DEVELOPMENT ECONOMICS

HUMAN CAPITAL

This Lecture

- We will talk about **human capital.**

- What is human capital?
- How to measure it?
- Can it explain differences in income across countries?

- Readings:
  - Weil's textbook Chapter 6 (sections 6.2 and 6.3)
  - Paper by Mankiw-Romer-Weil (sections 1, 2, 3.B)

What is human capital?

- Even when they have the same tools and environment, some people are more productive than others.

- Some of these qualities share the characteristics of physical capital, so we call them **human capital**.

- Note these qualities are embodied in a **person.**

- Specifically, we can think of human capital in the form of:
  - **Education.**
  - **Health.**

What is human **capital**?

- Remember the 5 characteristics of physical capital?
- They all apply to human capital too.
  - It is productive.
    - Healthier and more educated workers produce more.
  - It can be produced.
    - We can spend resources to make people healthier and more educated.
  - Its use is limited.
    - When a worker spends an hour doing something, that is an hour she cannot spend on something else.
  - It can earn a return.
    - People are paid for using their human capital (e.g., more educated people earn more).
  - It wears out.
    - First, people's health deteriorate and we forget the things we learn. Moreover, when a person dies, her human capital disappears.

- Innate talent is not human capital: it may fit 4 of the characteristics above, but it cannot be **produced.**
  - You can invest in getting more education, but you cannot invest in getting more talent.

Human capital and income differences

- Can differences in human capital (per capita) explain differences in income (per capita) across countries?
  - Sounds reasonable. For example, Europeans are one average more educated and healthier than most of the people in developing countries.

- This is what we will study in this lecture.
  - We will get a similar answer that we got for physical capital: it can explain part of the differences, but not all (or most) of it.

- We will focus mainly on education.
  - You will study health in the second part of the course

