

Cross-country Variation in Educational Attainment: Structural Change or Within Industry Skill Upgrading?

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Why does educational attainment differ across countries?

In Barro & Lee (2001): Average schooling ranges from 3.5 years (Sub-Saharan Africa) to 12 years (USA).

- 1 **Structural change:** Countries develop from ag-intensive to industry intensive. (Hansen & Prescott 2002; Lucas 2004; Gollin et al. 2007)
- 2 **Within industry** skill upgrading: Countries develop by adopting more skill intensive technologies (Galor & Weil 2000; Acemoglu 2002, 2003; Restuccia & Vandenbroucke 2008).

Purpose of the Paper

Measure the **relative importance** of structural change and "skill bias" for education gaps

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- over time within countries.

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Main finding:

- Around $3/4$ of cross-country and time series changes in education occur **within industries**.
- Only $1/4$ is structural change.

- Census data for 21 countries (from IPUMS).
- Cross-sectional results use the most recent waves (mostly 1990-2000).
- Time series results also use the earliest usable wave (mostly 10-20 years prior).
- Countries cover a wide range of incomes: USA, ESP, ..., VNM, RWA.
- Include "most" persons who work.

- Countries: $m = 1, \dots, M$.
- Industries: $i = 1, \dots, I$.
- The goal is to construct labor inputs at the country-industry level (skilled: $H_{m,i}$ and unskilled: $L_{m,i}$).
- I consider 3 definitions of "skilled:" primary, secondary, and higher education completed.
- Definitions follow Caselli & Coleman (2006, CC).

- Within a skill group (H or L), persons are perfect substitutes.
- Skilled labor input of country m / industry i :

$$H_{m,i} = \sum_h \omega_h l_h \quad (1)$$

- ω_h is person h 's sample weight.
- l_h is h 's labor input (hours \times efficiency).
- Efficiency is measured using a Mincer equation.

① **Broad:**

- 15 industries
- comparable across countries.

② **Detailed:**

- number of industries varies across countries.
- imperfect mapping.
- used for robustness analysis.

Measure educational attainment by

$$\eta_m = \ln(H_m/L_m) \quad (2)$$

Attainment varies dramatically across countries

	Std. (η_m)	U.S./Lowest 5
Primary	1.66	137.53
Secondary	1.43	85.14
College	1.35	40.61

Decomposing Cross-country Education Gaps

- The goal: decompose cross-country education gaps, $\eta_{US} - \eta_m$, into the contributions of
 - 1 product mix
 - 2 within industry education gaps.
- Two counter-factual experiments that transform η_m into η_{US} .

Experiment I

"How much would education gaps shrink if the U.S. downgraded within industry $H_{m,i}/L_{m,i}$ to country m 's level?"

$$\begin{aligned}\eta_m &= \ln \sum n_{m,i} \frac{H_{m,i}}{L_{m,i}} \\ &\xrightarrow{\text{Prod.mix}} \ln \sum n_{US,i} \frac{H_{m,i}}{L_{m,i}} \\ &\xrightarrow{\text{Within}} \ln \sum n_{US,i} \frac{H_{US,i}}{L_{US,i}} \\ &= \eta_{US}\end{aligned}$$

Weights: $n_{m,i} = L_{m,i}/L_m$.

Experiment II

"How much would education gaps shrink if country m upgraded to the U.S.'s within industry $H_{m,i}/L_{m,i}$?"

$$\begin{aligned}\eta_m &= \ln \sum n_{m,i} \frac{H_{m,i}}{L_{m,i}} \\ &\quad \xrightarrow{\text{Within}} \ln \sum n_{m,i} \frac{H_{US,i}}{L_{US,i}} \\ &\quad \xrightarrow{\text{Prod.mix}} \ln \sum n_{US,i} \frac{H_{US,i}}{L_{US,i}} \\ &= \eta_{US}\end{aligned}$$

Cross-country averages

- Most of the paper's findings are reported in the form of cross-country averages.
- Average educational attainment is defined as

