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POLICY BRIEF

The Impact of a High-Quality Pre-Kindergarten Program on Educational Achievement in Third and Fourth Grades: Evidence from Pre-K 4 SA in San Antonio

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June 2022

Executive Summary

This study examined the effect of attending Pre-K 4 SA on students' educational achievement in third and fourth grades. Pre-K 4 SA is a high-quality pre-kindergarten (pre-K) program in San Antonio that meets all quality standards defined by the National Institute for Early Education Research (NIEER).

We employed an instrumental variable (IV) approach to address selection arising from omitted parents' school preference and child ability that might be strongly correlated with pre-K program choice and educational outcomes in third and fourth grades.

The results showed that distance to Pre-K 4 SA centers was negatively associated with child enrollment in Pre-K 4 SA over the assigned neighborhood pre-K program. This result indicated that parents who lived farther away from the centers might face higher opportunity costs, information costs, and transportation costs, making the Pre-K4SA option less appealing over other local options. We also found that students by attending Pre-K 4 SA increased 0.3 (first cohort) and 0.6 (second cohort) standard deviations of STAAR reading test scores for the first and second cohorts, respectively, and 0.5 standard deviations of math test scores in third grade for both cohorts. Additionally, Pre-K 4 SA students were predicted to have larger impacts on their reading and math test scores in fourth grade than those in third grade, showing that the impacts on test scores were sustained and even growing for an additional year. On the other hand, we found none or some negative impacts on student behavioral outcomes. However, their statistical inference was weak, and the effects were not consistently observed across the grades.

What We Studied

In 2019, one in seven American children–nearly 10 million–lived in families with an annual income that fell below the federal poverty threshold (Semega et al., 2020). Hundreds of studies have documented the negative relationship between family poverty and children's developmental and educational outcomes, and the extent was shown to vary by the level and duration of exposure to poverty (e.g., Brooks-Gunn & Duncan, 1997; Currie, 2009; Patterson et al., 1990).

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Early childhood education (ECE) has served as an effective means of alleviating the negative consequences of childhood poverty (Barnett, 1998; Campbell et al., 2002). Most ECE programs are designed for four-year-old children from low-income families and children with some risk factors, including–but not limited to–limited English proficiency (LEP), English as a secondary language (ESL), and residential and family instability, which may keep them from being successful when they start formal schooling.

Heckman et al. (2010) showed that Perry Preschool, widely cited as a high-quality preschool, generated an estimated return of between $7 and $12 to the society for each $1 invested. Barnett et al. (2018) examined the effects of eight state-funded preschool programs and showed that graduating children had higher test scores in language, math, and literacy by averaged effect sizes of 0.24, 0.44, and 1.10 standard deviations than those who were just entering pre-K, respectively. McCoy et al. (2017) found that ECE participation reduced the probability of special education placement and grade retention by an averaged effect size of 0.33 standard deviations (or 8.1 percentage points) and 0.26 standard deviations (or 8.3 percentage points) than children in control groups. Moreover, dual language learners and children from low-income families, relative to those who were not attending pre-K, were found to have larger improvements in academic skills and self-regulation (Ansari et al., 2021).

However, there is also growing evidence that initial gains children made as a result of participation in pre-K might diminish or disappear after school ends (see, e.g., Bailey et al. 2017; Durlak et al., 2011). Moreover, studies claimed that the ability of pre-K to yield sizable and long-lasting impacts on children's developmental and educational outcomes rests heavily on the quality of the programs (Magnuson et al., 2007; Weiland et al., 2013; Valentino, 2018).

Unfortunately, most of America's young children are not attending high-quality preschools (Friedman-Krauss et al., 2020). The NIEER suggests ten quality standards as the minimum requirements for effective preschool education. Only 8 percent of children enrolled in state-funded preschools that met nine or ten quality standards, while four in ten children attended preschools that met less than five quality standards (Friedman-Krauss et al., 2020). Texas met three standards (*i.e.*, teacher degree, teacher's specialized training, and screening and referral), and only three states–Florida, North Dakoda, and Alaska–met less than three standards (Friedman-Krauss et al., 2020).

More relevant to the current study's region, the total number of children enrolled in public pre-K programs in Bexar County has increased substantially over the last two decades (Villarreal & Lee, 2021). Until the 2011/12 school year, San Antonio independent school district (SAISD) was the only school district that offered high-quality pre-K, reaching eight out of ten NIEER quality standards. These facts raised concerns about the lack or limited opportunity to access high-quality preschools in Bexar County, and civic and business leaders of San Antonio launched a campaign to expand access to high-quality pre-K in San Antonio. Voters twice ratified a program of four high-quality pre-K lab schools–named Pre-K 4 SA–in each quadrant of the city, professional development open to public schools, and a grant program to support quality improvements in pre-K provided by public schools (Villarreal & Lee, 2021). The lab schools of Pre-K4SA meet all ten NIEER quality standards.

