SCHOOL QUALITY

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Acknowledgments: Pascaline Dupas, Rob Garlick, Owen Ozier, Cristian Pop-Eleches, Miguel Urquiola
AGENDA

• State of schooling
• Theory -Education Production Functions (EPF)
• Empirical example – Lucas and Mbiti 2014
• More Theory on EPF
• Empirical example – Pop-Eleches and Urquiola (2013)
• What is School Quality
• Can you improve Quality through inputs?
  • Resources– Mbiti et al 2019
  • Class Size– Angrist 1999
• Can you improve Quality through information? Cilliers, Mbiti, and Zeitlin (2021)
LEARNING OBJECTIVES

• Understand patterns /trends in learning in developing countries
• Develop an understanding of the theoretical frameworks used and their predictions /implications
• Develop an understanding of the empirical approaches used by education researchers and some of the main challenges faced
ACCESS TO EDUCATION HAS BEEN INCREASING OVER TIME

Sources: Evans and Acosta, 2021

WB Data on Primary and Lower Secondary Completion Rates

Sources: Evans and Acosta, 2021
LEARNING LEVELS IN POORER COUNTRIES ARE LOW

WB data on Harmonized Test scores vs GDP/ Capita

Sources: Evans and Acosta, 2021
LEARNING LEVELS IN POORER COUNTRIES ARE LOW

Sources: Evans and Acosta, 2021

WB data on Learning Adjusted Yrs of Schooling vs GDP/ Capita

Sources: Evans and Acosta, 2021
ACCESS VS LEARNING LEVELS ACROSS THE WORLD

Angrist et al 2020
LEARNING LEVELS IN (SOME) AFRICAN COUNTRIES HAVE FALLEN OVER TIME

Harmonized Test Scores in 2000 vs 2010s for selected African Countries

Sources: Evans and Acosta, 2021
**Figure O.5** The percentage of primary school students who pass a minimum proficiency threshold is often low

Median percentage of students in late primary school who score above a minimum proficiency level on a learning assessment, by income group and region.

- **Low-income countries**
- **Lower-middle-income countries**
- **Upper-middle-income countries**
- **High-income countries**
- **Sub-Saharan Africa**
- **Middle East and North Africa**
- **Latin America and the Caribbean**
- **East Asia and Pacific**
- **Europe and Central Asia**

Figure 9.2 Simple associations between education spending and learning are weak

(a) Spending and learning outcomes

PISA 2015 mathematics score, conditional on GNI per capita (log, PPP) vs. Annual government spending on primary and secondary public education, per student (PPP), conditional on GNI per capita (log, PPP)

$y = 2.37 + 0.001x$
$t = 0.44$
$R^2 = 0.004$

(b) Changes in spending and learning

Average annual % change in PISA mathematics score, 2009-15 vs. Average annual % change in spending per secondary student, 2009-15

$y = -0.02 + 0.05x$
$t = 1.35$
$R^2 = 0.05$

Figure S6.1 Governments devote a large share of their budgets to education

a. Government education spending as percentage of GNP (1999 and 2012)

b. Government education spending as percentage of total government spending (1999 and 2012)

Figure O.1 Shortfalls in learning start early

Percentage of grade 2 students who could not perform simple reading or math tasks, selected countries

a. Grade 2 students who could not read a single word of a short text

b. Grade 2 students who could not perform two-digit subtraction
Figure 1.5: What matters for growth is learning

Annual average per capita growth in GDP, 1970-2015, conditional on test scores, years of schooling completed, and initial GDP per capita.

(a) Test scores and growth (conditional on initial GDP per capita and years of schooling)

- Test scores vs. Annual per capita GDP growth:
  - Regression equation: $y = 0.00 + 1.59x$
  - $t = 7.39$
  - $R^2 = 0.55$

(b) Years of schooling and growth (conditional on the initial GDP per capita and test scores)

- Years of schooling vs. Annual per capita GDP growth:
  - Regression equation: $y = 0.00 + 0.07x$
  - $t = 0.82$
  - $R^2 = 0.02$

Source: WDR 2018 team, using data on test scores from Hanushek and Woessmann (2012) and data on years of schooling and GDP from the World Bank’s World Development Indicators (database), 2017. Data at http://bit.do/WDR2018-Fig_1-5.
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• **Theory - Education Production Functions (EPF)**
  • Empirical example – Lucas and Mbiti 2014
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WHAT IS SCHOOL QUALITY?

