GEOGRAPHICAL ECONOMICS
"B"

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GEOGRAPHICAL ECONOMICS
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week 4

Geographical economics – growth and convergence

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1 Economic Growth and International Convergence

1.1 The Mankiw-Romer-Weil analysis

Growth
Economic Growth and the neoclassical model

- Solow-Swan model
- Mankiw, G., Romer, D. and Weil, D. (1992), A contribution to the empirics of economic growth, QJE
- Once a country has a growth rate below the steady-state level, they grow at a faster rate.
- = convergence to the steady-state level, which is the same for each country.
- ...if technologies and preferences are identical.

MRW: basic Solow model
Solow model, Cobb-Douglas, CRS

$$Y(t) = K(t)^{\alpha}[A(t)L(t)]^{1-\alpha} \tag{1}$$

- $A(t)$ – total factor productivity

$$\dot{K} = sY - \delta K \tag{2}$$

- $L_t = L_0 e^{nt}$ és $A_t = A_0 e^{gt}$
- s is investment rate, δ is depreciation rate, g is the rate of technological progress and n is the exogenous rate of population growth
- $k = K/L$, $y = Y/L$

$$\dot{k} = sy(t) - (n+g+\delta)k(t) = sk(t)^{\alpha} - (n+g+\delta)k(t) \tag{3}$$

MRW: First results

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)
$\bar{R}^2$	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)
$\bar{R}^2$	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.

Results

- They confirm some important theoretical results
- The coefficients of saving and population growth have opposite signs
- We cannot reject that the two effects are equal in magnitude.
- We can explain a lot of things…
- …but: α is too high
- …but: developed countries are different

Augmented Solow model

TABLE II
ESTIMATION OF THE AUGMENTED SOLOW MODEL

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)
$\bar{R}^2$	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)
$\bar{R}^2$	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.

MNW: Augmented model – results

- Human capital measure has a strong, significant effect
- The model explains almost 80 percent of variation in income per capita (increased)
- The sum of the coefficients is equal to zero.
- Restriction can not be rejected
- $\beta \simeq 0.3 - 0.4$
- Consistency with the data, e.g. $Y = L^{1/3}K^{1/3}H^{1/3}$

MNW: Conslusion

- Consistency with the data, e.g. $Y = L^{1/3}K^{1/3}H^{1/3}$
- On the whole, these models indicate different steady state levels that are affected by exogenous determinants.
- Steady-state: accumulation of human and physical capital, growing population
- Convergence only if we control for the determinants of the steady-state
- = conditional convergence
- The speed of convergence: $\lambda = (n + g + \delta)(1 - \alpha - \beta) \simeq 0.02$
- = GDP growth rate is the function of steady state, exogenous parameters (s_k, s_h,$n + g + \delta$) and the initial level of income (y_o) (*Deduct this result - homework!*)

1.2 Interpretation of convergence

Convergence estimation

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.

Convergence estimation

TABLE IV
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	1.93	2.23	2.19
	(0.83)	(0.86)	(1.17)
ln(Y60)	−0.141	−0.228	−0.351
	(0.052)	(0.057)	(0.066)
ln(I/GDP)	0.647	0.644	0.392
	(0.087)	(0.104)	(0.176)
$\ln(n + g + \delta)$	−0.299	−0.464	−0.753
	(0.304)	(0.307)	(0.341)
$\overline{R}^2$	0.38	0.35	0.62
s.e.e.	0.35	0.33	0.15
Implied λ	0.00606	0.0104	0.0173
	(0.00182)	(0.0019)	(0.0019)

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.

Convergence estimation

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.

Empirical results

- Basic setup: no convergence, poor countries do not grow faster (Table 3)
- When we take into account the steady state conditions, the effect of the initial level of income is significant and negative; conditional convergence (Table 4)
- Human capital matters, stronger convergence (Table 5)
- However, the convergence occurs as a quite slow process
- The Solow model is not so bad...

Two concepts of convergence: remarks

- Barro and Sala-i-Martin (1995): Economic Growth, Chapter 11
- Up until now we've dealt with β-convergence (poor countries catching up with rich nations)
- According to another concept, convergence occurs when the dispersion of log per capita income within a group of countries declines over time. We call this process σ-convergence.

Two concepts of convergence: remarks

- In the case of β-convergence there are no overtaking or big jumps
- β-convergence tends to generate σ-convergence – however, this is not a rule
- To put it in a more accurate way, β-convergence is a necessary but not a sufficient condition for σ-convergence. (*Derive this statement! - homework!*)
- The dispersion of income can be determined by exogenous shocks (e.g. oil-price shock), that affect only a limited number of countries. It can influence our convergence estimation.

