

Inputs in the Production of Early Childhood Human Capital: Evidence from Head Start

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Online Appendix

The data for this analysis come from the Head Start Impact Study (HSIS). The HSIS data includes information on 4,442 students. Each student applied to one of 353 Head Start centers in Fall 2002, and each center is associated with one of 84 regional Head Start program areas. The data includes separate files with information on test scores, answers to parental surveys, and Head Start center characteristics. This Appendix describes the procedure used to clean each data source and construct the data set used for analysis.

Test Score Data

Test score information comes from a series of assessments conducted in Fall 2002, Spring 2003, Spring 2004, Spring 2005 and Spring 2006. From each assessment file, I extract raw scores for the 17 tests listed in column (1) of Table 1. These 17 tests are the main outcomes examined by DHHS (2010). The data also include a few other tests (for example, the Leiter Sustained Attention Task), but DHHS (2010) expresses reservations about their reliability and hence they are excluded. Not all tests were administered every year, and there were some differences in the tests administered to Spanish-speaking and English-speaking students; for example, the TVIP and Spanish CTOPPP were administered to Spanish speakers only. To construct the cognitive summary index outcome, I standardize each test relative to the control group among students who took the test separately for each cohort and assessment period. I then compute the mean of observed standardized outcomes for each child. Finally, I append together the data sets for each assessment period, and use a unique student identifier to reshape the data into a wide format file with one observation per student and a separate variable for the cognitive summary index in each assessment period.

Parent Survey Data

Baseline demographics

Information on student demographics is drawn from a baseline survey of parents conducted in Fall 2002. Eighty-one percent of households responded to this survey (3,577 of 4,442). This demographic information is supplemented with a set of derived variables from the HSIS “Covariates and Subgroups” data file. This file combines the baseline survey with information collected during experimental recruitment to fill in missing values for some demographic variables. When variables are present in both files, information from the “Covariates and Subgroups” file is used.

Non-cognitive outcomes

Indices of non-cognitive skill are constructed from the baseline parental survey and follow-up surveys conducted in Spring 2003, Spring 2004, Spring 2005 and Spring 2006. I begin with the all social and emotional outcomes analyzed by DHHS (2010). Each outcome is redefined so that a positive sign is favorable, and then standardized relative to the control group separately by cohort and survey period. I also retain raw measures of each outcome. I then append together the files for all periods. To exclude outcomes without meaningful variation, I compute the mean of each raw outcome over all survey periods, and drop outcomes where more than 90% of responses were the same. This produces the set of outcomes listed in column (2) of Table 1. I then compute the non-cognitive summary index for each survey period as the mean of the remaining standardized outcomes. Finally, I use the unique student identifier to reshape the data into a wide format file with one observation per student and a separate variable for the non-cognitive summary index in each survey period.

Measuring Head Start Assignment and Attendance

Head Start assignment comes from an administrative variable generated at the time of random assignment. Head Start attendance in Spring 2003 is also measured administratively. To measure Head Start attendance

in later periods, I combine this administrative measure with parental survey information. Specifically, I set Head Start attendance equal to one for Spring 2004, Spring 2005 and Spring 2006 if the Spring 2003 administrative measure is one, or if a parent indicated Head Start attendance at any time up to the relevant time period. For time periods after Spring 2003, the Head Start attendance variable is missing for children whose parents did not respond to the survey, because attendance cannot be accurately measured for these students. This restriction does not affect the main results, which focus on Spring 2003.

Center Characteristics

The characteristics of Head Start centers are measured from a childcare center director survey conducted in Spring 2003. The survey attempted to collect information from directors of all childcare centers attended by sample children, including members of the control group who attended childcare outside of Head Start centers in the experimental sample. The director survey data set is a student-level file, with variables capturing responses of the center director at the center attended by each child. The seven inputs listed in Table 3 are derived from the following questions:

- **High/Scope curriculum:** “If your principal curriculum has a name, what is that name?” Centers are coded as High/Scope if the director selected High/Scope from among a list of possible answers to this question.
- **Fraction of staff with bachelors degree:** “Approximately what percentage of lead and assistant teachers in your center have a bachelors degree or higher?”
- **Fraction of staff with teaching license:** “Approximately what percentage of lead and assistant teachers in your center have a teaching certificate or license?”
- **Student/staff ratio:** This variable is an administrative measure that divides the sum of male female enrollment at a center by the number of staff at the center.
- **Full-day service:** “What child care options are provided at the center?” Centers are coded as full-day if the director selected “full-day” from a list of possible responses to this question.
- **More than three home visits per year:** “How many home visits are required per program year?” Directors were given a list of possible responses to this question. About 1 percent of responses were “1 visit,” 79 percent of responses were “2-3 visits,” and 20 percent of responses were “more than three visits.”
- **Center director experience:** “How many years have you worked with the following types of center-based and child care programs?” Directors were asked to answer this question for three categories: “Head Start,” “Non-Head Start center-based programs,” and “Non center-based child care programs.” Director experience is measured as the sum of years spent in Head Start and non-Head Start center-based programs.

