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?

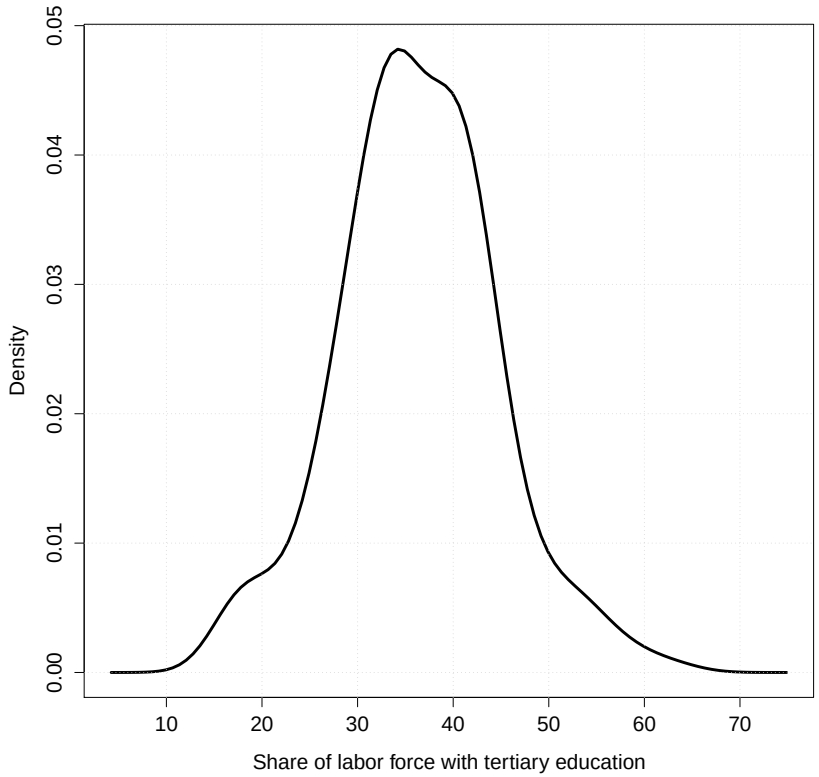


Figura: Distribution of the share of employment with tertiary education in European regions

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?

Solow Model with Human Capital

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

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

and

$$\frac{\dot{h}}{h} = \Phi\left(1, \left(\frac{k}{h}\right)^{1-\alpha}, s_h\left(\frac{k}{h}\right)^{1-\alpha}, CN\right) - \delta_h \tag{2}$$

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

$$\frac{\dot{k/h}}{k/h} = s\left(\frac{k}{h}\right)^{\alpha-1} - (\delta + n + g_A) + \tag{3}$$

$$- \left[\Phi\left(1, \left(\frac{k}{h}\right)^{1-\alpha}, s_h\left(\frac{k}{h}\right)^{1-\alpha}, CN\right) - \delta_h\right] \tag{4}$$

