale evaluations have supported the ECLS-K findings of short-term outcomes in the kindergarten year, but no significant long-term effects (Zvoch, Reynolds & Parker 2008, Hall-Kenyon, Bingham & Korth 2009). In general, findings on the impact of full-day kindergarten relative to half-day kindergarten suggest some positive associations, particularly in the early schooling years. Results related to the impact of full-day kindergarten over time, or the persistence of these positive findings, are more mixed. Recent experimental and quasi-experimental evidence on the impact of full-day kindergarten for participating children finds positive effects, but does not speak to longer-term effects nor the implications of greater provision of full-day kindergarten for schools and districts (Gibbs 2012). From the perspective of policymakers, the effects on overall academic achievement in schools and districts offering full-day kindergarten may be of greatest interest. The intention-to-treat effect may better capture—as opposed to participant-level treatment on the treated effects—the return on a school or district's investment in full-day kindergarten provision.

While some previous research has investigated the relationship between other types of childcare and women's employment (Blau & Robins 1988, Connelly 1992, Karoly et al. 1998, & Ribar 1992), there is more limited work exploring public education as a form of childcare with potential effects on maternal labor supply (Gelbach 2002). One paper uses the Early Childhood Longitudinal Study–Kindergarten Cohort (ECLS-K) to look specifically at full-day kindergarten impact on maternal employment (Cannon et al. 2006). Using state full-day kindergarten policies to explain maternal labor supply, they find that mothers are more likely to work full-time in the kindergarten year when full-day kindergarten is provided (*ibid*), but the identification strategy is not sufficiently rigorous to rule out potential confounding variables that may be related to both provision of full-day kindergarten and women's employment.

Most studies suggest that childcare subsidies and access to other subsidized early childhood programs increase maternal employment, though estimates vary based on the study and the policy being analyzed. Childcare subsidies, with an explicit intention of facilitating parental labor force participation, have been studied most extensively. In accordance with theoretical predictions, higher childcare prices reduce labor supply of mothers (Blau 2003). Estimated childcare cost elasticities of maternal employment range from 0 to approximately -1, with the most credible estimates varying between -0.1 and -0.5 (Anderson & Levine 2000). Overall, subsidization of childcare contributes to increased maternal employment (Connelly

& Kimmel 2003, Blau & Currie 2006, Tekin 2007, Blau & Tekin 2007, Herbst 2010).

Relatedly, researchers have also explored the availability of Head Start and other subsidized forms of preschool in relation to maternal employment. A study of single mothers who had received public assistance in Massachusetts found that both the availability of Head Start and state funding for preschool education for low-income children increased maternal employment (Lemke, Witt & Witte 2007). Interestingly, Fitzpatrick (2010) finds no increases in maternal labor supply when examining the effects of the introduction of a universal and near-universal preschool provision for four-year-olds in Georgia and Oklahoma in the 1990s.

There is a growing body of evidence to speak to the effects of public education on women's labor force attachment. Using a novel approach, Gelbach (2002) employs quarter-of-birth as an instrument for enrollment in kindergarten in 1980 and finds evidence of increases in maternal labor supply on the order of six to 24 percent. Barua (2007) finds similar effects as Gelbach (2002), but concentrated among married women whose youngest child is of kindergarten age. Similarly, Cascio (2009a)—exploiting variation in timing of public funding for kindergarten in the 1960s and 1970s—shows evidence of an increase in the labor supply of single mothers without other young children, but no effects for single mothers with younger children or for married mothers. Fitzpatrick (2012) finds that the labor supply of single mothers of five-year-olds without additional young children increases as a result of a child's enrollment in public kindergarten, but is unchanged for other mothers.

To date, the only study looking at the effects of full-day kindergarten on maternal employment is the aforementioned Cannon, Jacknowitz, and Painter (2006) paper. They use data from ECLS-K to study effects of full-day K policy enactment and find that mothers with students in full-day kindergarten are more likely to work compared to their half-day counterparts, although the effect is no longer significant when the child moves beyond kindergarten. Again, this study is observational and, while based on nationally representative data in the 1990s, cannot address the endogeneity of full-day kindergarten availability. While the existing literature certainly suggests that public schooling and subsidized childcare may relate to maternal employment—particularly for single women and for those with no younger children in the household—there is room to augment this research base with rigorous, causal research on a particularly understudied and relatively inexpensive intervention, full-day kindergarten.

2.3   Full-day Kindergarten in Indiana

This study leverages a policy change in Indiana that led to dramatic and relatively immediate changes in the availability of full-day kindergarten across the state. The study capitalizes on this plausibly exogenous shock in the provision of publicly funded child care to explore

the impact on female labor force participation using a triple-differences research design that accounts for underlying trends in labor force participation.

In 2007, the Indiana legislature passed legislation which provided funding to increase access and availability of full-day kindergarten in the 2007–08 school year, with grants targeted directly to school districts and charter schools (Indiana Public Law 234-2007). The stated goal of the bill was to allow, "school corporations [districts] and charter schools to provide full-day kindergarten programs to improve the academic and social development of children in kindergarten." A policy initiative of Governor Mitch Daniels' administration and supported by the Indiana State Board of Education and the Indiana Department of Education, the legislation expanded state grant funds for full-day kindergarten from $8.5 million in the 2006-07 school year to $33.5 million in the 2007-08 school year (Indiana General Assembly 2007). School districts and charter schools, operating as autonomous school districts in the state, were eligible to apply to the state for full-day kindergarten funding. [1] Grant funding was then dispersed to all applicants on a per-pupil basis, allocated based on kindergarten enrollment in the school or district in the 2007-08 school year.

