STEG Virtual Course on “Key Concepts in Macro Development”

Supplemental Lecture: Human capital in developing countries

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Human Capital

Stock of productivity-enhancing attributes embedded in people

- Multi-dimensional stock:
  - Knowledge, skills, habits, health, ...
- Produced by investments:
  - Education, training, practice, exercise, ...

Brought to the forefront of economics in the late 1950s and early 1960s

- Especially Becker (1964), Mincer (1974), and Ben-Porath (1967).

Two Goals for Today

Measure cross-country differences in stock of human capital

- Large relative to early consensus, cross-country income differences
- Note: only indirectly use the excellent literature on within-country human capital

Illustrate key model mechanisms literature has used to think about these differences

- Build out from Becker (1964) and Ben-Porath (1967).
- Three mechanisms at work.

Challenge

Thought experiment: what explains productivity differences among workers within a country?

- Goal: enumerate and quantify the characteristics embedded in people
- Separate from environmental factors

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- Goal: enumerate and quantify the characteristics embedded in people
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Complications grow when investigating cross-country differences

- Set of relevant characteristics is larger
- Greater differences in confounding, environmental factors

Measurement of Human Capital Differences

Production Function & Development Accounting

Assumption 1: Aggregate Production Function

$$Y_c = K_c^{\alpha}(A_c H_c)^{1-\alpha}$$

$$y_c = \underbrace{\left(\frac{K_c}{Y_c}\right)^{\frac{\alpha}{1-\alpha}} A_c}_{\equiv z_c} \underbrace{\frac{H_c}{L_c}}_{\equiv h_c}$$

Development Accounting Equation

$$\underbrace{\log(y_c)}_{\text{PPP GDP p.w.}} = \underbrace{\log(z_c)}_{\text{capital-output \& TFP}} + \underbrace{\log(h_c)}_{\text{human capital p.w.}}$$

Challenge: how to measure h_c?

- Probably not regressions (e.g., Mankiw, 1995)

Key Assumptions

Two assumptions allow substantial progress (Bils and Klenow, 2000)

1. Perfect substitution among labor types (efficiency units)
2. Competitive labor markets

Allow us to use firm's FOC to characterize demand for workers with h_i units of human capital:

$$
\begin{aligned}
w_{i,c} &= MPL_{i,c} \\
w_{i,c} &= (1-\alpha)\left(\frac{K_c}{Y_c}\right)^{\frac{\alpha}{1-\alpha}} A_c h_i \\
&= (1-\alpha) z_c h_i
\end{aligned}
$$

Two derivations

Connection to Micro-Labor Literature

This first-order condition implies a log-linear wage equation:

$$\log(w_{i,c}) = \underbrace{\log\left([1-\alpha]z_c\right)}_{\text{country effect}} + \underbrace{\log(h_i)}_{\text{worker human capital}}$$

Connects with a large micro-labor literature that estimates Mincer wage equations within a country:

$$\log(w_i) = \beta_0 + \beta_1 s_i + \beta_2 e_i + \beta_3 e_i^2 + \varepsilon_i$$

Connection between the two:

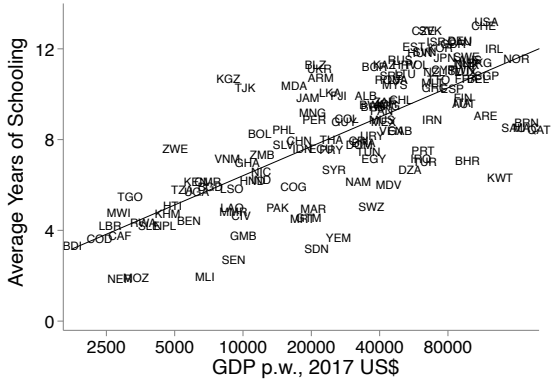
- The intercept β_0 captures country-specific.
- Other variables such as s and e are dimensions/proxies of h
- $\beta_1 - \beta_3$ capture the value of those dimensions

