UNIVERSITAT DE BARCELONA
SCHOOL OF ECONOMICS

MSc
Economics

Application of Regression Discontinuity Design

The impact of tracking in Kenyan primary schools

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Analysis & Evaluation of Public Policies
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Outline

Motivation

Introduction

Duflo, E., P. Dupas, & M. Kremer (2011) "Peer Effects, Teacher Incentives, and the Impact of Tracking: Evidence from a Randomized Evaluation in Kenya". In *American Economic Review*, 101: 1739-1774.

Def. 'Tracking': splitting up pupils according to prior achievements

Evidence from **studies in the U.S.**

- High-achieving pupils are widely regarded to gain from tracking
- Low-achieving pupils should be affected ambiguously
  - ↓ Less direct student-to-student spillovers (Epple, Newlon & Romano 2002).
  - ↑ Indirect effect: Teacher chooses an instruction level closer to pupil's ability (Figlio and Page, 2002; Zimmer, 2003; Lefgren, 2004).
- Mid-achieving pupils are divided by the median → **discontinuity**
  Just below the median:
  - ↓ Less direct student-to-student spillovers.
  - ↓ If teachers always target the middle of a class: Negative indirect effect.

Surprising result of **randomized experiment** in Kenyan primary schools:

→ Duflo et al. (2011) find that *all* quartiles receive a net benefit from tracking compared to the control group.

Background

Primary education in Kenya

Characteristics

- Centralized education system
  - National exams.
  - Curriculum benefitting only high-achieving pupils (Glewwe et al., 2009).
- Most teachers are hired centrally through the civil service
  - Face weak incentives (Duflo et al., 2011).
- A minority of teachers are hired locally on short-term contracts.
  - Face strong incentives $\rightarrow$ good track record can lead to a civil-service job.
- Kenya recently abolished school fees $\rightarrow$ huge heterogeneity in pupils.
  - Many 1^{st} generation learners.
  - Few have attended preeschools (costly and optional).

Incentives to target teaching to the top of the class

- Scores of own pupils in exit exam: A high rate drop out or repeat grades.
- Teachers are more likely to interact with parents of top-achievers.

Experimental design

In 2005 grants secured an extra teacher for 18 months in 121 primary schools in Western Kenya with a single 1st grade class that was split into two classes.

Random assignment into treatment:

T=1: **Tracking schools:** Students were assigned to each of the two classes based on prior test scores, i.e. above median or below median (60 schools).

T=0: **Non-tracking schools:** Students were randomly assigned to either of the two classes (61 schools).

- Contract teachers and civil-service teachers were randomly assigned.

Non-compliers and attrititon

- Many teachers did not comply to assignment
  $\rightarrow$ 10-14% of schools had to combine the classes again.
- Only a handful of pupils were reassigned due to parent's request.
  - 92-96% of pupils were found in their assigned class (on 5 unannounced visits to each school).
  - 21-23% of students repeated 1st grade. 0.5% dropped out.
  - Attrition rates: 18% for endline test, 22% one year after ended treatment.

