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?

This Paper

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

$\Rightarrow$ **comparability across countries at all income levels**

Roadmap

Does misallocation of teachers hold back learning?

PART 1: Facts

PART 2: Simulations

PART 3: Conclusion

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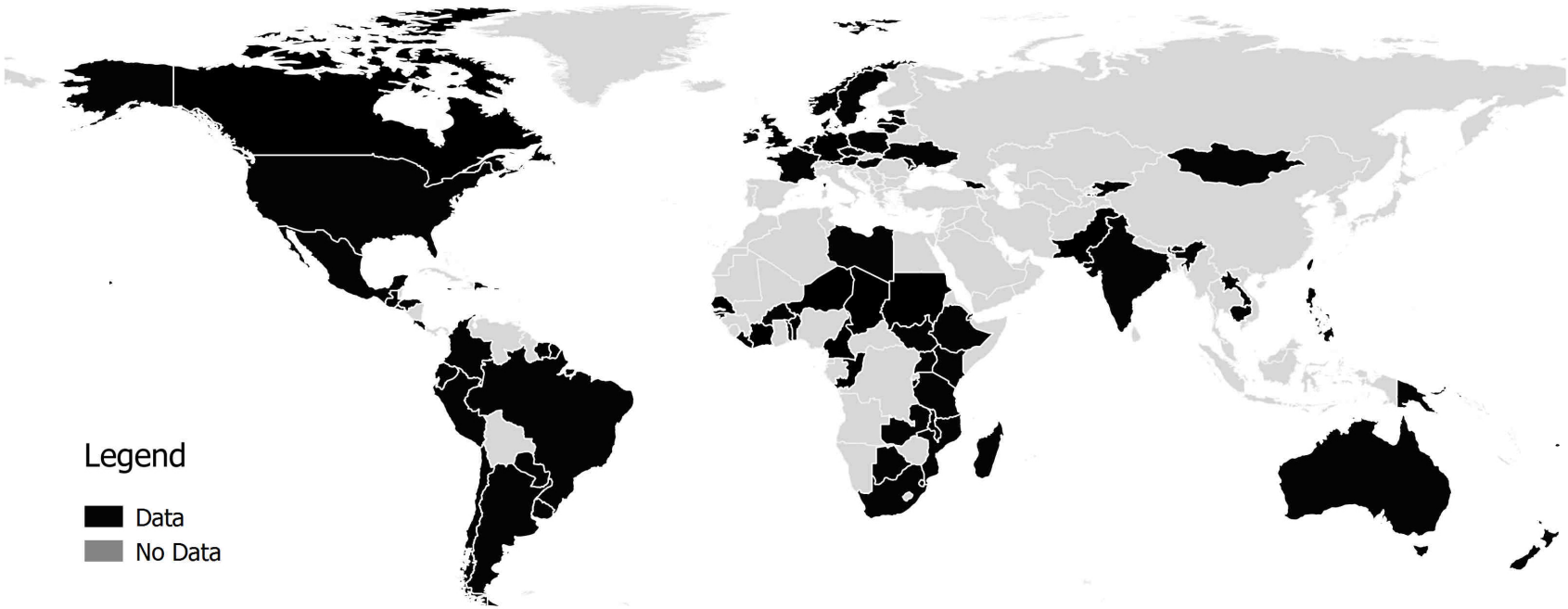
Global Data Collection

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.

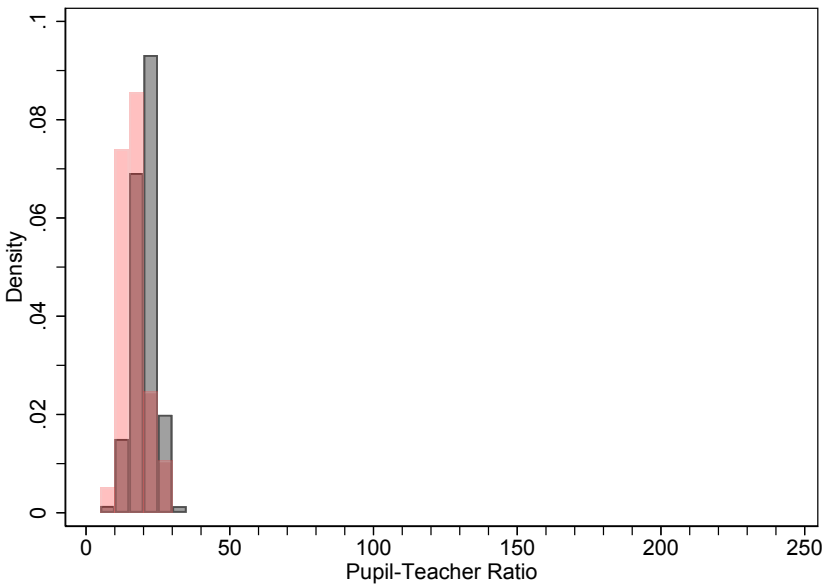
Data Elements

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

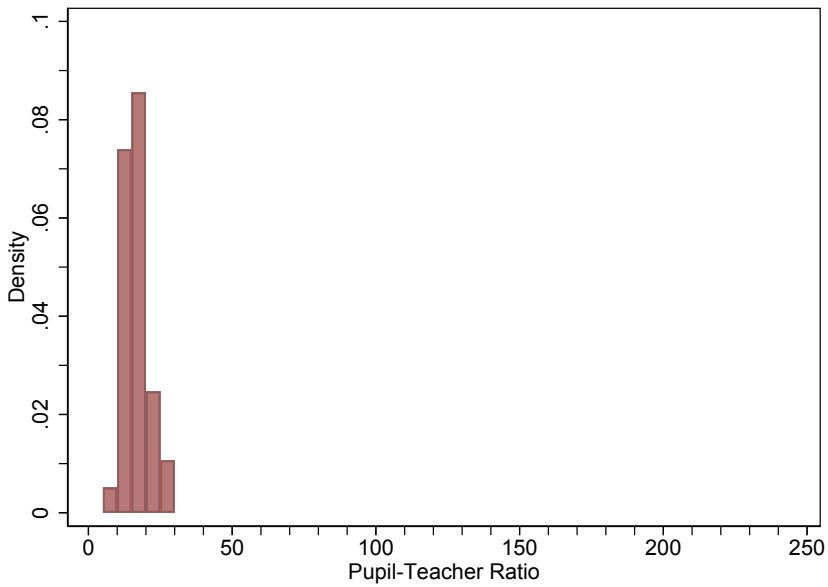
▸ Sample selection ▸ Data completeness ▸ Data quality

High-Income Countries

UK (2015)

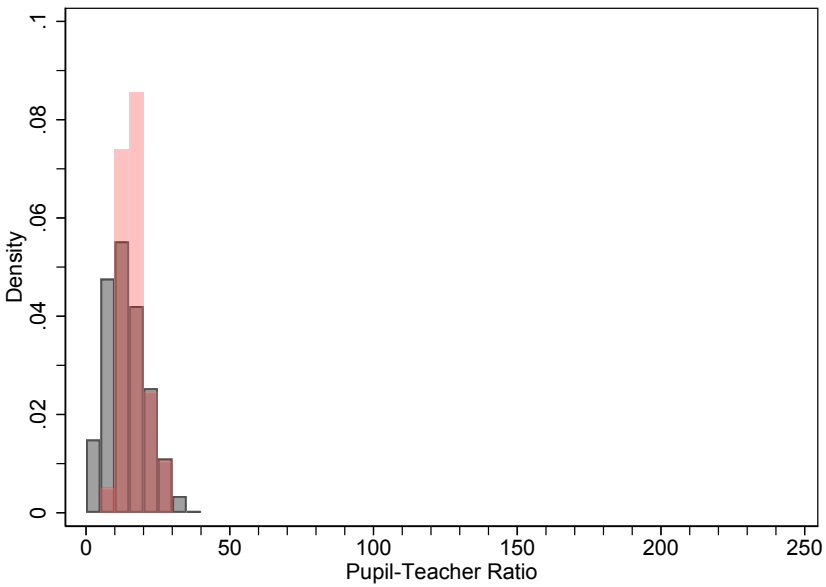


US (2014)

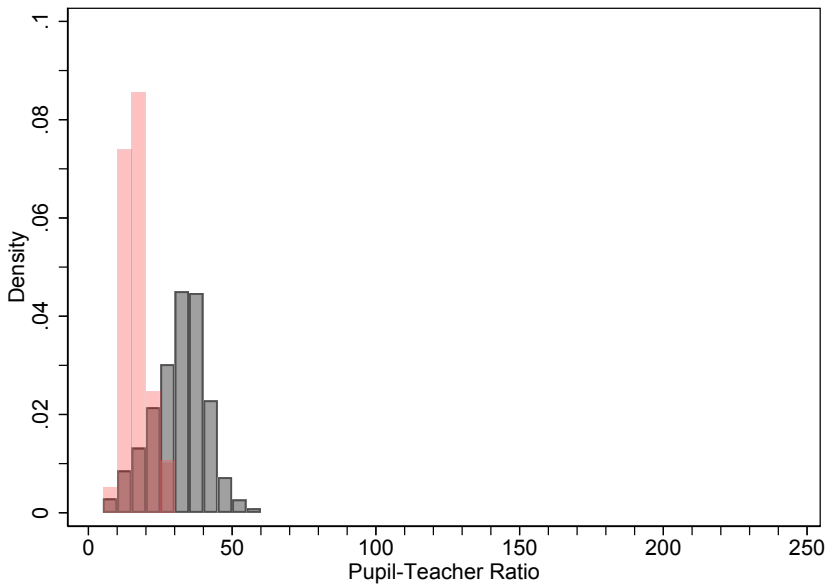


Upper-Middle-Income Countries

Peru (2016)

