Cross-country Income Differences

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Introduction

We study why there are rich and poor countries.

This borrows heavily from Caselli (2005).

You should also read Acemoglu (2009)

A Simple Start

A common view in the literature:

productivity accounts for at least half of cross-country income variation.

We build up this result and then look at recent contributions.

Development Accounting

The basic framework postulates

$$y = Ak^{\alpha}h^{1-\alpha}$$

where

- y: gdp per worker (PPP)
- k: capital per worker
- h: human capital per worker

A key parameter: $\alpha = 1/3$

- observable as the capital share – around $1/3$ in the U.S.
- Gollin (2002) argues that the capital share is roughly the same in rich and poor countries
- that motivates the Cobb-Douglas functional form
- but it may not actually be true

The basic question

The ratio of rich to poor incomes is given by

$$\frac{y_{rich}}{y_{poor}} = \frac{A_{rich}}{A_{poor}} \left(\frac{k_{rich}}{k_{poor}} \right)^{\alpha} \left(\frac{h_{rich}}{h_{poor}} \right)^{1-\alpha}$$

How big are the contributions of inputs (k, h) and "productivity" A?

Measurement

GDP:

- we assume that the PWT got this right.

Capital:

- we have data on investment (quantities)
  - meaning: expenditures deflated by the local price of capital
- perpetual inventory method: $K_{t+1} = (1 - \delta) K_t + I_t$
- assumption: $K_0 = I_0 / (g + \delta)$
- I_0: investment up to 1970 (or something like it)
- $\delta = 0.06$: based on studies of depreciation in rich countries

Measurement: Human capital

Here, things get tricky.

The standard approach follows Hall and Jones (1999)

$h = e^{\phi(s)}$

s: average years of schooling of population over age 25 (Barro-Lee)

$\phi(s)$: piecewise linear with slopes

- 0.13 for $s \leq 4$
- 0.10 for $4 < s \leq 8$
- 0.07 for $s > 8$

The rationale for this:

- assume that workers are paid their marginal products
- then variation of wages within countries reveals $\phi(s)$
- cross-country data show that $\phi(s)$ is higher in countries with low schooling (Psacharopoulos)
- that last fact is probably not true

Implicit assumptions:

- $h(0)$ is the same everywhere
- a year of schooling is the same everywhere

Measures of success

Define $y_{KH} = k^{\alpha} h^{1-\alpha}$.

Variation in y_{KH} is explained by inputs.

Fraction of income variation due to factors according to Caselli (2005):

$$success1 = \frac{var\left[\ln y_{KH}\right]}{var\left[\ln y\right]} = 0.39$$

$$success2 = \frac{y_{KH}^{90}/y_{KH}^{10}}{y^{90}/y^{10}} = 0.34$$

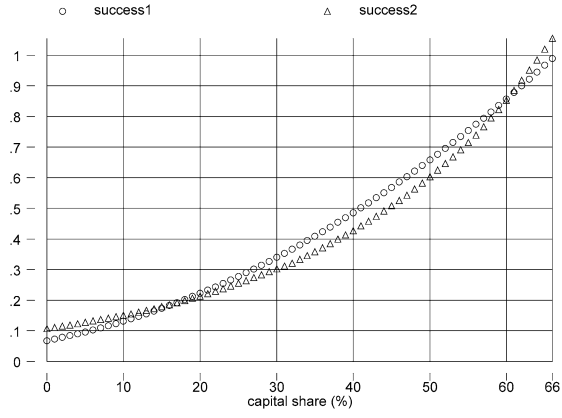
Exercise: Replicate these figures.

Robustness

Quantitatively not important (Caselli, 2005)

- depreciation rate δ
- how K_0 is constructed
- reasonable variation in $\phi(s)$
  - as long as it is consistent with wage data
  - return to schooling could be higher if there a big externalities
- differences in hours worked
  - hours are lower in richer countries

Robustness: Capital share



Higher capital share $\Longrightarrow$ higher success

Because capital varies more than h.

Robustness: School Quality

Since we observe wages by schooling, school quality cannot affect $\phi(s)$.