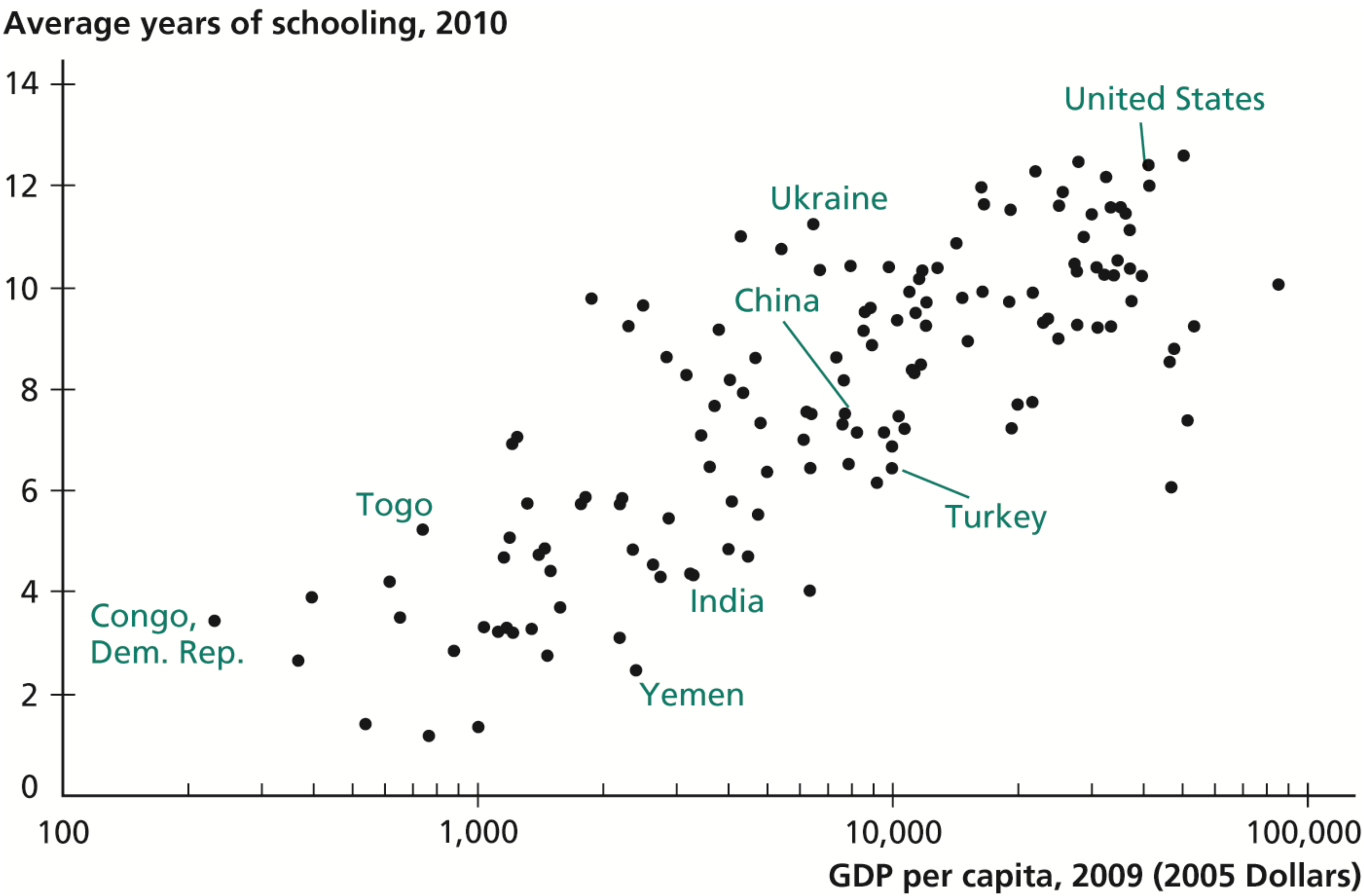
Education as Human Capital

- We all think of education as having value on itself.
  - "The consumption value" of education
- Here, we are more interested in education as human capital, as something that makes people more productive.
- We spend resources (physical capital, labor, and human capital) into making more human capital.
- Investment in education is very large.
  - Americans (mostly the government) spend 6.2% of GDP on it.
    - Teacher salaries, buildings, textbooks, financial aid.
  - This does not count the opportunity cost of student's time. They are forgoing wages when they are in school.

Education and Income Differences.

- Average years of education (in 2000, people age 15+):
  - USA: 12.05
  - Mexico: 6.73
  - India: 4.77
  - Liberia: 2.26

- We want to know if these differences in human capital can explain income differences.
  - One (naïve) way to do this: look at the relationship between GDP per capita on years of education.


Average years of schooling, 2010
14
12
10
8
6
4
2
0
100
1,000
10,000
100,000
GDP per capita, 2009 (2005 Dollars)
United States
Ukraine
China
Turkey
Togo
India
Congo,
Dem. Rep.
Yemen

HK and Per Capita GDP: Two Approaches

- We will add human capital to our "Solow" production function.
  - Plug real world data on the formula of predicted income per worker.
  - Compare it to actual income per worker.
    - Just like we did for physical capital (via the saving rate) and population growth.
  - To do this, we first need to know **human capital's share of wages.**

- We will then look at the MRW paper.
  - Estimate the "Augmented" Solow model using cross-country regressions
  - See how the fitted model accounts for the cross-country variation in income
  - Re-examine the issue of convergence in per-capita income

Human Capital's Share of GDP

- From last class: the fraction of GDP paid to owners of capital was about $1/3$.
  - The α in the production function.

- This means that $(1-\alpha) = 2/3$ of GDP is paid to labor.
  - But, what is the relative fraction that accrues to human capital Vs. the remaining fraction that represents a payment to "raw labor"?