I use these questions to derive the characteristics of each center of random assignment. To this end, I keep observations administratively coded as both assigned to the treatment group and attending Head Start. In some cases, codes for the center director were different for such students within a center of random assignment. I use responses for the center director most frequently associated with treated students at a given center of random assignment. For 7 percent of centers, there were two center director interviews associated with an equal number of treated students. I break ties randomly to determine which responses to use in these cases. I then keep one observation per center of random assignment. The resulting data set has information for 89 percent (314 out of 353) of centers in the HSIS experiment.

Constructing the Analysis Data Set

The procedure described above yields 5 data files: A test score file, a baseline demographic file, a non-cognitive outcome file, a file coding Head Start attendance after Spring 2003, and a center characteristics

file. I merge the first four of these files using a unique student identifier. I then merge the resulting file with the center characteristics file using an identifier for center of random assignment. Finally, I merge on a sixth file containing the HSIS baseline child weights, which yields the final data set used for analysis.

Table A1: Attrition by Cohort and Year

Time period	Cohort	Cognitive skills		Non-cognitive skills	
		Follow-up rate (1)	Differential (2)	Follow-up rate (3)	Differential (4)
Spring 2003	3-year-olds	0.842	0.027* (0.015) 2449	0.838	0.003 (0.013) 2449
	4-year-olds	0.814	0.047** (0.019) 1993	0.813	0.018 (0.016) 1993
Spring 2004	3-year-olds	0.835	0.021 (0.019) 2449	0.821	0.026 (0.020) 2449
	4-year-olds	0.770	0.009 (0.022) 1993	0.780	0.015 (0.018) 1993
Spring 2005	3-year-olds	0.787	-0.003 (0.019) 2449	0.819	0.008 (0.017) 2449
	4-year-olds	0.766	0.010 (0.025) 1993	0.781	0.026 (0.025) 1993
Spring 2006	3-year-olds	0.766	0.016 (0.020) 2449	0.805	0.032* (0.019) 2449

Notes: This table reports attrition rates for the HSIS sample. Columns (1) and (3) show fractions of children with observed outcomes by cohort and time period. Columns (2) and (4) report treatment/control differences. These differences are coefficients from regressions of a dummy for an observed outcome on treatment status, with the same controls and weighting scheme as in Table 4.

***significant at 1%; **significant at 5%; *significant at 10%

Table A2: Comparison of Instrumental Variables and Maximum Likelihood Estimates

Outcome (Spring 2003)	Instrumental variables		Maximum likelihood	
	First stage (1)	Head Start effect (2)	First stage (3)	Head Start effect (4)
Cognitive skills	0.681*** (0.026)	0.133*** (0.030)	0.719*** (0.019)	0.137*** (0.033)
Non-cognitive skills	0.681*** (0.025)	0.010 (0.025)	0.719*** (0.018)	0.026 (0.021)

Notes: This table compares parameter estimates from instrumental variables to maximum likelihood estimates of the selection model described in the text with no cross-center heterogeneity. The sample pools the three- and four-year-old cohorts. IV models use the same controls and weighting scheme as in Table 4. Standard errors are clustered at the Head Start center level.

