Cross-country Income Gaps: The Role of Human Capital

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Contents

Introduction

How important is human capital for cross-country income differences?

We know from Hall and Jones (1999):

- if "school quality" does not differ across countries, human capital contributes roughly a factor of 2

What if "school quality" differs?

How can we approach this question?

1. Model how human capital is produced.
   (a) estimate a human capital production function
   (b) somehow infer inputs in human capital investment across countries
   (c) Erosa, Koreshkova, and Restuccia (2010); Cordoba and Ripoll (2009); Manuelli and Seshadri (2010)

2. Infer human capital from the variation of wages by schooling
   (a) Jones (2011)

3. Use immigrant wages to measure human capital
   (a) Hendricks (2002); Schoellman (2011)

4. Use test scores
   (a) Hanushek and Woessman (2008); Cubas, Ravikumar, and Ventura (2013)

Erosa et al. (2010)

We study one model that takes the approach of estimating a human capital production function: Erosa, Koreshkova, and Restuccia (2010)

Demographics:

- there is a unit measure of infinitely lived dynasties
- individuals live for 3 periods (child, young, old)

Endowments at the beginning of time:

- h_o units of human capital of the old
- h_p units of human capital of the young
- a_0 units of capital

Endowments in each period:

- z: ability of the child, transition matrix $Q(z, z')$
- θ: taste for schooling, iid

Preferences

$\left(C_M^{\gamma} C_S^{1-\gamma}\right)^{1-\sigma} / (1-\sigma) + v(s, \theta)$

Households like

- consumption of 2 goods
- s: school time of the child

Note: parents invest because they like schooling, not because it pays

Technologies

- manufacturing: $Y_M = A_M K_M^\alpha H_M^{1-\alpha} = C_M + X$
  - $K' = (1-\delta) K + X$
- services: $Y_S = A_S K_S^\alpha H_S^{1-\alpha} = C_S + E$
  - E: aggregate spending on human capital
- human capital of a child: $h_c = A_H z \left(s^\eta e^{1-\eta}\right)^\xi$
  - e: school spending (services)
  - also requires $\bar{l}s$ units of market labor (teachers)

Household problem

$V\left(q,h_p,z,\theta\right)=\max_{c,e,s,h_c,a}U\left(C\right)+v\left(s,\theta\right)+\beta\mathbb{E}V\left(q',h_p',z',\theta'\right)$

subject to

$P_c c+P_S e+\left(w\bar{l}-p\right)s+a=\left(1-\tau\right)w\left[\psi_2 h_p+\psi_1 h_c\left(1-s\right)\right]+q$

$h_c=A_H z\left(s^{\eta}e^{1-\eta}\right)^{\xi}$

$q'=\left(1-\tau\right)\left[w\psi_3 h_p+ra\right]+a$

$h_p'=\mu' h_c$ with $\mu'\sim iid$

$a\geq 0$, $s\in[0,1]$

Notes:

- q is labor income of the old plus asset income (odd notation)
- government pays subsidy ps for schooling

Properties

Why is there heterogeneity in schooling?

If we drop the borrowing constraint and preference shocks, then:

- quantity of schooling only varies across persons if $\bar{l} > 0$
- intuition: ability affects school costs and benefits equally

Across individuals, increasing ability by 1% increases s, e, h by $1/\left(1-\xi\right)\%$.

- so ξ is the key parameter of the model

Amplification: Increasing w by 1% increases s, h by $\left(1-\eta\right)\xi/\left(1-\xi\right.$

- this is large if the share of goods in h production is large $\left(1-\eta\right)$
- or if returns to scale in the production of h are large $\left(\xi\right)$

GE Properties

Consider a world where countries differ only in $A_S^j = \left(A_M^j\right)^{\varepsilon}$.

Again abstract from preferences shocks and borrowing constraints.

Then: a 1% increase in A_M results in a steady state increase of h, s of

$$\frac{(1-\eta)\,\xi}{1-\xi}\left(\frac{1}{1-\alpha}-(1-\varepsilon)\right) \tag{1}$$

The first term is the partial equilibrium effect of w on h, s.

The second term is GE amplification.

