Quantitative Economics for the Evaluation of the European Policy

Dipartimento di Economia e Management

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- Solow model with poverty trap or better **multiple equilibria** (but why only two?)
  - ☑ **endogenous investment rate**
  - ☑ **endogenous growth rate of population/employment**
  - ☑ **increasing returns to scale (change in output composition)**
  - ➪ **endogenous level of human capital**
- Solow and **limited technological spillovers**
- Solow with open economy and **factor reallocation** across regions
- Solow with open economy, factor reallocation across countries, and limited technological spillover
- Solow with **two sectors** and factor reallocation across regions (core-periphery, i.e. North-South model)
- Solow with **many intermediate goods**

Human capital in European regions

Could human capital explain the differences in GDP per worker in European regions?

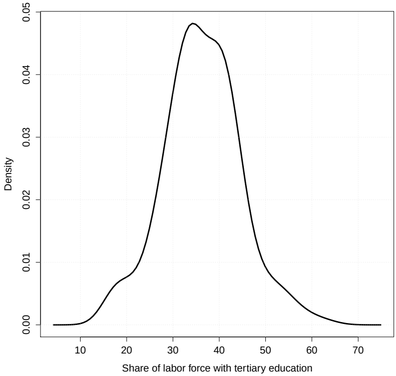

Figura: Distribution of the share of employment with tertiary education in European regions

Main issues about human capital

Main issues:

- How human capital is accumulated
- How is possible to measure it
- How is possible to favour the accumulation of human capital?

The theory of human capital

Remind standard Solow model:

$$\dot{k} = sf(k,h) - (\delta + g_A + n)\,k, \tag{1}$$

where

$$k \equiv \frac{K}{AL}\ ,\ f \equiv F\left(\frac{K}{AL}, h\right) \equiv f\,(k,h) \text{ and } f_k > 0, f_{kk} < 0 \tag{2}$$

and s and n are the exogenous saving/investment rate and growth rate of employment, h the level of human capital, δ the depreciation rate of physical capital, and g_A the growth rate of technological change.

Differences in the level of GDP per worker due to differences in human capital

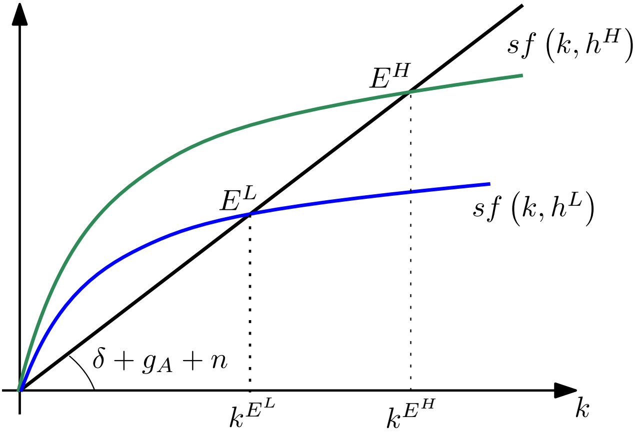

Figura:

$\Rightarrow$ **Now we want to formulate a theory of the level (dynamics) of h**

Suppose that the accumulation of human capital can be expressed as:

$$\dot{h} = \Phi\left(h, y, s_h y, CN\right), \tag{3}$$

with $\Phi_h > 0$, $\Phi_y > 0$, and $\Phi_{s_h} > 0$.

Why these explanatory variable?

- h: **spillover effects** deriving from living in a "skilled" environment (Lucas, Durlauf, Brock and Durlauf, etc.)
- y: **learning by doing** (Arrow and Lucas)
- s_h: **financial investment in education/human capital** (Lucas, Galor and Zeira)
- CN other determinants related to **cultural norms** (gender discrimination, etc.) (Weil)
- δ_h: depreciation of human capital due to various factors, among which the most important is the technological progress

Assumption: $\Phi(.)$ is homogeneous of degree one in the first three arguments

Example:

$$\Phi(h, y, s_h y, CN) = h^{\beta} y^{\gamma} s_h^{1-\beta-\gamma} \tag{4}$$

Then:

$$\dot{h} = h\Phi\left(1, \frac{y}{h}, \frac{s_h y}{h}, CN\right) - \delta_h h = \Phi\left(1, \frac{f(k,h)}{h}, \frac{s_h f(k,h)}{h}, CN\right) \tag{5}$$

from which:

$$\frac{\dot{h}}{h} = \Phi\left(1, \frac{y}{h}, \frac{s_h y}{h}, CN\right) = \Phi\left(1, \frac{f(k,h)}{h}, \frac{s_h f(k,h)}{h}, CN\right) - \delta_h \tag{6}$$

$\Rightarrow$ the dynamics of $\frac{\dot{h}}{h}$ crucially depends on the **average product of human capital** $\frac{f(k,h)}{h}$.

Two possibilities:

- If we consider technology where average product of human capital is bounded from below, i.e. it cannot go under a certain threshold then the accumulation of human capital ALONE can generate long-run growth (Lucas, Glaser, etc.) and differences in human capital generates differences in growth rates.

- If we take the usual Cobb-Douglas production function $y = k^{\alpha} h^{1-\alpha}$ then $\frac{f(k,h)}{h}$ is decreasing in h and converging to zero. Then we have to consider the **joint dynamics** of k and h to understand the overall dynamics and the level of equilibrium of income.

To study the joint dynamics of k and h consider the special case of Codd-Douglas production function. Then:

$$\frac{\dot{k}}{k} = s\frac{f(k)}{k} - (\delta + n + g_A) = s\left(\frac{k}{h}\right)^{\alpha-1} - (\delta + n + g_A) \tag{7}$$

and

$$\frac{\dot{h}}{h} = \Phi\left(1, \left(\frac{k}{h}\right)^{1-\alpha}, s_h\left(\frac{k}{h}\right)^{1-\alpha}, CN\right) - \delta_h \tag{8}$$

$\Rightarrow$ the crucial variable for the dynamics is the dynamics of the ratio k/h.

$$\begin{aligned}
\frac{\dot{\overline{k/h}}}{k/h} &= \frac{\dot{k}}{k} - \frac{\dot{h}}{h} = & (9)\\
&= s\left(\frac{k}{h}\right)^{\alpha-1} - (\delta + n + g_A) + & (10)\\
&- \left[\Phi\left(1, \left(\frac{k}{h}\right)^{1-\alpha}, s_h\left(\frac{k}{h}\right)^{1-\alpha}, CN\right) - \delta_h\right] & (11)
\end{aligned}$$

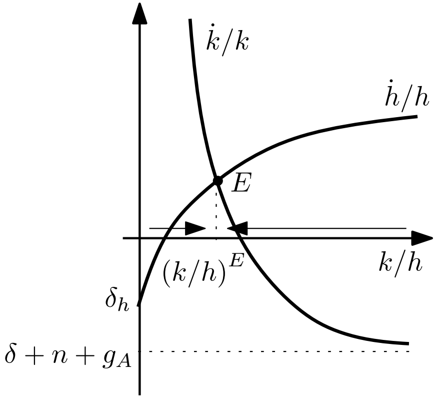

Figura: Dinamics of model with physical and human capital

An increase in $(k/h)^E$ can be the result of:

- an increase in s
- a decrease in n
- a decrease in s_h
- an increase in δ_h
- an increase in α