Figure 2 provides the timeline of the legislation relevant for this study's approach. Changes in full-day kindergarten availability and participation were realized quickly across the state. Full-day kindergarten enrollment in the state increased by 20 percentage points from 41 percent of kindergarten students in 2006-07 to 63 percent in 2007-08. The number of school districts and schools offering full-day kindergarten also increased with a 26 percentage-point increase in the number of school districts enrolling more than the vast majority of their kindergarten students in full-day settings, and a 21 percentage-point increase in the number of schools with nearly all of their kindergarten students in full-day settings (Lovell, Kochanek, Mathers & Burke 2009).[2] With the increased funding availability from the state, the full-day kindergarten grant became the primary means for supporting full-day kindergarten enrollment, coupled with federal Title I funds, school district general funds, and parent fees in some cases. School district data indicated that 91 percent of full-day kindergarten students in the state were funded, at least in part, by the state full-day kindergarten grant monies in 2007-08 (Lovell et al. 2009).

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[1] "Application" for full-day kindergarten funding consisted of indicating interest to the Indiana Department of Education and doing so by a deadline in order to establish enrollment numbers and make grant allocations.

[2] The definition employed for the purposes of reporting change in school district and school provision is that more than 80 percent of enrolled kindergarten students in the district or school participate in full-day kindergarten.

Figure 2: Study Background: Timeline
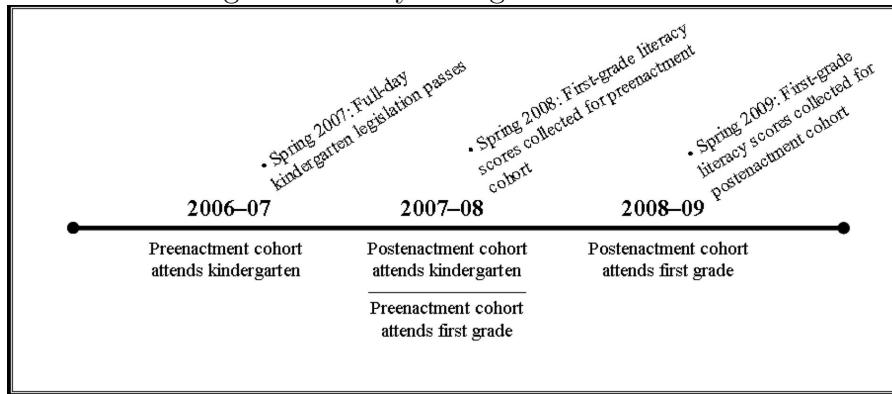
Participation rates responded to the policy change, and this result was driven through changes in school-level provision or availability of full-day kindergarten. Figures 3 and 4 display the distributions of the proportion of kindergarten students in full-day settings at the school level for the pre- and post-policy change school years.

Figure 3: School-level Provision of Full-day Kindergarten, 2006–07
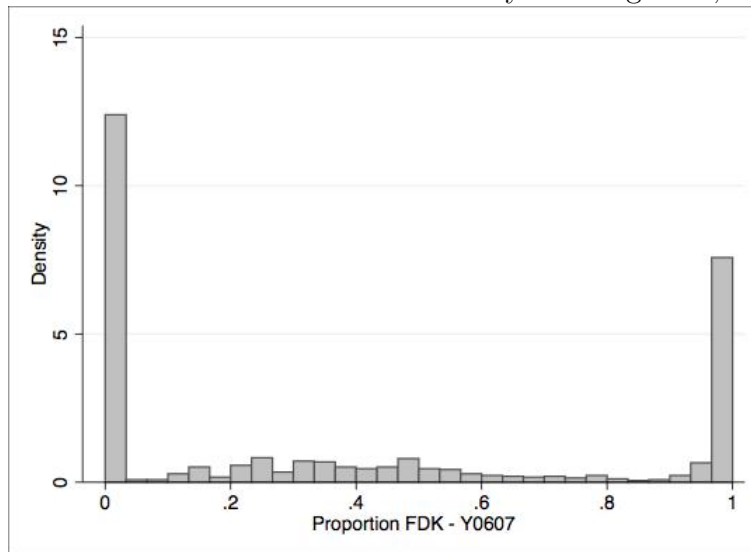
Figure 4: School-level Provision of Full-day Kindergarten, 2007–08
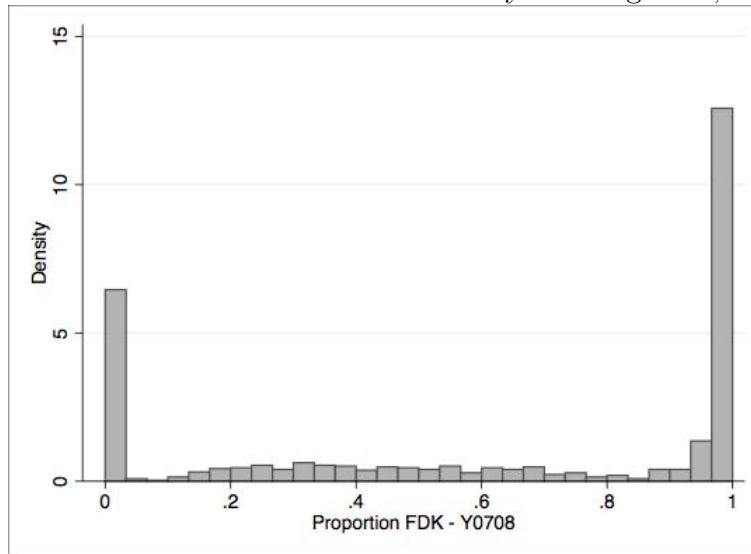
In 2006–07, 160 schools provided all full-day kindergarten, that is, kindergarten was only provided in full-day settings. That number increased to 306 schools in 2007–08. Relatedly, 428 schools provided only half-day kindergarten before the policy change, which decreased to 225 schools in the following academic year. School-level changes in full-day kindergarten provision are displayed in Figure 5. Notably, 317 schools experienced no change in proportion enrolled in full-day and 149 schools experienced a decline in full-day kindergarten participation over that same timeframe. 712 schools had an increase in full-day kindergarten participation with 75 schools moving from no full-day to all full-day in the pre- and post-policy change academic years.