Constructive Approach to Measuring Human Capital Stocks

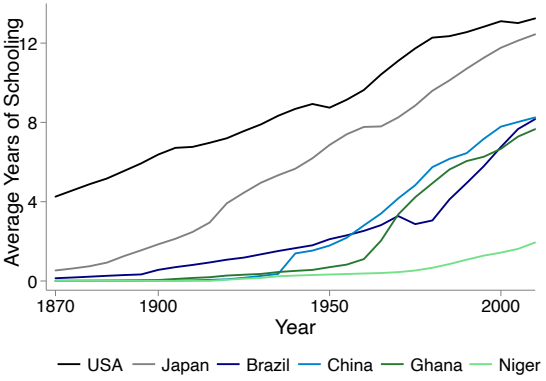
Four steps:

1. Select dimensions (attributes, proxies) of human capital to be measured
2. Measure each nation's stock along relevant dimensions
3. Evidence from Mincer wage equations is informative about value
4. Aggregate human capital

Education Quantity: Years of Schooling



Education & Development, 2010
(Barro and Lee, 2013)



Education for Select Countries, 1870–2010
(Lee and Lee, 2016)

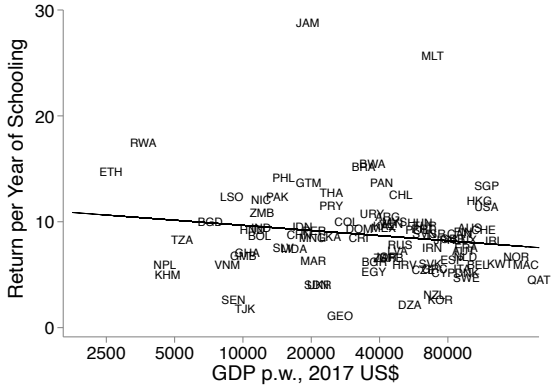
Valuing Years of Schooling

Literature: wages are log-linear in schooling

- U.S. return to schooling is 8–10%

Some evidence this is breaking down

- Lemieux (2006)



(Caselli et al., 2016)

Classic Estimate of Human Capital

Data description: large differences in years of schooling, common worldwide return of 8–10%.

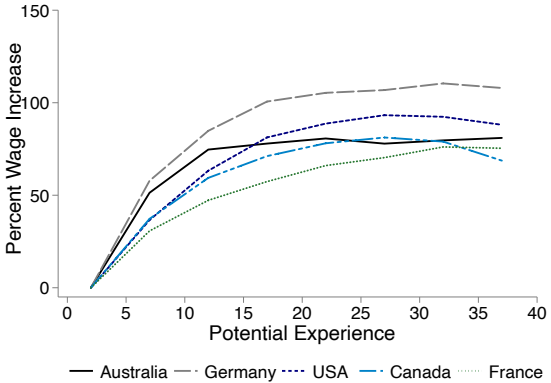
- Builds on earlier work of Psacharopoulos (1994), Psacharopoulos and Patrinos (2004)
- Weak or no evidence of diminishing returns (Banerjee and Duflo, 2005)
- See also new work with consistent, internal estimates (Jedwab et al., 2020; Rossi, 2020).

Construct human capital as $\log(h_c) = 0.1 s_c$.

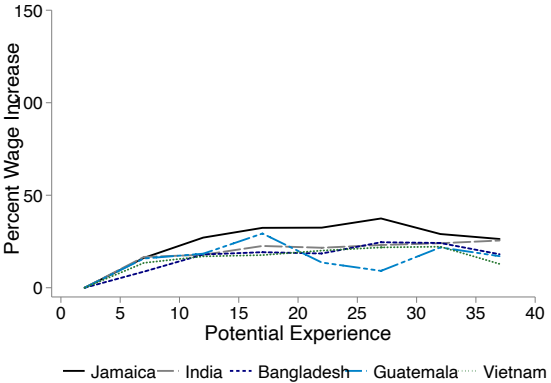
- $\frac{h_{90}}{h_{10}} = 2.1$; $\frac{y_{90}}{y_{10}} = 18.9$.
- $\frac{h_{90}/h_{10}}{y_{90}/y_{10}} = 10.9\%$.
- $\frac{cov(\log(h),\log(y))}{var(\log(y))} = 18.6\%$

