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**EARLY ACCESS: ELEMENTARY SCHOOL OUTCOMES FOR
ARKANSAS BETTER CHANCE PUBLIC PRE-KINDERGARTEN
PARTICIPANTS**

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EXECUTIVE SUMMARY

Public pre-Kindergarten programs are frequently promoted as promising early interventions for at-risk students, as they can equip 3- and 4-year-olds with the cognitive, behavioral, and social skills necessary for success in Kindergarten and beyond. The Arkansas Better Chance (ABC) program provides low-income and at-risk Arkansas students with tuition-free pre-K opportunities in school districts across the state. The current analysis describes the 3rd and 5th grade outcomes of students who enroll in ABC pre-K programs in Arkansas public schools. In an attempt to understand how well these programs are serving students, we follow four cohorts of program participants through elementary school, and we compare their math and reading achievement test scores to those of similar peers who did not attend ABC programs. We find ABC pre-K participants are more likely to fall into demographic groups that are considered at-risk for low academic performance, and that ABC students outperform similar peers on math and reading achievement tests in 3rd grade in three of four cohorts. These findings suggest that this program has the potential to set students up for lasting academic success. A brief outline of the report's findings is listed below:

- 1. What proportion of Arkansas public school students attend ABC pre-K, and how has enrollment changed over time?**
 - Overall enrollment of 4-year-olds in ABC programs housed in public schools has increased modestly over the last decade.
 - This enrollment included 12,774 students in the fall of 2008 and 15,771 in fall of 2019.
 - ABC participants make up approximately 25% of each Kindergarten class for each of the four analytic samples, which include students who enrolled in Kindergarten in the academic years of 2012-13 to 2015-16.
- 2. How likely are students of certain demographic groups to enroll in ABC pre-K programs?**
 - Approximately 75% of ABC participants have family incomes which qualify them for Free or Reduced Price lunch when they start Kindergarten.
 - Students who attend ABC pre-K programs are more likely to be low-income, Black, Hispanic, or have limited English proficiency, relative to non-participants.
- 3. What are the 3rd and 5th grade academic outcomes of ABC pre-K participants, and how do they compare to outcomes of students who did not attend ABC?**
 - After controlling for student-level demographic characteristics, there are positive, statistically significant relationships between ABC participation and 3rd grade math and reading achievement for three out of four cohorts of students.
 - Relationships between ABC participation and 5th grade achievement are smaller in magnitude than those of 3rd grade and largely not statistically significant.

I. INTRODUCTION

State-funded pre-Kindergarten (pre-K) programs are growing in prevalence and popularity, and states across the country are expanding these programs to serve more 3- and 4-year-olds. It is important to investigate the effectiveness of such programs to determine whether and to what extent they are contributing to positive academic outcomes for students and also whether program benefits persist throughout students' educational journeys. While some research indicates that cognitive benefits of pre-K fadeout by early elementary school (Lipsey, 2018), other research demonstrates that pre-K attendance can be associated with increased academic achievement through middle school (Dodge et al., 2019). Program advocates hope and expect pre-K to lead to lasting benefits for students, beyond better preparation for Kindergarten. In Arkansas, the state-funded Arkansas Better Chance (ABC) program provides pre-K opportunities for low-income or at-risk students across the state. This analysis follows four cohorts of students who attended ABC pre-K programs through 3rd grade, and two of those cohorts into 5th grade, to determine whether program participants experience achievement gains in mathematics and reading and how these effects persist.

Literature on Public Pre-Kindergarten Programs

Public pre-K programs have been slowly expanding in the United States since the inception of the Head Start program in 1965 by President Lyndon Johnson (K12 Academics, n.d.). As these programs expand, there is debate over whether the expense is justified. Recent research suggests that students who attend public pre-K demonstrate higher academic achievement than those who do not, but not all research findings have been positive, and there have been mixed findings regarding the duration of the programs' benefits (Ritter, 2014; Gorey, 2001; Stockard, 2015).

Researchers theorize that negative and null findings could be the result of poor-quality pre-K programs, indicating that specific program characteristics matter in determining potential benefits (Yoshikawa et al., 2013). Because program differences are often used to explain discrepancies in research findings, it is worth considering the characteristics of successful programs. According to a report by the Learning Policy Institute, some of the characteristics associated with successful programs include small class sizes, well-qualified teachers, ongoing educator support and development, developmentally appropriate standards and curricula, and formative assessment that considers children’s progress and guides program development (Meloy et al., 2019). Research has also demonstrated that full-day pre-K yields more positive benefits than half-day options (Atteberry, 2019).

Success stories of high-quality programs indicate that large scale public pre-K programs have the potential to improve a variety of student outcomes, including test scores, reduced incidence of grade retention, and reduced special education placement for low-income and otherwise vulnerable students (Jung et al., 2013; Yoshikawa et al., 2013).

Arkansas Better Chance (ABC) Pre-K Program

Arkansas has been prioritizing early childhood education for nearly three decades. In 1991, the state launched the Arkansas Better Chance (ABC) program with an initial 10 million dollar investment. This program funded various service providers for families with children birth to age 5. The Arkansas Better Chance for School Success (ABCSS) legislation passed in 2003 outlined specific guidelines and requirements for pre-K programs serving students with ABC funding. As a result, the ABC program now meets eight of ten quality standards set by the National Institute for Early Education Research, including early learning and development standards, curriculum supports, teacher specialized training, assistant teacher degree, maximum

class size, staff-child ratio, screening and referral, and continuous quality improvement system. ABC educators are required to have bachelor's degrees and current AR teacher licenses. These are considered rigorous standards compared to many public and private pre-K centers.

Students become eligible for spots in ABC classrooms based on a number of criteria. Families with combined household incomes less than or equal to 200% of the federal poverty level are eligible for free tuition and priority enrollment. Students can also qualify for eligibility if they have other risk factors, including disabilities, developmental delays, or limited English proficiency. When there are additional spots in ABC classrooms unfilled by qualifying students, other children in the community can enroll and pay tuition on an income-based sliding scale. Students enrolling in ABC must also meet age requirements. Children must turn 3 by August 1st of the application year for the 3-year-old program and 4 by that same date for the 4-year-old program. As of the 2018-19 school year, 100% of counties in Arkansas offer ABC pre-K enrollment opportunities for their surrounding communities (National Institute for Early Education Research, 2020).

A recent longitudinal analysis of the ABC program conducted by the Arkansas Research Center reports that ABC participants are more likely to be proficient on mathematics and reading state exams than students who did not attend any pre-K prior to entering Kindergarten (Argue & Holland, 2020). Using parent information forms, they are able to construct a comparison group of children who have not had any formal pre-K instruction. While the researchers note that changing state exams altered the proficiency rates across time for both groups, they argued that ABC showed promise because in some cases participating students achieved higher proficiency rates than the comparison group, and because retention rates were lower than the comparison group in some cases.

