Misallocation of State Capacity?
Evidence from Two Million Primary Schools

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Factor Misallocation in Education Systems

- Large amounts of government resources and development aid dedicated to education
- Yet learning achievement in many developing countries remains low
- Does inefficient allocation of resources within education systems hold back learning?
Does inefficient allocation of teachers across public primary schools hold back learning in developing countries?
Why Public Primary School Teachers?

1. Public primary education is universal

2. One key common input across countries: teachers

⇒ comparability across countries at all income levels
Roadmap

Does misallocation of teachers hold back learning?

PART 1: Facts

PART 2: Simulations

PART 3: Conclusion
Roadmap

*Does misallocation of teachers hold back learning?*

**PART 1: Facts**

**PART 2: Simulations**

**PART 3: Conclusion**
Global Data Collection

Dear [Name] or Sir,

I am writing to ask whether you would be able to help with a new comparative study on teacher allocation across schools in different contexts. The study will take place at The Survey and Toyota International Centres for Economics and Development (STICERD) at the London School of Economics (LSE).

Early findings suggest that access to teachers, measured by the pupil-teacher ratio, differs considerably across different areas of the same country and the phenomenon is more pronounced in lower-income countries. The aim of the study is to understand the sources of this difference and measure how much countries can improve educational outcomes by improving teacher allocation.

The success of the study and its usefulness depends entirely on having the largest geographical coverage. We therefore hope you can assist by sending the following information:

1. The number of students and teachers in each public primary school
2. The location of each public primary school (GPS coordinates or address)
3. The location of each private preschool (GPS coordinates or address)
4. The location of each private primary school (GPS coordinates or address)

Please feel free to ask any questions about the study.

Thank you in advance for your cooperation.

Yours sincerely,

[Your Name]
Put data together from ...

- 1.85 million public primary schools
- 314 million pupils (25% of children aged 5-14 worldwide)
- 13 million teachers
- Representing the public primary sector in 91 countries
  - Universe from 77 countries
  - Universe from subset of states in 6 countries
  - Representative school survey data from 8 countries

PASEC
Data Coverage

Data coverage as of 01/01/2020.

Legend
- Data
- No Data
Data Elements

- Pupil-teacher ratio
  - Ratio of pupil headcount to teacher headcount at each school
- School location
  - Administrative unit (83 countries)
  - GPS coordinates (52 countries)
High-Income Countries

UK (2015)  

US (2014)
Upper-Middle-Income Countries

Peru (2016)

South Africa (2015)
Lower-Middle-Income Countries

India (2015)

Philippines (2013)
Low-Income Countries

Mozambique (2016)

Cambodia (2014)
New Stylized Fact (1)

PTR variation negatively correlated with per capita income
New Stylized Fact (2)
Large PTR variation within subnational regions in LICs
New Stylized Fact (2)

Large PTR variation within subnational regions in LICs

Variation within and between 2nd tier administrative divisions
New Stylized Fact (3)

Larger PTRs in rural areas of LICs, and a lot of variation within these

In LICs, PTRs tend to be larger in rural areas, but population density cannot explain more than 3% of PTR variation.
New Stylized Fact (4)

PTRs negatively correlated with parental literacy in LICs

Data sources: National school censuses and DHS.
New Stylized Fact (5)

PTRs negatively correlated with school infrastructure in LICs

Classrooms

Toilets

PTR as a function pupil-classroom ratio

PTR as a function pupil-toilet ratio
Misallocation of Teachers in Developing Countries?

- Unequal distribution of teachers across schools increases inequality of opportunity in LICs
- This could be efficient if teachers and other inputs into education production are complements
- Could aggregate learning be increased if teachers were allocated differently across schools?
Roadmap

Does misallocation of teachers hold back learning?

