Geographical Economics

Course 4: Convergence

Rosella Nicolini

UAB

January 2016

What did we learn ?

1. Simple model to analyze the factors driving growth,

What did we learn ?

1. Simple model to analyze the factors driving growth,
2. Key role of the technology.

What are we learning ?

1. Empirical issues associated with the growth processes,

What are we learning ?

1. Empirical issues associated with the growth processes,
2. Convergence/divergence issues.

Emprical application: growth accounting

- Decomposition of the growth of the output per-worker into the contribution of the growth of capital per workers and other remaining residuals $\Longrightarrow$ *Solow residual*

Empirical application: convergence

- The Solow model predicts that countries converge to their balanced growth path.

Empirical application: convergence

- The Solow model predicts that countries converge to their balanced growth path.
- Differences in output arises when countries settle at different points of their balanced path

Empirical application: convergence

- The Solow model predicts that countries converge to their balanced growth path.
- Differences in output arises when countries settle at different points of their balanced path
- One would expect poor countries catch-up to the rich countries

Empirical application: convergence

Key equation:

$$\ln\left[\left(\frac{Y}{N}\right)_{i,t}\right] - \ln\left[\left(\frac{Y}{N}\right)_{i,t_0}\right] = a + b\ln\left[\left(\frac{Y}{N}\right)_{i,t_0}\right] + \varepsilon_i$$

- In case of convergence: $b < 0$: *if* $b = -1$ perfect convergence

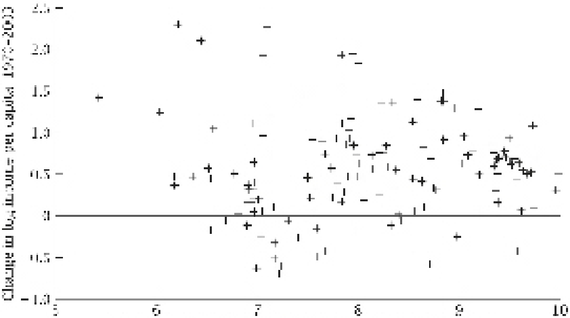
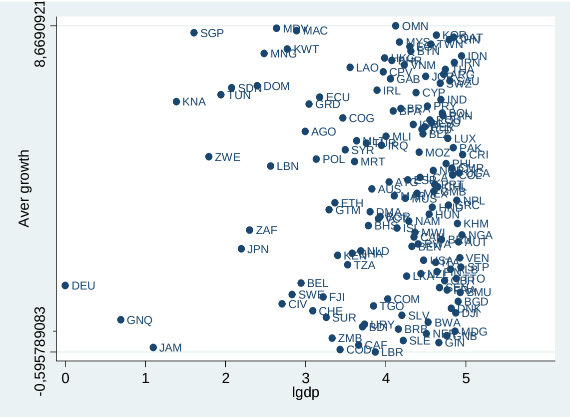
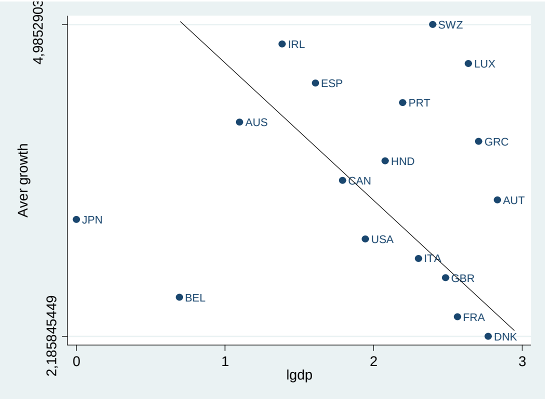


FIGURE 1.9 Initial income and subsequent growth in a large sample

Empirical application: convergence



Empirical application: convergence



Empirical application: convergence

Differences between:

- β or unconditional convergence

Empirical application: convergence

Differences between:

- β or unconditional convergence
- σ or conditional convergence

Further issues about growth

- One of the most convenient way to represent a production function is the Cobb-Douglas function:

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

Further issues about growth

- One of the most convenient way to represent a production function is the Cobb-Douglas function:

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

- It is a very flexible representation and it allows for several extensions: for instance, including *natural resources*

$$Y(t) = K(t)^{\alpha} R(t)^{\beta} T(t)^{\gamma} [A(t)L(t)]^{1-\alpha-\beta-\gamma}$$

Further issues about growth

- **Endogenous growth:** the growth process is driven by factors not suffering from decreasing returns to scale.