Figure 5: School-level Change in Provision of Full-day Kindergarten
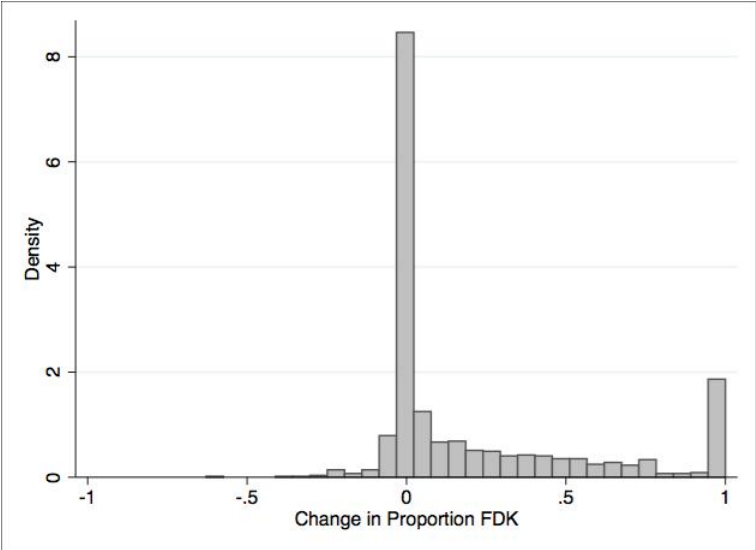
While the analysis of impact on achievement will leverage these school-level changes, models that explore impact on women's employment will be conducted at the county level. Figure 6 provides a similar distribution for county-level change in full-day kindergarten provision from the pre-policy year to the post-policy year.

Figure 6: County-level Change in Proportion of Kindergarten Students in Full-day Settings
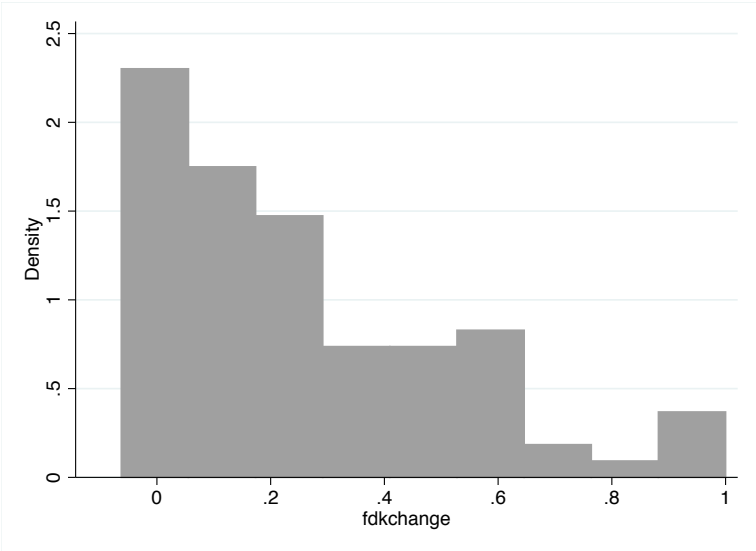
3 Methods

The study will employ rigorous approaches to identifying the causal effect of full-day kindergarten participation and availability on school achievement and women's employment. First, this work leverages these changes in full-day kindergarten provision and participation to look at effects on later academic performance at the school level. Because of data availability, the design relies on "treated" and "untreated" cohorts of students to identify effects of the expansions on student performance. Figure 6 provides the relevant cohorts for comparison in the triple-differences design described in more detail in the sections that follow.

Figure 7: Cohort Comparisons

	2006-07	2007-08	2008-09	2009-10	2010-11
Kindergarten	pre	post	post	post	post
1st Grade	pre	pre	post	post	post
2nd Grade	pre	pre	pre	post	post
3rd Grade	pre	pre	pre	pre	post
4th Grade	pre	pre	pre	pre	pre

Secondly, a triple-differences strategy compares employment among women of mothering age in areas that experienced rapid growth in full-day kindergarten provision to employment among women of mothering age in low or no change school areas, before and after the expansion of full-day kindergarten, netting out the changes in employment among women of older and younger age groups. That is, how much schools responded to full-day kindergarten policy changes in the expansion of their own programs will again be used to generate the comparison though at the county level for employment.

3.1 Data

This section first describes data used to quantify the treatment, or independent variable, in the proposed triple-differences analysis in order to gauge responsiveness of the outcomes of interest to a sweeping policy reform in Indiana to expand full-day kindergarten availability and access. The researcher has data on the number of children enrolled in kindergarten, and the number of those children in full- and half-day settings, in each school for both the 2006–07

and 2007–08 school years, also matched from schools and schools districts to counties and aggregated to the county level. The 2006–07 school year pre-dates the legislative reform, and its increased funding availability to school districts statewide for the provision of full-day kindergarten, and the 2007–08 school year is the first year in which the new policy was in place.

