How Important Is Capital? Part 2

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Econ520

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Outline

We developed an aggregate production function to measure the role of K/L for variation in Y/L across countries.

Next, we develop its implications.

Accounting for cross-country income gaps

The model in per capita terms

We want to understand variation in output per worker (Y/L).

Production function:

$$\begin{aligned} Y/L &= A^{1-\alpha}K^{\alpha}L^{1-\alpha}/L \\ &= A^{1-\alpha}(K/L)^{\alpha} \end{aligned} \tag{1}$$

Per capita notation: $y = Y/L$ and $k = K/L$.

$$y = A^{1-\alpha}k^{\alpha} \tag{2}$$

Output gap between 2 countries

$$\frac{y_{IND}}{y_{US}} = \left(\frac{A_{IND}}{A_{US}}\right)^{1-\alpha} \left(\frac{k_{IND}}{k_{US}}\right)^{\alpha} \tag{3}$$

This divides output gaps into two components:

1. One we understand / can measure: k.
2. One we don't understand:A - everything else.

We can use the model to measure the importance of capital versus everything else.

How does k affect y?

Recall

$$y = A^{1-\alpha} k^{\alpha}$$

with $\alpha = 1/3$.

Multiply k by factor λ, then y rises by...

How does k affect y?

Example

A country with $\lambda = 1/40$ of U.S. capital has $(1/40)^{1/3} = 0.32$ of U.S. output.

Why is the effect so "small"?

