Development economics

Lecture 4: Modern (endogenous) growth models, poverty traps, and empirics

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LMU, April 19, 2018

Human capital and economic growth

Conditional convergence again

Poverty traps continued

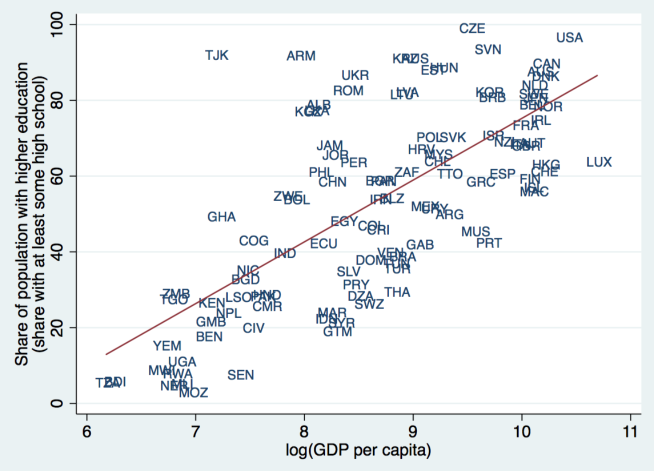
Technical progress

Taking stock on growth models

Human capital and economic growth

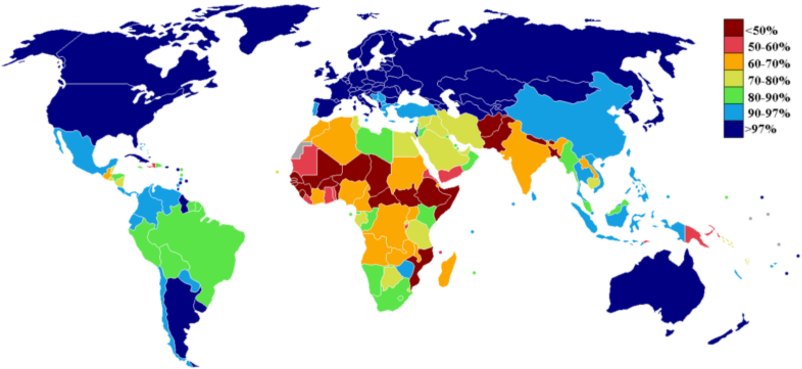
- Issues with Solow and Harrod-Domar model?
  - Unable to explain the huge income differences across countries, without assuming of constant returns to capital (Harrod-Domar)
  - Parameters are likely to be endogenous (savings, population growth, technology)
  - We explain growth by technical progress in Solow (with realistic decreasing returns to capital). But what drives it?
  - But if technology needed for growth, why don't poor countries benefit from "leapfrogging"?
- This lecture: Technical progress, human capital and economic growth

Human capital and economic performance



Source: PWT 6.1, and Barro and Lee (2013)

Literacy rate by country



Source: CIA World Factbook (2014)

Human capital and economic growth

- Recall Lucas paradox:
  - We should observe huge returns to capital in poor countries where labor is abundant, assuming that technology is a non-rival good. Not matched in reality.
  - Does "qualified labor" matter?

Geographical distribution of cross-border investment stocks

Table 4. Geographical distribution of cross-border investment stocks % of total international liabilities

	1913/1914	2001	Change (%-points)
Western Europe*	13.3	50.4	37.1
Eastern and South-Eastern Europe**	13.9	1.6	−12.3
Africa	9.9	1.1	−8.8
Asia (non-Japan)	9.5	8.6	−0.9
Japan	2.0	3.3	1.3
Latin America*	20.3	5.1	−15.2
North America**	25.2	28.3	3.1
Australia and New Zealand	5.6	1.7	−3.9

*Excluding off-shore financial centers.
**Includes Turkey.
Sources: For 1913/1914 Feis (1965) and Woodruff (1966). For end-2001: UNCTAD (2004) for direct investment, BIS (2004) for long-term bank loans and International Monetary Fund (2003) for stock of portfolio investments.