Our analysis is different and novel in several ways. In this study, we analyze the 3rd and 5th grade test scores of students who attend ABC pre-K programs, and we compare these outcomes to those of *all* students who began Kindergarten in Arkansas but did not attend ABC prior to enrolling in school. This allows us to determine how ABC is performing relative to “business as usual”, or all of the other pre-K options that families in the state are choosing. We also standardize students’ test scores, meaning that they are transformed from scale scores into units of standard deviation. Z-scores allow us to observe student achievement relative to other students in the sample, rather than an arbitrary and changing proficiency standard, and are a more sensitive measure of academic performance than proficiency rates. Also, controlling for student-level demographic characteristics, but not limiting our sample to just those students receiving free lunch, helps obtain a more valid estimate of the ABC program’s relationship to student success. Thus, we hope that our report will add new, helpful information regarding outcomes of Arkansas students who attend ABC pre-K.

II. DEFINITIONS

ABC Pre-K: Arkansas Better Chance (ABC) funds various service providers that offer early childcare and learning opportunities for Arkansas children. In this report, when we refer to ABC pre-K, we are only referring to pre-K classrooms housed in Arkansas public school districts, which are at least in-part funded by ABC.

Free or Reduced Price Lunch (FRL): This is a federal nutritional assistance program that is income-based, and it provides free or reduced-price meals for children in need. Families with incomes less than or equal to 185% of the Federal poverty level qualify for this program, so this classification is used as a proxy for low socioeconomic status, as we do not have data on actual family income.

English Language Learner: This classification refers to students who are not native English speakers and are determined to not yet be fluent in the English language. Students with this designation receive special services, and they are able to exit this program upon demonstration of English proficiency.

Race: Throughout this report, racial breakdowns are limited to White, Black, Hispanic, and “other”. The “other” racial category includes students who identify as Asian, Native Hawaiian/Pacific Islander, Native American/Alaskan Native, and Two or More Races.

III. DATA AND SAMPLE

The data for this analysis come from the Arkansas Department of Education and are accessed through the Office for Education Policy at the University of Arkansas. The dataset includes anonymized student-level demographic records for all students P-12 enrolled in Arkansas public schools as well as achievement records for students in grades 3-12. To compare the achievement outcomes among students who did or did not attend ABC pre-K, we follow four cohorts of Kindergarteners. Students in each Kindergarten cohort are matched by a unique research ID to their 3rd and 5th grade ACT Aspire mathematics and reading standardized test scores. In addition to math and reading test scores, the achievement dataset also includes student gender, race, Free/Reduced Lunch (FRL) eligibility, Special Education (SPED) status, and English language learner (ELL) designation.

Sample

To construct each cohort, we begin by compiling a dataset of every student enrolled in Kindergarten in Arkansas public schools in the academic years of 2012-13, 2013-14, 2014-15, or 2015-16. We note whether each of these students attended ABC pre-K in an Arkansas public

school in the year prior to entering Kindergarten or not, and the sample sizes of each of these Kindergarten cohorts are presented in Table 1 below:

Table 1: Sample Size by Cohort and ABC Pre-K Participation

Cohort (Kindergarten Year)	Total Number of Kindergarten Students	Number that Attended ABC Pre-K	Number that did not Attend ABC Pre-K
Cohort 1 (2012-13)	40,402	10,629	29,773
Cohort 2 (2013-14)	39,822	10,260	29,562
Cohort 3 (2014-15)	38,431	10,673	27,758
Cohort 4 (2015-16)	37,457	10,448	27,009

There were around 40,000 students in each Kindergarten class, and a little over a fourth of these students attended ABC in each cohort: 26.3% in Cohort 1, 25.7% in Cohort 2, 27.7% in Cohort 3, and 27.9% in Cohort 4. This proportion increased slightly across the four years of analysis but remained fairly consistent.

The next step in the construction of the dataset is to match these Kindergarten students to their 3rd and 5th grade achievement outcomes. We begin with 3rd grade assessments as that is the first year that students are assessed statewide in reading and mathematics. Fifth grade assessments were included to determine if any identified relationship between participation in ABC pre-K programs and academic outcomes is evidenced in later years. We limited our sample to these four cohorts as these are the only pre-K cohorts that have completed the ACT Aspire every year. We only include students who are consistently enrolled in Arkansas public schools from Kindergarten until at least 3rd grade and do not repeat or skip a grade. After this merging process, we are left with a smaller analytic sample for each cohort. It is of particular interest whether the analytic sample identified in Kindergarten changes substantially by the time they reach 3rd or 5th grade. In Table 2, we present the demographic makeup of students in the Kindergarten sample

that did or did not attend ABC pre-K for Cohort 1 as well as the demographic makeup of our analytic sample in 3rd and 5th grades. Overall, patterns are highly similar across all four cohorts, so we discuss descriptive statistics for Cohort 1 and include descriptive tables for the other three cohorts in the appendix.

Table 2: Descriptive Statistics, Cohort 1, by Grade

	Kindergarten		3 rd Grade		5 th Grade	
	ABC	Not ABC	ABC	Not ABC	ABC	Not ABC
Total Students	10,629	29,773	8,859	22,769	8,596	21,905
% of Students	26.3	73.7	28.0	72.0	28.2	71.8
% Female	49.7	47.6	51.0	48.9	51.0	49.0
% White	55.7	63.8	54.3	63.8	54.1	63.7
% Black	26.4	18.9	26.8	18.1	26.8	18.1
% Hispanic	14.2	11.7	15.1	12.7	15.3	12.9
% Other Race	3.7	5.6	3.8	5.4	3.8	5.4
% FRL Eligible	76.8	63.3	72.9	61.5	70.5	60.5
% Special Education	N/A	N/A	8.5	12.1	8.6	12.7
% English Language Learner	10.8	8.1	10.4	8.6	8.2	7.3

In the initial Kindergarten sample, described in the first two columns of data, there are several demographic differences between students who attended ABC and those who did not. Among ABC pre-K participants, a greater percentage were Black and Hispanic students, low-income students, and English Language Learners than in the group of kindergarten students that did not attend ABC pre-K. These trends are expected, as students who belong to racial minority groups, are low-income, or have limited English proficiency are considered at-risk for poor academic performance (American Psychological Association, 2017), and ABC targets those student populations in enrollment. Of the 40,402 students in this initial sample, there are 31,628 in the 3rd grade sample and 30,501 in the 5th grade samples. These analytic samples are considerably smaller in size than the initial Kindergarten sample at 78.3% of the initial sample in

3rd grade and 75.5% in the 4th grade sample. We recognize that these students who are included in our analysis could be different from the initial sample in fundamental ways, so we next explore the demographic characteristics of the 3rd and 5th grade analytic samples.

Initially, 26.3% of students in Cohort 1 were ABC attendees, but this proportion increased to 28% of the 3rd grade sample and 28.2% of the 5th grade sample. This pattern seems to suggest that there are fewer ABC participants being held back or leaving Arkansas public schools than their non-participant peers. Overall, the demographic compositions of the three groups seem comparable, even as sample size decreases. This suggests that there is relatively balanced attrition from the sample across the two groups, at least on observable characteristics.

