Working Paper

Evaluation of North Carolina Early Childhood Program among Middle School Students

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Introduction

Goals

1. Evaluate the effects of Smart Start (SS) and More at Four programs (MF) on academic outcomes among middle school students who were born in North Carolina from 01/01/1988 to 12/31/2000 and studied in North Carolina Public School system during School Year[2] 1999-2000 to School Year 2015-2016.

Academic Outcomes

a. End of Grade (EOG) scores in reading and math in Grade 6, 7, and 8;
b. Grade retention in Grade 6, 7, and 8[3]; Grade retention since Grade 3[4];
c. Special education placement in Grade 6, 7, and 8[5]; Special education placement since Grade 3;

[2] School Year is defined as the period from July 1st this year to June 30th in the following year.
[3] Grade retention is defined if a child was found in the same grade in consecutive years.
[4] The student information on Grade K, Grade 1, and Grade 2 is not available until 2005-2006 School Year. Thus, our study focuses on students from Grade 3 and beyond.
[5] A child is coded as being placed in special education for disability if any nongifted class of exceptionality was noted.

Design

There are 13 birth cohorts from 1988 to 2000. Eight cohorts experienced only SS (1988-1995), and five cohorts experienced both SS and MF (1996-2000). That is, the SS effects can be observed in 13 cohorts, and the MF effects can be observed in 5 cohorts.

Table 1: Research design

Birth Year	SS	MF
1988	√	
1989	√	
1990	√	
1991	√	
1992	√	
1993	√	
1994	√	
1995	√	
1996	√	√
1997	√	√
1998	√	√
1999	√	√
2000	√	√

Sample

The sample is composed of students who (1) were born from 01/01/1988 to 12/31/2000 (presented in North Carolina Vital Record); and (2) also were presented in NCERDC from SY 1999-2000 to SY 2015-2016 when they were enrolled in Grade 6, 7, and 8.

Match rate or Data quality

$$\% \text{ match rate} = \frac{\#\ of\ students\ in\ both\ NCER-DC\ and\ Vital\ Record}{\#\ of\ observations\ in\ Vital\ Record} = 74.55\%$$

Table 2: Match rate between NCERDC and Vital Record

	# of missingness in mastid	# of valid mastids	# of observations on Vital Record
Total	342,991	1,004,571	1,347,562
	25.45	74.55	100

Table 3: Sample sizes in each cohort

Birth cohort (n=13)	G3	G4	G5	G6	G7	G8	Total
1988	62,328	63,452	64,300	65,027	65,781	65,823	386,711
1989	66,153	67,105	67,822	68,595	69,102	68,971	407,748
1990	68,280	69,163	69,961	70,439	70,476	70,462	418,781
1991	67,971	68,834	69,450	69,781	69,757	69,905	415,698
1992	67,848	68,551	68,873	68,980	69,184	69,281	412,717
1993	67,097	67,539	67,791	67,957	68,111	67,891	406,386
1994	67,361	67,732	68,026	67,916	67,807	67,767	406,609
1995	67,629	68,043	68,182	67,867	67,600	66,887	406,208
1996	69,406	69,887	69,778	69,596	68,858	67,481	415,006
1997	70,991	71,507	71,713	70,906	69,378	68,140	422,635
1998	75,135	75,768	75,094	72,702	71,442	70,220	440,361
1999	76,834	76,641	74,731	72,699	71,437	70,312	442,654
2000	79,161	76,522	74,806	75,273	73,932	73,209	452,903
Total	906,194	910,744	910,527	907,738	902,865	896,349	5,434,417

Table 4: Comparison between matched and unmatched observations in Birth data after we matched children in Birth records with students in NCERDC

Birth data and NCER-DC (n=1,347,562)	Unmatched (n=342,991)		Matched (n=1,004,571)		Two group t-test
	N	Mean	N	Mean	P
Female	330,840	0.487	1,004,547	0.489	0.014
Extremely low birth weight	330,848	0.006	1,004,553	0.005	0.000
Very low birth weight	330,848	0.007	1,004,553	0.008	0.000
Low birth weight	330,848	0.057	1,004,553	0.069	0.000
Normal weight	330,848	0.816	1,004,553	0.818	0.001
High birth weight	330,848	0.114	1,004,553	0.100	0.000
Mother's education (years)	330,108	13.230	1,003,262	12.560	0.000
Marital status	330,822	0.793	1,004,507	0.667	0.000
Mother's age (years)	330,748	26.730	1,004,302	25.830	0.000
No dad information	330,848	0.093	1,004,553	0.145	0.000
Mother immigrant	330,773	0.122	1,004,441	0.059	0.000
First born	330,848	0.448	1,004,553	0.442	0.000
Mother white	330,848	0.703	1,004,553	0.637	0.000
Mother black	330,848	0.184	1,004,553	0.299	0.000
Mother native American	330,848	0.007	1,004,553	0.017	0.000
Mother Asian	330,848	0.027	1,004,553	0.011	0.000
Mother Hispanic	330,848	0.076	1,004,553	0.035	0.000
Mother other race	330,848	0.001	1,004,553	0.001	0.000

Since the match rate is 74.55% when we combine the birth record with NCER-DC data source (Table 2), a comparative analysis is conducted to examine difference between the two populations. Some characteristics of the unmatched observations are different from those of the matched observations (Table 4). For example, compared to those in the unmatched population, there were fewer children with mother as single parent (66.7% vs. 79.3%), fewer children whose mothers are immigrants (5.9% vs. 12.2%), and fewer children whose mothers are white (63.7% vs. 70.3%) in the matched population.

Table 5: Variable list

Variables	Definition	Source
Dependent Variables		
Grade 6, 7, 8 EOG Math score	Rescaled with Mean=0 and SD=1	NCERDC
Grade 6, 7, 8 EOG Reading score	Rescaled with Mean=0 and SD=1	NCERDC
Grade 6, 7, 8 Special education placement	Scored 0=no, 1=yes	NCERDC
Grade 6, 7, 8 Special education placement since Grade 3	Scored 0=no, 1=yes	NCERDC
Grade 6,7,8 Grade retention	Scored 0=no, 1=yes	NCERDC
Grade 6,7,8 Grade retention since Grade 3	Scored 0=no, 1=yes	NCERDC
Early childhood Initiative		
Smart Start ($00's)	Annual funding level by county	SS Program
More at Four ($00's)	Annual funding level by county	MF Program
Covariates		
Extremely low birth weight	1=Yes, 0=No	Vital Record
Very low birth weight	1=Yes, 0=No	Vital Record
Low birth weight	1=Yes, 0=No	Vital Record
Normal birth weight	Reference Group	Vital Record
High birth weight	1=Yes, 0=No	Vital Record
Child white	Reference Group	Vital Record
Child black	1=Yes, 0=No	Vital Record
Child native American	1=Yes, 0=No	Vital Record
Child Asian	1=Yes, 0=No	Vital Record
Child Hispanic	1=Yes, 0=No	Vital Record
Child mixed race	1=Yes, 0=No	Vital Record
Economic disadvantage	1=Yes, 0=No	NCERDC
Mother Characteristics		
Mother's education	Years	Vital Record
Marital status	1=Yes, 0=No	Vital Record
Mother's age	Years	Vital Record
No dad information	1=Yes, 0=No	Vital Record
Mother immigrant	1=Yes, 0=No	Vital Record
First born	1=Yes, 0=No	Vital Record
Mother white	Reference Group	Vital Record
Mother black	1=Yes, 0=No	Vital Record

Mother native American	1=Yes, 0=No	Vital Record
Mother Asian	1=Yes, 0=No	Vital Record
Mother Hispanic	1=Yes, 0=No	Vital Record
Mother other race	1=Yes, 0=No	Vital Record
County-level demographic data by birth year		
Share of births to black mothers	Percent	LINC[6]
Share of births to Hispanic mothers	Percent	LINC
Share of births to low education mothers	Percent	LINC
Population on Food Stamps (share of population)	Percent	LINC
Population on Medicaid (share of population)	Percent	LINC
Number of births	Log	Vital Record
Total population	Log	LINC
Median family income (2009 $)	$10,000	LINC
School characteristics, test year		
Black students (share of students)	Percent	NCERDC
Other minority students (share of students)	Percent	NCERDC
Charter school status	1=Yes, 0=No	NCERDC
Per-pupil spending by source, test year		
Federal (2009 dollars)	dollar	NCERDC, BLS[7]
State (2009 dollars)	dollar	NCERDC, BLS
Local (2009 dollars)	dollar	NCERDC, BLS
Same County if birth county and school county	1=Yes, 0=No	NCERDC, Vital Record

