

ONLINE APPENDIX:
**Public Investments in Early Childhood Education and
Academic Performance: Evidence from Head Start in Texas**

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I. Empirical Appendix

A. Tables

Table A.1: Falsification Tests: The Effect of Head Start Exposure on Exogenous Student Characteristics, County-level Income, and Predicted Test Scores

| | Black | Hispanic | Female | Free/Reduced Meal | Income PC | Predicted Test Scores |
|--------------------|-------------------|------------------|------------------|-------------------|------------------|-----------------------|
| Head Start Funding | -0.001 (0.001) | 0.001 (0.001) | 0.002 (0.006) | -0.008 (0.008) | 0.000 (0.001) | -0.000 (0.000) |
| Mean Y | 0.145 | 0.312 | 0.498 | 0.394 | 35164.821 | 0.010 |
| Obs | 742660 | 742660 | 742660 | 742660 | 742660 | 742660 |

Notes: This table reports results obtained when the dependent variables are race/ethnicity, sex, FRL status, income per capita at the county level and predicted test scores, separately. The independent variable is real federal Head Start (HS) spending per child (in 2014\$) when the child was four years old. HS spending per child is scaled by \$500 (average spending during the period of study), thus the coefficients should be interpreted as the effect of a \$500 increase in funding. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with county-specific linear trends. Sample consists of all the third-grade students. Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1988 and 1994. Standard errors are clustered at the county level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.2: Correlations between County-Level Variables and Average Head Start Funding per Child, 1988-1994

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|--|------------------|----------------------|--------------------|--------------------|--------------------|--------------------|---------------------|--------------------|----------------------|----------------------|------------------|---------------------|
| Percent Urban | 0.289 (2.054) | | | | | | | | | | | 0.891 (1.338) |
| Percent Black | | -20.678* (10.522) | | | | | | | | | | -12.964* (7.759) |
| Percent Hispanic | | | 12.048* (6.442) | | | | | | | | | 1.527 (2.457) |
| Percent Farmland | | | | 6.321** (2.971) | | | | | | | | 0.650 (1.173) |
| Education Expenditures per Capita | | | | | 2.190** (1.061) | | | | | | | 0.486 (0.445) |
| Welfare Expenditures per Capita | | | | | | 79.074 (84.746) | | | | | | 11.080 (10.697) |
| Income per Capita | | | | | | | -0.076** (0.037) | | | | | -0.019 (0.023) |
| Percent Single Mother | | | | | | | | 82.841 (61.262) | | | | 58.801 (51.039) |
| Percent of Children 0-18 under Poverty | | | | | | | | | 27.861** (13.610) | | | 5.819 (6.052) |
| Fraction of Pop Under 5 | | | | | | | | | | 177.278 (109.938) | | 24.701 (35.460) |
| Fraction of Pop Older than 65 | | | | | | | | | | | 8.712 (6.862) | 16.562 (11.556) |
| Log population | | | | | | | | | | | | 56.120 (54.299) |
| Obs | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 |
| R-Squared | 0.000 | 0.072 | 0.218 | 0.056 | 0.058 | 0.057 | 0.110 | 0.090 | 0.192 | 0.092 | 0.003 | 0.194 |
| F-test | 0.020 | 3.862 | 3.498 | 4.527 | 4.262 | 0.871 | 4.298 | 1.829 | 4.191 | 2.600 | 1.612 | 2.183 |
| p-value | 0.888 | 0.052 | 0.064 | 0.035 | 0.041 | 0.353 | 0.040 | 0.179 | 0.043 | 0.110 | 0.207 | 0.017 |

Notes: The dependent variable is the average federal Head Start (HS) spending per child (2014\$) from the Consolidated Federal Funds Reports (CFFR), coupled with the population counts for three- and four-year-olds from the SEER. The 1980 county controls are from the City and County Data Book. For more details about the data, see Appendix II. Estimates are weighted by the population of three- and four-year-olds. Standard errors are clustered at the community level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.3: Correlations between County-Level Variables and Change in Head Start Funding per Child, 1988-1994

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|--|-------------------|----------------------|---------------------|--------------------|--------------------|--------------------|----------------------|---------------------|---------------------|----------------------|--------------------|--------------------|
| Percent Urban | -0.502 (0.565) | | | | | | | | | | | 0.735 (0.596) |
| Percent Black | | -6.093*** (1.982) | | | | | | | | | | -4.672* (2.587) |
| Percent Hispanic | | | 3.084*** (0.958) | | | | | | | | | -1.596 (1.330) |
| Percent Farmland | | | | 1.662** (0.730) | | | | | | | | 0.219 (0.577) |
| Education Expenditures per Capita | | | | | 0.908** (0.405) | | | | | | | 0.214 (0.241) |
| Welfare Expenditures per Capita | | | | | | 10.127 (13.355) | | | | | | 1.461 (2.551) |
| Income per Capita | | | | | | | -0.022*** (0.006) | | | | | -0.000 (0.012) |
| Percent Single Mother | | | | | | | | 17.957* (10.301) | | | | 10.337 (16.791) |
| Percent of Children 0-18 under Poverty | | | | | | | | | 8.079*** (2.359) | | | 6.653* (3.374) |
| Fraction of Pop Under 5 | | | | | | | | | | 43.327** (19.223) | | 9.821 (17.683) |
| Fraction of Pop Older than 65 | | | | | | | | | | | 6.124** (2.776) | 4.550 (5.893) |
| Log population | | | | | | | | | | | | 20.987 (27.821) |
| Obs | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 |
| R-Squared | 0.005 | 0.087 | 0.199 | 0.054 | 0.138 | 0.013 | 0.128 | 0.059 | 0.225 | 0.077 | 0.021 | 0.102 |
| F-test | 0.789 | 9.452 | 10.370 | 5.193 | 5.015 | 0.575 | 13.869 | 3.039 | 11.725 | 5.080 | 4.867 | 2.249 |
| p-value | 0.376 | 0.003 | 0.002 | 0.024 | 0.027 | 0.450 | 0.000 | 0.084 | 0.001 | 0.026 | 0.029 | 0.013 |

Notes: The dependent variable is long-change in real federal Head Start (HS) spending per child (2014\$) from 1988 to 1994 from the Consolidated Federal Funds Reports (CFFR), coupled with the population counts for three- and four-year-olds at the county-level from the SEER. The 1980 county controls are from the City and County Data Book. For more details about the data, see Appendix II. Estimates are weighted by the population of three- and four-year-olds. Standard errors are clustered at the community level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.4: Head Start Funding and Director Quality, 1992-1994

| | (1) | (2) | (3) |
|--------------------------------------|-------------------|------------------|-------------------|
| Director has at least college degree | -0.003 (0.119) | | |
| Director's yrs of education | | 0.042 (0.036) | |
| Director's yrs of experience | | | -0.003 (0.005) |
| Mean X | 0.26 | 5.36 | 7.92 |
| Obs | 470 | 194 | 207 |

