Economic Growth

Seminar 1: Convergence of Countries

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Converging to Convergence

Kremer, Michael, Jack Willis, and Yang You.

Q2. Define absolute convergence.

Q3. Define conditional convergence.

Convergence of countries

- Low income countries growing faster than the high income countries, or income per capita of the low income countries catching up with the income per capita of the high income countries

Absolute convergence

> Convergence across countries without conditioning on the determinants of steady state income -- Kremer, Willis and You (2021)

Conditional convergence

- Convergence of countries conditional on the determinants of steady state income
- Acknowledging that countries differ in terms of key characteristics such as
    - investment rate,
    - population growth rate,
    - human capita,
    - productivity
- All these difference in key characteristics will have an effect on convergence of countries.

Q4. What is the prediction of the Solow model in convergence of countries?

If two countries have the same rate of investment but different levels of income, the country with lower income will have higher growth.

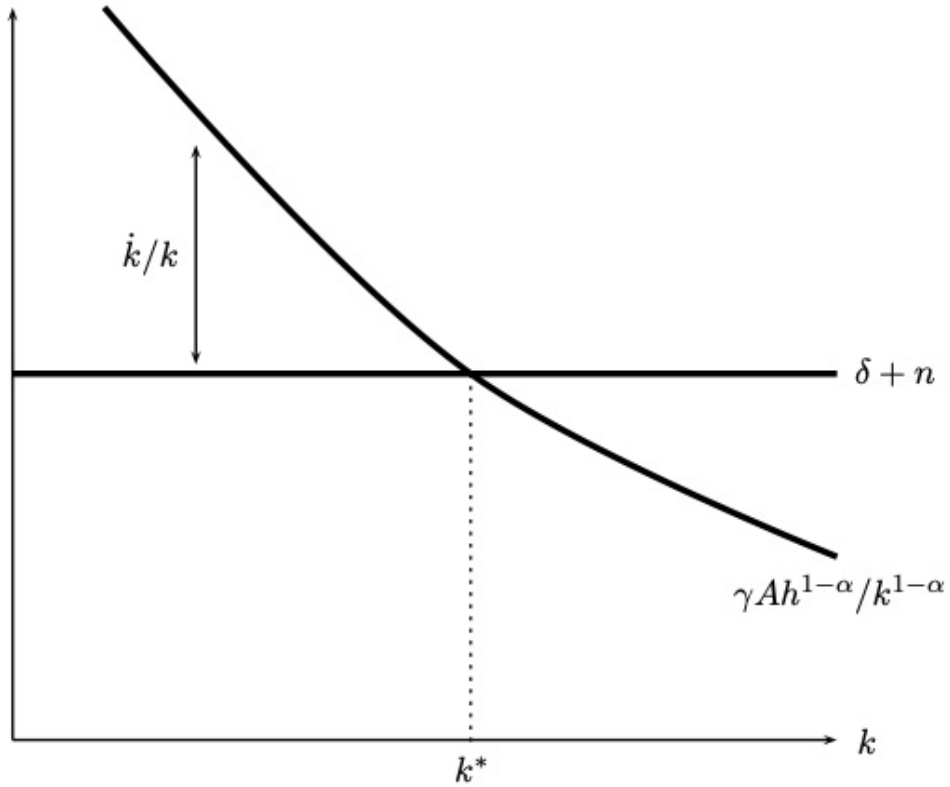
- The Solow model predicts that growth is faster when an economy is farther away from steady state.
- Start with

$$\dot{k} = \gamma A k^{\alpha} h^{1-\alpha} - (\delta + n)k$$

- Divide both left-hand and right-hand sides to get the growth rate of capital per worker, $\frac{\dot{k}}{k}$:

$$\frac{\dot{k}}{k} = \frac{\gamma A h^{1-\alpha}}{k^{1-\alpha}} - (\delta + n).$$

- As k rises, the growth rate of k falls.



Source: Jones and Vollrath (2013)

How do we test convergence?

Q6. Define β-convergence

Q7. Define σ-converge

β-convergence

> when poorer countries grow faster on average than richer countries -- Kremer, Willis and You (2021)

$$\frac{\log(GDPpc_{i,t+\Delta t}) - \log(GDPpc_{i,t})}{\Delta t} = \alpha + \beta \log(GDPpc_{i,t}) + \epsilon_{i,t}$$

If β is negative, then there is evidence of convergence

σ-converge

- When variance of GDP per capita across countries goes down over time

Q5. Does the empirical evidence until 1990s support the Solow model's prediction on convergence of countries?