The Indiana Department of Education provided kindergarten enrollment records for the 2006–07 and 2007–08 academic years (i.e., the pre- and post-policy change years). These kindergarten enrollment records include a flag at the individual-student level for full-day kindergarten participation. These records were aggregated to generate school-level, and in the employment analyses county-level, full-day kindergarten provision rates. Four versions of measuring within-school change from the 2006–07 to the 2007–08 academic year are employed in the analysis:

- Continuous measure of change in full-day kindergarten participation as a proportion of all kindergarteners within a school,

- Binary measure of a positive change, or increase, in full-day kindergarten participation as a proportion of all kindergarteners within a school,

- Binary measure of above average change, called high change, in full-day kindergarten participation as a proportion of all kindergarteners within a school, and

- Binary measure of change to provide all full-day kindergarten in schools that previously served fewer than all kindergarteners in full-day settings.

Table 1 displays the descriptive statistics for these four versions of the treatment variable across the 92 counties in the dataset, the level used in maternal employment models.

Table 1: Full-day Kindergarten Availability Variables at the County Level

Variable	Mean (SD)
Change in Proportion of County's Kindergarten Students in Full-day	0.2564 (0.2563)
Proportion of Counties with Positive Change	0.8804 (0.3262)
Proportion of Counties with Above Mean Change in Full-day	0.3913 (0.4907)
Proportion of Counties with 90% or More Kindergarten Students in Full-day	0.3478 (0.4789)

The school achievement analyses rely on administrative data on schools and districts in Indiana to capture school and district characteristics (e.g., per pupil expenditures, average daily attendance, average teacher salary, number of students, number of full-time equivalent teachers) and third and fourth grade reading and math performance. Student achievement

data and many school and district characteristics were collected from state-administered, publicly available datasets. This information was also supplemented by school and district characteristics in the Common Core Data maintained by the National Center for Education Sciences at the U.S. Department of Education.

I employ administrative data and specially collected student assessment data from a representative, statewide sample of first grade classrooms to assess the impact of the statewide policy change in the subsequent grade across cohorts. As mentioned, student achievement as measured by standardized assessments in reading and math in third and fourth grades was collected from state databases. The assessment in use over this time period was the Indiana Statewide Testing for Educational Progress–Plus (ISTEP+). I also utilize first grade literacy scores on the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) collected on a statewide representative sample of schools offering kindergarten and first grade to the pre-policy change (2007–08 for first graders) and post-policy change (2008–09) cohorts. Randomly selected first grade classrooms were tested with the sampled schools, drawn by NORC at the University of Chicago to be representative on the following dimensions:

- Poverty status proxy (proportion of kindergarten students receiving free or reduced-price lunch in the 2006–07 school year): low, high

- Locale: suburban, rural, urban

- Region: central, northeast, northwest, southeast, southwest

- Full-day kindergarten enrollment (proportion of kindergarten students in full-day kindergarten in the 2006–07 school year): low, high

For the maternal employment analyses, data on full-day kindergarten provision were linked by geography from the school and school district level to county to allow for merging with employment data. The workforce data for women in the relevant age range was obtained from data that Indiana contributes to the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages. While data from 2000 through 2013 is included, the focal pre- and post- quarters are Q1-Q3 in 2007, and Q4 in 2007 and Q1-Q2 in 2008, respectively. Moreover, to conduct the triple-differences analysis, employment data for different age groups are included in the merged data. The use of these different subgroups to generate causal estimates is described in further detail in the following section. The employment data contains approximately 50,000 observations of total employment, new hires, and job separations aggregated by sex and age group at the quarter by year by county level. For each county, there are observations for each quarter in each year 2000 through 2013 for men and women in each of the following age groups:

- 19-24 years old,

- 25-34 years old,

- 35-44 years old, and

- 45-54 years old.

For the purposes of this analysis, women ages 25-44 are considered "at risk" for treatment in that they are the most likely age group affected by full-day kindergarten expansions as child care.

3.2 Empirical Strategy

To account for district and school selection into greater availability of full-day kindergarten and to account for the threat of history in making pre-post comparisons of policy impact, I utilize a triple-difference approach to leverage cross-school (or cross-county), cross-time, and cross-cohort variation in exposure to full-day kindergarten availability. The triple-difference approach avoids concerns about time-varying, within-school or within-county characteristics as I difference out from the estimation of full-day kindergarten impact changes in outcomes for unaffected cohorts (i.e., older students in the same schools).

A simple specification would leverage pre-post variation within schools or counties as follows:

$$y_s = \alpha + \beta X_s + \theta POST_s + \delta_s + \varepsilon_s \tag{1}$$

The triple-differences empirical approach, leveraged in this paper, employs the following model:

$$y_{gjst} = \alpha + \beta X_{jst} + \theta FDK_{gjst} + \Gamma_g + \lambda_j + \delta_s + \gamma_t + \varepsilon_{gst} \tag{2}$$

where FDK captures change in full-day kindergarten enrollment, continuously or as a binary variable, turning on for affected groups, g, in treated schools or counties, s, in the post-policy time period (quarter j and year t). In the achievement analyses, the outcome is standardized test scores, and all pairwise interactions of school, year, and grade level are included as well as school and year dummies. Time-varying controls are also included in some specifications of the model. In the employment analyses, y is the employment outcome of total employment or new hires per 100 people in the specific subgroup. Age group, quarter, year, and county fixed effects are included. Regressions are population-weighted, and heteroskedasticity-robust standard errors are clustered on school or county.

3.3 Descriptive Statistics

Tables 1 through 3 in the appendix display summary statistics for the binary measures of full-day kindergarten change at the school level. Notably, the dimensions on which the treated and untreated group differ statistically change with the different specifications of treatment. When considering any increase in full-day kindergarten enrollment ("positive change"), the treatment schools are larger, with more pre-treatment kindergarten students and full-time equivalent teachers. They are also in districts that spent more per student on average before the policy change, and generally performed worse on measures of third and fourth grade reading and math achievement. This type of negative selection into the provision of full-day kindergarten, possibly as a means to improve subsequent test scores, is common at the national level.

