Quantitative Economics for the Evaluation of the European Policy

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Factor mobility

Two main types of factor mobility:

- Labour mobility
- Capital mobility

Many papers on the effect of factor mobility take into account only one of two. This is however crucial for the result.

For example the famous model by Paul Krugman in 1991 on the emergence of a *core-periphery* structure assume that only skilled workers migrate from one region to the other, while unskilled labour no. It also excludes any type of capital mobility.

Factor mobility (cont.d)

Main determinants of factor mobility:

- Differences in the **actual returns on factors** (i.e. wage, interest rate)
- Differences in the e**xpected dynamics** of some key variables (i.e. differences in expected growth rates of regional income)
- Differences in **provision of public goods** (i.e. differences in health services, welfare benefits, etc.)
- Differences in **local amenities** (i.e. differences in non-economic variables entering in individual well being as climate, cultural norms, social ties, etc.)

We will take into account only the first determinant, even though many studies suggest that the last two determinants are also crucial in the explanation of migration flows among EU countries and regions

Labour mobility

• Labour mobility under usual hypothesis of decreasing marginal product to labour lead to a convergence in GDP per worker if workers migrate according to the differences in wages

• Consider two regions, R (rich) and P (poor), with the following Cobb-Douglas production functions:

$$Y_R = K_R^{\alpha} (A_R L_R)^{1-\alpha} \tag{1}$$

$$Y_P = K_P^{\alpha} (A_P L_P)^{1-\alpha} \tag{2}$$

where K_i is the endowment of physical capital of region i, A_i its level of technological progress, and L_i its level of employment and

$$L = L_R + L_P.$$

Labour mobility (cont.d)

Under the assumption that labour is paid to its marginal productivity (i.e. factor markets are competitive) we have that real wages w in the two regions are given by:

$$w_R = \frac{\partial Y_R}{\partial L_R} = (1-\alpha) K_R^{\alpha} A_R^{1-\alpha} L_R^{-\alpha} = (1-\alpha) \frac{Y_R}{L_R} \tag{3}$$

and

$$w_P = \frac{\partial Y_P}{\partial L_P} = (1-\alpha) K_P^{\alpha} A_P^{1-\alpha} L_P^{-\alpha} = (1-\alpha) \frac{Y_P}{L_P} \tag{4}$$

and the reallocation of labour between the two regions should follow:

$$\dot{L_R} > 0 \text{ if } w_R > w_P, \tag{5}$$

and analogously

$$\dot{L_P} > 0 \text{ if } w_P > w_R. \tag{6}$$

Labour mobility (cont.d)