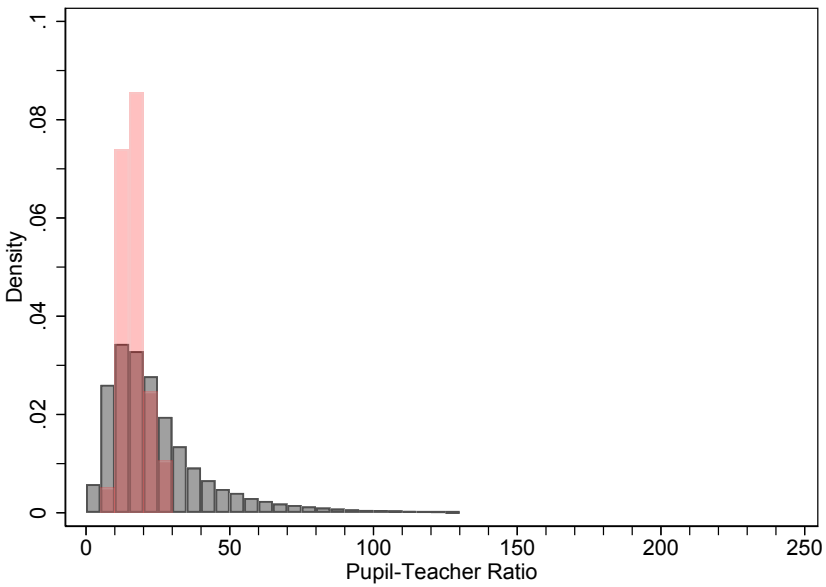


South Africa (2015)

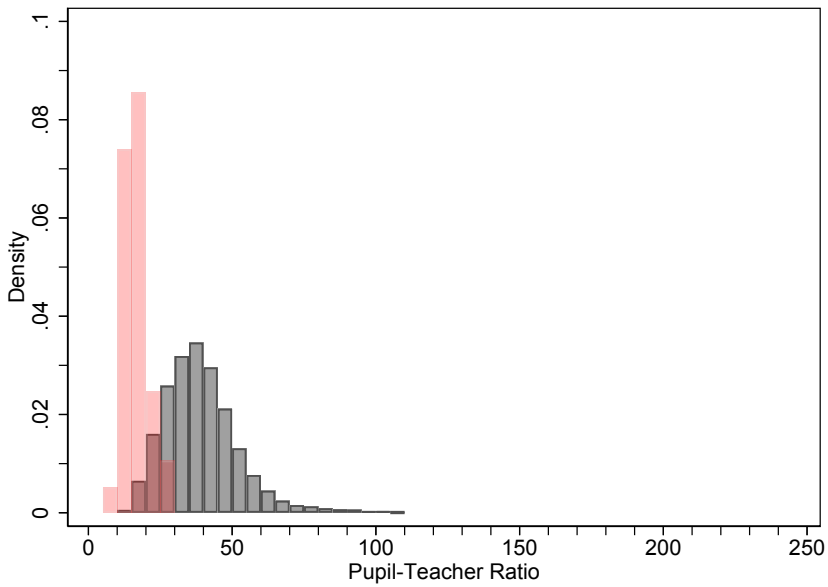


Lower-Middle-Income Countries

India (2015)

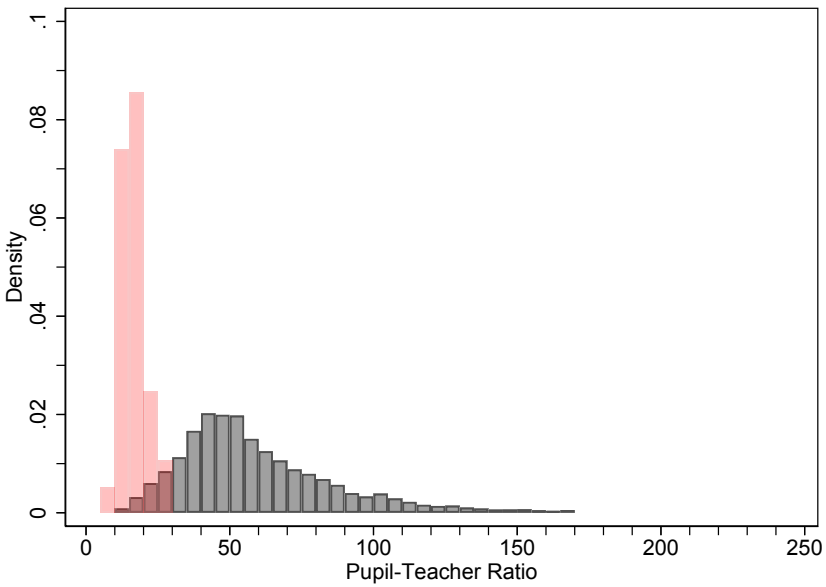


Philippines (2013)

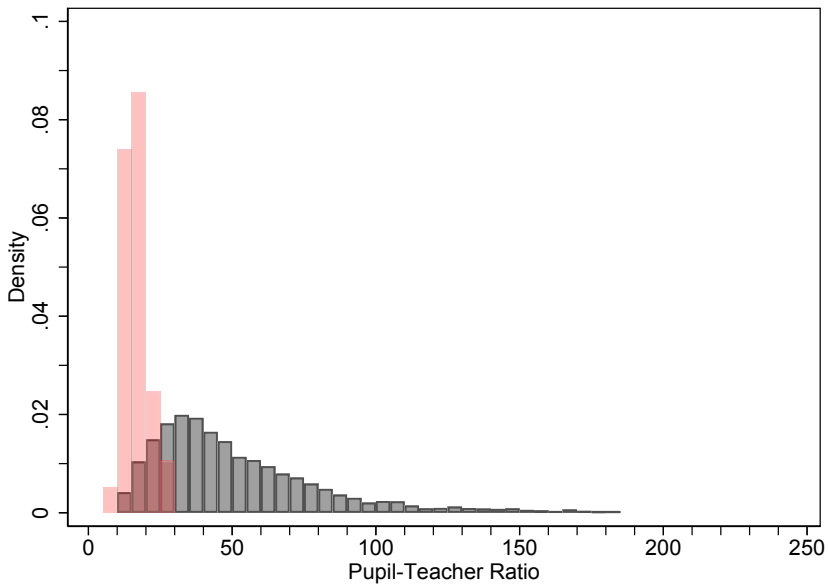


Low-Income Countries

Mozambique (2016)

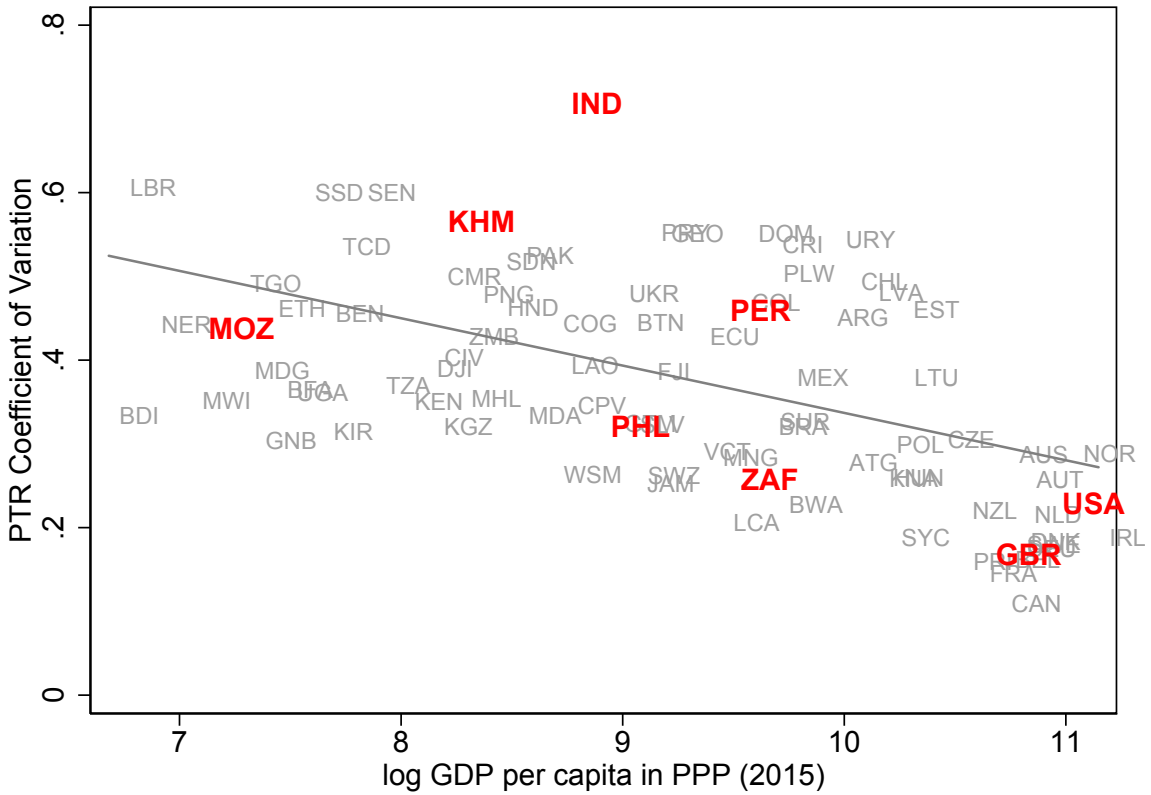


Cambodia (2014)