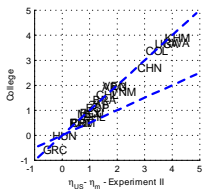
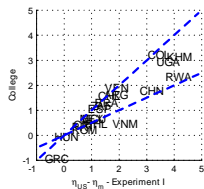
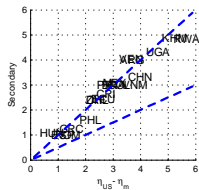
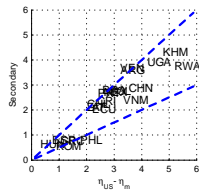
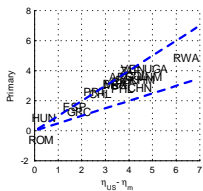
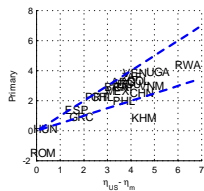
$$\bar{\eta}_m = M^{-1} \sum_{m=1}^M \eta_m \quad (3)$$

- Average education gaps are defined as $\eta_{US} - \bar{\eta}_m$.
- The average **fraction** of cross-country gaps that is due to within industry gaps is defined as
 1. $(\eta_{US} - \bar{\eta}_m^I) / (\eta_{US} - \bar{\eta}_m)$ for experiment I
 2. $(\bar{\eta}_m^{II} - \bar{\eta}_m) / (\eta_{US} - \bar{\eta}_m)$ for experiment II.

Cross-country Results

At least $2/3$ of cross-country education gaps are due to within industry gaps.

	Avg.gap	Experiment I Within gap	Fraction	Experiment II Within gap	Fraction
Primary	32.71	10.84	0.68	18.18	0.83
Secondary	20.27	10.94	0.80	16.67	0.94
College	6.11	3.34	0.67	4.86	0.87



Intuition: Why is industry mix not more important?

- Sectoral composition varies dramatically across countries.
 - Agricultural employment ranges from 2% (USA) to 88% (RWA).
- Why does this not translate into larger contributions of product mix?

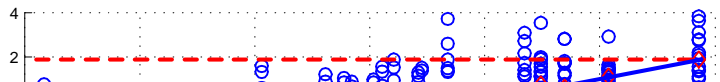
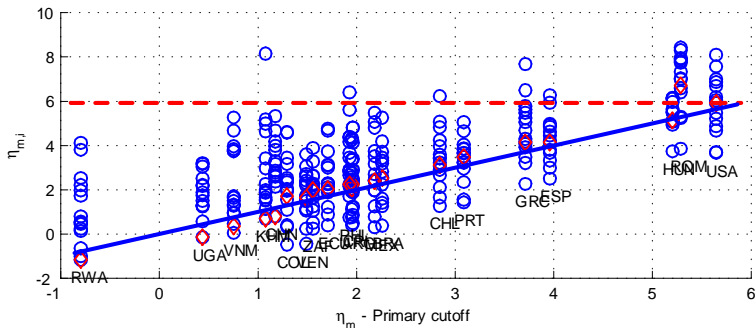
Within industry education gaps

- Fact 1: Educated countries employ large amounts of skilled labor in all industries.
- For each industry: Regress $\ln H_{m,i}/L_{m,i}$ on $\ln H_m/L_m$.
- Primary skill definition.

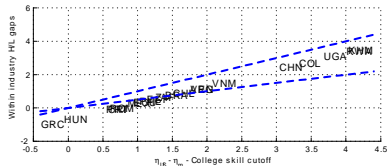
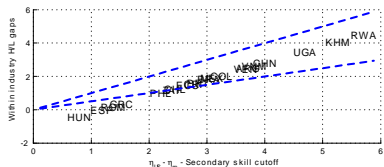
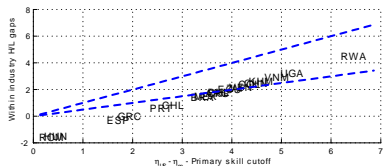
Skill cutoff	Avg. β	Avg. R^2	Avg. N	No.of.ind.
Primary	0.83 (0.16)	0.77 (0.14)	20.6	15
Secondary	0.86 (0.13)	0.81 (0.09)	20.9	15
College	0.79 (0.19)	0.75 (0.14)	20.8	15

Distributions of industry attainment

Fact 2: In nearly all industries, the least educated countries employ less skilled labor than the U.S. median sector.