When comparing high change (i.e., above average increases in full-day kindergarten participation) schools to other schools, they differ only on demographic composition–more white and less black and Hispanic than their non-high change counterparts–and district-level average daily attendance and teacher salary, both of which are lower in high change schools.

Finally, those schools that changed to full provision of full-day kindergarten are more disadvantaged and smaller (e.g., fewer students, fewer teachers, lower student-teacher ratio) than other schools. Their districts also had lower average teacher salaries before the policy change, and they exhibit worse student performance at the school level. The selection story is most pronounced with this cut at "treated" and "untreated" schools.

4 Results

Differences in achievement and maternal employment associated with the pre- and post-policy change time period point to the need for the triple-differences analyses conducted in this paper. Figure 8 displays the pre-/post- changes in achievement in schools that exhibited low and high starting points in full-day kindergarten availability. The figure indicates that effects might be more concentrated in places that did not have significant full-day kindergarten availability prior to the policy changes, though the noisiness in the estimates should also be noted.

Figure 8: Pre-/Post- Changes in Achievement in Schools with Low and High Baselines
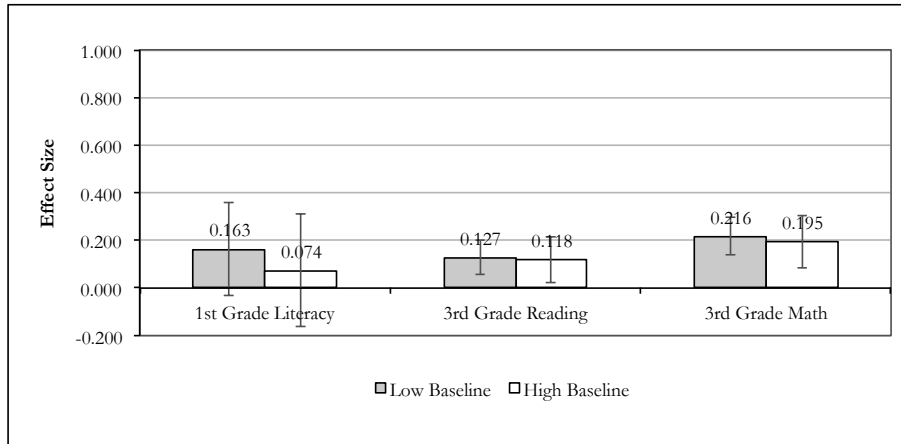
Figure 9 similarly displays pre-/post- differences in places with low and high *change* in full-day kindergarten provision over this time period. Again, the differences are suggestive of a concentration of effects in high change places, though the estimates are again imprecise.

Figure 9: Pre-/Post- Changes in Achievement in Schools with Low and High Change
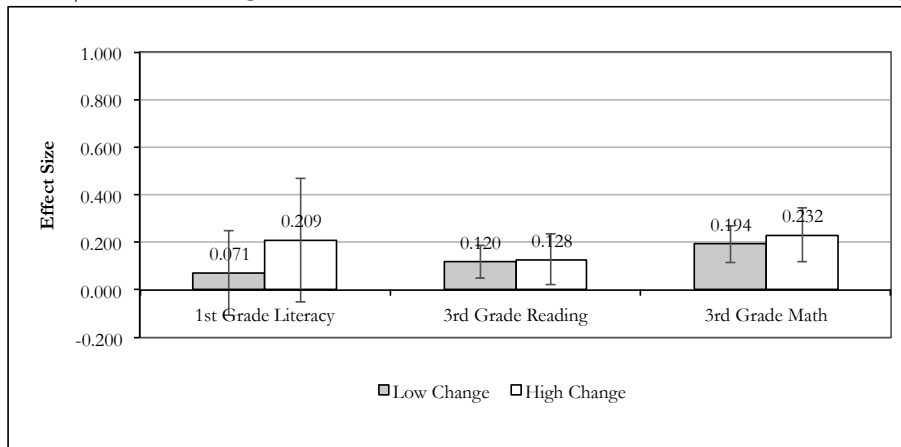
Figures 10 and 11 show pre-/post- changes in employment outcomes for all counties in the state and then within counties that experienced positive or above average change in full-day kindergarten provision, in counties that were above the mean in provision after the policy change, in counties that provided full-day kindergarten for all students after the policy change, and in counties that shifted to full provision of full-day kindergarten in this timeframe. As is evident in the tables, employment differences are positive in these places while flat overall.