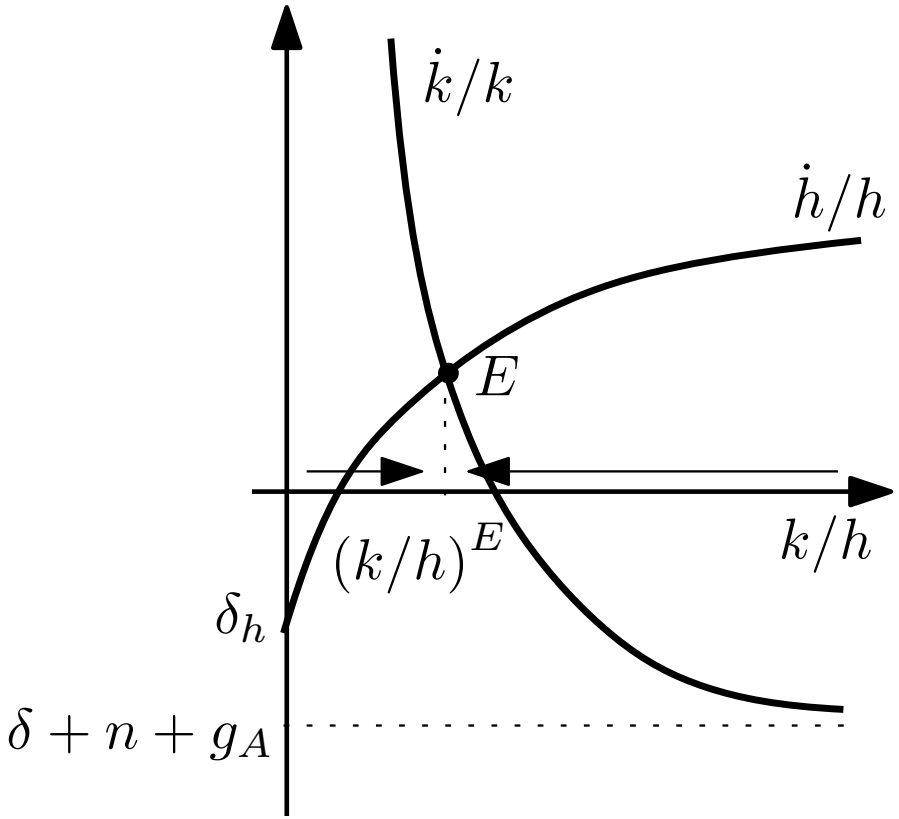


Figura: Dinamics of model with physical and human capital

A higher $(k/h)^E$ can be the result of:

- a higher s
- a lower n
- a lower s_h
- a higher δ_h
- a higher α

A brief summary

Summarizing:

- Human capital is a potential important source of growth and inequality across European regions
- It is difficult to calculate directly
- A Solow model augmented with human capital shows how the accumulation of human capital can be crucial for the overall dynamics

Compensations and human capital

Compensations of workers could be takes as a possible **proxy** of human capital.

Two main approach to the determination of compensations:

- Real wages are equal to the **marginal productivity of labour**
- Real wages are the result of **bargaining between unions and firms** in an economy with imperfectly competitive markets (both the factor and good markets).

However, in both approaches marginal productivity of labour is a reference point for the level of wages.

If real wage are equal to marginal productivity of labour then

$$\frac{W}{P} = \frac{\partial Y}{\partial L} = \frac{\partial Y}{\partial H}\frac{\partial H}{\partial L} = \frac{\partial Y}{\partial H}h \tag{5}$$

taking Cobb-Douglas technology then:

$$\frac{W}{P} = (1-\alpha)\,Ah\left(\frac{k}{h}\right)^{\alpha} \tag{6}$$

Therefore real wage depends on

- level of technological progress
- level of human capital
- level of the ration between physical and human capital
- technological parameter α

$\Rightarrow$ there is not a direct relationship between real wages and the stock of human capital.