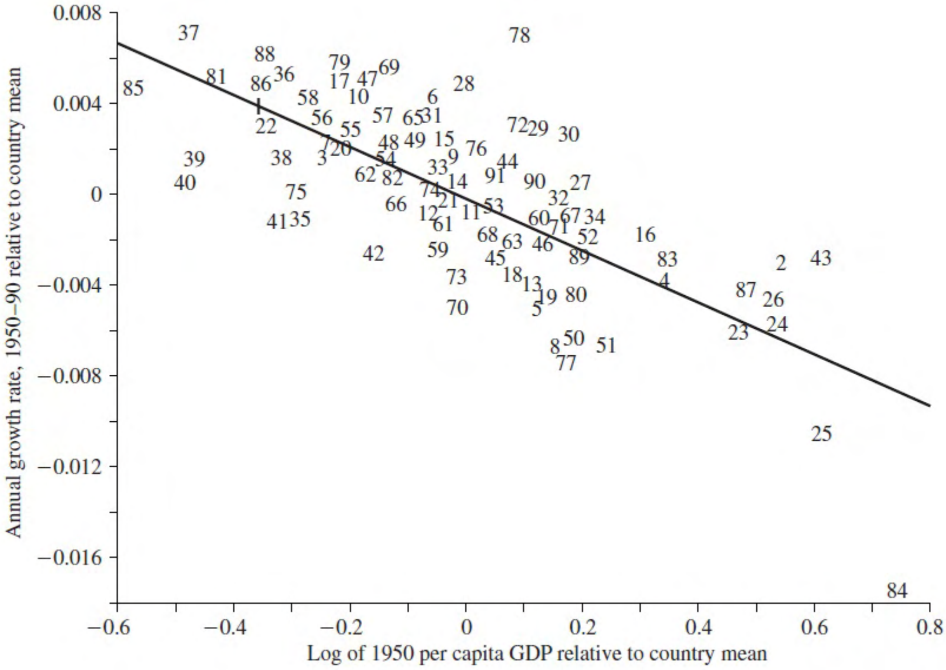
Two concepts of convergence: EU8

Table 11.3
Convergence Across European Regions

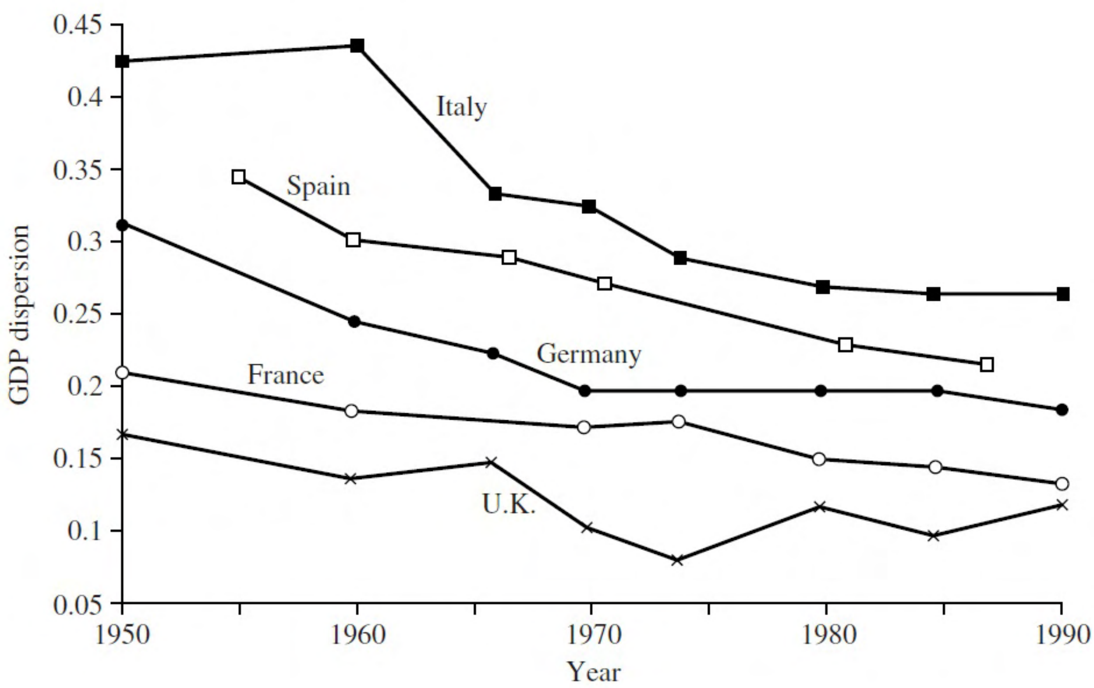
	(1) Equations with Country Dummies		(2) Equations with Sectoral Shares and Country Dummies	
Period	$\hat{\beta}$	$R^2[\hat{\sigma}]$	$\hat{\beta}$	$R^2[\hat{\sigma}]$
1950–60	0.018 (0.006)	0.83 [0.0099]	0.034 (0.009)	0.84 [0.0094]
1960–70	0.023 (0.009)	0.97 [0.0065]	0.020 (0.006)	0.97 [0.0064]
1970–80	0.020 (0.009)	0.99 [0.0079]	0.022 (0.007)	0.99 [0.0077]
1980–90	0.010 (0.004)	0.97 [0.0066]	0.007 (0.005)	0.97 [0.0064]
Joint, 4 subperiods	0.019 (0.002)	— —	0.018 (0.003)	— —
Likelihood-ratio statistic (p value)	4.9 (0.179)		8.6 (0.034)	

Two concepts of convergence: EU8

Convergence relative to the country mean



Two concepts of convergence: EU8



Two concepts of convergence: EU8

	β	σ	interesting
Germany	2,4%	0,31–0,19	
UK	2,8%	0,17–0,12	*
Italy	1,5%	0,42–0,27	*
France	1,2%	0,21–0,14	
Spain	1,8%	0,35–0,22	

How could we explain the differences? - homework!

A different model: Quah

Danny Quah: Convergence Clubs

- What if there appear plenty of connections within a group of countries, wherefore individual growth cannot explain precisely the convergence path?
- Empirical results: instead of unconditional convergence, evolving two groups and countries converge to one of these two 'peaks'
- = σ-convergence within the two groups
- ='twin peaks'
- e.g. Asian convergence and EU convergence to a different level

A different model: Quah