

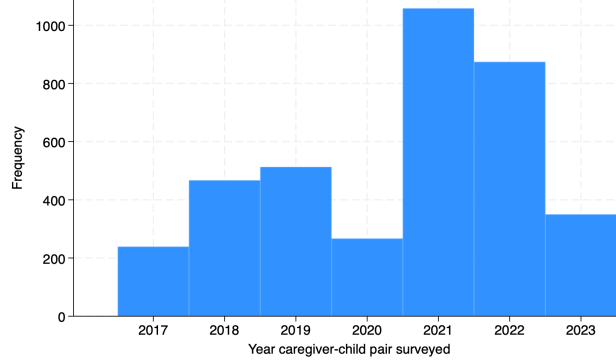
Online Appendix

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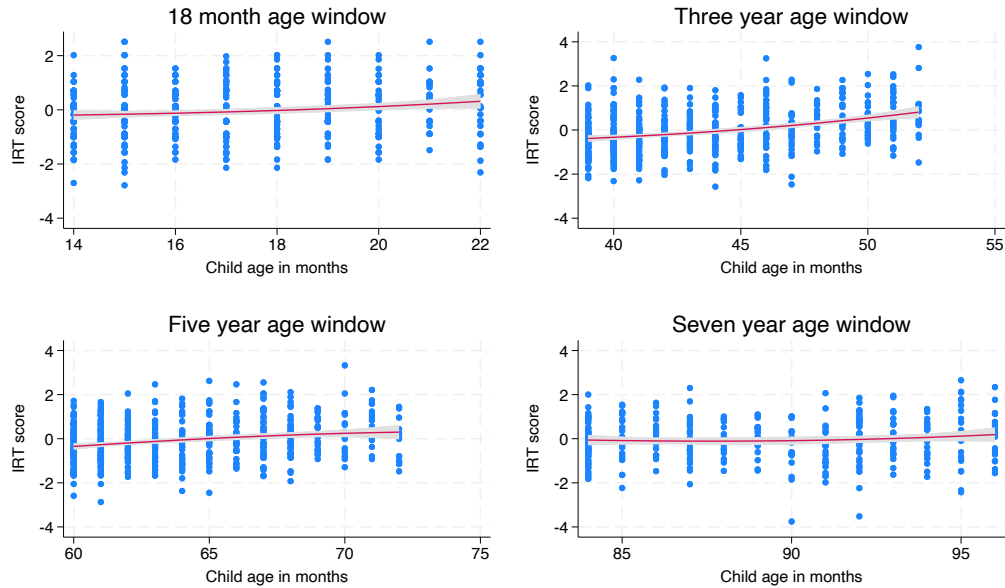
A Appendix Figures and Tables

Figure A1: Distribution of caregiver-child in-person surveys by year



Notes: Caregiver-child in-person surveys refer to the surveys where the caregiver answered a series of questions and the child attempted the child cognitive games.

Figure A2: Cognitive Development Scores by Age in Months



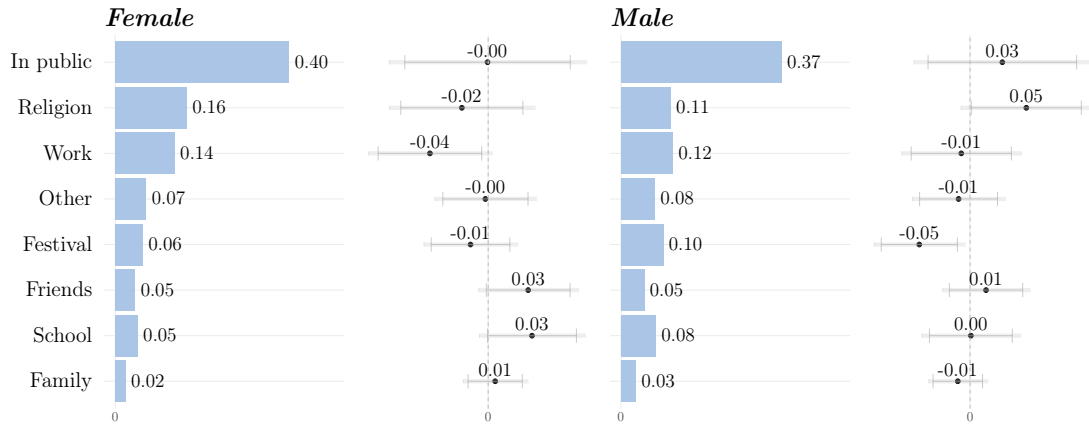
Notes: Plots only include the control group's children. Data are from 2017-2022 in-person measures administered by the surveyors with the target children at the following target ages: 14-22 months old ("18 month"), 39-52 months old ("Three"), 60-72 months old ("Five"), 84-96 months old ("Seven"). The latent abilities ("IRT score") of the child is estimated using a one parameter logistic item response theory model.

Figure A3: Marriage Market Outcomes for Scholarship-Lottery Participants

(a) Share ever living with a partner



(b) How/where did you meet your most recent partner?

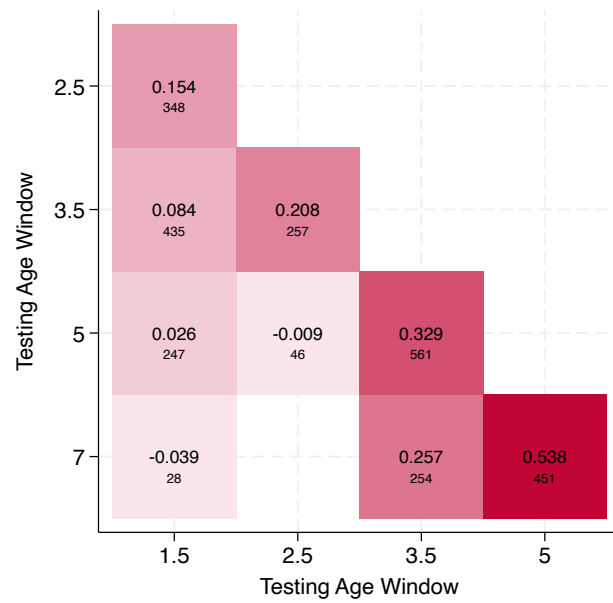


(c) Age Gap between Male and Female Partner



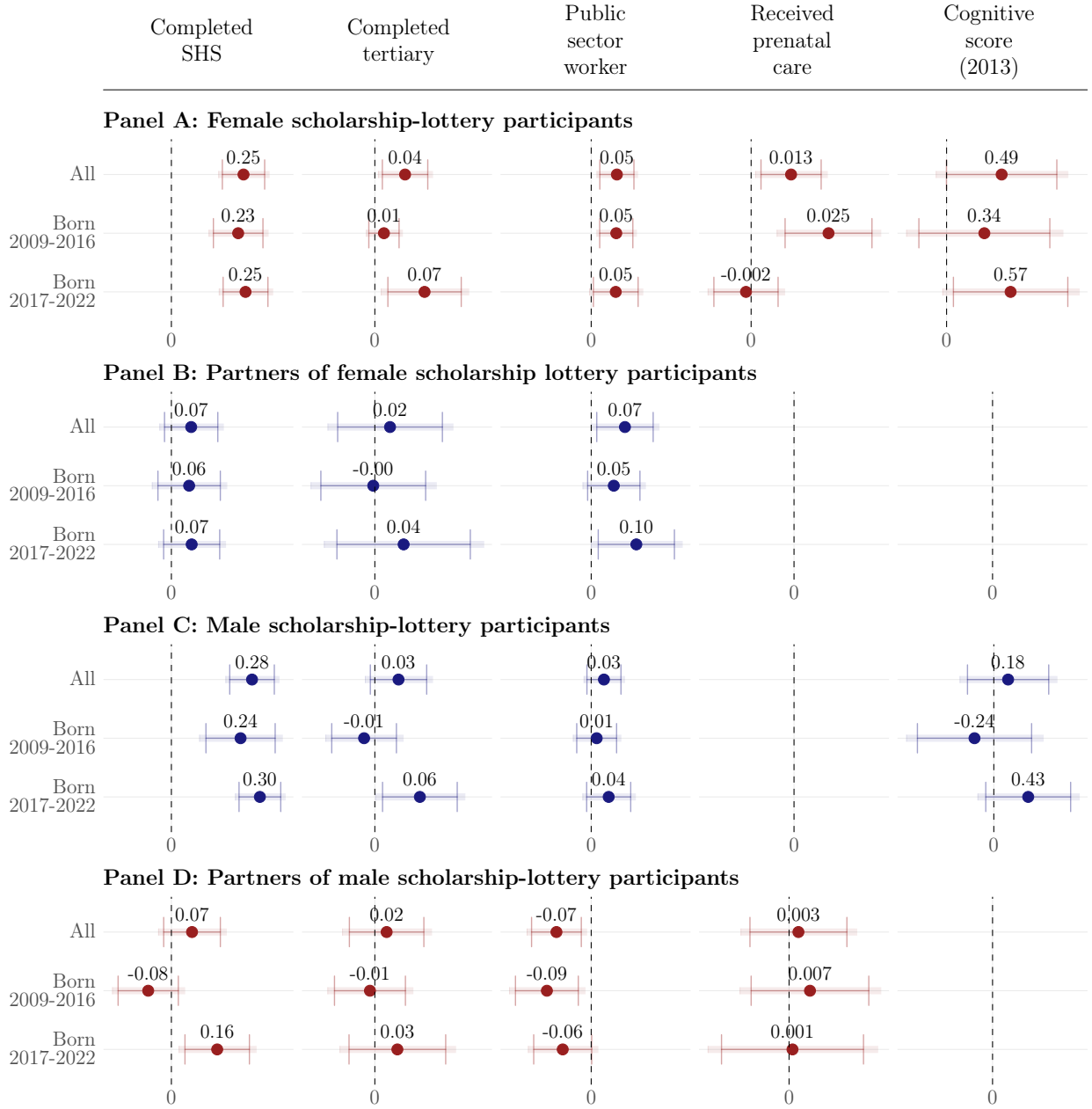
Notes: Observations are scholarship-lottery participants. Bars show comparison group means, and the point estimates and confidence intervals for the treatment effects. Subfigure (b) includes participants ever living with a partner by 2022.

Figure A4: Correlations Between Cognitive Development Scores Across Age Windows



Notes: This figure shows the pairwise correlations between cognitive test scores for children tested at least twice at different milestone age windows.

Figure A5: Scholarship lottery participant and partner characteristics: Survival-to-1 sample



Notes: An observation is a second-generation child for whom survival to age 1 is available. The graphs show characteristics of the child's "scholarship eligible" parent (Panel A if female, Panel C if male) and of the partner of the child's "scholarship-eligible" parent (Panels B and D). Within each panel, the two rows show the results for the pooled sample, and the next two rows split the sample at the median birth year (2017).

