Economics 270c
Graduate Development Economics

Professor Ted Miguel
Department of Economics
University of California, Berkeley

Economics 270c
Graduate Development Economics

Lecture 10 – March 31, 2009

Macroeconomic growth empirics

Lecture 1: Global patterns of economic growth and development (1/20)

Lecture 2: Inequality and growth (1/27)

The political economy of development

Lecture 3: History and institutions (2/3)

Lecture 4: Corruption (2/10)

Lecture 5: Patronage politics (2/17)

Lecture 6: Democracy and development (2/24)

Lecture 7: War and Economic Development (3/3)

Lecture 8: Economic Theories of Conflict (3/10) – Guest lecture by Gerard Padro

Human resources

Lecture 9: Human capital and income growth (3/17)

Lecture 10: Increasing human capital (3/31)

Lecture 11: Labor markets and migration (4/7)

Lecture 12: Health and nutrition (4/14)

Lecture 13: The demand for health (4/21)

Other topics

Lecture 14: Environment and development (4/28)

Lecture 15: Resource allocation and firm productivity (5/5)

Additional topics for the development economics field exam

-- Ethnic and social divisions

-- The Economics of HIV/AIDS

- Prerequisites: Graduate microeconomics, econometrics

- Grading:
  Four referee reports – 40%
  → Fourth referee report back next week

  Two problem sets – 20%
  → Problem set 1 to be distributed tomorrow, due next Thursday April 9 (email to Jonas)

  Research proposal – 30%
  Class participation – 10%

- All readings are available online (see syllabus)

- Additional references on syllabus

Lecture 10 outline

(1) Human capital in economic development

(2) Angrist and Lavy (1999) on pupil-teacher ratio in Israel

(3) Banerjee, Cole, Duflo, and Linden (2007) on remedial teacher and computer learning programs in India

(4) Muralidharan and Sundararaman (2008) on teacher incentives in India

(5) Kremer, Miguel, and Thornton (2007) on girls' scholarships in Kenya

(1) Human capital in economic development

- Last week: what is the return to schooling in less developed countries?
- This week: which inputs lead to more educational production? What does the education production function look like?
- Recall that in many poor countries, education is the largest single recurrent discretionary budget expenditure

(1) Human capital in economic development

- Educational production *H* for student *i* in school *j* is a function of multiple factors, including vectors of individual (or household characteristics) X_{ij}, classmate characteristics $X_{-i,j}$, and school characteristics / inputs Z_j:

$$H_{ij} = F(X_{ij}, X_{-i,j}, Z_j)$$

- For concreteness, let X_{ij} be student family background, let $X_{-i,j}$ be peer "quality", and Z_j be the pupil-teacher ratio

  -- Heterogeneity, complicated interactions are possible

- Since teacher salaries are a large share of spending, a major policy question is the impact of reducing the pupil-teacher ratio: $\partial H_{ij} / \partial Z_j$

(1) Human capital in economic development

- There are likely to be many unobserved (*) components:

$$H_{ij} = F(X_{ij}, X^*_{ij}, X_{-i,j}, X^*_{-i,j}, Z_j, Z^*_j)$$

- Key omitted variables include parent interest in education (X^*_{ij}) and teacher classroom effort (Z^*_j)

- Areas with "better" parents could both have greater school inputs and unobserved home educational inputs → positive bias. Or poor performing areas could be targeted for extra government transfers → negative bias

  -- Similarly the institutional aspects that affect teacher effort Z^*_j could be correlated with Z_i

(2) Angrist and Lavy (1999)

- Class size and test score performance in Israel

- Class size based on “a rule of 40” developed by Maimonides, a 12th century Jewish-Spanish philosopher

  -- I.e., up to 40 students get one teacher, 41-80 students get 2 teachers, 81-120 get 3 teachers, etc.

  -- Rule introduced into Israeli schools in 1969

(2) Angrist and Lavy (1999)

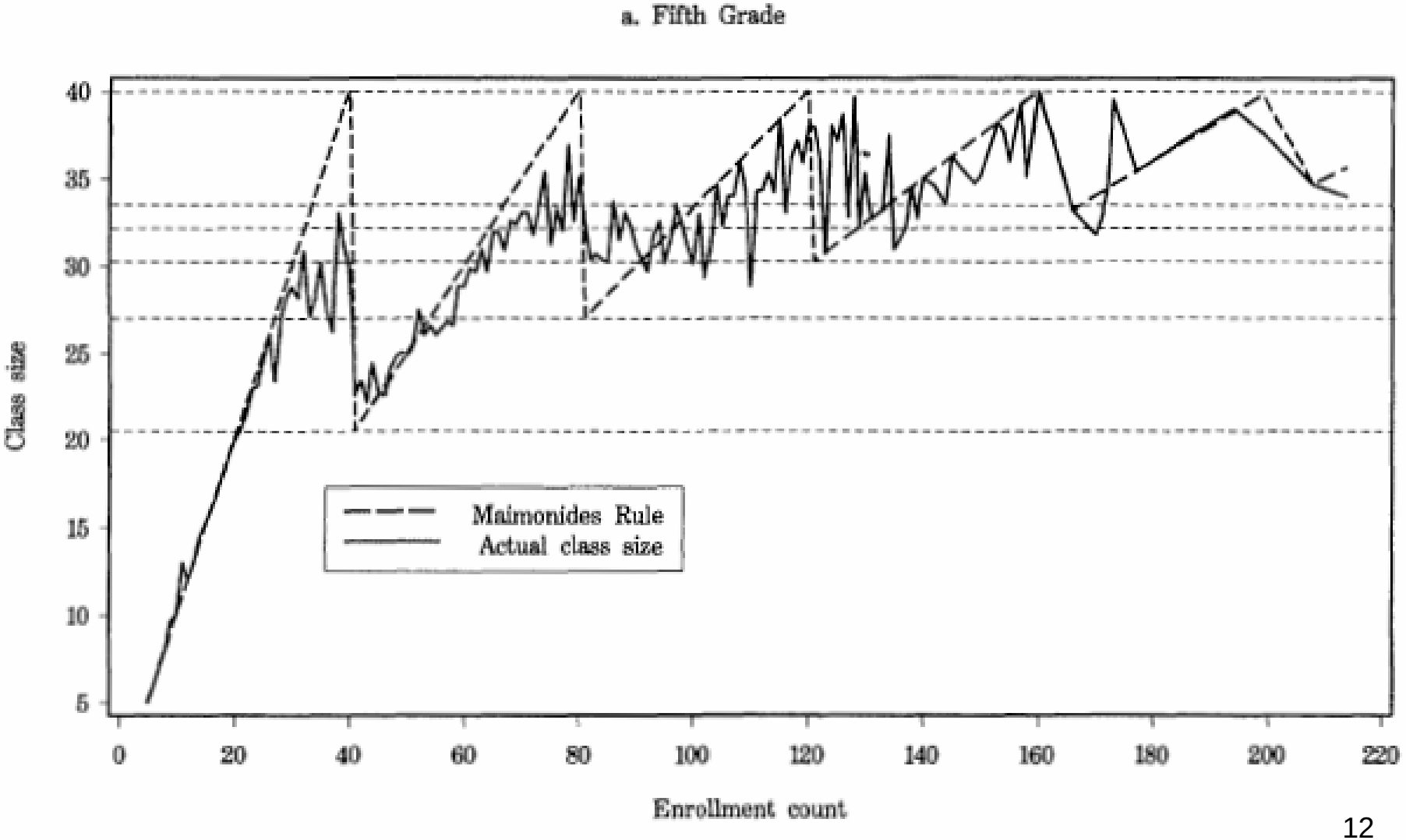
- Class size and test score performance in Israel

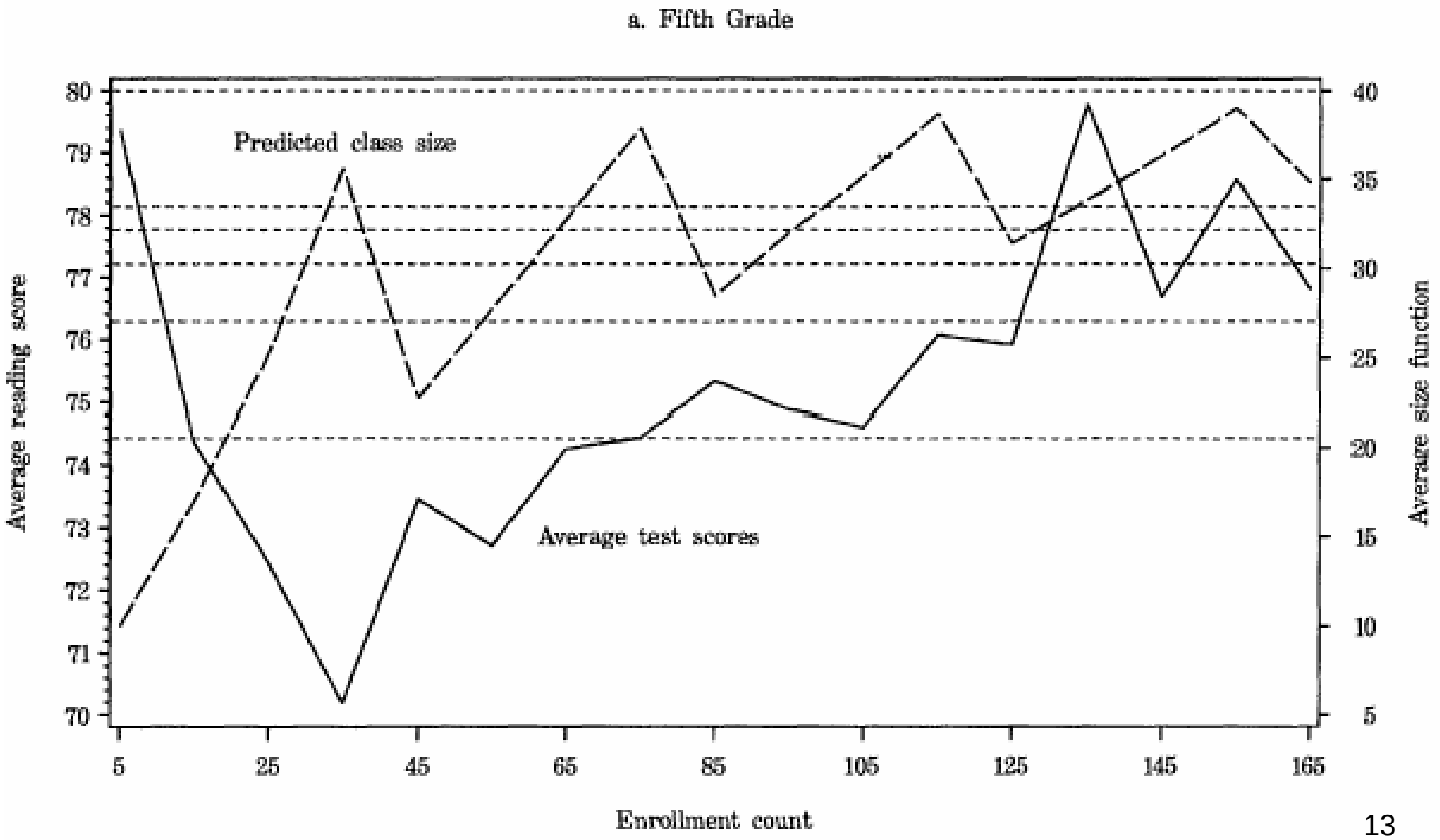
- Class size based on “a rule of 40” developed by Maimonides, a 12th century Jewish-Spanish philosopher

  -- I.e., up to 40 students get one teacher, 41-80 students get 2 teachers, 81-120 get 3 teachers, etc.