[6] Web resource for NC statistical data, http://linc.state.nc.us/

[7] Bureau of Labor Statistics, http://www.bls.gov/data/

Statistics Approach

Basic Model

The basic model takes the following form,

$$O_{icbtg} = \beta_0 + \beta_1 SS_{ict}^{*} + \beta_2 MF_{ict}^{*} + \beta_3 X_{ib} + \beta_4 Y_{it} + \beta_5 C_{cb} + \alpha_c + \gamma_b + \varepsilon_{icbt,}$$

where O_{icbtg} is a Grade g outcome (g=6, 7, and 8) (such as EOG math and reading scores) in year *t* for the i^{th} student born in county *c* in year *b*.

The linear regression models were used when the dependent variables were reading and math standardized scores. Logistic models were used when the dependent variables were grade retention (0/1), grade retention ever since Grade 3 (0/1), special education status (0/1), and special education status ever since Grade 3 (0/1).

The independent variables were both SS and MF county-average program investments when and where students were born (Table 5). They were used as continuous variables, based on state funding allocations for each program to each county by year.

A list of covariates (Table 5) included student characteristics (i.e., gender; extremely low birth weight, very low birth weight, low birth weight, and high birth weight; black, Hispanic, Asian, American Indian, and other race groups; economically disadvantaged status), mother characteristics (i.e., years of mother in education, marital status, age, dad information, immigration status, first born status, and racial groups), school characteristics (i.e., percent of non-Hispanic Black students, percent of Hispanic students, and charter school status), and birth county characteristics (i.e., percent of births to black mothers, percent of births to Hispanic mothers, percent of births to low education mothers, number of births, total population, median family income, population with food stamp, and population with Medicaid).

The model included county fixed effects (α_c) and year fixed effects (γ_b) effects, as well as county-level variables (C_{cb}).

Descriptive Analyses

Table 6: Descriptive analysis

	Grade 6 (n=907,738)			Grade 7 (n=902,865)			Grade 8 (n=896,349)		
Variables	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
Academic Outcomes									
Math standardized score	0.00	1.00	872,299	0.00	1.00	868,251	0.00	1.00	862,197
Reading standardized score	0.00	1.00	869,490	0.00	1.00	866,355	0.00	1.00	861,145
Grade retention	1.54%	-	907,738	1.45%	-	902,865	0.99%	-	896,349
Grade retention since G3	6.02%	-	907,738	7.04%	-	902,865	7.55%	-	896,349
Special education status	15.20%	-	907,738	14.70%	-	902,865	14.10%	-	896,349
Special education status since G3	19.75%	-	907,738	20.14%	-	902,865	20.37%	-	896,349
Program									
Smart Start (non-zero, $00's)	11.36	8.62	770,887	11.30	8.63	765,355	11.26	8.63	758,930
More at Four (non-zero,$00's)	3.33	2.51	267,681	3.34	2.51	262,742	3.34	2.51	258,885
Smart Start ($00's)	9.67	8.92	905,130	9.61	8.92	900,251	9.56	8.91	893,756
More at Four ($00's)	0.99	2.04	905,130	0.97	2.04	900,251	0.97	2.03	893,756
Student Characteristics									
Female	49.10%	-	907,733	49.10%	-	902,860	49.20%	-	896,344
Extremely low birth weight	0.46%	-	907,738	0.46%	-	902,865	0.46%	-	896,349
Very low birth weight	0.81%	-	907,738	0.81%	-	902,865	0.80%	-	896,349
Low birth weight	6.95%	-	907,738	6.94%	-	902,865	6.94%	-	896,349
Normal birth weight	81.80%	-	907,738	81.80%	-	902,865	81.80%	-	896,349
High birth weight	9.93%	-	907,738	9.94%	-	902,865	9.95%	-	896,349
Child white	60.50%	-	907,738	60.50%	-	902,865	60.40%	-	896,349
Child black	30.50%	-	907,738	30.40%	-	902,865	30.40%	-	896,349
Child native American	1.87%	-	907,738	1.90%	-	902,865	1.90%	-	896,349
Child Asian	0.97%	-	907,738	0.96%	-	902,865	0.95%	-	896,349

Child Hispanic	3.75%	-	907,738	3.77%	-	902,865	3.81%	-	896,349
Child mixed race	2.40%	-	907,738	2.43%	-	902,865	2.47%	-	896,349
Economic disadvantage	46.40%	-	906,675	46.10%	-	901,755	45.40%	-	894,541
Mother Characteristics									
Mother's education (years)	12.52	2.41	906,582	12.53	2.41	901,705	12.54	2.41	895,198
Marital status	66.20%	-	907,693	66.30%	-	902,821	66.40%	-	896,305
Mother's age (years)	25.82	5.88	907,517	25.83	5.88	902,641	25.84	5.88	896,127
No dad information	14.70%	-	907,738	14.70%	-	902,865	14.60%	-	896,349
Mother immigrant	5.81%	-	907,642	5.78%	-	902,768	5.75%	-	896,254
First born	44.00%	-	907,738	44.00%	-	902,865	44.10%	-	896,349
Mother white	63.20%	-	907,738	63.20%	-	902,865	63.20%	-	896,349
Mother black	30.40%	-	907,738	30.40%	-	902,865	30.50%	-	896,349
Mother native American	1.69%	-	907,738	1.69%	-	902,865	1.70%	-	896,349
Mother Asian	1.11%	-	907,738	1.11%	-	902,865	1.10%	-	896,349
Mother Hispanic	3.52%	-	907,738	3.48%	-	902,865	3.46%	-	896,349
Mother other race	0.06%	-	907,738	0.06%	-	902,865	0.06%	-	896,349
County-level demographic data by birth year									
Births to black mothers (share of births)	30.70%	16.90%	907,738	30.60%	16.90%	902,865	30.60%	16.80%	896,349
Births to Hispanic mothers (share of births)	3.51%	4.04%	907,738	3.48%	4.03%	902,865	3.47%	4.04%	896,349
Births to low education mothers (share of births)	23.70%	5.75%	907,738	23.60%	5.79%	902,865	23.40%	5.72%	896,349
Population on Food Stamps (share of population)	7.45%	3.77%	905,130	7.45%	3.77%	900,251	7.45%	3.77%	893,756
Population on Medicaid (share of population)	13.40%	5.66%	905,130	13.40%	5.66%	900,251	13.30%	5.66%	893,756
Number of births (log)	7.09	0.99	907,738	7.08	0.99	902,865	7.07	0.99	896,349
Total population (log)	11.70	0.99	905,130	11.70	0.99	900,251	11.70	0.98	893,756
Median family income (2009 $)	54948	9922	905,130	54,931	9,915	900,251	54,934	9,908	893,756
School characteristics, test year									
Black students (share of students)	29.8	22.9	904,292	29.5	22.8	901,608	29.2	22.8	894,800

Other minority students (share of students)	12.7	11.7	904,292	13.5	11.8	901,608	14.6	12.1	894,800
Charter School	2.48%	15.60%	906,589	2.44%	15.40%	901,608	2.40%	15.30%	894,800
Per-pupil spending by source, test year									
Federal (2009 dollars)	844.5	468.2	898,944	912.1	463.6	891,810	977.5	454.5	883,070
State (2009 dollars)	4622	1248	898,944	4,880	1,276	891,810	5,152	1,287	883,070
Local (2009 dollars)	2170	1259	898,944	2,242	1,240	891,810	2,316	1,219	883,070
Same County	76.70%	-	907,738	76.20%	-	902,865	75.80%	-	896,349

Table 6 shows the descriptive analysis of academic outcomes in each grade, program funding, students' characteristics when they were born, mothers' characteristics when the students were born, county-level demographic data in birth year, school characteristics in testing year, and county funding resources in testing year. Around 900,000 students were included in each grade panel: 907,738 for Grade 6 panel, 902,865 in Grade 7 panel, and 896,349 in Grade 8 panel.