No evindence of convergence until 1990s

> Empirical tests in the 1990s found little evidence of poor countries catching up with rich - unconditional convergence - since the 1990s, and divergence over longer periods.

Q9. What is the methodology of this paper?

Data sets

- World Development Indicators
- Penn World Tables
- the Maddison Project Database
- Within-country panel datasets

Run 10-year average growth regressions on initial GDP per capita

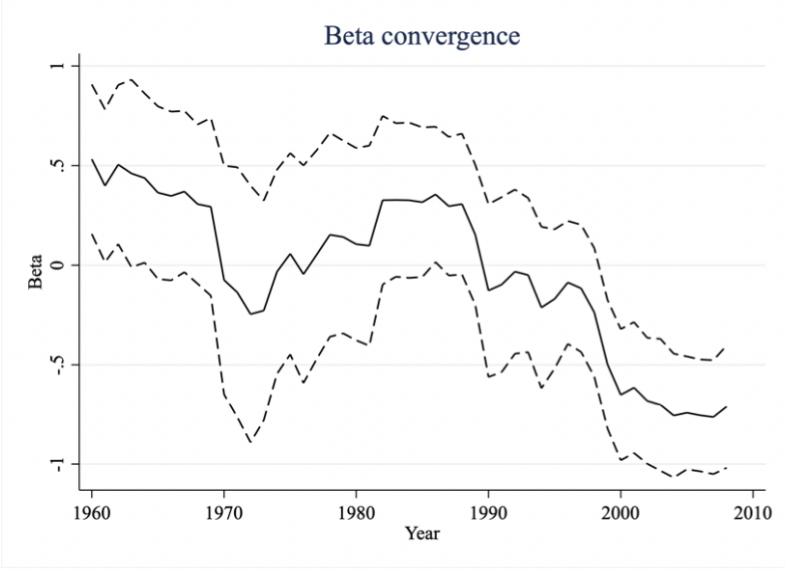
$$\frac{\log(GDPpc_{i,t+\Delta t}) - \log(GDPpc_{i,t})}{\Delta t} = \beta_t \log(GDPpc_{i,t}) + \mu_t + \epsilon_{i,t},$$

where β varies over time, μ_t is time fixed effects, and $\Delta t = 10$

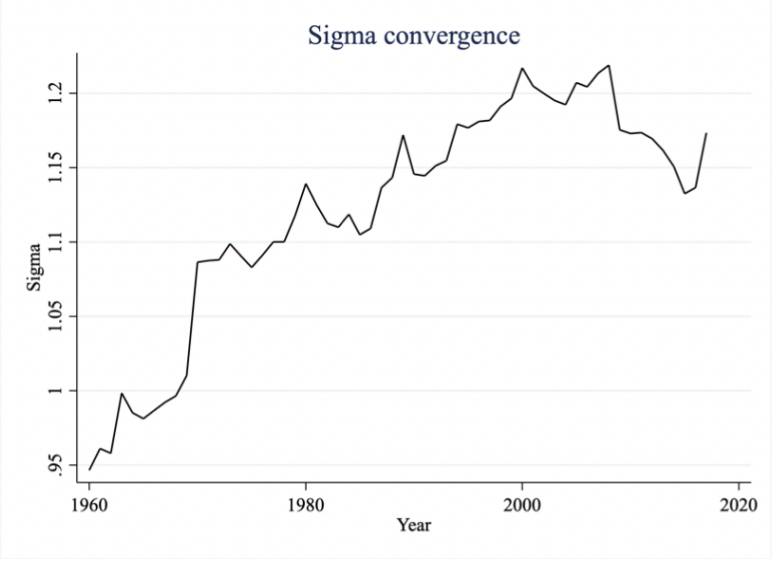
Q8. What are the key results of this paper?

Result 1: Absolute convergence since the late 1990s
Result 2: Convergence to convergence since 1990

Figure 2: Trend in income convergence, 1960-2007



Source: Kremer, Willis and You (2021)



(b) $\sigma-$convergence.