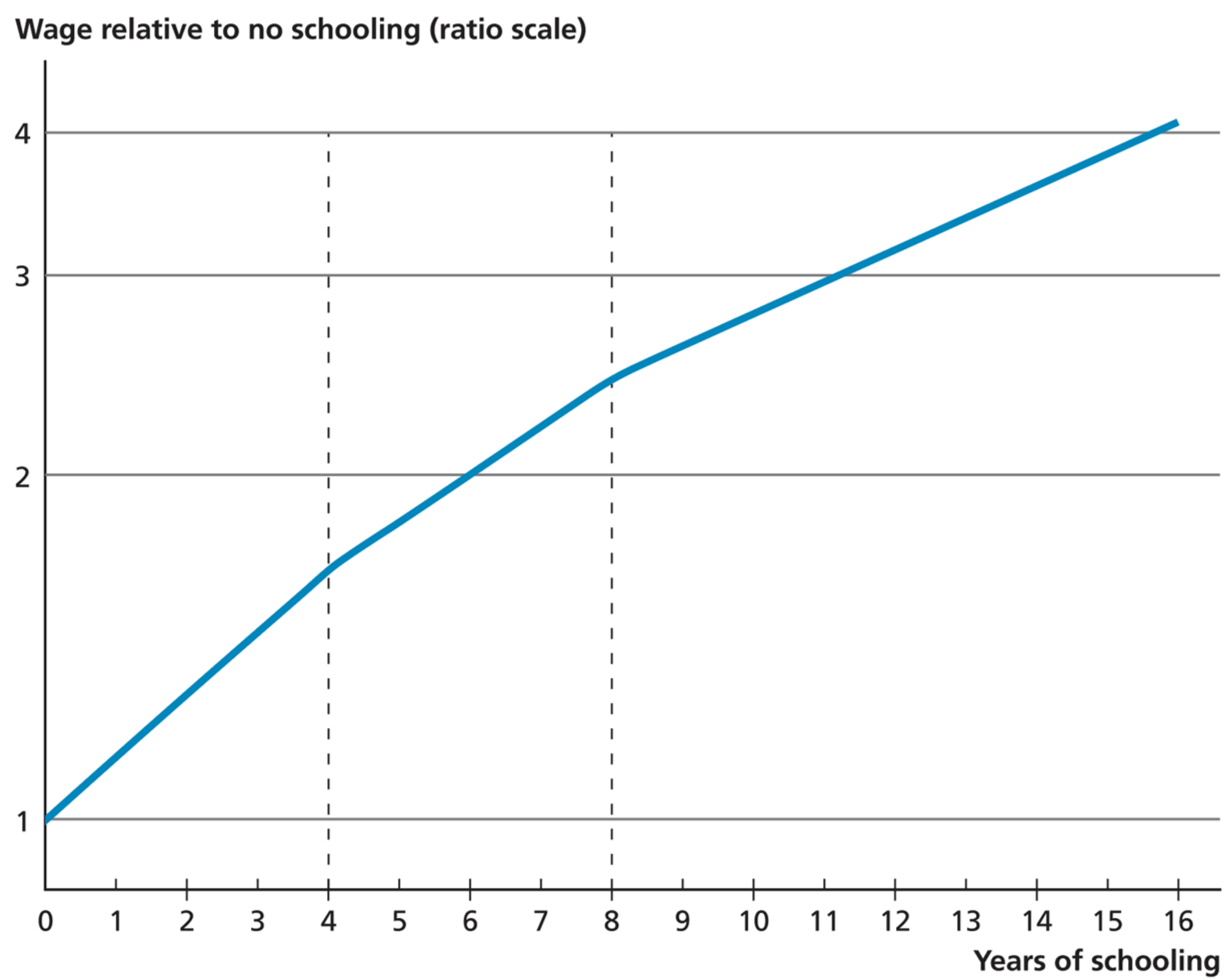
Education and Wages

- More educated people earn higher wages.
  - But by how much?

- Hall and Jones (1999) use individual-level (micro) data for multiple countries to get an answer:
  - An additional year of education is associated with a wage increase of:
    - 13.4% for the first 4 years (grades 1-4).
    - 10.1% for the next four years (grades 5-8).
    - 6.8% for education beyond eight years (high school, college, graduate school).

  - For example, someone with 5 years of schooling earns $1.134^4 \times 1.101 = 1.82$ times more than someone with zero years of education.

FIGURE 6.6
Effect of Education on Wages



A digression: Can we trust these estimates of the returns to education?

- They are achieved by regressing individual log wages on years of education (controlling for experience/age).

- Do we get a return of education from this regression?
  - In principle, no.
  - Why? There is the **omitted variable bias** arising from **unobserved "ability"**.
    - Some people are more productive (have more "ability"). This makes them, **by itself**, get higher wages, and also more likely to get more education.
    - The regression coefficient of education also captures the effect of ability.

  - "College graduates would earn more than high school graduates even if they had not gone to college".

Addressing the omitted variable bias in the returns to education

- Several economists tried to address this issue.

- The idea is to look at some people that got more schooling due to "**exogenous**" reasons.
  - One source: increases in compulsory schooling.
    - People born in different years are forced to stay longer in school – and this has nothing to do with unobserved ability.
  - Other sources: increases in the supply of schools.
    - College openings through different states and years in the US.
    - Construction of middle schools in developing countries (Indonesia).

- In econometrics, these are **instrumental variables** (or just **instruments**).

Instrumental variable estimates of the returns to education

- Most instrumental variable estimates are not that different from OLS estimates (like the one from Hall and Jones reported in the textbook).

- For our purposes, the numbers we just saw are in the right ballpark.

- From now on, assume the numbers we saw are the actual returns to education.

Human Capital’s Share of Wages

- A strong assumption: a person’s wage equals her marginal product of labor.
  - This comes off straight from a firm’s profit maximization problem, if firms are “price takers” in the labor market.
  - We’ll relax this assumption in the next class

- The wage of a worker with 0 years of education (0 human capital) is called “raw labor”.

