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Universal Preschool Lottery Admissions and Its Effects on Long-Run Earnings and Outcomes

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February 23, 2023

Abstract

We use an admissions lottery to estimate the effect of a universal (non-means tested) preschool program on students' long-run earnings, income, marital status, fertility and geographic mobility. We observe long-run outcomes by linking both admitted and non-admitted individuals to confidential administrative data including tax records. Funding for this preschool program comes from an Indigenous organization, which grants Indigenous students admissions preference and free tuition. We find treated children have between 5 to 6 percent higher earnings as young adults. The results are strongest for individuals from the lower half of the household income distribution in childhood. Likely mechanisms include high-quality teachers and curriculum.

Keywords: Children, Preschool, Returns to Education, Native Americans, Long-Run Outcomes, Income, Employment, Earnings, Wage Level
JEL classification: I20, I21, I24, I26, J24, J31

Disclaimer : Any opinions and conclusions expressed herein are those of the authors and do not represent the views of the U.S. Census Bureau. The Census Bureau has reviewed this data product for unauthorized disclosure of confidential information and has approved the disclosure avoidance practices applied to this release. DRB Approval Numbers: CBDRB-FY2022-CES010-022; CBDRB-FY2023-CES005-008.
Acknowledgments : Thanks to Andrew Penner, Chloe Gibbs, Joshua Goodman, Judy Scott-Clayton, William Ward, Tarajean Yazzie-Mintz, Andres Mira, and Erik Vickstrom for their insights and thoughts on this project. Any errors or omissions are those of the authors alone. This project was supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health (R01HD094007).
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1 Introduction

Understanding the effect of early childhood education on children's short- and long-term outcomes has practical policy implications for the funding of universal preschool programs or other targeted programs. A call for universal and free preschool was included in recent presidential administration goals for all three and four year olds in the U.S.[1] A few studies have shown that these preschool programs far exceed their investment costs (Bartik and Hershbein, 2017; Cascio, 2017; Heckman et al., 2010). More research is needed, however. Assessing the impact of universal preschool programs is often difficult due to the small size of treated cohorts, non-random implementation and take-up, and the lack of detailed data on initial familial conditions (Weiland et al., 2023). Moreover, we lack knowledge of the long-run effect of preschool programs on adult economic outcomes, such as earnings.

Our study overcomes these problems by leveraging an admissions lottery for an oversubscribed preschool program, and by using linked confidential administrative data. We examine long-run outcomes for children enrolled in a high-quality state-wide preschool program over five entry cohorts. The school system is operated by an Indigenous organization and provides dozens of classrooms, teachers and instructors aides throughout the state free of charge for Indigenous students and some non-Indigenous students. Indigenous children from a range of economic backgrounds apply for the program. The demand for these preschool services exceeds the total number of spaces available in every year the program has operated. Thus, the school system instituted a lottery system of admissions for the preschool programs within the districts throughout the state. Our analysis links admitted and non-admitted individuals from the preschool program to their adult tax records. As a result, we are able to directly examine the program's effects on individual earnings, total income, employment, marital status, fertility, and state of residence in young adulthood.

We instrument for attending the preschool program with the lottery offer of admissions in order to causally identify the effect of this preschool program on the long-run employment and earnings outcomes of the treated children. Our results indicate that the preschool program increases average annual earnings by 5 to 6.9 percent (or 4.9 to 6.7 log points) which is similar to the return to education for non-preschool education (Card, 1999). Disaggregating our data by gender indicates that men and women benefit equally from the preschool programs. However, separating the data at the median of initial parental earnings, we find that the long-run results are attributable primarily to increased earnings for children from the bottom half of the household earnings distribution. These results suggest that universal preschool reduces earnings (and income) inequality in adulthood.

We examine other adult outcomes such as state of residence, total number of children and marital status. These variables, included in standard IRS Form 1040 records, provide additional social characteristics outcomes for this population. We find that there are no statistical differences in marital status or fertility at the relatively young ages we assess. However, we do find that the children who were treated by the preschool program are more likely to live within the same state in adulthood. For Indigenous Peoples, the ability to reside in their home territories and homelands as adults has often been difficult due to the lack of employment and/or the relatively high cost of housing in many cases; thus, this finding is unique in the literature and indicates a potentially positive outcome given the accompanying increase in individual earnings and incomes.

[1] See https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/28/fact-sheet-the-american-families-plan/

Many existing studies focus on the effect of an additional year of early childhood education on students' school readiness through socialization and cognitive gains. Some of the strongest research findings come from the Perry Preschool Program and establish the importance of preschool on cognitive and non-cognitive (personality traits) skills for disadvantaged children (Heckman et al., 2013, 2010). Preschool participation in Tennessee and Oklahoma results in increased cognitive skills and school readiness for attending children and these effects persist into middle-school (Gormley Jr et al., 2005, 2018; Lipsey et al., 2018). In Boston, Weiland et al. (2020) show that participation in the city-wide lottery admissions preschool program produces positive results in early years, but effects fade by third grade. Examining several national studies, Cascio (2017) finds, in general, that there is an increase in math and reading scores in states with universal preschool programs. Dodge et al. (2017) finds that the positive effects of a targeted preschool program in North Carolina persists into fifth grade for reading and math scores and reduces special education placement. Campbell et al. (2014) show that the Abecederian program in North Carolina improves long-run health for the children as adults. Cascio and Schanzenbach (2013) finds that students in states with universal preschool programs had persistently higher math scores in eigth grade. Bartik and Hershbein (2017) finds that there are positive effects of preschool programs in regions with a majority African American population. Overall, there is evidence of short term gains that tend to accrue to the most initially disadvantaged population. However, some additional analyses have shown that these gains can fade out in certain programs and populations (Bailey et al., 2020; Currie and Thomas, 2000; Kline and Walters, 2016).