- Structure – the Education Production Function (following Todd and Wolpin 2003)
  \[ A = F(S, F, \mu) \] (suppressing time subscripts)
  \[ A = \text{achievement (test-score)}, S = \text{school inputs}, F = \text{Family inputs}, \mu = \text{unobserved “ability”}, F \text{ is the “Technology”} \]
  MP of all inputs in production fn is +ve
  - Examples of school inputs – resources, class size, # teachers, teacher skills, textbooks, peer quality, school management
  - Examples of family inputs– books at home, parental encouragement/ help,
  - Education policy typical focuses on school inputs
• $A = F(S, F, \mu)$
• Measuring the variables in the production function is not trivial
• A : typically measured by test scores. BUT
  • Which subjects (or domains of learning)? What about “non-cognitive skills” (e.g. grit, creativity etc.)?
  • Scaling and psychometrics (Classical test theory and Item Response Theory)
  • Measurement error
• Student test-taking effort matters e.g. Mbiti et al 2019
• Do schools/teachers/ students have an incentive to game/manipulate the test?
\[ A = F(S, F, \mu) \]

• Measuring the variables in the production function is not trivial
• S and F are also hard to measure— we use surveys, admin data.
  • Hawthorne effects and logistics/practical constraints can be important impediments
    • Example collecting teaching observations or teacher content knowledge
    • Technology e.g. video recording of teachers in the classroom can be useful (more innocuous).
• Ability is unobserved— try to proxy with measures such as Raven’s matrices, or differenced out when we have panel data
Input data from World Bank SDI Data (2011-2016) from selected African Countries

- Textbooks per student:
  - 2-3 students per textbook in Togo, Kenya, Nigeria. Almost 14 per textbook in Uganda

- School has “Min school infrastructure” (electricity, water, sanitation)
  - 23% in Togo, 17% in Nigeria, 40% in Tanzania, ~56% in Uganda and Kenya

- School has “Min Teaching Equip” (blackboard with chalk, pencils and notebooks)
  - 28% in Togo, 49% in Nigeria, 61% in Tanzania, ~95% in Uganda and Kenya

- Grade 4 Pupil teacher ratio (PTR)
  - ~19 in Madagascar and Nigeria, ~30 in Senegal and Kenya, ~45 in Uganda and Tanzania

- Teacher absence
  - From school: ~15% in Kenya, Nigeria and TZ; 18% in Togo and Senegal; 24% in Uganda
  - From the class: 22% in Nigeria, ~30 to 33 in Togo and Senegal, ~45% in Kenya, TZ; over 50% in Uganda & Morocco
**Teachers’ Content Knowledge: Minimum Thresholds**

<table>
<thead>
<tr>
<th>Subject knowledge: Language</th>
<th>All</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers with ...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80% of knowledge equivalent to a 4th grader</td>
<td>66%</td>
<td>26% (Nigeria)</td>
<td>94% (Kenya)</td>
</tr>
<tr>
<td>Minimum knowledge for teaching</td>
<td>7%</td>
<td>0% (Mozambique, Nigeria, Tanzania survey I, Togo)</td>
<td>34% (Kenya)</td>
</tr>
<tr>
<td>Number of teachers</td>
<td></td>
<td>3,770</td>
<td></td>
</tr>
</tbody>
</table>

**Subject knowledge: Mathematics**

<table>
<thead>
<tr>
<th>Teachers with ...</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum knowledge for teaching</td>
<td>68%</td>
<td>49% (Togo)</td>
<td>93% (Kenya)</td>
</tr>
<tr>
<td>Number of teachers</td>
<td></td>
<td>3,957</td>
<td></td>
</tr>
</tbody>
</table>

Source: Bold et al 2019
With the basic Education PF we might be tempted to think that we can focus on policies that increase input levels in order to improve learning outcomes.