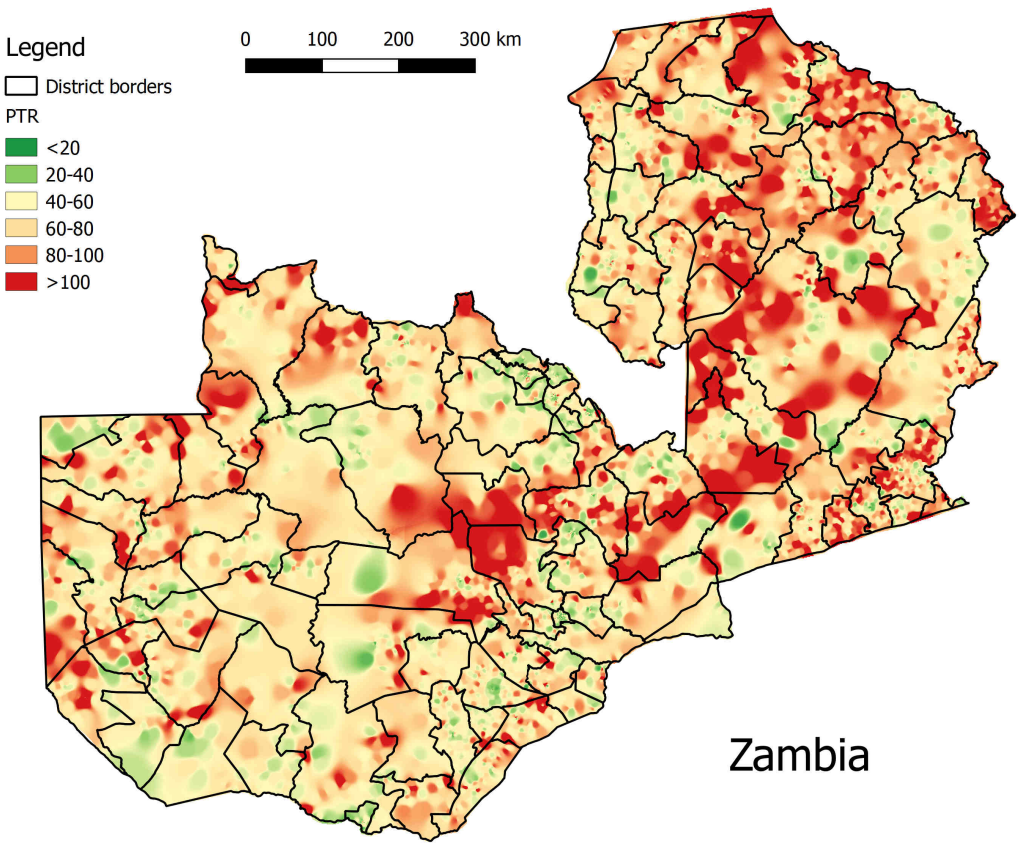
New Stylized Fact (1)

PTR variation negatively correlated with per capita income



New Stylized Fact (2)

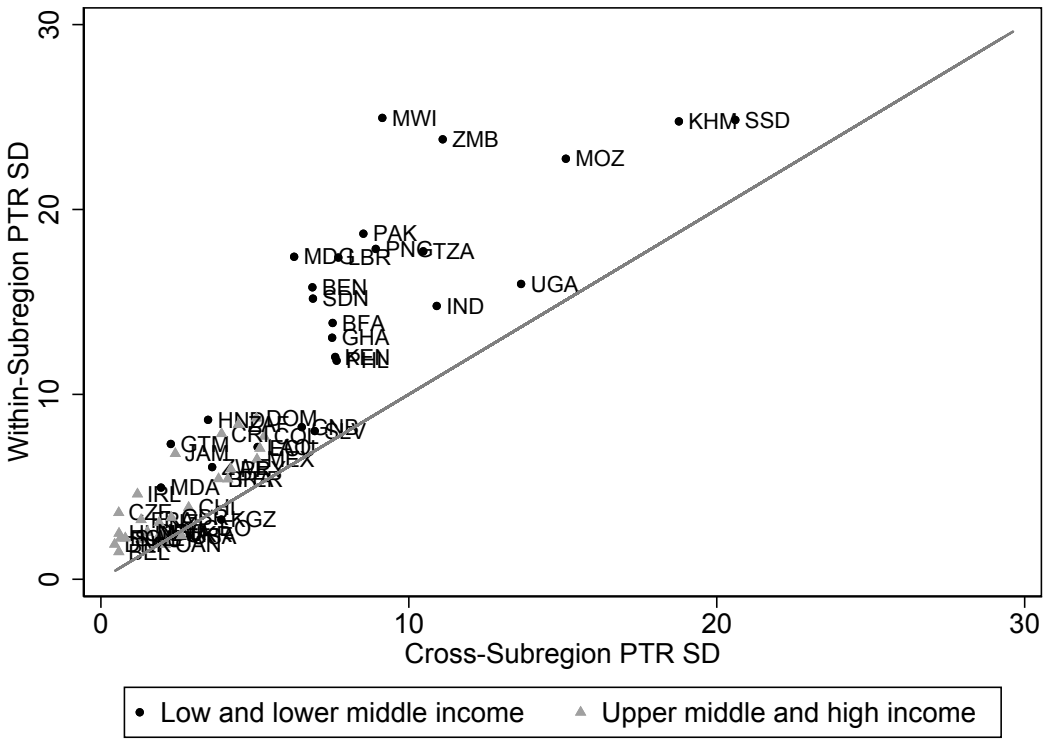
Large PTR variation within subnational regions in LICs



- Cambodia
- Guinea-Bissau
- Liberia
- Malawi
- Mozambique
- Pakistan
- Philippines
- Tanzania
- Uganda

New Stylized Fact (2)

Large PTR variation within subnational regions in LICs

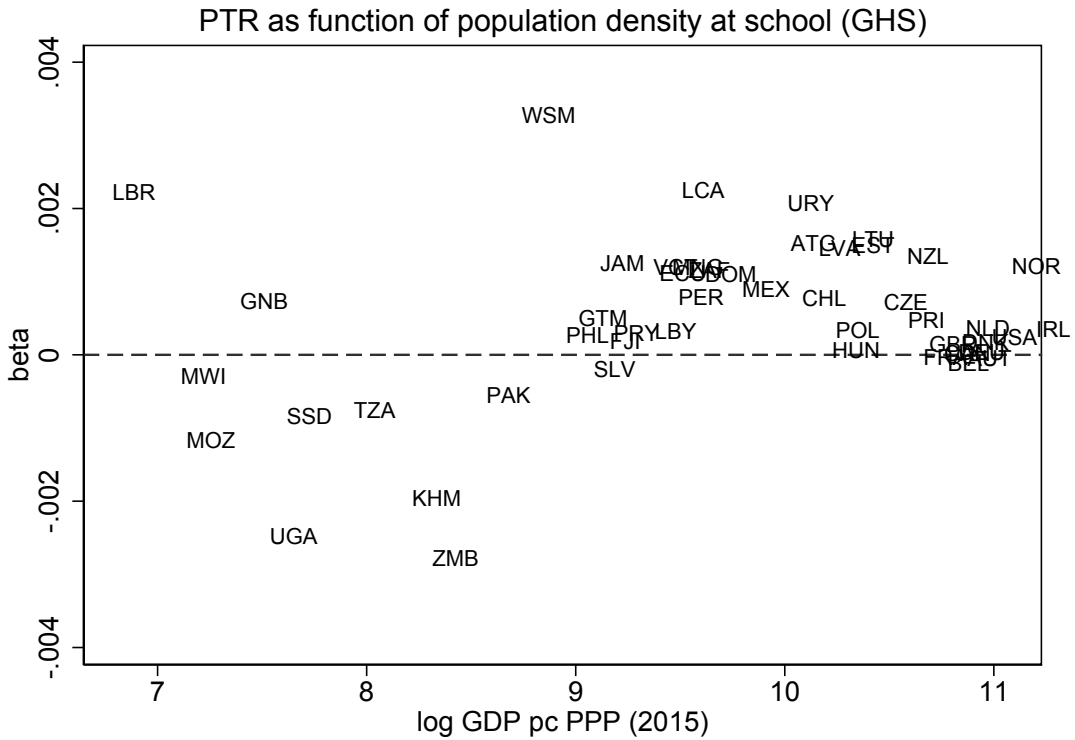


Variation within and between 2nd tier administrative divisions

▸ 1st tier administrative divisions

New Stylized Fact (3)

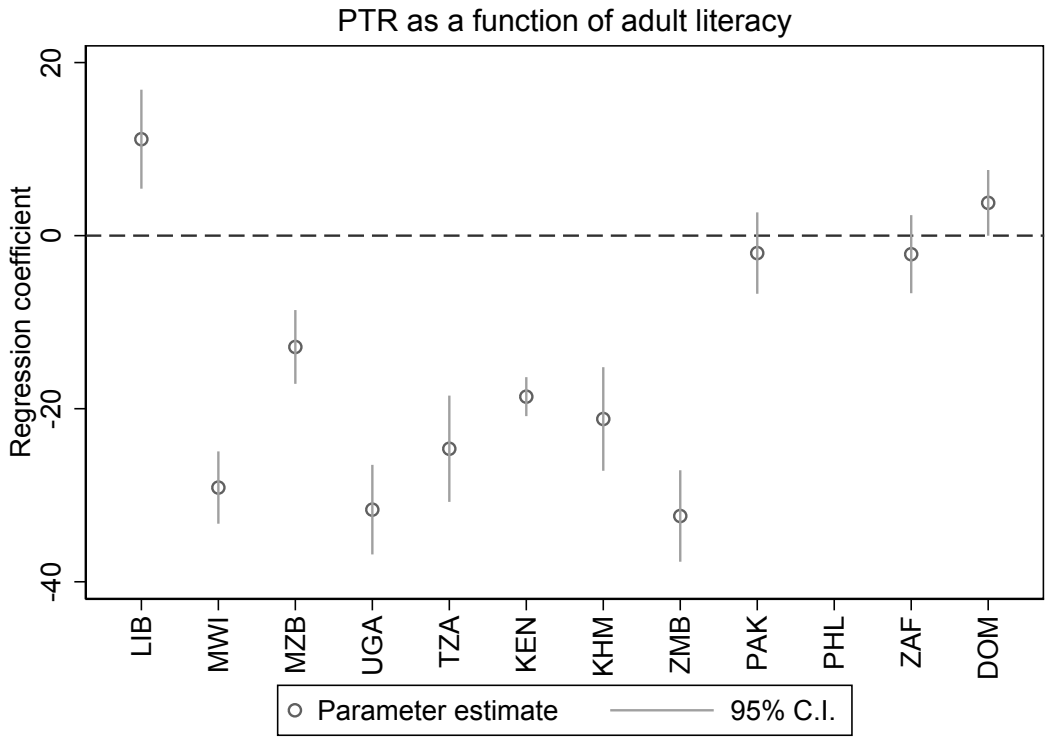
Larger PTRs in rural areas of LICs, and a lot of variation within these