Figura: Compensations per employee in 1991

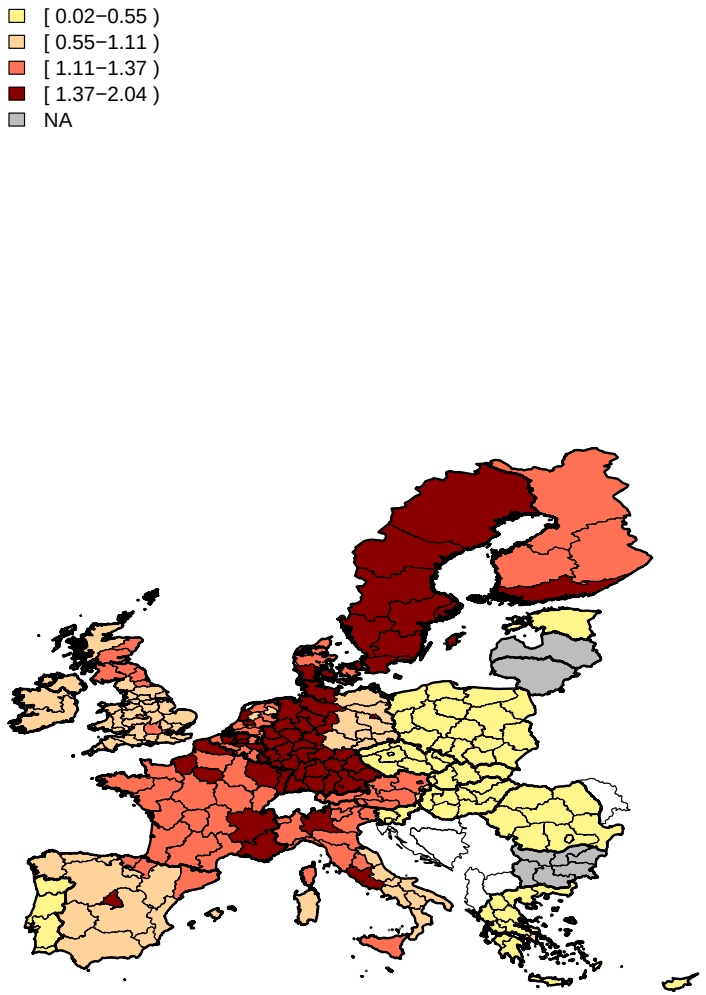


Figura: Compensations per employee in 2008

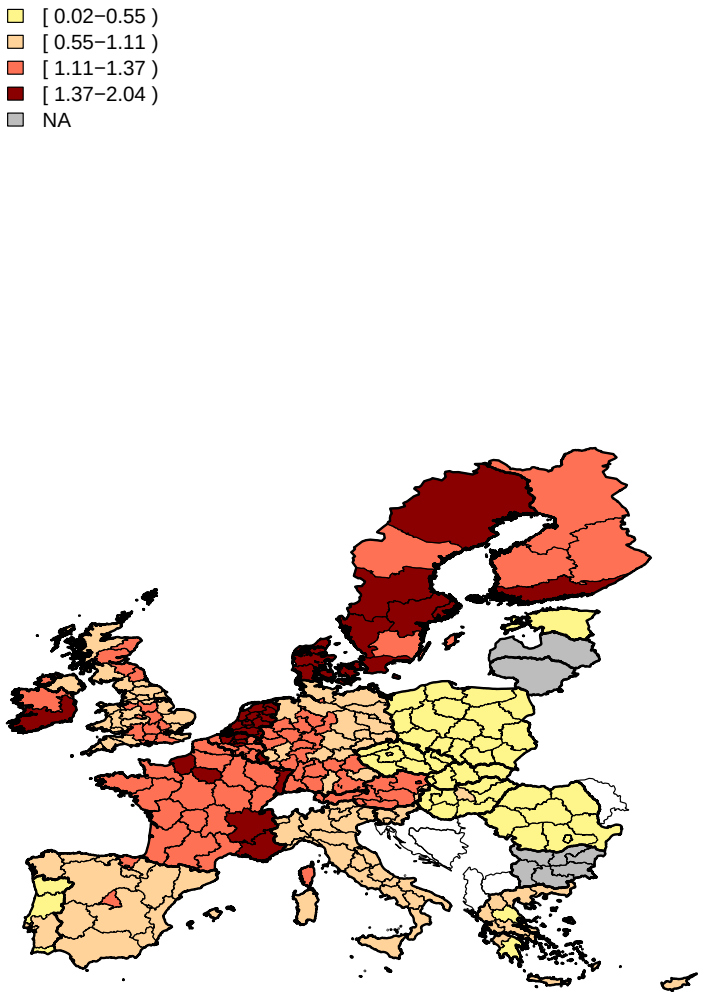
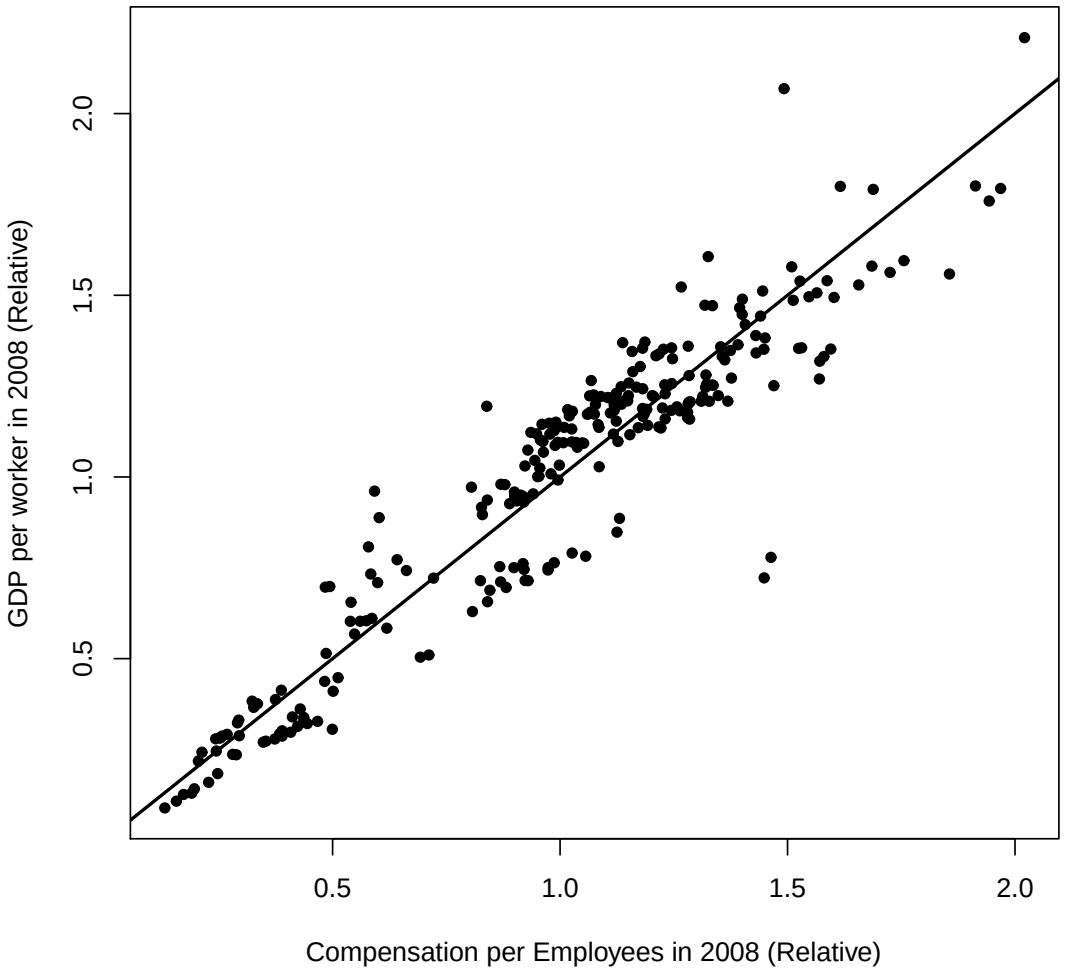