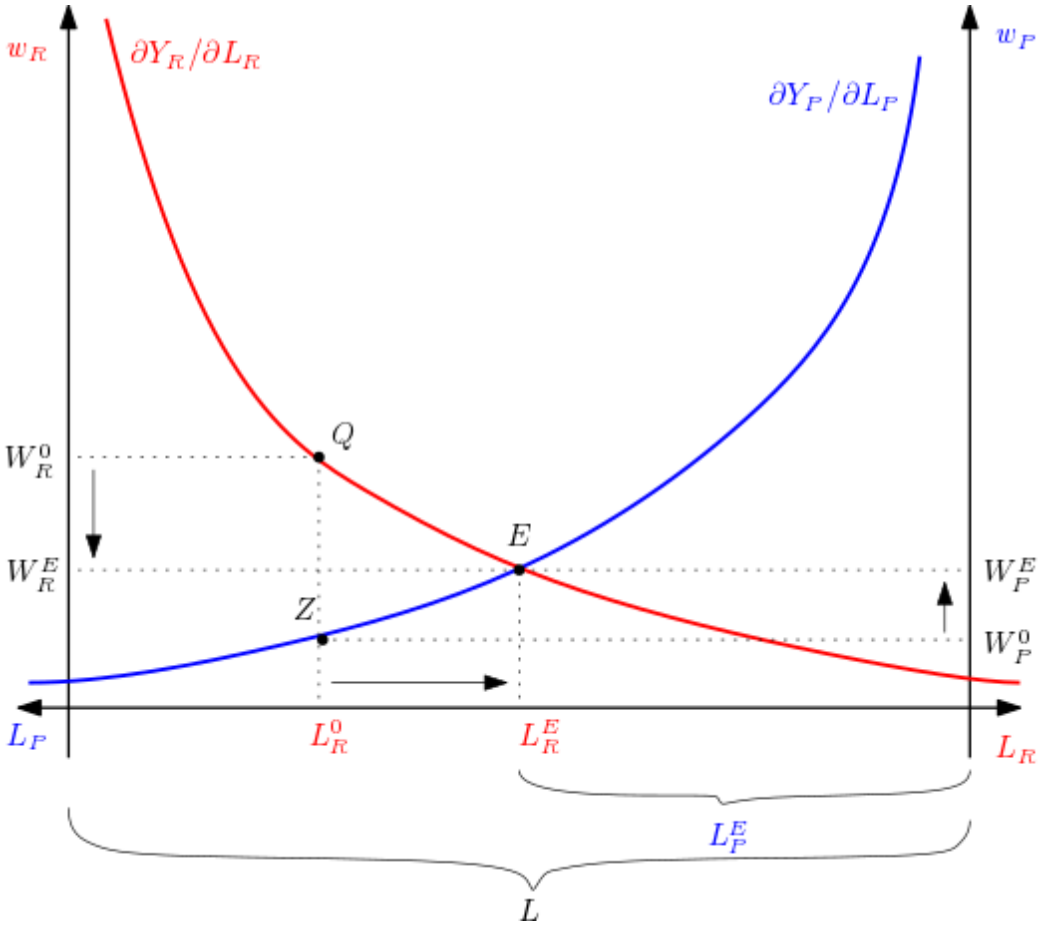

Figure: Allocation of labour between the two regions

- The marginal productivity of labour is assumed to be decreasing.
- If the allocation of labour between the two regions is (L_R^0, L_P^0), then the differences in wages $(w_R^0 > w_P^0)$ causes a reallocation of workers from region R to region P
- This reallocation will continue until wages in the two regions will be equal, i.e. employment will be (L_R^E, L_P^E).

Labour mobility (cont.d)

In E the GDP per worker in the two regions will be the same:

$$w_R^E = w_P^E \Rightarrow \left(\frac{Y_R}{L_R}\right)^E = \left(\frac{Y_P}{L_P}\right)^E \tag{7}$$

• **Migration** is therefore a **strong force of convergence**. This is because there exists a focus of European policy in favour of labour mobility among EU regions and there exists a specific agreement on free mobility of people among the most of EU countries (**Schengen Agreement**).

• Unfortunately this phenomenon was not strong enough so far to reduce the regional disparities, maybe with the exception of migration from regions of Eastern countries.

• There are many reasons for these insufficient migration flows, the difference in **languages** among EU countries is one of the most important, as well as difference in **cultural norms** and existence of strong **social ties**.

Capital mobility

Capital reallocation across EU regions seems to face less difficulties, therefore it appears as a good candidate to eliminate regional disparities: **we will see below that this is not true**.

As for labour, assume that capital is paid to its marginal productivity

$$r_R = \frac{\partial Y_R}{\partial K_R} = \alpha K_R^{\alpha-1} (A_R L_R)^{1-\alpha} = \alpha \frac{Y_R}{K_R} \tag{8}$$

and

$$r_P = \frac{\partial Y_P}{\partial L_P} = \alpha K_P^{\alpha-1} (A_P L_P)^{1-\alpha} = \alpha \frac{Y_P}{K_P} \tag{9}$$

and it is reallocated according to differences in the return, i.e.

$$\dot{K_R} > 0 \text{ if } r_R > r_P, \tag{10}$$

and analogously

$$\dot{K_P} > 0 \text{ if } r_P > r_R. \tag{11}$$

Capital mobility (cont.d)

In equilibrium returns on capital should be the same in the two regions, therefore:

$$r_R^E = r_P^E \Rightarrow \frac{Y_R}{K_R} = \frac{Y_P}{K_P} \Rightarrow \frac{Y_R}{Y_P} = \frac{K_R}{K_P} \Rightarrow \frac{Y_R/L_R}{Y_P/L_P} = \frac{K_R/L_R}{K_P/L_P} \tag{12}$$

This means that the ration between GDP per worker of two regions fully reflect the ratio of capital per worker of the two regions.
But since in equilibrium $r_R^E = r_P^E$, then:

$$\alpha K_R^{\alpha-1} (A_R L_R)^{1-\alpha} = \alpha K_P^{\alpha-1} (A_P L_P)^{1-\alpha} \tag{13}$$

i.e.

$$\left(\frac{K_R}{L_R}\right)^{\alpha-1} A_R^{1-\alpha} = \left(\frac{K_P}{L_P}\right)^{\alpha-1} A_P^{1-\alpha} \tag{14}$$

and finally:

$$\frac{K_R/L_R}{K_P/L_P} = \frac{A_R}{A_P} \tag{15}$$

Capital mobility (cont.d)

Therefore the free reallocation of capital lead to regional disparities reflecting the different level of technological progress, i.e.

$$\frac{Y_R/L_R}{Y_P/L_P} = \frac{A_R}{A_P}. \tag{16}$$

In general, A can reflect a different level of human capital, a different level of knowledge, or a different level of total facto productivity. In any case **no convergence happens in equilibrium**.
If A has also some spatial dependence, as in the model discussed in the previous classes, then we have also a potential explanation of the observed geographical clusters of regions with high and low GDP per worker.