One notable exception is the proportion of FRL eligible students across time. While 76.8% of ABC students were FRL eligible in the Kindergarten sample, only 70.5% of the ABC attendees in the 5th grade analytic sample are FRL eligible. Similarly, 63.3% of non-ABC students were FRL eligible in Kindergarten, and 60.5% of non-ABC students in the 5th grade sample are FRL eligible. This implies that all low-income students are more likely to be in the group of students who repeat a grade or leave Arkansas schools, and the difference in FRL proportion between ABC and non-ABC students shrinks over time. Students also have to reapply for the program each academic year, and it could also be possible that students lose eligibility or fail to complete the paperwork to qualify for the FRL program. While the mechanism for the change is unknown, this difference in FRL-eligibility rates of the sample is important to consider as we move forward with analysis of academic outcomes for these groups.

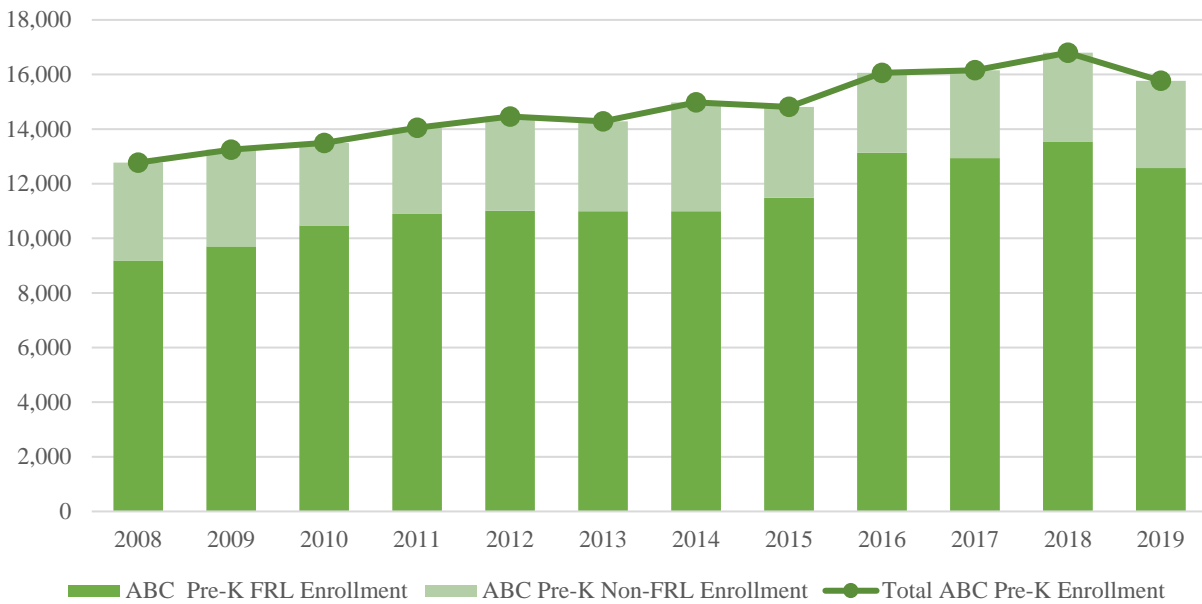
IV. DESCRIPTIVE TRENDS

In the next section, we describe trends in ABC enrollment over the past ten years, as well as the achievement trends of ABC and non-ABC groups during the time period of the current analysis.

ABC Enrollment Trends

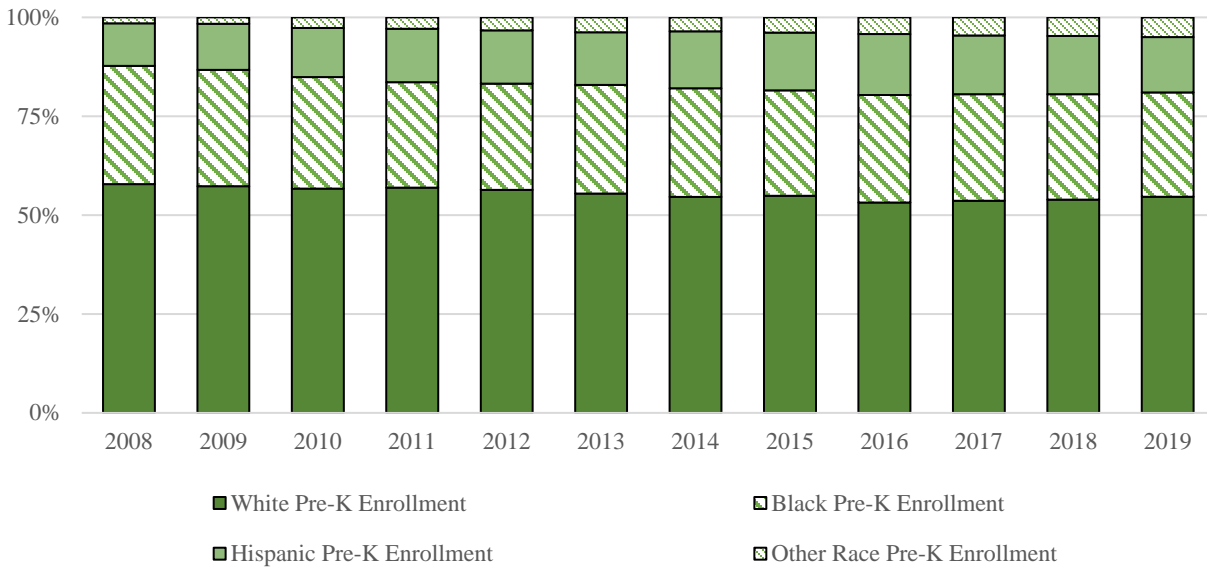
Figure 1 presents the number of students enrolled in ABC pre-K programs in Arkansas public schools from the fall of 2008 to the fall of 2019. This includes all 3- and 4-year-olds enrolled in each academic year, not only those included in our analytic sample. The figure also illustrates the proportion of students who are FRL eligible in each year:

Figure 1: ABC Pre-K Enrollment, 2008-09 through 2019-20



As shown, the number of students enrolling in ABC classrooms has increased since 2008. In the latest academic year, approximately 16,000 students were enrolled, compared to about 13,000 in the fall of 2008. In each year, the proportion of students who qualify for the FRL program is about 75%. This is higher than the state average of K-12 students who are FRL eligible, which is 65.5% in the 2020-21 school year, and this represents the targeted nature of this program toward low-income families. In Figure 2, we present the proportion of total enrollment for each of these years broken down by race:

Figure 2: Percentage of Total ABC Enrollment by Race, 2008-09 through 2019-20



As evidenced in Figure 2, across the last ten years, slightly over 50% of the ABC enrollment was comprised of White students. Black students comprised approximately 26 to 30% of the enrollment, and Hispanic students comprised about 11 to 15% of the enrollment. Notably, the proportion of Hispanic students enrolled has increased since the fall of 2008, while the proportion of Black students has decreased. Also, both Black and Hispanic student groups are overrepresented in ABC programs relative to their contribution to the K-12 enrollment. This also represents the targeted nature of the program toward at-risk student populations.