  -- Rule introduced into Israeli schools in 1969

- Introduces sharp discontinuities in class size across otherwise similar schools. What impact on test scores in grades 4 and 5?


a. Fifth Grade
Class size
40
35
30
25
20
15
10
5
0
20
40
60
80
100
120
140
160
180
200
220
Enrollment count
Maimonides Rule
Actual class size


a. Fifth Grade
Predicted class size
Average test scores
Average reading score
Average size function
Enrollment count
80
79
78
77
76
75
74
73
72
71
70
40
35
30
25
20
15
10
5
5
25
45
65
85
105
125
145
165

(2) Angrist and Lavy (1999)

- Main results: reducing class size by ten pupils increases test scores on average by 0.25 sd – a large effect

  -- Larger impacts on math tests than on language scores

(2) Angrist and Lavy (1999)

- Main results: reducing class size by ten pupils increases test scores on average by 0.25 sd – a large effect

  -- Larger impacts on math tests than on language scores

- Robust to many controls, restricting attention to the "discontinuity sample" near thresholds

  -- Largest effects for disadvantaged students (Jewish students of Sephardic / Middle Eastern origin)

- Similar to U.S. results: Tennessee STAR experiment, which reduced class size from 22 to 15 kids, improved test scores by 0.21 sd (Krueger and Whitmore 2001).

(3) Banerjee et al. (2006)

- Remedial teaching (“balsakhi”), computer assisted learning, and test scores in India (Vadodara, Mumbai)

- Several other recent papers (e.g., Miguel and Kremer 2004) find large increases in school participation do not translate into test score gains

  -- Do inputs alone have an impact? Or are more fundamental institutional reforms necessary? E.g., incentives, vouchers, etc.

(3) Banerjee et al. (2006)

- Learning per se is a major issue in India: most children are now in school but 44% of children 7-12 years old cannot read a basic paragraph (2005)

- In this sample, only 19.5% of third grade children in Vadodara, and 33.7% in Mumbai, pass the grade one competencies (number recognition, counting and one digit addition and subtraction) in math

  -- Baseline language skills somewhat better

(3) Banerjee et al. (2006)

- Large positive impacts of both programs on learning in the short-run (remedial education 0.14-0.28 standard deviations, computer learning 0.21 s.d.), especially among the low performing students targeted with the remedial class.

  -- But small / no effect one year after programs ended

  -- And no effects on attendance, drop-outs

(3) Banerjee et al. (2006)

- Large positive impacts of both programs on learning in the short-run (remedial education 0.14-0.28 standard deviations, computer learning 0.21 s.d.), especially among the low performing students targeted with the remedial class.

  -- But small / no effect one year after programs ended

  -- And no effects on attendance, drop-outs

- The remedial education findings echo some results in Angrist and Lavy (1999) and other education studies, e.g., larger math test impacts

  -- Computer impacts are much smaller in rich countries

Table III presents the results, for various years, cities and grades from a specification which regresses the change in a student's test score (post-test score minus pre-test score) on the treatment status of the child's school-grade, controlling for the pre-test score of child i in grade g and school j:

$$y_{igjPOST} - y_{igjPRE} = \lambda + \delta D_{jg} + \theta y_{igjPRE} + \epsilon_{igjPOST}, \quad (1)$$

where D_{jg} is a dummy equal to 1 if the school received a balsakhi in the child's grade g, and 0 otherwise.[9] This specification asks whether children improved more, relative to what would have been expected based on their pre-test score, in treatment schools than in comparison

Table II: Test Score Summary Statistics for Balsakhi and CAL Programs

		PRE TEST			POST TEST		
		Treatment	Comparison	Difference	Treatment	Comparison	Difference
		(1)	(2)	(3)	(4)	(5)	(6)
A. Balsakhi: Vadodara							
Year 1	Math	-0.007	0.000	-0.007	0.348	0.171	0.177
(Grades 3 and 4)				(0.059)			(0.070)
	Language	0.025	0.000	0.025	0.794	0.667	0.127
				(0.061)			(0.076)
Year 2	Math	0.046	0.000	0.046	1.447	1.046	0.401
(Grades 3 and 4)				(0.053)			(0.078)
	Language	0.055	0.000	0.055	1.081	0.797	0.285
				(0.058)			(0.071)
B. Balsakhi: Mumbai							
Year 1	Math	0.002	0.000	0.002	0.383	0.227	0.156
(Grade 3)				(0.108)			(0.126)
	Language	0.100	0.000	0.100	0.359	0.210	0.149
				(0.108)			(0.102)
Year 2	Math	-0.005	0.000	-0.005	1.237	1.034	0.203
(Grades 3 and 4)				(0.058)			(0.107)
	Language	0.056	0.000	0.056	0.761	0.686	0.075
				(0.054)			(0.061)
C. Computer Assisted Learning: Vadodara							
Year 2	Math	-0.054	0.000	-0.054	1.129	0.810	0.319
(Grade 4)				(0.076)			(0.087)
	Language	-0.009	0.000	-0.009	0.719	0.709	0.010
				(0.083)			(0.093)
Year 3	Math	0.125	0.000	0.125	0.813	0.232	0.581
(Grade 4)				(0.073)			(0.089)
	Language	0.116	0.000	0.116	0.118	0.014	0.104
				(0.079)			(0.080)

Table II: Test Score Summary Statistics for Balsakhi and CAL Programs

		PRE TEST			POST TEST		
		Treatment	Comparison	Difference	Treatment	Comparison	Difference
		(1)	(2)	(3)	(4)	(5)	(6)
A. Balsakhi: Vadodara							
Year 1	Math	-0.007	0.000	-0.007	0.348	0.171	0.177
(Grades 3 and 4)				(0.059)			(0.070)
	Language	0.025	0.000	0.025	0.794	0.667	0.127
				(0.061)			(0.076)
Year 2	Math	0.046	0.000	0.046	1.447	1.046	0.401
(Grades 3 and 4)				(0.053)			(0.078)
	Language	0.055	0.000	0.055	1.081	0.797	0.285
				(0.058)			(0.071)
B. Balsakhi: Mumbai							
Year 1	Math	0.002	0.000	0.002	0.383	0.227	0.156
(Grade 3)				(0.108)			(0.126)
	Language	0.100	0.000	0.100	0.359	0.210	0.149
				(0.108)			(0.102)
Year 2	Math	-0.005	0.000	-0.005	1.237	1.034	0.203
(Grades 3 and 4)				(0.058)			(0.107)
	Language	0.056	0.000	0.056	0.761	0.686	0.075
				(0.054)			(0.061)
C. Computer Assisted Learning: Vadodara							
Year 2	Math	-0.054	0.000	-0.054	1.129	0.810	0.319
(Grade 4)				(0.076)			(0.087)
	Language	-0.009	0.000	-0.009	0.719	0.709	0.010
				(0.083)			(0.093)
Year 3	Math	0.125	0.000	0.125	0.813	0.232	0.581
(Grade 4)				(0.073)			(0.089)
	Language	0.116	0.000	0.116	0.118	0.014	0.104
				(0.079)			(0.080)

Table II: Test Score Summary Statistics for Balsakhi and CAL Programs

		PRE TEST			POST TEST		
		Treatment	Comparison	Difference	Treatment	Comparison	Difference
		(1)	(2)	(3)	(4)	(5)	(6)
A. Balsakhi: Vadodara							
Year 1	Math	-0.007	0.000	-0.007	0.348	0.171	0.177
(Grades 3 and 4)				(0.059)			(0.070)
	Language	0.025	0.000	0.025	0.794	0.667	0.127
				(0.061)			(0.076)
Year 2	Math	0.046	0.000	0.046	1.447	1.046	0.401
(Grades 3 and 4)				(0.053)			(0.078)
	Language	0.055	0.000	0.055	1.081	0.797	0.285
				(0.058)			(0.071)
B. Balsakhi: Mumbai							
Year 1	Math	0.002	0.000	0.002	0.383	0.227	0.156
(Grade 3)				(0.108)			(0.126)
	Language	0.100	0.000	0.100	0.359	0.210	0.149
				(0.108)			(0.102)
Year 2	Math	-0.005	0.000	-0.005	1.237	1.034	0.203
(Grades 3 and 4)				(0.058)			(0.107)
	Language	0.056	0.000	0.056	0.761	0.686	0.075
				(0.054)			(0.061)
C. Computer Assisted Learning: Vadodara							
Year 2	Math	-0.054	0.000	-0.054	1.129	0.810	0.319
(Grade 4)				(0.076)			(0.087)
	Language	-0.009	0.000	-0.009	0.719	0.709	0.010
				(0.083)			(0.093)
Year 3	Math	0.125	0.000	0.125	0.813	0.232	0.581
(Grade 4)				(0.073)			(0.089)
	Language	0.116	0.000	0.116	0.118	0.014	0.104
				(0.079)			(0.080)

Table III: Estimates of the Impact of the Balsakhi Program, by City and Sample

	Number of Observations	Dependent Variable: Test Score Improvement (Posttest - Pretest)		
		Math	Language	Total
	(1)	(2)	(3)	(4)
A. Pooling Grades and Locations				
Mumbai and Vadodara Together Year 1	12855	0.182	0.076	0.138
		(0.046)	(0.056)	(0.047)
Mumbai and Vadodara Together Year 2	21936	0.353	0.187	0.284
		(0.069)	(0.050)	(0.060)
B. Pooling Both Grades				
Vadodara Year 1	8426	0.189	0.109	0.161
		(0.057)	(0.057)	(0.057)
Vadodara Year 2	11950	0.371	0.246	0.331
		(0.073)	(0.061)	(0.070)
Mumbai Year 1 (Grade 3 Only)	4429	0.161	0.086	0.127
		(0.075)	(0.066)	(0.067)
Mumbai Year 2	9986	0.324	0.069	0.188
		(0.145)	(0.081)	(0.112)
C. Grade 3				
Vadodara Year 1	4230	0.179	0.102	0.152
		(0.086)	(0.085)	(0.085)
Vadodara Year 2	5819	0.418	0.233	0.354
		(0.107)	(0.089)	(0.100)
D. Grade 4				
Vadodara Year 1	4196	0.190	0.114	0.166
		(0.072)	(0.076)	(0.073)
Vadodara Year 2	6131	0.307	0.240	0.289
		(0.078)	(0.068)	(0.074)
E. Two Year (2001-03)				
Mumbai Pretest Year 1 to Posttest Year 2	3188	0.612	0.185	0.407
		(0.141)	(0.094)	(0.106)
Vadodara Pretest Year 1 to Posttest Year 2	3425	0.282	0.181	0.250
		(0.094)	(0.079)	(0.088)