Source: Kremer, Willis and You (2021)

Notes: These figures show the trend in convergence from 1960 to 2007. Figure a) plots the β-convergence coefficient, for growth in the subsequent decade, over time. It is the coefficient from Equation 1 - regressing, across countries, the average growth in GDP per capita in the next decade (in %) on the log of GDP per capita, with year fixed effects, and with standard errors clustered by country. Income per capita is adjusted for PPP and comes from the Penn World Tables, v10.0. The sample is growing over time, and excludes countries with a population less than 200,000 or for whom natural resources account for $> 75\%$ of their GDP, as in Figure 1 (neither exclusion has a meaningful effect on the trend). Figure b) plots the evolution over time of the cross-country standard deviation in GDP per capita. *sigma*-convergence corresponds to a negative slope. Equivalent panels using balanced panels are in Figure A.5.

Result 3: conditional convergence since 1960

Table A.1: Convergence β with country fixed effects

	Panel A: Average growth in next decade ($\Delta t = 10$)					
	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007	
log(GDPpc)	-7.794***	-7.990***	-8.552***	-10.38***	-9.186***	
	(0.896)	(0.820)	(0.685)	(0.625)	(0.849)	
Year FE and Country FE	Y	Y	Y	Y	Y	
Obs	1,107	1,370	1,371	1,600	1,440	
	Panel B: Growth in the next year ($\Delta t = 1$)					
	(1)	(2)	(3)	(4)	(5)	(6)
	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2017
log(GDPpc)	-21.56***	-15.30***	-15.76***	-19.99***	-12.86***	-11.52*
	(3.561)	(3.419)	(3.366)	(3.698)	(3.481)	(4.570)
Year FE and Country FE	Y	Y	Y	Y	Y	Y
Obs	1,107	1,370	1,371	1,600	1,600	1,120

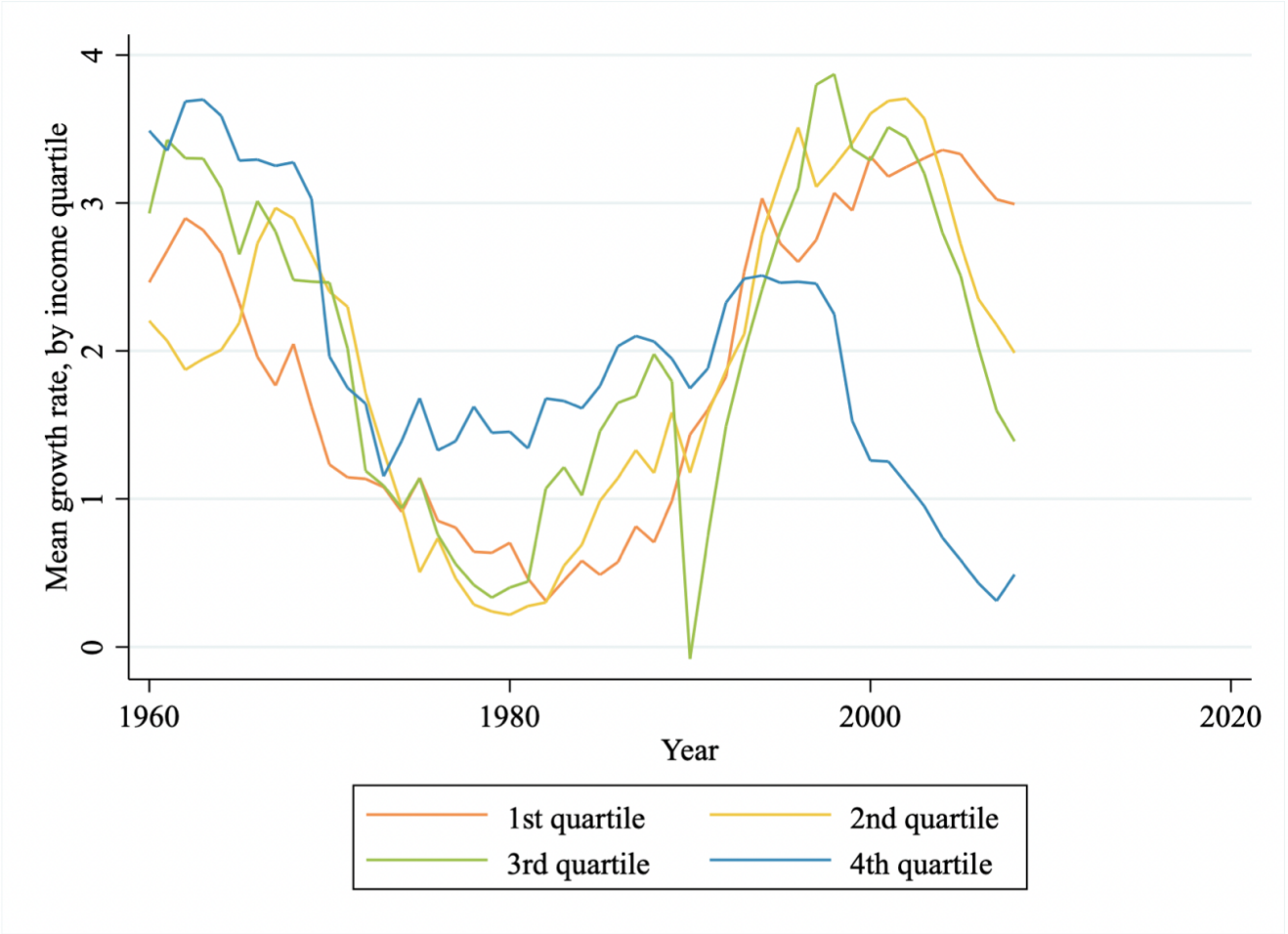
Notes: This table reports the β-convergence estimation with both country and year fixed effects included.