Human Capital's Share of Wages

- Difference between the wage of a worker with x years of education and one with 0 years is the return to x years of human capital.
  - Recall: a worker with 5 years of education received a wage 1.82 times higher than one with no schooling.
  - If the worker with 0 schooling earns \$100, and the one with 5 years earns \$182, we say that \$82 is the part paid to human capital, and \$100 to raw labor.
    - Hence 0.82/1.82=45% of the human capital share of her wage.

- If we do the same for all workers in a country, we can calculate the country-wide share of wages paid to human capital.

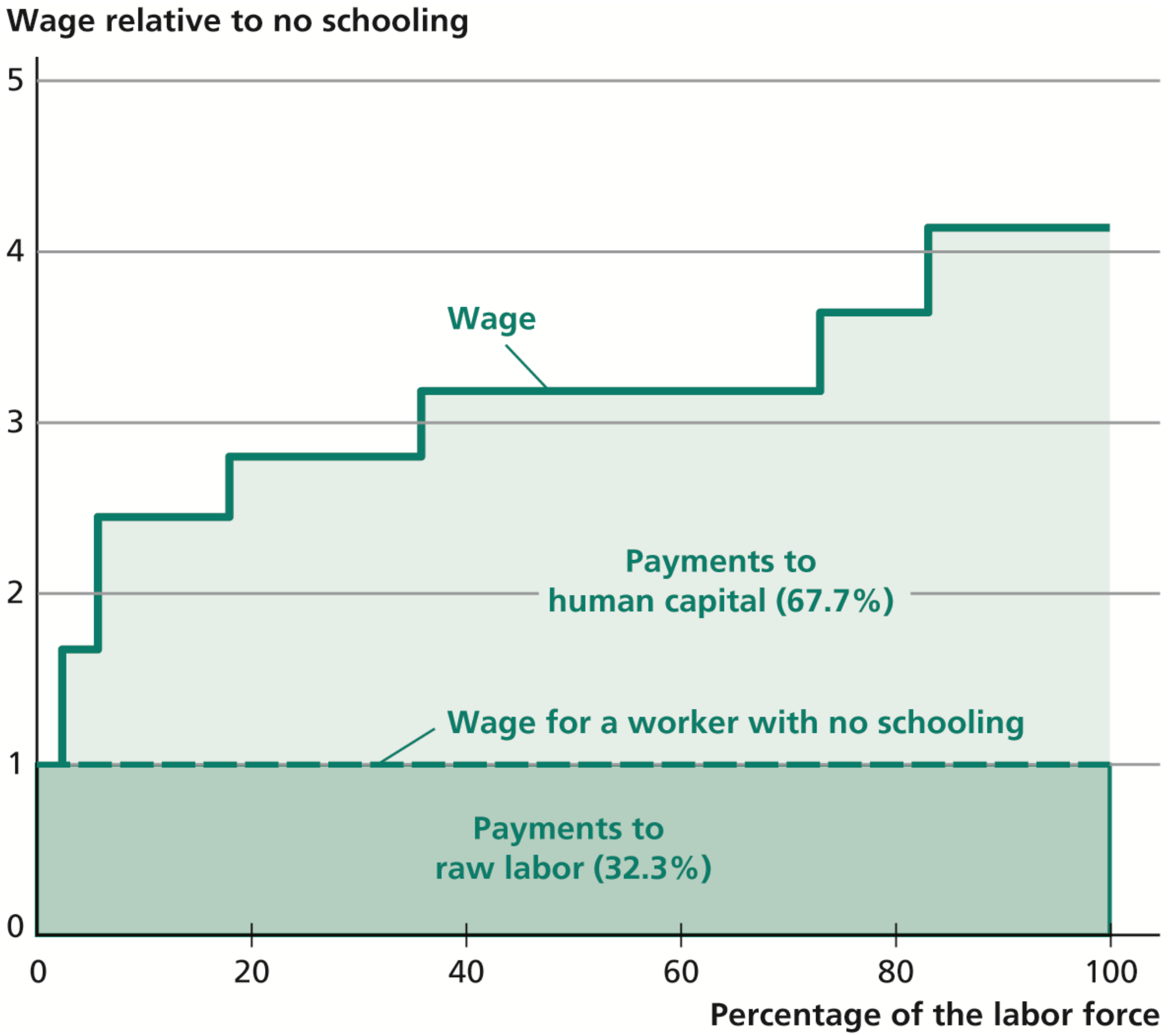
Table 6.2 Breakdown of the Population by Schooling and Wages

