ECONOMICS OF EDUCATION

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Week 6

Education and economic growth

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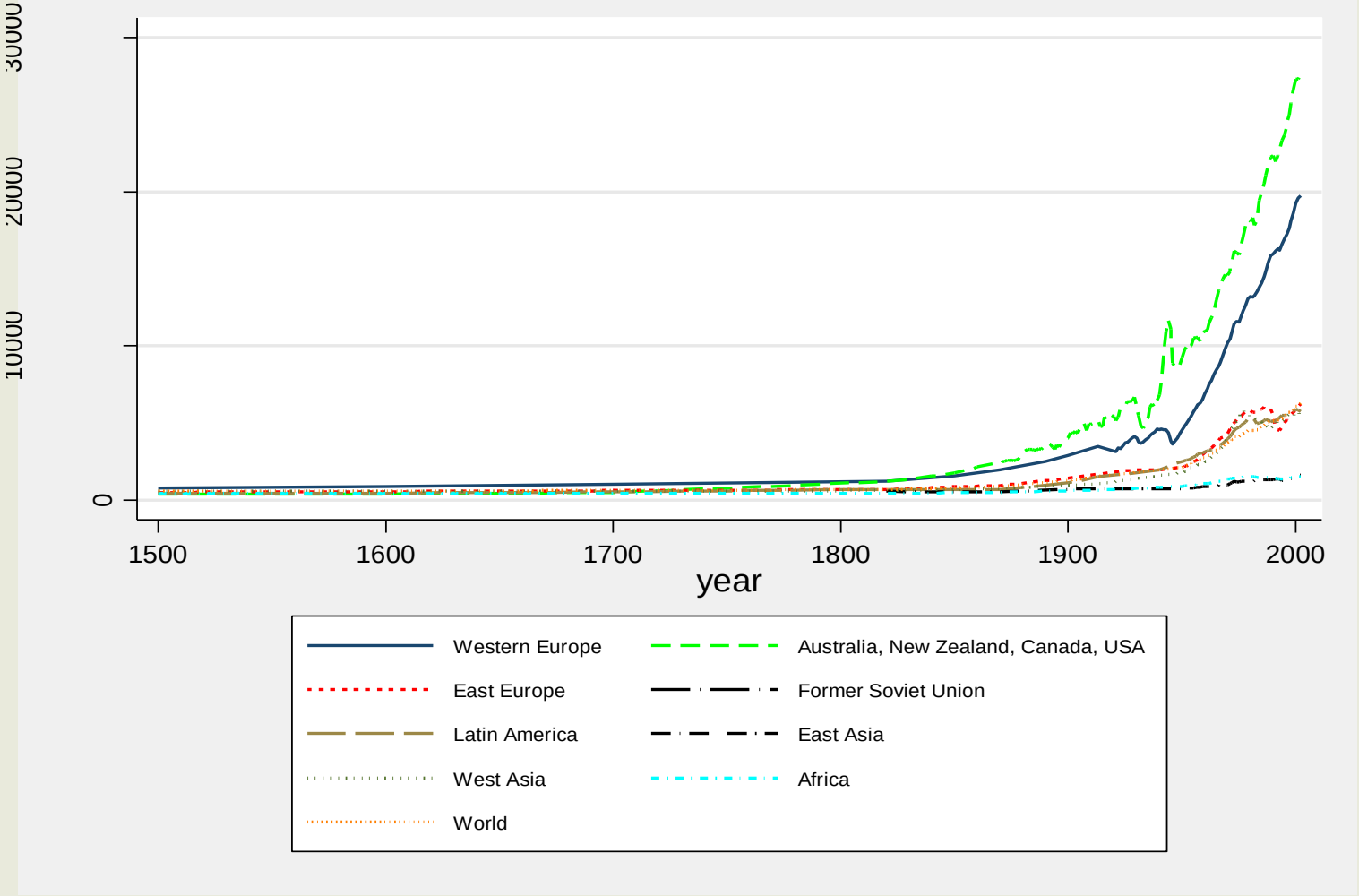
Per capita GDP 1500–2003