The averages of math standardized scores and reading standardized scores were 0. The percentages of grade repeaters were 1.54% in Grade 6, 1.45% in Grade 7, and 0.99% in Grade 8, respectively. The rates of students with special education labeling were 15.20% in Grade 6, 14.7% in Grade 7, and 14.10% in Grade 8, respectively.

The county-average SS investment when and where students were born was around $1,100 and county-average MF investment was around $330. The number of male students was almost equal to that of female students. Eighty-two percent of students were born with normal birth weight. Majority students were non-Hispanic whites (60.5%), 30% of students were non-Hispanic blacks, 3.8% were Hispanic students, 1.0% were Asians, and 1.9% were Native Americans. The distribution of race groups for students was the similar as that for their birth mothers. The average years birth mothers spent in schools were 12.5 and the average age of them were 25.8 year old. Sixty-six percent of students were those whose birth mothers were married when they were born. Forty-four percent of students had no siblings when they were born. Nearly 77% of students were those whose birth county was the same as school county.

During the research period, 2.48 percent of the six graders studied in charter schools. This percentage was stable across the grade (e.g., 2.44% in Grade 7 and 2.40 % in Grade 8). Over 45 percent of the students were identified as economic disadvantage in each grade (e.g., 46.4% in Grade 6, 46.1% in Grade 7, and 45.4% in Grade 8).

Table 7: Children whose birth county was the same as the county where they went to school vs. children whose birth county was different from the county where they went to school at Grade 6 (Same county vs. different county)

Grade 6 (n=907,738)	Same County (n=696,440)		Different County (n=211,298)		
	Mean	SD	Mean	SD	P
Smart Start	11.28	8.59	11.60	8.72	0.00
More at Four	3.31	2.49	3.42	2.57	0.00
Female	49.08%	-	49.03%	-	0.68
Child white	59.42%	-	64.19%	-	0.00
Child black	31.68%	-	26.49%	-	0.00
Child native American	1.97%	-	1.56%	-	0.00
Child Asian	0.98%	-	0.95%	-	0.30
Child Hispanic	3.69%	-	3.92%	-	0.00
Child mixed race	2.25%	-	2.88%	-	0.00
Extremely low birth weight	0.46%	-	0.45%	-	0.48
Very low birth weight	0.81%	-	0.77%	-	0.06
Low birth weight	6.97%	-	6.89%	-	0.22
Normal weight	81.82%	-	81.85%	-	0.79
High birth weight	9.91%	-	10.01%	-	0.18
Mother's education (years)	12.53	2.40	12.50	2.45	0.00
Marital status	66.23%	-	66.18%	-	0.66
Mother's age (years)	26.02	5.95	25.16	5.59	0.00
No dad information	14.88%	-	13.98%	-	0.00
Mother immigrant	5.82%	-	5.76%	-	0.28
First born	43.07%	-	46.96%	-	0.00
Mother white	61.94%	-	67.37%	-	0.00
Mother black	31.62%	-	26.48%	-	0.00
Mother native American	1.78%	-	1.37%	-	0.00
Mother Asian	1.11%	-	1.11%	-	0.98
Mother Hispanic	3.49%	-	3.61%	-	0.01
Mother other race	0.06%	-	0.05%	-	0.08

Table 7 compares the same-county sample with the different-county sample in children's characteristics and birth mothers' characteristics in Grade 6 panel. Children, whose birth county was the same as the county where they went to school, were less likely to be white.

Regression models on performance in a single time point

Table 8: Linear regression models on reading scores[8]

	(1) Grade 6	(2) Grade 7	(3) Grade 8
Smart Start ($00's)	0.0065***	0.0056***	0.0071***
	(0.0010)	(0.0010)	(0.0010)
More at Four ($00's)	0.0182***	0.0203***	0.0233***
	(0.0030)	(0.0030)	(0.0033)
Female	0.1685***	0.1649***	0.1547***
	(0.0037)	(0.0042)	(0.0034)
Child black	-0.2702***	-0.2657***	-0.2636***
	(0.0121)	(0.0117)	(0.0128)
Child native American	-0.1477***	-0.1338***	-0.1550***
	(0.0145)	(0.0134)	(0.0160)
Child Asian	0.0141	0.0267	0.0103
	(0.0209)	(0.0230)	(0.0207)
Child Hispanic	-0.0728***	-0.0379***	-0.0454***
	(0.0128)	(0.0122)	(0.0117)
Child mixed race	-0.0600***	-0.0418***	-0.0402***
	(0.0086)	(0.0079)	(0.0074)
Extremely low birth weight	-0.2556***	-0.2434***	-0.2279***
	(0.0136)	(0.0165)	(0.0161)
Very low birth weight	-0.0766***	-0.0838***	-0.0560***
	(0.0117)	(0.0118)	(0.0116)
Low birth weight	-0.0607***	-0.0515***	-0.0437***
	(0.0041)	(0.0043)	(0.0043)
High birth weight	0.0342***	0.0308***	0.0263***
	(0.0032)	(0.0031)	(0.0032)
Mother's education (years)	0.0967***	0.0936***	0.0899***
	(0.0019)	(0.0017)	(0.0018)
Marital status	0.0542***	0.0573***	0.0555***
	(0.0051)	(0.0046)	(0.0047)
Mother's age (years)	0.0104***	0.0101***	0.0103***
	(0.0005)	(0.0005)	(0.0005)
No dad information	-0.0332***	-0.0434***	-0.0518***
	(0.0053)	(0.0041)	(0.0042)
Mother immigrant	0.1197***	0.1297***	0.1233***
	(0.0124)	(0.0124)	(0.0097)

[8] Models with time and county fixed effects.

First born	0.1718***	0.1608***	0.1595***
	(0.0037)	(0.0036)	(0.0035)
Mother black	-0.1865***	-0.1668***	-0.1822***
	(0.0125)	(0.0113)	(0.0094)
Mother native American	-0.1078***	-0.0981***	-0.1190***
	(0.0185)	(0.0191)	(0.0174)
Mother Asian	0.0689***	0.0630***	0.0705***
	(0.0196)	(0.0201)	(0.0212)
Mother Hispanic	0.0018	0.0123	0.0126
	(0.0136)	(0.0130)	(0.0137)
Mother other race	0.1168***	0.1725***	0.1662***
	(0.0344)	(0.0349)	(0.0349)
Economic disadvantage	-0.2567***	-0.2470***	-0.2303***
	(0.0046)	(0.0046)	(0.0042)
Grade retention	-0.8426***	-0.7686***	-0.8062***
	(0.0159)	(0.0126)	(0.0183)
Births to black mothers (share of births)	-0.1453	-0.0764	-0.1134
	(0.1560)	(0.1350)	(0.1266)
Births to Hispanic mothers (share of births)	0.1640	0.1080	0.2160
	(0.2398)	(0.2375)	(0.2043)
Births to low education mothers (share of births)	-0.1874	-0.0772	-0.1531
	(0.1294)	(0.1341)	(0.1231)
Number of births (log)	-0.0068	-0.0632	-0.0583
	(0.0495)	(0.0477)	(0.0403)
Total population (log)	0.0858	0.0069	0.0801
	(0.1817)	(0.1918)	(0.1654)
Median family income (2009 $)	-96.1082	23.8623	-72.0037
	(120.5009)	(108.3553)	(109.2769)
Population on Food Stamps (share of population)	0.2418	0.2669	0.6071
	(0.4750)	(0.4848)	(0.4581)
Population on Medicaid (share of population)	0.4220	0.1294	-0.0653
	(0.5440)	(0.5803)	(0.5552)
Other minority students (share of students)	-0.0010***	-0.0010***	-0.0011***
	(0.0004)	(0.0004)	(0.0003)
Black students (share of students)	-0.0016***	-0.0016***	-0.0009***
	(0.0005)	(0.0004)	(0.0003)
Charter School	-0.1577***	-0.1201***	-0.0598**