It is large if:

- the labor share is small (higher h results in lots higher k)
- services productivity varies as much as manufacturing productivity (a small ε implies that low income countries have relative efficient / cheap schooling)

Calibration

Functional forms:

- $\ln z$ is AR(1)
- $v(s, \theta) = \theta(1 - e^{-s})$
- $\theta \in \{\theta_L, \theta_H\}$ – 2 values
- $\Pr(\theta_H|z) = \min\{0.5 + b \ln z, 1\}$

The model is calibrated to U.S. data only.

Targets

1. intergenerational correlation of

   (a) log earnings: 0.5

   (b) schooling: 0.46

2. variance of earnings (log?) earnings: 0.38

3. variance of log “permanent” earnings: 2/3 of var log earnings

4. mean and variance years of schooling (12.4 and 8.5)

5. public education spending of 3.9% of GDP

6. teacher and staff compensation = 5% of GDP

7. Mincer return of 10% and R^2 of Mincer equation

Calibration Summary

Parameters and data targets

Parameter		Value	Target	US	BE
Consumption preferences					
CRRA	σ	2	Empirical literature	—	—
Discount factor	$\beta^{1/20}$	.9646	Interest rate, %	5	5
Goods/services technologies					
Capital share	α	.33	Capital income share	.33	.33
Annual depreciation	δ	0.0745	Investment–output ratio	0.2	.2
Human capital technology					
Schooling cost*	$\bar{l}$	0.0327	Educ. inst. salaries, % GDP	5	5
H.C. RTS	ξ	1.00	Variance of fixed effects	0.67	0.67
H.C. time share	η	0.6	Correlation of schooling	0.46	0.48
*Tastes for schooling**					
Low	θ_L	0.3132	Mean years of schooling	12.6	12.6
High	θ_H	5.3662	R^2 in Mincer regression	0.22	0.21
Ability-taste interact.	b	1.09	Mincer return	0.1	0.1
Ability std	σ_z	0.23	Variance of schooling	8.5	8.3
Ability correlation	ρ_z	0.78	Correlation of earnings	0.5	0.49
Market luck std	σ_μ	0.375	Variance of earnings	0.36	0.38
Tax rate on income	τ	0.043	Public educ. exp., % GDP	3.9	3.9

Stepping Back

The key item to identify: the school technology.

$$h_c = A_H z \left(s^\eta e^{1-\eta}\right)^\xi \tag{2}$$

Key parameters:

- returns to goods $(1-\eta)\,\xi$
- variation in A_H across countries (shut down in this paper?)

The basic idea:

- countries vary in A_M, A_S, A_H (nothin else)
- h magnifies variation in A
- lower A_S or A_H (relative to A_M) and schooling will fall (relative to the wage, it gets more expensive)
- amplification is large if school technology is close to linear

Key question therefore: what data moments do we have to identify school technology?

How does identification work?

- schooling varies across people in a country only because of ability (setting aside some frictions)
- σ_z comes from accounting for the dispersion in schooling (heroic)
- given σ_z, we have to account for the variance of "permanent" earnings
- the only source of variation in permanent earnings in the model is h
- so dispersion in h must be large
- this can only happen if there is little curvature in the h production function
- given σ_z we also have to account for the dispersion in schooling
  - tastes take on only 2 values
  - one value is pinned down by mean schooling
  - large dispersion in schooling requires a large share of goods in h production

There is a pattern here:

- We are loading variation in observables onto a few things we care about (mostly z).
- To get a lot of variation in earnings and schooling, we then need lots of z amplification in individual decisions

What can go wrong:

- within country variation in schooling could have other reasons (preferences, borrowing constraints, school quality, ...)
- within country variation in wages has other sources (luck, compensating differentials, ...)
- then dispersion in z is smaller and h technology is less linear
- amplification of A gaps is smaller.

Key assumptions

1. countries only vary in TFP

    (a) important for assessing whether model can predict non-targeted observations

2. z does not affect earnings

3. functional forms estimated on US data extend to low incomes

4. parents can choose school quality e to match their childrens' z's.

Main Result

Calibrate the model to US data

Compute equilibria (steady states) for various values of A_M

Compute the elasticity of steady state output per worker w.r.to A_M.

Main result: the elasticity is around 2.4 (between 2 and 2.8 depending on ε).