Achievement Trends of ABC Participants

In order to analyze achievement over time and across changing standardized tests, we convert students’ individual test scores into standardized “z-scores”. A z-score is a value in units of standard deviations that tells us where students are scoring relative to the group average, where a value of 0 represents the average test score for all students in the analytic sample. The following figures present average z-scores for mathematics and reading achievement in 3rd grade, where the

light green bars represent the average for students who attended ABC pre-K and the dark green bars represent the average for the group of students who began Kindergarten at the same time but did not enroll in ABC pre-K.

In Figure 3, we see that ABC pre-K participants, on average, have higher math z-scores than non-ABC students in the first cohort, lower math z-scores in the second and third cohorts, and in the fourth cohort, ABC and non-ABC students had similar average math scores. For reading, there was a similar pattern presented in Figure 4, with ABC pre-K students scoring above their non-ABC peers in the first cohort but then lower than those students in the second, third, and fourth cohorts.

Figure 3: Average 3rd Grade Mathematics Z-scores for Analytic Sample by Cohort (3rd grade year)

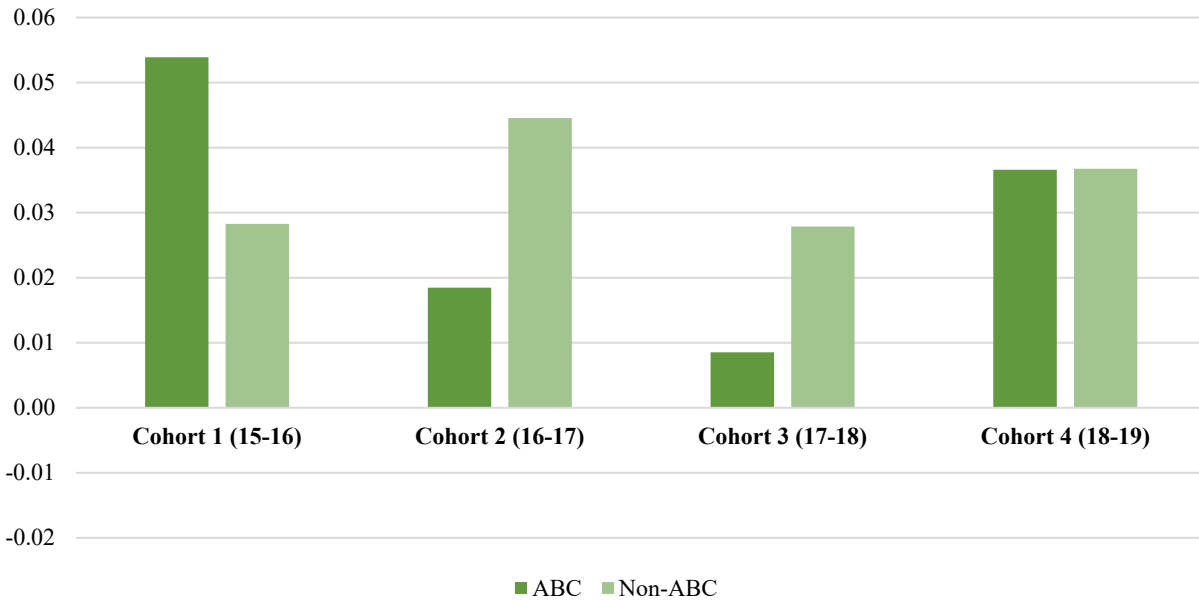
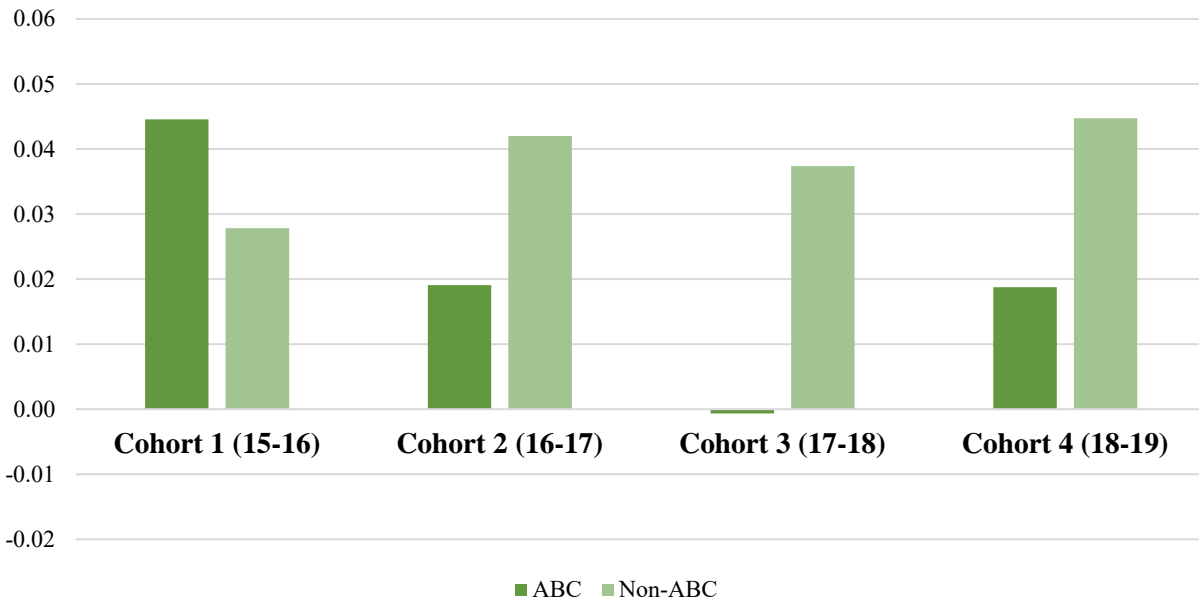


Figure 4: Average 3rd Grade Reading Z-scores for Analytic Sample by Cohort (3rd grade year)



At surface level, these figures suggest that students who attended ABC pre-K programs as an aggregate scored slightly higher on standardized math and reading exams in Cohort 1, relative to their peers who did not attend ABC, and they scored slightly lower than them for the later three cohorts. However, these differences of 0.05 standard deviations or smaller are not very large, so ultimately there is not a very meaningful difference between these two groups on this level. Low-income students, on the other hand, seem to benefit more from ABC attendance. Similar figures that describe only the subgroup of FRL-eligible students are presented below.

In Figures 5 and 6, we see that FRL-Eligible students overall consistently score below the state average on 3rd grade assessments of mathematics and reading. This is unsurprising because it is well documented that low-income students are at-risk for poor academic performance, and these student groups tend to score below their wealthier peers. However, we see that the group of students who did attend ABC pre-K has an average z-score that is much closer to the state average. In math, ABC attendees scored about 0.15 standard deviations higher than their peers in

Cohort 1, 0.12 standard deviations higher in Cohort 2, 0.07 standard deviations higher in Cohort 3, and 0.14 standard deviations higher in Cohort 4. There are similar, very large score differences between the two groups in reading. As evidenced in Figure 6, ABC participants scored 0.16 standard deviations higher than non-ABC students in Cohort 1, 0.13 standard deviations higher in Cohort 2, 0.07 standard deviations higher in Cohort 3, and 0.12 standard deviations higher in Cohort 4.