- Challenges
  - Which input is the binding constraint?
  - What if more than one input is binding?
  - Some constraints might be very difficult to alleviate e.g. Teacher content knowledge
- Suggest that understanding the structure of Education PF is important
  - But difficult to get good empirical estimates from observational data
    - Unobserved ability ($\mu$) likely correlated with school inputs (sorting)
DOES GOING TO A “BETTER” SCHOOL MATTER?

- Lets examine the impact of going to a “Better” school in terms of inputs – peer test scores (or avg test scores), teachers, resources.
- Lucas and Mbiti 2014 “Effects of School Quality on Student Achievement: Discontinuity Evidence from Kenya” AEJ Applied
- Context Kenya secondary schools in the mid 2000’s
- Set-up: to transition from primary to secondary school students have to take an exit exam. (KCPE)
- There are different tiers of school--- “Elite schools”, good schools, ok schools
- Students assigned to secondary schools, based on choices and “serial dictator” algorithm – top student gets their first choice, then second ranked students gets their first choice (if not full), if full the get second choice… etc
THE THREE TIERS OF SCHOOLS

- **National (ELITE) schools:**
  - 18 of these - all single sex boarding schools
  - Admit the top students from all over the country based on ranking and choices

- **Provincial Schools:**
  - Approximately 1000
  - Admit best remaining students from Province based on ranking and choices

- **District Schools:**
  - Approximately 3000
  - Admit remainder from District only

- **Private Schools:**
  - Mainly a “safety net” for richer low performing students
DISTRICT SCHOOL

The Senator Obama Kogelo Secondary School
PROVINCIAL SCHOOL

Compared with District schools: better facilities, more buildings with electricity and 2/3 of teachers were college graduates (NCKEF, 2004)
Description of National School:

“… Boasts a large, bright dining hall and assembly building, faculty housing, a computer center and a several storied library with large plate glass windows” (NCKEF, 2004)
NATIONAL SCHOOL FACILITIES
### NATIONAL SCHOOL CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>National</th>
<th>Provincial</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Teachers with college degree</td>
<td>73.5</td>
<td>67.3</td>
<td>69.6</td>
</tr>
<tr>
<td>% Teachers with advanced degree</td>
<td>7.0</td>
<td>4.1</td>
<td>3.3</td>
</tr>
<tr>
<td>Teacher experience (yrs)</td>
<td>14.8</td>
<td>13.6</td>
<td>12.1</td>
</tr>
<tr>
<td>No. of KCSE subjects offered</td>
<td>16.4</td>
<td>12.2</td>
<td>10.8</td>
</tr>
</tbody>
</table>
We can examine the differences in test score outcomes of students who just qualify for the best schools to students who just missed a place.

Identification assumption -- Students who just missed a place often miss by one or two points on the exam thus they are very similar to students who just scored above the qualification mark.

This approach is known as a Regression-Discontinuity Design (RDD).
ESTIMATING EQUATIONS

IV Approach

Second Stage:
\[ KCSE_i = \alpha + \beta \text{gradN}_i + f(KCPE_i - c_{sj}) + X_{isj}'\Gamma + \epsilon_i \]

First Stage:
\[ \text{gradN}_i = \gamma_0 + \gamma_1 I[KCPE_i \geq c_{sj}] + f(KCPE_i - c_{sj}) + X_{isj}'\Gamma + \eta_i \]

Reduced Form:
\[ \text{gradN}_i = \lambda_0 + \lambda_1 I[KCPE_i \geq c_{sj}] + f(KCPE_i - c_{sj}) + X_{isj}'\Gamma + \nu_i \]

\( c_{sj} \) is cutoff (by school x district), \( \text{gradN} = \) graduate from Nat School
\( X \) are controls : sex, district, public primary school, school choice dummies and school choice x district dummies
FIRST STAGE: NATIONAL SCHOOLS