Table A1: First Generation Impact of Scholarship—scholarship-lottery participants with at least one child

	(1) Cognitive test score (2013)	(2) Completed SHS (2019)	(3) Completed tertiary (2023)	(4) Earnings last 6 months (GHX, 2019)	(5) Earnings last 6 months (GHX, 2023)	(6) Self- employed (2019)	(7) In public sector (2019)	(8) In public sector (2023)
<i>Panel A: Female scholarship-lottery participants</i>								
Treatment	0.182** (0.080)	0.242*** (0.037)	0.100*** (0.029)	62.080 (119.138)	558.113** (255.201)	0.003 (0.036)	0.039* (0.020)	0.060*** (0.023)
P-value	0.023	0.000	0.001	0.602	0.029	0.927	0.053	0.010
Stepdown P-value	0.138	0.001	0.008	0.863	0.138	0.931	0.155	0.078
Comparison mean	-0.260	0.331	0.088	901.753	1768.683	0.317	0.048	0.054
N	792	789	688	781	685	789	789	687
<i>Panel B: Male scholarship-lottery participants</i>								
Treatment	0.125 (0.084)	0.314*** (0.042)	0.020 (0.030)	214.377 (197.551)	122.011 (406.727)	-0.030 (0.039)	0.019 (0.023)	0.026 (0.028)
P-value	0.137	0.000	0.505	0.278	0.764	0.437	0.417	0.360
Stepdown P-value	0.613	0.001	0.889	0.838	0.889	0.889	0.889	0.879
Comparison mean	0.040	0.409	0.101	2106.234	4542.702	0.262	0.063	0.085
N	549	557	491	542	480	557	557	489
P-val male=fem	0.572	0.145	0.069	0.450	0.346	0.613	0.445	0.277

Notes: Observations are scholarship-lottery participants who ever had a child by 2023, and are in the child survival sample. Data Sources: surveys conducted in 2013, 2019, and 2023. Year of survey in parentheses. The last row shows the p-values for tests that the effects are identical between males and females. The estimated treatment effects are in each panel's first row; standard errors are in each panel's second row in parentheses; the third and fourth row show the analytical p-value and the step-down p-value correcting for multiple hypothesis testing; control group means are in each panel's fifth row; sample size for the estimation is in each panel's sixth row. Controls include JHS finishing exam score and baseline region fixed effects.

Table A2: Survey Rates

	All	Control		Treatment		T=C
	Mean	Mean	N	Mean	N	P-value
Panel A: Female Scholarship-lottery participant						
<u>Scholarship-lottery Sample</u>						
Surveyed (2019)	0.95	0.95	703	0.96	335	0.331
Surveyed (2023)	0.80	0.79	703	0.83	335	0.154
Ever had a child	0.75	0.75	703	0.74	335	0.670
Any child ever elig. during tracking	0.69	0.70	703	0.68	335	0.625
All children too old when tracking began	0.05	0.05	703	0.05	335	0.711
At least one eligible child measured	0.64	0.65	703	0.64	335	0.791
At least one eligible child measured (if had any)	0.86	0.86	527	0.86	247	0.862
<u>Mortality Status available (Child-level)</u>						
1 yr old sample	0.93	0.93	1,268	0.93	559	0.880
3 yrs old sample	0.92	0.92	1,054	0.92	452	0.948
5 yrs old sample	0.90	0.90	836	0.90	359	0.958
<u>Cognitive Games Sample (Child-level)</u>						
Administered infant assessment if sampled	0.94	0.94	449	0.93	229	0.410
Administered two-yr old assessment if sampled	0.93	0.93	207	0.94	125	0.769
Administered three-yr old assessment if sampled	0.93	0.92	501	0.96	240	0.053
Administered five-yr old assessment if sampled	0.92	0.93	523	0.91	237	0.391
Administered seven-yr old assessment if sampled	0.79	0.78	349	0.81	165	0.490
<u>LENA Sample (Child-level)</u>						
LENA recording available if sampled	0.70	0.69	522	0.72	280	0.296
Panel B: Male Scholarship-lottery participant						
<u>Scholarship-lottery Sample</u>						
Surveyed (2019)	0.94	0.93	679	0.96	347	0.099
Surveyed (2023)	0.80	0.78	679	0.85	347	0.005
Ever had a child	0.52	0.51	679	0.53	347	0.622
Any child ever elig. during tracking	0.48	0.49	679	0.48	347	0.717
All children too old when tracking began	0.02	0.02	679	0.03	347	0.277
At least one eligible child measured	0.41	0.41	679	0.41	347	0.957
At least one eligible child measured (if had any)	0.79	0.80	349	0.78	184	0.602
<u>Mortality Status available (Child-level)</u>						
1 yr old sample	0.98	0.98	672	0.98	350	0.676
3 yrs old sample	0.98	0.98	511	0.97	265	0.537
5 yrs old sample	0.97	0.97	348	0.97	179	0.762
<u>Cognitive Games Sample (Child-level)</u>						
Administered infant assessment if sampled	0.91	0.92	266	0.90	155	0.529
Administered two-yr old assessment if sampled	0.89	0.90	173	0.86	86	0.323
Administered three-yr old assessment if sampled	0.91	0.92	266	0.90	153	0.303
Administered five-yr old assessment if sampled	0.88	0.86	252	0.92	123	0.088
Administered seven-yr old assessment if sampled	0.81	0.79	155	0.85	74	0.297
<u>LENA Sample (Child-level)</u>						
LENA recording available if sampled	0.65	0.64	400	0.67	199	0.387

Notes: For the mortality data sample, an observation is a child of a participant in the lottery for secondary school scholarships. It includes only those born at least 12 months prior to 2023 survey. The Cognitive Games sample includes children that were selected to be assessed through the cognitive games. The LENA Sample includes children whose recordings were kept in analysis. Panel A shows results for female scholarship-lottery participants; Panel B shows results for male scholarship-lottery participants.

Table A3: Baseline (2008) Characteristics and Balance—Scholarship-Eligible Students (subsamples with at least one child born by 2023 and at least one child surveyed by 2023)

	(1)	(2)	(3)	(4)	(5)	(6)
	Age in 2008	BECCE exam performance	No male head in the household	Number of HH members	Highest education of HH head: primary or less	Highest education of HH head: SHS or more
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Sample with at least one child born by 2023						
Female Scholarship-lottery participants:						
Treatment	-0.173 (0.133)	0.005 (0.007)	-0.023 (0.043)	-0.408** (0.181)	-0.006 (0.042)	0.020 (0.031)
P-value	0.195	0.533	0.597	0.024	0.892	0.514
Comparison mean	17.470	0.617	0.468	5.565	0.503	0.151
N	819	760	814	819	815	815
Male Scholarship-lottery participants:						
Treatment	-0.238 (0.185)	0.007 (0.008)	0.097* (0.050)	-0.248 (0.242)	0.037 (0.050)	-0.094*** (0.032)
P-value	0.199	0.366	0.055	0.305	0.455	0.004
Comparison mean	17.600	0.624	0.381	5.803	0.503	0.194
N	569	535	567	569	564	564
P-val male=fem	0.772	0.824	0.072	0.577	0.522	0.012
Panel B: Sample with at least one child surveyed by 2023						
Female Scholarship-lottery participants:						
Treatment	-0.225 (0.154)	0.005 (0.008)	-0.022 (0.048)	-0.424** (0.214)	-0.032 (0.048)	0.045 (0.036)
P-value	0.145	0.525	0.643	0.048	0.502	0.206
Comparison mean	17.534	0.619	0.461	5.670	0.519	0.149
N	670	620	666	670	666	666
Male Scholarship-lottery participants:						
Treatment	-0.358 (0.236)	0.014 (0.010)	0.145** (0.060)	-0.309 (0.281)	0.001 (0.060)	-0.079** (0.037)
P-value	0.130	0.171	0.016	0.273	0.986	0.035
Comparison mean	17.648	0.620	0.390	5.799	0.537	0.181
N	429	403	427	429	425	425
P-val male=fem	0.766	0.521	0.044	0.754	0.632	0.015

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

Notes: The unit of observation is a scholarship-lottery participant. Regressions use the number of children of scholarship-lottery participants as weights. Panel A shows results for sample limited to scholarship-lottery participants who ever had a child. Panel B shows results for sample limited to scholarship-lottery participants who ever had a child surveyed. Data Source: Baseline survey conducted in 2008 with scholarship-lottery participants and their guardians. Controls include region fixed effects. Refer to [Table 1](#) for other notes.

Table A4: Characteristics and Balance, per survey sample

	All		Control			Treatment			T=C
	Mean	SD	Mean	SD	N	Mean	SD	N	P-value
Panel A: Children of Female Scholarship-lottery participants									
Mortality Sample									
Child age in months (2023)	84.39	45.31	85.87	45.84	983	81.16	44.02	453	0.067
Child is first-born	0.40	0.49	0.40	0.49	1,186	0.42	0.49	521	0.330
Mom's age at birth	25.32	3.88	25.26	3.90	1,186	25.47	3.85	521	0.307
Cognitive Games Sample									
Child age in months	58.97	98.87	58.72	95.17	1,686	59.47	105.97	839	0.857
Child is female	0.50	0.50	0.49	0.50	1,660	0.52	0.50	821	0.221
Child is first-born	0.37	0.48	0.36	0.48	1,634	0.41	0.49	789	0.022
LENA Sample									
Child age in months	26.09	8.38	26.25	8.69	359	25.80	7.82	202	0.543
Child is female	0.52	0.50	0.50	0.50	358	0.55	0.50	201	0.284
Child is first-born	0.25	0.44	0.25	0.43	346	0.26	0.44	186	0.707
Panel B: Children of Male Scholarship-lottery participants									
Mortality Sample									
Child age in months (2023)	69.69	39.99	69.66	39.81	529	69.74	40.37	299	0.978
Child is first-born	0.51	0.50	0.51	0.50	665	0.52	0.50	344	0.785
Mom's age at birth	22.96	4.28	23.11	4.43	665	22.67	3.97	344	0.127
Cognitive Games Sample									
Child age in months	52.52	80.50	52.73	81.55	890	48.20	49.48	480	0.267
Child is female	0.51	0.50	0.50	0.50	879	0.54	0.50	478	0.190
Child is first-born	0.54	0.50	0.55	0.50	847	0.52	0.50	458	0.210
LENA Sample									
Child age in months	25.83	8.21	25.82	8.20	254	25.84	8.28	134	0.981
Child is female	0.50	0.50	0.48	0.50	250	0.54	0.50	134	0.253
Child is first-born	0.42	0.49	0.43	0.50	233	0.39	0.49	126	0.461

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

Notes: For the mortality data sample, an observation is a child of a participant in the lottery for secondary school scholarships. It includes all children born as of the 2022 survey. The Cognitive Games sample includes children that were selected to undergo the cognitive games. The LENA Sample includes children whose recordings were kept in analysis. Panel A shows results for children of female scholarship-lottery participants; Panel B shows results for children of male scholarship-lottery participants.

Table A5: Main results Pooling Female and Male Scholarship Lottery Participants

	(1)	(2)	(3)	(4)	(5)	(6)
	Survival			Cognitive ability index score		
<i>Age:</i>	1 years	3 years	5 years	3 year	5 years	7 years
Treatment	0.016** (0.006)	0.016** (0.008)	0.016 (0.011)	0.026 (0.058)	0.115* (0.069)	0.139 (0.095)
P-value	0.012	0.037	0.138	0.652	0.099	0.145
Stepdown P-value	0.016	0.042	0.132	0.674	0.282	0.282
Comparison mean	0.967	0.962	0.954	-0.004	-0.000	-0.003
N	2,716	2,160	1,599	968	966	534

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

Notes: See [Table 2](#) and [Table 3](#). Additional control for all columns is the gender of the scholarship recipient.