Notes: The dependent variable is real federal Head Start (HS) spending per child (2014\$) from Consolidated Federal Funds Reports (CFFR). Head Start program directors' data are from the Program Information Reports (PIR), and include years between 1992 to 1994. Director's years of education is a categorical variable which takes the value "1" for less than high school graduate, "2" for high school graduate, "3" for completed less than two years college, "4" for completed two to four years college but did not graduate, "5" for graduated college, "6" for some post-graduate credits, and "7" for graduate degree. For more details about the data description, see Appendix II. All regressions include county and year fixed effects. Estimates are weighted by the population of three- and four-year-olds. Standard errors are clustered at the community level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.5: Baseline Estimates of the Effect of Head Start Funding on Standardized Math and Reading Test Scores in Third Grade

| | All | Males | Females | Whites | Blacks | Hispanics |
|---------------------------------------|--------------------|-------------------|---------------------|-------------------|------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| <i>A: Standardized Math Scores</i> | | | | | | |
| Head Start Funding | 0.045** (0.018) | 0.052* (0.028) | 0.041*** (0.013) | -0.011 (0.045) | 0.052 (0.043) | 0.070*** (0.019) |
| Mean Y | -0.332 | -0.397 | -0.268 | -0.048 | -0.388 | -0.412 |
| <i>B: Standardized Reading Scores</i> | | | | | | |
| Head Start Funding | 0.023* (0.013) | 0.027 (0.018) | 0.023 (0.025) | -0.011 (0.042) | 0.033 (0.038) | 0.037*** (0.014) |
| Mean Y | -0.339 | -0.470 | -0.209 | -0.083 | -0.333 | -0.434 |
| Obs | 335311 | 166684 | 168627 | 72377 | 76436 | 182021 |

Notes: This table reports results obtained when the dependent variable is third-grade standardized test scores in math and reading separately, and the independent variable is real federal Head Start (HS) spending per child (in 2014\$) when the child was four years old. HS spending per child is scaled by \$500 (average spending during the period of study), thus the coefficients should be interpreted as the effect of a \$500 increase in funding. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with county-specific linear trends. Sample consists of third-grade students who are FRL certified or who are identified as economically disadvantaged, based on the description by the Texas Education Agency (TEA). Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1988 and 1994. Standard errors are clustered at the county level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.6: Effect of Head Start Funding on Standardized Test Scores
for Grades Three - Eighth

| | Grade 3 (1) | Grade 4 (2) | Grade 5 (3) | Grade 6 (4) | Grade 7 (5) | Grade 8 (6) |
|--|---------------------|---------------------|--------------------|-------------------|------------------|------------------|
| <i>A: All - Combined Test Score</i> | | | | | | |
| Head Start Funding | 0.031** (0.013) | 0.048** (0.021) | 0.025 (0.016) | 0.013 (0.017) | 0.017 (0.020) | 0.009 (0.035) |
| Mean Y | -0.355 | -0.356 | -0.359 | -0.287 | -0.300 | -0.217 |
| <i>B: All - Math Score</i> | | | | | | |
| Head Start Funding | 0.045** (0.018) | 0.043** (0.022) | 0.027 (0.023) | 0.008 (0.019) | 0.022 (0.019) | 0.009 (0.036) |
| Mean Y | -0.332 | -0.335 | -0.337 | -0.251 | -0.276 | -0.195 |
| <i>C: All - Reading Score</i> | | | | | | |
| Head Start Funding | 0.023* (0.013) | 0.050*** (0.019) | 0.022 (0.019) | 0.017 (0.018) | 0.011 (0.019) | 0.010 (0.033) |
| Mean Y | -0.339 | -0.361 | -0.366 | -0.305 | -0.307 | -0.227 |
| Mean X (\$) | 518 | 397 | 355 | 357 | 324 | 316 |
| Obs | 335311 | 209898 | 263722 | 264377 | 254212 | 143135 |
| <i>D: Hispanic - Combined Test Score</i> | | | | | | |
| Head Start Funding | 0.051*** (0.014) | 0.087*** (0.020) | 0.036** (0.017) | 0.027 (0.019) | 0.015 (0.017) | 0.010 (0.031) |
| Mean Y | -0.449 | -0.398 | -0.370 | -0.293 | -0.313 | -0.216 |
| <i>E: Hispanic - Math Score</i> | | | | | | |
| Head Start Funding | 0.070*** (0.019) | 0.082*** (0.020) | 0.035** (0.016) | 0.024 (0.021) | 0.009 (0.018) | 0.003 (0.034) |
| Mean Y | -0.412 | -0.368 | -0.332 | -0.241 | -0.275 | -0.183 |
| <i>F: Hispanic - Reading Score</i> | | | | | | |
| Head Start Funding | 0.037*** (0.014) | 0.090*** (0.019) | 0.039** (0.017) | 0.036* (0.021) | 0.025 (0.018) | 0.019 (0.028) |
| Mean Y | -0.434 | -0.411 | -0.389 | -0.327 | -0.334 | -0.238 |
| Mean X (\$) | 687 | 525 | 466 | 456 | 413 | 403 |
| Obs | 182021 | 121150 | 153815 | 157156 | 155284 | 87516 |

Notes: This table reports results obtained when the dependent variable is standardized test scores combined, in math and reading separately. The independent variable is real federal Head Start (HS) spending per child (in 2014\$) when the child was four years old. HS spending per child is scaled by \$500 (average spending during the period of study), thus the coefficients should be interpreted as the effect of a \$500 increase in funding. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with county-specific linear trends. Sample consists of students from third through eighth grade who are FRL certified, or who are identified as economically disadvantaged, based on the description by the Texas Education Agency (TEA). Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1983 and 1994. Standard errors are clustered at the county level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.7: Baseline Estimates of the Effect of Head Start Funding on Standardized Test Scores - Adding School Trends

| | All | Males | Females | Whites | Blacks | Hispanics |
|--------------------|------------------|------------------|------------------|-------------------|-------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Head Start Funding | 0.021 (0.013) | 0.018 (0.025) | 0.020 (0.021) | -0.050 (0.064) | -0.083 (0.093) | 0.047*** (0.015) |
| Mean Y | -0.355 | -0.459 | -0.253 | -0.069 | -0.382 | -0.449 |
| Obs | 335311 | 166684 | 168627 | 72377 | 76436 | 182021 |