In the late 19th and early 20th century international financial integration has led to massive net capital flows to poor countries, whereas today net capital movements between developed and less-developed economies are by and large flat. — Schularick (2006)

Lucas (1988): Augmented Solow model with human capital

- So far the production function was $Y = f(K, L)$
- But rich countries seem to invest in proportionally more in education, a productive factor in itself:
- Assume now: $Y = f(K, H, L)$
- Augmented Solow model:
  - Saving for investment in both K and H
- Assumptions:
  - Population growth constant
  - No depreciation
  - (Still no distributive concerns: inequality disregarded)

Lucas (1988): Augmented Solow model with human capital

- Per capita production function now:

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

- Difference from the previous Solow model? Before technical progress exogenous, here endogenized.
- We define the dynamics of capital (h and k) accumulation:

$$k(t+1) = k(t) + s_k y(t)$$
$$h(t+1) = h(t) + s_h y(t)$$

  - s_h – propensity to invest in human capital (recall macroeconomic balance $S = I$)
- Growth rates of physical capital?

$$\frac{k(t+1) - k(t)}{k(t)} = \frac{s_k y(t)}{k(t)} = \frac{s_k k(t)^{\alpha} h^{1-\alpha}}{k(t)} = \frac{s_k h^{1-\alpha}}{k^{1-\alpha}} = s_k r^{1-\alpha}$$

Lucas (1988): Augmented Solow model with human capital

$$\frac{k(t+1)-k(t)}{k(t)} = \frac{s_k y(t)}{k(t)} = \frac{s_k k(t)^{\alpha} h^{1-\alpha}}{k(t)} = \frac{s_k h^{1-\alpha}}{k^{1-\alpha}} = s_k r^{1-\alpha}$$

- Analogous for human capital growth:

$$\frac{h(t+1)-h(t)}{h(t)} = \frac{s_h y(t)}{h(t)} = \frac{s_h k(t)^{\alpha} h^{1-\alpha}}{h(t)} = \frac{s_h k^{\alpha}}{h^{\alpha}} = s_h r^{-\alpha}$$

- r – ratio of human to physical capital in the long run
- Note: human and physical capital grow in a fixed proportion!

Lucas (1988): Augmented Solow model with human capital

- Since growth rates of human and physical capital are the same (because ratio of human and physical capital stays the same - see production function), we have that: $s_k r^{1-\alpha} = s_h r^{-\alpha} \quad \Rightarrow \quad r = \frac{s_h}{s_k}$
- How much are the growth rates? Just plug r into the growth equations:

$$\frac{k(t+1) - k(t)}{k(t)} = s_k r^{1-\alpha} = s_k^{\alpha} s_h^{1-\alpha}$$

- Analogous for human capital:

$$\frac{h(t+1) - h(t)}{h(t)} = s_h r^{-\alpha} = s_k^{\alpha} s_h^{1-\alpha}$$

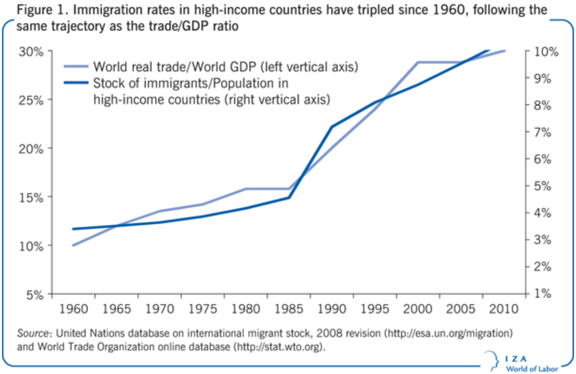
Lucas (1988): Augmented Solow model with human capital