Table III: Estimates of the Impact of the Balsakhi Program, by City and Sample

	Number of Observations	Dependent Variable: Test Score Improvement (Posttest - Pretest)		
		Math	Language	Total
	(1)	(2)	(3)	(4)
A. Pooling Grades and Locations				
Mumbai and Vadodara Together Year 1	12855	0.182	0.076	0.138
		(0.046)	(0.056)	(0.047)
Mumbai and Vadodara Together Year 2	21936	0.353	0.187	0.284
		(0.069)	(0.050)	(0.060)
B. Pooling Both Grades				
Vadodara Year 1	8426	0.189	0.109	0.161
		(0.057)	(0.057)	(0.057)
Vadodara Year 2	11950	0.371	0.246	0.331
		(0.073)	(0.061)	(0.070)
Mumbai Year 1 (Grade 3 Only)	4429	0.161	0.086	0.127
		(0.075)	(0.066)	(0.067)
Mumbai Year 2	9986	0.324	0.069	0.188
		(0.145)	(0.081)	(0.112)
C. Grade 3				
Vadodara Year 1	4230	0.179	0.102	0.152
		(0.086)	(0.085)	(0.085)
Vadodara Year 2	5819	0.418	0.233	0.354
		(0.107)	(0.089)	(0.100)
D. Grade 4				
Vadodara Year 1	4196	0.190	0.114	0.166
		(0.072)	(0.076)	(0.073)
Vadodara Year 2	6131	0.307	0.240	0.289
		(0.078)	(0.068)	(0.074)
E. Two Year (2001-03)				
Mumbai Pretest Year 1 to Posttest Year 2	3188	0.612	0.185	0.407
		(0.141)	(0.094)	(0.106)
Vadodara Pretest Year 1 to Posttest Year 2	3425	0.282	0.181	0.250
		(0.094)	(0.079)	(0.088)

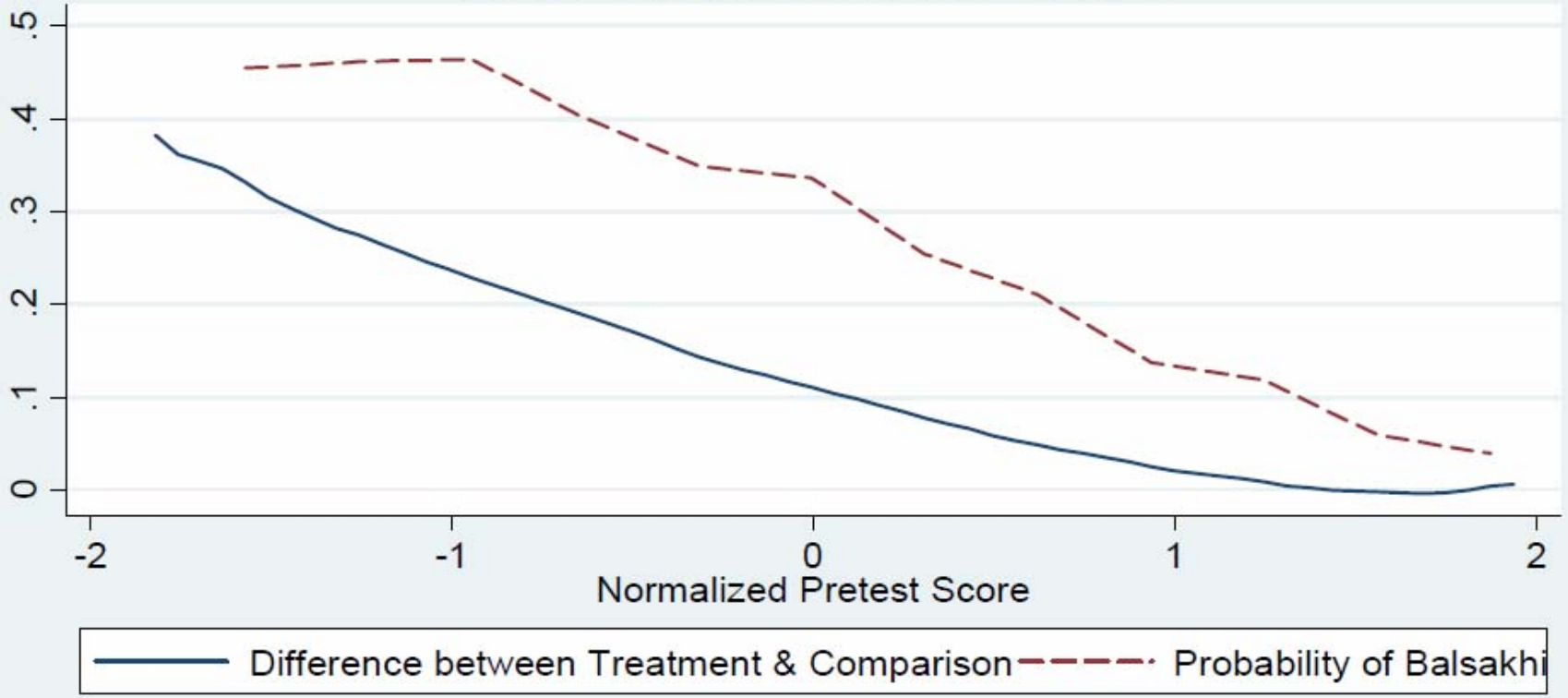
Table III: Estimates of the Impact of the Balsakhi Program, by City and Sample

	Number of Observations	Dependent Variable: Test Score Improvement (Posttest - Pretest)		
		Math	Language	Total
	(1)	(2)	(3)	(4)
A. Pooling Grades and Locations				
Mumbai and Vadodara Together Year 1	12855	0.182	0.076	0.138
		(0.046)	(0.056)	(0.047)
Mumbai and Vadodara Together Year 2	21936	0.353	0.187	0.284
		(0.069)	(0.050)	(0.060)
B. Pooling Both Grades				
Vadodara Year 1	8426	0.189	0.109	0.161
		(0.057)	(0.057)	(0.057)
Vadodara Year 2	11950	0.371	0.246	0.331
		(0.073)	(0.061)	(0.070)
Mumbai Year 1 (Grade 3 Only)	4429	0.161	0.086	0.127
		(0.075)	(0.066)	(0.067)
Mumbai Year 2	9986	0.324	0.069	0.188
		(0.145)	(0.081)	(0.112)
C. Grade 3				
Vadodara Year 1	4230	0.179	0.102	0.152
		(0.086)	(0.085)	(0.085)
Vadodara Year 2	5819	0.418	0.233	0.354
		(0.107)	(0.089)	(0.100)
D. Grade 4				
Vadodara Year 1	4196	0.190	0.114	0.166
		(0.072)	(0.076)	(0.073)
Vadodara Year 2	6131	0.307	0.240	0.289
		(0.078)	(0.068)	(0.074)
E. Two Year (2001-03)				
Mumbai Pretest Year 1 to Posttest Year 2	3188	0.612	0.185	0.407
		(0.141)	(0.094)	(0.106)
Vadodara Pretest Year 1 to Posttest Year 2	3425	0.282	0.181	0.250
		(0.094)	(0.079)	(0.088)

Table V: Short- and Longer-Run Impacts of Programs, by Initial Pretest Score

Sample	Probability of assignment to balsakhi	Program effect in Year 2: Math	Language	Total	Number of Observations	Persistence of program effect: Math	Language	Total	Number of Observations
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PANEL A: Balsakhi, 2002-2003									
All Children	0.313	0.371	0.246	0.331	11950	0.053	0.033	0.040	9925
		(0.073)	(0.061)	(0.070)		(0.047)	(0.041)	(0.041)	
Bottom Third	0.446	0.469	0.317	0.425	4053	0.096	0.097	0.103	3356
		(0.088)	(0.074)	(0.084)		(0.045)	(0.038)	(0.040)	
Middle Third	0.341	0.374	0.240	0.339	3874	0.021	-0.024	0.001	3226
		(0.082)	(0.069)	(0.080)		(0.056)	(0.054)	(0.052)	
Top Third	0.162	0.229	0.174	0.216	4023	0.015	0.006	0.009	3343
		(0.076)	(0.076)	(0.077)		(0.069)	(0.062)	(0.061)	
PANEL B: CAL, 2002-2003									
All Children		0.347	0.013	0.208	5732	0.092	-0.072	0.008	4688
		(0.076)	(0.069)	(0.074)		(0.045)	(0.048)	(0.045)	
Bottom Third		0.425	0.086	0.278	1962	0.107	0.004	0.046	1586
		(0.106)	(0.089)	(0.102)		(0.046)	(0.047)	(0.046)	
Middle Third		0.316	0.005	0.183	1844	0.085	-0.105	-0.015	1511
		(0.081)	(0.081)	(0.082)		(0.055)	(0.069)	(0.058)	
Top Third		0.266	-0.033	0.146	1926	0.073	-0.105	-0.013	1591
		(0.073)	(0.081)	(0.078)		(0.072)	(0.064)	(0.068)	

Figure I: Program Effect and Assignment Probability as a Function of Pretest Score



Note: The dashed line presents the probability a child is assigned to a balsakhi as a function of her place in the pretest score distribution. The solid line presents the difference in test score gains between children in treatment and comparison groups as a function of their place in the pretest score distribution. The values are computed using locally-weighted regressions with a bandwidth of 1.5.

Table V: Short- and Longer-Run Impacts of Programs, by Initial Pretest Score

Sample	Probability of assignment to balsakhi	Program effect in Year 2: Math	Language	Total	Number of Observations	Persistence of program effect: Math	Language	Total	Number of Observations
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PANEL A: Balsakhi, 2002-2003									
All Children	0.313	0.371	0.246	0.331	11950	0.053	0.033	0.040	9925
		(0.073)	(0.061)	(0.070)		(0.047)	(0.041)	(0.041)	
Bottom Third	0.446	0.469	0.317	0.425	4053	0.096	0.097	0.103	3356
		(0.088)	(0.074)	(0.084)		(0.045)	(0.038)	(0.040)	
Middle Third	0.341	0.374	0.240	0.339	3874	0.021	-0.024	0.001	3226
		(0.082)	(0.069)	(0.080)		(0.056)	(0.054)	(0.052)	
Top Third	0.162	0.229	0.174	0.216	4023	0.015	0.006	0.009	3343
		(0.076)	(0.076)	(0.077)		(0.069)	(0.062)	(0.061)	
PANEL B: CAL, 2002-2003									
All Children		0.347	0.013	0.208	5732	0.092	-0.072	0.008	4688
		(0.076)	(0.069)	(0.074)		(0.045)	(0.048)	(0.045)	
Bottom Third		0.425	0.086	0.278	1962	0.107	0.004	0.046	1586
		(0.106)	(0.089)	(0.102)		(0.046)	(0.047)	(0.046)	
Middle Third		0.316	0.005	0.183	1844	0.085	-0.105	-0.015	1511
		(0.081)	(0.081)	(0.082)		(0.055)	(0.069)	(0.058)	
Top Third		0.266	-0.033	0.146	1926	0.073	-0.105	-0.013	1591
		(0.073)	(0.081)	(0.078)		(0.072)	(0.064)	(0.068)	

(3) Banerjee et al. (2006)

- The balsakhi program was very cheap, since extra teacher salaries are low: only US$2.25 per year

  -- Computer assisted learning is much more expensive, at $15 per year

- A key remaining question is how durable program impacts are. Do they fully depreciate by year 3?