Upper bound for role of product mix



How large are education gaps if all labor is allocated to each country's most skill intensive industry?

- Apply the same decomposition to **changes** in educational **over time**.
- Notation:
 - $\eta_{t,m,i} = \ln H_{t,m,i} / L_{t,m,i}$.
 - $\eta_{t,m} = \ln H_{t,m} / L_{t,m}$.
 - $t = 1, 2$.
- The goal: Decompose $\eta_{2,m} - \eta_{1,m}$ into the contributions of product mix ($n_{t,m,i}$) changes and within industry ($\eta_{t,m,i}$) changes.
- Experiment I: change product mix - then η .
- Experiment II: change η - then product mix.

Time series results

	Avg.gap	Experiment I Within gap	Fraction	Experiment II Within gap	Fraction
Primary	4.75	3.50	0.81	4.36	0.95
Secondary	3.33	2.92	0.89	3.40	1.02
College	1.67	1.30	0.52	1.51	0.80

The fraction of within industry changes is larger than in the cross-section.

Summary: Broad industries

- For a large majority of countries: more than half of cross-country and time series education gaps are due to within industry education gaps.
- For the countries with the largest gaps: At least $3/4$ are due within industry gaps.

- Are the results robust when more disaggregated industry data are used?
- Countries report their own industry classifications.
- They differ in definitions and detail.
- U.S. reports 265 industries in 2000.

- 1 Industry definitions differ by country.
 - Mapping into U.S. industries by descriptive labels introduces measurement error.
- 2 The decomposition used so far requires complete industry coverage.

Solution:

- 1 Show that education gaps are approximately **industry neutral**.
- 2 Develop an alternative decomposition for an industry neutral model.

Industry neutral labor demand model

- An extension of CC to multiple sectors.
- Each industry is endowed with a production function of the form

$$y_{m,i} = A_{m,i} \left[\varphi_{m,i} H_{m,i}^\rho + (1 - \varphi_{m,i}) L_{m,i}^\rho \right]^{1/\rho} \quad (4)$$

- Labor is paid its marginal product:

$$\ln \left(\frac{w_{H,m}}{w_{L,m}} \right) = \phi_{m,i} + (\rho - 1) \eta_{m,i} \quad (5)$$

where

$$\phi_{m,i} = \ln \left(\frac{\varphi_{m,i}}{1 - \varphi_{m,i}} \right) \quad (6)$$

Industry neutral labor demand model

- Industry neutral means (Trefler 1993):

$$\phi_{m,i} = \alpha_m + \beta_i. \quad (7)$$

- The relative productivity of skilled labor $(\phi_{m,i} - \phi_{\hat{m},i})$ is the same in all industries for a given country pair.
- I call α_m country m 's *skill bias*.

Industry neutral results: Cross-section

Table 11: Industry neutral decomposition of cross-country education gaps

Skill cutoff	Avg.gap	$\Delta\alpha_m$	ΔW_m	ΔL_m	$\Delta\alpha_m + \Delta W_m$
Primary	41.2	16.5 (0.75)	1.1 (0.03)	1.0 (0.00)	18.2 (0.78)
Secondary	20.0	14.9 (0.90)	0.9 (-0.02)	1.0 (0.00)	13.9 (0.88)
College	4.5	3.2 (0.79)	0.9 (-0.06)	1.0 (0.00)	3.0 (0.73)

Result: Industry detail has little effect on the cross-sectional decomposition.

- Why does "skill bias" differ across countries?
- Is it skill bias or factor quality?
- Why are "skill bias" differences industry neutral?