Level of Experience is Similar, but Returns Vary

Potential experience = years since graduation = *age − schooling −* 6**.**



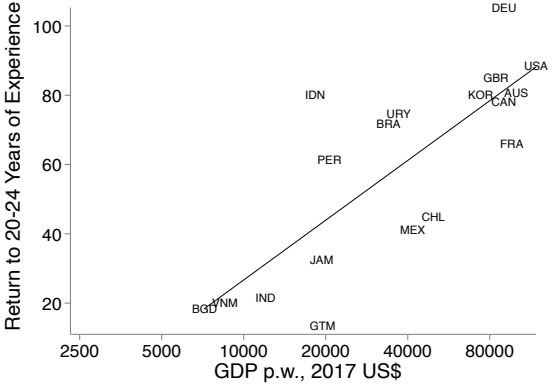
Profiles, Select Rich Countries



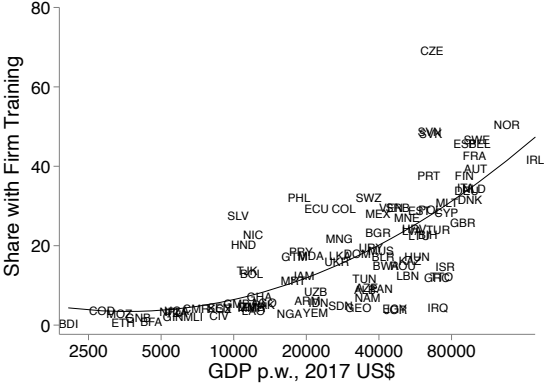
Profiles, Select Poor Countries

(Lagakos et al., 2018b)

Returns to Experience, Training, and Development

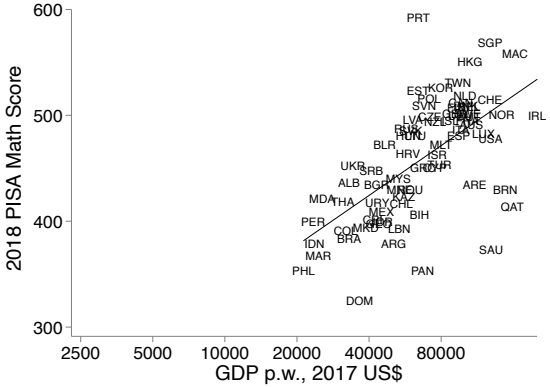


Returns to Experience and Development
(Lagakos et al., 2018b)

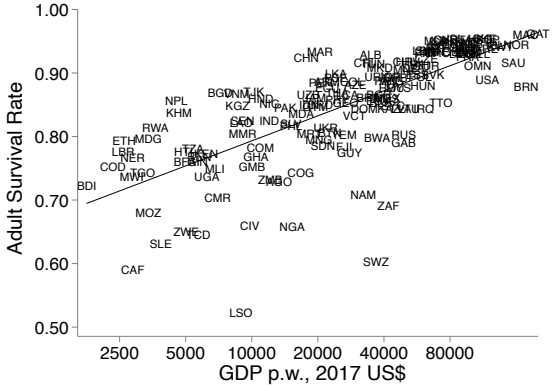


Training and Development
(Ma et al., 2020)

Education Quality & Health



2018 PISA Math Scores and Development
(*OECD PISA 2018 Database*, 2018)



2018 Adult Survival Rate and Development
(World Bank, 2020)

Total Constructed Human Capital

Cumulating, one step at a time, $\frac{cov(\log(h),\log(y))}{var\ \log(y)}$ metric:

- Years of schooling: 19%
- Years + quality of schooling: 38%
- Total schooling + experience: 56%
- Total schooling + experience + health: 59%