Country examples

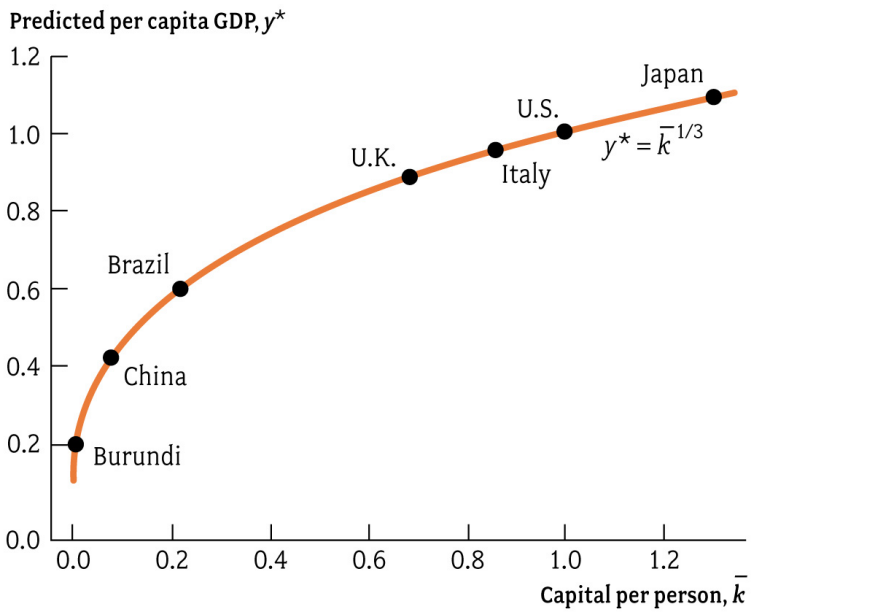


FIGURE 4.4 Predicted Per Capita in the Production Model

Macroeconomics, Charles I. Jones

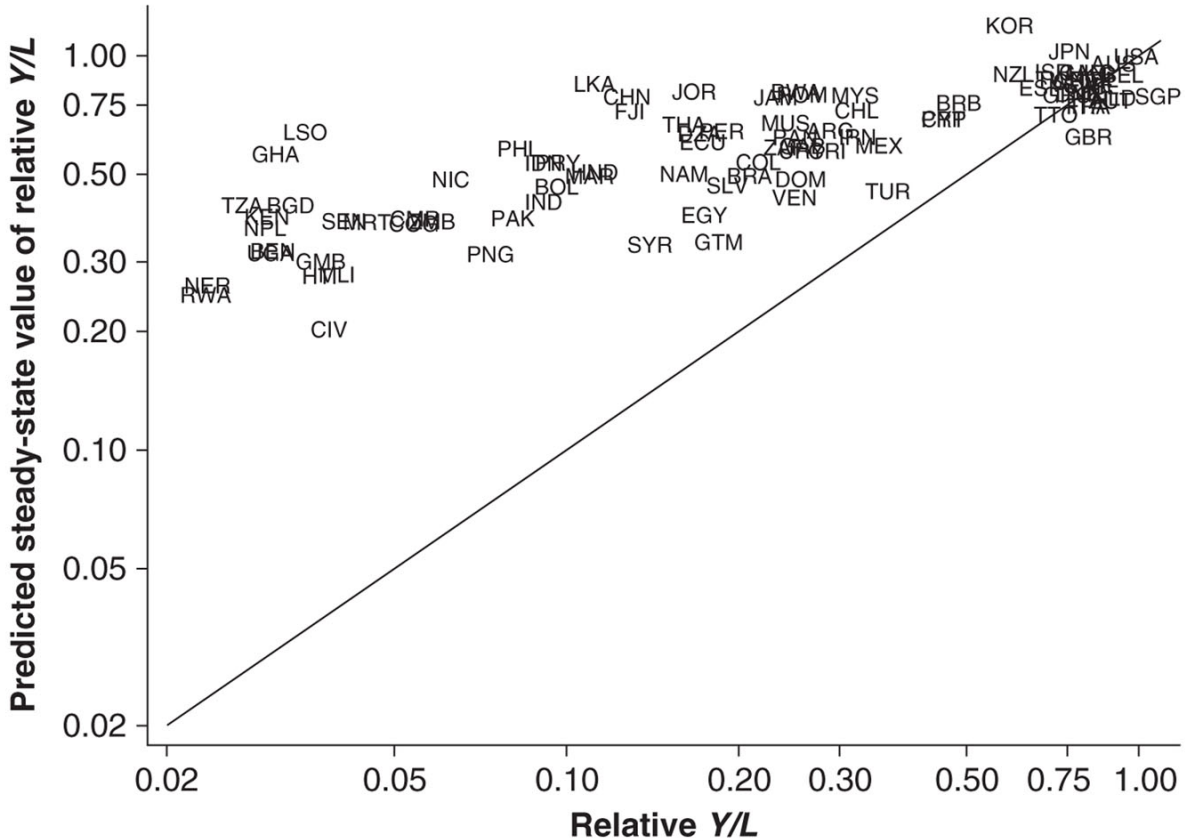
Thought experiment: Hold A constant and vary k.

Key: Even with very small k, output is 20% of US.

What would this graph look like with $\alpha = 0.99$?

The contribution of k to y gaps

FIGURE 3.1 THE "FIT" OF THE NEOCLASSICAL GROWTH MODEL, 2008



Predicted y: $\hat{y}_i = A_{US}^{1-\alpha} k_i^{\alpha}$.

Result: k gaps account for y gaps "only" up to 1/4 of US y.

The model as a measurement tool

A key idea

Models can be used to measure unobservable quantities and prices.

Think of the model as measuring $\bar{A}$ for each country i:

$$\bar{A}_i = A_i^{1-\alpha} = \frac{y_i}{k_i^{\alpha}} \tag{4}$$

Measuring Productivity

Country	Per capita GDP (y)	$\bar{k}^{1/3}$	Implied TFP ($\bar{A}$)
United States	1.000	1.000	1.000
Switzerland	0.793	1.106	0.717
Japan	0.741	1.092	0.679
Italy	0.654	0.951	0.688
United Kingdom	0.666	0.881	0.756
Spain	0.542	0.883	0.614
Brazil	0.216	0.591	0.365
South Africa	0.227	0.512	0.443
China	0.113	0.422	0.266
India	0.074	0.328	0.227
Burundi	0.016	0.190	0.083

Calculations are based on the equation $y = \bar{A}\,\bar{k}^{1/3}$. Implied productivity $\bar{A}$ is calculated from data on y and $\bar{k}$ for the year 2000, so that this equation holds exactly as $\bar{A} = y/\bar{k}^{1/3}$.