  -- Is the balsakhi model replicable elsewhere, e.g., in Africa or Latin America?

(4) Muralidharan and Sundararaman (2008)

- Banerjee et al (2008) show that more “inputs” (extra teachers and computers) can improve learning in India

  -- How does the effectiveness of spending on inputs compare to improved incentives?

- Examine a large-scale randomized evaluation in Andhra Pradesh state: 400 primary schools

  -- Schools tend to be small (3 classrooms / school)

  -- Teacher incentives and more inputs (same monetary value) provided to random subsets of schools

  -- Individual incentives versus group incentives

(4) Muralidharan and Sundararaman (2008)

- Why teacher incentives in India?

  -- 25% teacher absenteeism on any given day

  -- Teacher salaries 90% of non-capital education spending

- Concerns about incentive programs: cheating, teaching to the test (rather than “real” learning), teacher transfers between schools, political backlash from teachers?

- This paper is a model of clean (and ambitious) research design, precise survey instruments, and policy relevance

(4) Muralidharan and Sundararaman (2008)

- Punchline: incentives matter more than inputs in AP

  -- 0.22 sd gain in incentive schools, 0.08 in input schools

  -- Math gains again larger than language gains

  -- All students at least weakly gain

  -- No real evidence of diversion of efforts away from other subjects, cheating, mechanical / rote learning, or teacher opposition

- Mixed results in other studies: Lavy (2002, 2007) finds strong positive impacts of teacher incentives in Israel, Glewwe et al (2003) show weaker impacts in Kenya

Figure 1a: Andhra Pradesh (AP)

	India	AP
Gross Enrollment (Ages 6-11) (%)	95.9	95.3
Literacy (%)	64.8	60.5
Teacher Absence (%)	25.2	25.3
Infant Mortality (per 1000)	63	62

3.2 Sampling

We sampled 5 districts across each of the 3 socio-cultural regions of AP in proportion to population (Figure 1b).[22] In each of the 5 districts, we randomly selected one division and then randomly sampled 10 mandals in the selected division. In each of the 50 mandals, we randomly sampled 10 schools using probability proportional to enrollment. Thus, the universe of 500 schools in the study was representative of the schooling conditions of the typical child attending a government-run primary school in rural AP.

3.3 AP RESt Design Overview

The overall design of AP RESt is represented in the table below:

Table 3.1

	INCENTIVES (Conditional on Improvement in Student Learning			
		NONE	GROUP BONUS	INDIVIDUAL BONUS
INPUTS (Unconditional)	NONE	CONTROL (100 Schools)	100 Schools	100 Schools
	EXTRA PARA TEACHER	100 Schools		
	EXTRA BLOCK GRANT	100 Schools		

(4) Muralidharan and Sundararaman (2008)

- Modeling individual versus group incentives
- *w* is the teacher wage, as a function of the student test performance measure *P*. The cost of effort *a* is *c(a), c′ > 0, c″ > 0.* The returns to effort are *P(a)*, *P′ > 0, P″ > 0*

- Individual incentive: teacher i chooses effort to maximize $w(P(a_i)) - c(a_i) \rightarrow (\partial w_i/\partial P_i)(\partial P_i/\partial a_i) - c'(a_i) = 0$
- Group incentive (with *n* teachers per school): the FOC becomes: $(\partial w_i/\partial P_i)(\partial[(P_i + \Sigma P_{-i})/n]/\partial a_i) - c'(a_i) = 0$

- Thus unless benefits to cooperation are large (or the wage-performance schedule increases), higher teacher effort (and test scores) under individual incentives

Table 1: Sample Balance Across Treatments

	Panel A (Means of Baseline Variables)			
	[1]	[2]	[3]	[4]
	Control	Group Incentives	Individual Incentives	P-value (Equality of all groups)
School-level Variables				
Total Enrollment (Baseline: Grades 1-5)	113.2	111.3	112.6	0.82
Total Test-takers (Baseline: Grades 2-5)	64.9	62.0	66.5	0.89
Number of Teachers	3.07	3.12	3.14	0.58
Pupil-Teacher Ratio	39.5	40.6	37.5	0.66
Infrastructure Index (0-6)	3.19	3.14	3.26	0.84
Proximity to Facilities Index (8-24)	14.65	14.66	14.72	0.98
Baseline Test Performance				
Math (Raw %)	18.4	17.8	17.4	0.72
Math (Normalized - in Std. deviations)	0.022	-0.003	-0.019	0.74
Telugu (Raw %)	35.0	34.8	33.4	0.54
Telugu (Normalized - in Std. deviations)	0.019	0.014	-0.032	0.52

5.2 Specification

We first discuss the impact of the incentive program as a whole by pooling the group and individual incentive schools and considering this to be the 'incentive' treatment. All estimation and inference is done with the sample of 300 control and incentive schools unless stated otherwise. Our default specification uses the form:

$$T_{ijkm}(Y_n) = \alpha + \gamma \cdot T_{ijkm}(Y_0) + \delta \cdot Incentives + \beta \cdot Z_m + \varepsilon_k + \varepsilon_{jk} + \varepsilon_{ijk} \qquad (5.1)$$

The main dependent variable of interest is T_{ijkm}, which is the normalized test score on the specific test (normalized with respect to the score distribution of the control schools), where *i, j, k, m* denote the student, grade, school, and mandal respectively. Y_0 indicates the baseline tests, while Y_n indicates a test at the end of *n* years of the treatment. Including the normalized baseline test score improves efficiency due to the autocorrelation between test-scores across multiple periods.[37] All regressions include a set of mandal-level dummies (Z_m) and the standard errors are clustered at the school level.

Table 2: Impact of Incentives on Student Test Scores

	Panel A: Combined Across Subjects					
	Dependent Variable = Normalized End of Year Test Score					
	Year 1 on Year 0		Year 2 on Year 1		Year 2 on Year 0	
	[1]	[2]	[3]	[4]	[5]	[6]
Normalized Lagged Test Score	0.5	0.5	0.553	0.572	0.45	0.45
	(0.013)***	(0.013)***	(0.016)***	(0.018)***	(0.015)***	(0.015)***
Incentive School	0.153	0.175	0.143	0.124	0.217	0.226
	(0.042)***	(0.042)***	(0.035)***	(0.042)***	(0.047)***	(0.048)***
School and Household Controls	No	Yes	No	Yes	No	Yes
Observations	68702	64364	78613	48074	49516	45556
R-squared	0.29	0.31	0.29	0.36	0.23	0.24
	Panel B: Math					
	Dependent Variable = Normalized End of Year Test Score					
	Year 1 on Year 0		Year 2 on Year 1		Year 2 on Year 0	
	[1]	[2]	[3]	[4]	[5]	[6]
Normalized Lagged Test Score	0.49	0.495	0.496	0.512	0.418	0.417
	(0.017)***	(0.017)***	(0.021)***	(0.025)***	(0.022)***	(0.023)***
Incentive School	0.188	0.211	0.197	0.179	0.277	0.286
	(0.049)***	(0.050)***	(0.042)***	(0.052)***	(0.055)***	(0.056)***
School and Household Controls	No	Yes	No	Yes	No	Yes
Observations	34121	31970	39238	24000	24592	22621
R-squared	0.28	0.3	0.27	0.33	0.22	0.24