See also:

- Experience: Lagakos et al. (2018a); Jedwab et al. (2020)
- Education quality: Schoellman (2012); Hanushek and Woessmann (2012); Kaarsen (2014).
- Health: Weil (2007)

Summary

First approach to cross-country human capital differences is to construct it, piece by piece

- Accounts for differences in stocks or (perhaps) returns
- Resulting estimates are large, account for perhaps 60 percent of income differences

Some concerns:

- Necessary assumptions (see e.g. Jones, 2014).
- It is hard to be exhaustive
- May be double-counting

Deductive Approach

Human capital is, by definition, embedded in people.

- Migrants carry their human capital to new countries
- Their outcomes allow us to deduce the importance of human capital

Recall that under the maintained assumptions, wages are given by:

$$\log(w_{i,c}) = \log\left([1-\alpha]z_c\right) + \log(h_i)$$

Trade-off: two additional concerns that need to be addressed

- Migrants are not randomly chosen (selection)
- Migrants' human capital may not be the same (skill loss, discrimination)

Wage Gains at Migration

Wage gains for worker who migrates from c to c' is:

$$\log(w_{i,c'}) - \log(w_{i,c}) = \log(z_{c'}) - \log(z_c)$$

Change in z_c is one part of development accounting puzzle

$$\log(y_c) = \log(z_c) + \log(h_c)$$

Intuition: suppose worker migrates from poor to 10$\times$ richer country

- Wages increase 10$\times$? Country (z_c) explains low wages
- Wages don't change? Low human capital explains low wages
- Selection, skill loss?
- Alternatives: Hendricks (2002); Schoellman (2012); De Philippis and Rossi (forthcoming)

Implementation

Needed: data on pre- and post-migration wages. Two sources (Hendricks and Schoellman, 2018).

1. New Immigrant Survey: sample of adult LPR recipients to the US, May–November 2003
2. Migration Projects: sample of communities in Mexico and Latin America with high migration rates

Wages converted to PPP

- Compare real wage gains to gap in real GDP per worker

Large set of covariates

- Demographics, education, occupation, industry, visa status

Human Capital and Development Accounting

Group	Hourly Wage		Development Accounting			
	Pre-Mig.	Post-Mig.	Wage Gain	GDP Gap	*h* share	95% C.I.
Panel A: NIS Sample by GDP per worker category						
$< 1/16$	\$2.82	\$8.91	3.2	31.8	0.66	(0.60, 0.73)
$1/16 - 1/8$	\$4.19	\$11.83	2.8	11.9	0.58	(0.54, 0.62)
$1/8 - 1/4$	\$4.95	\$9.48	1.9	5.6	0.63	(0.55, 0.71)
$1/4 - 1/2$	\$5.05	\$9.11	1.8	3.0	0.48	(0.34, 0.62)
$1/2 - 1$	\$12.64	\$15.18	1.2	1.3	0.48	(-0.23, 1.19)
Panel B: MP Sample by Subsample						
Latin Am. MP	\$4.84	\$7.05	1.5	7.0	0.79	(0.71, 0.87)
Mexican MP	\$2.96	\$6.04	2.0	2.9	0.33	(0.29, 0.37)

Pool poor countries ($<$1/4 US GDP p.w.) in NIS: 62%

- Range of adjustments for skill loss: 50–60%

Summary of Measurement

Deductive approach: strengths and weaknesses

- Exhaustive, but not constructive
- Avoids double counting
- Requires additional assumptions about migrants

Quantitatively similar results

- Human capital accounts for 50–60% of income differences

Still room to explore

- Parenting & early childhood (Schoellman, 2016; De Philippis and Rossi, forthcoming)
- Culture (Ek, 2020)
- Specific skills (Hjort et al., 2021)

Models of Human Capital Differences

Goal for Model Section

Illustrate mechanisms that can help explain large human capital differences

- Why do people in some countries invest much more?
- Benchmark model that delivers no differences (Becker, 1964; Ben-Porath, 1967)
- Three mechanisms that deliver differences

Quantitative modeling as a measurement device

- Models can be calibrated or estimated using cross-country, cross-sectional data
- Ask: how important are mechanisms, human capital?