TABLE 4.4 Measuring TFP So the Model Fits Exactly

The model as a measurement tool

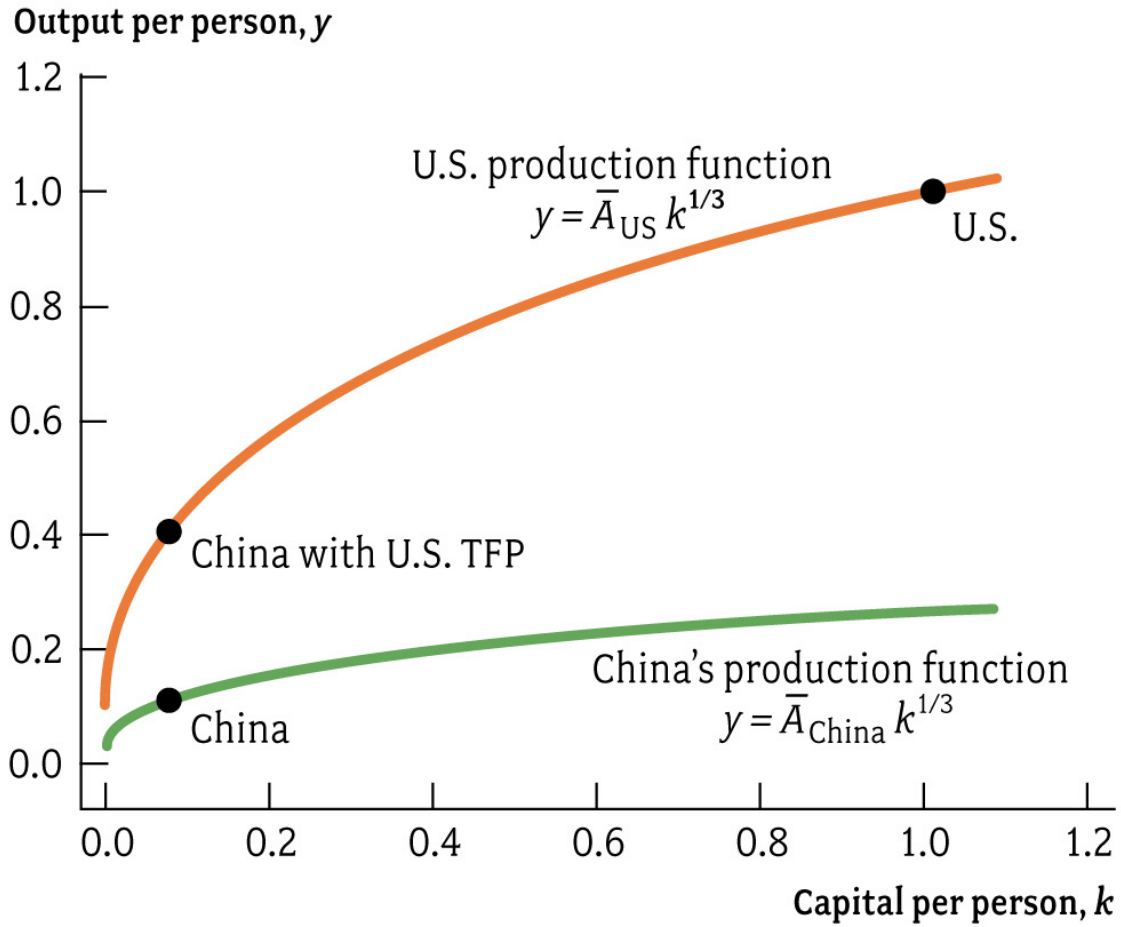


FIGURE 4.6 The U.S. and Chinese Production Functions

Macroeconomics, Charles I. Jones

Exercise

Given:

- $y = \bar{A}k^{\alpha}$; $\alpha = 1/3$
- U.S.: $y = 1$ and $k = 1$ (normalization).
- CHN: $y = 0.1$ and $k = 0.05$ (not exactly data, but close)