Notes: This table reports results obtained when the dependent variable is combined standardized test scores in math and reading. The independent variable is real federal Head Start (HS) spending per child (in 2014\$) when the child was four years old. HS spending per child is scaled by \$500 (average spending during the period of study), thus the coefficients should be interpreted as the effect of a \$500 increase in funding. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with school-specific linear trends. Sample consists of third-grade students who are FRL certified, or who are identified as economically disadvantaged, based on the description by the Texas Education Agency (TEA). Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1988 and 1994. Standard errors are clustered at the county level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.8: The Effect of Head Start Exposure on Third Grade Standardized Test Scores
Sensitivity of Results to Different Measures of Head Start Exposure

| | Per Child (Age 3-4) | Per Capita | Per Poor Child (Age 3-4) |
|-------------------------------------|---------------------|---------------------|--------------------------|
| Head Start Funding Per Child (Main) | 0.031** (0.013) | | |
| Head Start Funding Per Capita | | 0.026*** (0.009) | |
| Head Start Funding Per Poor Child | | | 0.027** (0.013) |
| Mean Y | -0.355 | -0.355 | -0.355 |
| Mean X (\$) | 518 | 18 | 480 |
| Obs | 335311 | 335311 | 335311 |

Notes: This table contains results obtained when the dependent variable is combined standardized test scores in math and reading. Each column reports results obtained using different independent variables: (1) federal Head Start (HS) spending per three- and four-year-old child, (2) federal Head Start spending per capita, and (3) federal Head Start spending per poor three- and four-year-old child. All the dollar values are in 2014 dollars. All HS spending measures are scaled by the mean spending, thus the coefficients should be interpreted as the effect of exposure to an average-sized program. The exposure variables are assigned based on the county and year the child was four years old. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with county-specific linear trends. Sample consists of third-grade students who are FRL certified or who are identified as economically disadvantaged, based on the description by the Texas Education Agency (TEA). Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1988 and 1994. Standard errors are clustered at the county level. * p<0.10, ** p<0.05, *** p<0.01.

Table A.9: The Effect of Alternative Head Start Funding Measures
on Third Grade Standardized Test Scores

| | All | Males | Females | Whites | Blacks | Hispanics |
|-----------------------------------|---------------------|--------------------|------------------|-------------------|------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Head Start Funding Per Capita | 0.026*** (0.009) | 0.037** (0.015) | 0.018 (0.013) | -0.023 (0.052) | 0.057 (0.051) | 0.041*** (0.010) |
| Mean Y | -0.355 | -0.459 | -0.253 | -0.069 | -0.382 | -0.449 |
| Mean X(\$) | 18447 | 18450 | 18444 | 10752 | 9725 | 25335 |
| <i>Panel B:</i> | | | | | | |
| Head Start Funding Per Poor Child | 0.027** (0.013) | 0.033 (0.020) | 0.023 (0.017) | 0.000 (0.029) | 0.037 (0.036) | 0.050*** (0.014) |
| Mean Y | -0.355 | -0.459 | -0.253 | -0.069 | -0.382 | -0.449 |
| Mean X (\$) | 480346 | 480912 | 479786 | 416108 | 363267 | 556897 |
| Obs | 335311 | 166684 | 168627 | 72377 | 76436 | 182021 |

Notes: This table contains results obtained when the dependent variable is combined standardized test scores in math and reading. The independent variables are (1) real federal HS spending per capita (2014\$) when the child was four years old in Panel A and (2) real federal HS spending per poor child (2014\$) when the child was four years old in Panel B. Each measure is scaled by the mean spending, thus the coefficients should be interpreted as the effect of exposure to an average-sized program. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with county-specific linear trends. Sample consists of third-grade students who are FRL certified or who are identified as economically disadvantaged, based on the description by the Texas Education Agency (TEA). Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1988 and 1994. Standard errors are clustered at the county level. * p<0.10, ** p<0.05, *** p<0.01.

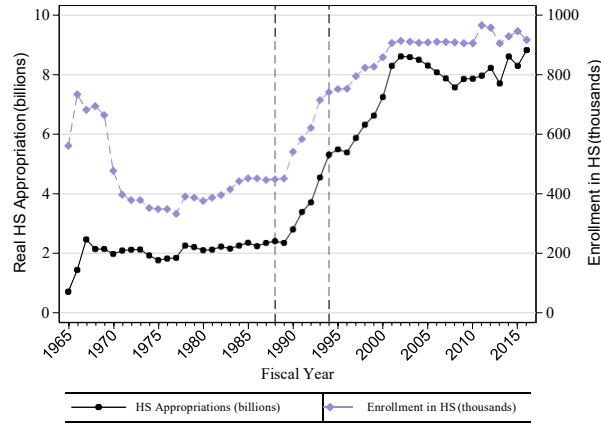
Table A.10: Falsification Tests: The Effect of Head Start Exposure on Third Grade
Standardized Test Scores for Students Not Certified for Free/Reduced Lunch

| | All | Males | Females | Whites | Blacks | Hispanics |
|--------------------|------------------|-------------------|------------------|------------------|------------------|-------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Head Start Funding | 0.002 (0.012) | -0.013 (0.023) | 0.006 (0.014) | 0.006 (0.017) | 0.017 (0.154) | -0.008 (0.026) |
| Mean Y | 0.312 | 0.255 | 0.369 | 0.392 | -0.037 | 0.050 |
| Obs | 407349 | 206309 | 201040 | 316015 | 31524 | 49827 |

Notes: This table reports results obtained when the dependent variable is combined standardized test scores in math and reading, and the independent variable is real federal HS spending per child (in 2014\$) when the child was four years old. HS spending per child is scaled by \$500 (average spending during the period of study), thus the coefficients should be interpreted as the effect of a \$500 increase in funding. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with county-specific linear trends. Sample consists of third-grade students who are *not* FRL certified based on the description by the Texas Education Agency (TEA). Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1988 and 1994. Standard errors are clustered at the county level. * p<0.10, ** p<0.05, *** p<0.01.