This study questioned whether Pre-K 4 SA improved students' academic and behavioral outcomes in third and fourth grades. For the purpose of this study, we defined two sets of outcomes: academic outcomes include the state-mandated reading and math tests, and behavioral outcomes include attendance, receipt of special education, and involvement in disciplinary action throughout students' third and fourth grades.

How We Analyzed the Data

Study Population

This study used Texas's statewide longitudinal data system (SLDS) operated by the University of Texas Educational Research Center (ERC). The SLDS system has maintained longitudinal datasets, containing a broad range of student and school characteristics for public pre-K to 12th-grade students. We also used administrative data, provided by Pre-K 4 SA, which identified Pre-K 4 SA locations where students attended. We then combined these two datasets to follow students' academic and behavioral outcomes through their fourth-grade year.

The study sample included all children who attended public pre-K programs in 2012/13 (first cohort) and 2013/14 (second cohort) in Bexar County. Children who attended Pre-K 4 SA were defined as the treatment group and children who attended public pre-K programs in Bexar County other than Pre-K4SA were defined as the control group. The total sample size of the treatment group amounted to 1,213 (308 children for the first cohort and 905 children for the second cohort). The total sample size of the control group amounted to 17,908 students (9,468 children for the first cohort and 8,440 children for the second cohort). Students who attended charter schools were excluded from the analysis due to the lack of their residential information.

Key Variables Used in this Study

This study defined five outcomes: *i*) STAAR reading test scores in third and fourth grades, *ii*) STAAR math test scores in third and fourth grades, *iii*) average annual attendance from first to third grade and first to fourth grade, *iv*) receipt of special education from first to third grade and first to fourth grade, and *v*) involvement in disciplinary action from first to third grade and first to fourth grade as indicated by receipt of school disciplinary reports. The test scores are expressed in both raw scores and z-scores to understand better the magnitude of Pre-K 4 SA's impacts on students' reading and math test performance.

The primary interest of the variable was enrollment in Pre-K 4 SA. It was defined as a binary variable that equaled 1 if a student attended Pre-K 4 SA and 0 if a student attended another public prekindergarten program. The study's research design controlled for characteristics of children that existed prior to or at initial enrollment into pre-K. These controls included gender, race and ethnic group, homelessness, and eligibility for the federal free-or-reduced-price lunch program. They also included indicators of LEP, and receipt of special education services in pre-K.

Empirical Strategy

We first construct the following linear model of academic achievement y_i of student *i* who attended public pre-K schools in Bexar County:

$$(1)\ \ y_i = \beta_0 + \beta_1 s_i + \beta_2' x_{1i} + \varepsilon_i,$$

where $\boldsymbol{x_{1i}}$ represents a vector of observable characteristics of student *i* while in pre-K that would affect his/her academic achievement in third and fourth grades, s_i is the binary indicator of attending Pre-K 4 SA, and ε_i is an error term. The parameter of interest is β_1. However, the estimation of equation (1) is problematic when the endogeneity problem arises. More specifically, endogeneity can cause the estimate of interest (β_1) to be biased when unobserved characteristics were correlated with children's enrollment in Pre-K4SA over the assigned neighborhood pre-K program and their future academic performance in the third- and fourth-grade years.

Previous studies found that parents valued a multitude of characteristics when choosing pre-K for their children (Grogan, 2012). Parents often consider a range of educational aspects of care such as the quality of teachers (*i.e.*, educational degree and teaching experience), teacher-child ratio, peer interactions, and school readiness curriculum (see, e.g., Fuller et al., 1996; Kim & Fram, 2009). Highly educated parents tend to place more importance on educational aspects and choose programs that provide additional services or prioritize the development of these areas (Early & Burchinal, 2001; Johansen et al., 1996). Studies also demonstrated that convenience factors such as program hours (half-day/full-day), location, and transportation costs are essential factors affecting pre-K selection (see, e.g., Barbarin et al., 2006; Johansen et al., 1996; Li-Grining & Coley, 2006).