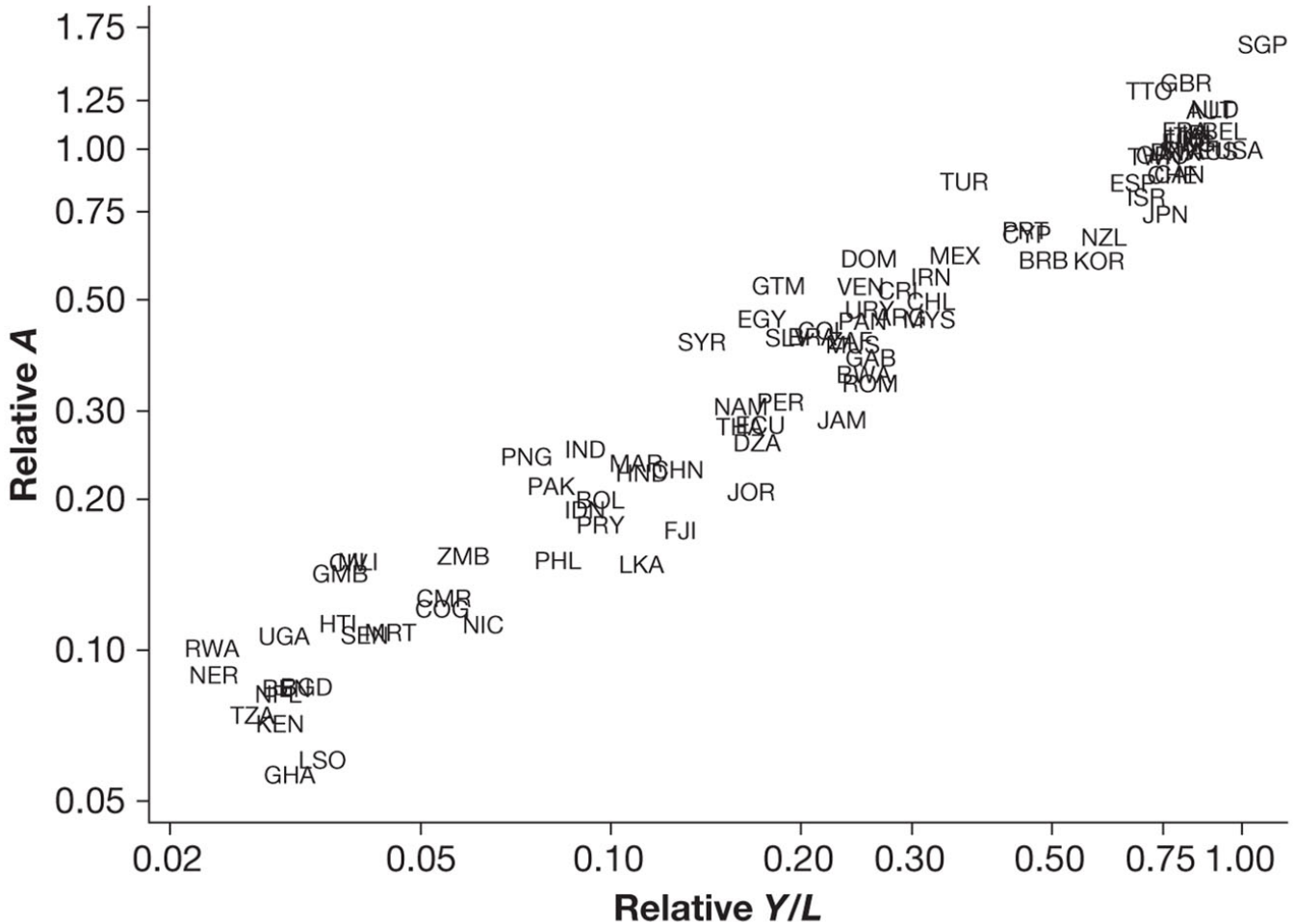
Find:

- $\bar{A}_{US}$, $\bar{A}_{CHN}$
- y_{US} with k_{CHN}
- y_{CHN} with k_{US}
- the fraction of y_{US}/y_{CHN} that is due to k and $\bar{A}$

How would your answer change with $\alpha = 2/3$?

The model as a measurement tool

FIGURE 3.2 **PRODUCTIVITY LEVELS, 2008**



Source: Jones (2013b)

What fraction of cross-country income gaps is due to capital?

The answer varies across countries.

For poor countries: about 1/3 is due to capital, 2/3 are yet unexplained (due to A).

Look back to the figure on the previous slide:

Y/L rich/poor	$(K/L)^{\alpha}$ rich/poor	$A^{1-\alpha}$ rich/poor
32	4	8
8	1.6	5
2	1	2

Summary

1. Capital accounts for about 1/3 of cross-country variation in per capita GDP.
   Later we argue: properly accounted, the fraction should be even smaller.
2. The main reason why the share is smallish:
   α is low
   Therefore: even with very little K/L a country can produce quite a bit of output.
3. This makes α a key parameter for modeling growth / development.

Human Capital

Adding human capital to the model

The goal: understand large differences in productivity A across countries.

We start with human capital.

Definition

Human capital: any knowledge or skills learned by workers that increase productivity.

Not just education, but also

- learning from parents, peers, on the job,
- health, ...