Figure 2: Probability of National School Graduation
CHANGE IN PEER QUALITY AROUND THE NATIONAL SCHOOL CUTOFF
SELECTION INTO TEST TAKING?
EFFECT OF ATTENDING NATIONAL SCHOOL
### Table 3: Achievement

<table>
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<tr>
<th>Dependent Variable:</th>
<th>Standardized KCSE Score</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>Reduced Form</td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Graduate From National School</td>
<td>0.294***</td>
<td>0.046*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0261)</td>
<td>(0.0270)</td>
<td></td>
</tr>
<tr>
<td>Admitted to a National School</td>
<td></td>
<td></td>
<td>0.008</td>
</tr>
<tr>
<td>Window</td>
<td>all</td>
<td>+/- 34</td>
<td>+/- 34</td>
</tr>
<tr>
<td>Observations</td>
<td>211,937</td>
<td>12,467</td>
<td>12,467</td>
</tr>
<tr>
<td>R squared</td>
<td>0.64</td>
<td>0.36</td>
<td>0.36</td>
</tr>
</tbody>
</table>
WHY NO TEST SCORE GAINS?

• Inputs don’t matter in this context?
• Elite schools are considered “good” because of sorting
  • Their reputations are based on who they attract rather than how well they teach.
• Measurement issue— wrong outcome? Perhaps we should look at earnings?
• Maybe we need to look closer at what our estimate is uncovering.
• At first glance we might think that our RDD estimate is telling us what is the effect of improving school inputs
  • To simplify the discussion just think of one input e.g. peer quality.
• But there may be other behavioral responses at play.
State of schooling

Theory - Education Production Functions (EPF)

Empirical example – Lucas and Mbiti 2014

**More Theory on EPF**

Empirical example – Pop-Eleches and Urquiola (2013)

What is School Quality

Can you improve Quality through inputs?
  * Resources – Mbiti et al 2019
  * Class Size – Angrist 1999

Can you improve Quality through information? Cilliers, Mbiti, and Zeitlin (2021)
PRODUCTION FUNCTIONS AND BEHAVIORAL EFFECTS

• Todd and Wolpin (2003) and Pop-Eleches and Urquiola (2013)

• Three periods: t-0 (before child starts school), t=1 and t=2 are the (start of) first and second years of school

\[ A_1 = g_0(F_0, \mu) \]

\[ A_2 = g_1(S_1, F_1, F_0, \mu) \]

At is child’s achievement at the start of period t,
St is school inputs in period t
Ft are family/household investments in period t
\( \mu \) is child’s (unobserved) “ability”, W is family wealth
• Parents “expect” child to review this level of inputs (or that is what they would like the child to receive)
  \[ S_1 = \theta(A_1, W, \mu) \]

• However, schools ultimately decide what inputs a child gets (i.e. parents can't fully control what goes on in classroom/school). The actual level of inputs actually received by child is:
  \[ S_1 = \Psi(A_1, \mu) \]

• The difference between the two is \((S_1 - \overline{S_1})\)

• Households observe this and then decide how much to invest \((F)\)
  \[ F_1 = \phi(A_1, W, \mu, S_1 - \overline{S_1}) \]
PRODUCTION FUNCTIONS AND BEHAVIORAL EFFECTS

- Insights from Todd and Wolpin (2003)
- What is the effect of an exogenously change one input in period 1 ($S_1$) holding all others constant.

$$\frac{\partial A_2}{\partial (S_1 - S_1)} = \frac{\partial A_2}{\partial S_1} = \frac{\partial g_1}{\partial S_1}$$

- This effect is driven solely the production function $\Rightarrow$ if you know the production function you can answer this

**However, experiments/quasi-experiments do not (typically) estimate this parameter**

- If you exogenously change inputs, parents are likely to respond
  - Teachers, students, etc can also respond.
PRODUCTION FUNCTIONS AND BEHAVIORAL EFFECTS

- Insights from Todd and Wolpin (2003)
- Experiments answer what is the TOTAL EFFECT of an exogenous change in one input in period 1 ($S_1$), not holding all others constant.
- The total effect includes direct effects (from prod fn) holding all other inputs constant and the indirect effects that operate through changes in other inputs.