If factors describing parents' school preference and children's academic ability were not controlled in the model, the effects of Pre-K 4 SA would be biased by the extent that such omitted factors were positively or negatively correlated with pre-K selection and study outcomes. To address the endogeneity problem, we utilized the endogenous treatment effect (ETE) model for a continuous outcome variable and the recursive bivariate probit (RBP) model for a binary outcome variable. See details on the methodology in the full report.

Identification

Distance has long been used as an instrument for school choice in educational research. For example, Cullen et al. (2005) examined whether high school students who opted out of their assigned neighborhood school outperformed students who enrolled in their assigned schools in Chicago Public School System (CPS). The authors argued that there existed substantial differences between students who opted out and those who did not, and such differences were strongly associated with both the likelihood of graduation and decisions to opt out. In other words, there was self-selection in students' school choices. Cullen et al. (2005) utilized distance to nearby schools as an instrument to address this selection problem. They claimed that distance from a student's residence to different schooling options (*i.e.*, career academy, high-achieving school, and regular school) was a strong predictor of which school the student attended but was uncorrelated with student outcomes. Further studies that instrumented for endogenous school selection with distance between student home and school can be found in Dobbie and Fryer (2011) and Schwartz et al. (2013).

Following previous literature, we used distance to Pre-K 4 SA centers as the instrument for choosing Pre-K 4 SA over the assigned neighborhood pre-K program. The distance variable was designed to capture multiple costs parents had to bear, reflecting searching costs for eligible pre-K options in Bexar County that met parents' and children's needs, transportation costs, and opportunity costs of time spent on commuting to the educational center. Such costs were assumed to increase with distance; hence, parents' probability of choosing Pre-K4SA would decrease as the relative distance to Pre-K 4 SA centers increased. The distance to Pre-K4SA was a gravitational measure of access that placed less weight on relatively distant locations using a distance decay function, defined as:

$$(2)\ z_{jl} = \sum_{l=1}^{l=4} e^{(-\pi d_{jl})},$$

where d_{jl} is the distance (in kilometers) between the centroid of school district *j* where a student lived and four Pre-K 4 SA locations, *l*, and π is the distance-decay parameter (Raphael, 1998).

What We Discovered

Table 1 presents the results for factors affecting student enrollment in Pre-K4SA. The coefficient on distance to Pre-K 4 SA centers was statistically significant and negative, indicating that the farther a student lived from Pre-k 4 SA centers, the less likely the student to attend Pre-K 4 SA over the assigned neighborhood school. We also found that Pre-K4SA tended to serve a higher proportion of Hispanic students whereas a lower proportion of students with free- or reduced-price lunch, LEP student, and special education students than those of the assigned neighborhood schools.

Table 2 presents the effect of Pre-K 4 SA on students' standardized reading and math test scores in their third grade. The coefficients and standard errors were obtained from the ETE regression model. The estimates indicated that the first cohort of Pre-K4SA students achieved higher STAAR reading test scores by 2.3 points relative to students who attended the assigned neighborhood schools. That is, students by attending Pre-K 4 SA increased 0.3 standard deviations in reading test scores compared to students in the control group. We also found a larger program effect for the second cohort of students, which increased the standardized reading test scores by 4.5 points or 0.6 standard deviations in the test scores. The results might be explained by the fact that Pre-K4SA improved the school's ability to enhance children's future academic performance based on lessons learned from the first cohort of students through creating, but not limited to, a better learning environment, teaching strategy, teacher-student relationship, and management. Additionally, both cohorts of Pre-K4SA students achieved higher math test scores by around 3 points relative to the control group students. In other words, students by attending Pre-K4SA increased 0.5 standard deviations in math test scores than students who attended the assigned neighborhood pre-K schools.

Pre-K 4 SA students were predicted to receive higher reading and math test scores, taken in fourth grade, by 5.1 and 5.3 points, respectively, which were equivalent to an increase of 0.7 standard deviations in reading and math test scores relative to students in the control group. The results suggested that Pre-K 4 SA students had larger impacts on their

reading and math test scores in their fourth grade than third grade relative to similar students. These results indicated that the impacts on the test scores were sustained and even growing for an additional year. On the other hand, we found none or some negative effects on student behavioral outcomes. However, their statistical inference was weak, and the effects were not consistently observed across the grades.