Production Model with Human Capital

For any country, the production function is now

$$Y_i = K_i^{\alpha}(A_i h_i L_i)^{1-\alpha} \tag{5}$$

or

$$y_i = (A_i h_i)^{1-\alpha} k_i^{\alpha} \tag{6}$$

New: h = human capital of a typical worker.

Cross-country Output Gaps

Output relative to the U.S.

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

How to measure h?

Measuring Human Capital

One idea: estimate how much a year of schooling raises wages within a country.

- **Mincer approach** (see Hall and Jones 1999)

Assume: $h = \exp(\phi s)$ where s is years of schooling.

- What does this say in words?
- $\phi > 0$ is a parameter ("Mincer return")

Example: $\phi = 0.1$ then

- college graduate: $h(16) = \exp(1.6) = 5$.
- high school graduate $h(12) = \exp(1.2) = 3.3$.
- the college grad is $5/3.3 = 1.5$ times as productive as the high school grad.

Measuring Human Capital

We can use data on U.S. wages by schooling to estimate ϕ:

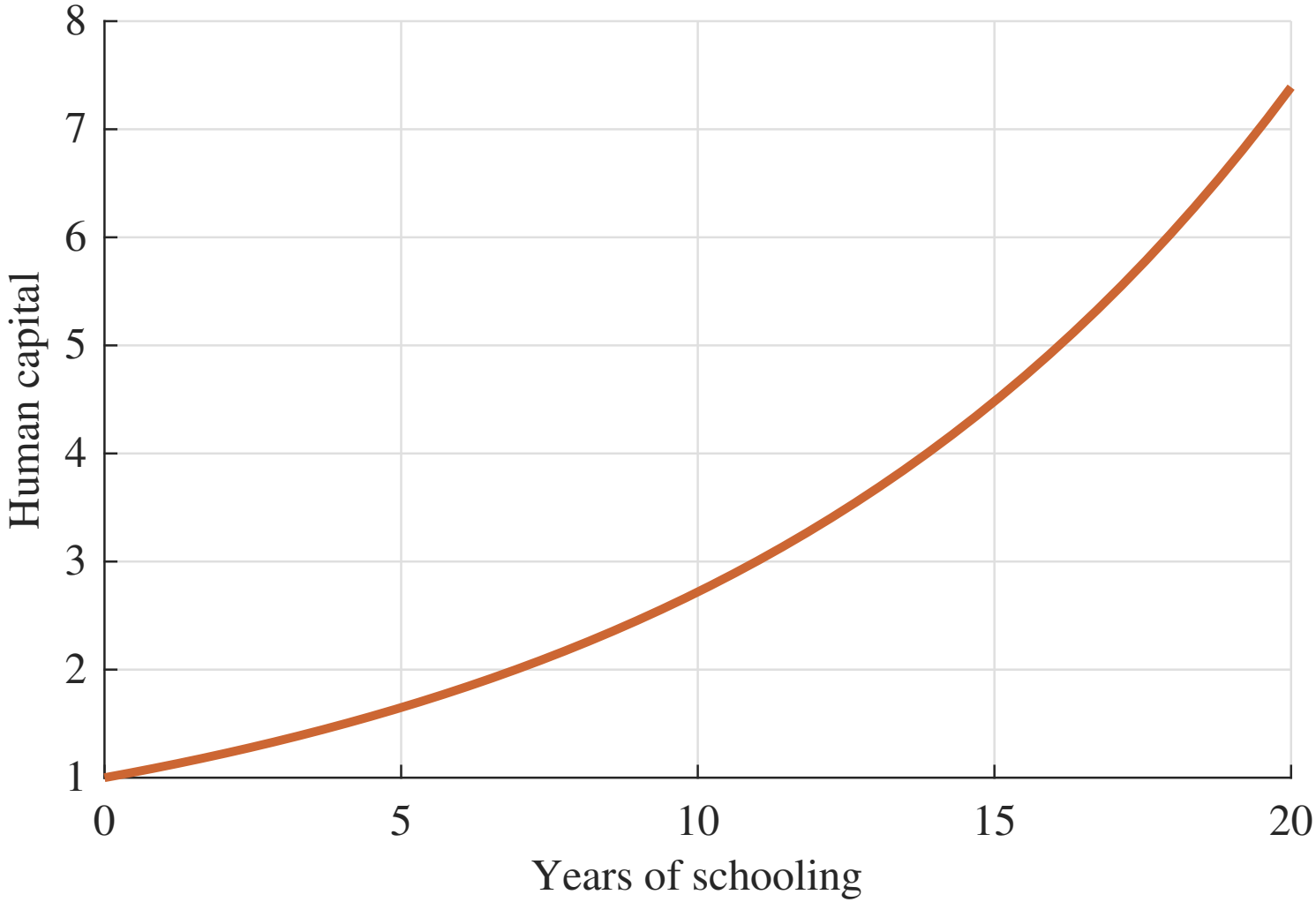
- Regress $\log(h) = \phi s$ on years of schooling
- Assumption: wages are proportional to h.