Figura: Compensations per employee versus GDP per worker in 2008



It is not so strict the relationship between compensations per employee and GDP per worker

Mincer approach to the determination of impact of education

There exists a complementary approach to study the impact of human capital on the wages and, indirectly, with the level of GDP per worker: **the Mincer approach**.

Mincer approach to the determination of wages takes as granted that individual wages are only a function of individual stocks of human capital on the base of the idea that each worker has access to the same level of technology and physical capital, i.e. differences in technology and capital across firms where workers are employed are random.

According to this approach we can calculate:

- **the rate of return to education** (where education is a source of accumulation of human capital)
- **the rate of return to experience** (where experience is a source of accumulation of human capital)

Growth accounting

Growth accounting is another approach to calculate the contribution of each individual factor to the overall growth.
Assume that production function can be expressed as it follows:

$$Y = F(K, A, H) \tag{7}$$

then take the logarithm of both sides and the first derivative with respect to time:

$$\frac{\dot{Y}}{Y} = \epsilon_K \frac{\dot{K}}{K} + \epsilon_A \frac{\dot{A}}{A} + \epsilon_H \frac{\dot{H}}{H} \tag{8}$$

where:

$$\epsilon_Q = \frac{\partial F}{\partial Q} \frac{Q}{Y}, \text{ with } Q \in \{K, A, H\} \tag{9}$$

is the **elasticity of production to factor** Q.