- $s_k^{\alpha} s_h^{1-\alpha}$ determines the growth rate of all variables: physical capital, human capital, and also of the output (just plug it into the production function)
- What does this model say?
  1. No convergence: Even with diminishing returns to physical capital, countries with similar savings rates but different income levels grow at same pace, but do not converge.
  2. Similar to Harrod-Domar model predictions, but with released (unrealistic) assumption of constant returns to capital.
  3. But maybe there are constant returns to physical and human capital combined (see: $g_y = g_k = g_h = s_k^{\alpha} s_h^{1-\alpha}$).
  4. Problem: add a third production factor growing exogenously (say, unskilled labor) and the constancy of returns goes away. Then results as in Solow.

Lucas (1988): Augmented Solow model with human capital

- **Endogenous growth model**: growth determined by variables within the model
- Partially explains the Lucas paradox: poor countries have low levels of human capital, which is necessary to work together with physical capital
    - Thus we rather observe the reverse trend of influx of skilled workers from poor to rich countries (*brain drain*).

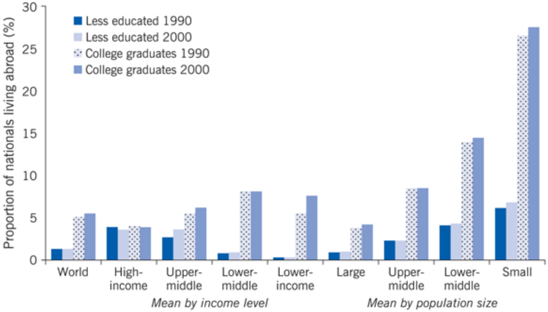
Brain drain



Source: Docquier (2014)

Brain drain

Figure 3. Brain drain rates decrease with economic development and population size in the home country



Source: Docquier, F., B. L. Lowell, and A. Marfouk. "A gendered assessment of highly skilled emigration." *Population and Development Review* 35:2 (2009): 297–322 [1].

IZA World of Labor

Source: Docquier (2014)

Human capital and economic growth

Conditional convergence again

Poverty traps continued

Technical progress

Taking stock on growth models

Mankiw, Romer, and Weil (1992): Conditional convergence again

- Some evidence on conditional convergence in the previous lecture (recall OECD countries case)
- Mankiw, Romer, and Weil (1992): use a proxy for the rate of human-capital accumulation (s_h) measuring share of the working-age population in secondary school:
  - Fraction of the eligible population (aged 12 to 17) enrolled in secondary school (from UNESCO yearbook) multiplied by the fraction of the working-age population that is of school age (aged 15 to 19).
    - Why a good proxy?
    - Why a bad proxy?

Mankiw, Romer, and Weil (1992): Conditional convergence again

- Regression analysis:
  - Unconditional:

$$g_i = \alpha + \beta_1 GDP_{i,1960} + \varepsilon_i \tag{1}$$

  - Conditional:

$$\begin{aligned} g_i = &\alpha + \beta_1 GDP_{i,1960} + \beta_2 ln(I/GDP) + \\ &+ \beta_3 ln(n + g + \delta) + \beta_4 ln(SCHOOL) + \varepsilon_i \end{aligned} \tag{2}$$

- Where:
  - $\alpha = ln(A_0)$
  - $\beta_1 = -\beta_2 = \frac{\alpha}{1-\alpha}$
  - $\beta_3 = \frac{\beta}{1-\alpha}$

MRW (1992): Unconditional convergence

TABLE III
TESTS FOR UNCONDITIONAL CONVERGENCE

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.

Source: Mankiw, Romer, and Weil (1992)

MRW (1992): Conditional convergence

TABLE V
TESTS FOR CONDITIONAL CONVERGENCE

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.

Source: Mankiw, Romer, and Weil (1992)

Miguel and Roland (2011): The long-run impact of bombing Vietnam

- Vietnam War (in Vietnam called an American War): 1965-1975: heavy losses of lives and of infrastructure
- Should poverty traps exist, Vietnam should be an ideal candidate for one.
- Miguel and Roland (2011) exploit the unequal incidence of bombing on subsequent indicators of local (district-level) development.