Very different prior achievement of class mates

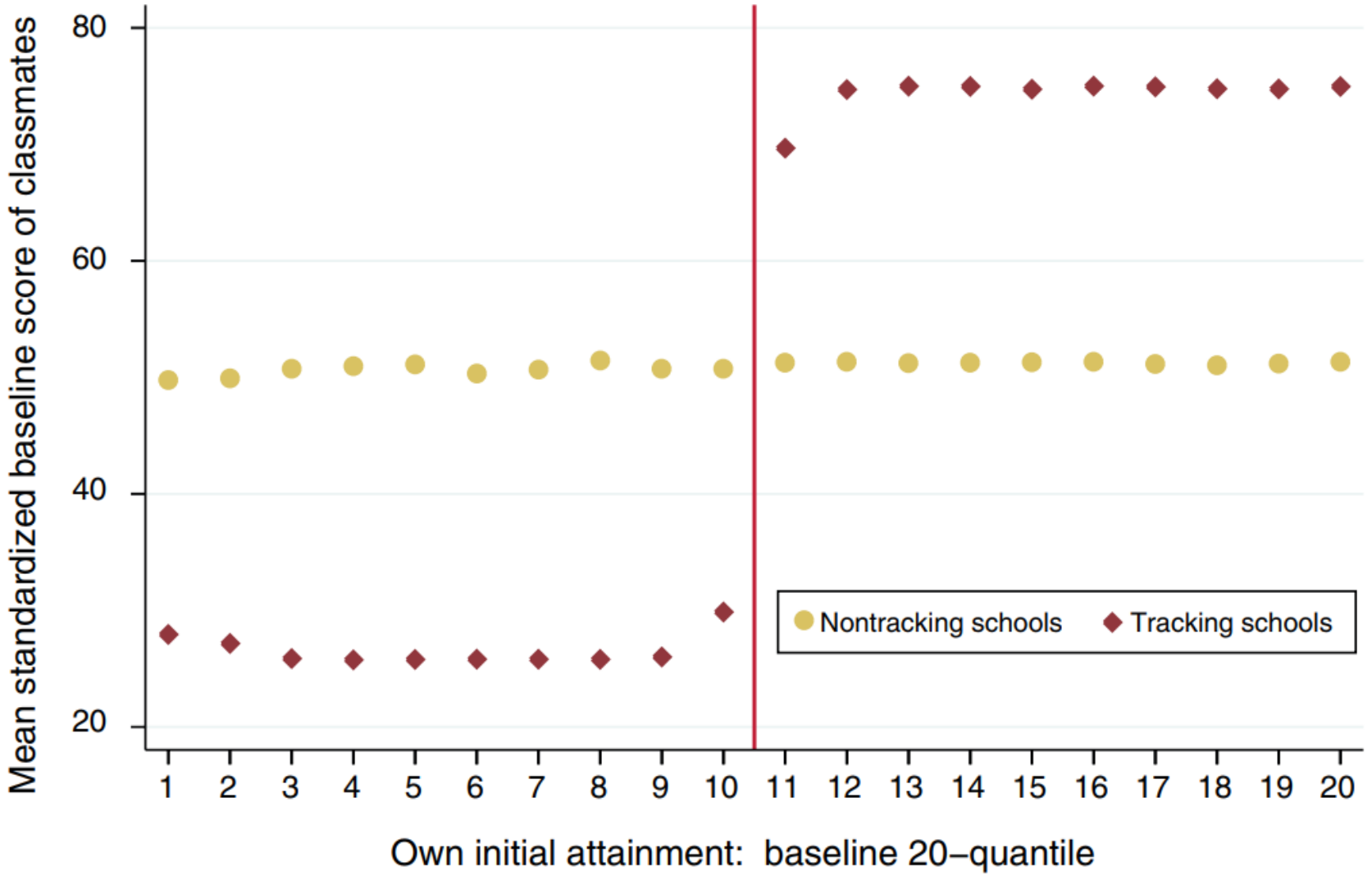

FIGURE 2. EXPERIMENTAL VARIATION IN PEER COMPETITION

Theoretical model

Model of educational outcome

y_{ij} : The educational outcome of a pupil i in class j, given by

$$y_{ij} = x_i + f(\bar{x}_{-ij}) + g(e_j)h(x_j^* - x_i) + u_{ij} \tag{3.1}$$

Where

x_i : Prior test score of the pupil.

$\bar{x}_{-ij}$: Average score of the other pupils in the class. $f(\bar{x}_{-ij})$: is direct peer effect.

e_j : Teacher's effort. $g(e_j)$ is concave.

x_j^* : The target level of teacher's instructions depending on class test scores. $h(\cdot)$: decreases to 0 when the difference between target and pupil's score is $x_j^* - x_i > \theta$.

u_{ij} : i.i.d. stochastic pupil- and class-specific factors (symmetric, single-peak).

Teacher's utility maximization problem

The teacher decides on effort e^* and target level x^* to **maximize utility**.

$P(x^*, e^*)$: Payoff function of the distribution of pupils' endline test scores.

$c(e^*)$: Cost function of effort (convex).

$\lambda > 1$: Contract teachers receive λ times more payoff than civil service teachers.

The empirical results are **inconsistent** with three special cases $\rightarrow$ decline:

- No direct peer-effects.
- No teacher response to class composition.
- Teachers payoffs are linear (or concave) in students' endline test scores.

Empirical results are **consistent** with a model where:

$\rightarrow$ Class composition has both direct and indirect effects.

$\rightarrow$ Teacher's payoffs are convex in student's test scores $\rightarrow$ target top of class.

Anticipated effects of tracking in general

The indirect effects depend on whether teachers are incentivized to target the top-, median- or low-achievers in a class (unaffected by treatment).

- High-achieving pupils should gain from tracking.
  - ↑ Direct student-to-student spillovers.
  - ↑ Indirect effect: Teacher increases effort and level.
- Low-achieving pupils could be affected ambiguously
  - ↓ Less direct student-to-student spillovers.
  - ↑ Indirect effect: Teacher chooses instruction level closer to pupil's ability.
- Mid-achieving pupils *above* the median could be affected ambiguously
  - ↑ Direct student-to-student spillovers
  - ↑↓ Indirect effect: Teacher might increase effort but also increase instruction level above pupil's ability. Depends on teacher's incentives (initial target).
- Mid-achieving pupils *below* the median could be affected ambiguously
  - ↓ Less direct student-to-student spillovers.
  - ↑↓ Indirect effect: Teacher will lower the instruction level. Direction of effect depends on teacher's incentives.