Figure 5: Average 3rd Grade Mathematics Z-scores for FRL-Eligible Students, by Cohort (3rd grade year)

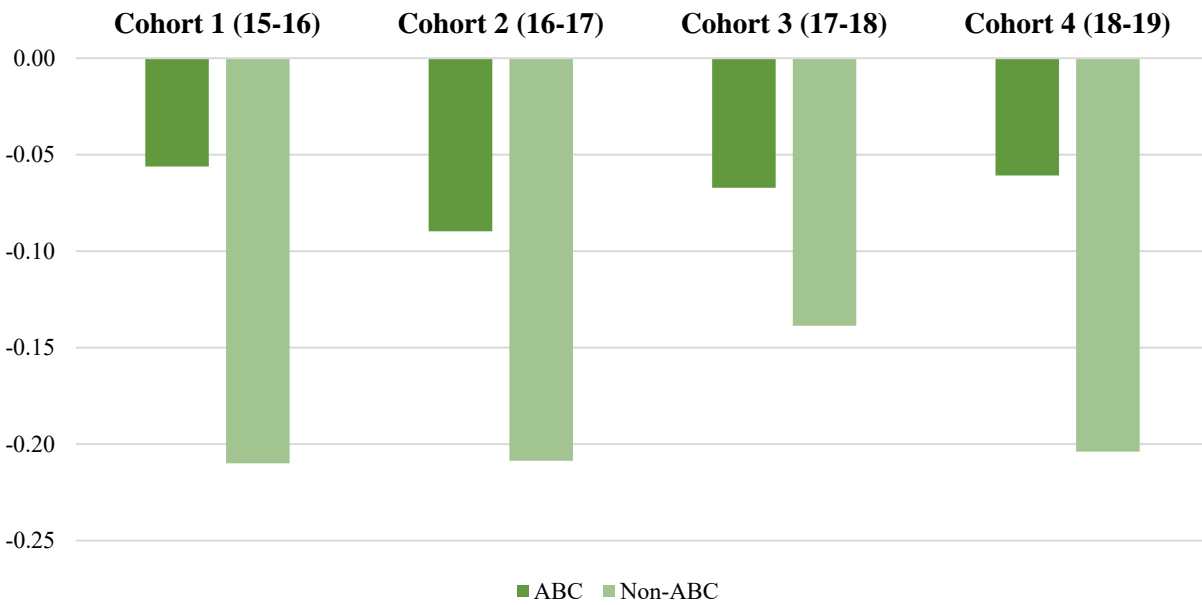
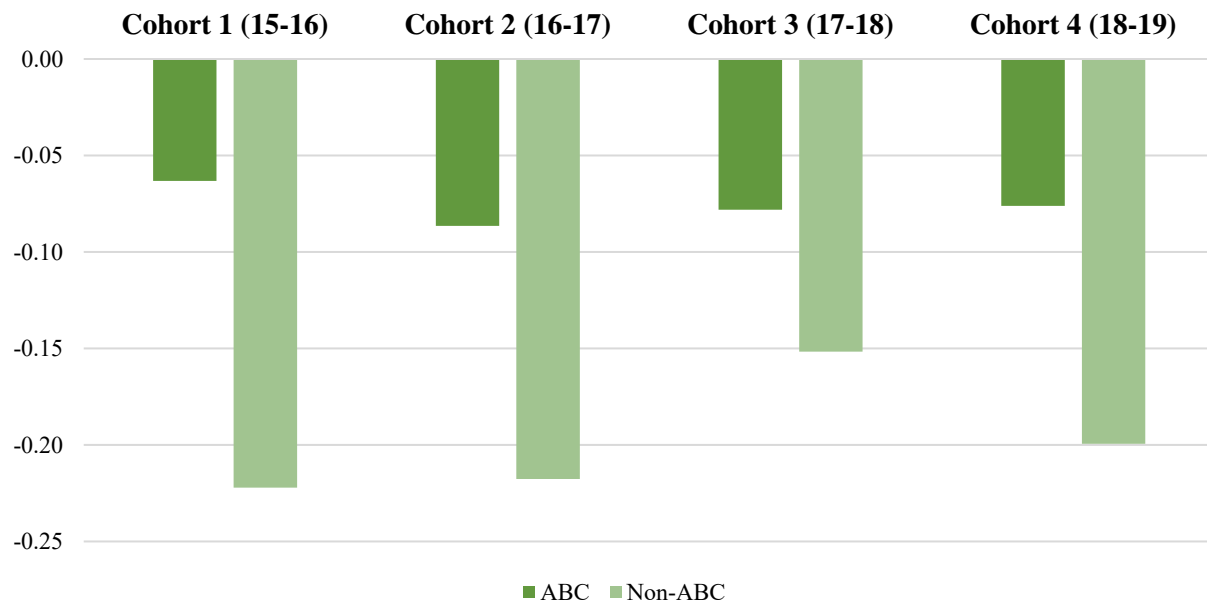


Figure 6: Average 3rd Grade Reading Z-scores for FRL-Eligible Students, by Cohort (3rd grade year)



While it is discouraging that the FRL-eligible students who attended ABC are still scoring below the state average, it seems that program participants are scoring much higher relative to similar peers who did not attend ABC pre-K before starting Kindergarten. All of these figures present purely descriptive information about the average achievement of ABC and non-ABC students in 3rd grade. To better determine the unique contribution of pre-K to these outcome differences, we run several linear regressions. The regression models allow us to produce more rigorous estimates of the relationship between the ABC program and student outcomes.

V. EMPIRICAL APPROACH

To examine the relationship between ABC pre-K attendance and achievement outcomes, we run several Ordinary Least Squares (OLS) regressions. Students' individual 3rd and 5th grade test scores are converted into standardized z-scores, representing their achievement relative to the

statewide mean for the grade level, subject, and year. We first regress these z-scores onto an indicator for ABC pre-K enrollment. This model is represented by equation (1):

$$TestScore_i = \beta_0 + \beta_1 PreK_i + \varepsilon_i \quad (1)$$

Here, $TestScore_i$ is each individual's standardized test score, β_0 is a constant, and $PreK_i$ is an indicator variable that takes value 1 if a student attended ABC. The β_1 coefficient will determine the relationship between attending an ABC pre-K program and test scores. The weakness of a simple regression is that it does not account for individual student differences that could be contributing to outcomes. We previously demonstrated the differences in demographic characteristics between students who do or do not attend ABC pre-K. To control for these differences, we run a series of multivariate regressions which include indicators for student gender, race, and designations of FRL participation, ELL status, or SPED status. Equation (2) represents this model:

$$TestScore_i = \beta_0 + \beta_1 PreK_i + \beta_2 X_i + \varepsilon_i \quad (2)$$

Here, $TestScore_i$ is again each individual's standardized test score, β_0 is a constant, $PreK_i$ is an indicator variable for ABC participation, and X_i is a matrix of individual student characteristics, including gender, race, Special Education status, ELL status, and FRL eligibility.