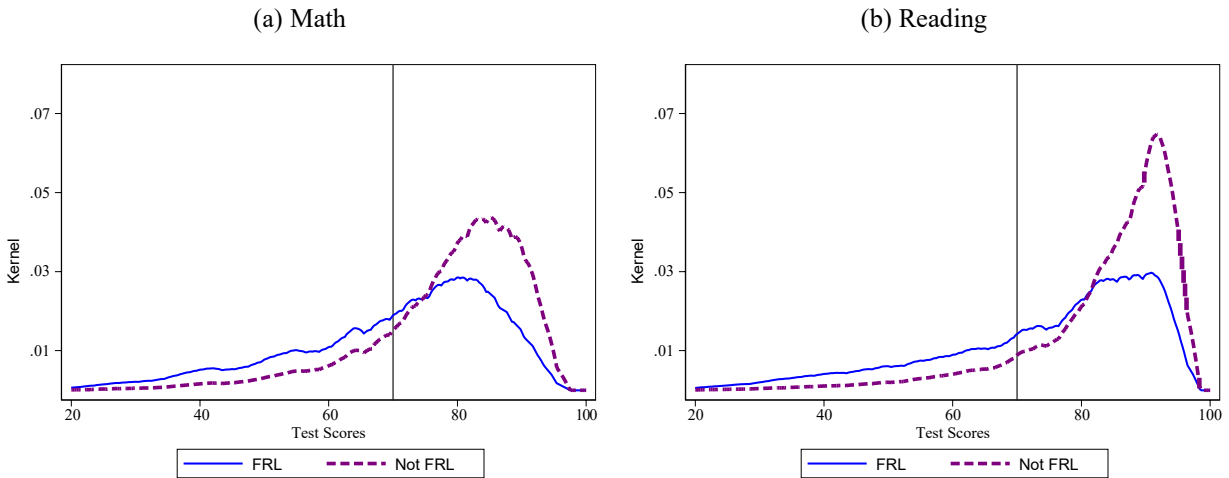
B. Figures

Figure A.1: Head Start Program Facts



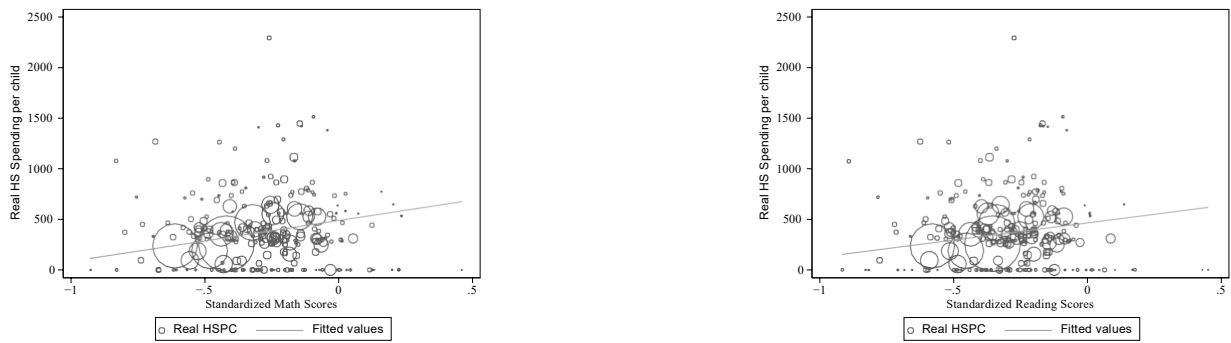
Notes: The data are from the U.S. Administration of Children Youth and Families in HHS. Retrieved from: <https://eclkc.ohs.acf.hhs.gov/hslc/data/factsheets/2015-hs-program-factsheet.html>. Federal Head Start appropriations are in 2014 dollars. The dashed lines highlight the period of this study, from 1988 to 1994.

Figure A.2: Kernel Density of Test Scores, by Free-or-reduced Lunch Status



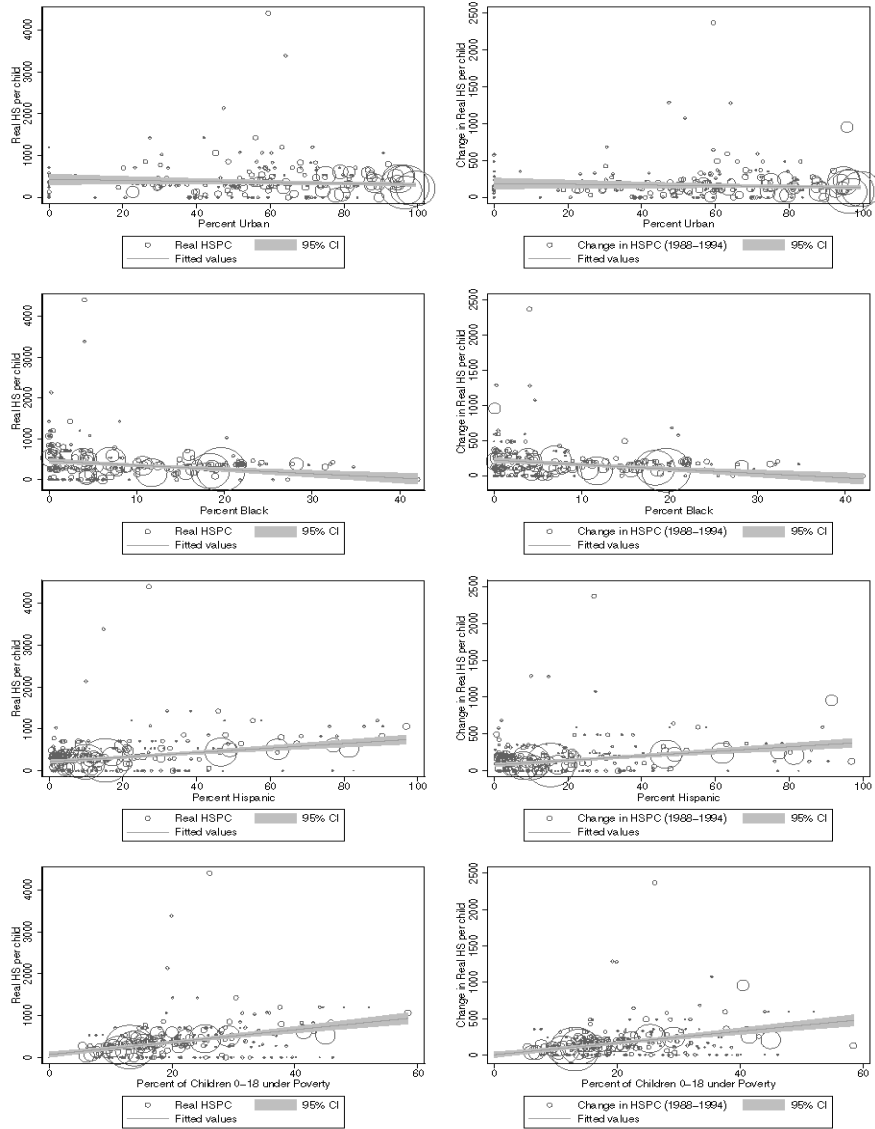
Notes: Test score data include all third-grade students who took the standardized test in Texas between 1994 and 1999, from the Texas Education Agency (TEA). The sample is divided into two groups: (i) students who are *not* identified as economically disadvantaged (Not FRL) and (ii) students who are FRL certified or who are identified as economically disadvantaged based on their families' welfare eligibility (FRL). The minimum passing score is 70, determined by the TEA. Kernel density calculated using a bandwidth of two.