Further issues about growth

- **Endogenous growth:** the growth process is driven by factors not suffering from decreasing returns to scale.
- Following the seminal paper by Romer (1990):

$$Y(t) = [(1 - a_k)K(t)]^{\alpha} [(1 - a_L)A(t)L(t)]^{1-\alpha}, \alpha > 0,$$

Further issues about growth

- **Endogenous growth:** the growth process is driven by factors not suffering from decreasing returns to scale.
- Following the seminal paper by Romer (1990):

$$Y(t) = \left[(1 - a_k)K(t)\right]^{\alpha} \left[(1 - a_L)A(t)L(t)\right]^{1-\alpha}, \alpha > 0,$$

- Labor effectiveness is driven by the creation of knowledge, for instance, with R&D (namely, creation of new ideas)

$$\dot{A}(t) = \underbrace{A(t)^{\vartheta}}_{Stock\ HC} B\left[(a_k)K(t)\right]^{\beta} \left[(a_L)L(t)\right]^{1-\beta}$$

Further issues about growth

- Key issue: importance of the returns to scale

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

$$\dot{A}(t) = BK(t)^{\varphi}; \varphi > 0 \; \& \; B > 0.$$

Further issues about growth

- Key issue: importance of the returns to scale
- **Exogenous vs endogenous growth:** for specific values of the parameters, increases in the saving rates and in the population increase the long run growth.

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

$$\dot{A}(t) = BK(t)^{\varphi}; \varphi > 0 \;\&\; B > 0.$$

Further issues about growth

- Key issue: importance of the returns to scale
- **Exogenous vs endogenous growth:** for specific values of the parameters, increases in the saving rates and in the population increase the long run growth.
- Optimal level of R&D ???? Open question

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

$$\dot{A}(t) = BK(t)^{\varphi}; \varphi > 0 \ \& \ B > 0.$$

Further issues about growth

- Key issue: importance of the returns to scale
- **Exogenous vs endogenous growth:** for specific values of the parameters, increases in the saving rates and in the population increase the long run growth.
- Optimal level of R&D ???? Open question
- Other source of endogenous growth: *learning by doing*

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

$$\dot{A}(t) = BK(t)^{\varphi}; \varphi > 0 \ \& \ B > 0.$$

Further issues about growth: including human capital

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

$$\dot{K}(t) = sY(t) - \delta K(t)$$

$$\dot{A}(t) = gA(t)$$

$$\dot{H}(t) = L(t)G(E);\;\; G\prime > 0 \;\&\; G\prime\prime \;??$$

$$\dot{L}(t) = nL(t)$$

$$G(E) = e^{\phi G(E)}$$

Further issues about growth: including human capital

In the balanced growth path

$$\frac{Y}{L} = AG(E)y$$

- Human capital influences the rate of growth and it can help to explain differences in income across countries. Intuition: education alters the output per-person on the balanced growth path by the same proportion.

Further issues about growth: including human capital

In the balanced growth path

$$\frac{Y}{L} = AG(E)y$$

- Human capital influences the rate of growth and it can help to explain differences in income across countries. Intuition: education alters the output per-person on the balanced growth path by the same proportion.
- The existence of human capital does not change the Solow model's implications about the effects of physical capital.

