Cross-country Income Gaps: The Role of Human Capital

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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 et al. (2010); Cordoba and Ripoll (2009); Manuelli and Seshadri (2014)
2. Infer human capital from the variation of wages by schooling
   (a) Jones (2014)
3. Use immigrant wages to measure human capital
   (a) Hendricks (2002); Schoellman (2012)
4. Use test scores
   (a) Hanushek and Woessman (2008); Hanushek and Woessmann (2012); Cubas et al. (2015)

Erosa et al. (2010)

We study one model that takes the approach of estimating a **human capital production function**: Erosa et al. (2010)

The idea underlying this literature:

- h is produced from time and goods
- in rich countries, goods inputs in h production are cheap relative to wages
- then people produce lots of human capital per year in school

Key: how elastic is h production w.r.to goods inputs?

Model Elements

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

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

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

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

$h'_p = \mu' h_c$ 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 (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 (nothing 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.

Other Papers

Manuelli and Seshadri (2014)

- Ben-Porath model of human capital production
- again: results are sensitive to a similar elasticity parameter in h production
- striking result: small TFP gaps are enough to account for cross-country income gaps.

Córdoba and Ripoll (2013)

- Ben-Porath
- contribution of h to cross-country income gaps not clear.

Cubas et al. (2015)

- h is produced from goods only
- countries differ in the distribution of "talent"

Conclusion

Wide range of results from the literature on h production functions.

The key elasticity is always: h w.r.to goods

Estimates vary widely – often not based on much evidence.

Does not look promising to me.

Possible papers for student presentations

Multiple skills:

- Jones (2014)

Production function approach:

- Córdoba and Ripoll (2013), Manuelli and Seshadri (2014)

Test scores:

- Cubas et al. (2015), Hanushek and Woessmann (2012)

Experience:

- Lagakos et al. (2015), Lagakos et al. (2016)

References

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

CÓRDOBA, J. C. AND M. RIPOLL (2013): "What explains schooling differences across countries?" *Journal of Monetary Economics*, 60, 184–202.

CUBAS, G., B. RAVIKUMAR, AND G. VENTURA (2015): "Talent, labor quality, and economic development," *Review of Economic Dynamics*.

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, 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, 607–668.

Hanushek, E. A. and L. Woessmann (2012): "Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation," *Journal of Economic Growth*, 17, 267–321.

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

Jones, B. F. (2014): "The Human Capital Stock: A Generalized Approach," *American Economic Review*, 104, 3752–77.

Lagakos, D., B. Moll, T. Porzio, N. Qian, and T. Schoellman (2015): "Experience Matters: Human Capital and Development Accounting," Manuscript. Princeton University.

——— (2016): "Life-Cycle Human Capital Accumulation Across Countries: Lessons From U.S. Immigrants," Working Paper 21914, National Bureau of Economic Research.

Manuelli, R. E. and A. Seshadri (2014): "Human Capital and the Wealth of Nations," *The American Economic Review*, 104, 2736–2762.

Schoellman, T. (2012): "Education quality and development accounting," *The Review of Economic Studies*, 79, 388–417.