Figure 2b: Quantile Treatment Effects after 2 Years

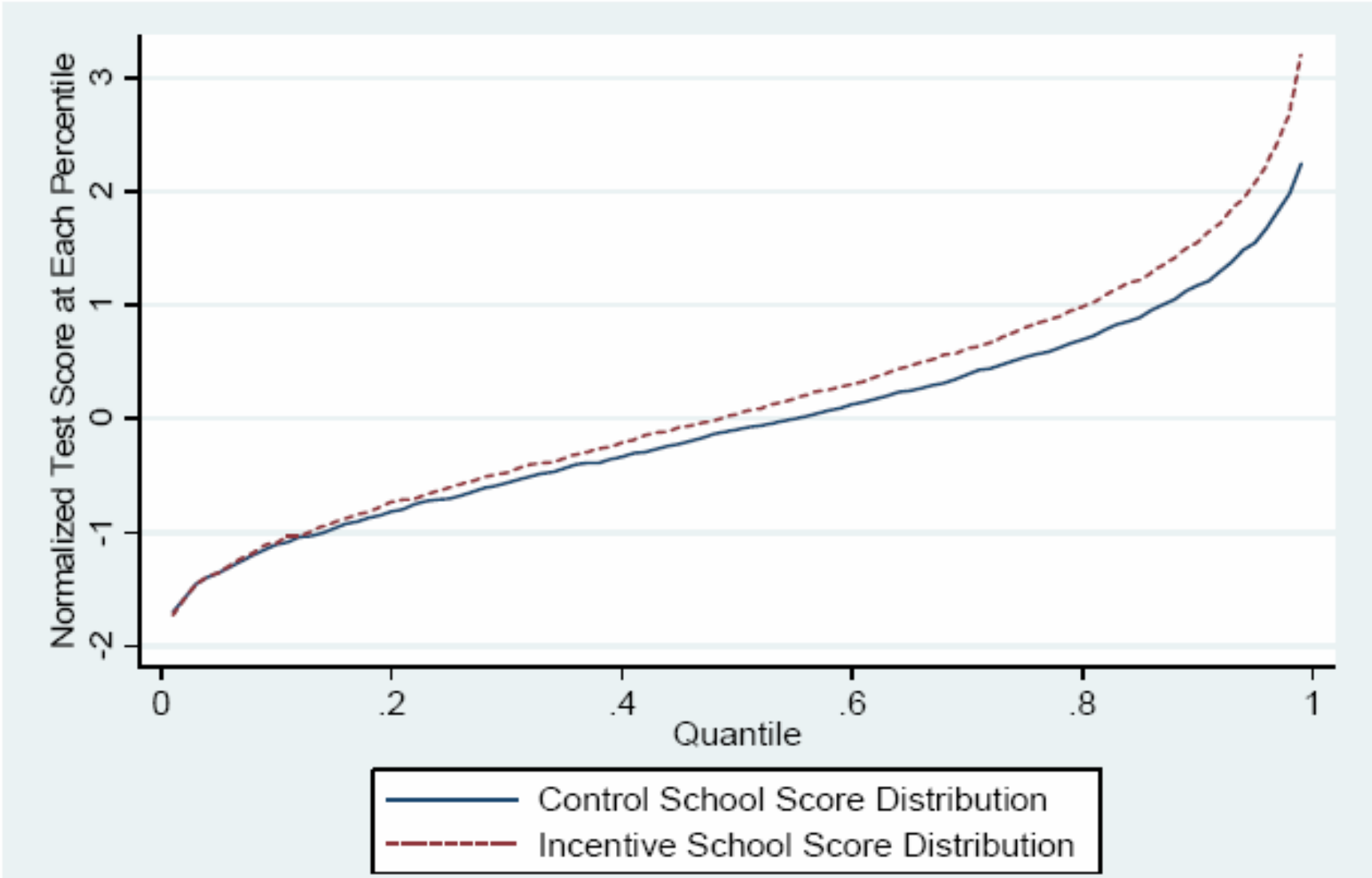


Figure 3b: Incentive versus Control School Performance – By Question Difficulty

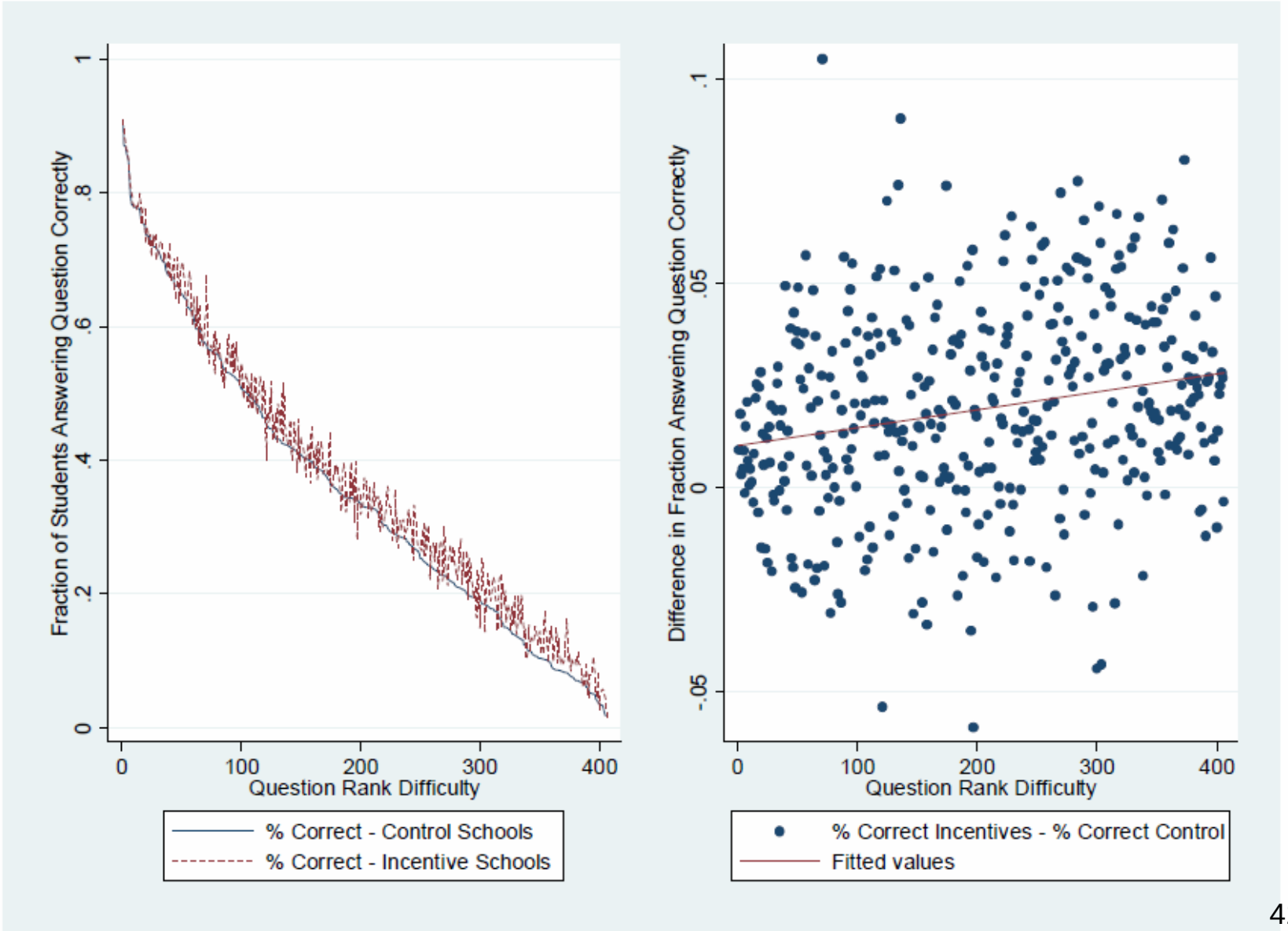


Table 3: Impact of Incentives by Grade

	Dependent Variable = Normalized Endline Test Score					
	Combined		**Math**		**Telugu (Language)**	
	Y1 on Y0	**Y2 on Y0**	**Y1 on Y0**	**Y2 on Y0**	**Y1 on Y0**	**Y2 on Y0**
	[1]	[3]	[4]	[6]	[7]	[9]
Incentives * Grade 1	0.102		0.106		0.098	
	(0.06)		(0.07)		(0.07)	
Incentives * Grade 2	0.107	0.14	0.12	0.166	0.095	0.115
	(0.054)**	(0.057)**	(0.058)**	(0.068)**	(0.06)	(0.053)**
Incentives * Grade 3	0.173	0.171	0.211	0.222	0.136	0.121
	(0.055)***	(0.056)***	(0.062)***	(0.068)***	(0.053)**	(0.053)**
Incentives * Grade 4	0.182	0.181	0.245	0.23	0.121	0.134
	(0.054)***	(0.061)***	(0.067)***	(0.070)***	(0.048)**	(0.057)**
Incentives * Grade 5	0.153	0.342	0.184	0.448	0.123	0.237
	(0.051)***	(0.065)***	(0.063)***	(0.081)***	(0.048)**	(0.058)***
Observations	68275	49516	33908	24592	34367	24924
F-Test p-value (Equality Across Grades)	0.679	0.011	0.303	0.005	0.971	0.119
R-squared	0.29	0.23	0.28	0.23	0.32	0.25

Notes:

1. All regressions include mandal (sub-district) fixed effects and standard errors clustered at the school level.

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

Table 5: Heterogenous Treatment Effects

Panel A: Household and School Characteristics

	[1] Number of Students in School	[2] Proximity (8 - 24)	[3] Infrastructure (0 - 6)	[4] Household Affluence (0 - 7)	[5] Parental Literacy	[6] SC/ST	[7] Gender	[8] Baseline Score
				Year 2 on Year 0				
Incentive	-0.188	-0.129	0.2	0.105	0.215	0.231	0.252	0.217
	(0.37)	(0.22)	(0.14)	(0.07)	(0.060)***	(0.048)***	(0.046)***	(0.047)***
Covariate	-0.075	-0.006	0.016	0.009	0.027	-0.054	0.015	0.453
	(0.05)	(0.01)	(0.04)	(0.01)	(0.006)***	(0.04)	(0.03)	(0.025)***
Interaction	**0.09**	**0.025**	**0.006**	**0.034**	**0.001**	**-0.013**	**-0.011**	**-0.005**
	(0.07)	**(0.015)***	**(0.04)**	**(0.017)****	**(0.01)**	**(0.06)**	**(0.03)**	**(0.03)**
Observations	49752	49516	49516	46596	46596	46584	46458	49516
R-squared	0.22	0.23	0.23	0.23	0.24	0.23	0.23	0.23
				Year 1 on Year 0				
Incentive	-0.401	-0.033	0.068	0.034	0.153	0.176	0.175	0.15
	(0.39)	(0.16)	(0.11)	(0.06)	(0.053)***	(0.045)***	(0.047)***	(0.042)***
Covariate	-0.115	-0.013	0.004	0.011	0.028	-0.006	0.021	0.502
	(0.059)*	(0.01)	(0.02)	(0.01)	(0.005)***	(0.03)	(0.02)	(0.021)***
Interaction	**0.106**	**0.014**	**0.03**	**0.035**	**0.001**	**-0.067**	**-0.005**	**-0.005**
	(0.08)	**(0.01)**	**(0.03)**	**(0.016)****	**(0.01)**	**(0.05)**	**(0.03)**	**(0.03)**
Observations	68438	66680	66680	65465	65465	65449	41232	68275
R-squared	0.29	0.3	0.3	0.31	0.31	0.3	0.31	0.29

Table 7: Impact of Incentives on Non-Incentive Subjects

	Normalized Endline Score			
	Year 1 on Year 0		Year 2 on Year 0	
	Science	**Social Studies**	**Science**	**Social Studies**
	[1]	[2]	[3]	[4]
Normalized Baseline Math Score	0.214	0.222	0.155	0.166
	(0.019)***	(0.018)***	(0.023)***	(0.023)***
Normalized Baseline Language Score	0.206	0.287	0.214	0.182
	(0.019)***	(0.019)***	(0.024)***	(0.024)***
Incentive School	0.107	0.135	0.112	0.177
	(0.052)**	(0.047)***	(0.045)**	(0.049)***
Observations	12011	12011	9166	9166
R-squared	0.26	0.3	0.18	0.18

Notes:

Social Studies and Science tests were only administered to grades 3 to 5

All regressions include mandal (sub-district) fixed effects and standard errors clustered at the school level.

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

Table 8: Impact of Group Incentives versus Individual Incentives

	Dependent Variable = Normalized Endline Test Score								
	Year 1 on Year 0			Year 2 on Year 1			Year 2 on Year 0		
	Combined	Maths	Telugu	Combined	Maths	Telugu	Combined	Maths	Telugu
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Normalized Lagged Score	0.5	0.49	0.516	0.554	0.497	0.616	0.451	0.418	0.485
	(0.013)***	(0.017)***	(0.014)***	(0.016)***	(0.021)***	(0.012)***	(0.015)***	(0.022)***	(0.014)***
Individual Incentive School (II)	0.16	0.194	0.128	0.198	0.252	0.144	0.271	0.321	0.223
	(0.049)***	(0.060)***	(0.043)***	(0.044)***	(0.052)***	(0.041)***	(0.058)***	(0.068)***	(0.053)***
Group Incentive School (GI)	0.146	0.183	0.11	0.087	0.14	0.035	0.162	0.232	0.092
	(0.050)***	(0.058)***	(0.046)**	(0.045)*	(0.056)**	(0.04)	(0.058)***	(0.071)***	(0.052)*
Observations	68702	34121	34581	78613	39238	39375	49516	24592	24924
F-Stat p-value (Testiing GI = II)	0.78	0.87	0.68	0.05	0.10	0.03	0.12	0.29	0.03
R-squared	0.29	0.28	0.32	0.3	0.27	0.34	0.23	0.23	0.25

Notes:

All regressions include mandal (sub-district) fixed effects and standard errors clustered at the school level.