Source: OECD Development Centre Studies The World Economy Historical Statistics
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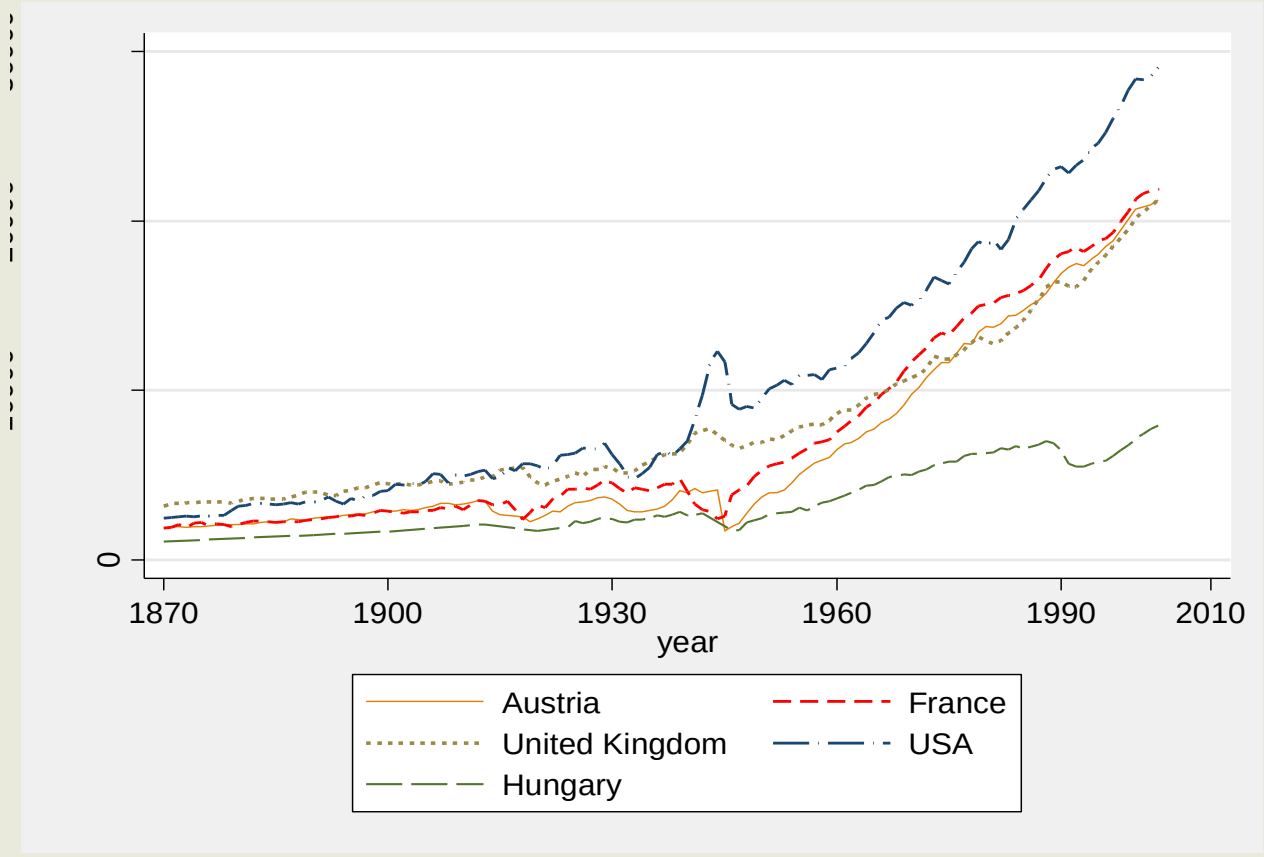
Per capita GDP 1870–2003 (1990 USD PPP)



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Per capita GDP 1870–2003

Growth rate of per capita GDP (yearly averages %)

	1500–1820	1820–1900	1900–2000
OECD		1.2	2.0
Non-OECD		0.4	0.6
World	0.04	0.8	1.9

Forrás: OECD Development Centre Studies The World Economy Historical Statistics http://www.oecd.org/document/33/0,3746,en_2649_33987_8007265_1_1_1_1,00&&en-USS_01DBC.html