As a result, subsequent researchers have examined longer-term outcomes such as high school graduation, college attendance and behavioral outcomes such as criminality and/or teen childbearing. A study in Montreal, Canada found that preschool programs result in improvement in non-cognitive skills that persist throughout the life-course resulting in more employment, higher earnings, and reduced criminality for the treated boys (Algan et al., 2022). Rossin-Slater and Wüst (2020) examines the long-run effect of Danish preschool programs and find that targeted programs increase children's educational attainment, lifespan and earnings in adulthood. Reexamining the Boston Preschool program, Gray-Lobe et al. (2023) identify that individuals who attend the preschool program are more likely to graduate high school and attend college, and experience a lower probability of incarceration for boys, in particular. Recent research examining the long-run effects of the Perry Preschool program has shown that there is an intergenerational effect on the children of the treated individuals; their children are in better health, more likely to be employed and experience less criminality (García et al., 2021). Generally, these research efforts identify several positive long-run outcomes and suggest that even when fadeout occurs during middle school or high school years, the positive effects of early childhood education may rebound in young adulthood.

A parallel research stream has examined the impact of Head Start programs on child outcomes. Unlike universal preschool programs, these programs target low income populations. Thus, the result of this research answers a slightly different set of policy questions. Nevertheless, the research finds similar positive effects. The rollout of Head Start improved outcomes for children, including educational attainment and economic outcomes; more recent work finds positive spillover effects for the subsequent generation of children as well (Bailey et al., 2021; Barr and Gibbs, 2022; Ludwig and Miller, 2007).

Our first contribution to the literature is that we provide a precisely estimated coefficient for the return to education for this year of early childhood education. Prior research for the U.S. did not have

well measured earnings or income data for treated populations; outcomes have focused on educational achievement, criminality, and postsecondary educational attainment. Additionally, we improve upon measures of socioeconomic status in childhood relative to existing work, which typically relies on proxy measures such as free or reduced price lunch eligibility. We observe tax-reported family income for program applicants during their childhood years.

Our final contribution is the extension of research to an understudied population - Indigenous children in the U.S. While there are broadly similar socioeconomic characteristics among Indigenous Peoples and other minority race and ethnic groups in the U.S., these groups also have a long and distinct political relationship and identity within this country. As a result, it is not immediately clear that the same types of interventions will function similarly in these populations (Faircloth, 2015; Romero-Little, 2010; Yazzie-Mintz, 2011). There are differences in preferences and histories that may create barriers not seen in other populations.

The rest of the paper is organized as follows. Section 2 provides an overview of the preschool program setting. We then, in Section 3, describe the data set and the sample selection. In Section 4 we detail the empirical strategy. In Section 5 we provide the main results and we discuss some likely mechanisms for our observed results in Section 6. We conclude in Section 7.

2 Description of the Universal Preschool Program

The particular setting is fairly unique: the program under study provides free preschool for Indigenous children at age 4 from a particular community that resides throughout the state.[2] However, as in the case of other programs, there is higher demand for places in these preschools than can be accommodated and as a result admissions are determined by a lottery annually. There are approximately a dozen districts that operate these schools and the lottery admission is conducted within each of those districts. The program was quite strict in that households had to show their residency within the local region for the district site that they applied for; proof of residence was required by showing a utility bill with the parents' names and address.

The preschool program began in the mid 1990's and has continued ever since with a new incoming cohort of students each year. As such, the youngest admitted cohorts are now approaching their middle to late 20s and it is possible to examine their adult earnings, employment and marital status outcomes.

The preschool program was open to all Indigenous residents in the community and it was not restricted to low income households or other family characteristics. Non-Indigenous children were eligible to submit their application to the preschool program but preference was given to Indigenous children. In a few cases, the leased spaces for these preschool programs were part of the public school system and non-Indigenous children attended those schools as well. These programs were a year in length. Additionally, the students were often, though not always, taught by Indigenous teachers and helpers in the classroom.

In this state, when the preschool program began there were very few preschool programs available for this Indigenous population. Private preschools existed, but they were often out of reach for many, but not all, in this population due to cost. This preschool program operated along normal school hours

[2]Note that under our data use agreement with this educational institution, we have agreed to keep identifying information confidential.

from 8 am to approximately 2 pm daily; other options existed but were primarily day care options. Thus, this preschool program provided an opportunity for school preparedness that many of these students would otherwise not have had access to.

3 Data Set Description and Sample Selection

3.1 Data Linking and Sample Selection

In order to examine the long-run effect of attending a preschool program for this population of Indigenous children, we link across multiple administrative and survey datasets. The educational institution provided identifying information on individuals who participated in the preschool admissions lottery, with indicators for which individuals were admitted and, subsequently, enrolled. After receiving these data securely, the U.S. Census Bureau ran them through the Person Information Validation System (PVS), which assigns each individual a Protected Information Key (PIK) using the personally identifiable information provided.[3] To conduct the analysis presented here, we use a version of the preschool administrative data that includes PIKs, but no name or social security information. Other datasets we use – including the 2000 decennial census and IRS Form 1040 and W-2 records – similarly undergo PVS and receive PIKs, permitting us to link anonymous individuals across various data sources in the Census Bureau's secure research environment.