\[
\frac{dA_2}{d(S_1 - \bar{S}_1)} = \frac{dA_2}{dS_1} = \frac{\partial g_1}{\partial S_1} + \frac{\partial g_1}{\partial F_1} \frac{\partial F_1}{\partial (S_1 - \bar{S}_1)}
\]

- The last term is the behavioral effect from households/parents
- Can extend this idea to account for multiple inputs
Insights from Todd and Wolpin (2003)

\[
\frac{dA_2}{d(S_1 - S_1)} = \frac{dA_2}{dS_1} = \frac{\partial g_1}{\partial S_1} \cdot \frac{\partial F_1}{\partial (S_1 - S_1)}
\]

If experiments do not uncover production function parameters, are they still useful?

YES! The experiment is recovering a “policy effect” – the Treatment on the Treated (TOT), i.e. what is the avg (total) effect of changing an input on children participating in the experiment. Quasi-experiments (IVs) estimate a local average treatment effect (LATE) (it is local because it applies to compliers)

This structure also makes clear the assumptions needed to justify external validity of results across multiple settings

• Production function is similar across settings
• The behavioral effect is similar on average
Let’s revisit our discussion on “going to a better school”.

In Kenya, Lucas and Mbiti (2014) do not find any test score benefits of attending a “Better school”.

Let’s examine a similar study by Pop-Eleches and Urquiola (2014) in Romania.

- RDD design with test-scores and test score based cutoffs for gaining admission to “Better schools”
Students who score above cutoff are more likely to attend a better school.
GOING TO A “BETTER SCHOOL” PART II

- Students who score above cutoff attend schools with better peers
• No selection into test-taking at end of school
GOING TO A “BETTER SCHOOL” PART II

Panel E: Baccalaureate grade--no controls

- Statistically significant increase in Baccalaureate (high stakes exam) grade (0.02-0.1 SD)
GOING TO A “BETTER SCHOOL” PART II

- Pop- Eleches and Urquiola (2013) conduct a survey to capture behavioral effects
- Parents of children just above cutoff cut back on helping children with hwk
  - “your teachers are good. you don’t need mama/papa”
- Students who score just above cutoff perceived themselves to be weaker than their peers. They also report more negative social interactions with peers.
- The estimates of the reductions in parental help and negative social interactions experienced by students diminish over time.
- Back to the Kenya example— perhaps another possibility is the behavioral effects in that context completely offset any positive test-score effects from going to an a “Elite school”
In our “Theory” we have not put any structure on production functions.

In practice we tend to linearize things. For example

\[ A_{it} = \alpha + F'_{it} \beta + \delta A_{it-1} + \varepsilon_{it} \]

A is measured achievement (test-score), F is measures family inputs, t is time period.

Although lagged test scores control for a lot, estimation is still complicated by the possibility of omitted variables and even non-random sorting within schools (to classes or teachers).
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WHAT IS SCHOOL QUALITY?

- Average test score are not a great measure of quality—-they likely reflect sorting by SES (or perhaps μ) 
- Best approach is to focus on “Value Added”
- If you have two schools, we can determine the better-quality school by holding inputs in F() fixed across both and observing which school produces greater A.
- However, VA is hard to observe so policymakers, parents, etc.
- The data might not exist to support its computation
  - Need at least one “cohort” of students where you observe their current test scores and their previous test scores.
  - Ideally you want more cohorts to get more reliable estimates.
    - VA estimates using one cohort might get thrown off by “shock” (eg many kids got sick around exam time)
    - Averaging over several cohorts you will get a more reliable estimate
Recall $A_1, A_2$ are achievement in first and second period respectively.

$A_1$ is arguably a sufficient statistic for cumulative inputs, SES, and $\mu$.

- You can get a lot out of 2 test scores over time!

To estimate a school's value added:

- Compute each student's predicted test-score in period 2 ($\hat{A}_2$) using all the data you have including $A_1$.
- The school's value-added estimate is the average of the differences between the actual and predicted scores of the students.