This model examines differences in outcomes between demographically similar students who did or did not attend ABC pre-K. This will allow us to better determine the unique contribution of the ABC program to subsequent outcomes. However, we acknowledge that there are likely still unobservable differences between families who enroll their children in ABC and those that do not. Parents of ABC participants might value education more or have more community and social connections that allow them to find available programs, find and complete applications, and enroll their children in this program. Such characteristics that influence

selection into the program could also influence later academic outcomes. To claim causality, we would need a mechanism to randomly assign students to the program or a way to determine a balance of unobservable characteristics across groups. Thus, we do not claim that this analysis represents a causal impact of ABC pre-K on outcomes.

VI. FINDINGS

Academic Outcomes of ABC Participants

To answer our primary research questions, we begin by presenting the results of the simple regression analyses on 3rd and 5th grade math and reading test scores by cohort. Tables 3 and 4 contain coefficients representing the relationships between ABC pre-K attendance and 3rd grade achievement outcomes:

Table 3: Simple Regression Analysis for 3rd Grade Mathematics, by Cohort

Variables	Cohort 1	Cohort 2	Cohort 3	Cohort 4
ABC Pre-K	0.0256** (0.0125)	-0.0261** (0.0126)	-0.0193 (0.0130)	-0.0002 (0.0125)
Constant	0.028*** (0.0066)	0.045*** (0.0066)	0.028*** (0.0071)	0.037*** (0.0068)
Observations	31,623	31,324	30,836	29,936
R-squared	0.000	0.000	0.000	0.000

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Table 4: Simple Regression Analysis for 3rd Grade Reading, by Cohort

Variables	Cohort 1	Cohort 2	Cohort 3	Cohort 4
ABC Pre-K	0.0167 (0.0125)	-0.0229* (0.0126)	-0.0380*** (0.0129)	-0.0260** (0.0126)
Constant	0.028*** (0.0066)	0.042*** (0.0066)	0.037*** (0.0070)	0.045*** (0.0068)
Observations	31,594	31,315	30,823	29,921
R-squared	0.000	0.000	0.000	0.000

Standard errors in parentheses
 *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

These coefficients represent the raw achievement differences between the group of students who attended ABC and the group that did not. Asterisks indicate a statistically significant difference between the two groups' scores. Total number of observations are slightly lower than reported sample sizes because a small proportion of students take alternative assessments and are not included in analysis. As evidenced in these tables, attending ABC in Cohort 1, compared to any other early childhood education option, was associated with a 0.0256 standard deviation increase in 3rd grade math achievement ($p < 0.05$) and no difference in achievement for 3rd grade reading. In Cohort 2, ABC attendance was associated with a 0.0261 standard deviation decrease in math achievement ($p < 0.05$) and no statistically significant difference in reading achievement. For Cohort 3, attending ABC was associated with a 0.0380 standard deviation decrease in 3rd grade reading achievement ($p < 0.01$) and no difference in 3rd grade math. In the most recent cohort, ABC attendance is not associated with any difference in 3rd grade math achievement, but it is associated with a 0.0260 standard deviation decrease in 3rd grade reading achievement ($p < 0.05$).

While this appears to be a discouraging pattern, it is more likely capturing program selection effects. As previously determined, students in ABC pre-K are more likely to be low-income and have other academic risk factors, so comparing scores between the two groups is likely to reflect the fact that ABC students tend to belong to vulnerable demographic groups.

We also examine patterns in 5th grade outcomes in an attempt to determine the program’s lasting impact. Detecting achievement gains in 5th grade, which is six years post-intervention, would signal that the program has the potential to set students up for lasting academic success. We only have 5th grade data for cohorts 1 and 2, as the two most recent cohorts of students have not yet completed 5th grade. In Table 5, we present simple relationships between ABC attendance and 5th grade academic outcomes:

Table 5: Simple Regression Analysis for 5th Grade Mathematics and Reading by Cohort

Variables	Math		Reading	
	Cohort 1	Cohort 2	Cohort 1	Cohort 2
ABC Pre-K	-0.0324*** (0.0101)	-0.0548*** (0.0128)	-0.0158 (0.0104)	-0.0172 (0.0127)
Constant	0.035*** (0.0054)	0.050*** (0.0067)	0.037*** (0.0055)	0.049*** (0.0067)
Observations	30,497	30,460	30,480	30,462
R-squared	0.000	0.001	0.000	0.000

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Based on the simple regression analysis in Table 5, we can see that program participation was associated with decreased math achievement but that there were no differences between the two groups on reading achievement in either cohort. In Cohort 1, ABC attendance, compared to

any alternative, was associated with a 0.0324 standard deviation decrease in 5th grade math achievement. For Cohort 2, ABC attendance was associated with a 0.0548 standard deviation decrease in 5th grade math achievement. Both of these estimates were statistically significant with 99% confidence. Again, these patterns are likely to reflect differences between student groups that are largely unrelated to the impact of ABC.

In order to go beyond simple group comparisons and mitigate selection bias, we also run multivariate regressions. The models that produced the following results included controls for student-level characteristics, including race, gender, and FRL, SPED, and ELL designations. Thus, we obtain more accurate estimates of the ABC program’s unique contribution to outcomes. Table 6 outlines the results of the multivariate analysis for 3rd grade math outcomes. Complete regression tables with all demographic coefficients are included in the appendix.

Table 6: Multivariate Regression Analysis for 3rd Grade Mathematics Scores by Cohort

Variables	Cohort 1	Cohort 2	Cohort 3	Cohort 4
ABC Pre-K	0.0832*** (0.0112)	0.0388*** (0.0111)	0.0156 (0.0124)	0.0532*** (0.0109)
Demographic Controls	X	X	X	X
Constant	0.485*** (0.0103)	0.527*** (0.0102)	0.379*** (0.0116)	0.554*** (0.0103)
Observations	31,623	31,324	30,836	29,936
R-squared	0.205	0.231	0.111	0.255

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

After controlling for student-level demographics, ABC pre-K attendance is associated with a 0.0832 standard deviation increase in 3rd grade math achievement for Cohort 1, a 0.0388 standard deviation increase for Cohort 2, no statistically significant difference for Cohort 3, and a

0.0532 standard deviation increase for Cohort 4. All three of the reported estimates are statistically significant at the 99% confidence level. Results for the analysis of 3rd grade reading scores are presented in Table 7:

Table 7: Multivariate Regression Analysis for 3rd Grade Reading Scores by Cohort

Variables	Cohort 1	Cohort 2	Cohort 3	Cohort 4
ABC Pre-K	0.0684*** (0.0111)	0.0401*** (0.0110)	-0.0071 (0.0121)	0.0223** (0.0110)
Demographic Controls	X	X	X	X
Constant	0.410*** (0.0102)	0.426*** (0.0101)	0.336*** (0.0113)	0.440*** (0.0104)
Observations	31,594	31,315	30,823	29,921
R-squared	0.233	0.256	0.141	0.256

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Holding all else constant, ABC pre-K attendance is associated with a 0.0684 standard deviation increase in 3rd grade reading achievement for Cohort 1, a 0.0401 standard deviation increase in Cohort 2, no statistically significant difference in Cohort 3, and a 0.0223 standard deviation increase in Cohort 4. Estimates for cohorts 1 and 2 are statistically significant at the 99% confidence level, and the estimate for cohort 4 is significant at the 95% confidence level. These results are more encouraging than those of the simple regression analysis. They represent more accurate relationships and are also larger in magnitude than the initial results.