Table A6: Survival Sample: Robustness to Choice of Controls and Mother's age at birth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Survival up to one year				Mother's age at birth		
					All	Born 2009-2016	Born 2017-2022
<i>Panel A: Children of female scholarship-lottery participants</i>							
Treatment	0.018** (0.008)	0.017** (0.008)	0.018** (0.008)	0.019** (0.008)	0.345 (0.238)	0.064 (0.207)	0.063 (0.168)
P-value	0.032	0.039	0.031	0.023	0.147	0.756	0.706
Comparison mean	0.965	0.965	0.965	0.965	24.797	22.112	28.709
N	1,707	1,707	1,707	1,707	1,825	1,065	760
<i>Panel B: Children of male scholarship-lottery participants</i>							
Treatment	0.014 (0.010)	0.013 (0.010)	0.013 (0.010)	0.014 (0.010)	-0.460 (0.376)	-0.559 (0.490)	-0.516 (0.338)
P-value	0.160	0.164	0.174	0.159	0.222	0.255	0.127
Comparison mean	0.970	0.970	0.970	0.970	23.022	20.285	25.070
N	1,016	1,016	1,016	1,016	1,033	436	597
P-val male=fem	0.716	0.751	0.728	0.705	0.113	0.314	0.136
Birth order fixed effects	Yes	No	Yes	Yes	Yes	Yes	Yes
Mother's age at birth control	No	No	Yes	No	No	No	No
Linear birth year control	Yes	Yes	Yes	No	No	No	No

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

Notes: See [Table 2](#) notes. Columns (1) and (2) replicate columns (1) and (2) of [Table 2](#) but exclude birth order controls. Columns (3) and (4) replicate columns (1) and (2) of [Table 2](#) but controls for mother's age at birth. Columns (5)-(7) control for the JHS finishing exam score and baseline region fixed effects of the scholarship-lottery participant, as well as the birth order of the child.

Table A7: Second Generation Cognitive Development:
Robustness to excluding Survey-Round Fixed Effects

	(1)	(2)	(3)	(4)	(5)
	Cognitive ability index score				
Age:	1.5 years	2.5 years	3 years	5 years	7 years
<i>Panel A: Children of female scholarship-lottery participants</i>					
Treatment	-0.050 (0.093)	-0.036 (0.129)	0.019 (0.082)	0.233*** (0.085)	0.250** (0.117)
P-value	0.592	0.777	0.819	0.006	0.034
Stepdown P-value	0.917	0.950	0.950	0.028	0.119
Comparison mean	0.013	0.028	-0.015	0.021	0.062
N	565	275	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>					
Treatment	0.147 (0.115)	-0.283* (0.153)	-0.037 (0.099)	-0.201* (0.115)	-0.001 (0.186)
P-value	0.201	0.065	0.711	0.082	0.996
Stepdown P-value	0.503	0.270	0.932	0.281	0.999
Comparison mean	-0.022	-0.037	0.039	-0.039	-0.111
N	343	208	345	300	175
P-val male=fem	0.285	0.276	0.706	0.003	0.215

This table reproduces [Table 3](#), excluding survey-round fixed effects. See [Table 3](#) notes.

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

Table A8: Second Generation Cognitive Development: Breakdown by Child Gender

	(1)	(2)	(3)	(4)	(5)
	Cognitive ability index score				
Age:	1.5 years	2.5 years	3 years	5 years	7 years
<i>Panel A: Children of female scholarship-lottery participants</i>					
Treatment	0.074 (0.135)	-0.063 (0.200)	0.016 (0.100)	0.136 (0.117)	0.347** (0.149)
Female child	0.157 (0.106)	-0.094 (0.153)	0.142* (0.084)	-0.077 (0.084)	0.268** (0.122)
Treatment x Female child	-0.278 (0.182)	0.076 (0.263)	0.016 (0.137)	0.216 (0.163)	-0.186 (0.221)
P-value	0.583	0.752	0.870	0.245	0.021
Stepdown P-value	0.923	0.929	0.929	0.636	0.101
Comparison mean	0.013	0.028	-0.015	0.021	0.062
N	565	275	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>					
Treatment	0.269* (0.142)	-0.208 (0.245)	0.156 (0.121)	-0.364** (0.151)	-0.419* (0.222)
Female child	0.186 (0.132)	-0.099 (0.165)	0.129 (0.115)	0.069 (0.145)	-0.052 (0.209)
Treatment x Female child	-0.200 (0.213)	-0.017 (0.308)	-0.292 (0.178)	0.284 (0.214)	0.578 (0.366)
P-value	0.060	0.396	0.197	0.017	0.061
Stepdown P-value	0.232	0.417	0.376	0.087	0.232
Comparison mean	-0.022	-0.037	0.039	-0.039	-0.111
N	343	208	345	300	175
P-val male=fem	0.228	0.257	0.988	0.004	0.090

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

See [Table 3](#) notes.

Table A9: Caregiver-reported Language Outcomes

	(1)	(2)	(3)	(4)
	IRT: 18 mo language	IRT: 18 mo says	IRT: 18 mo understands	IRT: 18 mo gestures sometimes
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	-0.022 (0.075)	-0.021 (0.066)	-0.041 (0.079)	-0.016 (0.072)
P-value	0.772	0.752	0.600	0.821
Stepdown P-value	0.963	0.963	0.891	0.963
Comparison mean	-0.025	-0.026	-0.018	0.008
N	645	645	645	645
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	-0.110 (0.082)	-0.092 (0.081)	-0.116 (0.086)	-0.031 (0.083)
P-value	0.182	0.261	0.177	0.713
Stepdown P-value	0.379	0.411	0.379	0.720
Comparison mean	0.083	0.073	0.093	-0.001
N	393	393	393	393
P-val male=fem	0.682	0.774	0.764	0.924

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

Index based on answers to questions adapted from the MacArthur-Bates Communicative Development Inventories (MB-CDI) to our context. All regressions control for child age in months, child gender, child birth order, scholarship-lottery participant baseline region fixed effects, and the junior high school finishing exam score of the scholarship-lottery participant.

Table A10: Household Composition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Caregiver is Mother	Caregiver is Father	Caregiver is Grandmother	Lives with Mother	Lives with Father	Lives with both parents	Num. other children in household	Number of siblings	Number of adults in household
Panel A: Children of female scholarship-lottery participants									
Treatment	-0.003 (0.017)	-0.001 (0.006)	0.006 (0.014)	-0.009 (0.014)	0.004 (0.034)	0.007 (0.035)	0.058 (0.117)	-0.104 (0.134)	0.039 (0.088)
P-value	0.841	0.891	0.691	0.515	0.906	0.851	0.622	0.437	0.657
Stepdown P-value	0.997	0.997	0.993	0.980	0.997	0.997	0.993	0.972	0.993
Comparison mean	0.906	0.014	0.061	0.933	0.646	0.632	1.642	1.926	2.380
N	3,087	3,087	3,087	3,042	2,695	2,669	2,757	2,996	2,733
Panel B: Children of male scholarship-lottery participants									
Treatment	0.036 (0.024)	-0.021 (0.018)	-0.022 (0.015)	0.024 (0.019)	-0.087** (0.039)	-0.092** (0.043)	0.160 (0.133)	0.174 (0.142)	0.060 (0.098)
P-value	0.136	0.238	0.138	0.215	0.024	0.032	0.227	0.223	0.544
Stepdown P-value	0.572	0.702	0.572	0.702	0.187	0.221	0.702	0.702	0.702
Comparison mean	0.740	0.158	0.077	0.888	0.711	0.656	1.323	1.416	2.369
N	1,767	1,767	1,767	1,603	1,647	1,491	1,536	1,686	1,523
P-val male=fem	0.138	0.280	0.133	0.114	0.115	0.120	0.600	0.170	0.965

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

Notes: An observation is a child of a participant in the lottery for secondary school scholarships, at a given age window (there can be multiple observations per child if the child was surveyed at multiple age windows). Panel A shows results for children of female Scholarship Study participants; Panel B shows results for children of male Scholarship Study participants. The estimated treatment effects are in the first row; standard errors clustered at the scholarship-lottery participant level are in the second row in parentheses; the third row reports the p-values; the fourth row reports the family-wise Romano-Wolf step-down p-values; comparison group means are in the fifth row; the sixth row reports the number of observations. Regression controls include child age, child gender, scholarship-lottery participant baseline region fixed effects and the JHS finishing exam score of the scholarship-lottery participant. Columns (1) - (7) also control for the child birth order. Standard errors are clustered at the scholarship-lottery participant-level.

Table A11: Main results: Robustness to including partner's education

	(1)	(2)	(3)	(4)	(5)
	Survival			Cognitive ability index score	
Age:	1 years	3 years	5 years	5 years	7 years
<i>Panel A: Children of Female scholarship-lottery participants</i>					
Treatment	0.018** (0.008)	0.022** (0.010)	0.026* (0.013)	0.220*** (0.084)	0.252** (0.121)
Most recent partner completed SHS	-0.005 (0.011)	-0.005 (0.013)	-0.004 (0.016)		
Most recent partner completed tert.	-0.002 (0.013)	-0.009 (0.017)	-0.024 (0.023)		
Partner of caregiver completed SHS				0.255*** (0.087)	0.104 (0.130)
Partner of caregiver completed tert.				0.041 (0.128)	0.029 (0.189)
P-value	0.027	0.031	0.051	0.009	0.038
Comparison mean	0.965	0.958	0.947	0.021	0.062
N	1,707	1,395	1,084	660	358
<i>Panel B: Children of Male scholarship-lottery participants</i>					
Treatment	0.014 (0.010)	0.007 (0.012)	-0.000 (0.017)	-0.199 (0.125)	-0.077 (0.190)
Most recent partner completed SHS	0.001 (0.011)	0.007 (0.013)	-0.001 (0.022)		
Caregiver completed SHS				0.420** (0.167)	0.588** (0.290)
P-value	0.151	0.574	0.999	0.112	0.687
Comparison mean	0.970	0.971	0.968	-0.039	-0.111
N	1,016	772	520	299	173

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

Notes: Columns (1), (2), and (3): an observation is a child of a participant in the lottery for secondary school scholarships. Controls include birth order, year of birth, scholarship-lottery participant baseline region fixed effects and the JHS finishing exam score of the scholarship-lottery participant. Standard errors are clustered at the scholarship-lottery participant-level.

Columns (4) and (5): an observation is a child of a participant in the lottery for secondary school scholarships at a given age window. Regressions control for child age in months, child gender, child birth order, measurement round fixed effects, scholarship-lottery participant baseline region fixed effects, and the JHS finishing exam score of the scholarship-lottery participant. The latent abilities of the child are estimated using a one parameter logistic item response theory model.

Panel A shows results for children of female scholarship-lottery participants; Panel B shows results for children of male scholarship-lottery participants. There are less than 10 partners of male scholarship-lottery participants who completed tertiary.