	(0.0256)	(0.0271)	(0.0280)
Federal (2009 dollars)	-0.0001***	-0.0001***	-0.0000
	(0.0000)	(0.0000)	(0.0000)
State (2009 dollars)	-0.0001***	-0.0001***	-0.0001***
	(0.0000)	(0.0000)	(0.0000)
Local (2009 dollars)	-0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)
Constant	-2.0643	-0.8228	-1.6428
	(1.9889)	(2.0821)	(1.8274)
Observations	855,538	847,607	804,051
R-squared	0.286	0.269	0.266

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The positive coefficients of SS program indicate that the SS program improved individual reading scores among students in Grade 6, Grade 7, and Grade 8 (B_{SS}=0.0065, p<0.01 for Grade 6; B_{SS}=0.0056, p<0.01 for Grade 7; B_{SS}=0.0071, p<0.01 for Grade 8; Table 8). The MF program was also found to increase reading scores in each grade panel (B_{MF}=0.0182, p<0.01 for Grade 6; B_{MF}=0.0203, p<0.01 for Grade 7; B_{MF}=0.0233, p<0.01 for Grade 8; Table 8).

Table 9: Linear regression models on math scores [9]

	(1) Grade 6	(2) Grade 7	(3) Grade 8
Smart Start ($00's)	0.0049***	0.0049***	0.0056***
	(0.0011)	(0.0012)	(0.0014)
More at Four ($00's)	0.0182***	0.0214***	0.0216***
	(0.0029)	(0.0029)	(0.0037)
Female	0.0369***	0.0594***	0.0580***
	(0.0032)	(0.0034)	(0.0033)
Child black	-0.2792***	-0.2575***	-0.2462***
	(0.0135)	(0.0130)	(0.0139)
Child native American	-0.1514***	-0.1366***	-0.1460***
	(0.0165)	(0.0185)	(0.0171)
Child Asian	0.1645***	0.1923***	0.2058***
	(0.0223)	(0.0242)	(0.0297)
Child Hispanic	-0.0134	0.0095	0.0089
	(0.0131)	(0.0128)	(0.0131)
Child mixed race	-0.1082***	-0.1004***	-0.0841***
	(0.0100)	(0.0092)	(0.0100)
Extremely low birth weight	-0.4166***	-0.3579***	-0.3333***
	(0.0151)	(0.0135)	(0.0160)
Very low birth weight	-0.1916***	-0.1759***	-0.1564***
	(0.0104)	(0.0095)	(0.0089)
Low birth weight	-0.1035***	-0.0940***	-0.0798***
	(0.0031)	(0.0035)	(0.0040)
High birth weight	0.0567***	0.0560***	0.0488***
	(0.0028)	(0.0033)	(0.0030)
Mother's education (years)	0.1052***	0.1037***	0.0992***
	(0.0023)	(0.0022)	(0.0022)
Marital status	0.0598***	0.0538***	0.0592***
	(0.0036)	(0.0037)	(0.0036)

[9] Models with time and county fixed effects.

Mother's age (years)	0.0065***	0.0067***	0.0068***
	(0.0005)	(0.0005)	(0.0005)
No dad information	-0.0351***	-0.0434***	-0.0507***
	(0.0040)	(0.0039)	(0.0041)
Mother immigrant	0.1814***	0.1906***	0.1886***
	(0.0118)	(0.0144)	(0.0138)
First born	0.1001***	0.1002***	0.0956***
	(0.0028)	(0.0028)	(0.0025)
Mother black	-0.1913***	-0.1743***	-0.1661***
	(0.0147)	(0.0132)	(0.0130)
Mother native American	-0.0895***	-0.0742***	-0.0969***
	(0.0170)	(0.0135)	(0.0147)
Mother Asian	0.1794***	0.1810***	0.1696***
	(0.0211)	(0.0222)	(0.0259)
Mother Hispanic	0.0411***	0.0613***	0.0725***
	(0.0143)	(0.0151)	(0.0138)
Mother other race	0.1489**	0.1431**	0.1853***
	(0.0581)	(0.0551)	(0.0455)
Economic disadvantage	-0.2551***	-0.2437***	-0.2211***
	(0.0049)	(0.0050)	(0.0052)
Grade retention	-0.8146***	-0.7417***	-0.8425***
	(0.0146)	(0.0114)	(0.0170)
Births to black mothers (share of births)	0.0369	0.0231	0.0737
	(0.1785)	(0.1674)	(0.1558)
Births to Hispanic mothers (share of births)	0.2273	0.0489	0.1818
	(0.2268)	(0.2266)	(0.1877)
Births to low education mothers (share of births)	-0.0555	0.0967	-0.0501
	(0.1419)	(0.1596)	(0.1265)
Number of births (log)	-0.0124	-0.0653	-0.0825
	(0.0501)	(0.0537)	(0.0541)
Total population (log)	0.4050**	0.1396	0.0995
	(0.1840)	(0.1779)	(0.1958)
Median family income (2009 $)	-374.0778***	-58.7695	-95.6881

	(114.3962)	(115.6201)	(113.3953)
Population on Food Stamps (share of population)	-0.4112	-0.0705	0.0143
	(0.5880)	(0.5473)	(0.5926)
Population on Medicaid (share of population)	1.0415	0.7678	-0.2750
	(0.6664)	(0.6637)	(0.6304)
Other minority students (share of students)	-0.0020***	-0.0021***	-0.0028***
	(0.0004)	(0.0004)	(0.0004)
Black students (share of students)	-0.0018***	-0.0016***	-0.0009**
	(0.0006)	(0.0005)	(0.0004)
Charter School	-0.2574***	-0.2131***	-0.1854***
	(0.0326)	(0.0335)	(0.0401)
Federal (2009 dollars)	-0.0001***	-0.0000*	0.0000
	(0.0000)	(0.0000)	(0.0000)
State (2009 dollars)	-0.0001***	-0.0001***	-0.0001***
	(0.0000)	(0.0000)	(0.0000)
Local (2009 dollars)	0.0000	0.0000	0.0000**
	(0.0000)	(0.0000)	(0.0000)
Constant	-5.4277***	-2.2248	-1.6134
	(1.9591)	(1.9231)	(2.1199)
Observations	858,326	848,946	805,164
R-squared	0.297	0.281	0.271

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The positive coefficients of SS program indicate that the SS program improved individual math scores among students in Grade 6, Grade 7, and Grade 8 (B_{SS}=0.0049, p<0.01 for Grade 6; B_{SS}=0.0049, p<0.01 for Grade 7; B_{SS}=0.0056, p<0.01 for Grade 8; Table 9). The MF program was also found to increase math scores in each grade panel (B_{MF}=0.0182, p<0.01 for Grade 6; B_{MF}=0.0214, p<0.01 for Grade 7; B_{MF}=0.0216, p<0.01 for Grade 8; Table 9).

Table 10: Logistic regression models on being a grade repeater[10]

	Grade 6	Grade 7	Grade 8
Grade Retention in each grade			
Smart Start ($00's)	0.9959	0.9974	0.9998
	(0.0074)	(0.0069)	(0.0072)
More at Four ($00's)	0.9965	0.9790	0.9435***
	(0.0228)	(0.0203)	(0.0199)
Observations	893,102	884,039	833,592
Grade Retention since Grade 3			
Smart Start ($00's)	0.9783***	0.9765***	0.9617***
	(0.0078)	(0.0072)	(0.0060)
More at Four ($00's)	0.9293***	0.9263***	0.8985***
	(0.0178)	(0.0174)	(0.0186)
Observations	893,102	884,039	833,592

The MF reduced probability of grade retention among students in Grade 8 (OR_{SS}=0.9435, p<0.01, Table 10). The Odds Ratio to repeat grade for students who were born in the counties with average SS investment as $1,100 per child was 0.53 (exp(ln(0.9435)*11)=0.53), indicating that SS program reduced the possibility of repeating the eighth grade by 47%, compared to those who were born in counties without SS program if holding all other variables constant. However, no similar findings was found for students in either Grade 6 or Grade 7.