Model: Firm(s)

Firm(s): same as above. Operates the aggregate technology:

$$Y_c = K_c^{\alpha}(A_c H_c)^{1-\alpha}$$

Maintain same two key assumptions:

1. Perfect substitution among labor types (efficiency units)
2. Competitive labor markets (workers paid marginal product)

Yields simple expression for wages:

$$w_{i,c} = (1-\alpha) z_c h_i$$

Benchmark Model: Simple School Choice

Consumer lives for one unit of time. They maximize utility:

$$\int_0^1 \log(c(t))dt$$

They divide their unit of time between school and work

- Attend school for length of time s
- Schooling yields human capital $h(s)$
- Work with $h(s)$ for the remaining $1 - s$

Budget constraint:

$$\int_0^1 c(t)dt = \mathbb{I} = (1 - \alpha)z_c h(s)(1 - s)$$

Two Results for Benchmark Model

Workers smooth consumption throughout the period

$$c(t) = c = \mathbb{I}$$

Optimal school choice maximizes income. FOC:

$$\underbrace{(1-\alpha)z_c(1-s)h'(s)}_{\text{marginal benefit of extra } s} = \underbrace{(1-\alpha)z_c h(s)}_{\text{marginal cost of extra } s}$$

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Simplify to find that optimal school choice is independent of z_c (Becker neutrality)

$$h'(s)(1-s) = h(s)$$

Mechanism 1: Borrowing Constraints

Model assumes worker consumes while in school, before earning

- $s\mathbb{I}$ units of consumption, in total
- Possibly direct costs of education as well

Limits on ability of children and families to finance this investment (Becker and Tomes, 1986):

1. Credit markets are imperfect
2. Children cannot enter binding contrants
3. Altruism may not be perfect
4. Parents cannot pass on debt to their children

Variation in mechanisms to address these limits may help explain human capital investment

Mechanism 2: Goods Inputs to Human Capital Production

Use time and goods to invest in human capital (Manuelli and Seshadri, 2014). New budget constraint:

$$\int_0^1 c(t)dt + e = \mathbb{I} = (1-\alpha)z_c h(s,e)(1-s)$$

Specialize to the power human capital production function:

$$h(s,e) = s^{\eta} e^{\gamma}$$

Solve for the elasticities (Erosa et al., 2010):

$$\varepsilon_{s,z} = 0$$

$$\varepsilon_{e,z} = \frac{1}{1-\gamma}$$

$$\varepsilon_{h,z} = \frac{\gamma}{1-\gamma}$$

Derivations

Mechanism 3: Complementary Role for Government

Allow for government expenditures into education g. Three channels:

1. $h(s, e+g) = s^{\eta}(e+g)^{\gamma}$: matters if g exceeds privately optimal level of e.
2. $h(s, e, g)$: raises the marginal product of schooling and/or expenditures
   - E.g., $h(s, e, g) = gs^{\eta}e^{\gamma}$ implies that e (but not s) responds to g
3. Alleviates borrowing constraints

Putting the Features to Work

Three papers put variations of these ideas to work

- (Plus some extra features..)
- Discipline the model to fit facts shown in the constructive method section
  - Time spent in school, return to schooling, life-cycle wage growth..

These models generate differences in school attainment and human capital quality:

- Córdoba and Ripoll (2013): human capital quality varies by a factor $\approx 2.5\times$
- Manuelli and Seshadri (2014): human capital quality varies by a factor of $\approx 5\times$.
- Erosa et al. (2010): human capital, TFP approximately equally important

Other Model Ideas

Other mechanisms

1. Quantity-quality tradeoff (Córdoba and Ripoll, 2013; Manuelli and Seshadri, 2014)
2. Life expectancy (Córdoba and Ripoll, 2013; Manuelli and Seshadri, 2014)
3. Skill-biased technical change (Goldin and Katz, 2008)
4. Structural change (Buera et al., 2018)
5. ...