Growth accounting – the sources of economic growth

1. The aggregate production function

2. Endogenous growth models

Aggregate production function

Solow model

$$Y_t = f(A_t, L_t, K_t, t)$$

Y – aggregate national product

A – land

L – labor

K – capital

t – disembodied technical change

Explicit form – Cobb–Douglas function

$$Y_t = e^{\varphi t} A_t^{\alpha} L_t^{\beta} K_t^{\gamma}$$

$\alpha+\beta+\gamma=1$

$$\frac{\Delta Y}{Y} = \phi + \alpha \frac{\Delta A}{A} + \beta \frac{\Delta L}{L} + \gamma \frac{\Delta K}{K}$$

The rate of growth is a result of the additive effects of growth in each of the inputs

$$\frac{\Delta Y}{Y} = \phi + \alpha \frac{\Delta A}{A} + \beta \frac{\Delta L}{L} + \gamma \frac{\Delta K}{K}$$

rate of growth of output

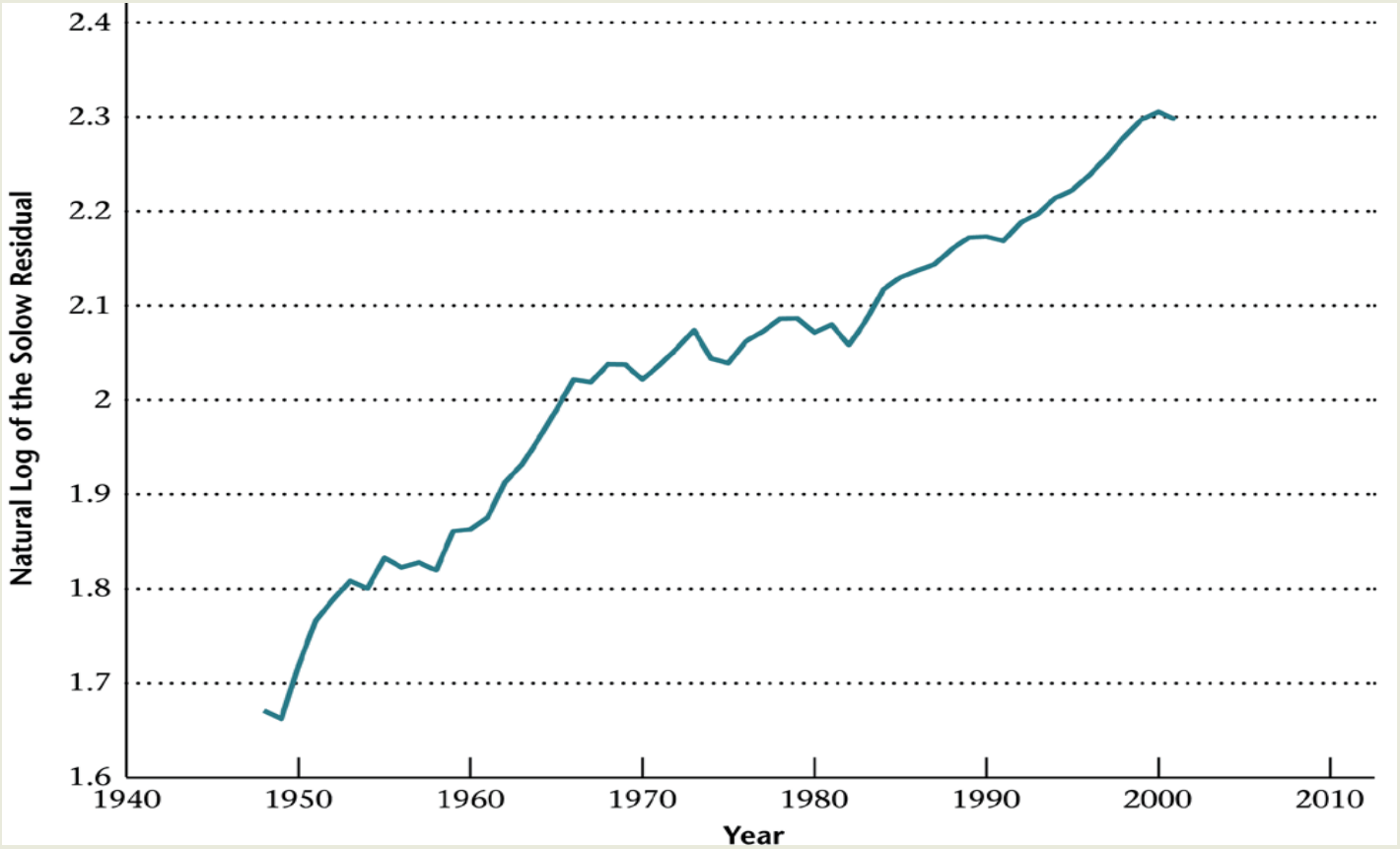
rate of growth in technical change

rate of growth of land under cultivation

rate of growth of labor

rate of growth of capital

The residual



The residual

Solow Residual From 1990 – 2001

Year	Y Income	K capital	N labor	z
1990	6709.9	20871.1	118.8	8.79
1991	6676.4	21207.6	117.7	8.74
1992	6880	21577.4	118.5	8.92
1993	7062.6	22027.7	120.3	9.00
1994	7347.7	22530.2	123.1	9.15
1995	7543.8	23072.9	124.9	9.23
1996	7813.2	23701	126.7	9.38
1997	8159.5	24383.6	129.6	9.56
1998	8508.9	25175.2	131.5	9.76
1999	8859	26033.2	133.5	9.94
2000	9191.4	26933.8	136.9	10.03
2001	9214.5	27711.2	136.9	9.95
1990	N/A	N/A	N/A	N/A
1991	-0.0050	0.01612	-0.00926	-0.00480
1992	0.0296	0.01744	0.00680	0.01967
1993	0.0259	0.02087	0.01519	0.00915
1994	0.0388	0.02281	0.02328	0.01687
1995	0.0260	0.02409	0.01462	0.00852
1996	0.0345	0.02722	0.01441	0.01639
1997	0.0424	0.02880	0.02289	0.01884
1998	0.0411	0.03246	0.01466	0.02134
1999	0.0395	0.03408	0.01521	0.01877
2000	0.0362	0.03459	0.02547	0.00853
2001	0.0025	0.02886	0.00000	-0.00770

Why we expect any contribution to growth from education?