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

Table 9: Teacher Behavior (Observation and Interviews)

Teacher Behavior	Incentive versus Control Schools (All figures in %)			
	Incentive Schools	Control Schools	p-Value of Difference	Coefficient of Teacher Behavior Indicator on Student Test Scores
Based on Observation				
Teacher Absence (%)	0.24	0.24	**0.82**	**-0.110** **
Actively Teaching at Point of Observation (%)	0.44	0.42	**0.57**	**0.124** ***
Based on Interviews				
Did you do any special preparation for the end of year tests? (% Yes)	0.63	0.25	**0.000****	**0.102** ***
What kind of preparation did you do? (UNPROMPTED) (% Mentioning)				
Extra Homework	0.42	0.15	**0.000****	**0.085** **
Extra Classwork	0.46	0.17	**0.000****	**0.091** ***
Extra Classes/Teaching Beyond School Hours	0.16	0.04	**0.000****	**0.181** ***
Gave Practice Tests	0.31	0.10	**0.000****	**0.111** ***
Paid Special Attention to Weaker Children	0.21	0.05	**0.000****	**0.017**

Notes:
Each teacher-year combination is treated as one observation with t-tests clustered at the school
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10: Impact of Inputs versus Incentives on Learning Outcomes

	Dependent Variable = Normalized Endline Test Score								
	Year 1 on Year 0			**Year 2 on Year 1**			**Year 2 on Year 0**		
	Combined [1]	**Math** [2]	**Language** [3]	**Combined** [4]	**Math** [5]	**Language** [6]	**Combined** [7]	**Math** [8]	**Language** [9]
Normalized Lagged Score	0.511	0.492	0.535	0.552	0.495	0.614	0.461	0.423	0.497
	(0.010)***	(0.012)***	(0.011)***	(0.012)***	(0.016)***	(0.010)***	(0.012)***	(0.016)***	(0.012)***
Incentives	0.155	0.183	0.121	0.145	0.199	0.091	0.217	0.277	0.158
	(0.041)***	(0.049)***	(0.038)***	(0.036)***	(0.044)***	(0.033)***	(0.048)***	(0.056)***	(0.045)***
Inputs	0.096	0.110	0.082	0.047	0.047	0.047	0.084	0.092	0.076
	(0.037)***	(0.042)***	(0.036)**	(0.03)	(0.04)	(0.03)	(0.043)*	(0.049)*	(0.042)*
Difference (Incentives - Inputs)	0.06	0.07	0.04	0.10	0.15	0.04	0.13	0.19	0.08
F-Stat p-value (Inputs = Incentives)	**0.09**	**0.08**	**0.23**	**0.01**	**0.00**	**0.17**	**0.00**	**0.00**	**0.04**
Observations	112238	55542	56269	119836	59820	60016	82596	41053	41543
R-squared	0.29	0.27	0.32	0.29	0.26	0.33	0.21	0.21	0.23

(4) Muralidharan and Sundararaman (2008)

- Further questions / issues:

  -- What is the optimal incentive contract? How steep should incentives be? What would utility costs be for risk averse teachers?

  -- Would incentives lead more able individuals into the teaching profession?

  -- Would teacher unions allow these experiments on a wider scale? Political backlash?

  -- How to boost teacher “value added” more generally beyond incentives? Status, work conditions?

(5) Kremer, Miguel, Thornton (2007)

- Merit scholarships and schooling in rural Kenya

- The debate over merit scholarships

  “Pros”: Incentives to exert effort, perhaps helping to deal with self-control problems, externalities to effort

  Possible “cons”: (1) Exacerbate inequality, (2) Weaken intrinsic motivation in either short or long run, (3) Gaming the system through cramming, cheating, less effort in other key dimensions

The Girls Scholarship Program (GSP)

- GSP is a randomized evaluation of a merit award for Grade 6 girls in Busia and Teso districts, Kenya
- 64 treatment schools, 63 comparison schools
- The top 15% of girls in program schools (by district) received a $38 prize for school fees and supplies over two years, and a public awards ceremony

Two GSP research questions

(#1) What impact do these incentives have on test scores and other measures of school performance?

→ Randomized evaluation methods

(#2) What impact does winning the GSP award have on later schooling choices and outcomes? In particular does it make it more likely that winners stay in school?

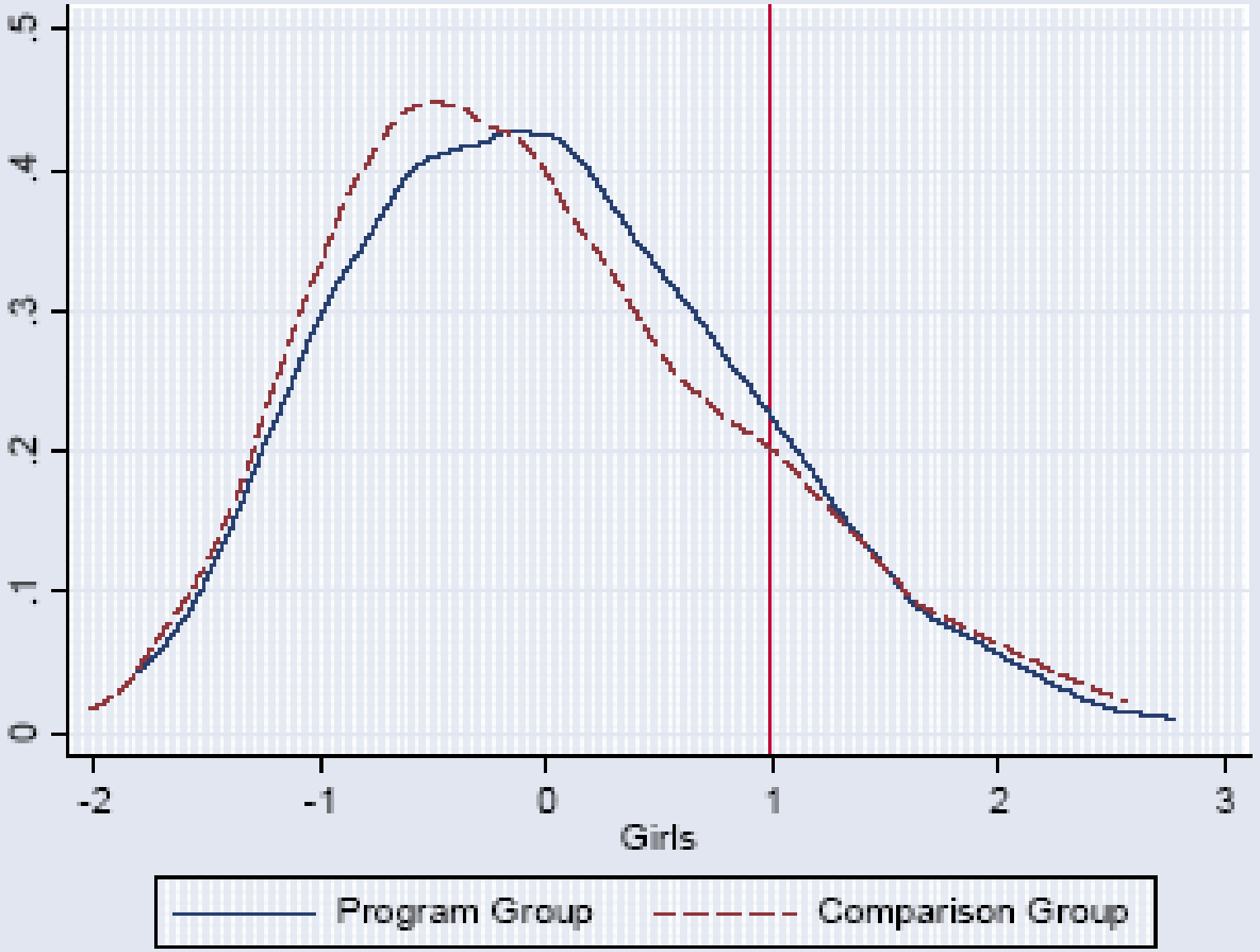
→ Regression discontinuity methods

The Girls Scholarship Program (GSP)

- The randomization “worked”: treatment and comparison group schools are similar at baseline (Table 3, Figure 5)

	---------Girls---------		
Panel A: Busia District	Program	Comparison	Difference (s.e.)
Age in 2001	13.5	13.4	0.0
			(0.1)
Father's education (years)	5.2	5.2	0.2
			(0.5)
Mother's education (years)	4.6	4.6	0.1
			(0.4)
Total children in household	7.0	6.5	0.5
			(0.5)
Proportion ethnic Luhya	0.49	0.47	0.03
			(0.05)
Latrine ownership	0.96	0.94	0.02
			(0.01)
Iron roof ownership	0.77	0.77	0.00
			(0.03)
Mosquito net ownership	0.33	0.33	0.00
			(0.03)
Test Score 2000–Baseline sample (cohort 1 only)	-0.05	-0.12	0.07
			(0.18)
Test Score 2000–Main sample (cohort 1 only)	0.07	0.03	0.04
			(0.19)

Panel (A)



Why might incentives have an impact? Theoretical perspectives

- Extrinsic motivation (exploiting immediate gratification)
- vs. Intrinsic motivation ("love of learning")

- Great teacher effort (altruism, recognition)
- Parent encouragement / pressure on the girls
- Community mobilization to support the program

GSP empirical impacts (2001-2002)

- Impacts are positive and quite large for cohort 1: 0.12-0.13 standard deviations on average (Table 4)
- There are positive effects for boys, too – even though they were not eligible for the prize: externalities
- Positive effects are concentrated in Busia district (gains of 0.2 s.d.), but are zero in Teso district – why?

Table 4: Program Impact on Test Scores
Longitudinal Sample, Cohort 1 Girls and Boys

	Dependent variable: Normalized test scores from 2001 and 2002				
	Busia and Teso districts			Busia district	Teso district
	(1)	(2)	(3)	(4)	(5)
Program school	0.12	0.13**	0.12*	0.19**	-0.02
	(0.13)	(0.06)	(0.07)	(0.08)	(0.09)
Male * Program School			0.01	0.01	0.01
			(0.05)	(0.05)	(0.09)
Male			0.16***	0.09**	0.28***
			(0.04)	(0.04)	(0.07)
Individual test score, 2000		0.80***	0.79***	0.85***	0.69***
		(0.02)	(0.02)	(0.03)	(0.02)
Sample Size	4294	4294	4294	2858	1436
R^2	0.00	0.61	0.61	0.67	0.53
Mean of dependent variable	0.13	0.13	0.13	0.13	0.12

Figure 6: Year 1 (2001) Test Score Distribution
Cohort 1 Busia Girls (Panel A) and Busia Boys (Panel B)
(Non-parametric kernel densities)