Table 1: Table of Matches

	N			
Total Preschool	7,000			
Total Preschool with PIK	4,300			
Total Preschool with PIK and Non-Missing Wages	3,700			
Total Indigenous in State	36,500			
Total Indigenous in State with PIK	29,000			
Total Indigenous in State with PIK and Non-Missing Wages	24,500			
Testing if Statistically Significantly Different	N	Mean	SD	T-stat
Admitted Preschool with PIK	4,300	0.72	0.45	2.9
Admittted Preschool if Missing PIK	2,700	0.75	0.43	
Male Preschool with PIK	4,300	0.53	0.5	4.8
Male Preschool with Missing PIK	2,700	0.48	0.5	

Note: All numbers have been rounded according to the U.S. Census Bureau Disclosure Review Board specifications for this table. These figures have been approved for disclosure. DRB Approval Number: CBDRB-FY2022-CES010-022.

In Table 1 we summarize the results of the linking process. In total, there are approximately 7,000 children who applied for the preschool program in five different birth cohorts.[4] From that initial population, approximately 61 percent (4,300 individuals) received PIKs. We note that this population is more difficult to identify in administrative data for at least two reasons. The first is that they

[3]For more information on PVS, see Layne et al. (2014).

[4]Note that the data have been rounded to comply with the U.S. Census Bureau Disclosure Review Board policies.

are relatively young; older individuals have a longer span of time in which they may have submitted administrative data such as annual tax forms, census responses, and other vital statistics data that would increase the probability of identifying them. The second potential difficulty is that racial and ethnic minorities with non-English names are also difficult to identify given the increased probability of name misspellings or other errors.

In the second panel of Table 1, we provide some analysis to identify linkage rates based on whether or not a person was admitted to the preschool program. We find that approximately 72 percent of applicants with PIKs were admitted to the program in contrast to 75 percent of applicants without a PIK. This three percentage point difference is statistically significant with a t-statistic of 2.9; therefore, we reject the null hypothesis that the averages are similar. While not optimal, we note that the differences are not large in magnitude (three percentage points) and are also not larger for the treatment group, which is reassuring. We also test whether there is a difference in identifying PIKs by gender. We find that approximately 53% of those assigned a PIK are male, while only 48% of those not assigned a PIK are male. These differences are also statistically significantly different with a t-statistic of 4.8. One might expect this result since we only have the individual child names at ages 4 years old; it is highly likely that some women may have changed their last names in adulthood when getting married. Nevertheless, while there is a difference, the imbalance does not appear to be exceedingly large.

Since the preschool program was open to all Indigenous children and tuition-free, we are also interested in how the outcomes of Indigenous preschool attenders compared to their counterparts who either were not admitted or did not apply. To investigate this, we use the 2000 decennial census to identify children of the same Indigenous racial/ethnic identity, born in the same years, and residing in the state where the preschool program was located. As shown in Table 1, we identified 36,500 individuals in this census sample, and approximately 79 percent of them received a PIK.

Table 2: Table of Means for Preschool Sample with PIK and Non-Missing Wages

Variable	Mean	SD
Male	0.54	0.5
Age	24	1.5
Birth Year	1994	1.5
Mean Wages	17,600	17,600
Log Mean Wages	9.55	0.74
Mean Total Income	17,800	17,900
Log Mean Total Income	9.55	0.75
Admitted to preschool Program	0.71	0.45
Attended preschool Program	0.68	0.46

Note: There are 3,700 observations. DRB Approval Number: CBDRB-FY2022-CES010-022.

3.2 Key Variables

The preschool administrative data identifies whether individuals applied, were admitted, and attended one of the preschools, as well as the year and location in which they applied. Table 2 provides the mean and standard deviations for the characteristics of our primary sample – individuals whose parents (or other caregivers) applied for a spot for them in the preschool program. These characteristics are

derived either from the preschool administrative data or the other administrative sources described below. As shown in Table 2, the vast majority of students who were admitted to the preschool program (71 percent of the sample with PIKs) also attended (68 percent). The preschool administrative data, as shown in Table 2, were collected in the late 1990s for individuals born between 1992-1996. These individuals turned 18 years old between 2010-2014. Thus, to observe their adult outcomes, we rely on IRS data from 2011-2018.

Our key outcome variables are constructed from two IRS data sources: forms W-2 and 1040. We assess these outcomes in the years in which individuals turn 19 or older. Form W-2 data is reported by employers to the IRS, while Form 1040 data is reported by the individual. Sometimes, an individual receives W-2 wages but does not file a tax return, though the vast majority of W-2 recipients in the sample also file a tax return. Informal earnings that are not reported to the IRS cannot be observed. We describe the following variables in detail used in the analysis to follow.

Wages. Wages are estimated by totaling the wages and tips in all the W-2 records associated with a given PIK in each year. Our main measure is mean wages across all adult years observed (for the 1992 birth cohort, this includes ages 19-26; for the 1996 birth cohort, this includes ages 19-22). In the main sample, the average mean wage (in nominal dollars) is $17,600. We also assess a modified version of the mean wages measure where we average wages observed at age 21 or higher.

Total income. Total income is defined as adjusted gross income from the form 1040 record in which the individual appears as a primary or secondary filer in a given year. This reflects an individual's income if not married filing jointly, or a couple's income if married filing jointly. Our main measure is mean total income across all adult years observed. In the main sample, the average total income is $17,800. This is similar to wages for this population, because young people are relatively unlikely to have non-wage sources of income or be married. We also assess a modified version of the mean total income measure where we average adjusted gross income observed at age 21 or higher.

Married. We designate individuals as married if they file a married filing jointly tax return as the primary or secondary filer in the last year of our analysis period (2018).

Has children. We designate individuals as having children if they report any child dependents on their tax return in the last year of our analysis period (2018).