- Education is a complementary to physical capital (*Griliches, 1969; Psachropoulos, 1973; Layard, 1975).*
- Education enhances the adoption and efficient use of new inputs *(Psacharopoulos, 1984*).
- Depreciation of human capital occurs at a slower rate than that of physical capital (*Miller, 1967*).
- Education is an alternative to consumption (expenditures on education are made mostly at the expense of consumption) (*Miller, 1967*)

Why we expect any contribution to growth from education?

Education

- increases labor productivity (*Mantis, Romer, Weil 1992*)ç
- increases the innovative capacity of the economy, and the new knowledge on new technologies, products and processes promotes growth – endogenous growth models (*Lucas, 1988; Romer, 1990; Aghion–Howitt,1998*)ç
- facilitates the diffusion and transmission of knowledge needed to understand and process new information and to successfully implement new technologies devised by others (*Nelson–Phelbs 1966; Benhabib–Spiegel, 2005).*

Education's contribution to growth Schultz's study (1961)

- Calculates the increase in the stock of education ΔSE
  (change in average number of school years completed in the labor force multiplying with the „value" of an equivalent year of school = cost of schooling including foregone earnings)

- Compute the difference between actual labor earnings per person employed and the level of real labor income that would have been observed if each member of the labor force earned the base year income ΔLI*

- Compute income at attributable to additional education VE=ΔSE r (***r*** = average rate of return to schooling

- The contribution of education to economic growth = VE/ΔLI*

Education's contribution to growth
Denison's study
(1962, 1964, 1967, 1974, 1979, 1984, 1985)

$$Y=AK^{\alpha}(LE)^{1-\alpha}$$

E – average level of education.