Table A12: Child Mortality, restricted to firstborns

	(1)	(2)	(3)
	Survival		Mother's age at birth
	Up to 1 year	Up to 3 years	
<i>Panel A: Children of female scholarship-lottery participants</i>			
Treatment	0.012	0.016	0.549*
	(0.015)	(0.017)	(0.307)
P-value	0.431	0.346	0.074
Stepdown P-value	0.455	0.432	0.170
Comparison mean	0.955	0.950	22.272
N	691	635	798
<i>Panel B: Children of male scholarship-lottery participants</i>			
Treatment	0.012	0.009	0.128
	(0.014)	(0.016)	(0.376)
P-value	0.407	0.598	0.734
Stepdown P-value	0.717	0.850	0.850
Comparison mean	0.968	0.966	21.501
N	522	440	539
P-val male=fem	0.930	0.789	0.409

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

Notes: An observation is a child of a participant in the lottery for secondary school scholarships. Panel A shows results for children of female Scholarship Study participants; Panel B shows results for children of male Scholarship Study participants. The estimated treatment effects are in the first row; standard errors clustered at the scholarship-lottery participant level are in the second row in parentheses; the third row reports the p-values; the fourth row reports the family-wise Romano-Wolf step-down p-values; comparison group means are in the fifth row; the sixth row reports the number of observations. Regression controls in columns (3) include scholarship-lottery participant baseline region fixed effects and the JHS finishing exam score of the scholarship-lottery participant. Controls in column (1)-(2) also include child year of birth fixed effects. Standard errors are clustered at the scholarship-lottery participant-level. All the variables have been restricted to the sample of firstborns.

Table A13: Child Health and Location

	(1) Caregiver reported child health index	(2) Physical development index	(3) Child lives in urban area	(4) Under 3 yrs when began creche/daycare/nursery
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	0.092* (0.047)	-0.050 (0.037)	0.004 (0.037)	0.019 (0.029)
P-value	0.050	0.171	0.923	0.518
Stepdown P-value	0.201	0.438	0.927	0.777
Comparison mean	0.056	-0.005	0.442	0.757
N	2,742	2,614	2,891	1,833
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	0.008 (0.077)	-0.090 (0.063)	-0.022 (0.043)	0.037 (0.040)
P-value	0.914	0.155	0.604	0.353
Stepdown P-value	0.918	0.516	0.849	0.742
Comparison mean	-0.099	0.009	0.404	0.682
N	1,528	1,478	1,645	941
P-val male=fem	0.372	0.526	0.660	0.597

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

Notes: The details of the indices are shown in [Table B3](#) and [Table B4](#). Refer to [Table 4](#) for other details on specifications and outcomes.

Table A14: LENA Sample, Attrition, Characteristics and Balance

	All		Control			Treatment			T=C
	Mean	SD	Mean	SD	N	Mean	SD	N	P-value
Panel A: Children of Female Scholarship-lottery participant									
<u>LENA Attrition</u>									
Refusal	0.18	0.39	0.20	0.40	474	0.15	0.36	251	0.105
If consent: LENA complete	0.85	0.36	0.85	0.35	428	0.84	0.37	245	0.677
If complete: kept in analysis	0.98	0.14	0.98	0.14	365	0.98	0.14	206	0.984
<u>Baseline Characteristics</u>									
Age in 2008	17.46	1.46	17.54	1.45	358	17.32	1.46	202	0.095
BECE exam performance	0.61	0.09	0.61	0.10	338	0.62	0.08	189	0.288
No male head in the household	0.45	0.50	0.46	0.50	353	0.41	0.49	202	0.221
Highest education of HH head: primary or less	0.55	0.50	0.55	0.50	351	0.54	0.50	202	0.904
Highest education of HH head: SHS or more	0.16	0.37	0.14	0.35	351	0.20	0.40	202	0.072
<u>Current Household Environment</u>									
Nb adults in HH	2.31	1.22	2.29	1.27	357	2.35	1.12	200	0.582
Nb siblings	1.76	1.25	1.76	1.27	345	1.77	1.23	186	0.934
Children 0 to 5 yrs in HH	0.78	0.85	0.74	0.83	357	0.84	0.87	200	0.169
Children 6 to 18 yrs in HH	1.15	1.14	1.14	1.12	357	1.18	1.20	200	0.693
Number of Bedrooms	1.48	0.97	1.43	0.89	357	1.57	1.09	201	0.104
Child is female	0.51	0.50	0.50	0.50	358	0.54	0.50	202	0.283
<u>LENA Measurement</u>									
Nb times device removed	0.22	0.49	0.19	0.49	342	0.26	0.49	197	0.133
Total minutes device removed	10.63	35.26	9.72	36.60	342	12.22	32.83	197	0.428
Nb times held on back	0.27	0.67	0.27	0.67	342	0.27	0.67	197	0.990
Total minutes held on back	10.75	34.03	10.52	36.20	339	11.14	30.02	197	0.840
LENA Recording Duration	906.15	176.42	912.47	164.56	358	894.94	195.60	202	0.259
LENA day reported as unusual	0.06	0.23	0.05	0.21	342	0.08	0.27	197	0.159
Panel B: Children of Male Scholarship-lottery participant									
<u>LENA Attrition</u>									
Refusal	0.22	0.42	0.23	0.42	376	0.20	0.40	177	0.421
If consent: LENA complete	0.84	0.37	0.83	0.37	315	0.85	0.36	163	0.677
If complete: kept in analysis	0.97	0.16	0.97	0.16	262	0.97	0.17	138	0.895
<u>Baseline Characteristics</u>									
Age in 2008	17.60	1.84	17.70	1.81	255	17.42	1.89	134	0.148
BECE exam performance	0.62	0.07	0.61	0.06	241	0.63	0.08	121	0.009
No male head in the household	0.40	0.49	0.36	0.48	254	0.48	0.50	134	0.028
Highest education of HH head: primary or less	0.53	0.50	0.52	0.50	254	0.55	0.50	132	0.580
Highest education of HH head: SHS or more	0.19	0.39	0.22	0.41	254	0.14	0.34	132	0.057
<u>Current Household Environment</u>									
Nb adults in HH	2.40	1.21	2.36	1.15	248	2.47	1.31	134	0.409
Nb siblings	1.21	1.07	1.16	1.03	234	1.32	1.15	126	0.179
Children 0 to 5 yrs in HH	0.81	0.94	0.75	0.86	248	0.94	1.07	134	0.053
Children 6 to 18 yrs in HH	0.84	1.23	0.81	1.25	248	0.90	1.19	134	0.540
Number of Bedrooms	1.40	0.82	1.39	0.83	249	1.43	0.79	134	0.589
Child is female	0.49	0.50	0.47	0.50	255	0.54	0.50	134	0.212
<u>LENA Measurement</u>									
Nb times device removed	0.22	0.49	0.24	0.53	240	0.18	0.41	131	0.270
Total minutes device removed	10.06	34.87	10.93	31.69	238	8.47	40.09	131	0.517
Nb times held on back	0.28	0.63	0.28	0.63	240	0.29	0.64	131	0.874
Total minutes held on back	16.37	63.50	15.07	53.14	238	18.75	79.11	131	0.595
LENA Recording Duration	899.56	192.84	889.81	201.94	255	918.10	173.43	134	0.169
LENA day reported as unusual	0.04	0.20	0.05	0.21	240	0.04	0.19	131	0.729

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

Notes: LENA data. Unit: recording. Sample: LENA surveyed individuals. The analysis is restricted to recording times between 7am to 6pm included. Only files with at least 5 hours of recording between 7am and 6pm are kept in the analysis.

Table A15: LENA Results Using Entropy Balancing

	(1) Child vocalizations per min	(2) Conversational turns per min	(3) Meaningful speech	(4) Adult word count per min	(5) Female adult word count per min	(6) Male adult word count per min
<i>Panel A: Children of female scholarship-lottery participants</i>						
Treatment	0.332*** (0.120)	0.069*** (0.023)	0.009 (0.007)	0.378 (0.709)	0.381 (0.599)	-0.003 (0.279)
P-value	0.005	0.002	0.234	0.594	0.525	0.991
Comparison mean	1.956	0.336	0.156	12.952	9.814	3.138
N	560	560	560	560	560	560
<i>Panel B: Children of male scholarship-lottery participants</i>						
Treatment	-0.210 (0.148)	-0.067** (0.028)	-0.019** (0.008)	-2.999*** (0.827)	-2.390*** (0.707)	-0.609* (0.312)
P-value	0.156	0.016	0.017	0.000	0.001	0.051
Comparison mean	2.210	0.380	0.171	14.260	10.677	3.584
N	391	391	391	391	391	391

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

Notes: See notes of [Table 6](#). Entropy balancing is used as a weighting method to match the characteristics of the original scholarship-lottery sample. The characteristics used for balancing are: age in 2008, BECE exam performance, no male head in the household, highest education of household head: SHS or more, highest education of household head: primary or less, and perceived returns to SHS.

B Indices Components

Table B1: SES—Index Components

	(1)	(2)	(3)	(4)	(5)
	Num. bedrooms per a.e.	Food consumption per a.e.	Mud walls (reversed in index)	Metal sheet roof	Phone credit value (GHS, last 7 days)
<i>Panel A: Children of female scholarship-lottery participants</i>					
Treatment	0.015 (0.014)	-1.274 (3.210)	-0.027 (0.025)	0.010 (0.012)	-0.398 (0.929)
P-value	0.302	0.691	0.276	0.420	0.669
Stepdown P-value	0.765	0.874	0.765	0.778	0.874
Comparison mean	0.403	74.507	0.152	0.960	11.709
N	2,729	2,734	2,741	2,741	2,728
<i>Panel B: Children of male scholarship-lottery participants</i>					
Treatment	0.021 (0.019)	-2.477 (4.369)	-0.041 (0.037)	-0.007 (0.013)	-0.580 (1.023)
P-value	0.257	0.571	0.267	0.616	0.571
Stepdown P-value	0.778	0.932	0.778	0.932	0.932
Comparison mean	0.409	86.199	0.241	0.966	13.581
N	1,518	1,523	1,525	1,525	1,523
P-val male=fem	0.777	0.772	0.818	0.368	0.668

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

Notes: An observation is a child of a scholarship-lottery participant at a given age window (meaning there can be multiple observations per child). Panel A shows results for children of female scholarship study participants; Panel B shows results for children of male scholarship study participants. The estimated treatment effects are in the first row; standard errors clustered at the scholarship-lottery participant level are in the second row in parentheses; the third row reports the p-values; the fourth row reports the family-wise Romano-Wolf step-down p-values; comparison group means are in the fifth row; the sixth row reports the number of observations. All regressions control for child age, child gender, child birth order, scholarship-lottery participant baseline region fixed effects, and the junior high school finishing exam score of the scholarship-lottery participant. In column names, “reversed” means this component was reverse-scored when we created the relevant index and a.e. stands for number of adult equivalents in the household.