Resides in home state. We designate individuals as residing in their home state if they report a mailing address in the same state as the preschool program on their tax return in the last year of our analysis period (2018).

IRS Form 1040 data provide a second use in our analysis: information on individuals' circumstances in childhood. Specifically, we can look for tax return records in which the target individuals are claimed as child dependents. We use our earliest 1040 records (starting in 2000) to infer parental income and marital status. Parental income is measured after preschool participation in nearly all cases, but well before individuals reach working age. These are the earliest available data for use in this analysis and we believe that it is indicative of the average family earnings and income conditions at the time of preschool application.

Parent wages. We estimate parental wages as the average wages and salary income reported on the Form 1040 records for the first three years we observe an individual claimed as a dependent. Typically, these are averages of parental wages from 2000-2002, when the individuals under study were 4-10 years old.

Parent total income. We estimate parental total income as the average adjusted gross income reported on the Form 1040 records for the first three years we observe an individual claimed as a dependent. Typically, these are averages of parental total income from 2000-2002, when the individuals under study were 4-10 years old.

Married parent. We designate parents as married if they are married filing jointly on the first Form 1040 record in which individuals are claimed as dependents.

3.3 Intergenerational Elasticity of Earnings Mobility

In Table 3 we provide a correlation of the log mean of children's earnings on that of the log mean of their parent's earnings. We provide ordinary least squares estimated coefficients including age and age squared measures. We show the regressions for the full set of observations, then we separate the observations into a group that was not admitted and a group that was admitted. These elasticities indicate the persistence of parental income or earnings on the subsequent generation's income or earnings; larger elasticity measures indicates less economic mobility. The first three columns of the table show the elasticity of earnings. On average, the elasticity of earnings is 4.24% indicating that a large proportion of the children and parent's earnings are not highly related to one another. In the next column, we estimate the elasticity of earnings for the group of children who were not admitted to the preschool program; their estimated elasticity is larger at 7.46% which indicates a larger correlation between parents and their children. In the third column, we provide elasticity of earnings for the group of children that were admitted to the preschool program and their elasticity is 3.05% which is less than half that of the previous column estimate. This initial analysis provides evidence that the preschool program leads to more economic mobility in earnings across the parent and children's generations. The next three columns in the table show a similar result for total family income measures. These results provide suggestive evidence that the preschool program increases intergenerational mobility.

Table 3: Intergenerational Elasticity of Earnings Mobility

VARIABLES	Log Mean Wages			Log Mean Total Income		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Parent Wages	0.0424***	0.0746***	0.0305*			
	(0.0145)	(0.0289)	(0.0170)			
Log Parent Total Income				0.0346**	0.0576*	0.0256
				(0.0163)	(0.0303)	(0.0197)
Admitted?	Total	No	Yes	Total	No	Yes
Observations	3600	1000	2500	3600	1000	2500
R-squared	0.043	0.049	0.041	0.043	0.047	0.041

Note: Results reported for full sample, non-admitted individuals, and admitted individuals. All regressions include age and age-squared. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1. DRB Approval Number: CBDRB-FY2023-CES005-008.

4 Empirical Strategy

Our causal identification strategy relies on the fact that individual students were admitted to the preschool program based not on their characteristics (other than age) but by a lottery admissions process. We use the offer of admissions to instrument for attending the preschool program in our analysis. In the second stage analysis, we use instrumented attendance to identify the effect on several adult outcome variables.

The first equation below indicates that the admission to the preschool program determines attendance in the school. The outcome variable is an indicator variable for whether the child i attended the preschool program. The variable admitted is an indicator variable for whether the child was offered admission to the preschool program. The vector X includes control variables for age, gender, parental income, parental marital status, and region of the state. We conduct this via ordinary least squares estimation in a two-stage least squares analysis. The predicted values for attended are then included in the second regression and we estimate the coefficient of interest β which explains the effect of attending the preschool program on long-run adult outcomes Y_i; these outcomes are wages, total income, marital status, fertility, and residing in the home state. We pool data for the five admitted cohorts for our analysis and report their outcomes in young adulthood.

$$Attended_i = \gamma \times Admitted_i + X_i^{'}\mu + \delta_i + \epsilon_i \tag{1}$$

$$Y_i = \beta \times Attended_i + X_i^{'}\theta + \delta_i + \epsilon_i \tag{2}$$

Our empirical specification also includes a year of application and district fixed effect as well as their interactions and indicated by δ_i.

We use the lottery based admissions to instrument for whether a person attends the preschool program or not. As is standard, we are concerned that individual children who attend these relatively novel preschool programs differ along unobservable family or individual characteristics. The two-stage least squares method and the lottery assignment for admissions should be unrelated to these unobserved characteristics. Pending Census disclosure review, we will provide a balancing analysis for the children's household characteristics during their childhood. We test whether parental income, earnings and marital status differ significantly between the admitted and non-admitted group of children after controlling for year of application and district. This test offers assurances that the lottery was truly random.

5 Results

In all of the regression results that follow, we provide the estimated coefficients from the two stage least squares regressions. Outcome variables for earnings and income are averaged over ages 19 and older or ages 21 and older; the other outcomes variables are measured at the last observed year for that individual in our data. We report the estimated coefficient for the instrumental variable at the bottom of all of the tables along with the F-statistic for the first stage regression.