Figure 10: Pre-/Post- Differences in Total Employment
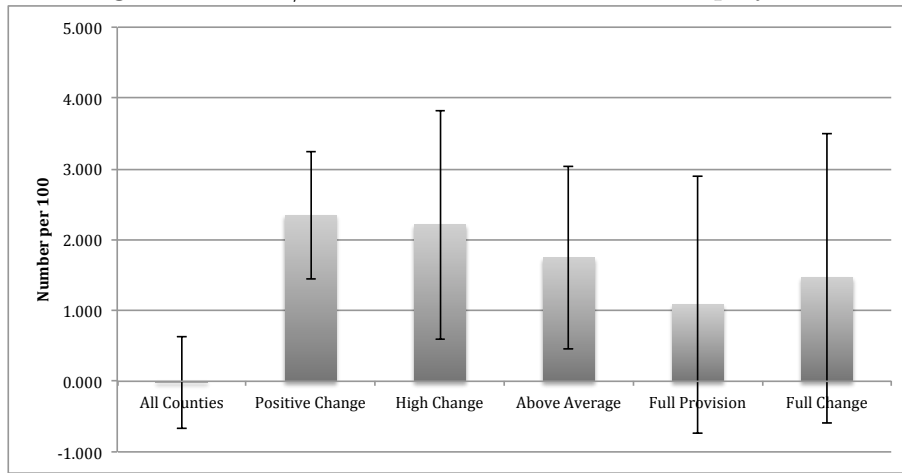
Figure 11: Pre-/Post- Differences in New Hires
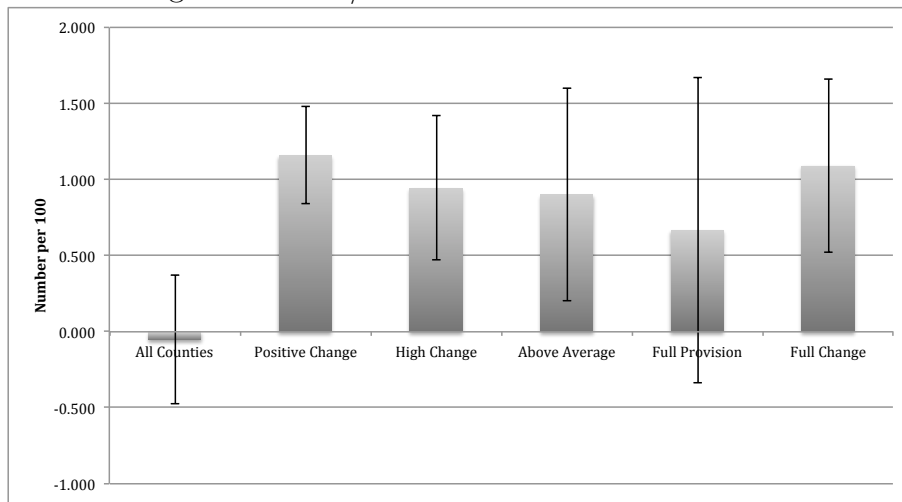
For the reasons outlined previously and in the summary statistics, this type of approach is insufficient in capturing the endogeneity of full-day kindergarten provision. This study design employs an additional attempt at dealing with threats to the internal validity of impact estimates by including untreated cohorts within the same schools. The pre-post changes for older students within the same schools, or older women within the same counties, may capture the other time-varying programs, resources, and events affecting student performance or female labor force participation over this time period. Tables 4 through 9 present the results of the triple-difference models, beginning with the continuous measure of full-day kindergarten change and then leveraging the alternative specifications of the treatment dummy.

The models of impact on school achievement are presented in Tables 4 through 7. While

the point estimates for the coefficient of interest in the first grade outcomes models suggest positive relationships, they are not statistically significant. Because the first grade literacy assessment was collected on only a subsample of schools in the state, these estimates lack precision. Notably, the post-policy change dummy is consistently positive and significant across models suggesting a secular upward trend in academic performance in the state across this same time period. Consistent with patterns of fade out in both the observational full-day kindergarten literature and in the broader evidence base on early childhood interventions, there are no effects in third grade and the coefficients are consistently zero. The evidence suggests that increases in full-day kindergarten provision have no school-level effects on later academic performance.

The analyses of maternal employment outcomes displayed in Tables 8 and 9, however, suggest a correspondence between increased full-day kindergarten provision and female employment, as measured both by total employment and new hires. The results indicate an increase of two to three new hires per 100 women associated with changes in full-day kindergarten availability resulting from the policy expansion. These results are particularly strong for new hires, and are consistent across specification of the treatment exposure variable.

This paper speaks to an as-yet-unanswered question in the literature about full-day kindergarten impact, that of the systemic return on the early investment in the form of subsequent student achievement. Rather than focusing on participant-level effects, this work sought to quantify the intention-to-treat effect, on both later school performance and female labor force participation, of making full-day kindergarten more available to students within schools. It could be argued that this is, in fact, the policy relevant parameter of interest.

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Tables

Table 1. Summary Statistics of Positive Change and Other Schools.

	Positive Change Schools n=579	Other Schools n=465	p-value
Panel A. School characteristics			
Title I schoolwide	0.64 (.482)	0.64 (.480)	0.859
Title I eligible	0.84 (.371)	0.79 (.405)	0.079
Total students	450.35 (164.08)	414.15 (164.20)	0.000**
Pre-K students	6.04 (12.94)	5.90 (17.95)	0.883
K students	69.62 (29.33)	62.87 (28.69)	0.000**
Student/teacher ratio	17.24 (4.60)	17.56 (2.77)	0.181
Full-time equivalent teachers	26.30 (8.67)	23.70 (8.85)	0.000**
% Black and Hispanic	0.21 (.268)	0.18 (.271)	0.174
% White	0.73 (.282)	0.76 (.283)	0.111
% Free or reduced-price lunch	0.48 (.228)	0.45 (.242)	0.110
Panel B. School district characteristics			
K-4th grade students	239.59 (299.94)	223.38 (289.54)	0.382
Per-pupil expenditures	11189.19 (1841.59)	10911.07 (1876.87)	0.017*
Daily attendance	8990.10 (10096.22)	8427.48 (9623.02)	0.366
Teacher salary	47209.54 (4140.19)	47624.48 (4605.82)	0.130
Panel C. Pre-policy test scores			
1st grade reading (2007-08)	-.087 (.525)	-.079 (.483)	0.931
3rd grade reading (2009-10)	-.041 (.927)	.091 (1.026)	0.032*
3rd grade math (2009-10)	-.051 (.935)	.110 (1.026)	0.010*
4th grade reading (2010-11)	.214 (.925)	.344 (.968)	0.036*
4th grade math (2010-11)	.130 (.953)	.252 (.984)	0.054

Notes: Standard deviations are provided in parentheses. P-values from the statistical tests of mean differences are displayed.

Table 2. Summary Statistics of High Change and Other Schools.