We find that ϕ is near 0.1.

- On average a year of schooling raises wages by 10%.
- How to interpret $\hat{\phi}$?

IV estimates...

Human capital and schooling



Mincer equation with $\phi = 0.1$

How Important Is Human Capital for Y/L?

Average years of schooling in the U.S.: $s_{US} = 13$

Average years of schooling in a typical country with 1/30 of U.S. output per worker: $s_{poor} = 3$

Gap in years of schooling: $s_{US} - s_{poor} = 10$

Gap in $\log(h)$: $0.1 \times 10 = 1$

h gap between U.S. and poor country worker:

$$h_{US}/h_{poor} = e^1 = 2.7$$

Levels Accounting

$$\underbrace{\frac{y_{US}}{y_{poor}}}_{32} = \underbrace{\left(\frac{A_{US}}{A_{poor}}\right)^{1-\alpha}}_{4} \underbrace{\left(\frac{h_{US}}{h_{poor}}\right)^{1-\alpha}}_{2} \underbrace{\left(\frac{k_{US}}{k_{poor}}\right)^{\alpha}}_{4}$$

Contribution of h: $2.7^{1-\alpha} = 2$

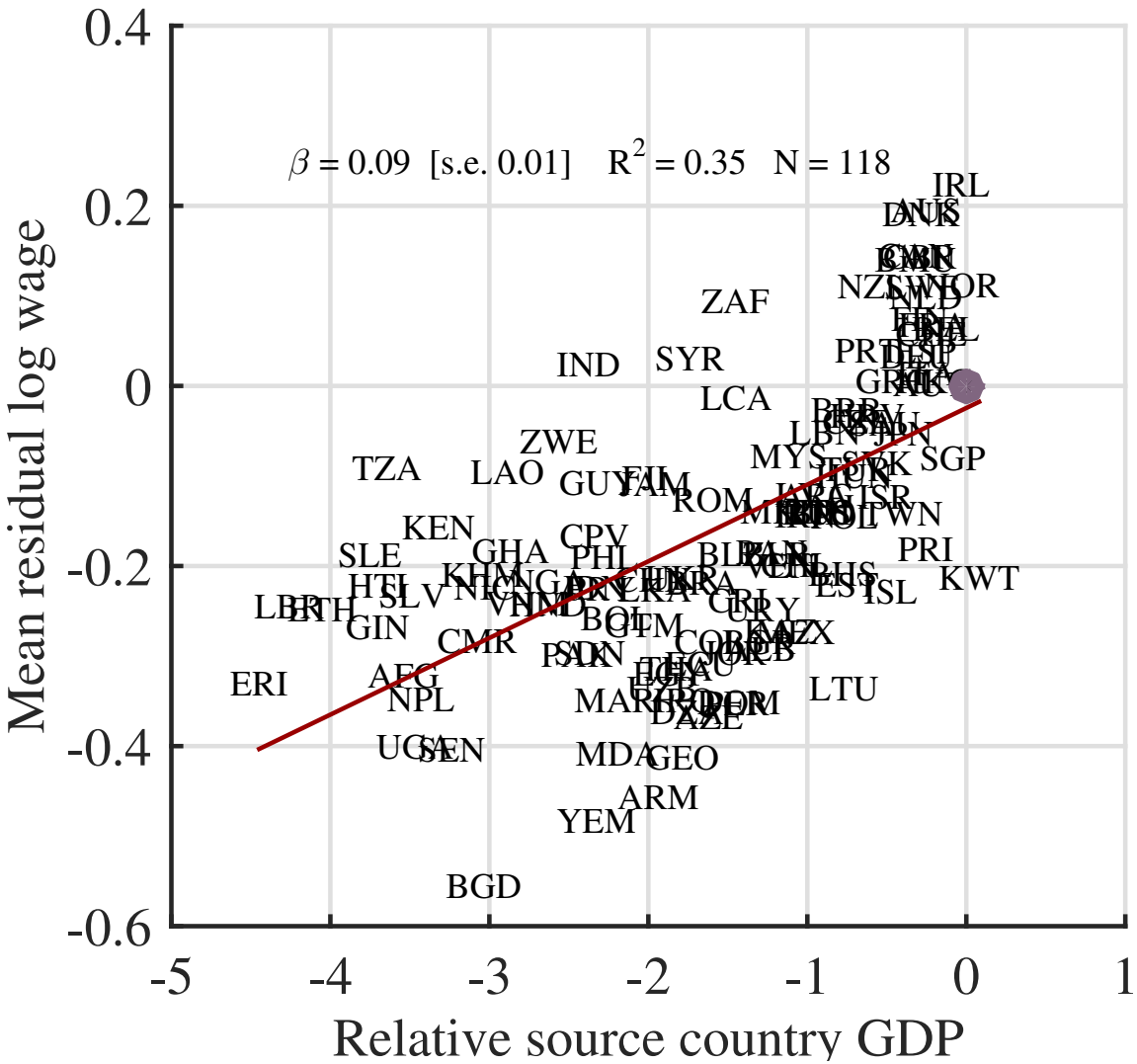
Human capital

Does this calculation sound convincing?

What might it be missing?

How else could h be measured?

Immigrant wages



U.S. immigrants from poor countries do not earn much less than immigrants from rich countries.

Source: 2010 U.S. Census data.

Immigrant wage gains

More direct evidence:

Compare wages of the **same persons** in the U.S. and at home.

- Wage gains are surprisingly small.
- Small wage gains imply small TFP gaps.

Intuition:

- If wage gains are as large as output gaps, TFP and capital are everything.
- If wage gains are zero, TFP and capital are nothing.