Further issues about growth: empirical analysis about human capital

Common function to be estimated (for a country $_i$):

$$ln(\frac{Y_i}{L_i}) = \frac{\alpha}{1-\alpha} ln(\frac{K_i}{Y_i}) + \ln \frac{H_i}{L_i} + \ln A_i$$

- Data sources: Penn World tables

Further issues about growth: empirical analysis about human capital

Common function to be estimated (for a country $_i$):

$$ln(\frac{Y_i}{L_i}) = \frac{\alpha}{1-\alpha} ln(\frac{K_i}{Y_i}) + \ln \frac{H_i}{L_i} + \ln A_i$$

- Data sources: Penn World tables
- Principal issues:
  1/6 gap between richest and poorest countries is due to physical capital
  1/4 gap between richest and poorest countries is due to schooling

Further issues about growth: other factors

The basic setting can be augmented by using other factors that may explain differences in income across countries:

- **Social infrastructure**: this means institutions and policies that help enhancing the returns of the physical and human capital.

Further issues about growth: other factors

The basic setting can be augmented by using other factors that may explain differences in income across countries:

- **Social infrastructure**: this means institutions and policies that help enhancing the returns of the physical and human capital.
- **Geography:** it covers a range of factors from the simple idea of land composition to the spirit of clustering.

Regional convergence

- **Regional convergence**: Studying convergence at regional dimension where interaction among the spatial units is crucial

Regional convergence

- **Regional convergence**: Studying convergence at regional dimension where interaction among the spatial units is crucial
- The sampling model of independence of observations seems inadequate to the case considered because regional observations are likely to display positive spatial dependence (Arbia, 1989)

Regional convergence

- **Regional convergence**: Studying convergence at regional dimension where interaction among the spatial units is crucial
- The sampling model of independence of observations seems inadequate to the case considered because regional observations are likely to display positive spatial dependence (Arbia, 1989)
- A correct way to estimate regional convergence is with the *spatial lag model (ML method)*

$$\log\left(\frac{Y_{i,t}}{Y_{i,0}}\right) = c + b\log(Y_{i,0}) + \rho L\left[\log\left(\frac{Y_{i,t}}{Y_{i,0}}\right)\right] + \varepsilon_{i,t}$$

Regional convergence

- **Regional convergence**: Studying convergence at regional dimension where interaction among the spatial units is crucial
- The sampling model of independence of observations seems inadequate to the case considered because regional observations are likely to display positive spatial dependence (Arbia, 1989)
- A correct way to estimate regional convergence is with the *spatial lag model (ML method)*

$$\log\left(\frac{Y_{i,t}}{Y_{i,0}}\right) = c + b\log(Y_{i,0}) + \rho L\left[\log\left(\frac{Y_{i,t}}{Y_{i,0}}\right)\right] + \varepsilon_{i,t}$$

- $L[\cdot]$ is the spatial lag operator.

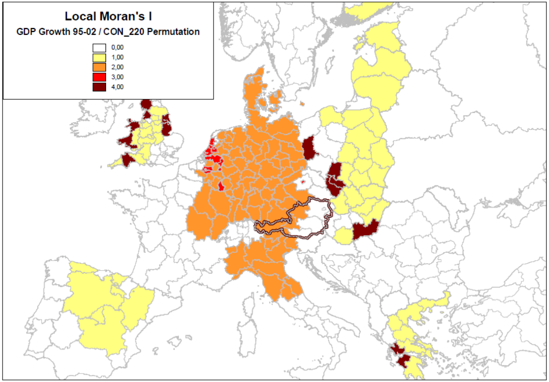
Regional convergence: spatial lag operator

The *Spatial lag operator* $L[\cdot]$is a weighted average of random variables at neighbouring locations (spatial smoother): WY

- W is nxn spatial weights matrix of neighbouring regions
- Y is nx1 vector of observations on the random variable
- Elements W: non-stochastic and exogenous

Spatial autocorrelation

Exploiting the idea of spatial depdendence due to proximity, it is possible to assess the importance of spatial dimension in defining clusters of slow and fast growth rate (ESDA; Moran Index) (Feldkierker, 2006)



Source: Author's calculations.