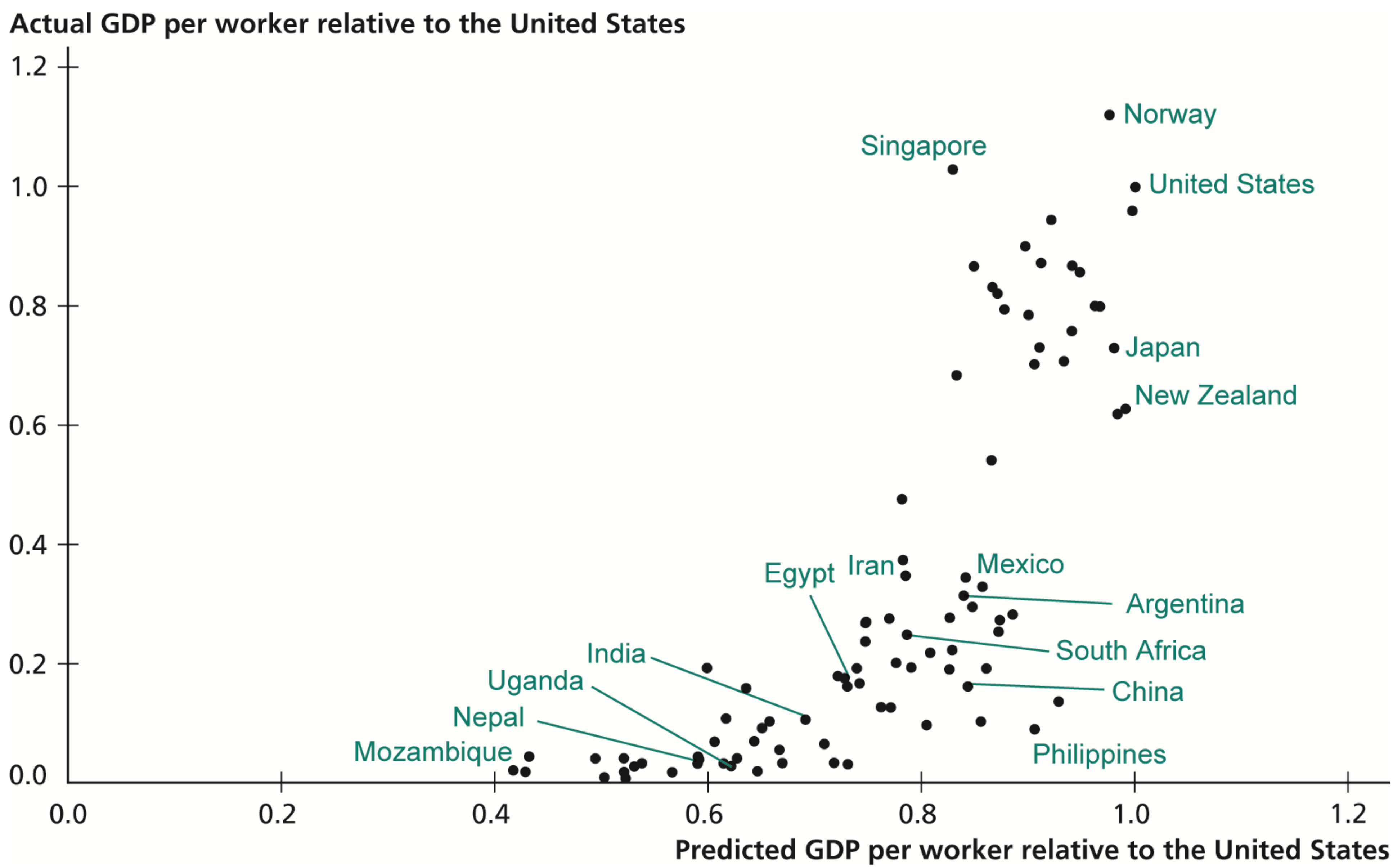
			Percentage of the Population	
Highest Level of Education	**Years of schooling**	**Wage Relative to No Schooling**	**Developing Countries**	**Advanced Countries**
No Schooling	0	1.00	20.8	2.5
Incomplete Primary	4	1.65	10.4	3.4
Complete Primary	8	2.43	18.0	12.3
Incomplete Secondary	10	2.77	19.3	17.8
Complete Secondary	12	3.16	23.2	37.4
Incomplete Higher	14	3.61	2.9	9.9
Complete Higher	16	4.11	5.3	16.6

Source: Barro and Lee (2010).