Table B2: Preventive Health Behaviors—Index Components

	(1)	(2)	(3)	(4)	(5)	(6)
	Took child for check-up in past 12 mo	Child sleeps under mosquito net	Treats child's drinking water	Shows card and has all vaccines	Improved Toilet	HH has priv. toilet
<i>Panel A: Children of female scholarship-lottery participants</i>						
Treatment	0.011 (0.020)	0.057* (0.034)	-0.002 (0.012)	0.013 (0.028)	-0.004 (0.033)	0.077** (0.034)
P-value	0.598	0.093	0.851	0.630	0.900	0.025
Stepdown P-value	0.963	0.409	0.975	0.963	0.975	0.180
Comparison mean	0.368	0.610	0.047	0.481	0.302	0.234
N	2,742	2,742	2,742	2,734	2,741	2,741
<i>Panel B: Children of male scholarship-lottery participants</i>						
Treatment	-0.026 (0.025)	0.066 (0.042)	-0.003 (0.018)	-0.024 (0.036)	-0.003 (0.039)	-0.012 (0.039)
P-value	0.296	0.115	0.865	0.497	0.934	0.753
Stepdown P-value	0.839	0.542	0.979	0.939	0.979	0.974
Comparison mean	0.400	0.588	0.052	0.486	0.269	0.217
N	1,530	1,530	1,530	1,523	1,525	1,525
P-val male=fem	0.314	0.934	0.953	0.327	0.842	0.067

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

Notes: Refer to [Table B1](#).

Table B3: Caregiver-reported Child Health—Index Components

	(1) Cg-report of health	(2) Fevers over 3 mos	(3) Diarrhea over 3 mos	(4) Burned badly ever	(5) Broke bone ever	(6) Concussed ever
<i>Panel A: Children of female scholarship-lottery participants</i>						
Treatment	0.033 (0.041)	-0.067* (0.037)	-0.012 (0.017)	-0.024 (0.018)	-0.003 (0.008)	-0.005 (0.008)
P-value	0.421	0.070	0.470	0.186	0.734	0.511
Stepdown P-value	0.873	0.355	0.873	0.631	0.873	0.873
Comparison mean	4.215	0.505	0.147	0.138	0.034	0.041
N	2,742	2,741	2,740	2,742	2,742	2,742
<i>Panel B: Children of male scholarship-lottery participants</i>						
Treatment	-0.047 (0.053)	0.011 (0.051)	-0.012 (0.025)	0.010 (0.027)	0.001 (0.013)	-0.018* (0.010)
P-value	0.374	0.833	0.637	0.695	0.933	0.075
Stepdown P-value	0.892	0.982	0.982	0.982	0.982	0.392
Comparison mean	4.150	0.523	0.204	0.175	0.043	0.047
N	1,530	1,528	1,529	1,530	1,530	1,530
P-val male=fem	0.283	0.225	0.991	0.311	0.848	0.416

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

Notes: Refer to [Table B1](#). Caregiver-report of child health was on a Likert scale from 1 (very bad) to 5 (very good). When constructing the index, the injury-related variables shown here are reversed so that a higher Child Health Index means the caregiver reported that the child is healthier.

Table B4: Physical Development—Index Components (Anthropometrics)

	(1)	(2)	(3)	(4)
	Weight-for-age Z-score	Body mass index-for-age	Length/height for-age	Weight-for length/ height
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	-0.051 (0.075)	-0.039 (0.083)	-0.005 (0.087)	-0.027 (0.082)
P-value	0.499	0.636	0.951	0.743
Stepdown P-value	0.807	0.894	0.946	0.929
Comparison mean	-0.666	-0.489	-0.591	-0.539
N	2,609	1,990	1,999	1,745
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	-0.244** (0.097)	-0.195* (0.118)	-0.201* (0.120)	-0.177 (0.108)
P-value	0.012	0.099	0.096	0.101
Stepdown P-value	0.038	0.222	0.222	0.222
Comparison mean	-0.695	-0.424	-0.657	-0.463
N	1,473	1,090	1,100	974
P-val male=fem	0.138	0.438	0.171	0.432

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

Notes: We calculate z-scores for height-for-age, weight-for-age, weight-for-height, and body mass index using the WHO growth standards. All regressions control for child age in months, child gender, measurement round fixed effects, scholarship-lottery participant baseline region fixed effects, and the junior high school finishing exam score of the scholarship-lottery participant. Column (1) includes all age groups. Columns (2) to (4) exclude the infant/1.5 year-old group.

Table B5: Child Investment- Index Components

	(1)	(2)	(3)	(4)
	Child ate protein in the morning	Child ate protein in the evening	Number of books	HH has writing materials
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	-0.032 (0.026)	0.020 (0.015)	0.025 (0.127)	0.011 (0.018)
P-value	0.215	0.191	0.847	0.546
Stepdown P-value	0.543	0.543	0.840	0.769
Comparison mean	0.674	0.887	1.571	0.799
N	2,593	2,678	2,722	2,734
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	-0.015 (0.031)	0.004 (0.022)	-0.093 (0.145)	-0.028 (0.031)
P-value	0.628	0.843	0.521	0.368
Stepdown P-value	0.896	0.896	0.896	0.828
Comparison mean	0.682	0.883	1.252	0.742
N	1,474	1,500	1,521	1,523
P-val male=fem	0.617	0.442	0.690	0.284

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

Notes: Refer to [Table B1](#).

Table B6: Schooling—Index Components

	(1)	(2)	(3)	(4)
	Currently attends school	Currently private school	Mins. in school per day	Under 3 yrs when began creche/daycare/nursery
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	-0.007 (0.015)	0.015 (0.037)	-4.676 (9.618)	0.019 (0.029)
P-value	0.629	0.691	0.627	0.518
Stepdown P-value	0.910	0.910	0.910	0.896
Comparison mean	0.939	0.629	453.659	0.757
N	1,833	1,833	1,833	1,833
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	0.022 (0.025)	-0.002 (0.045)	6.802 (14.621)	0.037 (0.040)
P-value	0.375	0.961	0.642	0.353
Stepdown P-value	0.711	0.955	0.850	0.711
Comparison mean	0.894	0.576	424.507	0.682
N	941	941	941	941
P-val male=fem	0.364	0.816	0.495	0.597

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

Notes: The sample is restricted to children over 36 months old. Refer to [Table B1](#) for other table notes.

Table B7: Child Stimulation—Index Components

	(1)	(2)	(3)	(4)	(5)
	Sang to child in past month	Read to child in past month	Told stories to child in past month	Played with child in past month	Named/counted/drew with child in past month
<i>Panel A: Children of female scholarship-lottery participants</i>					
Treatment	0.059** (0.024)	0.018 (0.025)	0.041 (0.029)	0.028** (0.014)	0.053** (0.023)
P-value	0.014	0.469	0.149	0.043	0.022
Stepdown P-value	0.073	0.459	0.233	0.112	0.082
Comparison mean	0.661	0.622	0.388	0.882	0.691
N	2,736	2,733	2,730	2,735	2,735
<i>Panel B: Children of male scholarship-lottery participants</i>					
Treatment	-0.029 (0.036)	0.020 (0.036)	-0.037 (0.035)	-0.053** (0.021)	-0.010 (0.035)
P-value	0.414	0.582	0.292	0.012	0.775
Stepdown P-value	0.749	0.794	0.684	0.063	0.794
Comparison mean	0.691	0.546	0.396	0.922	0.685
N	1,524	1,526	1,526	1,528	1,526
P-val male=fem	0.034	0.923	0.098	0.002	0.173

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

Notes: Refer to [Table B1](#).

Table B8: Caregiver Beliefs on parental stimulation —Index Components

	(1) Believes parents should sing songs to child before turns 7 mos	(2) Believes parents should read stories to child before turns 1	(3) Believes should talk to child in full sentences at birth	(4) Believes should talk to child in full sentences before turns 7 mos
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	0.033 (0.024)	0.035 (0.028)	-0.008 (0.017)	-0.030 (0.026)
P-value	0.171	0.215	0.651	0.250
Stepdown P-value	0.492	0.492	0.688	0.492
Comparison mean	0.818	0.182	0.072	0.208
N	2,741	2,741	2,740	2,740
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	0.029 (0.034)	0.009 (0.029)	-0.014 (0.013)	-0.032 (0.028)
P-value	0.399	0.752	0.308	0.253
Stepdown P-value	0.692	0.773	0.692	0.692
Comparison mean	0.775	0.156	0.041	0.162
N	1,524	1,521	1,524	1,524
P-val male=fem	0.823	0.505	0.751	0.980

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

Refer to [Table B1](#).

C Cognitive Development Results: Robustness to Scoring Decisions, and Results by Skill Type

Table C1: Robustness to Scoring Decisions: unattempted questions scored as incorrect

	(1)	(2)	(3)	(4)	(5)
	Cognitive ability index score				
Age:	1.5 years	2.5 years	3 years	5 years	7 years
<i>Panel A: Children of female scholarship-lottery participants</i>					
Treatment	-0.105	-0.019	0.040	0.239***	0.245**
	(0.099)	(0.128)	(0.080)	(0.084)	(0.118)
P-value	0.291	0.880	0.622	0.005	0.039
Stepdown P-value	0.599	0.857	0.843	0.021	0.142
Comparison mean	0.014	0.016	-0.009	0.021	0.062
N	565	275	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>					
Treatment	0.152	-0.213	0.005	-0.224*	-0.128
	(0.117)	(0.152)	(0.095)	(0.122)	(0.191)
P-value	0.194	0.161	0.962	0.069	0.503
Stepdown P-value	0.507	0.507	0.965	0.289	0.767
Comparison mean	-0.022	-0.023	0.029	-0.038	-0.112
N	343	208	345	300	175
P-val male=fem	0.177	0.243	0.897	0.005	0.096

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

Notes: Refer to [Table 3](#). The only difference with [Table 3](#) is that in this case we consider unattempted questions as failed/incorrect (i.e., scored 0) instead of missing.

Table C2: Language Skills Development

	(1) 3.5 years	(2) 5 years	(3) 7 years
<i>Panel A: Children of female scholarship-lottery participants</i>			
Treatment	-0.015 (0.082)	0.159* (0.088)	0.258** (0.111)
P-value	0.860	0.070	0.021
Stepdown P-value	0.843	0.129	0.065
Comparison mean	-0.019	-0.022	0.032
N	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>			
Treatment	-0.052 (0.102)	-0.433*** (0.119)	-0.145 (0.179)
P-value	0.611	0.000	0.422
Stepdown P-value	0.678	0.005	0.678
Comparison mean	0.052	0.053	-0.047
N	345	300	175
P-val male=fem	0.941	0.001	0.041

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

Notes: Refer to [Table 3](#). The 18 months language outcome is based on caregiver reports so it is not included in the overall 18 months cognitive score.

Table C3: Math and Numeracy Development

	(1) 2.5 years	(2) 3.5 years	(3) 5 years	(4) 7 years
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	0.007 (0.132)	0.081 (0.079)	0.162* (0.084)	0.265** (0.116)
P-value	0.958	0.305	0.054	0.023
Stepdown P-value	0.954	0.512	0.148	0.086
Comparison mean	0.001	-0.003	0.041	0.065
N	275	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	-0.172 (0.146)	0.093 (0.100)	-0.069 (0.131)	-0.015 (0.192)
P-value	0.241	0.353	0.597	0.938
Stepdown P-value	0.671	0.728	0.853	0.944
Comparison mean	0.008	0.016	-0.075	-0.118
N	208	345	300	175
P-val male=fem	0.365	0.771	0.217	0.250

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

Notes: Refer to [Table 3](#).