To examine longer term outcomes, we conduct multivariate regressions of 5th grade math and reading achievement, and the results of these regression analyses are shown in Table 8:

Table 8: Multivariate Regression Analysis for 5th Grade Mathematics and Reading by Cohort

Variables	Math		Reading	
	Cohort 1	Cohort 2	Cohort 1	Cohort 2
ABC Pre-K	0.0121 (0.0091)	0.0070 (0.0114)	0.0098 (0.0087)	0.0205* (0.0105)
Demographic Controls	X	X	X	X
Constant	0.395*** (0.0080)	0.543*** (0.0104)	0.354*** (0.0079)	0.442*** (0.0096)
Observations	30,497	30,460	30,480	30,462
R-squared	0.199	0.230	0.318	0.331

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

For the two cohorts with available data, it appears that program benefits largely fadeout by 5th grade. Holding all else constant, ABC pre-K participation among students in Cohort 1 was associated with a statistically insignificant 0.0121 standard deviation increase in 5th grade math achievement and a 0.0098 standard deviation increase in 5th grade reading achievement. Because these estimates are not statistically significant, we cannot distinguish them from zero. In Cohort 2, ABC participation was associated with no meaningful difference in 5th grade math achievement but a marginally significant 0.0205 standard deviation increase in 5th grade reading achievement ($p < 0.1$).

VII. CONCLUSIONS AND IMPLICATIONS

We recognize that this analysis is limited in several ways. Families voluntarily select into ABC programs, and as a result, there are likely be differences between families who do or do not choose to enroll their children in these programs that are immeasurable and contribute to subsequent academic outcomes. Thus, we cannot claim that these results are the causal effect of program participation. However, our regression models do control for student-level demographic

characteristics, making the findings more rigorous than a simple correlational analysis. We also do not know if students in the non-ABC group attended private pre-K, received home care, or participated in some other pre-K program outside of the public school system. This limits our ability to determine exactly which alternatives ABC outperforms or underperforms. Conducting these analyses of ABC participants to only students who had no pre-K experience, such as in the Arkansas Research Center (2020) report, could yield more significant results.

Despite these challenges, findings from this analysis suggest that Arkansas Better Chance (ABC) pre-K programs in Arkansas are contributing to academic achievement for participating students. We followed four cohorts of students who attended ABC pre-K in the academic years of 2011-12 through 2014-15 and found positive, statistically significant relationships between pre-K attendance and 3rd grade math and reading achievement in three of four cohorts. We found mostly null effects on 5th grade achievement, which is disappointing, but the consistently positive results identified in 3rd grade, which is 4 years post-intervention, are much longer lasting than results that researchers have identified in other pre-K contexts (Hill et al., 2015; Lipsey et al., 2018).

Positive results associated with this program are especially promising because students who attend ABC are more likely to be low-income and have other risk factors for poor academic performance. Programs and interventions that serve these vulnerable students should be of particular interest to policymakers and advocates. These findings suggest that high-quality pre-K education is a critical tool for ensuring all students have the opportunity to succeed. While ABC participants score demonstrably higher than similar peers on standardized tests, there are likely even more program benefits for these students. Prior pre-K research demonstrates that these programs can lead to positive social and behavioral outcomes in addition to academic and

cognitive benefits (Gorey, 2001). Getting an additional year or two to learn classroom rules and procedures, socialize with peers, and adapt to the school routine should equip students with behavioral and social skills that will help them succeed in Kindergarten and beyond. In future research, it would be helpful to analyze trends in discipline, retention, and attendance to see if the ABC pre-K experience also contributes to lasting effects on these outcomes for Arkansas students.

Enrollment in ABC programs has been slowly increasing over the last decade, and within our analysis, approximately 25% of each Kindergarten class attended ABC pre-K. Findings from the current analysis suggest that the state should consider expanding enrollment. ABC participants are outperforming peers who are attending a variety of alternatives around the state on 3rd grade achievement tests. Particularly for low-income and disadvantaged students, increased enrollment opportunities for this high-quality, state-funded program could mean an opportunity for lasting academic success.

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APPENDIX

Table 9: Descriptive Statistics for Kindergarten Sample, Cohort 1

	ABC Pre-K Participants	Not ABC Pre-K Participants	P-Value
Total N: 40,402			
Total Kindergarten Students	10,629	29,773	
% of Kindergarten Students	26.3	73.7	
% Female	49.7	47.6	0.00***
% White	55.7	63.8	0.00***
% Black	26.4	18.9	0.00***
% Hispanic	14.2	11.7	0.00***
% Other Race	3.7	5.6	0.00***
% Free/Reduced Lunch Eligible	76.8	63.3	0.00***
% Special Education			
% English Language Learner	10.8	8.1	0.00***

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Descriptive Statistics for Kindergarten Sample, Cohort 2

	ABC Pre-K Participants	Not ABC Pre-K Participants	P-Value
Total N: 39,822			
Total Kindergarten Students	10,260	29,562	
% of Kindergarten Students	25.8	74.2	
% Female	49.2	47.9	0.02**
% White	53.7	63.2	0.00***
% Black	27.4	19.3	0.00***
% Hispanic	14.9	11.7	0.00***
% Other Race	4.0	5.7	0.00***
% Free/Reduced Lunch Eligible	72.9	63.4	0.00***
% Special Education	N/A	N/A	
% English Language Learner	10.5	8.2	0.00***

*** p<0.01, ** p<0.05, * p<0.1

Table 11: Descriptive Statistics for Full Analytic Sample, Cohort 2

	Kindergarten		3 rd Grade		5 th Grade	
	ABC	Not ABC	ABC	Not ABC	ABC	Not ABC
Total Students	10,260	29,562	8,571	22,756	8,352	22,121
% of Students	25.8	74.2	27.4	72.6	27.4	72.6
% Female	49.2	47.9	50.2	49.3	50.5	49.2
% White	53.7	63.2	52.7	63.4	52.7	63.3
% Black	27.4	19.3	27.6	18.6	27.6	18.6
% Hispanic	14.9	11.7	15.7	12.3	15.8	12.3
% Other Race	4.0	5.7	4.0	5.7	4.0	5.8
% FRL Eligible	72.9	63.4	73.2	61.7	71	61.7
% Special Education	-	-	8.8	12.0	9.1	13
% English Language Learner	10.5	8.2	10.0	8.0	14.3	2.6