The SS program reduced the probability of being a grade repeater since Grade 3 among students in Grade 6, 7, and 8 (OR_{SS}=0.9783, p<0.01 for Grade 6; OR_{SS}=0.9765, p<0.01 for Grade 7; OR_{SS}=0.9617, p<0.01 for Grade 8) (Table 10). In addition, the MF program decreased the likelihood of being a grade repeater since Grade 3 among students in Grade 6, 7, and 8 (OR_{SS}=0.9293, p<0.01 for Grade 6; OR_{SS}=0.9263, p<0.01 for Grade 7; OR_{SS}=0.8985, p<0.01 for Grade 8) (Table 10).

[10] Models with time and county fixed effects.

Table 11: Logistic regression models on receiving special education[11]

	Grade 6	Grade 7	Grade 8
Special Ed in each grade			
Smart Start ($00's)	0.9916***	0.9925***	0.9873***
	(0.0024)	(0.0021)	(0.0023)
More at Four ($00's)	0.9607***	0.9601***	0.9502***
	(0.0066)	(0.0061)	(0.0069)
Observations	893,102	884,039	833,592
Special Ed ever since Grade 3			
Smart Start ($00's)	0.9911***	0.9919***	0.9876***
	(0.0022)	(0.0020)	(0.0021)
More at Four ($00's)	0.9663***	0.9642***	0.9594***
	(0.0061)	(0.0057)	(0.0062)
Observations	893,102	884,039	833,592

The SS funding reduced probability of receiving special education services among students in Grade 6 (OR_{SS}=0.9916, p<0.01, Table 11). The Odds Ratio to receive special education for students who were born in the counties with average SS investment as $1,100 per child was 0.91 (exp(ln(0.9916)*11) =0.91), indicating that SS program reduced the possibility of special education placement by 9%. Similar findings were also seen for students in both Grade 7 and Grade 8.

The MF program reduced probability of receiving special education services among students in Grade 6, 7, and 8 (OR_{MF}=0.9607, p<0.01 for Grade 6; OR_{MF}=0.9601, p<0.01 for Grade 7; OR_{MF}=0.9502, p<0.01 for Grade 8, Table 11). The Odds Ratio to receive special education for students who were born in the counties with average MF investment as $1,100 per child was 0.64 (exp(ln(0.9607)*11) =0.64), indicating that MF program reduced the possibility of special education placement by 36% for sixth graders. Similar findings were also found for students in both Grade 7 and Grade 8.

[11] Models with time and county fixed effects.

Sensitivity analysis

Nearly one fourth of students in our grade panels changed their family residence from one county (i.e., where they were born) to another (i.e., where they went to school) in North Carolina (Table 6). We conducted a sensitivity analysis to explore whether the program effects were affected by moving from birth county to school county (Table 12a and 12b).

From Table 12a and 12b, we can conclude that whether students moved from their birth counties to other counties did not affect the positive relationship between program funding level and math/reading scores.

Table 12a: Sensitivity analysis if birth county was not school county (Math standardized score)

	(1) Full Sample	(2) Same County	(3) Different County	(4) Different County
Grade 6				
Smart Start ($00's)	0.0049***	0.0061***	0.0102***	0.0316***
	(0.0011)	(0.0014)	(0.0027)	(0.0023)
More at Four ($00's)	0.0182***	0.0245***	0.0045***	0.0023***
	(0.0029)	(0.0040)	(0.0008)	(0.0009)
Observations	858,326	661,574	196,752	196,752
R-squared	0.297	0.307	0.278	0.279
Grade 7				
Smart Start ($00's)	0.0049***	0.0061***	0.0138***	0.0316***
	(0.0012)	(0.0016)	(0.0028)	(0.0028)
More at Four ($00's)	0.0214***	0.0280***	0.0042***	0.0028***
	(0.0029)	(0.0040)	(0.0009)	(0.0009)
Observations	848,946	650,696	198,250	198,250
R-squared	0.281	0.291	0.264	0.265
Grade 8				
Smart Start ($00's)	0.0056***	0.0068***	0.0186***	0.0286***
	(0.0014)	(0.0016)	(0.0029)	(0.0026)
More at Four ($00's)	0.0216***	0.0259***	0.0047***	0.0026***
	(0.0037)	(0.0047)	(0.0011)	(0.0008)
Observations	805,164	615,569	189,595	189,595
R-squared	0.271	0.280	0.254	0.254

Note:

a. Column (1) is the model output for full sample; Column (2) is the model for those if birth county was the same as school county; Column (3) and (4) are the models for those if birth county was different from school county: (3) uses $ from birth county; (4) uses $ from school county.

b. All variables in Table 5 are controlled.

c. Robust standard errors in parentheses;
d. *** p<0.01, ** p<0.05, * p<0.1

Table 12b: Sensitivity analysis if birth county was not school county (Reading standardized score)

	(1) Full Sample	(2) Same County	(3) Different County	(4) Different County
Grade 6				
Smart Start ($00's)	0.0065***	0.0078***	0.0127***	0.0303***
	(0.0010)	(0.0012)	(0.0027)	(0.0020)
More at Four ($00's)	0.0182***	0.0232***	0.0052***	0.0031***
	(0.0030)	(0.0041)	(0.0008)	(0.0007)
Observations	855,538	659,391	196,147	196,147
R-squared	0.286	0.293	0.269	0.270
Grade 7				
Smart Start ($00's)	0.0056***	0.0069***	0.0141***	0.0312***
	(0.0010)	(0.0013)	(0.0030)	(0.0023)
More at Four ($00's)	0.0203***	0.0263***	0.0044***	0.0040***
	(0.0030)	(0.0040)	(0.0008)	(0.0007)
Observations	847,607	649,575	198,032	198,032
R-squared	0.269	0.277	0.251	0.252
Grade 8				
Smart Start ($00's)	0.0071***	0.0082***	0.0202***	0.0254***
	(0.0010)	(0.0012)	(0.0032)	(0.0020)
More at Four ($00's)	0.0233***	0.0275***	0.0056***	0.0041***
	(0.0033)	(0.0040)	(0.0008)	(0.0006)
Observations	804,051	614,680	189,371	189,371
R-squared	0.266	0.274	0.248	0.249

Note:

a. Column (1) is the model output for full sample; Column (2) is the model for those if birth county was the same as school county; Column (3) and (4) are the models for those if birth county was different from school county: (3) uses $ from birth county; (4) uses $ from school county.
b. All variables in Table 5 are controlled.
c. Robust standard errors in parentheses;
d. *** p<0.01, ** p<0.05, * p<0.1

Program effects on subpopulations

A statistically significant coefficient of interaction indicates a significant difference in the slope of program funding among subpopulations. For example, a significant coefficient of the interaction between MF funding and mother's low education indicates that the slopes of two regression lines (i.e., children whose mothers had 12 or more years in education and those whose mothers had 11 or fewer years in education) are different. Moreover, the line of those whose mothers had 11 or fewer years in education is steeper than the other line (i.e., b=0.0099, p<0.01; Table 13). Based on the effect of MF on reading score as a function of mother education, Figure 3 shows the difference in conditional margin effects between the two groups when 12 or more year education for mothers is used as a reference category. The steeper, the more marginal score was gained for those whose mothers had 11 or fewer years in education, compared to their peers whose mothers had 12 or more years in education (Figure 1).