Table 4: Table of Two-Stage Least Squares Regression Results for Wages and Total Income

	Log Mean Wages				Log Mean Total Income			
	Ages 19+		Ages 21+		Ages 19+		Ages 21+	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attended	0.0521*	0.0493*	0.0670**	0.0639*	0.0523*	0.0496*	0.0672**	0.0642*
	(0.0300)	(0.0298)	(0.0334)	(0.0332)	(0.0301)	(0.0299)	(0.0335)	(0.0333)
Log Parent Wages	0.0320**		0.0434**		0.0330**		0.0445**	
	(0.0161)		(0.0180)		(0.0162)		(0.0180)	
Log Parent Tot. Inc.		0.021		0.0277		0.0218		0.0286
		(0.0188)		(0.0209)		(0.0189)		(0.0210)
Married Parent	0.0152	0.0242	0.0325	0.0436	0.0157	0.0249	0.0331	0.0444
	(0.0285)	(0.0294)	(0.0317)	(0.0327)	(0.0286)	(0.0295)	(0.0319)	(0.0328)
Male	0.218***	0.220***	0.215***	0.217***	0.217***	0.219***	0.215***	0.217***
	(0.0242)	(0.0240)	(0.0269)	(0.0267)	(0.0242)	(0.0241)	(0.0270)	(0.0268)
Observations	3500	3600	3500	3600	3500	3600	3500	3600
R-squared	0.076	0.076	0.062	0.061	0.077	0.076	0.062	0.062
First stage coeff.	0.962	0.961	0.962	0.962	0.962	0.962	0.962	0.961
First stage SE	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
First stage F	615	607	615	615	615	608	615	608

Note: All regressions includes region-by-application-year fixed effects and a continuous age variable. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1.DRB Approval Number: CBDRB-FY2023-CES005-008.

5.1 Effects on Income

In Table 4 we provide the two-stage least squares regression estimates for the effect of attending the preschool program on young adult wages and income for the treated individuals. In all instances, the F-statistic is larger than 100 and is thus a strong instrument.

The first four columns in the table report the estimated treatment effect of preschool attendance on log mean wages. We report results for mean wages across all observed adult ages, and for mean wages at age 21 and above. The odd columns include a control variable for the log mean of parental wages and the even columns include a control variable for the log mean of parental income. Individuals who attended the preschool program have approximately 5 percent higher wages (0.0493 to 0.0521 log points) than those who did not. When we focus on wages at age 21 and above, the treatment effect climbs above 6 percent (0.0639 to 0.0670 log points). The effects differ only slightly across the two measures of parental income in these first four columns. The next four columns in the table display the two-stage least squares regression with the child's log mean of total income as the outcome variable. The results are nearly identical in magnitude to the results in the first four columns of the table given that total income is almost entire comprised of earnings for these relatively young adults.

We repeat the same analysis as shown in Table 4 in Appendix Table A3 where we expand our control group to include additional Indigenous individuals from the same birth cohorts who did not apply to the preschool program. These regressions do not include district fixed effects, as we cannot assign non-applicants to sub-state districts. The estimated treatment effect is positive and statistically significant across all specifications. This suggests that attenders enjoy wage gains relative to their Indigenous counterparts broadly. However, the magnitude appears to be smaller than that of the main

Table 5: Two-Stage Least Squares Regression Results for Wages and Total Income Split By Median Parental Income

	Log Mean Wages				Log Mean Total Income			
	Ages 19+		Ages 21+		Ages 19+		Ages 21+	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attended	0.116***	-0.015	0.132***	-0.00343	0.117***	-0.0151	0.133***	-0.00374
	(0.0434)	(0.0411)	(0.0486)	(0.0456)	(0.0436)	(0.0413)	(0.0487)	(0.0458)
Log Parent Wages	0.0383*	-0.053	0.0468*	-0.0209	0.0390*	-0.0519	0.0478*	-0.0197
	(0.0229)	(0.0567)	(0.0256)	(0.0628)	(0.0230)	(0.0569)	(0.0257)	(0.0631)
Married Parent	-0.0068	0.0676	0.00226	0.102	-0.0062	0.0671	0.00301	0.102
	(0.0351)	(0.0590)	(0.0393)	(0.0654)	(0.0352)	(0.0592)	(0.0394)	(0.0657)
Male	0.251***	0.191***	0.256***	0.178***	0.251***	0.191***	0.256***	0.177***
	(0.0348)	(0.0333)	(0.0389)	(0.0369)	(0.0349)	(0.0335)	(0.0390)	(0.0371)
Below Median?	Y	N	Y	N	Y	N	Y	N
Observations	1800	1800	1800	1800	1800	1800	1800	1800
R-squared	0.069	0.12	0.062	0.095	0.069	0.121	0.063	0.096
First stage coeff	0.959	0.965	0.959	0.965	0.959	0.965	0.959	0.965
First stage SE	0.0094	0.0086	0.0094	0.0086	0.0094	0.0086	0.0094	0.0086
First stage F	277	345	277	345	277	345	277	345

Note: The sample is split by parent wages above or below the median. All regressions includes region-by-application-year fixed effects and a continuous age variable. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1. DRB Approval Number: CBDRB-FY2023-CES005-008.

(applicant) sample.

5.2 Effects by Parental Median Earnings

In Table 5, we report the same regressions as in Table 4, but separate the sample by the median of parental wages at the earliest point we observe them (2000-2002 for most individuals). The odd numbered columns provide results for individuals whose parental earnings were below the median and the even columns provide results for individuals whose parental earnings were at or above the median. The result is striking: wage and total income gains from preschool attendance are concentrated among individuals whose parents earned below the median during childhood.[5] These individuals from low-income households experience wage gains of 12 percent for earnings at age 19 and above and 14 percent for earnings at ages 21 and above. In contrast, there is no statistically significant effect of attendance for children from households with high-income parents.

As shown in Appendix Table A4, the pattern of large income effects for attenders from low-income families and near-zero effects for attenders from high-income families also persists with the expanded statewide sample, though once again the magnitudes are smaller.