***significant at 1%; **significant at 5%; *significant at 10%

Table A3: Random Coefficients Estimates By Time Period

Parameter	Description	Cognitive skills		Non-cognitive skills	
		Spring 2003 (1)	Spring 2005 (2)	Spring 2003 (3)	Spring 2005 (4)
$E[\alpha_{ij}]$	Mean treated outcome	0.105*** (0.026)	-0.010 (0.028)	0.024 (0.017)	0.016 (0.017)
$E[\alpha_{0j}]$	Mean non-treated outcome	-0.009 (0.026)	-0.021 (0.028)	0.000 (0.017)	0.015 (0.017)
$E[\lambda_j]$	Mean of intercept in selection equation	-1.351*** (0.026)	-0.412*** (0.028)	-1.346*** (0.017)	-0.429*** (0.017)
$E[\log\pi_j]$	Mean of log of offer coefficient in selection equation	0.838*** (0.026)	0.396*** (0.028)	0.837*** (0.017)	0.411*** (0.017)
$[Var(\alpha_{ij})]^{1/2}$	Std. dev. of mean treated outcome	0.223*** (0.020)	0.251*** (0.035)	0.103*** (0.013)	0.083*** (0.015)
$[Var(\alpha_{0j})]^{1/2}$	Std. dev. of mean non-treated outcome	0.256*** (0.025)	0.269*** (0.044)	0.092*** (0.016)	0.074*** (0.020)
$[Var(\lambda_j)]^{1/2}$	Std. dev. of intercept in selection equation	0.921*** (0.106)	0.509** (0.218)	0.883*** (0.102)	0.481*** (0.125)
$[Var(\log\pi_j)]^{1/2}$	Std. dev. of log of offer coefficient in selection equation	0.569*** (0.064)	0.434*** (0.072)	0.500*** (0.060)	0.410*** (0.064)
σ_1	Std. dev. of error in treated equation	0.579*** (0.011)	0.649*** (0.012)	0.413*** (0.009)	0.450*** (0.010)
σ_0	Std. dev. of error in non-treated equation	0.626*** (0.015)	0.699*** (0.018)	0.414*** (0.010)	0.461*** (0.015)
ρ_1	Correlation between treated outcome and selection error	0.089 (0.083)	-0.038 (0.066)	0.011 (0.088)	0.041 (0.077)
ρ_0	Correlation between control outcome and selection error	0.142*** (0.053)	0.076 (0.069)	-0.012 (0.051)	0.025 (0.065)

Notes: This table lists maximum simulated likelihood estimates of parameters of the cross-center distribution of Head Start effects by year. The sample pools the three- and four-year-old cohorts, and observations are weighted using the HSIS baseline child weights. The MSL procedure uses 1,000 simulations for each Head Start center. Standard errors are robust to misspecification and are clustered at the Head Start center level.

***significant at 1%; **significant at 5%; *significant at 10%

Table A4: Random Coefficients Estimates for Spring 2005

Parameter	Description	Cognitive skills		Non-cognitive skills	
		Estimate (1)	Standard error (2)	Estimate (3)	Standard error (4)
$E[\Phi(\lambda_j + \pi_j) - \Phi(\lambda_j)]$	Mean compliance probability	0.520***	0.023	0.527***	0.022
$[Var(\Phi(\lambda_j + \pi_j) - \Phi(\lambda_j))]^{1/2}$	Std. dev. of compliance probability	0.184***	0.011	0.174***	0.011
$E[\alpha_{1j}]$	Mean treated outcome	-0.014	0.029	0.019	0.018
$E[\alpha_{0j}]$	Mean non-treated outcome	-0.029	0.097	-0.004	0.027
$E[\alpha_{1j} - \alpha_{0j}]$	Mean Head Start effect	0.015	0.095	0.022	0.033
$[Var(\alpha_{1j} - \alpha_{0j})]^{1/2}$	Std. dev. of Head Start effects	0.065**	0.028	0.033***	0.007

Notes: This table lists maximum simulated likelihood estimates of parameters of the cross-center distribution of Head Start effects in Spring 2005. The sample pools the three- and four-year-old cohorts, and observations are weighted using the HSIS baseline child weights. The MSL procedure uses 1,000 simulations for each Head Start center. Standard errors are robust to misspecification and are clustered at the center level.

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Table A5: Maximum Likelihood Estimates of Finite-type Models