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



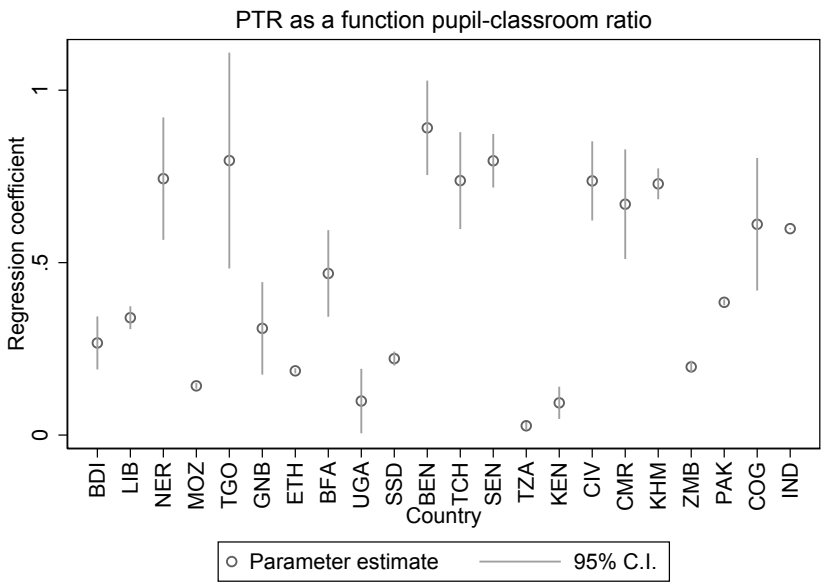
Data sources: National school censuses and DHS.

▸ Afrobarometer ▸ School survey data

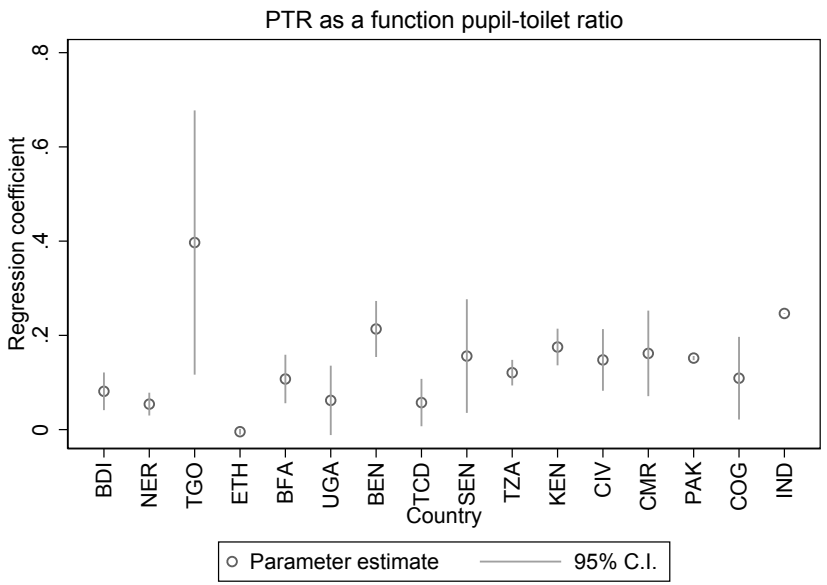
New Stylized Fact (5)

PTRs negatively correlated with school infrastructure in LICs

Classrooms



Toilets



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

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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

$$\max_{T_s} \quad \sum_s \frac{P_s}{\sum_j P_j} H_s(T_s) \quad \text{s.t. } w \sum_s T_s \leq B$$

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
  - β: Elasticity of learning achievement with respect to PTR

Primary School Exam Data

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

Calibration

- Empirical evidence consistent with the common intuition that a lack of teachers affects pupil achievement negatively ▸ Details
- Magnitude of this effect uncertain and likely context-specific $=>$ examine sensitivity of results with respect to β
- Invert education production function to back out A_s:

$$A_s = H_s / PTR_s^{\beta}$$

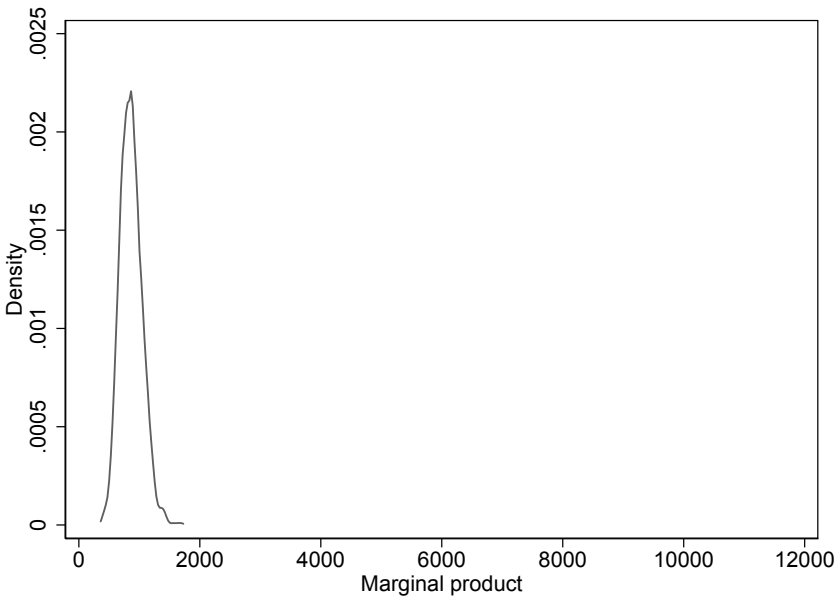
Counterfactuals

1) Optimal allocation

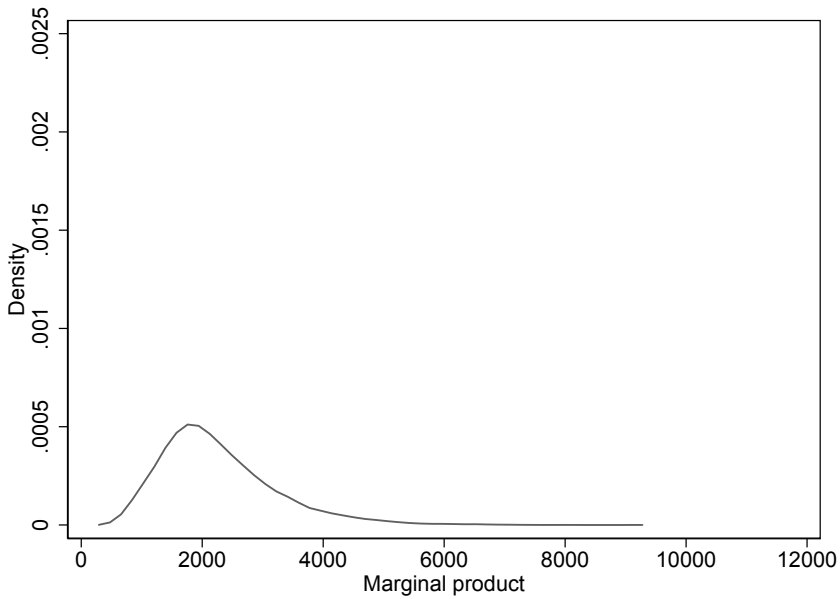
2) Rule-based PTR equalization

Distribution of Marginal Products

US (NY)