Figure A.3: Raw Correlations between Head Start Funding per Child and Standardized Test Scores - Free/Reduced Lunch Certified Sample
(a) Math (b) Reading



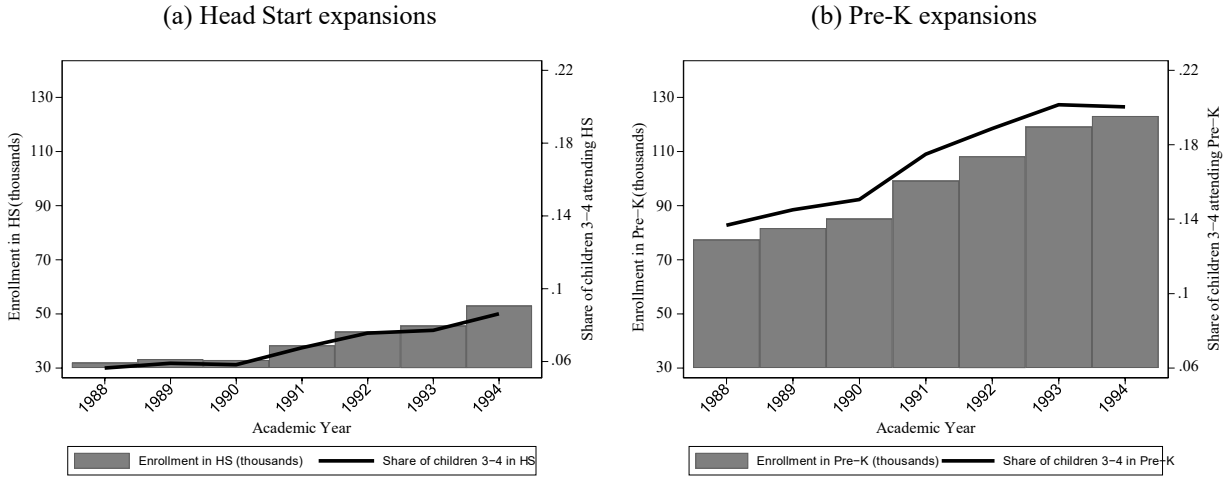
Notes: Head Start spending (in 2014\$) data are obtained from the Consolidated Federal Funds Reports), coupled with the population counts for three- and four-year-olds at the county-level from the SEER. Third-grade student test score data are from the Texas Education Agency (TEA) between 1994 and 1999. The data are collapsed to the county-level using averages. The bubbles represent counties, and weighted by the population of three- and four-year-olds.

Figure A.4: Correlations between 1980 County Characteristics and Head Start Funding per Child



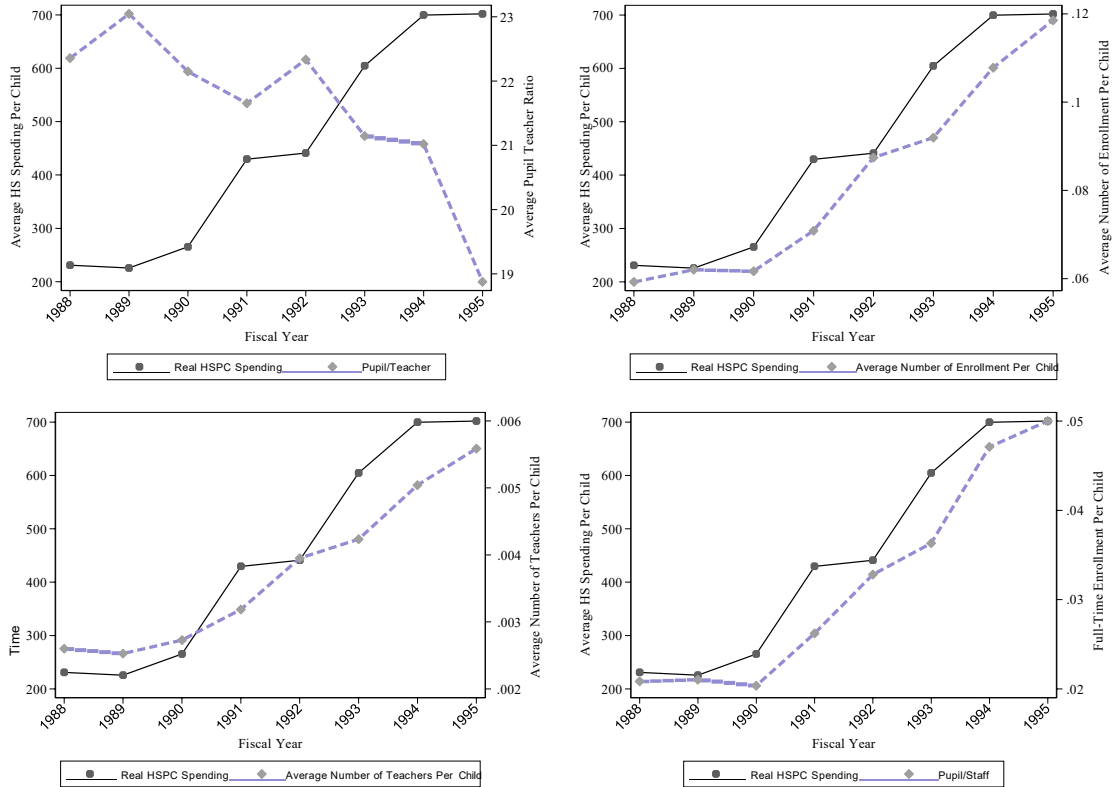
Notes: Head Start spending (in 2014\$) data are from Consolidated Federal Funds Reports (CFFR), coupled with the population counts for three- and four-year-olds at the county-level from the SEER. The 1980 county controls are from City and County Data Book. The bubbles present the counties, weighted by the population of three- and four-year-olds. On the left, the figures present the correlations between the county characteristics and the *average* HS spending per child for 1988-1994. On the right, the figures show the correlations between the county characteristics and the *change* in HS spending per child from 1988 to 1994.

Figure A.5: Early Childhood Education Expansions in Texas



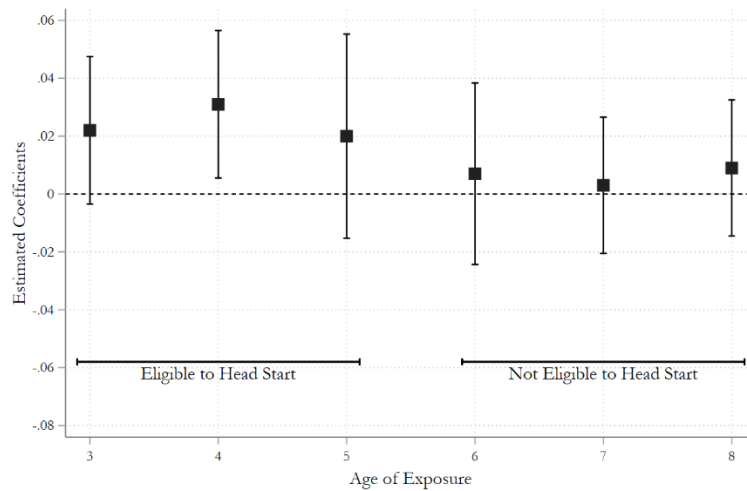
Notes: Head Start enrollment data are from the Program Information Reports (PIR). Pre-K enrollment data are from the Common Core Data (CCD). The share measure is calculated using the population counts for three- and four-year-olds from the SEER.