The same idea can be applied used to calculate teacher VA (or classroom VA).

- Debate about potential for these to be biased. Depends on data availability, context, etc.

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EXPERIMENTAL EVIDENCE ON SCHOOL INPUTS

- Thus far we have focused on RDD evidence on going to a “better school”
- What about changing one input?
  - Resources – Mbiti et al 2019 shows that only increasing resources does not lead to better learning
  - Class size– Mixed evidence here.
  - Peers– Mixed
SCHOOL RESOURCES

• Mbiti et al 2019
• Large and representative 350 school RCT in Tanzania with four arms
  • Capitation grant schools (extra resources)
  • Teacher incentive schools
  • Combo schools (incentives + grants)
  • Control schools (business as usual)
• You will cover this more next week but today I will focus on the results from the capitation grant intervention
At the time CG policy was TZS 10,000 per pupil per year

Schools had autonomy on how they could spend money (with some guidelines)
  - Couldn’t pay teachers, couldn’t use funds for new construction

Funds from central govt transferred to schools via multiple steps. Resulted in “37% leakage rate” (World Bank 2012)

Disbursement schedule was not predictable

The treatment gave schools full amount of CG for two years.

Large increase in resources: 3x mean (pre-treatment) school expenditure (excluding teacher salaries)
## SCHOOL RESOURCES

How much are schools and households spending per pupil?

<table>
<thead>
<tr>
<th></th>
<th>(1) Grant exp.</th>
<th>(2) Other school exp.</th>
<th>(3) Total school [(1)+(2)]</th>
<th>(4) Household exp.</th>
<th>(5) Total exp. [(3)+(4)]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Year 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grants</td>
<td>8,070.68***</td>
<td>-2,407.92***</td>
<td>5,662.75***</td>
<td>-1,014.96</td>
<td>4,647.79***</td>
</tr>
<tr>
<td>(314.09)</td>
<td>(813.88)</td>
<td>(848.58)</td>
<td>(1,579.79)</td>
<td></td>
<td>(1,724.64)</td>
</tr>
<tr>
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<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
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<tr>
<td>Mean control</td>
<td>0.00</td>
<td>5,959.67</td>
<td>5,959.67</td>
<td>28,821.01</td>
<td>34,780.68</td>
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<tr>
<td><strong>Panel B: Year 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grants</td>
<td>6,033.08***</td>
<td>-2,317.74**</td>
<td>3,715.34***</td>
<td>-2,164.18*</td>
<td>1,585.75</td>
</tr>
<tr>
<td>(336.95)</td>
<td>(1,096.16)</td>
<td>(1,122.60)</td>
<td>(1,201.53)</td>
<td></td>
<td>(1,548.42)</td>
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<td>349</td>
<td>349</td>
<td>350</td>
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<tr>
<td>Mean control</td>
<td>0.00</td>
<td>4,524.03</td>
<td>4,524.03</td>
<td>27,362.34</td>
<td>31,886.37</td>
</tr>
<tr>
<td><strong>Panel C: Year 1 + Year 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Grants</td>
<td>7,059.29***</td>
<td>-2,367.94***</td>
<td>4,688.04***</td>
<td>-1,589.57</td>
<td>3,133.33**</td>
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<tr>
<td>(230.64)</td>
<td>(688.89)</td>
<td>(724.91)</td>
<td>(1,053.64)</td>
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<tr>
<td>Mean control</td>
<td>0.00</td>
<td>5,241.85</td>
<td>5,241.85</td>
<td>28,091.68</td>
<td>33,333.53</td>
</tr>
</tbody>
</table>
How much are schools and households spending per pupil?