Miguel and Roland (2011)

- 3-times more bombs dropped on Vietnam than during WW2
- Most bombing (70%) concentrated in a 10% of districts
  - Most bombing around arbitrarily drawn division line between North and South Vietnam (17° Northern latitude)
- Q: Do the hardest hit districts remain underdeveloped?

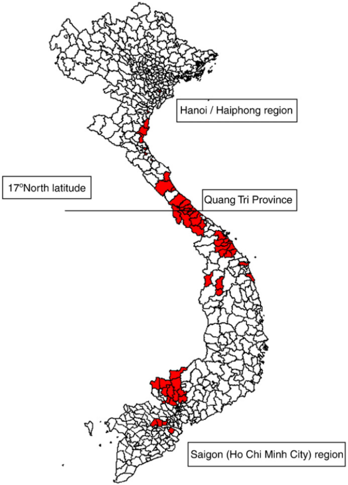


Fig. 1. Map of Vietnam – 10% of districts with the highest total U.S. bombs, missiles, and rockets per km^2 shaded.

Miguel and Roland (2011)

- Regression specification:

$$y_{it} = \alpha + X_i'\beta + \gamma BOMBS_{i;1965-75} + \varepsilon_{it}$$

  - What do we want to see as y_{it}?
  - X: fixed district characteristics including geographic controls (soil type, elevation, and latitude) and population density in 1960 (the pre-U.S. bombing baseline period) $\rightarrow$ partially proxy for differences in steady-state outcomes
  - $BOMBS$: total intensity of bombs, missiles, and rockets dropped in the district during 1965–1975 per km^2
- Specification issues? Use IV:

$$BOMBS_{i,1965-75} = a + X_i'B + cDISTANCE_i + e_{it}$$

Miguel and Roland (2011)

Table 3
Predicting bombing intensity.

	Dependent variable: Total U.S. bombs, missiles, and rockets per km^2		
	(1)	(2)	(3)
|Latitude − 17°N|	−14.8***	−17.0***	−10.2***
	(5.3)	(6.0)	(2.2)
Population density (province), 1960–61	0.0050	−0.0035**	−0.0034**
	(0.0043)	(0.0016)	(0.0014)
Former South Vietnam	−138.5*	−134.5	−37.1
	(74.9)	(87.2)	(27.7)
Proportion of land area 250–500 m	89.5*	−27.6	−26.6*
	(47.1)	(20.5)	(14.2)
Proportion of land area 500–1000 m	−49.6	−17.7	−10.5
	(65.3)	(18.9)	(16.8)
Proportion of land area over 1000 m	156.3*	−6.0	−6.0
	(81.4)	(30.4)	(19.1)
Average precipitation (cm)	0.26	0.22	0.15*
	(0.17)	(0.18)	(0.08)
Average temperature (Celsius)	15.2	−0.2	−0.6
	(0.8)	(4.4)	(3.6)
Latitude (°N)	−8.7	−10.0	−2.3
	(6.3)	(7.1)	(2.6)
District soil controls	No	Yes	Yes
Exclude Quang Tri province	No	No	Yes
Observations	55	584	576
R^2	0.54	0.33	0.25
Mean (S.D.) dependent variable	30.6 (51.7)	32.3 (68.5)	27.1 (50.6)

Notes: Ordinary least squares (OLS) regressions. Robust Huber–White standard errors in parentheses. Significant at 90(*), 95(**), and 99(***) percent confidence. Disturbance terms are clustered at the province level in regressions 2–3. The district soil type controls include the proportion of district land in 18 different soil categories. The omitted altitude category is 0–250 m.

Miguel and Roland (2011)

Table 4
Local bombing impacts on estimated 1999 poverty rate.