Table C4: Spatial Reasoning

	(1)	(2)	(3)	(4)
	2.5 years	3.5 years	5 years	7 years
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	-0.047	0.087	0.194**	0.210*
	(0.123)	(0.085)	(0.087)	(0.116)
P-value	0.700	0.302	0.026	0.072
Stepdown P-value	0.695	0.500	0.098	0.188
Comparison mean	0.060	-0.026	0.007	0.068
N	275	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	-0.149	-0.093	-0.200	0.013
	(0.156)	(0.111)	(0.122)	(0.210)
P-value	0.340	0.406	0.103	0.951
Stepdown P-value	0.697	0.697	0.334	0.958
Comparison mean	-0.078	0.040	-0.006	-0.131
N	208	345	300	175
P-val male=fem	0.503	0.146	0.016	0.323

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

Notes: Refer to Table 3.

Table C5: Executive Function

	(1)	(2)	(3)	(4)	(5)
	1.5 years	2.5 years	3.5 years	5 years	7 years
<i>Panel A: Children of female scholarship-lottery participants</i>					
Treatment	-0.072	0.008	-0.037	0.244***	0.189
	(0.094)	(0.150)	(0.083)	(0.079)	(0.128)
P-value	0.445	0.958	0.656	0.002	0.142
Stepdown P-value	0.826	0.957	0.874	0.011	0.439
Comparison mean	0.013	-0.045	0.038	0.034	0.033
N	565	275	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>					
Treatment	0.165	-0.111	0.126	0.006	-0.310*
	(0.117)	(0.157)	(0.110)	(0.136)	(0.179)
P-value	0.158	0.480	0.252	0.967	0.085
Stepdown P-value	0.523	0.733	0.592	0.972	0.375
Comparison mean	-0.022	0.056	-0.067	-0.080	-0.059
N	343	208	345	300	175
P-val male=fem	0.217	0.656	0.218	0.129	0.040

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

Notes: Refer to Table 3.

Table C6: Social Cognitive Development

	(1)	(2)	(3)	(4)
	2.5 years	3.5 years	5 years	7 years
<i>Panel A: Children of female scholarship-lottery participants</i>				
Treatment	0.054	-0.039	0.008	0.041
	(0.132)	(0.085)	(0.094)	(0.117)
P-value	0.682	0.648	0.936	0.730
Stepdown P-value	0.983	0.983	0.983	0.983
Comparison mean	-0.043	-0.003	0.004	0.079
N	275	633	670	363
<i>Panel B: Children of male scholarship-lottery participants</i>				
Treatment	-0.115	0.029	-0.170	0.192
	(0.171)	(0.129)	(0.147)	(0.184)
P-value	0.501	0.824	0.248	0.297
Stepdown P-value	0.746	0.818	0.690	0.690
Comparison mean	0.050	0.018	-0.004	-0.149
N	208	345	300	175
P-val male=fem	0.454	0.690	0.386	0.500

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

Notes: Refer to [Table 3](#).

D Description of the Cognitive Development Measures

In this section, we briefly describe the novel assessments used to measure child cognitive development across a number of domains. [Coffey and Spelke \(2023\)](#) provides further details on the assessments and presents evidence for the validity of each test.

D.1 Executive function assessments

Executive function captures the set of “cognitive skills responsible for formulating goals, planning how to achieve them, and carrying out these plans effectively.” ([Anderson and Reidy, 2012](#)) For the younger age groups (14-22 months old, 30-36 months old and 3-4 years old), the surveyors administered the executive function games using toys and cups. In these games, the surveyors tested the child’s working memory, object permanence, attention switching, and mental simulation/rotation by hiding toys under the cups, moving the cups, and asking the child to identify the location of the toy. Older age groups (5-6 years old and 7-8 years old) completed a Simon task on a computer ([Simon and Wolf, 1963](#)).

D.2 Language skill assessments

For 14-22 months old and 30-36 months old, language skills were assessed through caregiver reports on a version of the MacArthur-Bates Communicative Development Inventories Words & Gestures (MB-CDI-WG) adapted to our context through piloting. Surveyors assessed the vocabulary of 3-4 years old, 5-6 years old or 7-8 years old by asking them to point to the image corresponding to a given word on a laminated card for 3-4 year olds ([Figure D.1](#)) and on a computer screen for children above 4 years old. For 7-8 year olds, surveyors also tested their ability to identify letters or words, and their ability to read simple sentences. These assessments were carried in the primary language spoken to the child in their home according to the caregiver.

Figure D.1: 3-year old playing Vocabulary game

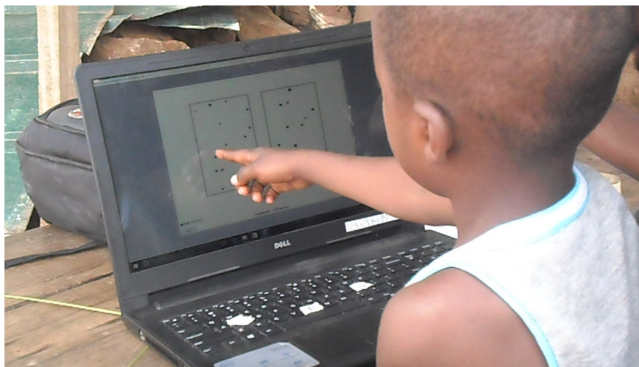


Note: A surveyor testing a 3-year old’s vocabulary during piloting using laminated cards. The surveyor says a word in the child’s primary language and asks the child to point to the picture of this word.

D.3 Math & numeracy assessments

For 14-22 months, 30-36 months old, 3-4 year olds and 5-6 years old, we tested their approximate number sense (ANS) aptitude through the Panamath game (Figure D.2). Research has shown that ANS aptitude at early ages is predictive of mathematical ability later on in life (Libertus et al., 2011). Surveyors used laminated cards for children under 4 years old and computers for children above 4 years old. For 30-36 months old, 3-4 year olds and 5-6 years old, surveyors also tested the child's ability to identify Arabic numbers and correctly count the numbers of objects in a given picture. For children over 3 years old, we tested addition and subtraction skills as well.

Figure D.2: 5-year old playing Panamath game



Notes: A surveyor playing the Panamath game with a 5-year old during piloting. This game measures the child's approximate number system aptitude. The child is asked which box has more dots or which dots has more dots of a particular color.

D.4 Social cognition assessments

To measure social cognition, we tested the child's ability to interpret the gaze and emotion of faces. In these tests, the child had to correctly interpret the gaze or emotion of the faces shown to them on the computer or laminated cards. The gaze-related tests were conducted with children over 30 months old, while the emotion-related tests were conducted with children over 3 years old.

D.5 Spatial reasoning assessments

The spatial reasoning tests measured the child's ability to concerns skills think about and manipulate objects in space. The spatial reasoning assessments asked 30-36 month-olds to identify the block that matched the shape of a given hole. Children above 3 years old were tested on their ability to read maps. They were shown a laminated map that charted the shapes on a large mat places on the floor (Figure D.3). The surveyor pointed to the map and asked the child to place an object on the corresponding spot on the mat. All children above 3 years old were tested on their understanding of geometry as well.

Figure D.3: 5-year old playing Reading Maps game



Notes: A five-year old placing an object on the indicated spot during the Reading Maps game in piloting.

References

- Anderson, Peter J. and Natalie Reidy**, “Assessing Executive Function in Preschoolers,” *Neuropsychology Review*, 2012, 22 (4), 345-360.
- Coffey, Joseph R. and Elizabeth S. Spelke**, “Evaluating a battery of direct assessments of the cognitive skills of preschool children in Ghana,” *Working Paper*, 2023.
- Simon, J. Richard and James D. Wolf**, “Choice Reaction Time As A Function Of Angular Stimulus-Response Correspondence And Age,” *Ergonomics*, 1963, 6 (1), 99-105.

E Description of the Language and ENvironmental Analysis (LENA) System for Measuring the Child’s Auditory Environment

E.1 Description of technology and survey protocols

The Language Environment Analysis (LENA) System is a recording technology that is used to record the naturalistic speech that a child hears and produces throughout the day. In this study, we used the LENA to measure the auditory environment of children aged 14-22 months and 30-36 months.

The LENA device was given to the family by the surveyor team that administered the caregiver survey and cognitive assessments for children 14-22 months and 30-36 months. The device was held in a T-shirt so that it could easily be worn by the target child the next day. The family was instructed that the child should wear the shirt and device the entire day if possible (refer to [Figure E.1](#) for example of a child wearing the LENA shirt). The device has a battery life of 16 hours.

A separate team of surveyors was tasked with collecting the device from the family and administering a short debrief survey. The short debrief survey included questions about factors that may have influenced the quality of the data (e.g., carrying the child on your back, taking off the LENA device, or having an unusual day).

Figure E.1: Child wearing LENA shirt



Notes: A child wearing the LENA shirt during piloting. The LENA device is stored in the patterned pocket on the front of the shirt.

E.2 Description of analysis of LENA data

The audio from the LENA device was processed using LENA Pro software. LENA Pro software automatically generates a number of variables relating to the child’s auditory environment. Below we define the variables used in this paper:³⁴

- **Adult words count:** Number of words spoken by adults near the child during the recording.
- **Child vocalization count:** Number of speech-like utterances by the child wearing the LENA device. Speech-like utterances include words or pre-speech communicative sounds (e.g., babbles or squeals), but excludes non-speech sounds (e.g., breathing or burping).

³⁴These definitions draw upon [Xu et al. \(2009\)](#) and [Gilkerson and Richards \(2020\)](#).

- **Conversational turn count:** Number of times an adult and the child wearing the LENA device have a back-and-forth vocal interaction (i.e. the adult speaks and child vocalizes or vice verse.)
- **% audio of meaningful speech:** Percentage of the total audio recorded by the device containing speech where the LENA could identify the primary speaker as a female adult, male adult, child wearing the LENA device, or other child. Excludes overlapping speech where the LENA could not identify a primary speaker.

References

Gilkerson, Jill and Jeffrey A Richards, “A Guide to Understanding the Design and Purpose of the LENA System,” *LENA Foundation Technical Report*, 2020

Xu, Dongxin, Umit Yapanel, and Sharmi Gray, “Reliability of the LENA Language Environment Analysis System in Young Children’s Natural Home Environment” *LENA Foundation Technical Report*, 2009

F Details of the Cost-Effectiveness, Cost-Benefit, and MVPF Analyses

This section describes in-detail how we calculate the cost-effectiveness, benefit-cost ratios, and MVPF estimates presented in [Table 7](#).

F.1 Benefits

We consider the benefits from the scholarship for the recipients in terms of averted child deaths and increases in scholarship recipient wages. The numerator in the MVPF calculations includes the value of the scholarships themselves. The positive fiscal externalities for the government include increased tax revenue and VAT from the scholarships.