Share of HK in Wages in Developing Countries

Share of HK in Wages in Developed Countries

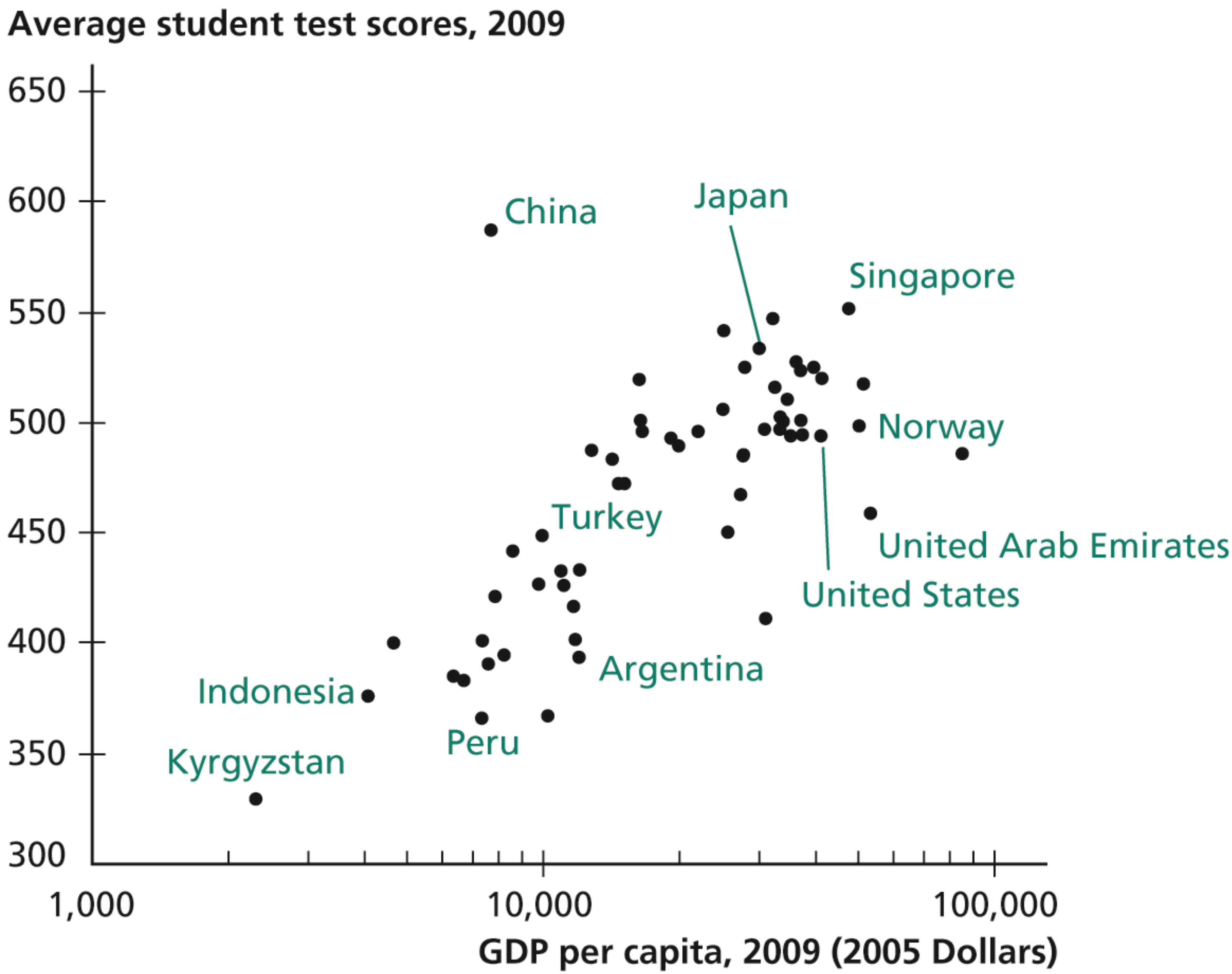



Actual GDP per worker relative to the United States
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Norway
Singapore
United States
Japan
New Zealand
Egypt
Iran
Mexico
Argentina
South Africa
India
Uganda
Nepal
Mozambique
China
Philippines
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Predicted GDP per worker relative to the United States

What are we missing?