	Dependent variable: estimated poverty rate, 1999					
	OLS	OLS	OLS	OLS	OLS	IV-2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Total U.S. bombs, missiles, and rockets per km^2	−0.00087*	−0.00040*	−0.00065***	−0.00079***		0.00026
	(0.00048)	(0.00022)	(0.00012)	(0.00016)		(0.00042)
Population density (province), 1960–61 (÷100)	−0.0089***	−0.0021**		−0.0023**	−0.0021**	−0.0020*
	(0.0016)	(0.0009)		(0.0010)	(0.0010)	(0.0010)
Former South Vietnam	−0.317***	−0.174**		−0.122*	−0.139**	−0.104
	(0.087)	(0.071)		(0.071)	(0.058)	(0.082)
Proportion of land area 250–500 m	0.341***	0.339***	0.182***	0.325***	0.342***	0.349***
	(0.096)	(0.070)	(0.067)	(0.069)	(0.070)	(0.073)
Proportion of land area 500–1000 m	0.386**	0.261***	0.157**	0.261***	0.253***	0.257***
	(0.172)	(0.052)	(0.062)	(0.053)	(0.054)	(0.055)
Proportion of land area over 1000 m	0.571**	−0.048	−0.001	−0.066	−0.044	−0.043
	(0.231)	(0.113)	(0.159)	(0.111)	(0.120)	(0.116)
Average precipitation (cm)	0.00027	0.00111***	0.00060	0.00110***	0.00068*	0.00063
	(0.00044)	(0.00035)	(0.00046)	(0.00033)	(0.00038)	(0.00044)
Average temperature (Celsius)	0.033	−0.012	−0.034	−0.013	−0.0143	−0.0143
	(0.029)	(0.019)	(0.022)	(0.020)	(0.0196)	(0.0199)
Latitude (°N)	−0.0127	−0.0088	0.038	−0.0044	−0.0051	−0.0025
	(0.0108)	(0.0088)	(0.026)	(0.0088)	(0.0081)	(0.0100)
|Latitude − 17°N|					−0.0044	
					(0.0069)	
District soil controls	No	Yes	Yes	Yes	Yes	Yes
Province fixed effects	No	No	Yes	No	No	No
Exclude Quang Tri province	No	No	No	Yes	No	No
Observations	55	584	584	576	584	584
R^2	0.75	0.61	0.79	0.63	0.60	–
Mean (S.D.) dependent variable	0.39 (0.16)	0.41 (0.20)	0.41 (0.20)	0.41 (0.20)	0.41 (0.20)	0.41 (0.20)

Notes: Robust Huber–White standard errors in parentheses. Significant at 90(*), 95(**), and 99(***) percent confidence. Disturbance terms are clustered at the province level in regressions 2–7. The district soil type controls include the proportion of district land in 18 different soil categories. The omitted altitude category is 0–250 m. The instrumental variable in regression 6 is |Latitude − 17°N|.

Miguel and Roland (2011)

Table 7
Local war impacts on physical infrastructure and human capital.

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	IV-2SLS (6)
Panel A: dependent variable: proportion of households with access to electricity, 1999						
Total U.S. bombs, missiles, and rockets per km^2	0.00168***	0.00036***	0.00025	0.00043**		0.0019**
	(0.00055)	(0.00012)	(0.00016)	(0.00017)		(0.0009)
|Latitude − 17°N|					−0.033***	
					(0.009)	
District soil controls	No	Yes	Yes	Yes	Yes	Yes
Province fixed effects	No	No	Yes	No	No	No
Exclude Quang Tri province	No	No	No	Yes	No	No
Observations	55	584	584	576	584	584
R^2	0.59	0.57	0.75	0.57	0.58	–
Mean (S.D.) dependent variable	0.72 (0.21)	0.71 (0.27)	0.71 (0.27)	0.71 (0.27)	0.71 (0.27)	0.71 (0.27)
Panel B: dependent variable: proportion of literate respondents, 1999						
Total U.S. bombs, missiles, and rockets per km^2	0.00005	0.00003	0.00009	0.00012**		0.00041
	(0.00012)	(0.00006)	(0.00006)	(0.00006)		(0.00037)
|Latitude − 17°N|					−0.0070	
					(0.0052)	
District soil controls	No	Yes	Yes	Yes	Yes	Yes
Province fixed effects	No	No	Yes	No	No	No
Exclude Quang Tri province	No	No	No	Yes	No	No
Observations	55	584	584	576	584	584
R^2	0.65	0.59	0.75	0.59	0.59	–
Mean (S.D.) dependent variable	0.89 (0.07)	0.88 (0.11)	0.88 (0.11)	0.88 (0.11)	0.88 (0.11)	0.88 (0.11)