Tanzania

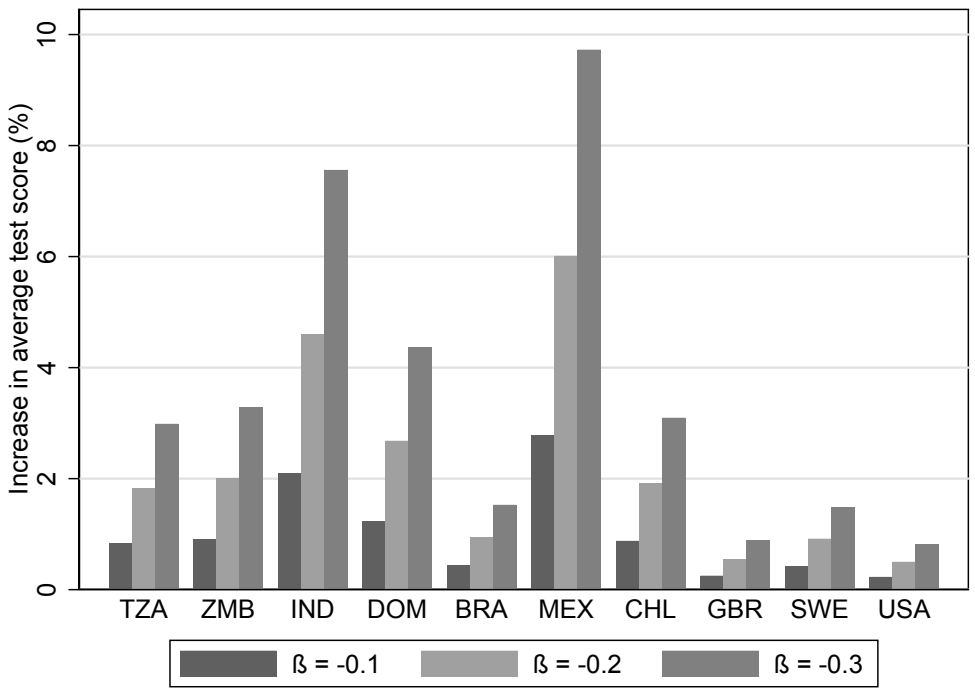


where the marginal product is $A_s PTR_s^{1+\beta} = H_s PTR_s$

▸ Optimality conditions

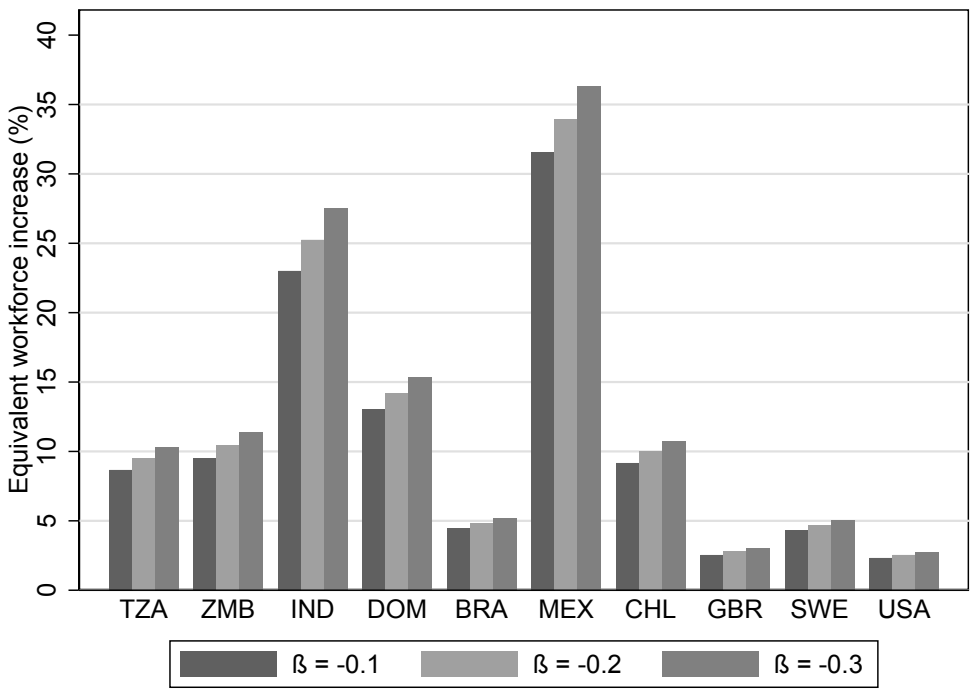
Gains from Optimal Allocation

- By how much would the average pupil test score increase?



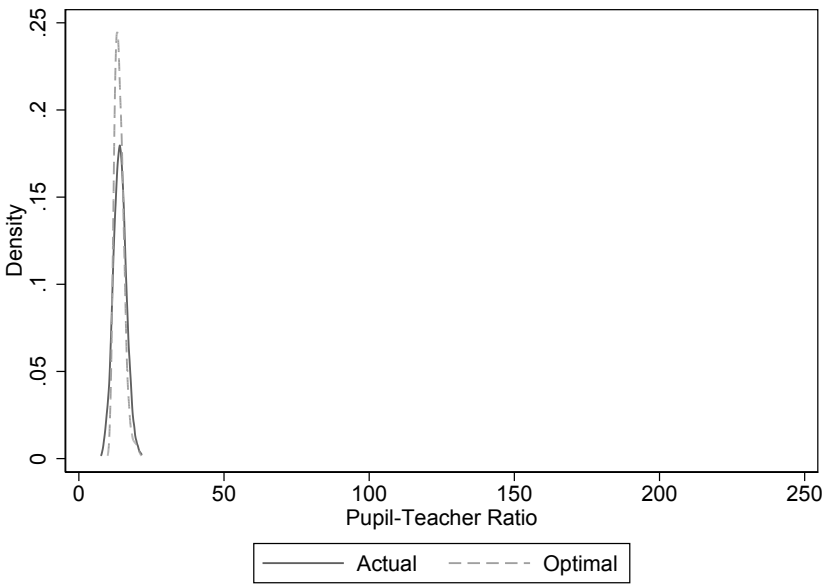
Gains from Optimal Allocation

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

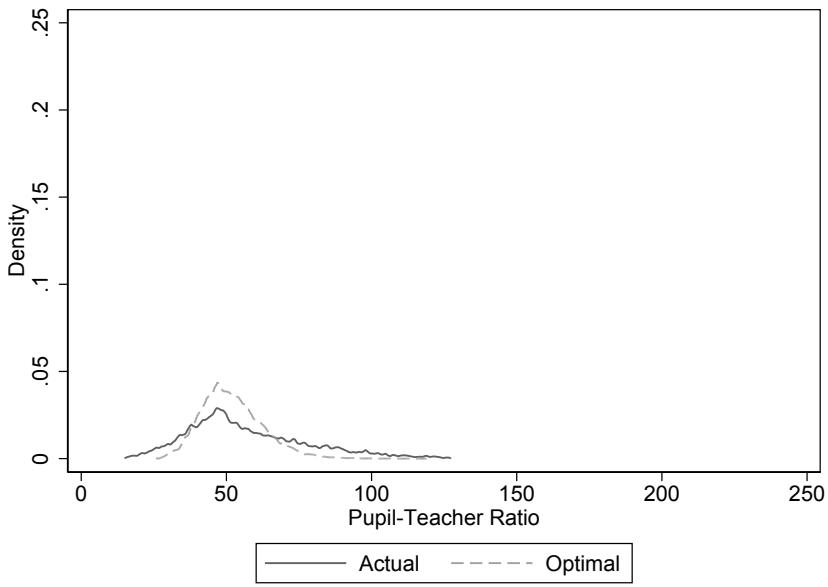


PTR Distribution under Optimal Allocation

US (NY)



Tanzania



Counterfactuals

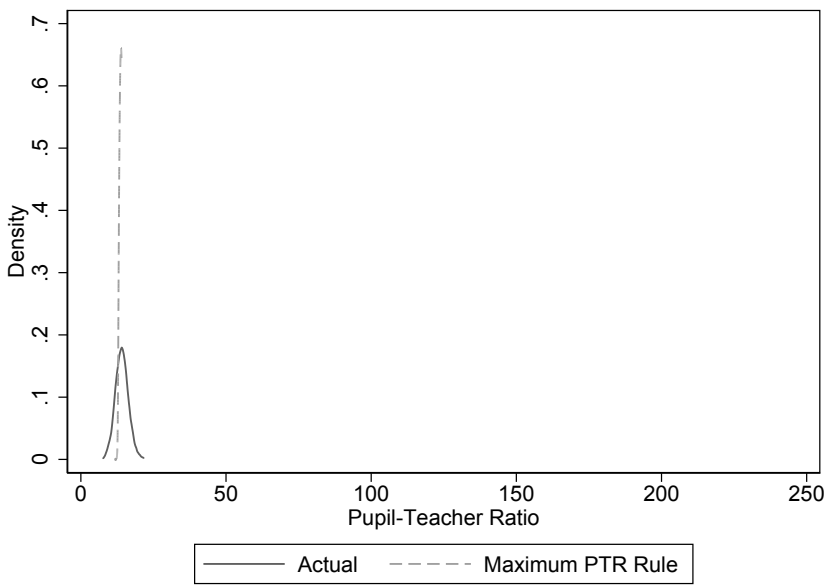
1) Optimal allocation

2) Rule-based PTR equalization

PTR Distribution under Rule-based Equalization

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

US (NY)



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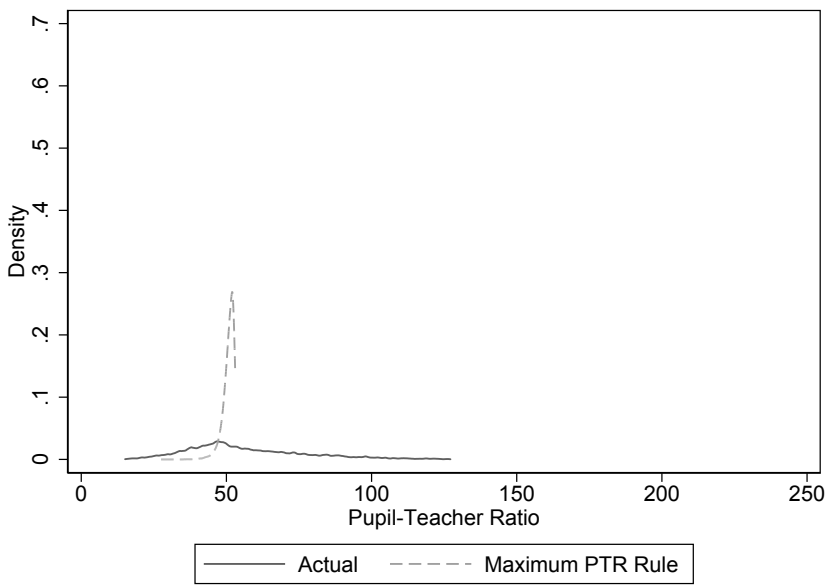
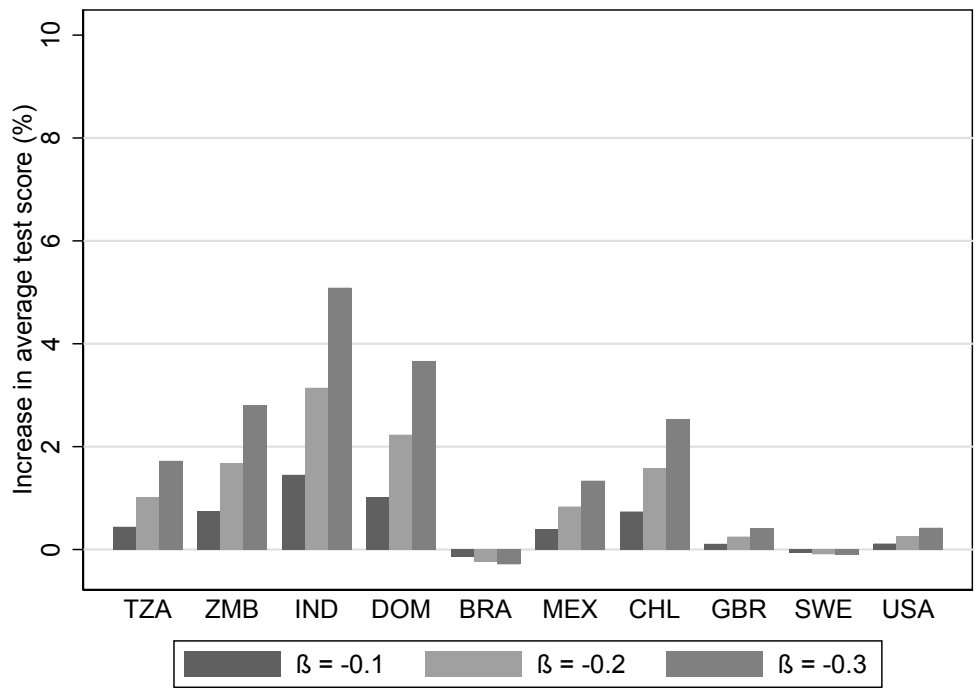