Conclusion: Two Main Ideas

Measurement: human capital varies substantially across countries

- Constructive & deductive approaches: 50–60% of income differences

Model: we have mechanisms to help generate such differences

- Deviate from classic, simple school choice model
- Borrowing constraints, goods investments, public education, ..

Extra Slides

Wage Equation (Derivation #1)

Firm hires H_c units of human capital at a wage per unit of human capital ω_c

$$\max_{K_c, H_c} K_c^{\alpha}(A_c H_c)^{1-\alpha} - r_c K_c - \omega_c H_c$$

FOC for human capital sets the price per unit of human capital:

$$\begin{aligned}
\omega_c &= (1-\alpha)\frac{K_c(A_c H_c)^{1-\alpha}}{H_c} \\
&= (1-\alpha)\frac{K_c(A_c H_c)^{1-\alpha}}{L_c}\frac{1}{h_c} \\
&= (1-\alpha)\left(\frac{K_c}{Y_c}\right)^{\frac{\alpha}{1-\alpha}} A_c \\
&= (1-\alpha) z_c
\end{aligned}$$

Worker who supplies $h_{i,c}$ units of human capital earns observed wage $w_{i,c}$:

$$\begin{aligned}
w_{i,c} &= \omega_c h_{i,c} \\
&= (1-\alpha) z_c h_{i,c}
\end{aligned}$$

Wage Equation (Derivation #2)

Firm chooses quantity $N_{i,c}$ of workers with human capital $h_{i,c}$ to hire at wage $w_{i,c}$:

$$\max_{K_c, N_{i,c}} K_c^{\alpha} \left(A_c \sum_i N_{i,c} h_{i,c} \right)^{1-\alpha} - r_c K_c - \sum_i w_{i,c} N_{i,c}$$

FOC for type i labor sets the wage:

$$\begin{aligned} w_{i,c} &= (1-\alpha) K_c^{\alpha} \left(A_c \sum_i N_{i,c} h_{i,c} \right)^{-\alpha} A_c h_{i,c} \\ &= (1-\alpha) \frac{K_c^{\alpha} \left(A_c \sum_i N_{i,c} h_{i,c} \right)^{1-\alpha}}{L_c} \frac{L_c}{H_c} h_{i,c} \\ &= (1-\alpha) \left(\frac{K_c}{Y_c} \right)^{\frac{\alpha}{1-\alpha}} A_c h_{i,c} \\ &= (1-\alpha) z_c h_{i,c} \end{aligned}$$

Back

Elasticity Derivation

Worker chooses schooling and expenditures to maximize income net of expenditures:

$$\max_{e,s} \quad \mathbb{I} - e = (1-\alpha) z_c s^{\eta} e^{\gamma} (1-s)$$

First-order conditions:

$$\begin{aligned} s: \quad & (1-\alpha) z_c \eta s^{\eta-1} e^{\gamma} (1-s) = (1-\alpha) z_c s^{\eta} e^{\gamma} \\ e: \quad & (1-\alpha) z_c s^{\eta} \gamma e^{\gamma-1} (1-s) = 1 \end{aligned}$$

Re-arrange to yield expressions for s, then e, then h in turn:

$$\begin{aligned} s^* &= \frac{\eta}{1+\eta} \\ e^* &= \left[(1-\alpha) \frac{\eta^{\eta}}{(1+\eta)^{1+\eta}} \right]^{\frac{1}{1-\gamma}} z_c^{\frac{1}{1-\gamma}} \\ h^* &= \left[(1-\alpha) \frac{\eta^{\eta}}{(1+\eta)^{1+\eta}} \right]^{\frac{\gamma}{1-\gamma}} z_c^{\frac{\gamma}{1-\gamma}} \left(\frac{\eta}{1+\eta} \right)^{\eta} \end{aligned}$$

Back

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