PART 1: Facts

PART 2: Simulations

PART 3: Conclusion
Model

- Social planner allocates homogeneous teachers to schools
- Objective is to maximize total learning in the country, as measured by the sum of scores at national exams
- Budget constraint requires payment of all teachers given available resources

\[
\max_{T_s} \sum_s \frac{P_s}{\sum_j P_j} H_s(T_s) \quad \text{s.t.} \quad w \sum_s T_s \leq B
\]
Education Production Function

• Production function:

\[ H_s = A_s \left( \frac{P_s}{T_s} \right)^\beta \]

• where
  • \( H_s \): Average pupil test score (national primary school exam)
  • \( A_s \): School productivity (also captures demand side factors)
  • \( P_s \): Number of pupils
  • \( T_s \): Number of teachers
  • \( \beta \): Elasticity of learning achievement with respect to PTR
# Primary School Exam Data

<table>
<thead>
<tr>
<th>Country</th>
<th>Examination</th>
<th>Subject</th>
<th>Coverage</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>Grade 3 (ANA)</td>
<td>Math</td>
<td>45%</td>
<td>2016</td>
</tr>
<tr>
<td>Chile</td>
<td>Grade 6 (SIMCE)</td>
<td>Math</td>
<td>74%</td>
<td>2015</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>Grade 8 (Pruebas Nacionales)</td>
<td>All</td>
<td>61%</td>
<td>2016</td>
</tr>
<tr>
<td>India (MP)</td>
<td>Grade 5 (District Exams)</td>
<td>All</td>
<td>71%</td>
<td>2010</td>
</tr>
<tr>
<td>Mexico</td>
<td>Grade 6 (PLANEA BASICA)</td>
<td>Math</td>
<td>73%</td>
<td>2015</td>
</tr>
<tr>
<td>Sweden</td>
<td>Grade 6 (National Exams)</td>
<td>Math</td>
<td>61%</td>
<td>2015</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Grade 7 (PSLE)</td>
<td>All</td>
<td>94%</td>
<td>2016</td>
</tr>
<tr>
<td>UK (England)</td>
<td>Grade 6 (Key Stage 2)</td>
<td>Math</td>
<td>85%</td>
<td>2016</td>
</tr>
<tr>
<td>US (NY)</td>
<td>Grade 5 (NY State Test)</td>
<td>Math</td>
<td>80%</td>
<td>2015</td>
</tr>
<tr>
<td>Zambia</td>
<td>Grade 7 (PSLE)</td>
<td>All</td>
<td>55%</td>
<td>2014</td>
</tr>
</tbody>
</table>
Calibration

- Empirical evidence consistent with the common intuition that a lack of teachers affects pupil achievement negatively.
- Magnitude of this effect uncertain and likely context-specific, so examine sensitivity of results with respect to $\beta$.
- Invert education production function to back out $A_s$:

$$A_s = H_s / PTR_s^\beta$$
Counterfactuals

1) Optimal allocation

2) Rule-based PTR equalization
Distribution of Marginal Products

**US (NY)**

- Marginal product distribution for US (NY)

**Tanzania**

- Marginal product distribution for Tanzania

where the marginal product is $A_s P T R_s^{1+\beta} = H_s P T R_s$
Gains from Optimal Allocation

• By how much would the average pupil test score increase?
Gains from Optimal Allocation

- Holding relative PTRs between schools fixed, how many additional teachers would have to be hired to achieve equivalent gains?
PTR Distribution under Optimal Allocation

US (NY)

Tanzania
Counterfactuals

1) Optimal allocation

2) Rule-based PTR equalization
PTR Distribution under Rule-based Equalization

- Maximum PTR rule: *School-level PTR must not exceed* $x$

**US (NY)**

**Tanzania**
Effects of PTR Equalization

- Would there be gains from equalizing PTRs across schools through the implementation of the smallest feasible maximum PTR rule?

![Graph showing the effects of PTR equalization on average test score increase]
Roadmap

Does misallocation of teachers hold back learning?

PART 1: Facts

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PART 3: Conclusion
Conclusion

• Large variation in pupil-teacher ratios across public primary schools in lower income countries

• Simulations suggest that reallocating teachers could lead to substantial gains in aggregate learning in these countries

• Teacher reallocation likely to be significantly more cost-effective than hiring additional teachers

→ Teacher misallocation across public primary schools an important obstacle to learning
Implications

- Not only lack of resources, but also inefficient allocation of resources constrains education in developing countries
  → What are the causes of resource misallocation?
  → How could resources be distributed more efficiently?

