

# Educational Investment in Spatial Equilibrium: Evidence from Indonesia

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# Motivation

- Governments invest \$3 trillion in education annually (World Bank 2022)
  - In Indonesia, 61,807 new primary schools (INPRES 1973-1978)
- Schools serve students locally
  - But graduates seek employment nationally
- **How does migration shape educational investment?**

# This paper

- Aggregate and distributional effects of the **INPRES** program
  - Difference-in-difference with long-run outcomes (Duflo 2001)
  - Spatial equilibrium model to decompose effects and redesign program
- Complementarity between education and migration
  - ① Rural schooling depends on urban wages (non-local incentives)
  - ② Rural schools increase urban output (non-local effects)
- **Results:** aggregate output  $\uparrow$  (8%), inequality  $\updownarrow$  (people  $\downarrow$  5%, places  $\uparrow$  12%)
  - Tension between returns to education and regional convergence

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# Literature

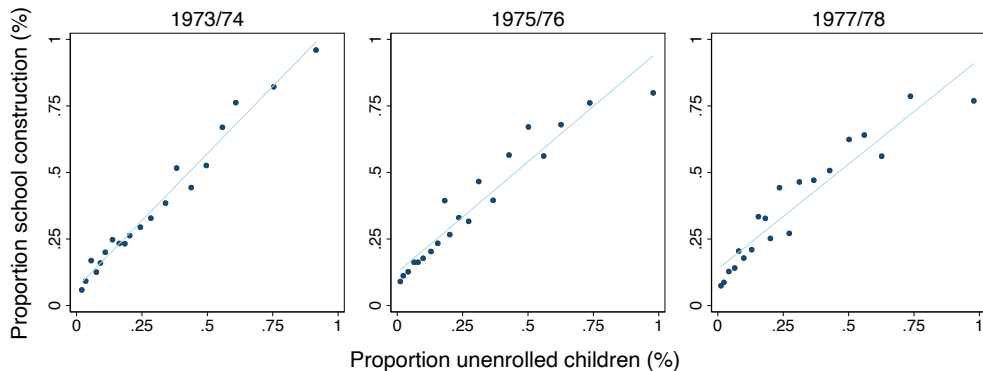
- **Education and migration** at scale in general equilibrium
  - Education: Khanna 2021, Dinerstein et al. 2022 (no migration)
  - Migration: Dahl 2002, Bryan et al. 2014, Bryan & Morten 2019 (no education)
  - Both: Eckert & Kleineberg 2021, Agostinelli et al. 2022 (no school construction)
- **INPRES program** evaluation with aggregate effects and counterfactuals
  - Duflo 2001/2004, Martinez-Bravo 2017, Ashraf et al. 2020, Bazzi et al. 2021
- **Place-based policy** with portable human capital benefits
  - Glaeser & Gottlieb 2008, Kline & Moretti 2014, Busso et al. 2013, Austin et al. 2018

# Data and Stylized Facts





# INPRES built 62,000 new primary schools



# Data

- **Treatment** at district level
  - INPRES school construction (1973-1978)
  - Pre-program primary schools, child populations, enrollment rates
- **Long-run outcomes** at individual level
  - SUSENAS household surveys (2011-2014)
  - Districts of residence and birth, years of schooling, monthly wages

## Difference-in-difference variation (Duflo 2001)

$$Y_{ijk} = \delta_j + \delta_k + \beta S_j T_k + C_j T_k \boldsymbol{\phi} + \varepsilon_{ijk}$$

- ① **Young vs. old** students by age cohort  $k$
- ② **More vs. less** school construction by origin district  $j$

## Long-run education and wage effects

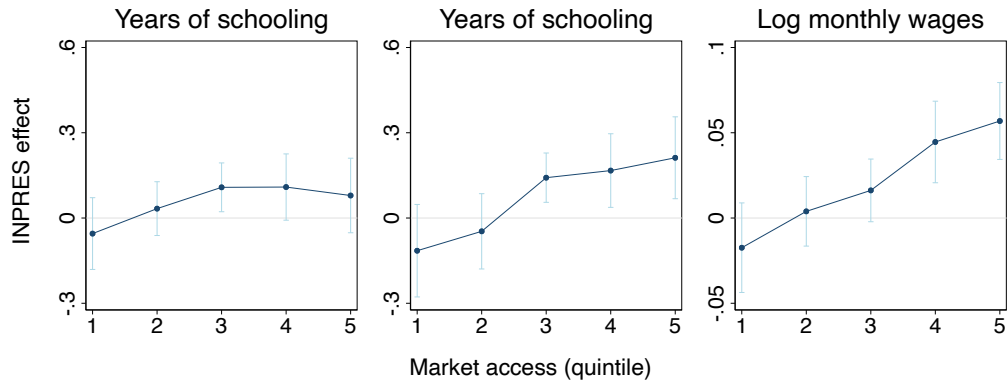
Outcomes	Estimate	SE	Obs
Years of schooling	0.103**	(0.0424)	233,517
— For wage earners	0.121**	(0.0495)	89,404
Log monthly wages	0.020**	(0.0092)	89,404