- Quality of education.
  - One year of schooling in the USA may add more human capital than one year in Uganda.
  - In the second part of the course, you will study various factors that may explain lower quality of education in low-income countries

- Externalities.
  - We see the **individual** returns to education may be smaller than the **social** returns to education.
    - The educated contribute to society's production in ways they are not remunerated for.
    - This is part of the reason why governments subsidize education



Average student test scores, 2009
650
600
550
500
450
400
350
300
China
Japan
Singapore
Norway
United Arab Emirates
United States
Turkey
Argentina
Indonesia
Peru
Kyrgyzstan
1,000
10,000
100,000
GDP per capita, 2009 (2005 Dollars)

Mankiw, Romer and Weil (QJE, 1992)

- This paper rigorously tests the Solow model, in two forms
  - The "classic" version with physical capital
  - The "augmented" version with human capital

- Main findings are:
  - Classic Solow model is rejected in the data
  - Solow model with human capital does a much better job at explaining the cross-country differences in income per capita
  - Solow model predicts conditional convergence

The Classic Solow Model

- Solow model we saw in the last class is:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha} \qquad 0 < \alpha < 1.$$

  - Where both L and A are assumed to grow exogenously at rates n and g, respectively.

- Steady state is

$$k^* = [s/(n + g + \delta)]^{1/(1-\alpha)}$$

  - Small k here denotes capital per effective unit of labor: K/AL
  - Here, investment rate is denoted by s

The Classic Solow Model

- Substituting this into the production function and taking logs:

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(0) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta).$$

- Theoretical predictions:
  - The model implies an elasticity of income per capita with respect to the investment rate of approximately 0.5 ($\alpha=1/3$ so $\alpha/(1-\alpha)=0.5$)
  - And an elasticity of income per capita with respect to changes in all the other factors ($n+g+\delta$) of approximately -0.5.

From Theory to Empirics

- Assumptions:
  - g and delta are constant across countries: $g+\delta=0.05$
  - A(0) may vary as it likely reflects initial endowments of technology, resources, climate, institutions, etc.

$$\ln A(0) = a + \epsilon,$$

  - S and n are independent of error term (epsilon above)

- Plugging this into previous equation for income per capita gives:

$$\ln\left(\frac{Y}{L}\right) = a + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \epsilon.$$

Estimation Results (I)

Dependent variable: log GDP per working-age person in 1985			
Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	5.48	5.36	7.97
	(1.59)	(1.55)	(2.48)
ln(I/GDP)	1.42	1.31	0.50
	(0.14)	(0.17)	(0.43)
$\ln(n + g + \delta)$	−1.97	−2.01	−0.76
	(0.56)	(0.53)	(0.84)
$\overline{R}^2$	0.59	0.59	0.01
s.e.e.	0.69	0.61	0.38
Restricted regression:			
CONSTANT	6.87	7.10	8.62
	(0.12)	(0.15)	(0.53)
$\ln(I/GDP) - \ln(n + g + \delta)$	1.48	1.43	0.56
	(0.12)	(0.14)	(0.36)
$\overline{R}^2$	0.59	0.59	0.06
s.e.e.	0.69	0.61	0.37
Test of restriction:			
p-value	0.38	0.26	0.79
Implied α	0.60	0.59	0.36
	(0.02)	(0.02)	(0.15)

Note. Standard errors are in parentheses. The investment and population growth rates are averages for the period 1960–1985. $(g + \delta)$ is assumed to be 0.05.

Estimation Results (I)

- Coefficients on investment rate and population growth have the predicted sign
- Restriction that coeff. on ln(s) is equal in magnitude with opposite sign of coeff. on $\ln(n+g+\delta)$ is not rejected
- Cross-country differences in saving rates and population growth account for a large fraction of the variation in income per capita (adjusted R^2=0.59)
- Implied $\alpha=0.6$, which is much larger than 1/3 for the capital share

Adding Human Capital in the Solow Model

- Let the production function be

$$Y(t) = K(t)^{\alpha}H(t)^{\beta}(A(t)L(t))^{1-\alpha-\beta},$$

  - Where H is the stock of human capital in the country, which evolves over time as physical capital with investment rate s_h (and s_k denotes the investment rate of physical capital)
  - Assume that $\alpha+\beta < 1$ (decreasing return to overall capital)
- Steady state in this model is

$$k^* = \left(\frac{s_k^{1-\beta}s_h^{\beta}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)}$$

$$h^* = \left(\frac{s_k^{\alpha}s_h^{1-\alpha}}{n+g+\delta}\right)^{1/(1-\alpha-\beta)}$$

Adding Human Capital in the Solow Model

- Substituting steady-state expressions into production function:

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(0) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta)$$

$$+ \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h).$$

- Theoretical predictions
  - Coefficient on ln(s_k) is now greater than $\alpha/(1-\alpha)$
  - Coefficient on $\ln(n+g+\delta)$ is larger than coeff on ln(s)