Child survival

We quantify the benefits averted child deaths using the Value of a Statistical Life (VSL) benchmarks. These benchmarks come from the recommendations of [Robinson et al. \(2019\)](#):

1. Low scenario: “VSL extrapolated from a U.S. estimate to the target country using an income elasticity of 1.5. The starting point for this calculation should be a U.S. VSL to GNI per capita ratio of 160, based on a U.S. VSL of \$9.4 million and U.S. GNI per capita of \$57,900.”
2. High scenario: “VSL = 160* GNI per capita in the target country. This calculation applies the U.S. ratio to all countries, which is equivalent to using that ratio as the starting point and assuming income elasticity is 1.0.”
3. Medium scenario: “VSL = 100* GNI per capita in the target country. This calculation applies the OECD ratio to all countries, which is equivalent to using that ratio as the starting point and assuming income elasticity is 1.0.”

With the VSL estimates in hand, we can calculate the survival benefits.

We estimate the total survival-related benefits generated by the program by multiplying the value of a statistical life (VSL), adjusted for age weighting and the estimated program impact on child survival, by the average number of children per participant in the treated group.

We define three cohorts of children:

- **Cohort 1 (born by 2017)**: These children’s survival benefits are discounted by 10 years.
- **Cohort 2 (born 2017–2023)**: Discounted by 15 years.
- **Cohort 3 (post-2023 to reach replacement fertility)**: Only included in the full fertility scenario. Discounted by 19 years.

Total survival benefits are indexed by:

- $s \in \{\text{low, medium, high}\}$: VSL scenario,
- p : program group (e.g., girls-only, all),
- $f \in \{\text{not-full, full}\}$: fertility scenario.

The total survival benefits expression is:

$$\text{Total Survival Benefits}_{p,f,s} = \text{VSL}_s \cdot \text{Age weight} \cdot \beta_{\text{survival}}(p) \cdot \left(\frac{N_{\text{child},p}^{(1)}}{(1 + 0.05)^{10}} + \frac{N_{\text{child},p}^{(2)}}{(1 + 0.05)^{15}} + \mathbf{1}_{\{f=\text{full}\}} \cdot \frac{N_{\text{child},p}^{(3)}}{(1 + 0.05)^{19}} \right)$$

where:

- $\beta_{\text{survival}}(p)$ is the estimated program impact on child survival under program p ,
- $N_{\text{kids},p}^{(1)}$: Average number of children ever born in treatment group by 2017,
- $N_{\text{kids},p}^{(2)}$: Average number of children ever born in treatment group between 2017 and 2023
- $N_{\text{kids},p}^{(3)}$: Additional children needed to reach replacement fertility (2.1), only included for full fertility scenario ($f = \text{full}$).

We multiply the VSL by an age weight of 1.33 to reflect the fact that more years of life are lost due to under-3 deaths relative to deaths of the average Ghanaian.³⁵

$\beta_{\text{survival}}(p)$ differs by the program type. Given our assumptions, $\beta_{\text{survival}}(p)$ is equal to the effect on the children of female scholarship recipients (1.7 pp increases; Table 2) for the scholarships available to females-only, while it is equal to the effect on scholarship recipients of either gender (1.6 pp increase) when we evaluate the program open to both genders.

Earnings and Income Tax

Following Duflo et al. (2025), we attribute the observed earnings gains among female scholarship recipients entirely to increased employment in the public sector: a 6.7 percentage point increase for women, and 3.9 percentage points when including both female and male recipients. Among women, this rise in public sector employment is primarily due to increases in teaching (4 percentage points) and health sector employment (2 percentage points).

To estimate the scholarship's impact on lifetime earnings, we model earnings separately for public sector and non-public sector workers, disaggregated by gender. For public sector workers, we assume a starting monthly wage equal to the average in our sample among public sector workers—USD 91 for women and USD 111 for men (2020 USD, nominal). For non-public sector workers, the starting wage is set to the monthly average earnings in the control group (USD 25 for women, USD 58 for men).

To project earnings over the recipients' working lives, we apply age- and sector-specific earnings growth factors from ILO data on the Ghanaian labor market. We then calculate the annual difference in earnings (net of income tax in the public sector), discount these differences back to the start of the program, and sum them over the working life. Finally, we multiply this sum by the estimated treatment effect on public sector employment to quantify the program's impact on lifetime after-tax earnings:

$$\text{Lifetime Earnings Impact}_p = \beta_{\text{public sector}}(p) \cdot \sum_{t=30}^{60} \frac{E_t^{\text{pub}} - E_t^{\text{non}} - T_t^{\text{pub}}}{(1 + 0.05)^{t-17}}$$

where $\beta_{\text{public sector}}(p)$ is the estimated treatment effect on public sector employment as a function of program type p (e.g., 0.067 for women only), E_t^{pub} and E_t^{non} are projected earnings in year t , T_t^{pub} is

³⁵The average Ghanaian is 20 years old, so we compute $\frac{\text{Years of Life Lost due to 1-5 year old death}}{\text{Years of Life Lost due to 20-25 year old death}}$ using the WHO's 2019 guidelines (World Health Organization, 2020).

the income tax owed by public sector workers based on Ghana’s income tax scheme, and 0.05 is the discount rate.

We assume full tax compliance in the public sector and zero compliance in the non-public sector. Accordingly, we calculate the program-induced increase in income tax revenue as:

$$\text{Lifetime Income Tax Revenue Impact}_p = \beta_{\text{public sector}}(p) \cdot \sum_{t=30}^{64} \frac{T_t^{\text{pub}}}{(1 + 0.05)^{t-17}}$$

This expression captures the fiscal return to the government under the assumption that income taxes are only collected from public sector workers.

Scholarship value, or Willingness to Pay (WTP) for Scholarships

The numerator of the Marginal Value of Public Funds includes recipients’ willingness to pay (WTP) for secondary school scholarships. Following the methodology of [Finkelstein and Hendren \(2020\)](#), we calculate this as a weighted average of WTP among both marginal and inframarginal recipients. For inframarginal recipients—those who would have completed senior high school even in the absence of the scholarship—the program functions effectively as a cash transfer, and their WTP equals the full value of the scholarship. For marginal recipients—those whose schooling decisions were influenced by the program—we do not observe whether it was the first or last dollar of the subsidy that induced SHS completion. That is, even a scholarship worth less than full tuition might have been sufficient to alter their behavior. In the absence of precise data on this threshold, we adopt a midpoint assumption: we treat half of the scholarship value as the cost of inducing enrollment (the behavioral margin), and the other half as a cash-equivalent transfer.

The formula is given by:

$$\text{Program WTP}_p = \text{Share Inframarginal}_p \cdot \text{Scholarship Cost}_p + \frac{1}{2} \cdot \text{Share Marginal}_p \cdot \text{Scholarship Cost}_p$$

where:

- $\text{Share Inframarginal}_p$ is the share of control group participants that completed SHS under program p ,
- Share Marginal_p is the treatment effect on SHS completion under program p ,
- $\text{Scholarship cost}_p$ is the full monetary value of the scholarship.

VAT and Fiscal Externalities

The scholarship program affects government revenues through Ghana’s value-added tax (VAT) system. We distinguish between two channels:

1. A direct fiscal offset: when disbursing scholarship funds, a portion of that spending returns immediately to the government through VAT, since scholarships are used to purchase VAT-liable goods and services such as tuition, boarding, and school materials;
2. A long-run fiscal externality: recipients who experience higher lifetime earnings also consume more over their lifetimes, generating additional VAT revenue.

Let:

- $\tau_{\text{VAT}} = 0.15$: the statutory VAT rate (15%),
- θ_{VAT} : the VAT compliance rate, (50%)
- Scholarship Cost_{*p*}: present value of the scholarship cost per recipient in program *p*,
- Lifetime Earnings Impact_{*p*}: increase in lifetime after-tax earnings caused by program *p*, as defined previously.

VAT offset from scholarship spending.

Because scholarships are spent on VAT-liable goods and services, part of the expenditure returns immediately to the government. This direct fiscal offset is given by:

$$\text{VAT Offset}_p = \tau_{\text{VAT}} \cdot \theta_{\text{VAT}} \cdot \text{Scholarship Cost}_p$$

VAT revenue from lifetime consumption.

Recipients with higher lifetime earnings also generate more consumption, a share of which is subject to VAT. The resulting long-run fiscal externality is:

$$\text{VAT Revenue from Lifetime Consumption}_p = \tau_{\text{VAT}} \cdot \theta_{\text{VAT}} \cdot \text{Lifetime Earnings Impact}_p$$

These expressions reflect two ways in which the VAT system reduces the net fiscal cost of the program: an immediate return of a portion of scholarship spending, and a long-run expansion of the VAT base through increased consumption.

F.2 Costs

Direct program costs

The most important cost of the program is the value of the senior secondary school scholarships. We calculate the total present value of scholarship costs by summing disbursements across the years 2009 to 2013 and discounting each to the program start year (2008). All values are assumed to be in constant 2020 USD:

$$\text{Scholarship Cost}_p = \frac{1}{N_{\text{treated}}^{(p)}} \sum_{y=2009}^{2013} \frac{C_{p,y}}{(1 + 0.05)^{t_y}}$$

Where:

- Scholarship Cost_{*p*}: Present value of scholarship cost per recipient in program *p*,
- $N_{\text{treated}}^{(p)}$: Number of scholarship recipients under program *p*,
- $C_{p,y}$: Total value of scholarships disbursed in year *y* under program *p*, in 2020 USD,
- $t_y = y - 2008$: Number of years from disbursement year *y* to base year 2008.

Indirect program costs

We divide indirect program costs into two components: *targeting costs* (from the listing survey used to identify eligible students) and *administrative costs* (staff time used to implement the program).

These are calculated under two scenarios: (i) as incurred during the pilot and (ii) under a scaled-up implementation.

Notation:

- Number of eligible students: $N_{\text{eligible}} = 2064$
- Share included in 2016 survey: $p_{\text{survey}} = 0.98$
- Listing cost: $C_{\text{total}}^{\text{listing}}$
- Let $N_{\text{treated}}^{(p)}$ be the number of scholarship recipients under program type p .
- Admin staff monthly salary: W

Targeting (Listing Survey) Costs: During the study, a full listing survey was conducted. Since only a subset of surveyed students received scholarships, we scale the listing cost by the proportion treated:

$$C_{\text{pilot}}^{\text{listing}} = C_{\text{total}}^{\text{listing}} \cdot \left(\frac{N_{\text{treated}}^{(\text{All})}}{N_{\text{eligible}} \cdot p_{\text{survey}}} \right)$$

Under scale, we assume that the government would not need to conduct a separate listing survey. Instead, we proxy targeting with one month of administrative staff time per year, over five years. The discounted present value of that time is:

$$C_{\text{scale}}^{\text{listing}} = W \cdot \sum_{t=0}^4 \frac{1}{(1 + \delta)^t}$$

Administrative Costs: Administrative costs cover time spent processing scholarships. In both the pilot and scale scenarios, we assume 3 months of admin time per year for 5 years. The total discounted cost is:

$$C^{\text{admin}} = W \cdot 3 \cdot \sum_{t=0}^4 \frac{1}{(1 + \delta)^t}$$

Total Indirect Costs per Recipient:

We compute the per-recipient indirect costs as:

- **Pilot scenario:**

$$c_{\text{pilot}}^{\text{indirect}}(p) = \frac{C_{\text{pilot}}^{\text{listing}} + C^{\text{admin}}}{N_{\text{treated}}^{(p)}}$$

- **Scale scenario:**

$$c_{\text{scale}}^{\text{indirect}}(p) = \frac{C_{\text{scale}}^{\text{listing}} + C^{\text{admin}}}{N_{\text{treated}}^{(p)}}$$

These per-recipient costs feed into our program cost estimates and are reflected in the MVPF calculations. As the number of recipients differs across program variants (e.g., all students vs. girls only), the per-recipient indirect cost varies with p .