Effects of PTR Equalization

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



Roadmap

Does misallocation of teachers hold back learning?

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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

$\rightarrow$ **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

  $\rightarrow$ What are the causes of resource misallocation?

  $\rightarrow$ 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)

  $\rightarrow$ How important is misallocation of state capacity in those?

APPENDIX

PASEC 2014

Programme d'Analise des Systemes Educatifs de la de la Conference des ministres de l'Education des Etats 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.), Cote d'Ivoire, Niger, Senegal, Togo

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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

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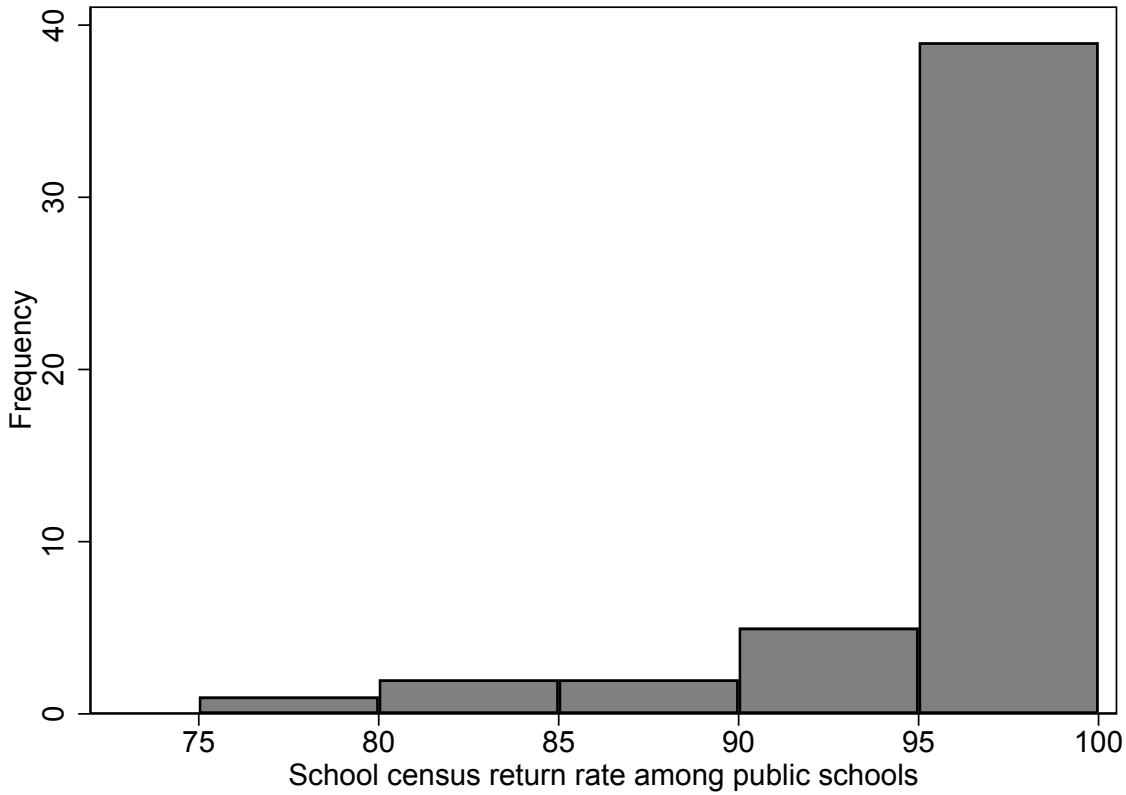
School Census Return Rates in Africa



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%.

▸ Back

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

Survey	Sample Size	ρ_P	ρ_T	$P_{pres} > P_{reg}$	$T_{pres} > T_{reg}$
ASER India 2014	13036	0.89	0.94	0%	0%
ASER Pakistan 2015	4613	0.99	0.98	0%	0%
UWEZO Kenya 2013	4123	0.96	0.91	16.3%	2.1%
UWEZO Tanzania 2013	3453	0.89	0.91	3.2%	0%
UWEZO Uganda 2013	2114	0.85	0.91	5.3%	0%

- Number of present and registered highly correlated
- Number of present pupils and teachers exceeds number of registered in some schools in East Africa

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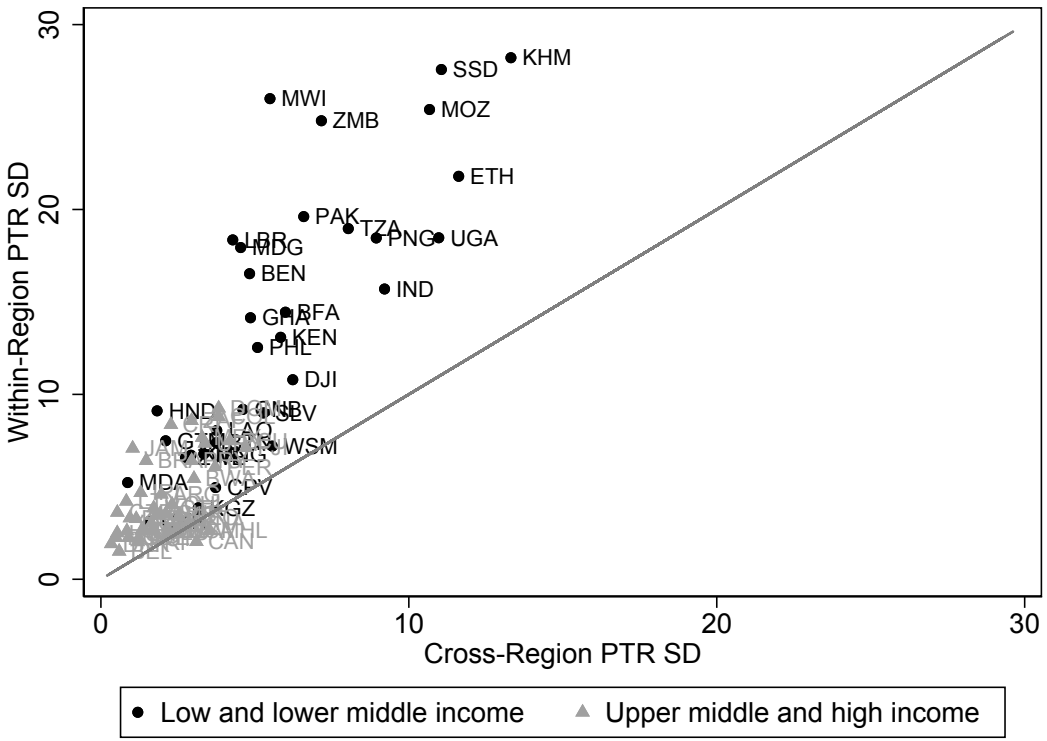
New Stylized Fact (2)

Large PTR variation within subnational regions in LICs



Variation within and between 1st tier administrative divisions

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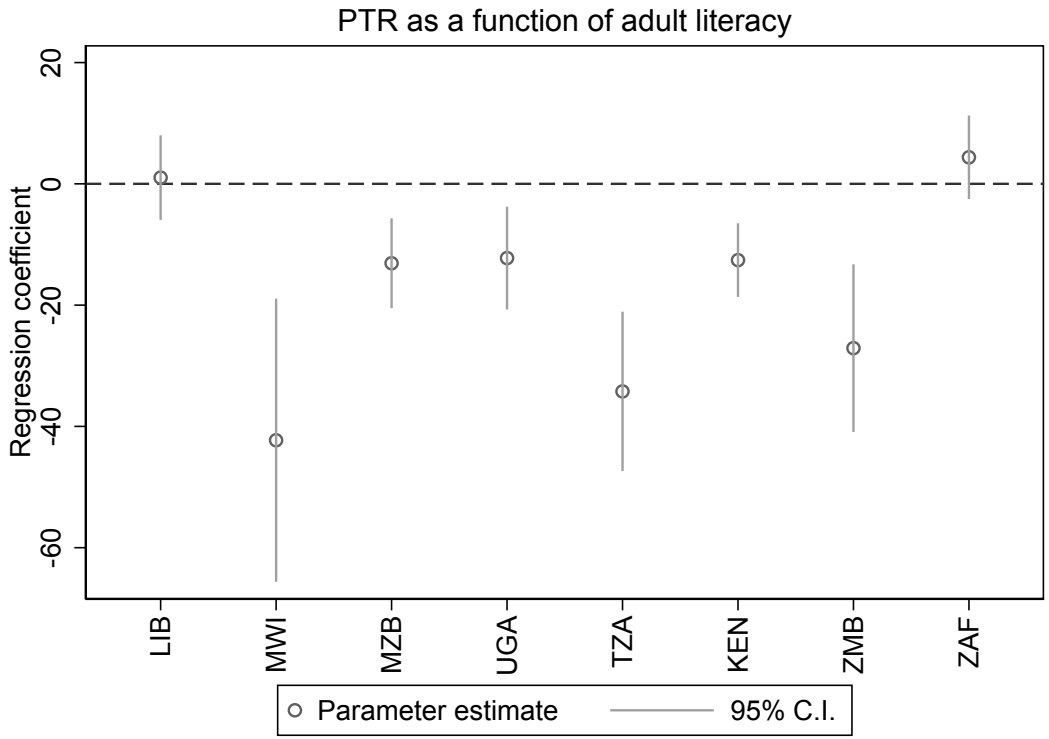
New Stylized Fact (4)