Table 1. Determinants of Enrollment in Pre-K4SA Over the Assigned Neighborhood Pre-K School

	1st Cohort				2nd Cohort	
	3rd Grade		4th Grade		3rd Grade	
	Coefficient	M.E.	Coefficient	M.E.	Coefficient	M.E.
Female	-0.084	-0.005	-0.063*	-0.010	-0.064	-0.004
	(0.051)		(0.037)		(0.052)	
African American	0.071	0.005	0.255**	0.042	0.109	0.007
	(0.142)		(0.101)		(0.149)	
Hispanic	0.203**	0.014	0.207***	0.034	0.241**	0.017
	(0.102)		(0.075)		(0.109)	
Asian	0.149	0.010	0.267	0.044	0.453*	0.031
	(0.270)		(0.229)		(0.239)	
Economically Disadvantaged	-0.160**	-0.011	-0.178***	-0.029	-0.164**	-0.011
	(0.064)		(0.049)		(0.067)	
Homeless	-0.153	-0.010	0.124	0.020	-0.265	-0.018
	(0.208)		(0.114)		(0.232)	
LEP	-0.527***	-0.036	-0.570***	-0.094	-0.530***	-0.037
	(0.084)		(0.055)		(0.084)	
ESL	0.522**	0.036	0.148	-0.024	0.106	0.007
	(0.253)		(0.229)		(0.244)	
Special Education	-0.631***	-0.043	-0.485***	-0.080	-0.634***	-0.044
	(0.221)		(0.121)		(0.221)	
Distance to Pre-K4SA Centers	-0.483***	-0.033	-0.433***	-0.071	-0.481***	-0.033
	(0.075)		(0.055)		(0.076)	
Intercept	-1.453***		-0.911***		-1.486***	
	(0.107)		(0.080)		(0.112)	
Log-likelihood	-1309.087		-2848.976		-1279.551	
Pseudo R^2	0.043		0.042		0.044	
Observations	9,776		9,345		9,485	

Note. M.E. denote marginal effect. Robust standard errors are reported in parenthesis.

*p < .10. **p < .05. ***p < .01.

Table 2. Impacts of Pre-K4SA on STARR Reading and Math Test Scores in Third and Fourth Grades

	Reading				Math			
	1st Cohort		2nd Cohort		1st Cohort		2nd Cohort	
	Raw Score	Z-Score	Raw Score	Z-Score	Raw Score	Z-Score	Raw Score	Z-Score
Third Grade								
Pre-K4SA	2.330*	0.336*	4.528***	0.631***	3.411***	0.480***	3.143***	0.470***
	(1.196)	(0.172)	(0.808)	(0.113)	(0.997)	(0.140)	(0.589)	(0.088)
Control Group Mean	20.829	-0.267	20.425	-0.339	19.461	-0.270	19.969	-0.308
Distance to Pre-K4SA Centers	-0.500***		-0.463***		-0.521***		-0.465***	
	(0.076)		(0.054)		(0.077)		(0.055)	
/athrho	-0.148**		-0.323***		-0.212***		-0.253***	
	(0.071)		(0.056)		(0.054)		(0.041)	
Wald χ^2	4.37***		32.91***		15.45***		37.24***	
	[0.037]		[< 0.001]		[< 0.001]		[< 0.001]	
Observations	9,776		9,345		9,776		9,345	
	1st Cohort				1st Cohort			
	Raw Score	Z-Score			Raw Score	Z-Score		
Fourth Grade								
Pre-K4SA	5.146***	0.683***			5.327***	0.714***		
	(1.351)	(0.179)			(1.830)	(0.245)		
Control Group Mean	21.664	-0.280			19.875	-0.281		
Distance to Pre-K4SA Centers	-0.514***				-0.520***			
	(0.076)				(0.076)			
/athrho	-0.314***				-0.327***			
	(0.083)				(0.116)			
Wald χ^2	14.19***				7.96***			
	[< 0.001]				[< 0.001]			
Observations	9,485				9,345			

Note. Robust standard errors are reported in parenthesis. *P*-values are reported in bracket.

*$p < .10$. **$p < .05$. ***$p < .01$.

Discussion/Policy Recommendations

Our study findings showed that Pre-K 4 SA was responsible for producing large gains in their participating students' reading and math abilities. In addition, program effects grew as the program matured. Finally, program effect sizes also grew as students matured from third grade to fourth grade. This last finding is noteworthy as it runs counter to one study that suggested pre-K effects decreased in time.

Pre-K 4 SA appears to not make a meaningful difference on behavior at school. It had no impact on school attendance. Though, it produced mixed results on receipt of school disciplinary reports. Consequently, it may be responsible for some students not complying with school behavior norms, possibly due to Pre-K 4 SA students acquiring a different set of school norms at Pre-K 4 SA. Future analysis should disaggregate Pre-K 4 SA's impact on school disciplinary reports received by type of public school (traditional or charter) and school district to better understand this possible impact.

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