$$log(GDP_{i,t+\Delta t}) - log(GDP_{i,t}) = \beta log(GDP_{i,t}) + \mu_t + \gamma_i + \epsilon_{i,t}$$

The data sample is 1960-2017. Each column reports the β coefficient estimated for each decade. Panel A reports average growth in the next decade ($\Delta t = 10$), and Panel B report growth in the next year ($\Delta t = 1$). Standard deviations are clustered at country level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Result 4: convergence is driven by 'both faster catch-up growth and slower growth of the frontier'

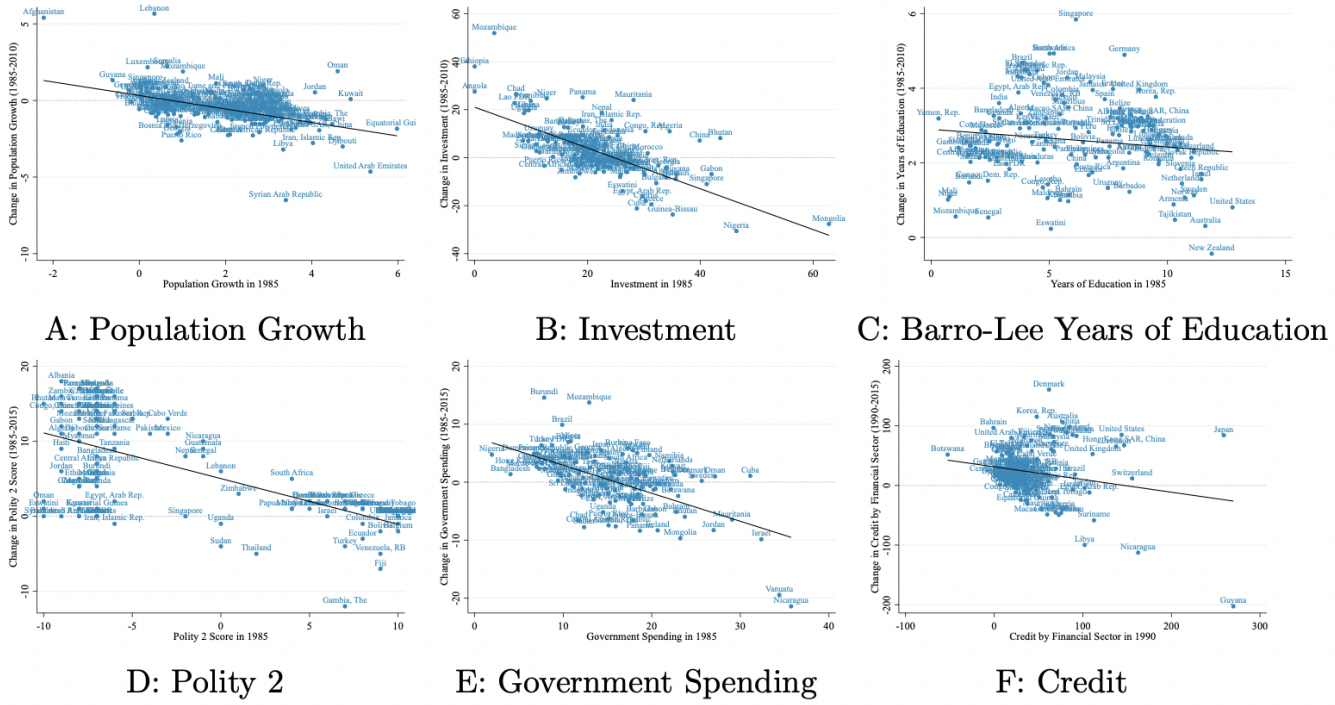
Figure 3: Trend in income growth by income quartile, 1960-2007



Notes: The plots show the average annual growth in GDP per capita, PPP, for the subsequent decade, averaged by income per capita quartile. Income per capita quartile is classified based on GDP per capita in that year, with the first quartile being the lowest income and the fourth quartile the highest.