Notes: Robust Huber–White standard errors in parentheses. Significant at 90(*), 95(**), and 99(***) percent confidence. Disturbance terms are clustered at the province level in regressions 2–6. All regressions include Population density (province) 1960–61, Former South Vietnam, Proportion of land area 250–500 m, Proportion of land area 500–1000 m, Proportion of land area over 1000 m, Average precipitation (cm), Average temperature (Celsius), and Latitude (°N). The district soil type controls include the proportion of district land in 18 different soil categories. The omitted altitude category is 0–250 m. The instrumental variable in regression 6 is |Latitude − 17°N|.

Human capital and economic growth

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Poverty traps continued

Technical progress

Taking stock on growth models

Technical progress

- Recall Harrod-Domar model: $\frac{1}{\theta}$ affects growth rate

$$g_{PC} \approx \frac{1}{\theta} - (n + \delta)$$

- Recall Solow model: all growth driven by technical progress

$$k^* = \left(\frac{sA_{pc}}{n + \delta}\right)^{\frac{1}{1-\alpha}}$$

- Constant returns permit "endogenous" growth (Harrod-Domar and human capital models), but diminishing returns (Solow) predict growth to die out.
- But: How does technical progress accumulate?

Romer (1990): Deliberate technical progress

- Firms invest in capital or R&D
- Often knowledge can be used by other agents (diffusion of technology): technology as a non-rival good.
- Model:
  - Stock of human capital H in an economy
  - H devoted to production of final goods (rival, excludable) and of knowledge (non-rival, non-excludable)
  - Investment in knowledge reveals these new technologies

Romer (1990): Deliberate technical progress

- Production function:

$$Y(t) = E(t)^{\gamma} K(t)^{\alpha} \Big[uH\Big]^{1-\alpha}$$

  - $E(t)$ – amount of technical know-how (productivity of final goods)
  - u – fraction of human capital devoted to final goods production

- Growth (law-of-motion) of *knowledge*:

$$\frac{E(t+1) - E(t)}{E(t)} = a(1-u)H$$

  - a positive constant

Romer (1990): Deliberate technical progress

$$Y(t) = E(t)^{\gamma} K(t)^{\alpha} \Big[uH\Big]^{1-\alpha}$$

$$\frac{E(t+1) - E(t)}{E(t)} = a(1-u)H$$

- Capital grows as usual:

$$K(t+1) = K(t) + sY(t)$$

  - We disregard depreciation and population growth now, but generally similar predictions
- Resembles Solow model, but crucial differences?
  1. Both H and $(1-u)$ affect the rate of technical progress!
  2. Trade-off: Better technology tomorrow or higher production now?

Romer (1990): Deliberate technical progress

- Some questions:
  - How is u chosen?
  - Does the non-rivalry of technology hold only within country or across countries? Incentives for investments locally? Free riding problems?
  - Think of political cycles and incentives for boosting current consumption at the expense of future innovation. Are authoritarian regimes better for innovation?