PTR differences tend to reinforce educational inequality in LICs

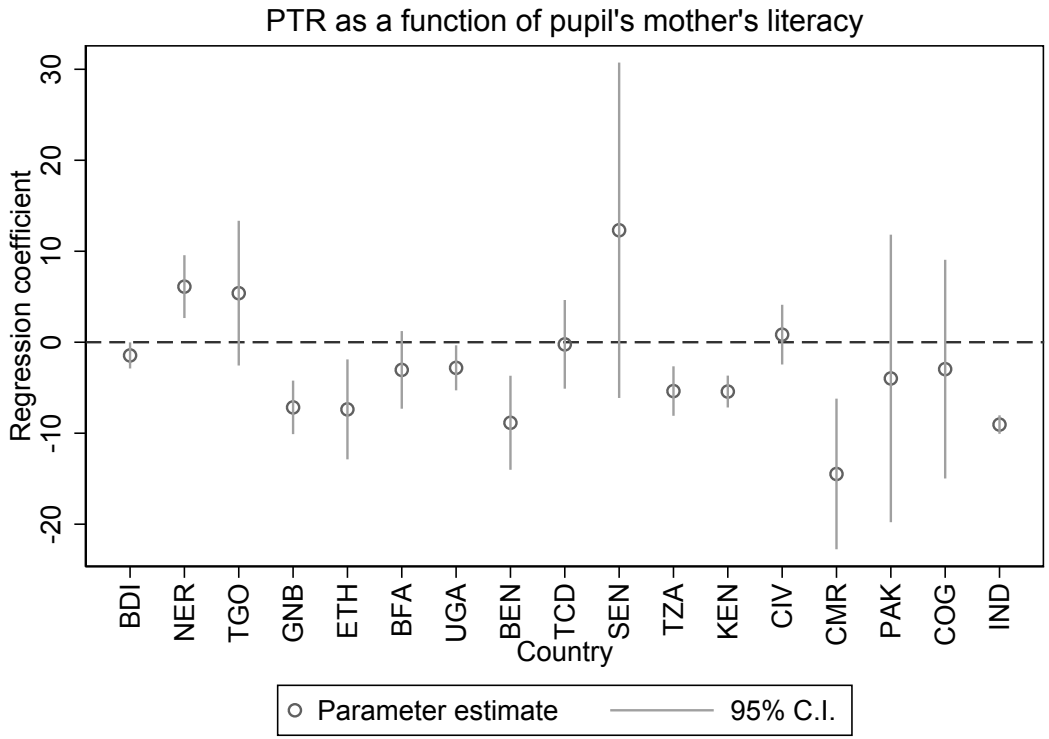


Data sources: National school censuses and Afrobarometer Round 6.

Back

New Stylized Fact (4)

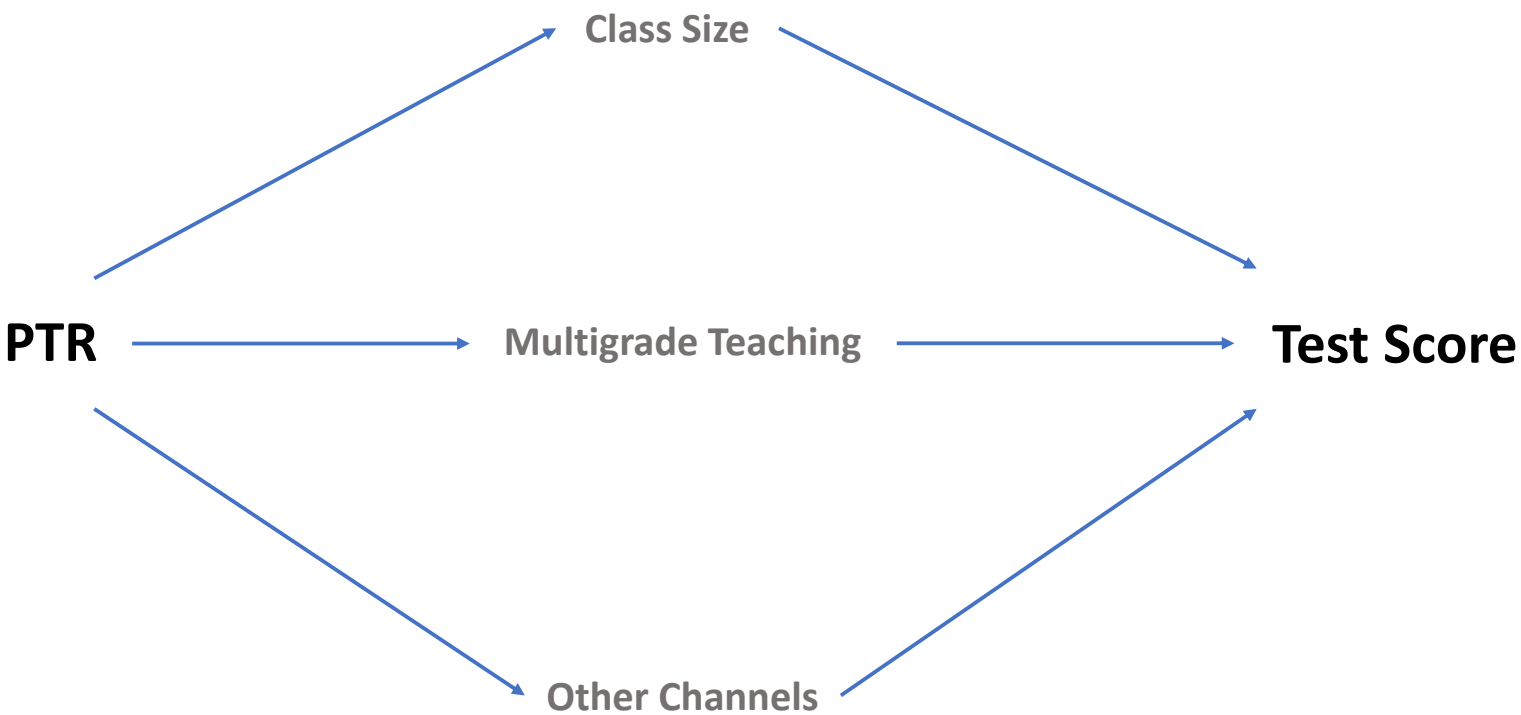
PTR differences tend to reinforce educational inequality in LICs



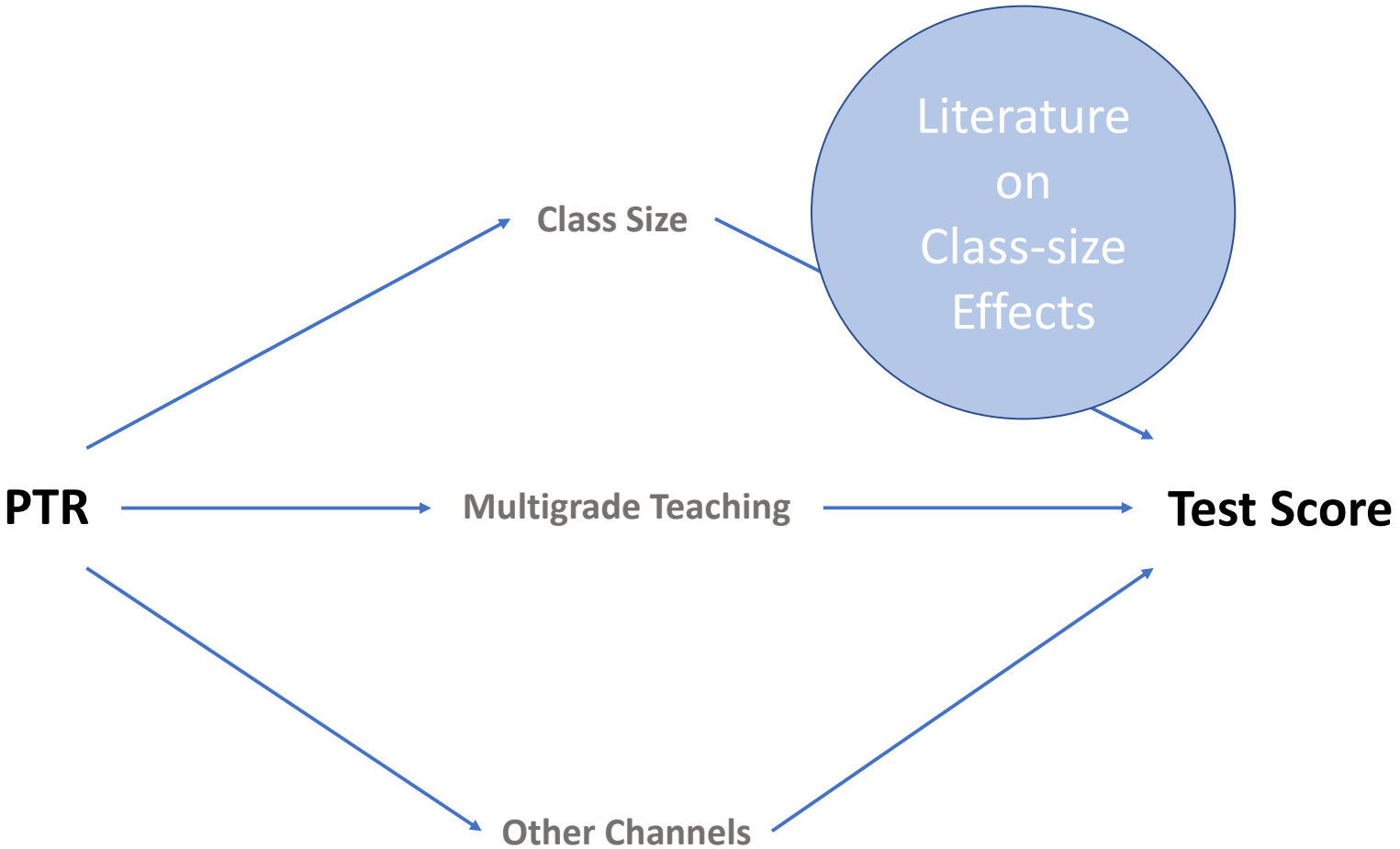
Data sources: ASER 2014, ASER Pakistan 2015, PASEC 2014, UWEZO 2014.