5.3 Analysis by Gender

In Table 6, we divide the sample by gender. The effects of attendance are similar for each gender, and similar to the overall treatment effect shown in Table 4. They are not, however, statistically significant.

[5]These results are robust to splitting the data by parental income medians as well.

Table 6: Table of Two-Stage Least Squares Regression Results for Wages and Total Income Split By Gender

	Log Mean Wages		Log Mean Income	
	(1)	(2)	(3)	(4)
Attended	0.0419	0.0548	0.0422	0.0474
	(0.0425)	(0.0422)	(0.0423)	(0.0422)
Log Parent Wages	0.0409*	0.0316		
	(0.0238)	(0.0218)		
Log Parent Total Income			0.0222	0.024
			(0.0286)	(0.0247)
Married Parent	0.000249	0.028	0.0117	0.0413
	(0.0405)	(0.0401)	(0.0423)	(0.0411)
Gender	Male	Female	Male	Female
Observations	1900	1600	1900	1700
R-squared	0.061	0.074	0.059	0.077
First stage coeff.	0.959	0.965	0.959	0.963
First stage SE	0.0092	0.0086	0.0092	0.0088
First stage F	298	353	303	333

Note: The sample is split by gender. All regressions includes region-by-application-year fixed effects and a continuous age variable. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1. DRB Approval Number: CBDRB-FY2023-CES005-008.

Thus, we conclude that the effect of the preschool program for this population of Indigenous children did not have differential effects by gender.

5.4 Preschool Effects on Geographic Mobility, Marital Status and Fertility

The linked tax return data permits us to proxy three additional outcomes of interest: whether individuals stay in their home state, marry, and have children. The two-stage least squares regression results are shown in Table 7. Attending the preschool program increases the likelihood that individuals reside in their home state by almost 4 percentage points. It is not clear whether this is due to the higher earnings as shown previously in Table 4 or perhaps due to cultural connections emphasized in these specific preschool programs.

Overall, there does not appear to be any difference for individuals who attended the preschool program in childhood in whether they are married or have children. It is possible that differences will manifest in later years as these individuals are relatively young (in their early to mid-20s). We note, however, that these estimated coefficients are positive, though imprecise.

In Appendix Table A5, we separate these additional outcomes by median parental earnings. Once again, the programs effects are largest for individuals from low-income families. The preschool program increases the probability of residing in the home state by 6.6 percentage points for individuals from below-median income families compared to their low-income counterparts who were not admitted to the preschool. The effect for individuals from high-income families is practically zero.

Table 7: Additional Tax Unit Characteristics

	Resides In Home State	Married	Has Children
	(1)	(2)	(3)
Attended	0.0373**	0.00829	0.0166
	(0.0185)	(0.0155)	(0.0175)
Log Parent Wages	-0.00712	0.000882	-0.0454***
	(0.0101)	(0.00839)	(0.00953)
Married Parent	0.0251	0.00435	-0.0196
	(0.0177)	(0.0148)	(0.0168)
Male	0.0336**	-0.0579***	-0.143***
	(0.0149)	(0.0124)	(0.0141)
Observations	3200	3200	3200
R-squared	0.016	0.039	0.081
First stage coeff	0.963	0.963	0.963
First stage SE	0.00648	0.00648	0.00648
First stage F	587	587	587

Note: All regressions includes region-by-application-year fixed effects and a continuous age variable. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1. DRB Approval Number: CBDRB-FY2023-CES005-008.

6 Discussion of Potential Mechanisms

While the analysis has identified the long-run effect of preschool attendance on earnings, income and geographic mobility, it is useful to discuss the potential mechanisms responsible for the observed results. Other researchers have pointed to the impact that early childhood education interventions have on a children's cognitive and non-cognitive skills. Researchers have shown that educational achievement in test scores often fade out in many of the Head Start evaluations (Bailey et al., 2020; Currie and Thomas, 2000; Kline and Walters, 2016). Heckman et al. (2013) points out that improvement in non-cognitive skills (personality traits) may play an important role in student long-term success. In fact, this may help to explain why many of these early childhood education interventions display long-run effects. While the shorter term cognitive skills may moderate over time, the social skills learned early in preschool persist into young adulthood and may play an ever increasing role in educational and labor market success (Deming, 2017).

One additional component of skill development that this preschool provided was the inclusion of cultural connections and content into the learning environment. Speaking with the teachers, they conveyed that the curriculum and methods of teaching were informed and based upon various aspects of this Indigenous People's history, traditions and language. Often, the teachers and their classroom aides were from the same Indigenous community as the students; this has often been shown to assist in student outcomes in other settings (Gershenson et al., 2022). The preschool program also provided enrichment activities such as field trips and excursions. However, the preschool curriculum was firmly focused on standard achievement outcomes. Aggregate data for the total preschool Peabody Picture Vocabulary Tests scores indicate that there were significant improvements over the course of the school year. Table 8 provides data from annual reports for the preschool program for various years. In general, there were improvements in the PPVT scores from the beginning to the end of the year by approximately 15 to 20 percentage points. Additionally, the preschool program required all teachers to

Table 8: Classroom Description and English Language Achievement Scores

School Year	No. of Classrooms	No. Enrolled	Avg Classroom Size	Avg PPVT-R Scores Start %ile	End %ile
1995-1996	39	780	20	16	34
1996-1997†	48	921	19	30	42
1997-1998	47	940	20	21	39
1998-1999‡	48	960	20	34	53
1999-2000	49	942	19	37	53

Note: †This measure is interpolated as the data was provided within three different score range categories 1-25, 26-75, 76-99. ‡The PPVT Changed in 1998-1999 and percentiles are not comparable to previous years. Source: Annual Preschool program reports 1995-2000 school years.

have at least a Bachelor's degree in early childhood education; the teaching assistants (there was one in each classroom) were required to have a child development associate's degree at a minimum. The teachers were also required to take 16 hours of professional development training each year as well. In later years, the program reimbursed part of the teacher's tuition in pursuing their Masters degrees.