TABLE 5

Amplification

ε	0.1	0.3	0.4	1
	Human capital model			
TFP elasticity of GDP				
PPP prices	1.53	1.94	2.08	2.8
Domestic prices	1.98	2.16	2.26	2.8
A_M ratio for GDP, PPP, ratio of 20	7.1	4.7	4.0	2.9
TFP elasticity of physical capital	1.97	2.15	2.23	2.8
TFP elasticity of human capital	0.46	0.63	0.70	1.24
	Exogenous human capital model			
TFP elasticity of GDP				
PPP prices	0.856	1.046	1.12	1.49
Domestic prices	1.49	1.49	1.49	1.49
A_M ratio for GDP, PPP, ratio of 20	33.1	17.5	14.5	7.5
TFP elasticity of physical capital	1.49	1.49	1.49	1.49

Is it robust?

Take-away points

This is a good paper. The authors know what they are doing. It's careful.

Yet the results don't seem all that compelling.

That suggests a problem with the approach.

It's hard to estimate a production function for h (especially without micro data), given that most inputs are not observed.

Computing the Model

We write code top down.

Level 1:

1. Set parameter values.
2. Guess prices
3. Solve household problem for policy functions, such as $s(q, h_p, z, \theta)$
   (a) z and θ are on a grid
   (b) for each grid point, approximate $s(q, h_p)$ using a 2-dimensional grid
4. Simulate a large number of households
   (a) compute aggregates
   (b) compute deviations from market clearing
5. Search for prices that clear markets.

Solving the household problem

1. Guess a value function
   (a) for each (z, θ), set V on a 2-dimensional grid (q, h_p)
2. Solve the max part, given V on the RHS of the Bellman equation
   (a) for each point in the state space, find controls that satisfy first-order conditions
3. Iterate until V converges

Simulating household histories

1. Draw random variables for the endowments and shocks
2. For each (z, θ), guess a distribution over (q, h_p) [on a grid]
3. Using policy functions, simulate one generation
4. Compute next generation's distributions of $(q, h_p | z, \theta)$
5. Iterate over distributions until convergence.

Immigrant Earnings

How could one measure human capital without knowing the production function?

The problem: we only observe wages

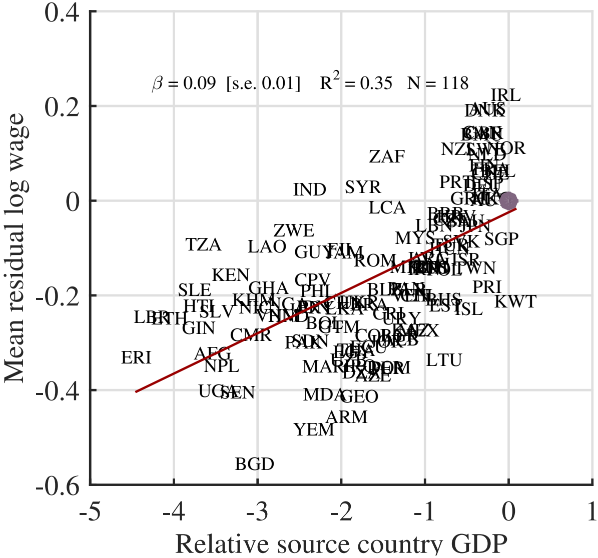
- wage = [skill price] * [human capital]
- skill prices (unobserved) differ across countries

A simple idea: observe workers from different countries in the same labor market

- with the same skill prices
- Hendricks (2002)

Immigrant Earnings in the U.S.

The motivating fact: immigrant earnings do not vary much across rich / poor source countries.



Source: 2010 U.S. Census

Approach

1. run a descriptive wage regression

   (a) LHS: log hourly wage

   (b) RHS: schooling, experience, sex, marital status, ...

2. for each person, compute residual log wage

3. sort workers by country of birth

4. for each country of birth: compute mean residual log wage

5. plot it against relative gdp per worker (PPP, PWT)

Main result: A 1 log point increase in gdp is associated with a 0.09 log point increase in wages (given characteristics).

Interpretation Issues

If there were no immigrant selection: the graph would measure source country human capital relative to the U.S.

Main concern:

Immigrants from low income countries are more positively selected than immigrants from rich countries.