Table 13: Interactions between program effects and students' characteristics (race & education level of birth mother)

	Reading			Math		
	Grade 6	**Grade 7**	**Grade 8**	**Grade 6**	**Grade 7**	**Grade 8**
Smart Start ($00's)	0.0067***	0.0057***	0.0067***	0.0056***	0.0049***	0.0048***
	(0.0011)	(0.0012)	(0.0011)	(0.0014)	(0.0014)	(0.0017)
More at Four ($00's)	0.0122***	0.0073**	0.0042	0.0116***	0.0044	0.0029
	(0.0033)	(0.0030)	(0.0033)	(0.0032)	(0.0031)	(0.0033)
SS x Mother's low education	0.0009	0.0007	0.0016**	0.0008	0.0010	0.0024***
	(0.0007)	(0.0007)	(0.0008)	(0.0008)	(0.0007)	(0.0008)
MF x Mother's low education	0.0099***	0.0218***	0.0203***	0.0104***	0.0263***	0.0274***
	(0.0023)	(0.0024)	(0.0024)	(0.0022)	(0.0024)	(0.0028)
SS x Mother Black	-0.0007	-0.0002	0.0005	-0.0020	-0.0003	0.0016
	(0.0012)	(0.0011)	(0.0012)	(0.0012)	(0.0014)	(0.0013)
MF x Mother Black	0.0090**	0.0187***	0.0357***	0.0102***	0.0261***	0.0320***
	(0.0034)	(0.0037)	(0.0045)	(0.0036)	(0.0047)	(0.0052)
SS x Mother Hispanic	-0.0046***	-0.0053***	-0.0032**	-0.0050***	-0.0039**	-0.0030***
	(0.0016)	(0.0017)	(0.0013)	(0.0018)	(0.0018)	(0.0011)
MF x Mother Hispanic	0.0037	0.0088**	0.0205***	0.0076*	0.0110**	0.0060

	(0.0041)	(0.0042)	(0.0047)	(0.0041)	(0.0044)	(0.0040)
Mother's low education	-0.2650***	-0.2700***	-0.2650***	-0.2671***	-0.2756***	-0.2842***
	(0.0073)	(0.0075)	(0.0076)	(0.0087)	(0.0078)	(0.0086)
Mother black	-0.1768***	-0.1735***	-0.2173***	-0.1661***	-0.1851***	-0.2046***
	(0.0137)	(0.0156)	(0.0143)	(0.0162)	(0.0172)	(0.0204)
Mother Hispanic	-0.0408**	-0.0331*	-0.0756***	-0.0136	-0.0213	-0.0092
	(0.0176)	(0.0188)	(0.0170)	(0.0231)	(0.0240)	(0.0195)
Observations	855,538	847,607	804,051	858,326	848,946	805,164
R-squared	0.264	0.249	0.246	0.270	0.255	0.245

Note:

a. All models are conducted with time and county fixed effects.
b. All variables in Table 6 are controlled.
c. Robust standard errors in parentheses;
d. *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Contrasts of conditional marginal effects of low-educated mother status on reading score for 8th graders

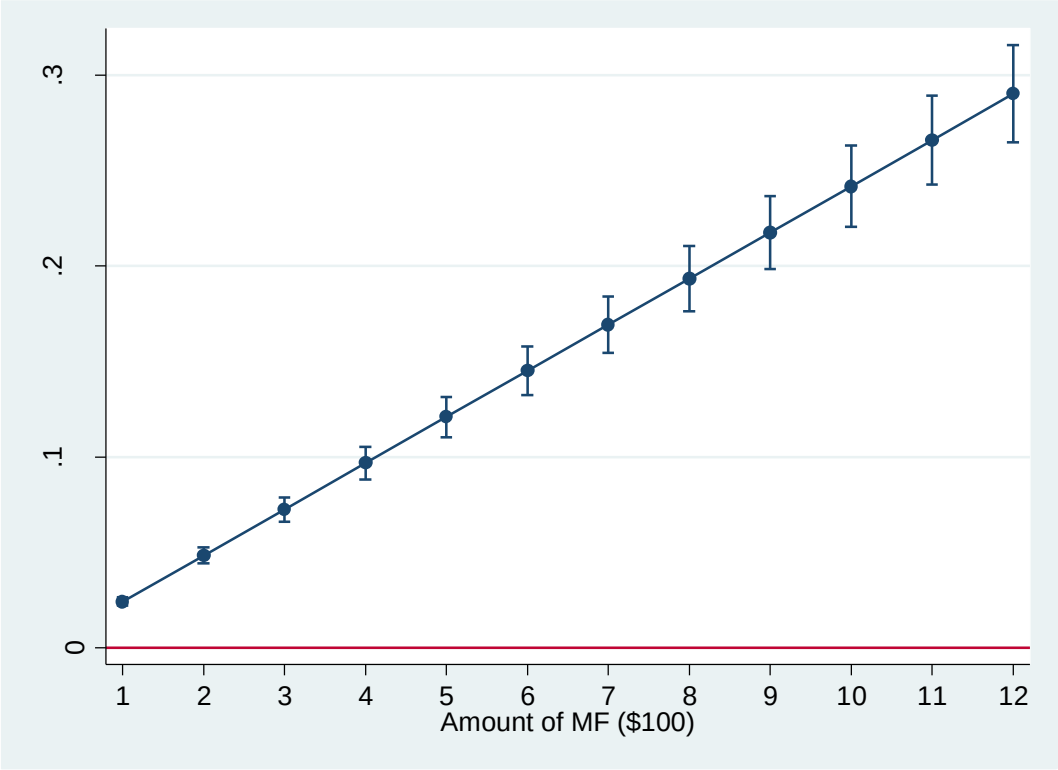


Figure 2: Contrasts of conditional marginal effects of African American mother status on reading score for 8th graders

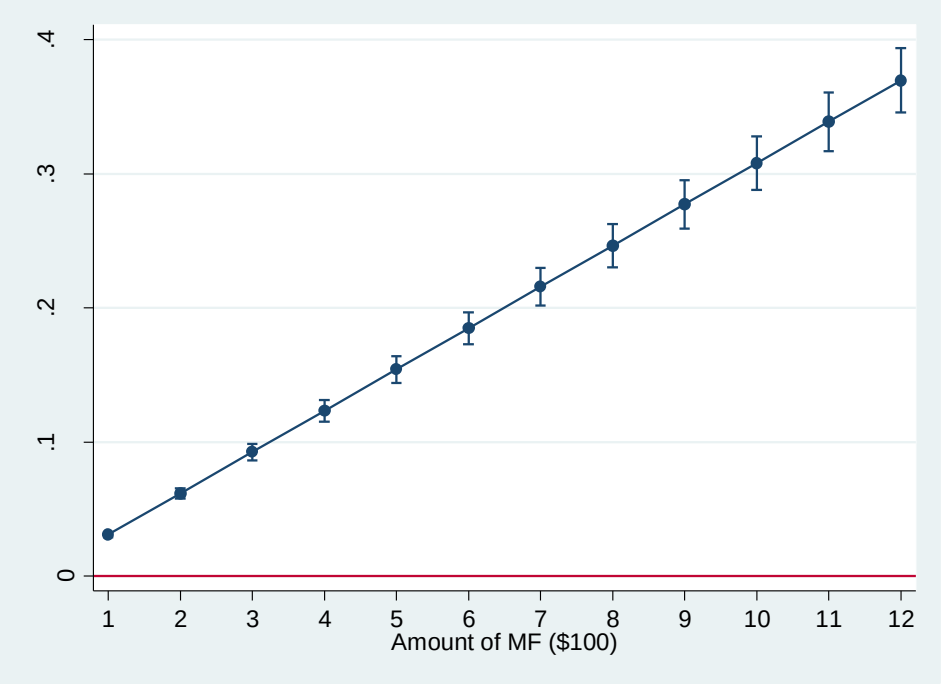


Figure 3: Contrasts of conditional marginal effects of low-educated mother status on math score for 8th graders