The data also indicate that on average classroom sizes were kept relatively small ranging between 19 and 20 students per classroom over all five years in our data. Other researchers studying the randomization of classroom size in Tennessee have shown that assignment to smaller classroom sizes in kindergarten led to beneficial long-run outcomes (Chetty et al., 2011).

6.1 Evidence on College Attendance

Researchers have shown that attending preschool programs leads to an increase in educational attainment and college completion (Bailey et al., 2021; Gray-Lobe et al., 2023). This is a likely intermediate mechanism that may explain the higher earnings that we observe in our study. While we observe the long-term earnings in early adulthood for the children who attended the preschool program, we do not have information on their college enrollment or postsecondary educational attainment. We do have data on the years in which the children's parent's claimed them as dependents in the IRS 1040 data. Thus, we will examine whether there are differences in parents' claiming their children as dependents during the standard college-going years (ages 19-22) based on the preschool attendance. If there is a positive effect, this suggests higher college attendance among treated individuals. If we further find evidence that earnings gains are concentrated among those claimed on their parents' taxes after age 18, this would provide suggestive evidence that the observed earnings differences are due to higher educational attainment for this population. These results would be in line with findings from other preschool programs. We will conduct this analysis in subsequent versions of this paper.

7 Conclusion

Our analysis focuses on a universal preschool program with lottery admissions for a population of Indigenous children throughout a single U.S. state. In contrast to prior work, we are able to link individuals who were and were not offered admissions via the lottery to their reported earnings and income data in their IRS Form W-2 and 1040 records. Additionally, we are able to link individuals back to their parents' 1040 tax forms to construct measures of childhood family income. As a result,

we provide the first estimates of the return to education for an early childhood education intervention in the U.S., including documenting heterogeneity in returns by family income.

We find that attending a preschool program for one year increases average adult earnings by approximately 5 to 6 percent. These results are robust to different measures of parental income or earnings. However, when we separate the data at the median of parental earnings, we find that the improvement in earnings (and income) for the treated children is all due to gains by those who were initially in the lower half of the parental earnings distribution. In particular, attending the preschool program tends to increase adult earnings for the treated children by about 12 to 14 percent as compared to their untreated counterparts (also from the bottom half of the parental earnings distribution). These results are within the range that others have found for the returns to schooling for post-preschool educational attainment. This suggests that early childhood education interventions may have a similar effect on adult earnings as increased educational attainment in later years. Our results also suggest that high quality preschool programs may play an important role in reducing income and earnings inequality in adulthood.

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A Appendix Tables

Table A1: Intergenerational Elasticity of Earnings Mobility for Statewide Data

VARIABLES	Log Mean Wages			Log Mean Total Income		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Parent Wages	0.0630***	0.0661***	0.0308*			
	(0.00579)	(0.00617)	(0.0169)			
Log Parent Total Income				0.0645***	0.0679***	0.0258
				(0.00631)	(0.00667)	(0.0197)
Admitted?	Total	No	Yes	Total	No	Yes
Observations	21500	19000	2500	21500	19000	2500
R-squared	0.029	0.028	0.041	0.029	0.028	0.041

Note: Results reported for full statewide sample, non-admitted (including non-applicant) individuals, and admitted individuals. All regressions include age and age-squared. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1. DRB Approval Number: CBDRB-FY2023-CES005-008.

Table A2: Table of Two-Stage Least Squares Regression Results for Wages and Total Compensation with Clustered Standard Errors

	Log Mean Wages				Log Mean Total Income			
	Ages 19+		Ages 21+		Ages 19+		Ages 21+	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attended	0.0521*	0.0493*	0.0670**	0.0639**	0.0523*	0.0496*	0.0672**	0.0642**
	(0.0277)	(0.0291)	(0.0295)	(0.0306)	(0.0278)	(0.0291)	(0.0296)	(0.0307)
Log Parent Wages	0.0320**		0.0434***		0.0330**		0.0445***	
	(0.0129)		(0.0162)		(0.0129)		(0.0161)	
Log Parent Tot. Inc.		0.021		0.0277		0.0218		0.0286
		(0.0163)		(0.0188)		(0.0163)		(0.0188)
Married Parent	0.0152	0.0242	0.0325	0.0436	0.0157	0.0249	0.0331	0.0444
	(0.0271)	(0.0266)	(0.0275)	(0.0279)	(0.0272)	(0.0267)	(0.0276)	(0.0279)
Male	0.218***	0.220***	0.215***	0.217***	0.217***	0.219***	0.215***	0.217***
	(0.0213)	(0.0220)	(0.0256)	(0.0261)	(0.0214)	(0.0221)	(0.0257)	(0.0263)
Observations	3500	3600	3500	3600	3500	3600	3500	3600
R-squared	0.076	0.076	0.062	0.061	0.077	0.076	0.062	0.062
First stage coeff.	0.962	0.961	0.962	0.961	0.962	0.961	0.962	0.961
First stage SE	0.0095	0.01	0.0095	0.01	0.01	0.01	0.01	0.01
First stage F	2600	2500	2600	2500	2600	2500	2600	2500

Note: Standard errors (in parentheses) clustered by application year and district. All regressions includes region-by-application-year fixed effects and a continuous age variable. ***p<0.01, ** p<0.05, * p<0.1.DRB Approval Number: CBDRB-FY2023-CES005-008.