Denison's study – steps of calculating education's contribution to economic growth

1. Calculate a weighting factor (w_e) that indicates the relative earnings of persons with any one level of education in comparison to a base level of education (w_8).
2. Calculate the percentage distribution of employment by level of education P_e.
3. Calculate initial indexes for males and females for all relevant years.
4. Adjust initial indexes by the level of unemployment, by school days per year and rates of attendance.
5. Calculate a global index: the two (male, female) indexes are weighted by total earnings to obtain the final index of both sex combined.
6. Standardized final indexes for education are employed, in conjunction of other labor inputs to compute the change in the labor input over time.
7. The relative contribution of education to growth is calculated by computation of the increase in the quality of labor ascribed to education, multiplied by the share of labor compensation in national income.

$$\sum_{c=0}^{9} w_e e_e$$

Denison's study

Education level (highest school grade completed)	**Weighting factor w_e**	**Percentage distribution of full-time-equivalent employment March 1976 P_e**		**Initial indexe w_e*P_e**	
	(1)	Males (2)	Female (3)	Males (1)*(2)	Females (1)*(3)
None	87	0.32	0.26	0.278	0.226
Elementary, 1–4	93	1.65	0.72	1.535	0.670
Elementary, 5–7	97	4.65	2.75	4.511	2.638
Elementary, 8	100	6.36	4.92	6.360	4.920
High school, 1–3	111	15.68	15.97	17.405	17.727
High school, 4	122	38.80	49.88	17.336	60.854
College, 1–3	142	15.69	16.28	22.280	23.443
College, 4	184	10.00	6.42	18.400	11.813
College, 5 or more	207	6.85	2.80	14.180	5.796
Total	-	100	100	132.315	128.087

Denison's study

Estimates of the contribution of education to past growth of real national income

	1929-48	1948-73	1973-82
Growth rate of total real national income	2.44	3.58	1.26
Amount of growth rate ascribed to education	0.48	0.52	0.62
Percentage of growth rate ascribed to education %	19.70	14.00	49.20
Growth rate o real national income per person employed	1.33	2.45	– 0.26
Amount of growth rate ascribed to education	0.48	0.52	0.62
Percentage of growth rate ascribed to education %	36.1	21.2	..

Source: Denison 1985

The contribution of education to national income growth %

Country	Contribution of education as a percentage o national income growth
Canada	25.0[b]
USA	15.0[b]
Belgium	14.0[b]
Denmark	4.0[b]
France	6.0[b]
Germany	2.0[b]
Italy	7.0b
Greece	3.0[b]
Israel	4.7[b]
Netherlands	5.0[b]
Norway	7.0[b]
UK	12.0[b]
South Korea	15.9[a]
Malaysia	14.7[a]

Source: Psacharopoulos, 1984

[a]Schultz's method

[b] Denison's method

Data pertain to the 1960s

Measurement problems

Earnings diffentials are used for measuring the contribution of education to labor quality

Denison (weighting factor), Schultz (rate of return)

- cross-section data problems
- ability bias
- is human capital theory correct?
- MP=W?

  Cobb–Douglas production function

  too restrictive – elasticity of substitution between any to inputs is unity

  Causation problem

  Growth in total factor productivity is exogenous

Educated labor as a factor of production CES function (Mankiw, Romer,Weil 1992)

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta}$$

Output

Capital

Human capital stock

Technology

Labor

α+β<1

Endogenous growth models

• In Solow model sustained growth is due to exogenous forces.

• Endogenous growth theory – models that examine the determinants of the rate of technological progress, which Solow takes as given.

• Sustained economic growth can be explained endogenously by human capital accumulation.

• Higher rates of growth can be attained by greater time allocation to education, more efficient educational systems.

Endogenous growth models (Lucas, 1990)

$$Y_t = AK_t^{\beta}(u_t h_t L_t)^{1-\beta} h_{a,t}^{\gamma}$$

output

Labor - number of persons employed

The average level of education

The level of technology

Physical capital

Fraction of time a typical worker devotes to production as opposed to human capital accumulation

Level of education of typical worker

Education measures

Level of years of schooling (endogenous growth) or change in years of schooling (neoclassical models) is more important?