Opportunity Cost of Schooling

We estimate the opportunity cost of additional schooling by computing the present value of reduced earnings during the years of attending secondary school, from 2009 to 2012. These reductions are attributed to time out of the labor market due to continued education among treated students. We assume monthly earnings impacts are in 2020 USD and are indexed by program type p .

$$\text{Opportunity Cost}_p = \sum_{y=2009}^{2012} \frac{M_y \cdot \beta_{\text{Monthly earnings 2009-13}}(p)}{(1 + 0.05)^{t_y}}$$

Where:

- $\beta_{\text{Monthly earnings 2009-13}}(p)$ is the estimated treatment effect on average monthly earnings from 2009-2013 for program type p ,
- M_y is the number of months during year y in which earnings are affected (12 months for all years except $M_{2012} = 6$),
- t_y is the number of years from 2008 to year y , used to discount earnings to the program start year (i.e., $t_{2009} = 1$, ..., $t_{2012} = 4.5$).

Government education expenditure

Notation

- E_y^{sec} : Government expenditure per secondary school student in year y (in 2020 USD)
- E_y^{ter} : Government expenditure per tertiary student in year y (in 2020 USD)
- $\beta_y^{\text{sec}}(p)$: Estimated increase in years of secondary education for year y of schooling under program type p
- $\beta_y^{\text{ter}}(p)$: Estimated increase in enrollment in year y of tertiary education under program type p

Secondary Education Costs

The scholarship program begins in the 2008–09 school year (Grade 10). The control group had completed on average 11.056 years of schooling for girls and 11.806 for boys. Therefore, the marginal years of education due to the program occur primarily in Grade 12 (2010–11 school year) and Grade 13 (2011–12 school year).

The government bears the cost of additional public schooling induced by the program. These costs are discounted based on when the expenditure occurs.

$$\text{GovEd}^{\text{sec}}(p) = \beta_{11}^{\text{sec}}(p) \cdot E_{2010}^{\text{sec}}(1 + r)^2 + \beta_{12}^{\text{sec}}(p) \cdot E_{2011}^{\text{sec}}(1 + r)^3$$

- $\beta_{11}^{\text{sec}}(p)$ is the portion of the secondary schooling increase that occurred in Grade 12 (school year 2010–11), discounted by 2 years from 2008.
- $\beta_{12}^{\text{sec}}(p)$ is the portion that occurred in Grade 13 (school year 2011–12), discounted by 3 years.
- These effects are multiplied by per-student government spending.

Tertiary Education Costs

Tertiary education impacts begin several years after the program starts. Enrollment data suggest that most students began tertiary education between 2015 and 2020, with roughly 1/3 of those who ever enrolled starting in each of three periods:

- Batch 1: 2015–2018
- Batch 2: 2016–2019
- Batch 3: 2017–2020

For each batch, we assume:

- Students attend up to 4 years of tertiary education
- Enrollment follows a linear trajectory: $\beta_1^{\text{ter}}(p)$ in year 1, increasing linearly to $\beta_4^{\text{ter}}(p)$ in year 4
- Costs are calculated using per-student expenditure from 2014 (held constant for 2015–2020) and discounted accordingly

Define slope of attendance effect:

$$\Delta_{\text{slope}}(p) = \frac{\beta_4^{\text{ter}}(p) - \beta_1^{\text{ter}}(p)}{3}$$

$$\beta_2^{\text{ter}}(p) = \beta_1^{\text{ter}}(p) + \Delta_{\text{slope}}(p) \quad ; \quad \beta_3^{\text{ter}}(p) = \beta_2^{\text{ter}}(p) + \Delta_{\text{slope}}(p)$$

$$\text{GovEd}^{\text{ter}}(p) = \sum_{b=1}^3 \sum_{y=1}^4 \left(\frac{1}{3} \cdot \frac{\beta_y^{\text{ter}}(p) \cdot E_{2014+y-1}^{\text{ter}}}{(1 + 0.05)^{d_b}} \right)$$

Discount factors by batch:

- $d_1 = 6$ (batch starting in 2015)
- $d_2 = 7$ (batch starting in 2016)
- $d_3 = 8$ (batch starting in 2017)

Explanation:

- Each batch contributes one-third of the students.
- Year-specific enrollment effects are applied per cohort year, discounted appropriately based on when costs occur relative to program start.

Total Cost

$$\text{GovEd}(p) = \text{GovEd}^{\text{sec}}(p) + \text{GovEd}^{\text{ter}}(p)$$

F.3 Estimates

Cost-Effectiveness

We calculate cost-effectiveness (CE) for second-generation cognitive development and child mortality outcomes under different program assignment and fertility scenarios.

Let:

- $\beta_{\text{cog}}(p)$: treatment effect on second generation cognitive ability (standard deviation units) for program p at age 7.

We define two fertility assumptions:

- “Not full fertility”: uses actual estimated fertility per recipient.
- “Full fertility”: assumes each recipient has 2.1 children (replacement fertility).

Then the cost-effectiveness for cognitive gains is calculated as:

$$CE_{p,f}^{\text{cog}} = \frac{\text{Scholarship Cost}_p + c_{\text{scale}}^{\text{indirect}}(p)}{n_{p,f} \cdot \beta_{\text{cog}}(p)}$$

and for mortality reduction:

$$CE_{p,f}^{\text{mort}} = \frac{\text{Scholarship Cost}_p + c_{\text{scale}}^{\text{indirect}}(p)}{n_{p,f} \cdot \beta_{\text{surv}}(p)}$$

Where:

$$n_{p,f} = \begin{cases} N_{\text{kids},p} & \text{if } f = \text{not-full} \\ 2.1 & \text{if } f = \text{full} \end{cases}$$

Note that the definition of costs here only includes the direct and indirect program costs, excluding any government or beneficiary externalities.

Marginal Value of Public Funds (MVPF)

We define the Marginal Value of Public Funds (MVPF) as the ratio of recipients’ total willingness to pay (WTP) to the net fiscal cost borne by the government:

$$\text{MVPF}_{p,s,f}^v = \frac{\text{WTP}_{p,s,f}^v}{\text{NetGovCost}_p}$$

where:

- p : program variant (e.g., girls-only, all),
- $s \in \{\text{low, medium, high}\}$: VSL scenario,
- $f \in \{\text{not-full, full}\}$: fertility scenario,
- $v \in \{\text{full, second-generation only}\}$: valuation scope (includes or excludes recipient earnings).

Willingness to Pay (WTP).

We compute WTP under two valuation scopes. The *full* scope includes recipient earnings gains, while the *second-generation only* scope excludes them.

$$\begin{aligned} \text{WTP}_{p,s,f}^{\text{full}} &= \text{Program WTP}_p + \text{Total Survival Benefits}_{p,s,f} + \text{Lifetime Earnings Impact}_p \\ \text{WTP}_{p,s,f}^{\text{second-gen only}} &= \text{Program WTP}_p + \text{Total Survival Benefits}_{p,s,f} \end{aligned}$$

Net Government Cost.

Net cost is calculated as the sum of all public expenditures minus the tax revenues recovered through income tax and VAT. This expression is independent of s , f , and v , but indexed by program p :

$$\text{NetGovCost}_p = \underbrace{\text{Scholarship Cost}_p + c_{\text{scale}}^{\text{indirect}}(p) + \text{Opportunity Cost}_p + \text{GovEd}_p}_{\text{Gross Program Cost}} - \underbrace{\text{VAT Offset}_p + \text{VAT Revenue from Lifetime Consumption}_p + \text{Income Tax Revenue Impact}_p}_{\text{Fiscal Externalities}}$$

where:

- $c_{\text{scale}}^{\text{indirect}}(p)$: indirect cost per recipient under scale implementation,
- $\text{GovEd}_p = \text{GovEd}^{\text{sec}}(p) + \text{GovEd}^{\text{ter}}(p)$: government education costs due to increased secondary and tertiary enrollment,
- $\text{VAT Offset}_p = \tau_{\text{VAT}} \cdot \theta_{\text{VAT}} \cdot \text{Scholarship Cost}_p$,
- $\text{VAT Revenue from Lifetime Consumption}_p = \tau_{\text{VAT}} \cdot \theta_{\text{VAT}} \cdot \text{Lifetime Earnings Impact}_p$,
- $\text{Lifetime Income Tax Revenue Impact}_p$: as defined in the income tax section.

Together, these components yield the MVPF indexed by program (rows), scenario (columns), valuation scope (panels), and fertility assumption (panels), and are reported in [Table 7](#).

Cost-Benefit Ratios

We define the Cost-Benefit Ratio (CBR) as the ratio of total government and opportunity costs to the total social benefits generated by the program. These benefits include gains to scholarship recipients and their children, as well as fiscal revenues returned to the government.

$$\text{CBR}_{p,s,f}^v = \frac{\text{Total Cost}_p}{\text{Benefits}_{p,s,f}^v}$$

where:

- p : program variant (e.g., girls-only, all),
- $s \in \{\text{low, medium, high}\}$: VSL scenario,
- $f \in \{\text{not-full, full}\}$: fertility scenario,
- $v \in \{\text{full, second-generation only}\}$: valuation scope.

Total Cost.

Costs include all government expenditures and opportunity costs of time in school:

$$\text{Total Cost}_p = \text{Scholarship Cost}_p + c_{\text{scale}}^{\text{indirect}}(p) + \text{Opportunity Cost}_p + \text{GovEd}_p$$

Total Benefits.

Benefits consist of private and fiscal gains from the program. These vary by valuation scope:

$$\begin{aligned}\text{Benefits}_{p,s,f}^{\text{full}} = & \text{Total Survival Benefits}_{p,s,f} + \text{Lifetime Earnings Impact}_p \\ & + \text{VAT Offset}_p + \text{VAT Revenue from Lifetime Consumption}_p \\ & + \text{Income Tax Revenue Impact}_p\end{aligned}$$

$$\begin{aligned}\text{Benefits}_{p,s,f}^{\text{second-gen only}} = & \text{Total Survival Benefits}_{p,s,f} \\ & + \text{VAT Offset}_p + \text{VAT Revenue from Lifetime Consumption}_p \\ & + \text{Income Tax Revenue Impact}_p\end{aligned}$$

This approach treats fiscal externalities as genuine societal benefits rather than cost offsets, consistent with a social planner perspective.

As with MVPF, these CBR estimates are reported by program variant, scenario, fertility assumption, and valuation scope in [Table 7](#).

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