Table A3: Table of Two-Stage Least Squares Regression Results for Wages and Total Compensation for Statewide Data

	Log Mean Wages				Log Mean Total Income			
	Ages 19+		Ages 21+		Ages 19+		Ages 21+	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attended	0.0394**	0.0396**	0.0434**	0.0439**	0.0392**	0.0393**	0.0432**	0.0437**
	(0.0164)	(0.0163)	(0.0179)	(0.0178)	(0.0165)	(0.0164)	(0.0180)	(0.0179)
Log Par. Wages	0.0650***		0.0771***		0.0664***		0.0786***	
	(0.00636)		(0.00693)		(0.00638)		(0.00696)	
Log Par. Tot. Inc.		0.0679***		0.0818***		0.0695***		0.0835***
		(0.00712)		(0.00777)		(0.00715)		(0.00780)
Married Parent	-0.0114	-0.0178	-0.0108	-0.0195	-0.0105	-0.0172	-0.00982	-0.0187
	(0.0117)	(0.0120)	(0.0127)	(0.0131)	(0.0117)	(0.0120)	(0.0128)	(0.0131)
Male	0.212***	0.212***	0.208***	0.209***	0.211***	0.211***	0.207***	0.208***
	(0.0102)	(0.0101)	(0.0111)	(0.0110)	(0.0102)	(0.0102)	(0.0111)	(0.0111)
Observations	21500	21500	21500	21500	21500	21500	21500	21500
R-squared	0.049	0.048	0.04	0.039	0.049	0.048	0.04	0.039
First stage coeff	0.963	0.962	0.963	0.962	0.963	0.962	0.963	0.962
First stage SE	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
First stage F	61500	60500	61500	60500	61500	60500	61500	60500

Note: All regressions includes region-by-application-year fixed effects and a continuous age variable. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1.DRB Approval Number: CBDRB-FY2023-CES005-008.

Table A4: Table of Two-Stage Least Squares Regression Results for Wages and Total Compensation Split By Median of Parental Income for Statewide Data

	Log Mean Wages				Log Mean Total Income			
	Ages 19+		Ages 21+		Ages 19+		Ages 21+	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attended	0.0703***	0.00855	0.0697**	0.0172	0.0705***	0.008	0.0700**	0.0167
	(0.0251)	(0.0216)	(0.0276)	(0.0234)	(0.0251)	(0.0217)	(0.0276)	(0.0235)
Log Par. Wages	0.0660***	-0.00752	0.0703***	0.0217	0.0666***	-0.00465	0.0710***	0.0246
	(0.00992)	(0.0197)	(0.0109)	(0.0212)	(0.00995)	(0.0197)	(0.0109)	(0.0213)
Married Parent	-0.0268*	0.0199	-0.0317*	0.0221	-0.0262*	0.0205	-0.0311*	0.023
	(0.0149)	(0.0209)	(0.0164)	(0.0226)	(0.0150)	(0.0210)	(0.0165)	(0.0227)
Male	0.230***	0.194***	0.229***	0.186***	0.229***	0.194***	0.228***	0.186***
	(0.0146)	(0.0141)	(0.0160)	(0.0153)	(0.0146)	(0.0142)	(0.0161)	(0.0153)
Below Median?	Y	N	Y	N	Y	N	Y	N
Observations	10500	10500	10500	10500	10500	10500	10500	10500
R-squared	0.039	0.057	0.032	0.043	0.039	0.057	0.031	0.043
First stage coeff.	0.957	0.968	0.957	0.968	0.957	0.968	0.957	0.968
First stage SE	0.002	0.0018	0.002	0.0018	0.002	0.0018	0.002	0.0018
First stage F	26500	35000	26500	35000	26500	35000	26500	35000

Note: Results reported for full statewide sample, split by parental wages above or below the median. All regressions includes region-by-application-year fixed effects and a continuous age variable. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1. DRB Approval Number: CBDRB-FY2023-CES005-008.

Table A5: Additional Tax Unit Characteristics by Median Parental Income

	Resides In Home State		Married		Has Children	
	(1)	(2)	(3)	(4)	(5)	(6)
Attended	0.0659**	0.00626	-0.0161	0.0286	0.0103	0.017
	(0.0267)	(0.0258)	(0.0223)	(0.0214)	(0.0269)	(0.0226)
Log Parent Wages	-0.0143	-0.00904	0.015	-0.0553*	-0.0115	-0.100***
	(0.0142)	(0.0368)	(0.0119)	(0.0305)	(0.0143)	(0.0323)
Married Parents	0.0137	0.0216	0.0159	-0.00737	-0.00896	0.00992
	(0.0215)	(0.0383)	(0.0180)	(0.0317)	(0.0217)	(0.0336)
Male	0.0262	0.0432**	-0.0456**	-0.0681***	-0.173***	-0.118***
	(0.0213)	(0.0209)	(0.0178)	(0.0173)	(0.0215)	(0.0184)
Below Median	Y	N	Y	N	Y	N
Observations	1600	1600	1600	1600	1600	1600
R-squared	0.028	0.034	0.043	0.067	0.079	0.09
First stage coeff	0.961	0.966	0.961	0.966	0.961	0.966
First stage SE	0.0095	0.009	0.0095	0.009	0.0095	0.009
First stage F	270	316	270	316	270	316

Note: All regressions includes region-by-application-year fixed effects and a continuous age variable. Standard errors in parentheses. ***p<0.01, ** p<0.05, * p<0.1.DRB Approval Number: CBDRB-FY2023-CES005-008.