

# **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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## Motivation

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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

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## 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 → good track record can lead to a civil-service job.
- Kenya recently abolished school fees → huge heterogeneity in pupils.
  - Many 1<sup>st</sup> 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 1<sup>st</sup> 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 attrition

- Many teachers did not comply to assignment
  - 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 1<sup>st</sup> grade. 0.5% dropped out.
  - Attrition rates: 18% for endline test, 22% one year after ended treatment.

## Very different prior achievement of class mates

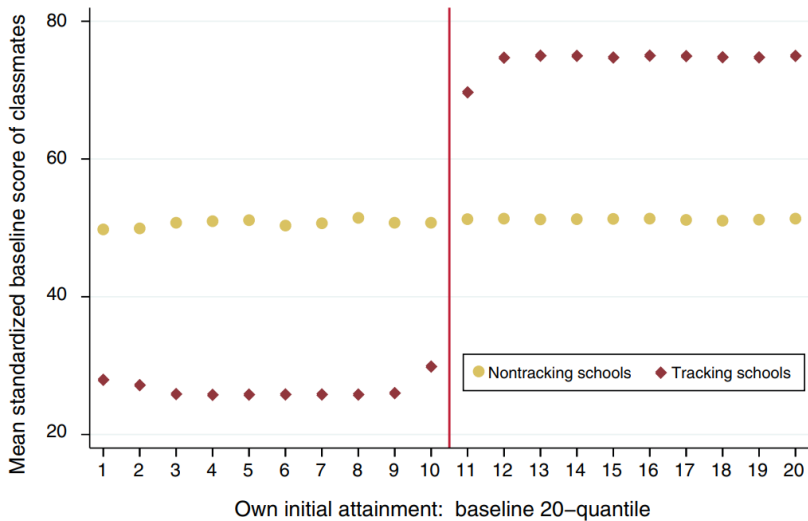


FIGURE 2. EXPERIMENTAL VARIATION IN PEER COMPETITION



## Theoretical model

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## Model of educational outcome

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

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

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  $\lambda$  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<sup>th</sup> grade; many low- and medium-achievers drop out  $\Rightarrow$  Kenyan teachers target top-achievers in a class

- High-achieving pupils gain from tracking

- ↑ Direct student-to-student spillovers.

- ↑ Indirect effect: Teacher increases effort ~~and level~~.

- Low-achieving pupils receive a net gain

- ↓ Less direct student-to-student spillovers.

- ↑ Indirect effect: Teacher chooses instruction level closer to pupil's ability.

- Mid-achieving pupils *above* the median receive a net gain

- ↑ Direct student-to-student spillovers.

- ↑↓ 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

- ↓ Less direct student-to-student spillovers.

- ↑↓ 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.*

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

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

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

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

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

i.e. the estimated effect of tracking is

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

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

## Results

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- 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)
<i>Panel A. Short-run effects (after 18 months in program)</i>								
(1) Tracking school	0.139 (0.078)*	0.176 (0.077)**	0.192 (0.093)**	0.182 (0.093)*	0.139 (0.073)*	0.156 (0.083)*	0.198 (0.108)*	0.166 (0.098)*
(2) In bottom half of initial distribution $\times$ tracking school			-0.036 (0.07)		0.04 (0.07)		-0.091 (0.08)	
(3) In bottom quarter $\times$ tracking school				-0.045 (0.08)		0.012 (0.09)		-0.083 (0.08)
(4) In second-to-bottom quarter $\times$ tracking school				-0.013 (0.07)		0.026 (0.08)		-0.042 (0.07)
(5) In top quarter $\times$ tracking school				0.027 (0.08)		-0.026 (0.07)		0.065 (0.08)
(6) Assigned to contract teacher		0.181 (0.038)***	0.18 (0.038)***	0.18 (0.038)***	0.16 (0.038)***	0.161 (0.037)***	0.16 (0.038)***	0.16 (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
<i>Total effects on bottom half and bottom quarter</i>								
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

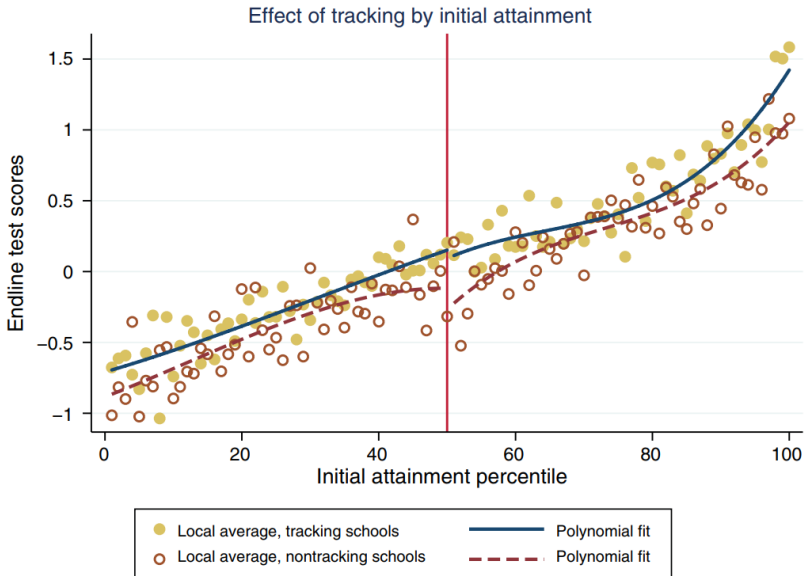


FIGURE 3. LOCAL POLYNOMIAL FITS OF ENDLINE SCORE BY INITIAL ATTAINMENT

## Conclusion

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- 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 continuous treatment.
- More studies are important to consolidate the robustness of the results.








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

## References

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