So we must assume it affects $h(0)$:

$$h = A_h e^{\phi(s)} \tag{1}$$

The problem: if this is the quality of learning, why does it affect all workers equally?

For this to make sense, we need workers with different s to be imperfect substitutes.

We will return to this later.

A simple specification (Caselli 2005):

$$A_h = p^{\phi_p} m^{\phi_m} k_h^{\phi_k} h_t^{\phi_h} \tag{2}$$

This is freely invented.

The inputs are:

- p: teacher-pupil ratio
- m: teaching materials per student
- k_h: capital in education sector
- h_t: teacher human capital.

Why these inputs?

- because we can observe them

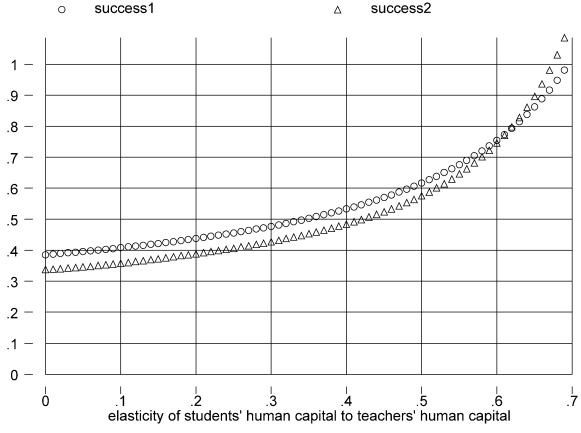
Problem: we don't know anything about the elasticities

- in micro studies using rich country data, the elasticities look like 0
- but there are measurement issues (Hanushek)

A special case

Only include teacher human capital (Bils and Klenow, 2000)

Assume steady state: $h_t = h$.



Source: Caselli (2005)

Clearly, quality could be important.

Problem: how to estimate the h production function?

Later, we look at some sophisticated efforts to do just this.

Promising Ideas

Test scores

Assume that $A_h = e^{\phi_\tau \tau}$

τ is a standardized test score.

Problem:

within a country, a 1 standard deviation increase in test scores increases earnings by at most 20%

See Hanushek and Woessman (2008)

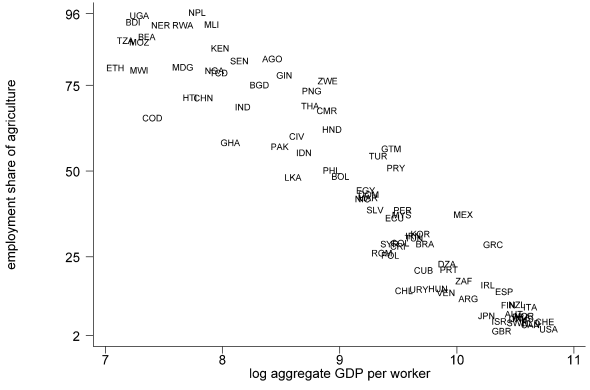
Health

Any measure of health (e.g. mortality) is strongly related to income.

Problem: how to quantify the effect of health on h?

Agriculture

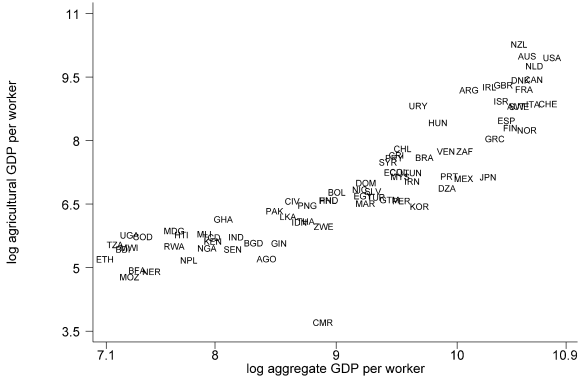
Fact: fraction of workers in agriculture varies from essentially 0 to essentially 1.



Source: Caselli (2005)

Large Variation in Ag Productivity

Variation in Ag productivity is much greater than variation in non-ag productivity



Source: Caselli (2005)

The pattern: low income countries employ large amounts of labor in a sector with particularly low productivity.

How much does this matter?