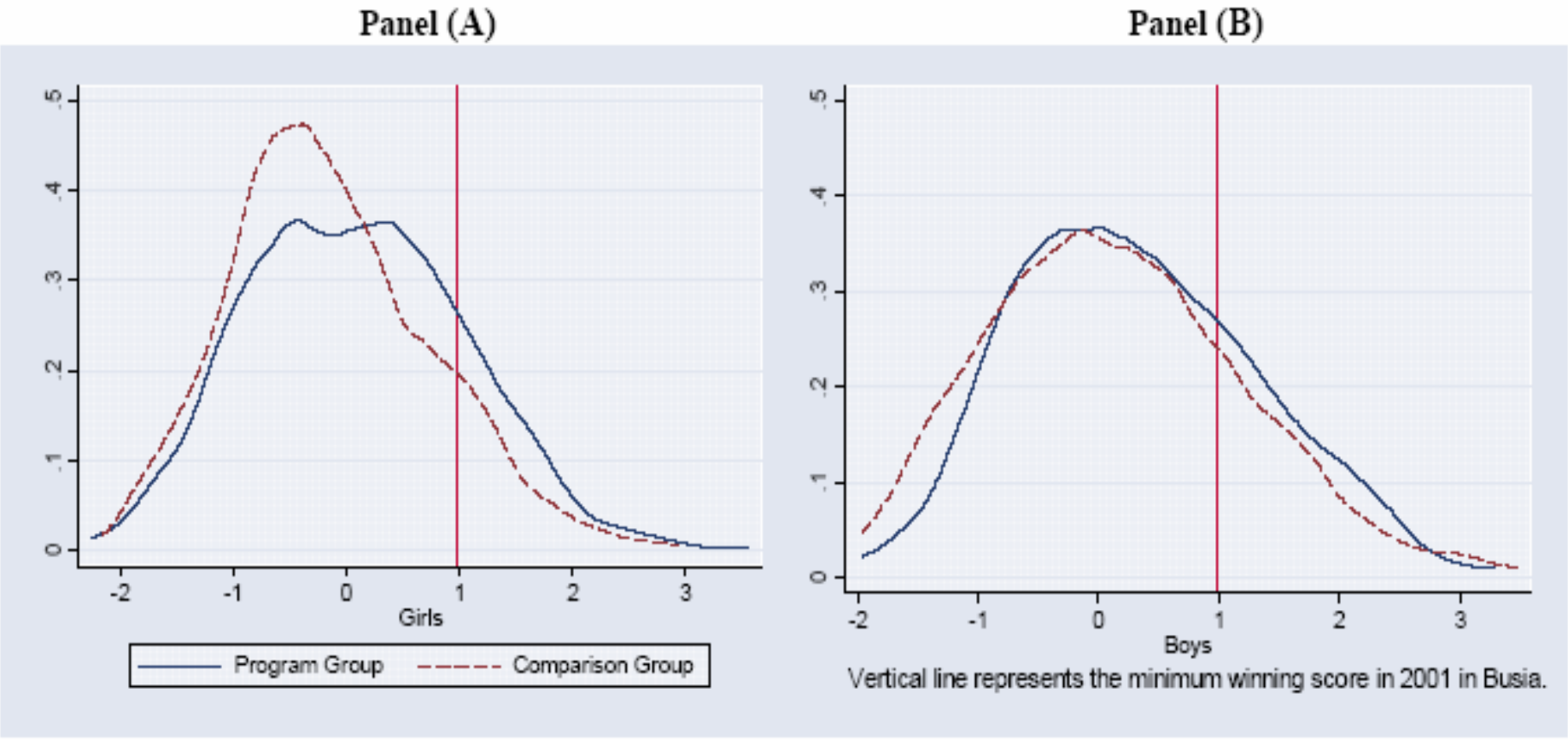
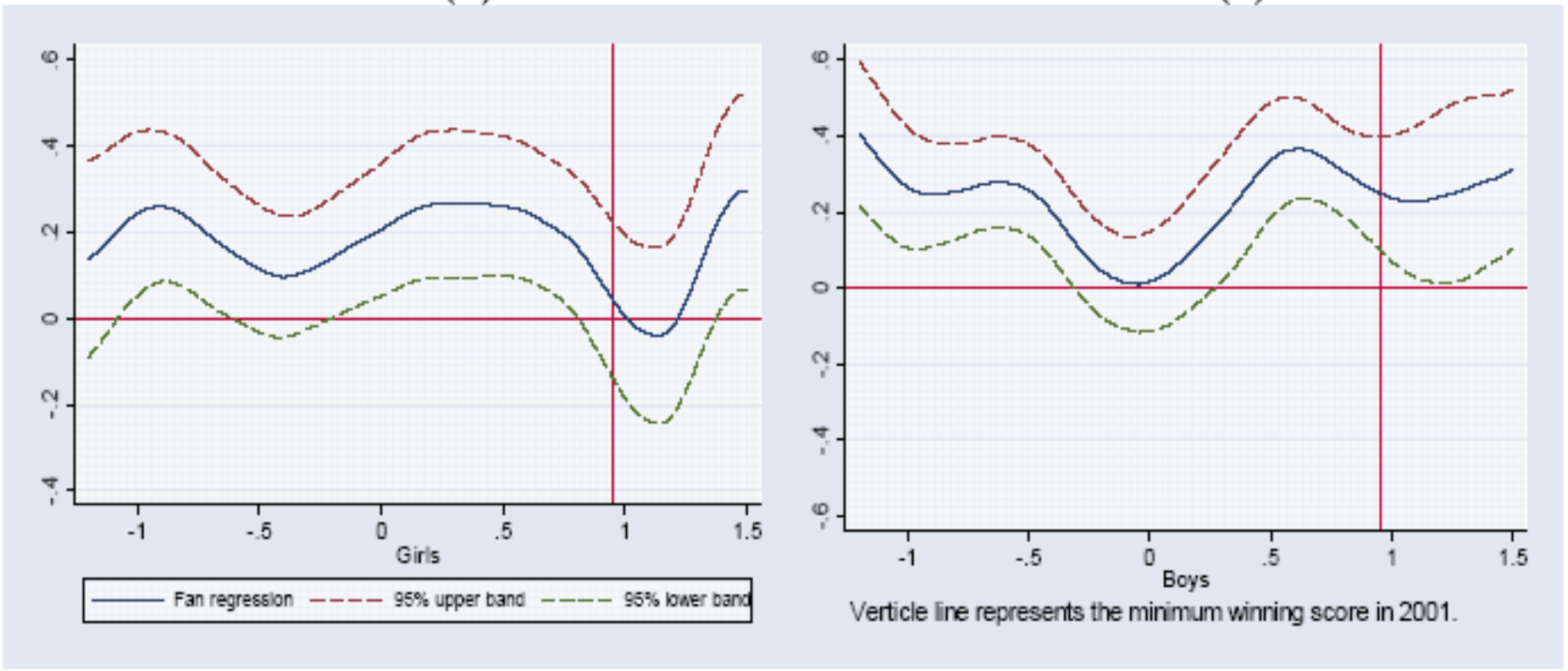


Figure 7: Year 1 (2001) Test Score Impacts by Baseline (2000) Test Score
Difference between Program Schools and Comparison Schools
Cohort 1 Busia Girls (Panel A) and Busia Boys (Panel B)
(Non-parametric Fan locally weighted regression)

Panel (A) **Panel (B)**



Difficulties in Teso district

- This NGO, and other NGOs, have long had trouble introducing new projects into Teso district
- The dominant ethnic groups are different in Busia district (Luhya) and Teso district (Teso)

- There was a tragic lightning strike incident in a Teso district primary school in April 2001 – seven students died (27 injured), and NGO project work became even more difficult afterwards. Five Teso district schools pulled out of the program

Figure 1: Map of Busia District and Teso District, Kenya,
with location of Girls Scholarship Program Schools (legend below)

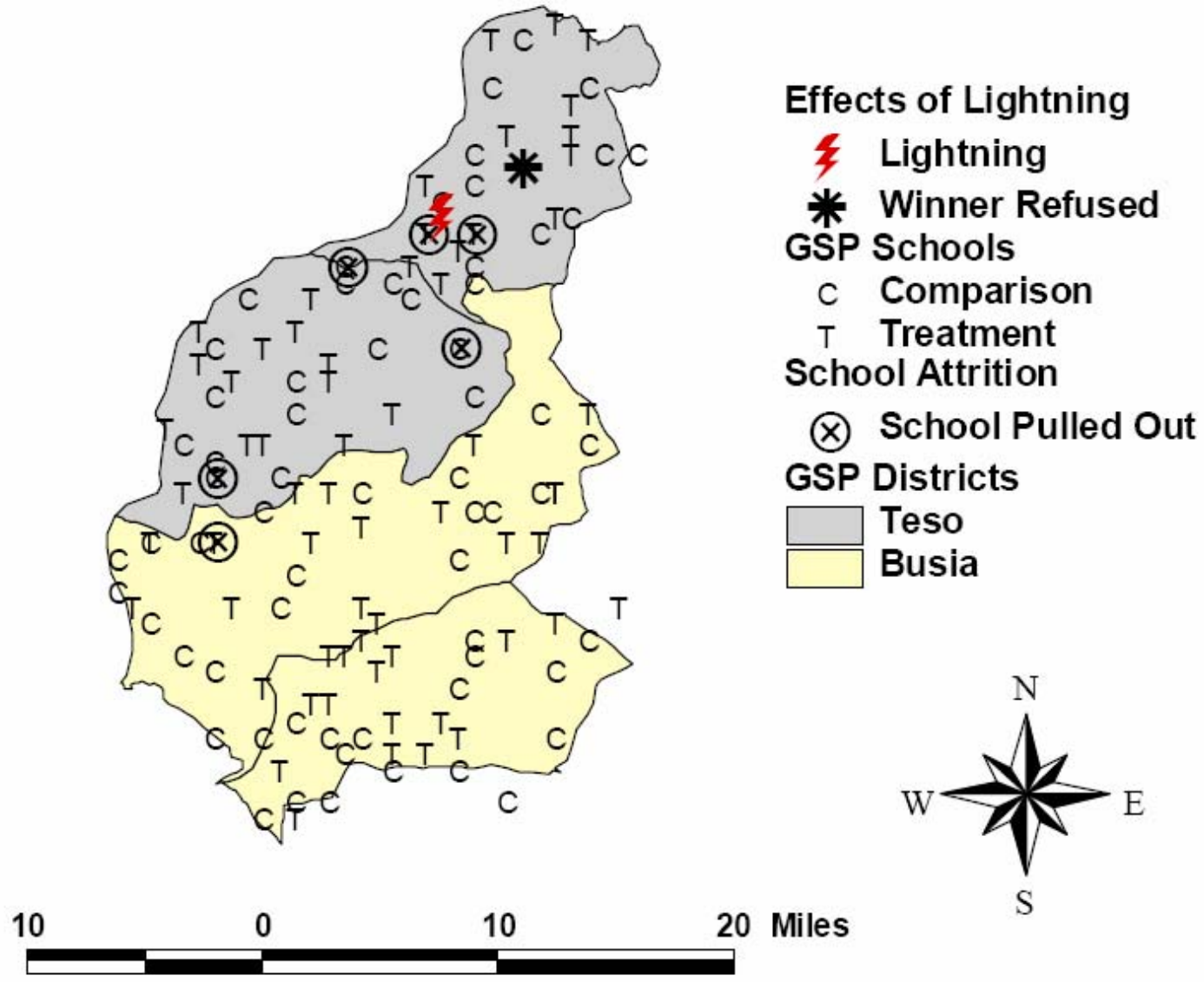


Figure 3: Proportion of Baseline Students in the 2001 Main sample by Baseline (2000) Test Score
Cohort 1 Busia Girls (Panel A) and Busia Boys (Panel B)
(Non-parametric Fan locally weighted regressions)