Indirect evidence on selection:

1. Studies that follow migrants across borders show little selection
   (a) but mostly Latin American countries
2. Return migrants earn roughly the same as never-migrants
3. Refugees earn roughly the same as other migrants
4. For some countries (SLV, JAM), a large fraction of workers migrates to the U.S. at some point
   (a) lots of back and forth migration

Not everyone is convinced ...

Work in progress: construct direct measures of selection from NIS data (New Immigrant Survey).

Schoellman (2011)

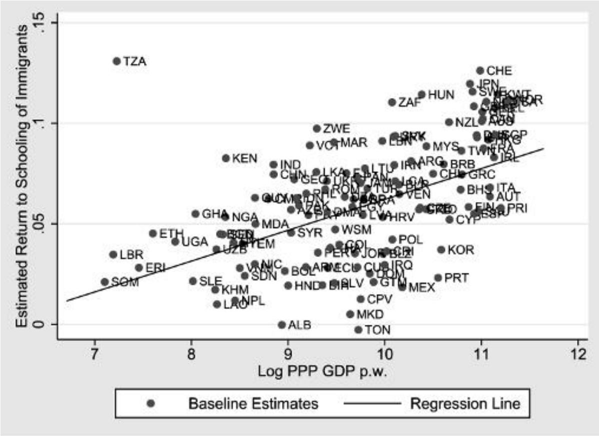
An extension of the immigrant earnings approach by Schoellman (2011)

The idea: use returns to schooling in the U.S. to measure school quality.

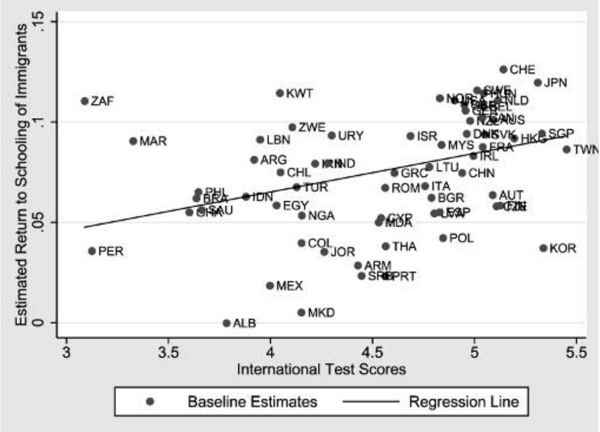
Step 1: Estimate immigrant returns to schooling Run a simple wage regression where coefficient on schooling varies by source country.

Result: school coefficient varies from 0 (ALB, TON) to 12% (CHE, JPN)

Richer countries have higher returns



Countries with higher test scores have higher returns



What about selection?

Selection could be a problem if immigrants from low income countries are selected to have below average school quality, but above average schooling

- perhaps a priori not too plausible

Restrict sample to countries with high fraction of refugees (50%+)

Transferability

There really isn't good evidence to rule out that the human capital acquired in low income countries is a poor match for rich country labor markets.

But we are living in a model with only 1 type of human capital.

Accounting Model

Aggregate production function:

$$Y_j = A_j K_j^{\alpha} \left[h\left(S_j, Q_j\right) L_j\right]^{1-\alpha} \tag{3}$$

Human capital measurement equation

$$h\left(S_j, Q_j\right) = \exp\left[\left(S_j Q_j\right)^{\eta} / \eta\right] \tag{4}$$

This is an invention, due to Bils and Klenow (2000).

Observed:

- Y_j, K_j: PWT
- S_j: Barro and Lee (2013)

We need to estimate Q_j and η.

Then we can construct h for each j and perform levels accounting.

Estimating Q_j

The idea:

- immigrant returns to schooling reveal Q_j

We want to estimate Q_j by running the regression

$$\ln W\left(S_{US}^{j}\right) = c + M_{US}\frac{Q_j}{Q_{US}}S_{US}^{j} \tag{5}$$

In words:

- Run a Mincer regression with country specific returns to schooling
- Then j's Mincer coefficient is proportional to its Q_j

This is really based on intuition, not a model.

Motivating Model for the Wage Regression

To motivate this regression, we develop a simple model.