Figure A.6: Head Start Funding and Program Quality Trends



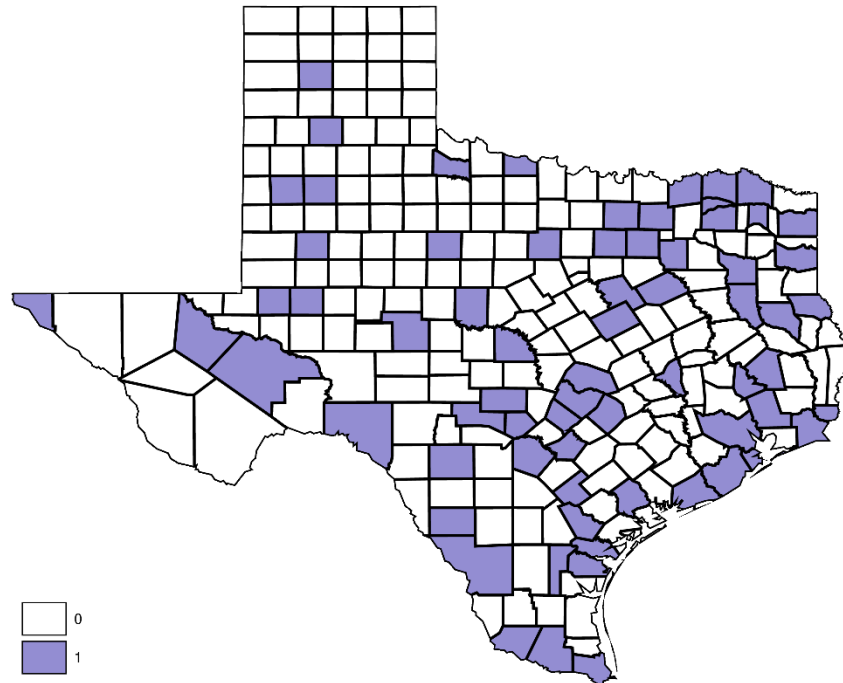
Notes: Head Start spending (in 2014\$) data are from Consolidated Federal Funds Reports (CFFR), coupled with the population counts for three- and four-year-olds at the county-level from the SEER. Head Start program data are from the Program Information Reports (PIR) for the years 1988 to 1995.

Figure A.7: Falsification Test: The Effect of Head Start Funding Exposure on Third Grade Test Scores - Differential Effects by Age



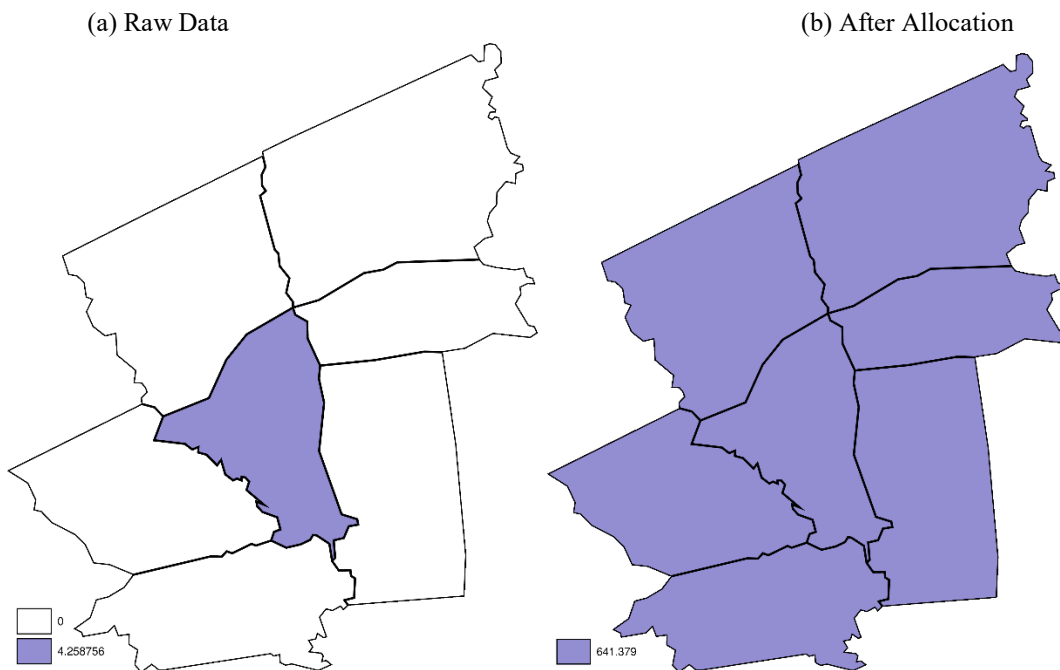
Notes: This figure reports coefficients and their 95% confidence intervals obtained from separate regressions when the dependent variable is combined standardized test scores in math and reading. The independent variable is real federal HS spending per child (in 2014\$), assigned when the child was at ages 3 to 8 years old. HS spending per child is scaled by \$500 (average spending during the period of study), thus the coefficients should be interpreted as the effect of a \$500 increase in funding. All regressions include controls for demographics and county-level characteristics, school, test year and birth year fixed effects, along with county-specific linear trends. Sample consists of third-grade students who are FRL certified or who are identified as economically disadvantaged, based on the description by the Texas Education Agency (TEA). Student data are from the TEA which include information on year of birth, ethnicity, economic disadvantage indicators and test scores conducted between 1994 and 1999. HS spending data are from the Consolidated Federal Files Reports (CFFR) and include years between 1988 and 1994. Standard errors are clustered at the county level.

Figure A.8: Raw Data: Indication of Positive Head Start Spending in 1994



Notes: Raw federal Head Start spending data at the grantee-level, from the Consolidated Federal Funds Reports. There are 69 grantees that served 196 counties in 1994.

Figure A.9: Brazos Valley Community Action Agency, Before and After Reallocation



Notes: Federal Head Start spending (in 2014\$) data at the grantee level are obtained from the Consolidated Federal Funds Reports, coupled with administrative data on the counties that each grantee serves (PCCOST data) from Currie and Neidell (2007). The figure on the left shows the raw federal funding data for Brazos Valley Community Action Agency in 1994. Using the PCCOST data, I determine the serving counties for this agency and distribute Head Start dollars at the local level based on the share of total age-eligible children living in a community.

II. Data Appendix

A. Public Use Data

- **Head Start Spending Data from Consolidated Federal Funds Reports (CFFR):**

Federal government expenditures data are reported annually in states and counties of the U.S. by program type. CFFR reports detailed information on the geographic distribution of federal program expenditures, including Head Start grants, using data submitted by federal departments and agencies. Head Start is administered by the Department of Health and Human Services (HHS), Administration for Children and Families (ACF), and Office of Head Start (OHS). HHS describes “grantees” as the agencies that receive grant awards directly. “Delegates” are other agencies that grantees may contract services. CFFR data span from 1983-2007, available through the National Archives. The program identification code for Head Start expenditures is 93.600.