Panel (A) **Panel (B)**

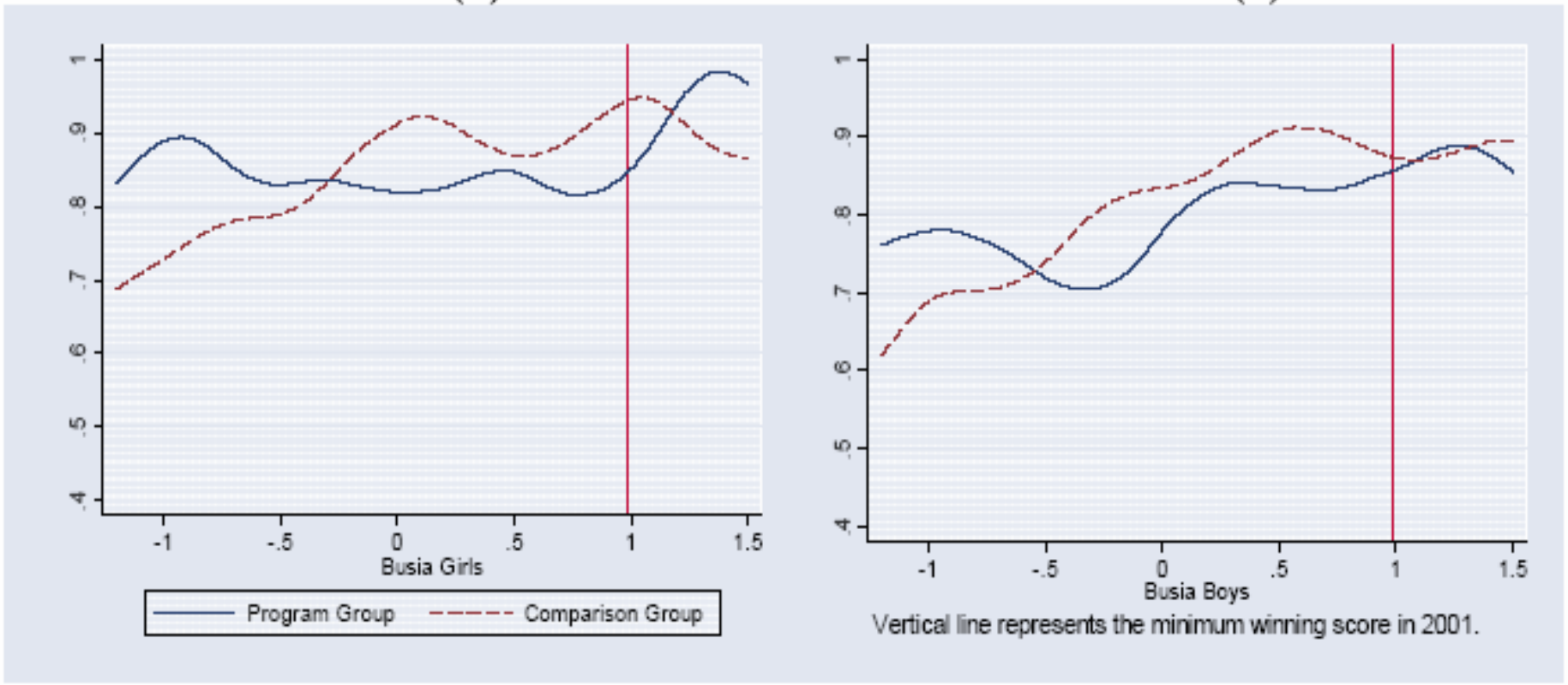


Figure 4: Proportion of Baseline Students in the 2001 Main sample by Baseline (2000) Test Score
Cohort 1 Teso Girls (Panel A) and Teso Boys (Panel B)
(Non-parametric Fan locally weighted regressions)

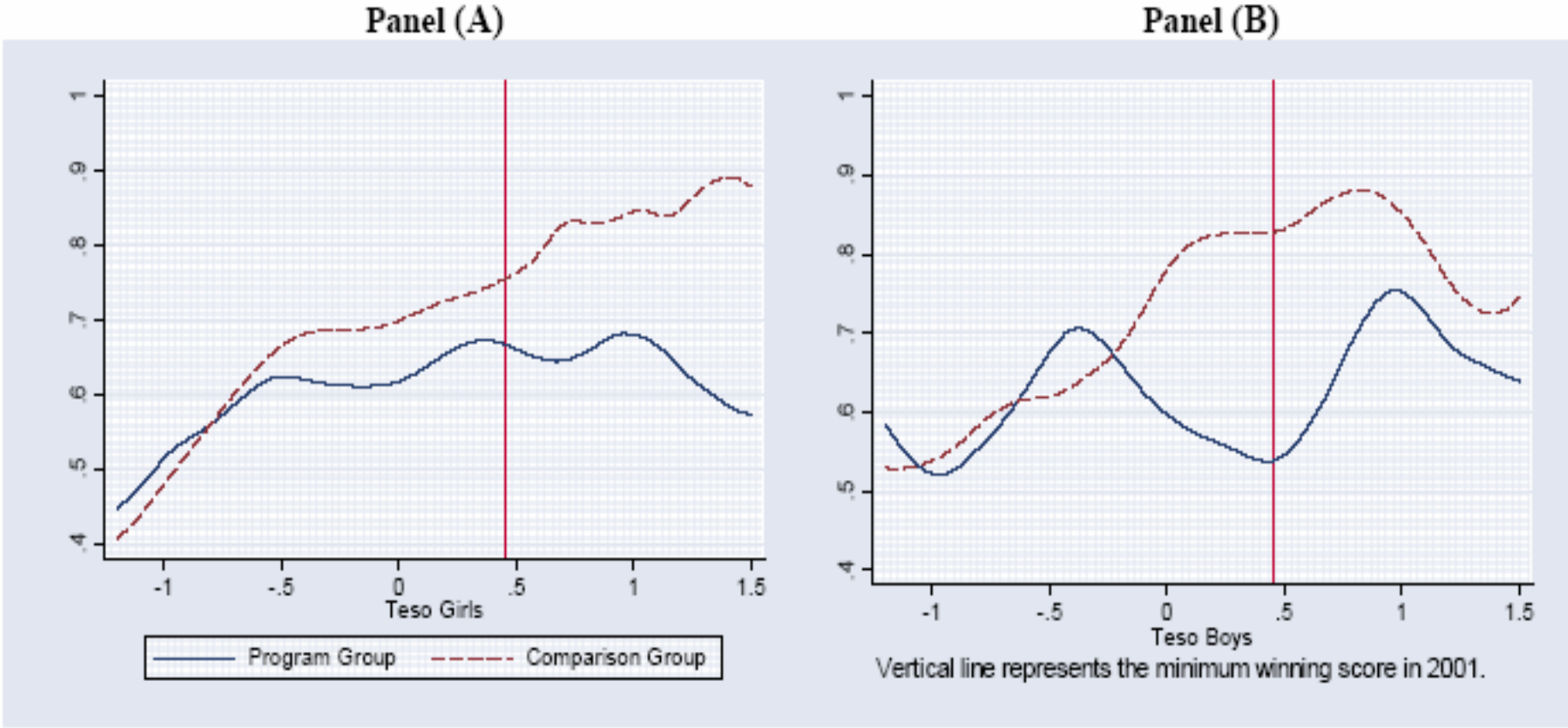


Table 5: Program Impact on Test Scores
Main sample, Cohorts 1 and 2 Girls and Boys

	Dependent variable: Normalized test scores from 2001 and 2002			
	----------Girls----------		----------Boys----------	
	Busia and Teso	Busia District	Busia and Teso	Busia District
	(1)	(2)	(3)	(4)
Program year, Cohort 1 (2001)	0.18**	0.28***	0.10	0.18**
	(0.08)	(0.10)	(0.07)	(0.09)
Program year, Cohort 2 (2002)	0.13*	0.21**	0.04	0.11
	(0.07)	(0.10)	(0.10)	(0.13)
Post-competition year, Cohort 1 (2002)	0.12	0.25***	0.05	0.07
	(0.08)	(0.09)	(0.07)	(0.09)
Mean school test score, 2000	0.75***	0.83***	0.78***	0.87***
	(0.05)	(0.05)	(0.06)	(0.06)
Sample Size	4736	2917	5332	3206
R^2	0.29	0.36	0.26	0.32
Mean of dependent variable	-0.06	-0.03	0.21	0.21

Notes: Significantly different than zero at 90% (*), 95% (**), 99% (***) confidence. OLS regressions, Huber robust standard errors in parenthesis. Disturbance terms are allowed to be correlated across observations in the same school, but not across schools. Test scores were normalized such that comparison group test scores had mean zero and standard deviation one. Indicator variables are included in both specifications for Cohort 1 in 2001, Cohort 1 in 2002, and Cohort 2 in 2002 (coefficient estimates not shown). Main sample includes students who were registered in grade 6 (cohort 1) or grade 5 (cohort 2) in January 2001, in schools that did not pull out of the program, for whom we have mean school test score data in 2000, and who took the 2001 or 2002 test.

Evaluating critiques of merit scholarships

- No statistically significant changes in test score inequality in treatment schools
- Effort increased: student school participation increased by 5 percentage points in program schools (Table 7), for girls and boys in Busia district
- Teacher attendance increased 5 percentage points
- There are no significant changes in students' study habits, work at home, or attitudes toward education / stated intrinsic motivation (Table 6)

	Busia and Teso Districts	
	---------Girls---------	
Dependent Variables:	Estimated impact (s.e.)	Mean (s.d.) of dep. var.
Panel A: Attitudes towards education		
Student prefers school to other activities (index) [a]	0.02	0.72
	(0.01)	(0.18)
Student thinks s/he is a "good student"	0.02	0.73
	(0.04)	(0.44)
Student thinks being a "good student" means "working hard"	-0.02	0.69
	(0.03)	(0.46)
Student thinks can be in top three in the class	0.00	0.33
	(0.04)	(0.47)
Panel B: Study/Work habits		
Student went for extra coaching in last two days	-0.04	0.40
	(0.04)	(0.49)
Student used a textbook at home in last week	0.01	0.85
	(0.03)	(0.36)
Student did homework in last two days	0.03	0.78
	(0.04)	(0.41)
Teacher asked the student a question in class in last two days	0.03	0.81
	(0.04)	(0.39)
Amount of time did chores at home [b]	0.02	2.63
	(0.05)	(0.82)
Panel C: Educational Inputs		
Number of textbooks at home	0.09	3.83
	(0.19)	(2.15)
Number of new books bought in last term	0.15	1.54
	(0.14)	(1.48)

What are the policy implications?

- Positive impacts:

  -- Test scores improved more than any other project we have studied in Kenya, and for relatively low cost

  -- GSP could promote empowerment of women and changes in social norms about girls' education

- Possible concerns / limitations:

  -- Will the impacts last? In the long-run, will GSP really destroy the "love of learning" for these kids?

Whiteboard #1

Whiteboard #2

Whiteboard #3

Whiteboard #4

Whiteboard #5


ARCTIC OCEAN
GREENLAND
BEAUFORT SEA
BAFFIN SEA
GREENLAND SEA
NORWEGIAN SEA
BARENTS SEA
KARA SEA
EAST SIBERIAN SEA
RUSSIA
CANADA
UNITED STATES OF AMERICA
KAZAKHSTAN
MONGOLIA
CHINA
ATLANTIC OCEAN
PACIFIC OCEAN
BRAZIL
INDIAN OCEAN
AUSTRALIA
International Date Line
Midnight
The direction of the earth's rotation
West
East