- State not only a key player in education, but also in other important domains (e.g. health, law enforcement)
  → How important is misallocation of state capacity in those?
PASEC 2014

Programme d’Analyse des Systèmes Éducatifs de la Conférence des Ministres de l’Éducation des États et Gouvernements de la Francophonie:

- Nationally representative school survey in French-speaking African countries
- Sample frame: all schools with at least one class in grade 6
- Sampling: Probability proportional to total number of grade 6 pupils in school
- Number of teachers and pupils reported by head teacher
- Data source for 8 countries: Burundi, Cameroon, Chad, Congo (Rep.), Côte d’Ivoire, Niger, Senegal, Togo
Sample Selection

- Use latest available data from each country
- Restrict to school type that is main provider of primary education in each country:
  - Mostly primary schools, sometimes comprehensive schools
- Restrict to public schools (where possible)
  - Exceptions: CPV, FJI, SWZ, UKR, VCT
  - Private sector small in all of these countries
School Census Return Rates in Africa

Source: UNESCO Institute for Statistics and World Bank International Comparison Program Database. Latest available data for each country as of 13/07/2017. Sample size: 49 countries. The mean return rate across countries is 97.3%.
Appendix

Cross-Checks with Other Data Sources

- Availability of alternative data sources limited
- ASER and UWEZO record the number of registered pupils and teachers as well as headcounts of those present
- Problem: differences between registered and present capture both absenteeism and misreporting in registers
## Registered and Present Pupils and Teachers

<table>
<thead>
<tr>
<th>Survey</th>
<th>Sample Size</th>
<th>$\rho_P$</th>
<th>$\rho_T$</th>
<th>$P_{\text{pres}} &gt; P_{\text{reg}}$</th>
<th>$T_{\text{pres}} &gt; T_{\text{reg}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASER India 2014</td>
<td>13036</td>
<td>0.89</td>
<td>0.94</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>ASER Pakistan 2015</td>
<td>4613</td>
<td>0.99</td>
<td>0.98</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>UWEZO Kenya 2013</td>
<td>4123</td>
<td>0.96</td>
<td>0.91</td>
<td>16.3%</td>
<td>2.1%</td>
</tr>
<tr>
<td>UWEZO Tanzania 2013</td>
<td>3453</td>
<td>0.89</td>
<td>0.91</td>
<td>3.2%</td>
<td>0%</td>
</tr>
<tr>
<td>UWEZO Uganda 2013</td>
<td>2114</td>
<td>0.85</td>
<td>0.91</td>
<td>5.3%</td>
<td>0%</td>
</tr>
</tbody>
</table>

- Number of present and registered highly correlated
- Number of present pupils and teachers exceeds number of registered in some schools in East Africa
New Stylized Fact (2)
Large PTR variation within subnational regions in LICs

Variation within and between 1st tier administrative divisions
New Stylized Fact (4)
PTR differences tend to reinforce educational inequality in LICs

Data sources: National school censuses and Afrobarometer Round 6.
New Stylized Fact (4)
PTR differences tend to reinforce educational inequality in LICs

Learning as a Function of PTR

PTR → Class Size
PTR → Multigrade Teaching
PTR → Other Channels

Class Size → Test Score
Multigrade Teaching → Test Score
Other Channels → Test Score
Learning as a Function of PTR

- PTR
- Class Size
- Multigrade Teaching
- Other Channels
- Literature on Class-size Effects
- Test Score
Learning as a Function of PTR

Appendix

<table>
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<tr>
<th>PTR Test Score</th>
<th>Class Size</th>
<th>Multigrade Teaching</th>
<th>Other Channels</th>
<th>Literature on Class-size Effects</th>
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46
Learning as a Function of PTR

- PTR
- Class Size
- Multigrade Teaching
- Other Channels
- Literature on Class-size Effects
- Literature on Multigrade Teaching
- Test Score
Direct Evidence

- Only one paper: Muralidharan & Sundararaman (2013)
- RCT across public primary schools in Andhra Pradesh, India
- Extra contract teacher treatment induced average PTR reduction by 10.814 after two years
- One unit reduction in PTR led to an increase in standardized test scores by 0.0144 standard deviations in this time period
- No evidence of heterogeneous effects with respect to student and household characteristics
Optimality

• Maximization problem:

\[
\max_{T_s} \sum_s \frac{P_s}{\sum_j P_j} H_s \quad \text{s.t} \quad \sum_s wT_s \leq B \quad \text{and} \quad H_s = A_s P T R_s^\beta
\]

• FOC necessary and sufficient for optimality if \( \beta > -1 \):

\[
A_k \left( \frac{P_k}{T_k} \right)^{1+\beta} = A_m \left( \frac{P_m}{T_m} \right)^{1+\beta} \quad \forall k, m
\]