When the federal government announces grant availability for a specific local community, it also announces which counties each grantee is expected to serve. However, the retrospective grant announcements are not available to researchers. To determine the serving counties for each grantee, I use an administrative data set on Head Start budgets (called PCCOST) provided by Currie and Neidell (2007). PCCOST includes detailed information on the allocation of total expenditures for education, health, and other services for each grantee and its network. These data cover the years 1990-2000 with comprehensive coverage of networks for the year 1994. I assigned the networks using the 1994 data. Based on my web search for a randomly chosen subset of grantees in Texas, I did not find evidence that the serving counties changed from 1988 to 1994.¹ I then confirmed these networks of counties using grantees’ websites and an additional data set provided by Frisvold (2006).

¹ If the assignment of the networks is wrong for some counties, it will create measurement error in the main right hand side variable in my analysis.

Frisvold (2006) constructed these networks of counties in 2005 using the website of the state's Head Start Association, the state's Head Start Collaboration Office, or through personal communication with a staff member in these organizations. Appendix Figure A.8 maps out the raw data in Texas in 1994, with 69 grantees. These grantees serve 196 counties in Texas.

To give a concrete example of the construction of these networks, consider the Brazos Valley Community Action Agency's headquarters in Texas, established in 1967,² located in Bryan, Texas (Brazos County). This grantee serves Head Start programs in six other counties.³ Thus, the raw data as shown in Appendix Figure A.9a records around \$4.3 million in expenditures for Brazos County in 1994 and zero dollars for all the serving counties. Using the network of counties that I constructed, I reallocated dollars for the serving counties in proportion to the number of age-eligible children in each network (see Appendix Figure A.9b for reallocation map).

- **Population Counts:** I use two separate data sets to construct the three different measures of the size of the Head Start program: Head Start spending per age-eligible child, per capita, and per poor child.
 - (a) County-level population data of children three and four years old are constructed using data from the Surveillance, Epidemiology, and End Results Program (SEER), which includes county-level population counts for each age group starting in 1969.
 - (b) County-level population to construct the per capita measure also comes from SEER.
 - (c) The number of poor children is from the Small Area Income and Poverty Estimates (SAIPE) of the U.S. Census Bureau. In the SAIPE data, county-level estimates of children younger than 17 and children 5-17 are available. Using these two variables, I construct the number of children younger than age five by taking

² Website: <http://www.bvcaa.org/history-of-bvcaa-inc/>

³ Website: <http://www.bvcaa.org/programs/head-startearly-head-start/>

the difference. To create age-eligible poor child counts, I follow Frisvold (2006) that states that children who are age 3-4 years old are two-fifths of children younger than age 5. These data are only available for years 1989, 1993, 1995, 1997-1999, the years in between are determined through linear interpolation.

- **Program Information Reports (PIR):** Starting in 1988, the Office of Head Start has collected comprehensive data from all grantees and delegates on the services, staff, children, and families served by the program. These data are essential for my analysis as they provide information on the number of funded enrollees, number of staff, demographic composition of children, qualifications of directors and teachers, and so on. I use this information to show how much funding expansions translate into enrollment versus the quality of the Head Start programs. PIR data are not commonly used because the format of these data and variables collected changed over time. The main variables I use from the PIR dataset, enrollment (all and full-time), and number of teachers, are available all the years starting in 1988. Enrollment by race/ethnicity is available in 1988, and between 1992 and 1994, the missing data in the years between (1989-1991) are linearly interpolated.

PIR data have become more comprehensive with additional information (i.e., educational background of directors and teachers) included in the surveys during and after the 1990s. For example, relevant but not usable in my analysis, the number of teachers with AA or BA degrees is collected starting in 1999. For my purposes, data on directors' salary and education levels are available starting in 1992. Part of these data from 1988 and 1998 were generously provided to me by Currie and Neidell (2007).

- **Common Core of Data (CCD):** CCD includes the school level information for all *public* schools. These data are available starting in 1986 at the school level and provide information on pupil-teacher ratio, a measure used for education quality in the education literature and the demographic composition of students and the grade

levels offered in a specific school.

CCD's pre-K attendance data report public pre-K enrollment that takes place in public elementary schools, excluding public pre-K programs that take place in private preschools or daycare. Therefore, it has measurement error.

- **County-level Demographics:** I use the Regional Economic Information Systems (REIS) to construct county-year data on per capita income, per capita transfer payments for cash income support (Aid to Families with Dependent Children and SSI), medical benefits (Medicare, Medicaid, and Children's Health Insurance Program), food assistance (food stamps), retirement, and disability programs. I add county-level controls (income per capita and other government transfers including food stamps per capita and cash transfers per capita) at birth and the survey time to my analysis.

Using the 1983 City and County Data Book (before the 1990s Head Start spending expansion), I construct other county demographics. These include the 1980 population living in an urban area, black, Hispanic, single parent, less than age 5, ages 65 or older, and percentage of 0- to 18-year-olds living in poverty as well as income, education, and welfare spending per capita (in 2014 dollars). To control for exposure to business cycles at birth, I use the county-year unemployment rate from the Bureau of Labor Statistics.

Finally, I use SEER data to control for the composition of the population demographics at the county level by racial and age groups.

B. Data from Texas Education Agency (TEA)

Student-level data from the TEA⁴ include information on test scores monitored through the Texas Academic Assessment System (TAAS) for grades 3 to 8 between 1994 and 1999. These data are de-identified and are not linked across the years. They contain information on birth year, sex, race/ethnicity, FRL status for all students, language proficiency, and

⁴ These data are currently administered and available to approved researchers by the University of Texas Education Research Centers in Austin and Dallas. The data available at these centers are more detailed and available to be linked across years.