Education measures

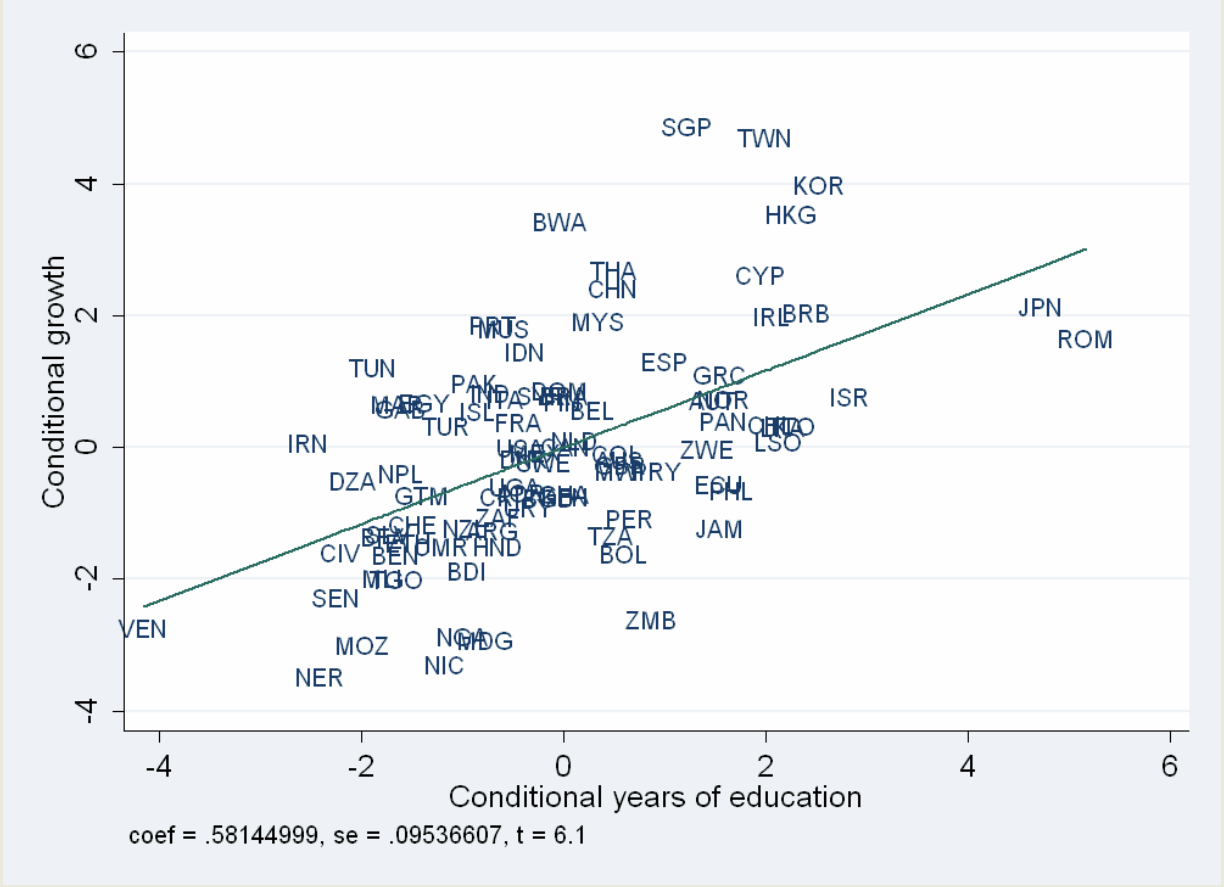
Quantitative measures

- Adult literacy rates – (*Romer)*
- School enrollment ratios (*Barro 1991, Mankiw, Romer, Weil*)
- Average years of schooling (*Barro–Lee, 1993, 2001*)

Qualitative measures: how much students have learned while in school?

- Perfomance on standardized international tests (*Hanushek–Kimko, 2001, Wössman, 2003)*

Quantity of schooling and economic growth



Added-variable plot of a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960–2000 on average years of schooling in 1960 and the initial level of real GDP per capita in 1960.