	High Change Schools n=335	Other Schools n=709	p-value
Panel A. School characteristics			
Title I schoolwide	0.62 (.486)	0.65 (.478)	0.492
Title I eligible	0.84 (.368)	0.81 (.395)	0.212
Total students	432.98 (170.47)	434.82 (162.53)	0.867
Pre-K students	4.85 (10.50)	6.51 (17.18)	0.103
K students	65.98 (28.93)	66.91 (29.38)	0.633
Student/teacher ratio	17.04 (2.42)	17.54 (4.42)	0.051
Full-time equivalent teachers	25.34 (9.06)	25.05 (8.74)	0.611
% Black and Hispanic	0.17 (.235)	0.21 (.283)	0.013*
% White	0.78 (.253)	0.73 (.295)	0.007**
% Free or reduced-price lunch	0.46 (.194)	0.47 (.252)	0.418
Panel B. School district characteristics			
K-4th grade students	206.73 (275.17)	244.33 (303.71)	0.057
Per-pupil expenditures	11114.98 (11042.17)	11042.17 (1847.36)	0.556
Daily attendance	7792.33 (9384.60)	9183.98 (10090.05)	0.036*
Teacher salary	46952.74 (3869.08)	47602.70 (4556.36)	0.026*
Panel C. Pre-policy test scores			
1st grade reading (2007-08)	-.118 (.529)	-.063 (.495)	0.547
3rd grade reading (2009-10)	.023 (.790)	.015 (1.051)	0.905
3rd grade math (2009-10)	-.008 (.837)	.033 (1.040)	0.534
4th grade reading (2010-11)	.267 (.808)	.273 (1.006)	0.924
4th grade math (2010-11)	.189 (.870)	.182 (1.013)	0.915

Notes: Standard deviations are provided in parentheses. P-values from the statistical tests of mean differences are displayed.

Table 3. Summary Statistics of Schools that Changed to Full-day Only and Others.

	Change to All Full-day Schools n=202	Other Schools n=854	p-value
Panel A. School characteristics			
Title I schoolwide	0.71 (.455)	0.62 (.486)	0.025*
Title I eligible	0.86 (.352)	0.81 (.396)	0.094
Total students	384.54 (150.13)	446.18 (166.06)	0.000**
Pre-K students	5.28 (10.61)	6.14 (16.24)	0.000**
K students	57.55 (26.00)	68.69 (29.65)	0.000**
Student/teacher ratio	16.12 (2.46)	17.70 (4.10)	0.000**
Full-time equivalent teachers	24.03 (9.11)	25.39 (8.76)	0.048*
% Black and Hispanic	0.19 (.278)	0.20 (.268)	0.864
% White	0.75 (.291)	0.74 (.282)	0.543
% Free or reduced-price lunch	0.54 (.213)	0.45 (.236)	0.000**
Panel B. School district characteristics			
K-4th grade students	246.44 (324.39)	227.91 (286.68)	0.424
Per-pupil expenditures	11191.69 (2077.43)	11035.46 (1802.00)	0.285
Daily attendance	8996.66 (11074.21)	8642.54 (9543.71)	0.649
Teacher salary	46086.17 (4721.848)	47686.22 (4214.91)	0.000**
Panel C. Pre-policy test scores			
1st grade reading (2007-08)	-.208 (.448)	-.058 (.516)	0.206
3rd grade reading (2009-10)	-.191 (.901)	.066 (.987)	0.001**
3rd grade math (2009-10)	-.176 (.914)	.068 (.988)	0.002**
4th grade reading (2010-11)	.058 (.857)	.321 (.959)	0.001**
4th grade math (2010-11)	-.030 (.889)	.233 (.980)	0.001**

Notes: Standard deviations are provided in parentheses. P-values from the statistical tests of mean differences are displayed.

Table 4. Triple-Difference Model with Continuous Full-day K Change Measure.

	Standardized Test Score Outcome				
	1st Grade Reading	3rd Grade Reading		3rd Grade Math	
Full-day K Exposure	0.100	-0.020	0.001	0.031	0.056
	(1.266)	(0.181)	(0.179)	(0.184)	(0.180)
Post	0.973**	0.121**	0.159**	-0.009	0.027
	(0.316)	(0.033)	(0.035)	(0.035)	(0.037)
1st Grade	0.574	—	—	—	—
	(0.316)				
3rd Grade	—	-0.318**	-0.318**	-0.079**	-0.079**
		(0.000)	(0.000)	(0.000)	(0.000)
Post*Grade	0.238	-0.119	-0.125	0.048	0.043
	(0.490)	(0.073)	(0.073)	(0.077)	(0.078)
School fixed effects	X	X	X	X	X
School*Post interactions	X	X	X	X	X
School*Grade interactions	X	X	X	X	X
Controls			X		X
Adj. R²	0.781	0.796	0.796	0.786	0.787
n	2,462	4,219	4,191	4,220	4,192

Notes: Robust standard errors in parentheses, clustered on school. Time-varying controls include number of students, student-teacher ratio, full-time equivalent teachers, and student demographic characteristics. Because of limited sample size and collinearity, 1st grade reading models cannot be estimated with controls.

* $p < 0.05$, ** $p < 0.01$

Table 5. Triple-Difference Model with Binary Measure of Increase in Full-day K.