<table>
<thead>
<tr>
<th></th>
<th>(1) Grant exp.</th>
<th>(2) Other school exp.</th>
<th>(3) Total school [(1)+(2)]</th>
<th>(4) Household exp.</th>
<th>(5) Total exp. [(3)+(4)]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Year 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grants</td>
<td>8,070.68***</td>
<td>-2,407.92***</td>
<td>5,662.75***</td>
<td>-1,014.96</td>
<td>4,647.79***</td>
</tr>
<tr>
<td>(314.09)</td>
<td>(813.88)</td>
<td>(848.58)</td>
<td>(1,579.79)</td>
<td>(1,724.64)</td>
<td></td>
</tr>
<tr>
<td>N. of obs.</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
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</tr>
<tr>
<td>Mean control</td>
<td>0.00</td>
<td>5,959.67</td>
<td>5,959.67</td>
<td>28,821.01</td>
<td>34,780.68</td>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Panel B: Year 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grants</td>
<td>6,033.08***</td>
<td>-2,317.74**</td>
<td>3,715.34***</td>
<td>-2,164.18*</td>
<td>1,585.75</td>
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<tr>
<td>(336.95)</td>
<td>(1,096.16)</td>
<td>(1,122.60)</td>
<td>(1,201.53)</td>
<td>(1,548.42)</td>
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<td>N. of obs.</td>
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<td>349</td>
<td>349</td>
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</tr>
<tr>
<td>Mean control</td>
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<td>4,524.03</td>
<td>4,524.03</td>
<td>27,362.34</td>
<td>31,886.37</td>
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<td></td>
</tr>
<tr>
<td><strong>Panel C: Year 1 + Year 2</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Grants</td>
<td>7,059.29***</td>
<td>-2,367.94***</td>
<td>4,688.04***</td>
<td>-1,589.57</td>
<td>3,133.33**</td>
</tr>
<tr>
<td>(230.64)</td>
<td>(688.89)</td>
<td>(724.91)</td>
<td>(1,053.64)</td>
<td>(1,241.09)</td>
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<tr>
<td>N. of obs.</td>
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<td>699</td>
<td>699</td>
<td>700</td>
<td>699</td>
</tr>
<tr>
<td>Mean control</td>
<td>0.00</td>
<td>5,241.85</td>
<td>5,241.85</td>
<td>28,091.68</td>
<td>33,333.53</td>
</tr>
</tbody>
</table>

Yr 1 is unanticipated so no HH response
Yr 2 is expected so HH cut back on spending
Despite this still a large increase in resources
### Do Grants Increase Test scores?

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Year 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td>-0.05</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>N. of obs.</td>
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<td>9,142</td>
<td>9,142</td>
<td>9,142</td>
</tr>
<tr>
<td><strong>Panel B: Year 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td>0.01</td>
<td>-0.00</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
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<tr>
<td>N. of obs.</td>
<td>9,439</td>
<td>9,439</td>
<td>9,439</td>
<td>9,439</td>
</tr>
</tbody>
</table>

Can rule out effects > 0.11SD in yr 2

Inputs = grants treatment
SCHOOL RESOURCES

• Why don’t resources improve learning?
• Muted by behavioral effects (but not completely offset)
• Muted by “precautionary savings”
  • This saving behavior also documented in Sabarwal et al. 2014) where schools stored textbooks rather let students use them
• They don’t fundamentally change the process of learning (no change in “productivity of school”)
• Mbiti et al 2019 argue that Tanzanian schools may face multiple binding constraints. Thus alleviating one binding constraint will not improve outcomes because the other constraint is still binding
• Better outcomes in schools that receive both grants and incentives
• Grants are effective when teachers are motivated and have resources to support them.
• The argue that resources and teacher incentives are complements in the production function
• These two ideas- multiple constraints and behavioral effects can help us understand why many input based policies fail to improve outcomes.
CLASS SIZE

- Policy makers, parent, and stakeholders advocate for smaller class sizes
  - better individual attention
- Classic paper on this is Angrist and Lavy (1999)
- Maimonides rule caps class size at max of 40
- Cohorts sized 1–40 are in a single class, but cohort sized 41–80 are split into two classes with average size 20.5–40, and so on…
Does Lower class Size improve learning?

Reducing class size by ten pupils increases test scores on average by 0.25 standard deviations – a large effect.

Can rule out effects > 0.11SD in yr 2
Urquiola and Verhoogen (2009) apply Angrist and Lavy's approach to study the impact of class sizes in Chile.