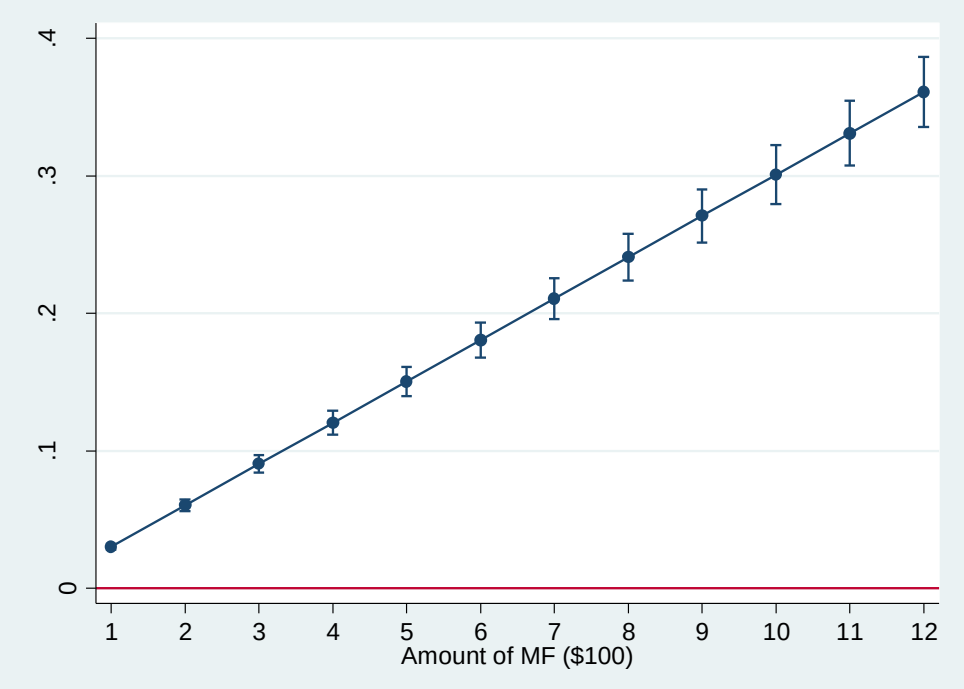
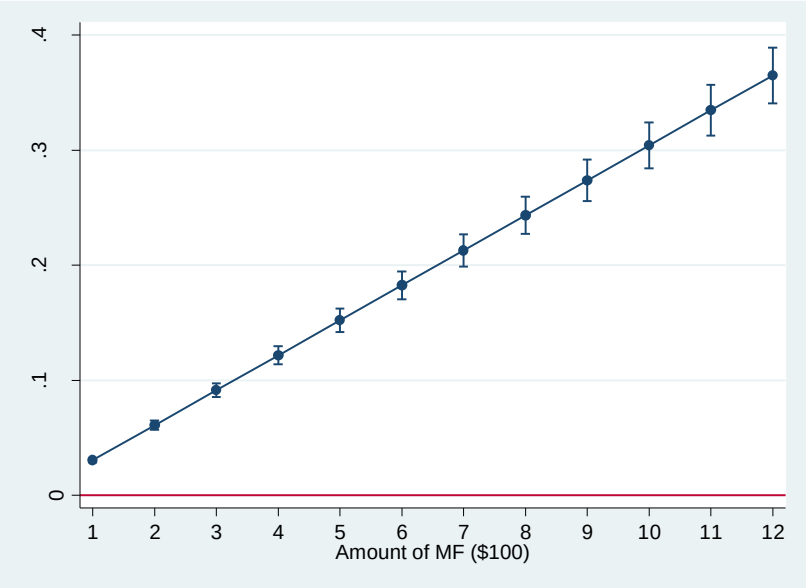


Figure 4: Contrasts of conditional marginal effects of African American mother status on math score for 8th graders



To examine whether SS and MF funding level had different effects on mother education level, we repeated models with the addition of interaction terms (i.e., SS × mother education status and MF × mother education status) (Table 13). The mother education status was coded as 1 if the number of years in education was less than 12 when the child was born; otherwise, it was coded as 0. The MF investment was set to $100. Thus, the total effect of MF on reading score was a sum of two coefficients: MF and the interaction term (i.e., MF × Low educated mothers) for students whose mothers completed less than 12 years in education. For students whose mothers completed 12 or more years in education, the total effect of MF on reading score is the coefficient of MF only. Then, we converted the coefficients to the number of month gains in reading score by using the same approach we applied before. The cumulative number of months gained in EOG reading from MF was 0.2 for the sixth graders whose mother completed 12 or more years in education, while this number increased to 0.4 for the sixth graders whose mother completed less than 12 years in education. The pattern that the students with low educated mothers gained more months in reading than their peers with highly educated mothers was also seen in seventh graders and eighth graders (0.6 vs. 0.1 for Grade 7; 0.5 vs 0.1 for Grade 8, respectively) (Table 13).

We reported similar findings on EOG math score when testing whether the interaction between the program funding level and mother education level was significant. Among those

born in the counties with MF program, the students whose mother completed less than 12 years in education gained more number of months than their peers (0.3 vs. 0.2 for sixth graders; 0.5 vs. 0.1 for Grade 7; 0.5 vs 0.0 for Grade 8, respectively) (Table 13).

We can learn at least two findings from Table 14. First, the students gained more months from MF than from SS. Second, if they were born in the counties with MF program, the students whose mother completed less than 12 years in education gained more number of months than their peers with highly educated mothers.

Table 14. Comparison in magnitudes of SS and MF between students whose mothers completed 12 or more years in education and those whose mothers did not[12].

Program	Grade	Mother with low education	Month Gain	
			Reading	Math
SS	6	No	0.1	0.1
		Yes	0.2	0.1
	7	No	0.1	0.1
		Yes	0.1	0.1
	8	No	0.1	0.1
		Yes	0.2	0.1
MAF	6	No	0.2	0.2
		Yes	0.4	0.3
	7	No	0.1	0.1
		Yes	0.6	0.5
	8	No	0.1	0.0
		Yes	0.5	0.5

Note:

1. SS and MF investment are set to $100.

[12] See Appendix for the calculation in detail.

Table 15: Interactions between program effects and economic disadvantage status of student

	(1) Grade 6	(2) Grade 6_interaction	(3) Grade 7	(4) Grade 7_interaction	(5) Grade 8	(6) Grade 8_interaction
EOG Reading score						
Smart Start ($00's)	0.0065***	0.0065***	0.0056***	0.0058***	0.0072***	0.0069***
	(0.0009)	(0.0011)	(0.001)	(0.0011)	(0.001)	(0.001)
More at Four ($00's)	0.0182***	0.0135***	0.0204***	0.0062*	0.0233***	0.0032
	(0.003)	(0.0036)	(0.003)	(0.0033)	(0.0033)	(0.0031)
Economic disadvantage (ED)	-0.3309***	-0.3377***	-0.3170***	-0.3324***	-0.2969***	-0.3336***
	(0.0066)	(0.0105)	(0.0065)	(0.0100)	(0.0052)	(0.0097)
SS x ED		0.0000		-0.0005		0.0006
		(0.0010)		(0.0010)		(0.0009)
MF x ED		0.0068**		0.0210***		0.0319***
		(0.0029)		(0.0030)		(0.0030)
Observations	855,538	855,538	847,607	847,607	804,051	804,051
R-squared	0.263	0.263	0.248	0.248	0.244	0.246
EOG Math score						
Smart Start ($00's)	0.0049***	0.0054***	0.0049***	0.0053***	0.0058***	0.0054***
	(0.0011)	(0.0014)	(0.0012)	(0.0014)	(0.0014)	(0.0016)
More at Four ($00's)	0.0183***	0.0145***	0.0215***	0.0032	0.0216***	-0.0012
	(0.0030)	(0.0038)	(0.0029)	(0.0032)	(0.0037)	(0.0033)
Economic disadvantage	-0.3387***	-0.3354***	-0.3253***	-0.3429***	-0.2973***	-0.3394***
	(0.0076)	(0.0109)	(0.0067)	(0.0107)	(0.0059)	(0.0106)
SS x ED		-0.0009		-0.0008		0.0007
		(0.0011)		(0.0010)		(0.0009)
MF x ED		0.0057*		0.0270***		0.0363***
		(0.0034)		(0.0031)		(0.0032)
Observations	858,326	858,326	848,946	848,946	805,164	805,164
R-squared	0.269	0.269	0.253	0.254	0.243	0.244
Special education placement						
Smart Start ($00's)	0.9917***	0.9946**	0.9929***	0.9943**	0.9941***	0.9943**
	(0.0024)	(0.0026)	(0.0021)	(0.0022)	(0.0021)	(0.0023)
More at Four ($00's)	0.9606***	0.9599***	0.9599***	0.9613***	0.9621***	0.9673***
	(0.0066)	(0.0075)	(0.0062)	(0.0075)	(0.0059)	(0.0077)
Economic disadvantage	1.9098***	1.9920***	1.9413***	1.9816***	1.9051***	1.9216***
	(0.0191)	(0.0261)	(0.0206)	(0.0301)	(0.0238)	(0.0346)
SS x ED		0.9953***		0.9979		0.9997
		(0.0011)		(0.0013)		(0.0014)

