Application of Regression Discontinuity Design

The impact of tracking in Kenyan primary schools

Thor Donsby Noe

November 19, 2018

Analysis & Evaluation of Public Policies

Outline

Motivation

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).
    Which Epple, Newlon and Romano find to dominate in the US.
  - ↑ Indirect effect: Teacher chooses an instruction level closer to pupil's ability (Figlio and Page, 2002; Zimmer, 2003; Lefgren, 2004).
    Figlio and Lefgren find the two effects to cancel out, Zimmer finds the indirect effect to dominate.
- 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

Background

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 1st generation learners.
    - Few have attended preschools (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.
  As they're more similar

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.

140 schools, but 19 are excluded from analysis due to having more than 1 first-grade class → Sampling bias: Only smaller schools (one 1st grade).

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
  → 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).
    Regardless, the analysis is based on the initial assignment.
  - 21-23% of students repeated 1st grade. 0.5% dropped out.
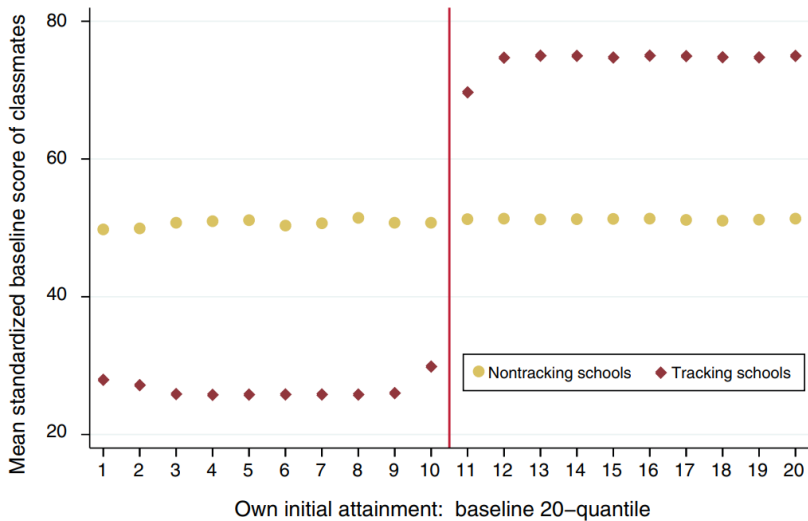 - Attrition rates: 18% for endline test, 22% one year after ended treatment.

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.
  Teachers would target the middle of a class, i.e. the just below median pupil would receive worse teaching from tracking.

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 8th 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:

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

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} :

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

i.e. the estimated effect of tracking is

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

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

Results

- All quartiles benefit from tracking in endline test scores.
    - No quartile benefit significantly more than others.
- Persistent effects one year after program ended.
  The classes were united after end-of-funding in all but 5 schools.
    - 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 (0.07)		0.04 (0.07)		−0.091 (0.08)	
(3) In bottom quarter × tracking school				−0.045 (0.08)		0.012 (0.09)		−0.083 (0.08)
(4) In second-to-bottom quarter × tracking school				−0.013 (0.07)		0.026 (0.08)		−0.042 (0.07)
(5) In top quarter × 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
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
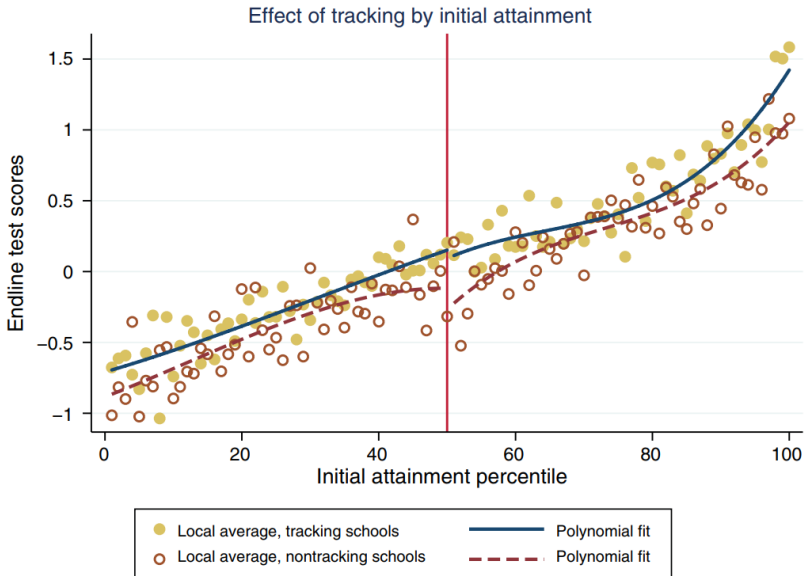
FIGURE 3. LOCAL POLYNOMIAL FITS OF ENDLINE SCORE BY INITIAL ATTAINMENT

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.

References

References

Duflo, Esther, Pascaline Dupas, and Michael Kremer (2011). "Peer effects, teacher incentives, and the impact of tracking: Evidence from a randomized evaluation in Kenya". In: American Economic Review 101.5, pp. 1739–74.

Epple, Dennis, Elizabeth Newlon, and Richard Romano (2002). "Ability tracking, school competition, and the distribution of educational benefits". In: Journal of Public Economics 83.1, pp. 1–48.

Figlio, David N and Marianne E Page (2002). "School choice and the distributional effects of ability tracking: does separation increase inequality?" In: Journal of Urban Economics 51.3, pp. 497–514.

Glewwe, Paul, Michael Kremer, and Sylvie Moulin (2009). "Many children left behind? Textbooks and test scores in Kenya". In: American Economic Journal: Applied Economics 1.1, pp. 112–35.

Lefgren, Lars (2004). "Educational peer effects and the Chicago public schools". In: Journal of urban Economics 56.2, pp. 169–191.

Manning, Alan and Jörn-Steffen Pischke (2006). "Comprehensive versus selective schooling in England in Wales: What do we know?" In:

Zimmer, Ron (2003). "A new twist in the educational tracking debate". In: Economics of Education Review 22.3, pp. 307–315.