Workers maximize lifetime earnings:

$$\max_{S} pvEarn - sCost \tag{6}$$

where

$$pvEarn = h\left(S, Q_j\right) \int_{\tau+S}^{\tau+T} e^{-r_j t} w_j\left(0\right) e^{g_j t} dt \tag{7}$$

$$sCost = \int_{\tau}^{\tau+S} e^{-r_j t} \lambda_j w_j\left(0\right) e^{g_j t} h\left(t-\tau, Q_j\right) dt \tag{8}$$

They take Q_j as given.

The cost of schooling is proportional to foregone earnings.

Optimal Schooling

Optimal schooling satisfies

$$S_j = \left[Q_j^{\eta}/M_j\right]^{1/(1-\eta)} \tag{9}$$

where

$$M_j = \frac{(r_j - g_j)(1+\lambda_j)}{1 - \exp\left[-(r_j - g_j)(T - S_j)\right]} \approx (r_j - g_j)(1+\lambda_j)$$

Claim: M_j is the Mincer return in country j.

- This is a bit fishy b/c in the model everyone is the same (no variation in S).
- Not clear what is supposed to change to induce changing S (likely Q) within a country

Some poorly explained messing around with the equilibrium wage in the US then yields the desired regression equation.

Now we have Q_j as a function of M_j (roughly the same everywhere) and S_j.

Estimating η

The idea:

Use the equilibrium schooling equation

$$\ln S_j = \frac{\eta}{1-\eta} \ln Q_j + \frac{1}{1-\eta} \ln M_j \tag{10}$$

Set $M_j = \bar{M}$ based on estimated Mincer regressions.

Instrument Q_j with test scores.

Development Accounting

Main result: Quality differences are as important as school quantity differences.

	This paper			Literat
	$\eta = 0{\cdot}42$	$\eta = 0{\cdot}5$	$\eta = 0{\cdot}58$	Hall and Jones (1999)
h_{90}/h_{10}	6·3	4·7	3·8	2·0
$\frac{h_{90}/h_{10}}{y_{90}/y_{10}}$	0·28	0·21	0·17	0·09
$\frac{\text{var}[\log(h)]}{\text{var}[\log(y)]}$	0·36	0·26	0·19	0·06

Comments

The empirical idea is quite nice:

- use immigrant returns to schooling as a proxy for source country school quality

Quantitatively, it's a bit hard to make this work

We run again into the two issues that plague the entire literature:

1. What is the production function for h?
2. How do deal with migrant selection?

The only clear way out (I think): direct measures of migrant selection (NIS data)

References

Barro, R. J., and J. W. Lee (2013): "A new data set of educational attainment in the world, 1950–2010," *Journal of Development Economics*, 104(0), 184 – 198.

Bils, M., and P. J. Klenow (2000): "Does Schooling Cause Growth?," *The American Economic Review*, 90(5), 1160–1183.

Cordoba, J. C., and M. Ripoll (2009): "Schooling and Development: The Role of Credit Limits, Public Education, Fertility and Mortality," Mimeo. Iowa State University.

Cubas, G., B. Ravikumar, and G. Ventura (2013): "Talent, labor quality, and economic development," *Federal Reserve Bank of St. Louis Working Paper Series*, (2013-027).

Erosa, A., T. Koreshkova, and D. Restuccia (2010): "How important is human capital? a quantitative theory assessment of world income inequality," *The Review of Economic Studies*, 77(4), 1421–1449.

Hall, R. E., and C. I. Jones (1999): "Why do some countries produce so much more output per worker than others?," *Quarterly Journal of Economics*, 114, 83–116.

Hanushek, E. A., and L. Woessman (2008): "The role of cognitive skills in economic development," *Journal of Economic Literature*, 46(3), 607–668.

Hendricks, L. (2002): "How Important Is Human Capital for Development? Evidence from Immigrant Earnings," *The American Economic Review*, 92(1), 198–219.

Jones, B. F. (2011): "The human capital stock: a generalized approach," Discussion paper, National Bureau of Economic Research.

Manuelli, R., and A. Seshadri (2010): "Human Capital and the Wealth of Nations," Mimeo. University of Wisconsin.

Schoellman, T. (2011): "Education Quality and Development Accounting," *The Review of Economic Studies*.