Exploit class-size cap of 45 students in schools that accept government vouchers.

As in the Israeli case, average achievement jumps at the discontinuity.

But parental characteristics `jump', too, suggesting that sorting may drive these results.

Manipulation around the RD cutoff are a major threat to identification

- Check for jumps in RD on characteristics, and also use McCary (2008) test.
- Potential to use “Donut” RD to fix this. See Barreca, Lindo, and Wadell (2011) for an example
CLASS SIZE -- SORTING

Panel B: Mothers’ schooling

4th grade enrollment

Mothers' schooling
Spending on teachers accounts for the majority of education budgets in developing countries. The average teacher in a sub-Saharan African country earns almost four times GDP per capita, compared to OECD teachers who earn 1.3 times GDP per capita (OECD, 2017; World Bank, 2017). Yet, absence is high and teacher content knowledge is low (World Bank, 2018).

Well designed teacher incentives can improve their motivation (next week's lecture). How can we improve teacher effectiveness?

Evidence that supporting teachers with mentoring/coaching can improve outcomes.

Evidence that detailed teacher guides can also have big impacts.

See Piper et al (2018) for evidence from PRIMR program in Kenya which combined coaching, and teacher guides and led to large increases in learning.
In 2013, Tanzania introduced a series of reforms aimed at improving education outcomes “Big Results Now in Education” (BRN).

A key initiative was publication of nationwide and within-district school rankings based on previous year test scores on primary school exit exam (NOT value added).

No monetary rewards or punishments

Limited school choice so there is limited scope for parents to react

But publication put pressure on officials throughout the education system.
  • Perhaps motivated by career incentives

Can this simple system do anything?

Cilliers, Mbiti and Zeitlin (2021) use a Diff-in-Diff approach to examine this.
INFORMATION ON SCHOOL QUALITY

**Impacts of the Reform on School Exam Performance**

<table>
<thead>
<tr>
<th></th>
<th>Marks (1)</th>
<th>Marks (2)</th>
<th>Pass Rate (3)</th>
<th>Pass Rate (4)</th>
<th>Number Passed (5)</th>
<th>Number Passed (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0–10th percentile in previous year</strong></td>
<td>4.406***</td>
<td>6.147***</td>
<td>0.058***</td>
<td>0.079***</td>
<td>1.828*</td>
<td>2.180***</td>
</tr>
<tr>
<td></td>
<td>(1.004)</td>
<td>(0.849)</td>
<td>(0.012)</td>
<td>(0.011)</td>
<td>(1.026)</td>
<td>(0.754)</td>
</tr>
<tr>
<td><strong>10–20th percentile in previous year</strong></td>
<td>2.049***</td>
<td>2.382***</td>
<td>0.024***</td>
<td>0.030***</td>
<td>0.930</td>
<td>0.852**</td>
</tr>
<tr>
<td></td>
<td>(0.563)</td>
<td>(0.578)</td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.845)</td>
<td>(0.379)</td>
</tr>
<tr>
<td>Diff-diff</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>School fixed effects</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Control lagged exam score</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Control mean, post BRN</td>
<td>109.46</td>
<td>109.46</td>
<td>0.58</td>
<td>0.58</td>
<td>30.82</td>
<td>30.82</td>
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<tr>
<td>Observations</td>
<td>77,731</td>
<td>77,431</td>
<td>77,731</td>
<td>77,431</td>
<td>77,731</td>
<td>77,431</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.655</td>
<td>0.801</td>
<td>0.607</td>
<td>0.763</td>
<td>0.425</td>
<td>0.912</td>
</tr>
</tbody>
</table>

Test scores in bottom ranked schools improved ~ a 0.25SD increase relative to pre reform
BUT….
Part of the improvements are because schools are gaming the system by excluding certain students. NOT just excluded from the Test, they are pushed out of school!
WRAPPING UP

- Education production function is a key framework
- Specify the relationship between inputs, the “technology” and learning outcomes.
- Test scores are not great measures of school quality
- Value Added approaches are better
- The framework also helps us understand what we parameters we estimate in research
- Highlights the importance of behavioral effects