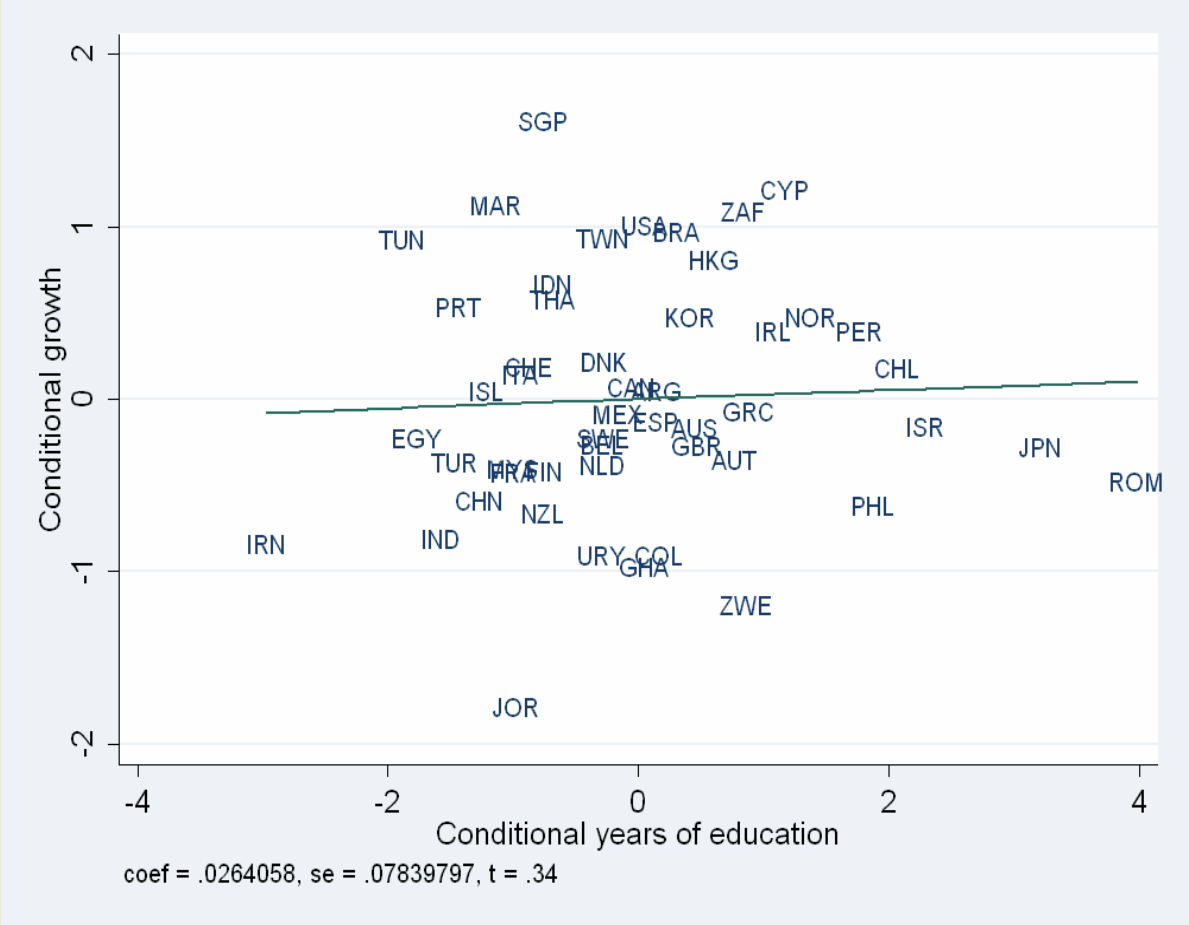
Source: Hanushek, E. & Woessmann, L. (2007). *Education quality and economic growth*. Washington, DC: The World Bank.

Quality of schooling and economic growth

Added-variable plots of a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960–2000 on the initial level of real GDP per capita in 1960, average test scores on international student achievement tests, and average years of schooling in 1960.

Source: Hanushek, E. & Woessmann, L. (2007). *Education quality and economic growth*. Washington, DC: The World Bank.

Quality of schooling and economic growth



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