A counterfactual experiment by Caselli (2005):

moving all labor into industry (holding productivity constant) would cut cross-country income differences by 3/4

This provides the background for papers that ask:

1. Why is so much labor employed in the wrong sector in low income countries?
   (a) Gollin, Parente, and Rogerson (2002)
   (b) Gollin, Parente, and Rogerson (2007)
   (c) Restuccia, Yang, and Zhu (2007)
2. Why is labor productivity so low in agriculture
   (a) Gollin, Lagakos, and Waugh (2011)
   (b) Lagakos and Waugh (2013)
   (c) Herrendorf and Schoellman (2011)

Non-neutral Productivity Differences

What if we relax the Cobb-Douglas assumption?
For example:

$$Y = \left[\alpha \left(A_k K\right)^{\sigma} + \left(1-\alpha\right)\left(A_h h L\right)^{\sigma}\right]^{1/\sigma} \tag{3}$$

with elasticity of substitution $\eta = 1/\left(1-\sigma\right)$.

Parameterizing this: Assume that factors are paid marginal products:

$$r = \alpha \left(y/k\right)^{1-\sigma} A_k^{\sigma} \tag{4}$$

$$w = \left(1-\alpha\right)\left(y/h\right)^{1-\sigma} A_h^{\sigma} \tag{5}$$

Given data on y, k, h, r, w, we can back out productivities:

$$A_k = \left(S_k/\alpha\right)^{1/\sigma} y/k \tag{6}$$

$$A_h = \left(S_h/\left(1-\alpha\right)\right)^{1/\sigma} y/h \tag{7}$$

where S_k, S_h are factor income shares.

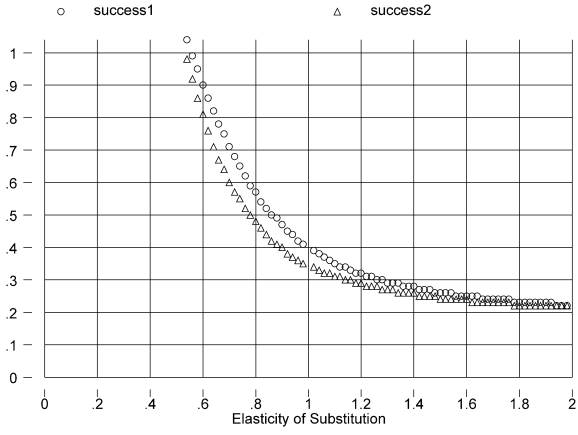
Problem: we don't know much about η.

Implications

1. For any reasonable value of η not close to 1 (Cobb-Douglas),
   (a) A_h is positively related to y, but
   (b) A_k is *negatively* related to y.
2. A generalization: extend the model to have skilled and unskilled labor, then: poor countries use
   (a) skilled labor less efficiently
   (b) unskilled labor *more* efficiently (Caselli and Coleman, 2006).
3. If the elasticity of substutition between factors is low enough, factor inputs account for a large share of cross-country income gaps.

Illustration from the 2 factor (k, h) model

Assume that all countries use the U.S. technology

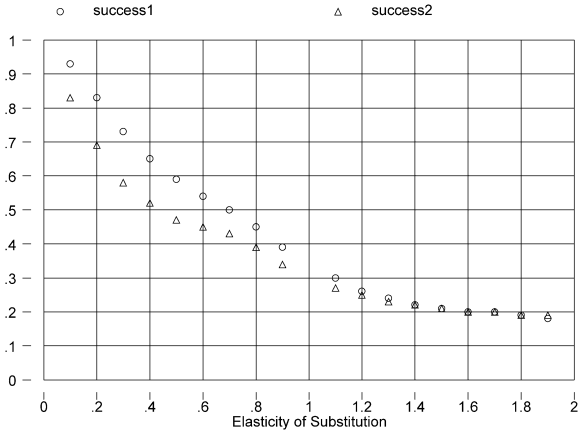


This experiment is a bit awkard.

It forces low income countries to use a k intensive technology, even though their endowments are h intensive.

Alternative experiment:

Let each country choose from the menu of technologies observed in the data.



The conclusion remains: the Cobb-Douglas assumption matters.

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