Parameter	Description	Three-type model			Five-type model				
		Type 1 (1)	Type 2 (2)	Type 3 (3)	Type 1 (4)	Type 2 (5)	Type 3 (6)	Type 4 (7)	Type 5 (8)
α_1^k	Mean treated outcome	-0.055** (0.027)	0.385*** (0.033)	0.069 (0.054)	-0.059** (0.027)	0.355*** (0.039)	0.408*** (0.095)	0.116 (0.104)	0.106 (0.064)
α_0^k	Mean control outcome	-0.184*** (0.032)	0.249*** (0.038)	0.281** (0.133)	-0.171*** (0.032)	0.318*** (0.043)	-0.144 (0.109)	0.925*** (0.192)	0.005 (0.139)
$\alpha_1^k - \alpha_0^k$	Head Start effect	0.130*** (0.039)	0.135*** (0.046)	-0.211 (0.131)	0.112*** (0.040)	0.037 (0.052)	0.552*** (0.137)	-0.809*** (0.199)	0.101 (0.154)
$\Phi(\lambda^k + \pi^k) - \Phi(\lambda^k)$	Compliance probability	0.760*** (0.020)	0.865*** (0.019)	0.214*** (0.079)	0.748*** (0.022)	0.842*** (0.024)	0.936*** (0.033)	0.552*** (0.103)	0.012 (0.099)
P^k	Type probability	0.524*** (0.051)	0.344*** (0.045)	0.133*** (0.032)	0.518*** (0.052)	0.263*** (0.047)	0.097** (0.039)	0.034** (0.017)	0.088*** (0.027)
$\left[\sum P^k ((\alpha_1^k - \alpha_0^k) - (\bar{\alpha}_1 - \bar{\alpha}_0))^2 \right]^{1/2}$	Std. dev. of Head Start effects		0.116				0.222		

Notes: This table reports maximum likelihood estimates of finite-type models for cognitive skills in Spring 2003. Columns (1)-(3) come from a model assuming Head Start centers belong to one of three types, while columns (4)-(8) come from a model assuming centers belong to one of five types. Standard errors are robust to misspecification and are clustered at the center level.

Table A6: Relationships Between Inputs and Head Start Effects in Spring 2005

Variable	Cognitive skills			Non-cognitive skills		
	Two-stage least squares		Maximum likelihood	Two-stage least squares		Maximum likelihood
	Bivariate	Multivariate		Bivariate	Multivariate	
(1)	(2)	(3)	(4)	(5)	(6)	
<i>A. Center characteristics</i>						
Any staff with bachelor's degree	0.034 (0.077)	0.003 (0.069)	0.023 (0.050)	0.065 (0.072)	0.026 (0.069)	-0.003 (0.033)
Any staff have teaching license	-0.012 (0.083)	-0.011 (0.084)	0.038 (0.051)	0.003 (0.072)	-0.057 (0.079)	-0.008 (0.036)
Low student/staff ratio	-0.041 (0.077)	-0.044 (0.076)	-0.060 (0.050)	0.027 (0.071)	0.050 (0.069)	0.031 (0.034)
Full day service	-0.035 (0.080)	0.000 (0.075)	0.043 (0.049)	0.014 (0.074)	-0.020 (0.069)	-0.016 (0.032)
More than three home visits per year	0.028 (0.100)	0.009 (0.093)	0.093 (0.061)	0.008 (0.093)	0.002 (0.082)	-0.033 (0.041)
High/Scope curriculum	-0.070 (0.080)	-0.104 (0.078)	0.026 (0.051)	0.124* (0.069)	0.123* (0.067)	0.041 (0.033)
High center director experience	0.006 (0.077)	-0.024 (0.071)	0.004 (0.050)	0.026 (0.070)	0.027 (0.063)	0.010 (0.032)
<i>B. Child characteristics</i>						
Mother graduated high school	0.117 (0.077)	0.119* (0.072)	-0.028 (0.054)	-0.059 (0.060)	-0.108* (0.062)	-0.024 (0.036)
High income	-0.065 (0.080)	-0.105 (0.072)	-0.104** (0.047)	0.115* (0.059)	0.126** (0.058)	0.016 (0.034)
High baseline skills	0.112 (0.078)	-0.004 (0.066)	-0.052 (0.045)	0.008 (0.060)	0.039 (0.060)	0.029 (0.036)
<i>C. Counterfactual childcare choices</i>						
High center-based preschool complier share	0.059 (0.074)	0.080 (0.078)	-0.048 (0.052)	0.029 (0.061)	0.025 (0.063)	-0.023 (0.031)
Residual std. dev. of Head Start effects	-	-	0.062	-	-	0.027
<i>R</i> -squared			0.099			0.345

Notes: This table reports estimates of relationships between Head Start effects and inputs in Spring 2005. Two-stage least squares models instrument Head Start attendance and its interactions with inputs using assignment to Head Start and its interactions with inputs, with the same weighting scheme and controls as in Table 4. Columns (1) and (4) estimate a separate interaction model for each input, while columns (2)-(3) and (5)-(6) include all interactions simultaneously. Main effects of interacting variables are included as controls. Standard errors are clustered at the Head Start center level.

***significant at 1%; **significant at 5%; *significant at 10%