Effects of tracking in Kenya consistent with empirical results

Incentive to maximize final scores at the end of 8^{th} grade; many low- and medium-achievers drop out $\Rightarrow$ Kenyan teachers target top-achievers in a class

- High-achieving pupils gain from tracking
  - $\uparrow$ Direct student-to-student spillovers.
  - $\uparrow$ Indirect effect: Teacher increases effort ~~and level~~.
- Low-achieving pupils receive a net gain
  - $\downarrow$ Less direct student-to-student spillovers.
  - $\uparrow$ Indirect effect: Teacher chooses instruction level closer to pupil's ability.
- Mid-achieving pupils *above* the median receive a net gain
  - $\uparrow$ Direct student-to-student spillovers.
  - $\uparrow\downarrow$ Indirect effect: Teacher might increase effort ~~but also increase instruction level above pupil's ability~~. *Teachers initially target top-achievers anyway*.
- Mid-achieving pupils *below* the median receive a net gain
  - $\downarrow$ Less direct student-to-student spillovers.
  - $\uparrow\downarrow$ Indirect effect: Teacher will lower the instruction level. *Positive effect as teacher now targets mid-achievers as they are the top of the new class.*

Estimation strategy

Simple impact of tracking in school j on student i's' test score:

$$\underbrace{y_{ij}}_{\text{Endline test result}} = \underbrace{\alpha T_j}_{\text{tracking dummy}} + \underbrace{X_{ij}\beta}_{\text{controls}} + \varepsilon_{ij} \tag{3.2}$$

Control variables X_{ij} : baseline score, gender, age, and contract teacher.

With interaction between being in a tracking school and in the bottom half B_{ij} :

$$y_{ij} = \alpha T_j + \underbrace{\gamma T_j \times B_{ij}}_{\text{interaction term}} + X_{ij}\beta + \varepsilon_{ij} \tag{3.3}$$

i.e. the estimated effect of tracking is

$\hat{\alpha}$: for the top half.

$\hat{\alpha} + \hat{\gamma}$: for the bottom half.

Results

Main results

- All quartiles benefit from tracking in endline test scores.
  - No quartile benefit significantly more than others.
- Persistent effects one year after program ended.
  - Overall the effect is slightly, but not significantly larger than endline test.
  - Lower and insignificant persistent effects for bottom quartile pupils.

TABLE 2—OVERALL EFFECT OF TRACKING

	Total score				Math score		Literacy score	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Short-run effects (after 18 months in program)								
(1) Tracking school	0.139	0.176	0.192	0.182	0.139	0.156	0.198	0.166
	(0.078)*	(0.077)**	(0.093)**	(0.093)*	(0.073)*	(0.083)*	(0.108)*	(0.098)*
(2) In bottom half of initial distribution × tracking school			−0.036		0.04		−0.091	
			(0.07)		(0.07)		(0.08)	
(3) In bottom quarter × tracking school				−0.045		0.012		−0.083
				(0.08)		(0.09)		(0.08)
(4) In second-to-bottom quarter × tracking school				−0.013		0.026		−0.042
				(0.07)		(0.08)		(0.07)
(5) In top quarter × tracking school				0.027		−0.026		0.065
				(0.08)		(0.07)		(0.08)
(6) Assigned to contract teacher		0.181	0.18	0.18	0.16	0.161	0.16	0.16
		(0.038)***	(0.038)***	(0.038)***	(0.038)***	(0.037)***	(0.038)***	(0.038)***
Individual controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,795	5,279	5,279	5,279	5,280	5,280	5,280	5,280
Total effects on bottom half and bottom quarter								
Coeff (Row 1) + Coeff (Row 2)			0.156		0.179		0.107	
Coeff (Row 1) + Coeff (Row 3)				0.137		0.168		0.083
F-test: total effect = 0			4.40	2.843	5.97	3.949	2.37	1.411
p-value (total effect for bottom = 0)			0.038	0.095	0.016	0.049	0.127	0.237
p-value (effect for top quarter = effect for bottom quarter)				0.507		0.701		0.209