Hendricks and Schoellman (2018)

- Wage gains 3-4 for immigrants coming from countries with about 1/25 of U.S. Y/L.
- TFP and capital account for about 1/3 of output gaps
- Human capital accounts for about 2/3

Summary

Human capital is hard to measure.

If we believe the Mincer approach:

- human capital accounts for output gaps on the order of 2
- this is a lower bound (no quality differences)

If we believe the immigrant wage approach:

- human capital accounts for gaps on the order of 3 (we have not worked that out)

Most researchers therefore believe that **productivity is the main source** of cross-country income variation.

- but Hendricks and Schoellman (2018) do not...

Reasons for TFP differences

We think that countries are poor because they lack

1. Capital (1/3 of output gaps)
2. Human capital (1/6?)
3. Technology (more than half)

These are "**proximate** causes" of poverty.

They reflect different choices people make:

1. Save less
2. Go to school less
3. Invest less in technology adoption and development

We need to look for "**deep**" causes.

- Why do people in poor countries make "bad" choices?

Institutions

We do not fully understand the deep causes of poverty.

Most researchers believe that **institutions** are a major cause.

Institutions are a vague collection of "rules of the game" - hard to define but obvious when you see them.

Examples:

- Freedom of expression.
- Right to participate in elections.
- Rule of law.

Later, we talk about why institutions are likely important.