MF x ED		1.0018		0.9985		0.9929
		(0.0055)		(0.0065)		(0.0063)
Observations	893,138	893,138	886,023	886,023	876,753	876,753
Grade retention						
Smart Start ($00's)	0.9957	0.9936	0.9972	0.9889	0.9987	0.9976
	(0.0074)	(0.0072)	(0.0069)	(0.0071)	(0.0066)	(0.0071)
More at Four ($00's)	0.9958	0.9846	0.9785	0.9657	0.9400***	0.9515**
	(0.0230)	(0.0282)	(0.0204)	(0.0242)	(0.0196)	(0.0237)
Economic disadvantage	2.2399***	2.1976***	1.9548***	1.8226***	1.6880***	1.6813***
	(0.0799)	(0.0785)	(0.0613)	(0.0708)	(0.0631)	(0.0730)
SS x ED		1.0027		1.0110***		1.0016
		(0.0034)		(0.0034)		(0.0051)
MF x ED		1.0122		1.0133		0.9848
		(0.0218)		(0.0248)		(0.0207)
Observations	893,138	893,138	886,023	886,023	876,753	876,753

Note:

a. All models are conducted with time and county fixed effects.
b. All variables in Table 6 are controlled.
c. Robust standard errors in parentheses;
d. *** p<0.01, ** p<0.05, * p<0.1

In this analysis, we found a statistically significant and positive sign for the interaction terms, indicating that the programs made a greater improvement in the students with economic disadvantage (ED) than their peers who did not receive the programs (Table 15). For example, a significant and positive coefficient of the interaction between MF funding and ED on reading score shows that, among those with ED, the eighth graders who received MF had a higher reading score in average than those who did not received MF (b=0.0319, p<0.01 for Grade 8; Table 15). In addition, the eighth graders who received MF had a higher math score in average than those who did not received MF (b=0.0363, p<0.01). However, such improvement effects of MF were not found in either special education placement in grade retention (p>0.1).

Figure 5: Contrasts of conditional marginal effects of student' economically disadvantage status on reading score for 8th graders

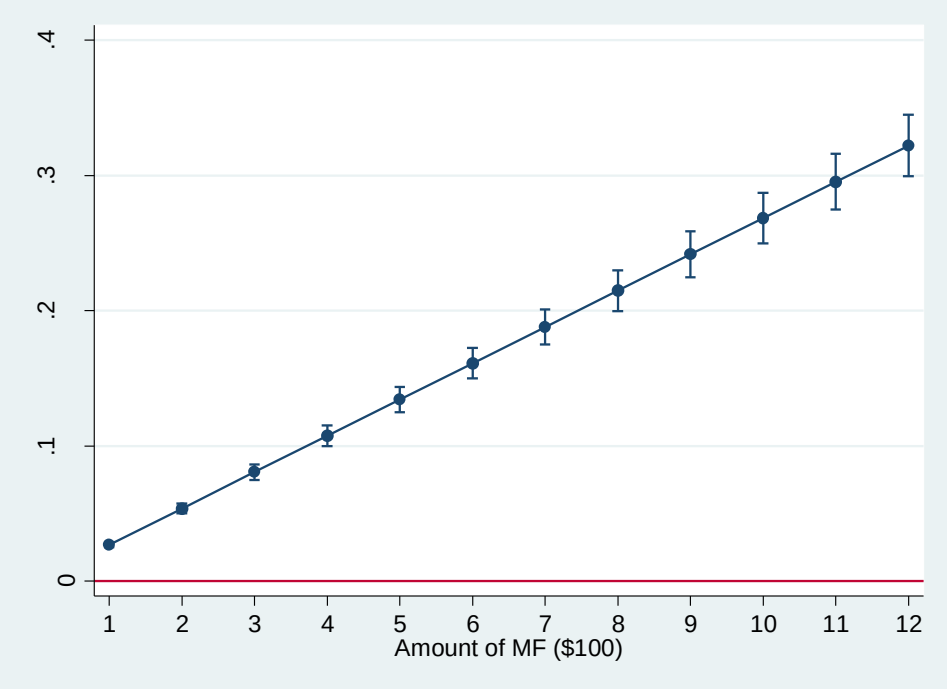
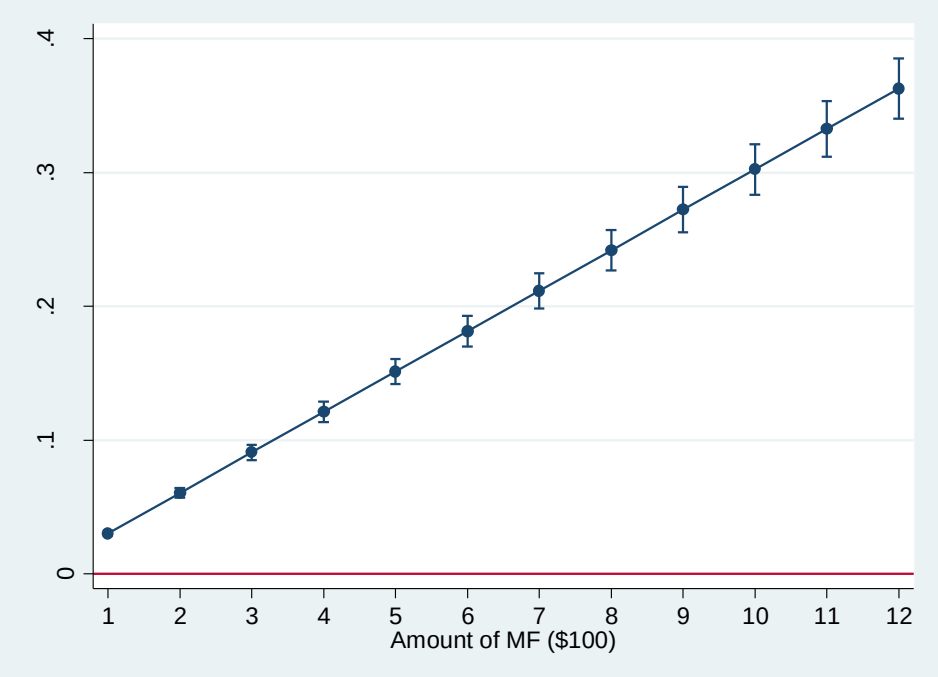


Figure 6: Contrasts of conditional marginal effects of student' economically disadvantage status on math score for 8th graders



Summary

Table 16: Summary of models on a single time point

		Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
EOG math scores	**SS**	+	+	+	+	+	+
	MF	+	+	+	+	+	+
EOG reading scores	**SS**	+	+	+	+	+	+
	MF	+	+	+	+	+	+
Grade retention in each grade	**SS**	-					
	MF						-
Grade retention since Grade 3	**SS**	n/a	-	-	-	-	-
	MF	n/a	-	-	-	-	-
Special education placement in each grade	**SS**	-	-	-	-	-	-
	MF	-	-	-	-	-	-
Special education placement since Grade 3	**SS**	n/a	-	-	-	-	-
	MF	n/a	-	-	-	-	-

Note:

+ program has positive effects on outcomes (statistically significant).

- program has negative effects on outcomes (statistically significant).

Our findings indicate that early childhood program effect was consistent from Grade 3 to Grade 8,

1) both Smart Start and More at Four statistically significantly increased math scores and reading scores;
2) both Smart Start and More at Four statistically significantly reduced probability of being placed in special education service in each grade, of being placed in special education service since Grade 3, and of repeating grade since Grade 3.

Reference

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