## Driven by labor market access

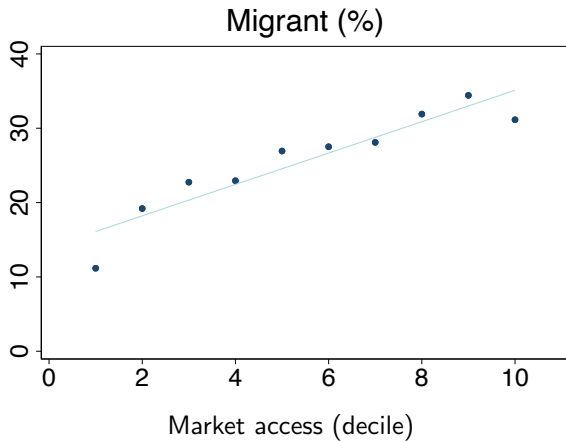
$$MA_d = \sum_{d'} w_{d'} \text{popden}_{d'} \quad \text{for} \quad w_{d'} \propto (1 + \text{dist}_{dd'})^{-2}$$

- Captures access to high urban wages
  - Population density in 1971 + Euclidean distances

## Driven by labor market access



## Migration rates are high



## People benefit, but not places

Outcomes	People		Places	
	Estimate	SE	Estimate	SE
Years of schooling	0.103**	(0.0424)	0.052	(0.0452)
— For wage earners	0.121**	(0.0495)	0.026	(0.0506)
Log monthly wages	0.020**	(0.0092)	0.011	(0.0076)



Model

# Spatial equilibrium model

## ① Government constructs schools

- Build human capital that is portable (aggregate output)

## ② Individuals invest in education

- In a district, more schools → better access → lower costs of education

## ③ Individuals migrate for work

- Mobility gives rural students access to high urban wages (person-based inequality)
- But rural students leave after graduation (place-based inequality)

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# Education and migration frictions

- Individual  $i$ , origin  $j(i)$ , age cohort  $k(i)$ , destinations  $\ell$

- 1 Choose education for future labor

$$U_i(e) = \mathbb{E}[\max_{\ell} U_{i\ell}(e, \epsilon_{i\ell})] - \tau_{jk}^e e$$

- 2 Choose labor migration given education and skill draws (Fréchet)

$$U_{i\ell}(e, \epsilon_{i\ell}) = \left( \frac{a_{\ell} w_{\ell} s_{jkl}}{\tau_{jkl}^m} \right) e^{\eta} \epsilon_{i\ell}$$

# Migration, education, and wages

- Closed form for  $m_{jkl}$ ,  $e_{jk}$ , and  $w_{jkl}$  (data)
- Labor market access  $\uparrow \Rightarrow$  migration  $\uparrow$ , education  $\uparrow$ , wages  $\uparrow$

$$MA_{jk} \equiv \sum_{\ell} \left( \frac{a_{\ell} w_{\ell} s_{jkl}}{\tau_{jkl}^m} \right)^{\theta}$$

## Equilibrium and output

$$H_\ell^{\text{supply}}(w_\ell) = H_\ell^{\text{demand}}(w_\ell) \quad \forall \ell$$

- Supply: individuals choose  $e_{jk}$  and  $m_{jk\ell}$  in response to  $w_\ell$
- Demand: firms set  $w_\ell$  to marginal product
- Production uses human capital ( $0 < \kappa < 1$ )

$$Y_\ell = A_\ell H_\ell^\kappa, \quad w_\ell = \kappa A_\ell H_\ell^{\kappa-1}, \quad Y = \frac{1}{\kappa} \sum_{j,k,\ell} N_{jk} m_{jk\ell} w_{jk\ell} \quad (Y^U, Y^R)$$

# Estimation



## 1. Education and migration costs (INPRES as DD)

$$\frac{w_{jkl}}{e_{jk}} = \frac{\tau_{jk}^e \tau_{jkl}^m}{\eta a_\ell}$$

$\Downarrow$

$$\tilde{w}_{jkl} - \tilde{e}_{jk} = -\tilde{\eta} - \sigma \tilde{S}_{jk} + \delta \tilde{D}_{j\ell} - \tilde{a}_\ell + \tilde{\tau}_j + \tilde{\tau}_k + \tilde{\varepsilon}_{jkl}^\tau$$