Table 12: Descriptive Statistics for Kindergarten Sample, Cohort 3

	ABC Pre-K Participants	Not ABC Pre-K Participants	P-Value
Total N: 38,431			
Total Kindergarten Students	10,673	27,758	
% of Kindergarten Students	27.8	72.2	
% Female	50.5	46.9	0.00***
% White	53.6	63.3	0.00***
% Black	27.2	19.0	0.00***
% Hispanic	15.5	12.2	0.00***
% Other Race	3.6	5.5	0.00***
% Free/Reduced Lunch Eligible	77.2	65.9	0.00***
% Special Education	N/A	N/A	
% English Language Learner	10.7	8.2	0.00***

*** p<0.01, ** p<0.05, * p<0.1

Table 13: Descriptive Statistics for Full Analytic Sample, Cohort 3

	Kindergarten		3 rd Grade	
	ABC	Not ABC	ABC	Not ABC
Total Students	10,673	27,758	9,117	21,728
% of Students	27.8	72.2	29.6	70.4
% Female	50.5	46.9	51.3	47.9
% White	53.6	63.3	52.3	63.9
% Black	27.2	19.0	27.3	17.9
% Hispanic	15.5	12.2	16.6	12.6
% Other Race	3.6	5.5	3.7	5.5
% Free/Reduced Lunch Eligible	77.2	65.9	71.5	61.3
% Special Education	N/A	N/A	10.0	13.8
% English Language Learner	10.7	8.2	10.6	8.3

Table 14: Descriptive Statistics for Kindergarten Sample, Cohort 4

	ABC Pre-K Participants	Not ABC Pre-K Participants	P-Value
Total N: 37,457			
Total Kindergarten Students	10,448	27,009	
% of Kindergarten Students	27.9	72.1	
% Female	49.7	47.6	0.00***
% White	54.6	62.4	0.00***
% Black	25.9	19.0	0.00***
% Hispanic	15.3	12.2	0.00***
% Other Race	4.2	6.4	0.00***
% Free/Reduced Lunch Eligible	78.5	65.2	0.00***
% Special Education	N/A	N/A	
% English Language Learner	9.9	7.9	0.00**

*** p<0.01, ** p<0.05, * p<0.1

Table 15: Descriptive Statistics for Full Analytic Sample, Cohort 4

	Kindergarten		3 rd Grade	
	ABC	Not ABC	ABC	Not ABC
Total Students	10,448	27,009	8,837	21,103
% of Students	27.9	72.1	29.5	70.5
% Female	49.7	47.6	50.6	48.6
% White	54.6	62.4	53.9	63.2
% Black	25.9	19	25.7	18.1
% Hispanic	15.3	12.2	16.2	12.5
% Other Race	4.2	6.4	4.2	6.2
% Free/Reduced Lunch Eligible	78.5	65.2	73.9	61.9
% Special Education	-	-	10.6	14.3
% English Language Learner	9.9	7.9	9.8	7.9

Table 16: Multivariate Regression Analysis for 3rd Grade Math Scores by Cohort

Variables	Cohort 1	Cohort 2	Cohort 3	Cohort 4
ABC Pre-K	0.0832*** (0.0112)	0.0388*** (0.0111)	0.0156 (0.0124)	0.0532*** (0.0109)
SPED	-0.980*** (0.0161)	-1.031*** (0.0158)	-0.764*** (0.0170)	-1.061*** (0.0147)
LEP	-0.220*** (0.0247)	-0.396*** (0.0239)	-0.326*** (0.0269)	-0.504*** (0.0234)
FRL	-0.389*** (0.0113)	-0.421*** (0.0110)	-0.254*** (0.0124)	-0.361*** (0.0111)
Black	-0.503*** (0.0134)	-0.489*** (0.0130)	-0.346*** (0.0148)	-0.522*** (0.0132)
Hispanic	0.011 (0.0213)	0.098*** (0.0202)	0.055** (0.0228)	0.034* (0.0195)
Other	0.057** (0.0238)	0.055** (0.0229)	0.001 (0.0265)	0.022 (0.0221)
Female	0.013 (0.0100)	0.016* (0.0099)	-0.015 (0.0113)	-0.028*** (0.0099)
Constant	0.485*** (0.0103)	0.527*** (0.0102)	0.379*** (0.0116)	0.554*** (0.0103)
Observations	31,623	31,324	30,836	29,936
R-squared	0.205	0.231	0.111	0.255

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Table 17: Multivariate Regression Analysis for 3rd Grade Reading Scores by Cohort

Variables	Cohort 1	Cohort 2	Cohort 3	Cohort 4
ABC Pre-K	0.0684*** (0.0111)	0.0401*** (0.0110)	-0.0071 (0.0121)	0.0223** (0.0110)
SPED	-1.042*** (0.0159)	-1.053*** (0.0156)	-0.819*** (0.0166)	-1.014*** (0.0148)
LEP	-0.373*** (0.0244)	-0.421*** (0.0237)	-0.388*** (0.0262)	-0.531*** (0.0236)
FRL	-0.408*** (0.0111)	-0.431*** (0.0109)	-0.297*** (0.0121)	-0.387*** (0.0111)
Black	-0.455*** (0.0132)	-0.470*** (0.0129)	-0.333*** (0.0145)	-0.464*** (0.0133)
Hispanic	0.063*** (0.0210)	0.091*** (0.0200)	0.090*** (0.0222)	0.100*** (0.0196)
Other	0.077*** (0.0234)	0.086*** (0.0226)	0.042 (0.0258)	0.062*** (0.0222)
Female	0.196*** (0.0099)	0.229*** (0.0098)	0.157*** (0.0110)	0.203*** (0.0010)
Constant	0.410*** (0.0102)	0.426*** (0.0101)	0.336*** (0.0113)	0.440*** (0.0104)
Observations	31,594	31,315	30,823	29,921
R-squared	0.233	0.256	0.141	0.256

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Table 18: Multivariate Regression Analysis for 5th Grade Math and Reading Scores by Cohort

Variables	Math		Reading	
	Cohort 1	Cohort 2	Cohort 1	Cohort 2
ABC Pre-K	0.0121 (0.0091)	0.0070 (0.0114)	0.0099 (0.0087)	0.0205* (0.0105)
SPED	-0.662*** (0.0129)	-0.888*** (0.0157)	-1.013*** (0.0122)	-1.231*** (0.0145)
LEP	-0.240*** (0.0202)	-0.534*** (0.0259)	-0.465*** (0.0192)	-0.661*** (0.0239)
FRL	-0.299*** (0.0090)	-0.409*** (0.0112)	-0.293*** (0.0085)	-0.385*** (0.0103)
Black	-0.469*** (0.0108)	-0.569*** (0.0133)	-0.462*** (0.0103)	-0.503*** (0.0123)
Hispanic	0.061*** (0.0161)	0.087*** (0.0184)	0.090*** (0.0152)	0.112*** (0.0170)
Other	0.059*** (0.0193)	0.076*** (0.0230)	0.030* (0.0183)	0.052** (0.0212)
Female	-0.007 (0.0082)	-0.013 (0.0101)	0.192*** (0.0078)	0.236*** (0.0093)
Constant	0.395*** (0.0084)	0.543*** (0.0104)	0.354*** (0.0079)	0.442*** (0.0096)
Observations	30,497	30,460	30,480	30,462
R-squared	0.199	0.230	0.318	0.331

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1