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Taking stock on growth models

Taking stock

TABLE I
PRODUCTIVITY CALCULATIONS: RATIOS TO U. S. VALUES

Country	Y/L	Contribution from $(K/Y)^{\alpha/(1-\alpha)}$	Contribution from H/L	Contribution from A
United States	1.000	1.000	1.000	1.000
Canada	0.941	1.002	0.908	1.034
Italy	0.834	1.063	0.650	1.207
West Germany	0.818	1.118	0.802	0.912
France	0.818	1.091	0.666	1.126
United Kingdom	0.727	0.891	0.808	1.011
Hong Kong	0.608	0.741	0.735	1.115
Singapore	0.606	1.031	0.545	1.078
Japan	0.587	1.119	0.797	0.658
Mexico	0.433	0.868	0.538	0.926
Argentina	0.418	0.953	0.676	0.648
U.S.S.R.	0.417	1.231	0.724	0.468
India	0.086	0.709	0.454	0.267
China	0.060	0.891	0.632	0.106
Kenya	0.056	0.747	0.457	0.165
Zaire	0.033	0.499	0.408	0.160
Average, 127 countries:	0.296	0.853	0.565	0.516
Standard deviation:	0.268	0.234	0.168	0.325
Correlation with Y/L (logs)	1.000	0.624	0.798	0.889
Correlation with A (logs)	0.889	0.248	0.522	1.000

The elements of this table are the empirical counterparts to the components of equation (3), all measured as ratios to the U. S. values. That is, the first column of data is the product of the other three columns.

Source: Hall and Jones (1999)

- Income decomposition into differences in:
  - Capital-output ratio
  - Human capital
  - Productivity
- $y_i = \frac{K_i}{Y_i}^{\alpha/(1-\alpha)} h_i A_i$
- Where:
  - $y_i = Y_i/L_i$
  - $h_i = H_i/L_i$

Taking stock

- Poor countries are not growing faster (unconditional convergence)
- Difficult to explain a large share of variance in incomes across countries without relying on fairly restrictive assumptions.
  - Homogenous agents / aggregate production function with diminishing returns to capital
  - Perfect competition
  - Perfectly functioning credit markets. This also implies:
    - Factor ownership does not matter
    - Everyone faces the same rental rate (interest rate)
    - (Aggregate production function)
  - Non-rivalry of technologies (what level?)
  - Perfectly defined and enforceable property rights
  - Risk-neutrality and no worries about subsistence thresholds
- Are these based on micro foundations?

Are returns to capital larger in poor countries?

- **Physical capital:**
  - Are the poor willing to pay higher interest rates?
    - Seems so, surveys reveal striking rates averaging about 50% p.a. (recall Banerjee and Duflo, 2007) but easily reaching over 100% p.a. (but high default rates).
  - More directly:
    - Recall De Mel et al. (2008) (more evidence in McKenzie and Woodruff, 2003): 15% *per month* for small firms
    - Extremes: Goldstein and Udry (1999): 1200% for switching from cassava cultivation to pineapple growing (cash crop) in Ghana (but no RCT, maybe selection issues?)
    - RCT in Duflo, Kremer and Robinson (2011): despite high returns to using fertilizer (170-500%), many people do not take-up on the investment in upcoming years.
    - In sum: heterogeneity in returns across firms and industries: can be reconciled with the variance in interest rates.
- **Human capital:** Banerjee and Duflo (2005): rather opposite but fairly constant, poorest country 7%, richest country 10%.

Do higher returns translate to higher investment in poor countries?

- **Physical capital:**
  - Success stories: Taiwan and South Korea had extremely high investment levels and extremely high growth rates.
  - Overall, does not seem so: Correlation between PPP investment rate and PPP income per capita for the 136 PWT countries in 2000: 0.65 (run the .do file; similar to Hsieh and Klenow, 2007)
  - Explanation: PPP consumption prices cheaper (relative to investment) in poorer countries.
    - But despite this, returns seem to be higher, which should more than compensate for the price difference.

- **Human capital:** Does not seem so. Government expenditures in education: 4% of GDP in low income countries, 5% of GDP in high income countries in 2013 (World Bank).