$\Downarrow$

$$\hat{\sigma} = 0.110^{**}(0.047), \quad \hat{\delta} = 0.042^{***}(0.004)$$

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## 2. Human capital and skill (INPRES as IV)

$$w_{jkl} = w_{\ell} s_{jkl} e_{jk}^{\eta} m_{jkl}^{-\frac{1}{\theta}} \gamma$$

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$$\tilde{w}_{jkl} = \tilde{\gamma} + \eta \tilde{e}_{jk} - \frac{1}{\theta} \tilde{m}_{jkl} + \tilde{w}_{\ell} + \tilde{s}_j + \tilde{s}_k + \tilde{\varepsilon}_{jkl}^s$$

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$$Y_{\ell} = A_{\ell} H_{\ell}^{\kappa}$$

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$$\tilde{Y}'_{\ell} = \tilde{\kappa} + \kappa \tilde{H}_{\ell} + \tilde{A}_{\ell}$$

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# Counterfactuals

# Goals

- **Evaluate** relative to zero-construction counterfactual
  - Aggregate and distributional effects
- **Decompose** effects of mobility by mechanism
  - And separate each from the general equilibrium effects
  - Diff-in-diff avoids model but only captures net effects
- Study program **design**
  - By simulating alternative allocations of school construction

The program increased aggregate output by 8%

	Aggregate output
Zero construction	<b>1.00</b>
+ Direct effect of construction	1.03
+ Migration	1.05
+ Migration-induced schooling	1.09
+ New equilibrium wages	<b>1.08</b>

- Small gains without migration (direct effect) or without education (sorting)
  - Complementarity between education and migration
  - Gains from sorting are already large (Bryan et al. 2014)

## With especially large benefits for rural students

	Inequality (people)
Zero construction	<b>1.00</b>
+ INPRES construction	<b>0.95</b>

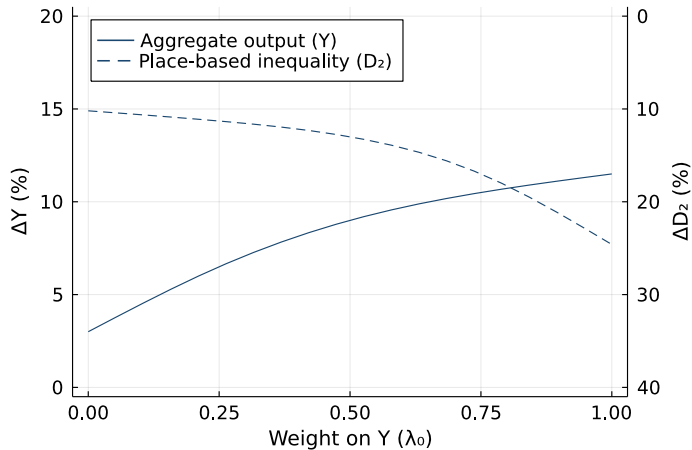
- Expanded opportunity for rural students with high marginal returns
  - Decreased inequality between rural and urban students by 5%

But also increased inequality across places by 12%

	Inequality (places)
Zero construction	<b>1.00</b>
+ INPRES construction	<b>1.12</b>

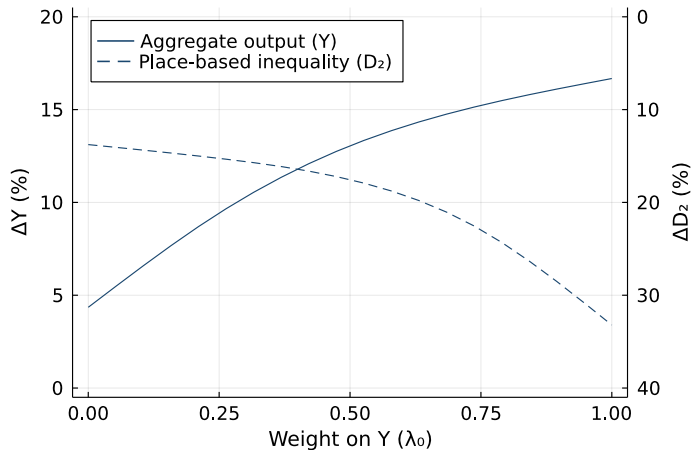
- The program explicitly aimed to encourage regional convergence
  - But mobility places convergence in tension with output gains
  - Rural regions still enjoy net gains, but urban regions gain more

## Equity-efficiency tradeoff for policymaker



- Targeting rural areas: output  $\uparrow$ , but rural-urban gap  $\uparrow$  (implied 50-50 weight)

## Equity-efficiency tradeoff for policymaker



- Especially with schools + roads, but roads drain rural areas



## Conclusion

# Summary

- Evaluating large-scale educational investment in spatial equilibrium
  - Indonesia's INPRES program built 62,000 primary schools in 1970s
  - Aggregate output  $\uparrow$  (8%), person-based inequality  $\downarrow$  (5%), place-based  $\uparrow$  (12%)
- Education and migration are **complementary**
  - Big gains for rural students who leave rural regions behind