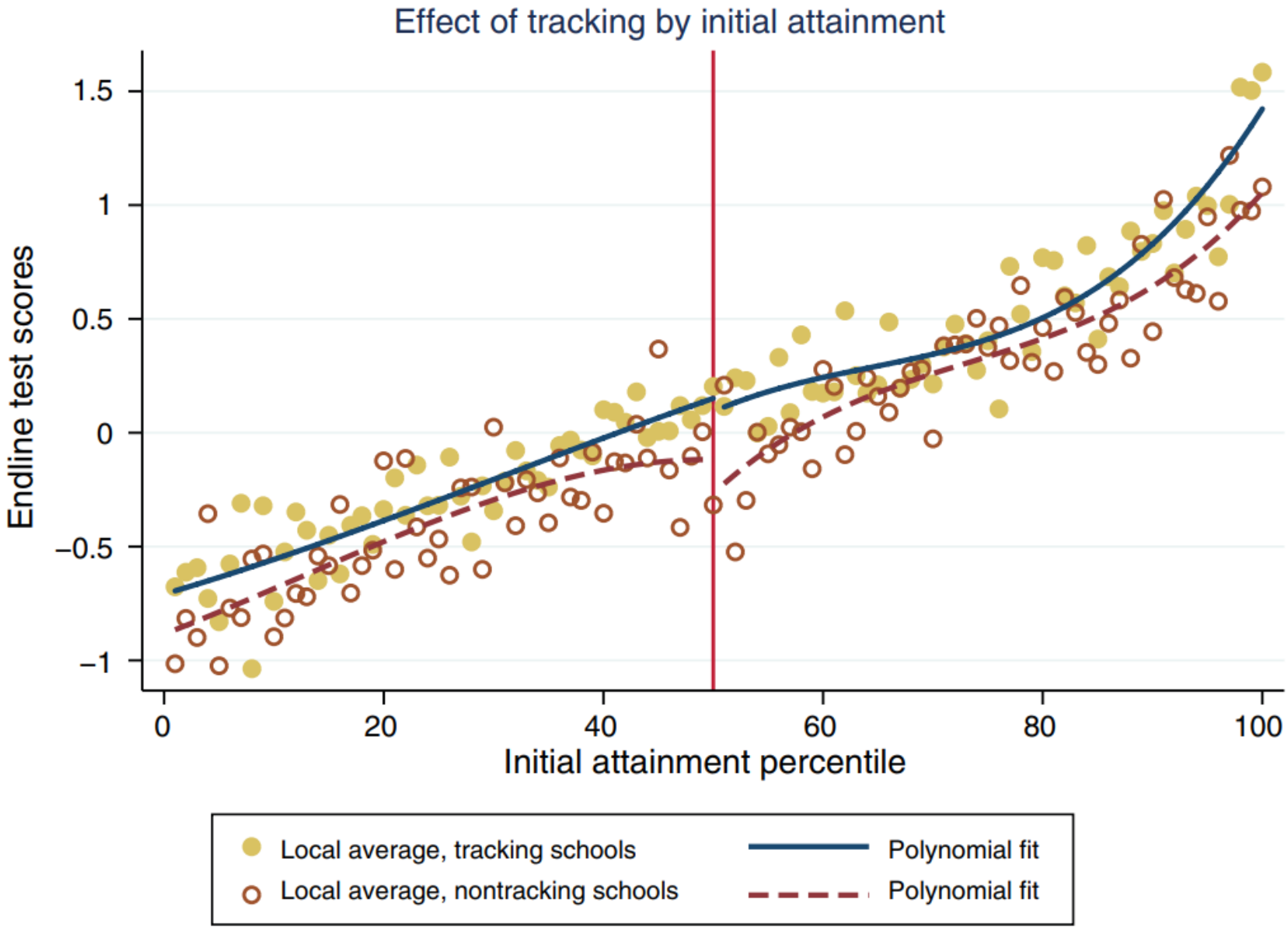

FIGURE 3. LOCAL POLYNOMIAL FITS OF ENDLINE SCORE BY INITIAL ATTAINMENT

Conclusion

Policy implications

- Tracking can be beneficial for all pupils if
  - Teachers target their instruction to the top of the distribution.
  - The variation in initial achievement is high.
  - Direct peer effects are present.
  - The school initially just had one class per grade.
- The combination of an extra teacher and tracking in early years
  - Can have persistent effects for top- and mid-achieving pupils.
  - Low-achieving pupils need continous treatment.
- More studies are important to consolidate the robustness of the results.

Econometric takeaways

- In a UK study they could not emit selection bias just by controlling for prior test scores (Manning and Pischke, 2006).
  - $\rightarrow$ Need detailed matching or experimental data with a low level of non-compliers.
- 60 different discountinuities provides robustness to the result
  - The median pupil will have different achievement levels.
  - The distribution of peers will be different at different schools.

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