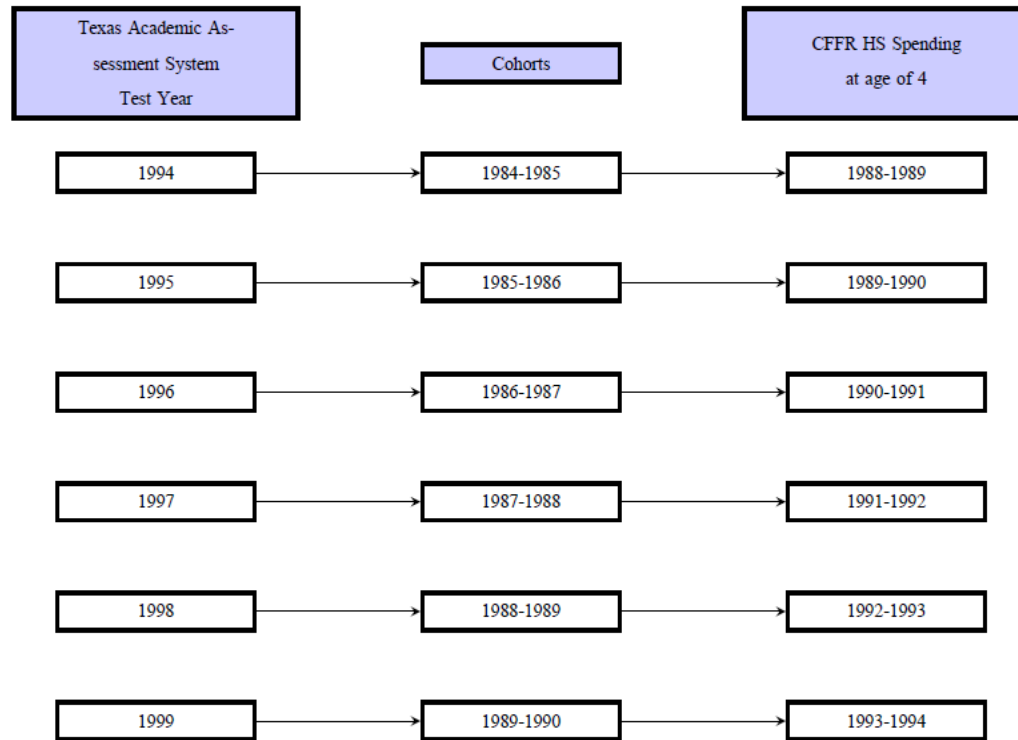
special education status for students in the third grade. Descriptions for two critical variables:

- i. Main outcome variable: Texas Learning Index (TLI) reading and math scores.
- ii. Economic disadvantage variable:
 1. 0: Not identified as economically disadvantaged
 2. 1: certified for free meals under the National School Lunch and Child Nutrition Program
 3. 2: Eligible for reduced-price meals under the National School Lunch and Child Nutrition Program
 4. 9: Other economic disadvantage, including:
 - a. from a family with an annual income at or below the official federal poverty line
 - b. eligible for Temporary Assistance to Needy Families (TANF) or other public assistance
 - c. received a Pell Grant or comparable state program of need-based financial assistance
 - d. eligible for programs assisted under Title II of the Job Training Partnership Act (JTPA)
 - e. eligible for benefits under the Food Stamp Act of 1977

School district to county crosswalk is obtained from the TEA website: <http://mansfield.tea.state.tx.us/TEA.AskTED.Web/Forms/DownloadFile.aspx>. For schools that do not currently operate, I manually entered the county information gathered via web searches.

C. Data Structure

The chart below shows the correspondence of test years with third-grade cohorts and their Head Start exposure at age four.



III. Cost-Benefit Analysis

This section provides a back-of-the-envelope calculation of a cost-benefit analysis of federal Head Start spending expansions. Several studies have attempted to calculate the social benefits of the Head Start program and have shown that, in most cases, the program passes a cost-benefit test. However, as stated in Elango et al. (2015), this is a challenging exercise and requires strong assumptions. Here, I attempt to obtain the costs and benefits associated with a \$500 increase in federal Head Start funding, assuming that the Head Start program accrues test score gains in the third grade and that these estimates will translate into later earnings.⁵ This analysis adopts the cost-benefit formulation constructed by Kline and Walters (2016) for one year of Head Start attendance using the HSIS. All monetary values are converted to 2014 dollars. The marginal cost is \$500 per child because the analysis is based on the test score impact of a \$500 increase in federal funding per child. To calculate the marginal benefit, I need two parameters: (1) the potential link between third-grade test scores and earnings and (2) a prediction of average earnings for my sample (FRL-certified students in Texas). Although I cannot directly measure the impact on earnings due to data limitations, other studies that examine the link between test scores and earnings provide estimates. Following Kline and Walters (2016), I use a conservative estimate that earnings rise by 10 percent for each standard deviation increase in test scores.

Chetty et al. (2011) calculate that the present value of earnings at age 12 for the average individual in the U.S. is approximately \$566,720 (in 2014 dollars). The average present discounted value of the predicted earnings at age four corresponds to around \$434,000, with a discount rate of 3 percent. Adjusting that the median earnings in Texas are about 94 percent of the median earnings in the U.S., the average present discounted value corresponds to \$407,960.⁶

⁵ Following Kline and Walters (2016), I assume that there are no effects on crime, health, or grade repetition or no impacts on parents that raise benefits of the return of the program. This is an unrealistic assumption, considering that Carneiro and Ginja (2014) find large and significant health and behavioral effects for cohorts who attended Head Start in similar years. There is also an implicit assumption that third-grade test score effects do not fade out over time.

⁶ Using the Current Population Survey (CPS) Annual Social and Economic Supplement (CPS ASEC), between 1988 and 1994, the median earnings in the U.S. was \$25,310 (in 2014 dollars), while in Texas it was approximately \$23,814 (in 2014 dollars).

Children who participate in FRL are economically disadvantaged and are likely to earn less than the median earner. As an approximation, the median income for families at or below 150 percent of the federal poverty level is 38 percent of the average in Texas.⁷ Using the estimate for intergenerational income elasticity reported by Lee and Solon (2009) of 0.4, the average child in FRL is expected to earn 75.2 percent of the average $(1 - (1 - 0.38) * 0.4)$. These predictions yield a present value of earnings of approximately \$307,000.

Putting the pieces together, 10 percent of \$307,000 is \$30,700 and multiplying it with the test score impact of 0.031 yields a projected earnings impact of roughly \$950. These calculations show that a conservative estimate of the benefit-cost ratio is around 1.9. This estimate of 1.9 is much larger than the estimated rates of return associated with the Earned Income Tax Credit (0.88) and the Food Stamps Program (0.66) reported in Hendren (2016).

Finally, I compute the marginal value of public funds (MVPF) using the framework developed by Kline and Walters (2016) and Hendren and Sprung-Keyser (2020) and assuming the tax and transfer rate of 20 percent on the earnings. The MVPF is the ratio of the willingness to pay (the net after-tax benefits to individuals) divided by the net cost of the policy to the government (including the upfront cost and the other fiscal externalities) (Hendren and Sprung-Keyser, 2020). In my setting, the government's tax collection would be close to \$190 ($=\$950*0.2$) from a \$950 increase in earnings with a 20 percent tax and transfer rate, which would imply that the net after-tax benefit to the participants of \$760 ($=\$950-\190) and the net cost of a \$500 increase in funding for Head Start to the government of \$310 ($=\$500-\190). These calculations show a conservative estimate of the MVPF of 2.45 ($=\$760/\310), which is similar to the estimated MVPF of one year of Head Start attendance reported in Kline and Walters (2016) for the HSIS cohorts (around 2.41) but larger than the estimated MVPF for the EITC and the nutrition assistance program expansions (Hendren and Sprung-Keyser, 2020).⁸

⁷ Between 1988 and 1994 in Texas, the median earnings was about \$25,310, but families with incomes at or below 150 percent of the poverty level made \$9,584 according to the CPS.

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