	1st Grade Reading	Standardized Test Score Outcome			
		3rd Grade Reading		3rd Grade Math	
Positive Change in Full-day K	0.153	0.017	0.020	0.084	0.089
	(0.800)	(0.120)	(0.121)	(0.127)	(0.127)
Post-policy	0.960**	0.119**	0.132**	-0.029	-0.013
	(0.246)	(0.039)	(0.037)	(0.040)	(0.038)
1st Grade	0.561*	—	—	—	—
	(0.246)				
3rd Grade	—	-0.318**	-0.318**	-0.079**	-0.079**
		(0.000)	(0.000)	(0.000)	(0.000)
Post*Grade	0.173	-0.133	-0.136	0.008	0.006
	(0.630)	(0.092)	(0.093)	(0.098)	(0.099)
School fixed effects	X	X	X	X	X
School*Post interactions	X	X	X	X	X
School*Grade interactions	X	X	X	X	X
Controls			X		X
Adj. R²	0.777	0.791	0.791	0.780	0.780
n	2,318	3,908	3,888	3,909	3,935

Notes: Robust standard errors in parentheses, clustered on school. Time-varying controls include number of students, student-teacher ratio, full-time equivalent teachers, and student demographic characteristics. Because of limited sample size and collinearity, 1st grade reading models cannot be estimated with controls.

* $p < 0.05$, ** $p < 0.01$

Table 6. Triple-Difference Model with Binary Measure of Above Average Change in Full-day K.

	Standardized Test Score Outcome				
	1st Grade Reading	3rd Grade Reading		3rd Grade Math	
High Change in Full-day K	0.063	0.047	0.058	0.074	0.088
	(0.803)	(0.127)	(0.127)	(0.132)	(0.132)
Post-policy	0.972**	0.130**	0.146**	0.001	0.019
	(0.319)	(0.036)	(0.037)	(0.038)	(0.039)
1st Grade	0.573	—	—	—	—
	(0.319)				
3rd Grade	—	-0.318**	-0.318**	-0.079**	-0.079**
		(0.000)	(0.000)	(0.000)	(0.000)
Post*Grade	0.240	-0.139	-0.144*	0.031	0.027
	(0.487)	(0.072)	(0.073)	(0.076)	(0.077)
School fixed effects	X	X	X	X	X
School*Post interactions	X	X	X	X	X
School*Grade interactions	X	X	X	X	X
Controls			X		X
Adj. R^2	0.776	0.791	0.791	0.780	0.781
n	2,318	3,908	3,888	3,909	3,889

Notes: Robust standard errors in parentheses, clustered on school. Time-varying controls include number of students, student-teacher ratio, full-time equivalent teachers, and student demographic characteristics. Because of limited sample size and collinearity, 1st grade reading models cannot be estimated with controls.

$* p < 0.05, ** p < 0.01$

Table 7. Triple-Difference Model with Binary Measure of Change to Offering Only Full-day K.

	1st Grade Reading	3rd Grade Reading		3rd Grade Math	
		Standardized Test Score Outcome			
Full-day K Only	0.248	-0.045	-0.034	0.009	0.026
	(1.127)	(0.162)	(0.162)	(0.164)	(0.162)
Post-policy	0.891	0.117**	0.132**	-0.010	0.007
	(0.524)	(0.032)	(0.032)	(0.034)	(0.034)
1st Grade	0.492	—	—	—	—
	(0.524)				
3rd Grade	—	-0.318**	-0.318**	-0.079**	-0.079**
		(0.000)	(0.000)	(0.000)	(0.000)
Post*Grade	0.217	-0.113	-0.116	0.053	0.050
	(0.411)	(0.064)	(0.065)	(0.068)	(0.069)
School fixed effects	X	X	X	X	X
School*Post interactions	X	X	X	X	X
School*Grade interactions	X	X	X	X	X
Controls			X		X
Adj. R²	0.779	0.790	0.791	0.779	0.780
n	2,342	3,954	3,934	3,955	3,935

Notes: Robust standard errors in parentheses, clustered on school. Time-varying controls include number of students, student-teacher ratio, full-time equivalent teachers, and student demographic characteristics. Because of limited sample size and collinearity, 1st grade reading models cannot be estimated with controls.

* p < 0.05, ** p < 0.01

Table 8. Triple-Difference Models with Female Employment Outcomes.

| | Female Employment Outcome | | | |
	Total Employment		New Hires	
Full-day K Exposure	4.287*	4.161*	5.157**	9.289**
	(1.688)	(1.674)	(0.597)	(1.406)
County fixed effects	X	X	X	X
Year fixed effects	X	X	X	X
Quarter fixed effects	X	X	X	X
Population-weighted		X		X
Adj. R^2	0.933	0.957	0.464	0.556
n	2,208	2,208	2,208	2,208
Positive Change in Full-day K	2.594**	1.802**	3.661**	4.465**
	(0.587)	(0.579)	(0.206)	(0.336)
County fixed effects	X	X	X	X
Year fixed effects	X	X	X	X
Quarter fixed effects	X	X	X	X
Population-weighted		X		X
Adj. R^2	0.934	0.957	0.529	0.623
n	2,208	2,208	2,208	2,208

Notes: Robust standard errors in parentheses, clustered on county.

* $p < 0.05$, ** $p < 0.01$

Table 9. Triple-Difference Models with Female Employment Outcomes (continued).

| | Female Employment Outcome | | | |
	Total Employment		New Hires	
High Change in Full-day K	1.983*	1.179	2.387**	2.872**
	(0.852)	(0.957)	(0.207)	(0.313)
County fixed effects	X	X	X	X
Year fixed effects	X	X	X	X
Quarter fixed effects	X	X	X	X
Population-weighted		X		X
Adj. R^2	0.933	0.956	0.451	0.524
n	2,208	2,208	2,208	2,208
Full-day K Only	2.778**	2.858**	2.351**	3.063**
	(0.776)	(0.796)	(0.244)	(0.424)
County fixed effects	X	X	X	X
Year fixed effects	X	X	X	X
Quarter fixed effects	X	X	X	X
Population-weighted		X		X
Adj. R^2	0.934	0.957	0.448	0.518
n	2,208	2,208	2,208	2,208

Notes: Robust standard errors in parentheses, clustered on county.

* $p < 0.05$, ** $p < 0.01$