▸ Back

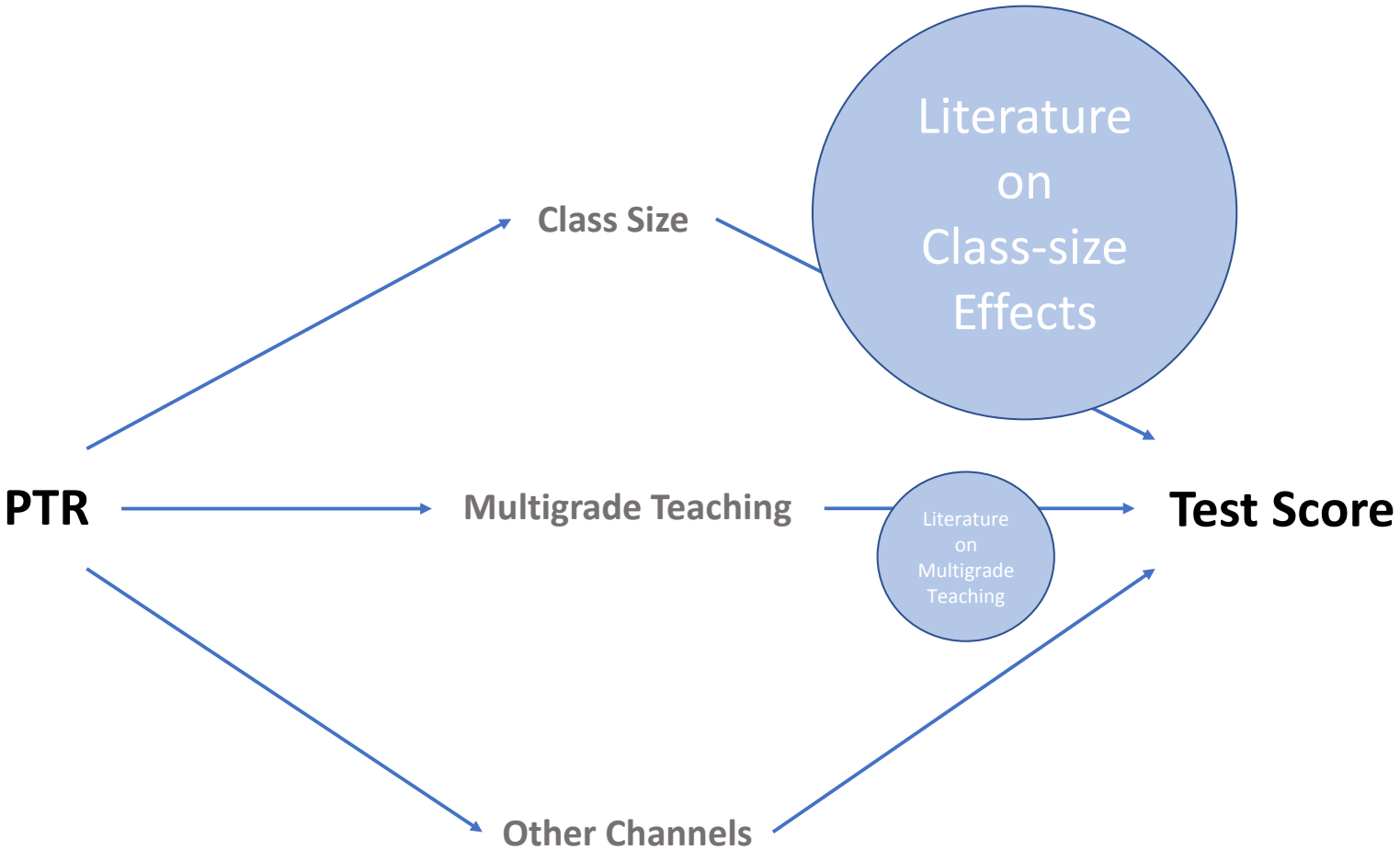
Learning as a Function of PTR



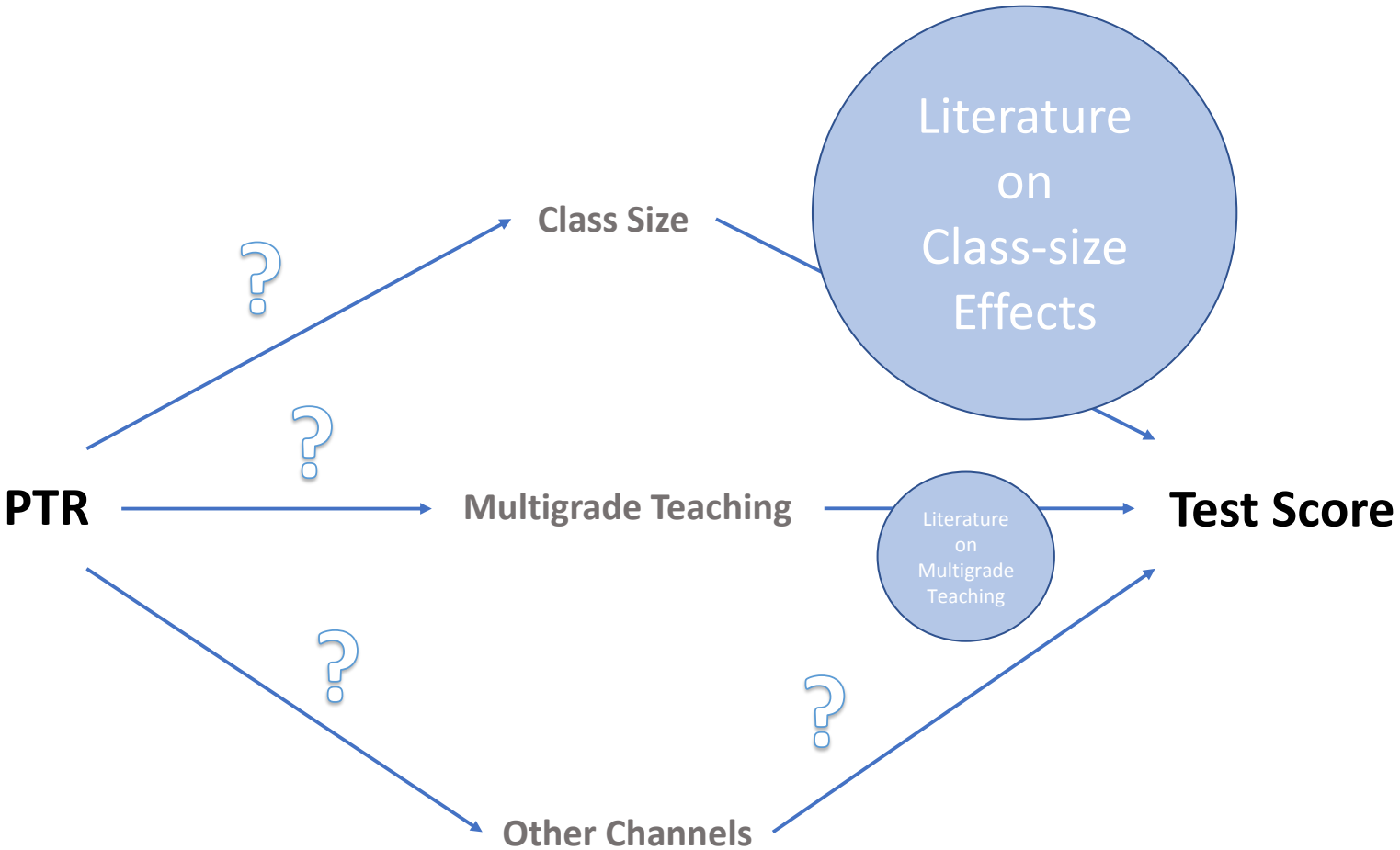
Learning as a Function of PTR



Learning as a Function of PTR



Learning as a Function of PTR



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

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Optimality

- Maximization problem:

$$\max_{T_s} \sum_s \frac{P_s}{\sum_j P_j} H_s \text{ s.t } \sum_s w T_s \leq B \text{ and } H_s = A_s PTR_s^{\beta}$$

- FOC necessary and sufficient for optimality if $\beta > -1$:

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

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