Does investment respond to rates of return?

- Goldstein and Udry (1999): 18% of the land used for pineapple farming (1200% returns).
- Duflo, Kremer, and Robinson (2011): 15% of maize farmers used fertilizer in the previous season (over 170% returns).
- Education: Munshi and Rosenzweig (2006): sudden increase in returns to English education in India (boom in tech industry) $\rightarrow$ increase in English education for lower caste girls, but not boys (traditional social networks predefining occupational choice might be at play here)
- Health interventions: deworming (Miguel and Kremer, 2004), malaria prevention (Cohen and Dupas, 2010), or iron deficiency treatment (Thomas et al., 2006).

Access to technology and the productivity gap

- E.g., Grossman and Helpman (1991): technological differences imply TFP gap.
- But micro-evidence suggests it is not availability of technology but its use:
  - McKinsey Global Institute (2001): big Indian firms across many industries using latest technologies
  - But most firms do not use these:
    - Economies of scale
    - Neo-classical trap: if labor cheap, not so crucial to invest in labor-saving (capital intensive) technologies (i.e. not ineffective allocation given firm size, but rather small firms do not need large investments and hence remain small)

Human capital externalities

- TFP differences across countries possibly due to aggregate increasing returns (due to HC externalities)
  - Recall: positive correlation between human capital accumulation and income of countries
- But: Private returns to extra year of education: 10% (average), fairly constant across the world (e.g., Psacharopoulos, 1994)
  - Difference between 10th and 90th quantile of countries in terms of years of schooling (in 2000): 8 years
  - This would explain why a top decile country could be about twice as rich (0.1*8); but not 20 times richer per capita
  - Externalities would have to be in the order of magnitude of about 200% (*ceteris paribus*); implausible

Coordination failure

- Macro level:
  - À la Rosenstein-Rodan (1943): Possible.
  - $\rightarrow$ Aggregate production function probably not a viable approximation for studying developing countries, as we still need to explain why there can be big firms in the country.
- Micro level:
  - Ellison and Glaeser (1997): Bangalore as a Silicon valley of India; positive spillover-effects
  - Besley and Case (1994): high-yield-value seed adoption by an Indian farmers correlated with adoption among their neighbors; Duflo et al. (2011) finds the same in Kenya using RCT

Government failure, property rights, and legal enforcement

- Firms may delay investment because incentives set by governments are not conductive of good investment climate.
  - Example: While it take 1 procedure and 12 hours to obtain the permit to start company in New Zealand, it takes 12 procedures, 96 business days and 219 percent of per capita GDP in Haiti (Doing Business, 2017).
- Evidence of correlation between "institutions" and wealth:
  - Macro: (Knack and Keefer, 1995), also causal evidence (Acemoglu, Johnson, and Robinson, 2001)
  - Micro: Goldstein and Udry (2002) Ghanian farmers less likely to leave their land fallow unless they are high ranking in village hierarchy.

Role of credit constraints and insurance

- **Credit markets**: poorly functioning (discussed above). Credit rating and collateral limited, contract enforcement weak
  - Consequences for investment: cannot borrow against future profits (at reasonable rates), need to rely on own capital stocks (creating inequalities)
  - No reason to think that richer people would have better business plans (potential capital misallocation)
- **Insurance markets**:
  - Formal insurance lacking
  - Informal (village/social networks sharing) almost always present, but only to some extent (Townsend 1994; Morduch, 1995).
  - Adverse selection, moral hazard, and limited commitment (e.g., Coate and Ravallion, 1993)

Behavioral issues

- Duflo et al. (2011): demand for commitment in a form of purchase of a voucher for fertilizer right after harvest, not having to purchase fertilizer before planting season when not enough money
- Ashraf, Karlan, and Yin (2006): demand for commitment savings product in the Philippines
- Mani, Mullainathan, and Shafir (2013): Poverty affects cognitive function