Result 5: convergence in determinants of economic growth

Figure 4: Convergence in growth correlates: level in 1985 versus change 1985-2015



Notes: This figure plots β-convergence for growth six representative correlates (potential determinants of steady-state income) from 1985 (or the earliest available year) to 2015 against the baseline correlate level in 1985. We include six of the correlates which are comparable over time, for illustration: Population growth rate (%), Investment rate (% of GDP), Barro-Lee average years of education among 20-60-year-olds, Polity 2 score, government spending (% of GDP), credit by the financial sector. The sample for each figure is the complete set of countries for which the relevant data is available in 1985 and 2015.

Table 3: Change and convergence in enhanced Solow fundamentals and growth correlates from 1985* to 2015*

	Dev-Favored	**Mean in 1985**	**Mean in 2015**	**Change (in σ_{1985})**		**Convergence β**
				Estimate	p-val	
Gross capital formation (% of GDP)	High	22.07	24.18	0.23	0.06	-2.98***
Population growth (annual %)	Low	1.99	1.42	-0.43	0.00	-1.53***
Barro-Lee Education Age 20-60	High	6.19	8.80	0.86	0.00	-0.16
Average of Solow Fundamentals						-1.56
Education Gap (Male-Female)	Low	0.97	0.33	-0.66	0.00	-0.81***
Labor Force Participation Rate	Low	62.48	62.61	0.01	0.79	-0.66***
Polity 2 Score	High	-0.87	4.69	0.73	0.00	-2.03***
Freedom House Political Rights	High	5.86	6.53	0.30	0.00	-1.39***
Freedom House Civil Liberty	High	5.72	6.56	0.41	0.00	-1.36***
Media Freedom Score	High	52.63	49.93	-0.12	0.02	-0.88***
WGI Political Stability	High	-	-	-	-	-
WGI Government Effective	High	-	-	-	-	-
WGI Regulatory Quality	High	-	-	-	-	-
WGI Rule of Law	High	-	-	-	-	-
WGI Control of Corruption	High	-	-	-	-	-
Overall Economic Freedom Index	High	-	-	-	-	-
Government Integrity	High	-	-	-	-	-
Property Rights	High	-	-	-	-	-
Business Freedom	High	-	-	-	-	-
Equal-weighted Tariff	Low	9.46	4.36	-0.47	0.00	-3.46***
Value-weighted Tariff	Low	8.11	3.09	-0.70	0.00	-3.38***
Taxes on Income & Capital Gain	High	25.54	28.79	0.20	0.06	-1.61***
Government Spending (%GDP)	High	15.90	15.96	0.01	0.90	-1.61***
Taxes on Goods and Services	N/A	28.47	31.38	0.21	0.17	-2.51***
Tax Burden Score	N/A	-	-	-	-	-
Private Investment	High	0.63	0.63	0.00	0.99	-1.60***
Military Expenditure (%GDP)	N/A	3.38	1.89	-0.47	0.00	-2.10***
Inflation	Low	16.19	2.25	-0.54	0.00	-3.07***
Central Bank Independence	N/A	0.38	0.60	1.77	0.00	-2.56***
Credit to Private Sector	High	31.46	55.60	0.95	0.00	0.89**
Credit by Financial Sector	High	49.42	69.15	0.47	0.00	-0.98
Financial Freedom	High	-	-	-	-	-
Investment Freedom	High	-	-	-	-	-

Q10. Exercise #5 from Chapter 2 of Jones and Vollrath (2013):

> Can we save too much? Consumption is equal to output minus investment: $c = (1-\gamma)y$. In the context of the Solow model, what is the savings rate that maximizes steady-state consumption per worker? What is the marginal product of capital in this steady state? Show this point in a Solow diagram. Be sure to draw the production function on the diagram, and show consumption and saving and a line indicating the marginal product of capital. Can we save too much