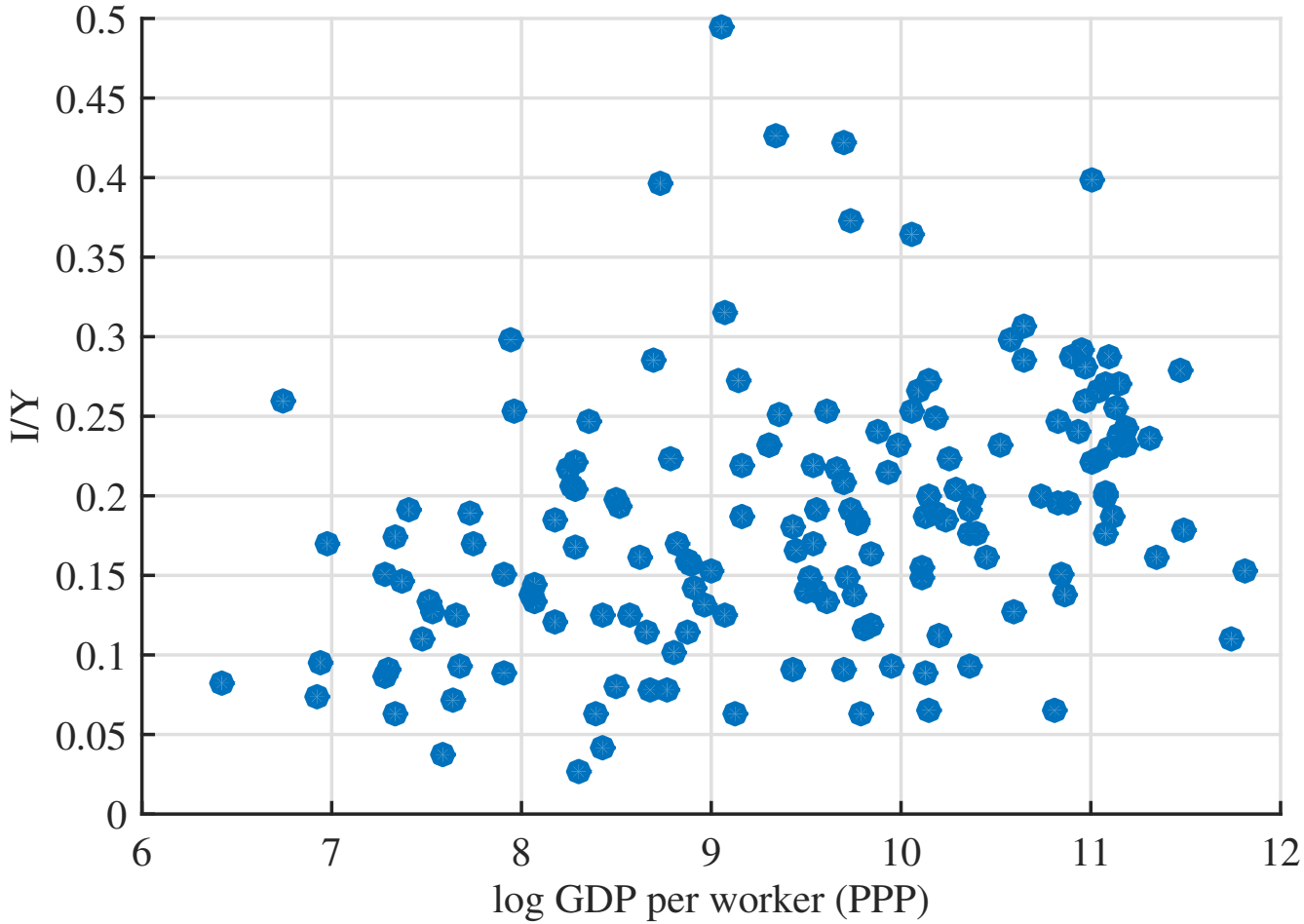
Why is K/L low in poor countries?

Why is K/L low in poor countries?

- We have treated K/L as exogenous - now we need to move beyond that.
- We know that K/L and Y/L are correlated in the data.
- Why might that be?

Why is K/L low in poor countries?

Poor countries have low investment rates.



Source: Penn World Tables

Is that why K/L is low?

Why is K/L low in poor countries?

Why is K/L low in poor countries?

- Low saving rates?
- A consequence of low income?
- Something else causes low K/L and low Y/L?

A General Lesson

It is impossible to figure out causality by looking at data alone. Only theory can say something about causality.

That's why we now work on a model of capital accumulation.

Summary of Key Points

1. We need a model to answer questions of the type: "How much does X affect Y?"
   1.1 Regressions (or other statistical tools) only describe the data.
2. The production model shows:
   2.1 Capital accounts for a small fraction of cross-country income gaps.
   2.2 The main reason: diminishing returns.

Reading

- Jones (2013b), ch. 1

Additional reading:

- Jones (2013a), ch. 3
- Caselli (2005) shows that the contribution of human capital does not increase too much when quality is taken into account (via education spending or test scores)

References I

Caselli, F. (2005): "Accounting for Cross-Country Income Differences," in *Handbook of Economic Growth*, ed. by P. Aghion and S. N. Durlauf, Elsevier, vol. 1B, chap. 9.

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.

Hendricks, L. and T. Schoellman (2018): "Human Capital and Development Accounting: New Evidence From Immigrant Earnings," *Quarterly Journal of Economics*, 133, 665–700.

Jones, C. I. (2013a): *Macroeconomics*, W W Norton, 3rd ed.

Jones, Charles; Vollrath, D. (2013b): *Introduction To Economic Growth*, W W Norton, 3rd ed.