From Theory to Empirics

- Assumptions:
  - Restrict human capital to education (no health, etc.)
  - Proxy the rate of human capital accumulation (s_h) in the economy with the percentage of the working-age population that is in secondary school
    - This variable is positively correlated with the investment rate (s_k) and negatively correlated with population growth (n)
  - Same assumptions on initial technology, etc as before

$$\ln A(0) = a + \epsilon,$$

Estimation Results (II)

Dependent variable: log GDP per working-age person in 1985			
Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	6.89	7.81	8.63
	(1.17)	(1.19)	(2.19)
ln(I/GDP)	0.69	0.70	0.28
	(0.13)	(0.15)	(0.39)
$\ln(n + g + \delta)$	−1.73	−1.50	−1.07
	(0.41)	(0.40)	(0.75)
ln(SCHOOL)	0.66	0.73	0.76
	(0.07)	(0.10)	(0.29)
$\overline{R}^2$	0.78	0.77	0.24
s.e.e.	0.51	0.45	0.33
Restricted regression:			
CONSTANT	7.86	7.97	8.71
	(0.14)	(0.15)	(0.47)
$\ln(I/GDP) - \ln(n + g + \delta)$	0.73	0.71	0.29
	(0.12)	(0.14)	(0.33)
$\ln(SCHOOL) - \ln(n + g + \delta)$	0.67	0.74	0.76
	(0.07)	(0.09)	(0.28)
$\overline{R}^2$	0.78	0.77	0.28
s.e.e.	0.51	0.45	0.32
Test of restriction:			
p-value	0.41	0.89	0.97
Implied α	0.31	0.29	0.14
	(0.04)	(0.05)	(0.15)
Implied β	0.28	0.30	0.37
	(0.03)	(0.04)	(0.12)

Note. Standard errors are in parentheses. The investment and population growth rates are averages for the period 1960–1985. $(g + \delta)$ is assumed to be 0.05. SCHOOL is the average percentage of the working-age population in secondary school for the period 1960–1985.

Estimation Results (II)

- Ln(School) enters significantly in the income equation
- The presence of schooling reduces the role of investment rate on income per capita
- Investments in (physical+human) capital+population growth jointly explain 80 percent of the cross-country variation in income per capita
- Estimates quantitatively match the theoretical predictions
  - Alpha=1/3, beta=1/3

Convergence

- As we discussed in the first class, we can empirically test for convergence in income per capita across countries by regressing the log difference in income per capita between two periods t and t0 on log(income_t0)
- This is called "unconditional convergence", in the sense that we are not considering that different countries may be converging to different states (as the Solow model predicts!)
- So, a more accurate test of convergence needs to account for the determinants of the steady state: population growth, investment rates in physical and human capital.

Estimation Results (III)

Dependent variable: log difference GDP per working-age person 1960–1985			
Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	−0.266	0.587	3.69
	(0.380)	(0.433)	(0.68)
ln(Y60)	0.0943	−0.00423	−0.341
	(0.0496)	(0.05484)	(0.079)
$\overline{R}^2$	0.03	−0.01	0.46
s.e.e.	0.44	0.41	0.18
Implied λ	−0.00360	0.00017	0.0167
	(0.00219)	(0.00218)	(0.0023)

Note. Standard errors are in parentheses. Y60 is GDP per working-age person in 1960.

Estimation Results (III)

Dependent variable: log difference GDP per working-age person 1960–1985			
Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	3.04	3.69	2.81
	(0.83)	(0.91)	(1.19)
ln(Y60)	−0.289	−0.366	−0.398
	(0.062)	(0.067)	(0.070)
ln(I/GDP)	0.524	0.538	0.335
	(0.087)	(0.102)	(0.174)
$\ln(n + g + \delta)$	−0.505	−0.551	−0.844
	(0.288)	(0.288)	(0.334)
ln(SCHOOL)	0.233	0.271	0.223
	(0.060)	(0.081)	(0.144)
$\overline{R}^2$	0.46	0.43	0.65
s.e.e.	0.33	0.30	0.15
Implied λ	0.0137	0.0182	0.0203
	(0.0019)	(0.0020)	(0.0020)

Note. Standard errors are in parentheses. Y60 is GDP per working-age person in 1960. The investment and population growth rates are averages for the period 1960–1985. $(g + \delta)$ is assumed to be 0.05. SCHOOL is the average percentage of the working-age population in secondary school for the period 1960–1985.

Estimation Results (III)

- No unconditional convergence
- After including the determinants of the steady state, the coefficient of log(income_t0) becomes negative and significant
- Overall, the data seem very much consistent with the predictions of the Solow model once we consider the role of human capital in explaining cross-country income differences