From theory to the econometric model

A continue reallocation of capital among regions could be represented as:

$$\log r_{i,t} = (1 - \phi) \log r_{i,t-\tau} + \log \bar{r} + \epsilon_{i,t}, \tag{17}$$

where $r_{i,t}$ is the real interest rate of region i at year t, τ is lag in the dynamic of interest rate expressed in years, ϕ is the parameter measuring the "frictions" in the reallocation of capital among regions, $\bar{r}$ is the constant equilibrium interest rate, and $\epsilon_{i,t}$ is a i.i.d. random shock with usual properties ($E[\epsilon_{i,t}] = 0$, etc.).

Eq. (17) states that $r_{i,t}$ follows a autoregressive process, and in equilibrium we should observe all regions with an interest rate equal to $\bar{r}$ unless random deviations.

From theory to the econometric model (cont.d)

Since

$$r_{i,t} = \alpha Y_{i,t}/K_{i,t},$$

and

$$K_{i,t} = \left[\frac{Y_{i,t}}{(A_{i,t}L_{i,t})^{1-\alpha}}\right]^{1/\alpha}$$

we have:

$$r_{i,t} = \alpha\left(\frac{A_{i,t}L_{i,t}}{Y_{i,t}}\right)^{(1-\alpha)/\alpha} = \alpha\left(\frac{A_{i,t}}{y_{i,t}}\right)^{(1-\alpha)/\alpha},$$

where $y_{i,t} \equiv Y_{i,t}/L_{i,t}$ is the GDP per worker of region i.

Substituting in Eq. (17):

$$\log \alpha \left(\frac{A_{i,t}}{y_{i,t}} \right)^{(1-\alpha)/\alpha} = (1-\phi) \log \alpha \left(\frac{A_{i,t-\tau}}{y_{i,t-\tau}} \right)^{(1-\alpha)/\alpha} + \phi \log \bar{r} + \epsilon_{i,t},$$

i.e.

$$\log \left(\frac{y_{i,t}}{y_{i,t-\tau}} \right) = \left(\frac{\phi\alpha}{1-\alpha} \right) \log \left(\frac{\alpha}{\bar{r}} \right) - \phi \log y_{i,t-\tau} + \tag{18}$$

$$+ \log \left(\frac{A_{i,t}}{A_{i,t-\tau}} \right) + \phi \log A_{i,t-\tau} + \epsilon_{i,t}. \tag{19}$$

Taking the usual approximation that $\log x_t / x_{t-\tau} \approx g_x \tau$, i.e. that the logarithm of the ratio of x at the end and at the begin of the period $[t-\tau, t]$ is approximately equal to the average growth rate times the number of years τ of the period we have:

$$g_{y_i} \approx \left[\frac{\phi\alpha}{\tau(1-\alpha)} \right] \log \left(\frac{\alpha}{\bar{r}} \right) - \left(\frac{\phi}{\tau} \right) \log y_{i,t-\tau} + g_{A_i} + \left(\frac{\phi}{\tau} \right) \log A_{i,t-\tau} + \frac{\epsilon_{i,t}}{\tau}. \tag{20}$$

• Assuming that the average growth rate of technological progress of region i, g_{A_i}, depends from its neighbours, and initial level of technological progress, $A_{i,t-\tau}$, also depend on the initial levels of technological progress of neighbours, we have that Eq. (20) suggests to estimate a **fixed-effect spatial panel model**.

• Differences in the equilibrium level of GDP per worker among regions will be due to different initial levels of technology but also to different initial levels of technology of my neighbours.

• $A_{i,t-\tau}$ should be taken as any initial condition/variable which affect the total factor productivity, as norms, geography, social capital, etc.

Increasing returns and output specialization

In a famous contribution in 1991 Paul Krugman discusses how also with labour mobility the presence of increasing returns to scale leads to disparities among regions. The aim of the model is also to stress the importance of structural change as a crucial perspective to study such a type of phenomenon, i.e. as output specialization can help to explain differences in the level of development.

• Consider two regions, region A specialized in agriculture, and region M specialized in manufacturing.

• The production function of the two types of goods are respectively given by:

$$Q_A = F_A(L_A), \tag{21}$$

and

$$Q_M = \kappa F_M(L_M)., \tag{22}$$

where κ is a parameter measuring the technological progress in manufacturing

Labour mobility and increasing returns to scale (cont.d)

• Workers can freely move between the two regions and their total number is L, therefore:

$$L_A + L_M = L. \tag{23}$$

• Assuming that factor markets are competitive, then nominal wage in the two regions are given by:

$$W_A = P_A \frac{\partial F_A}{\partial L_A} \tag{24}$$

and

$$W_M = P_M \kappa \frac{\partial F_M}{\partial L_M}. \tag{25}$$

• In equilibrium with free mobility between the two regions:

$$W_A = W_M. \tag{26}$$

Labour mobility and increasing returns to scale (cont.d)

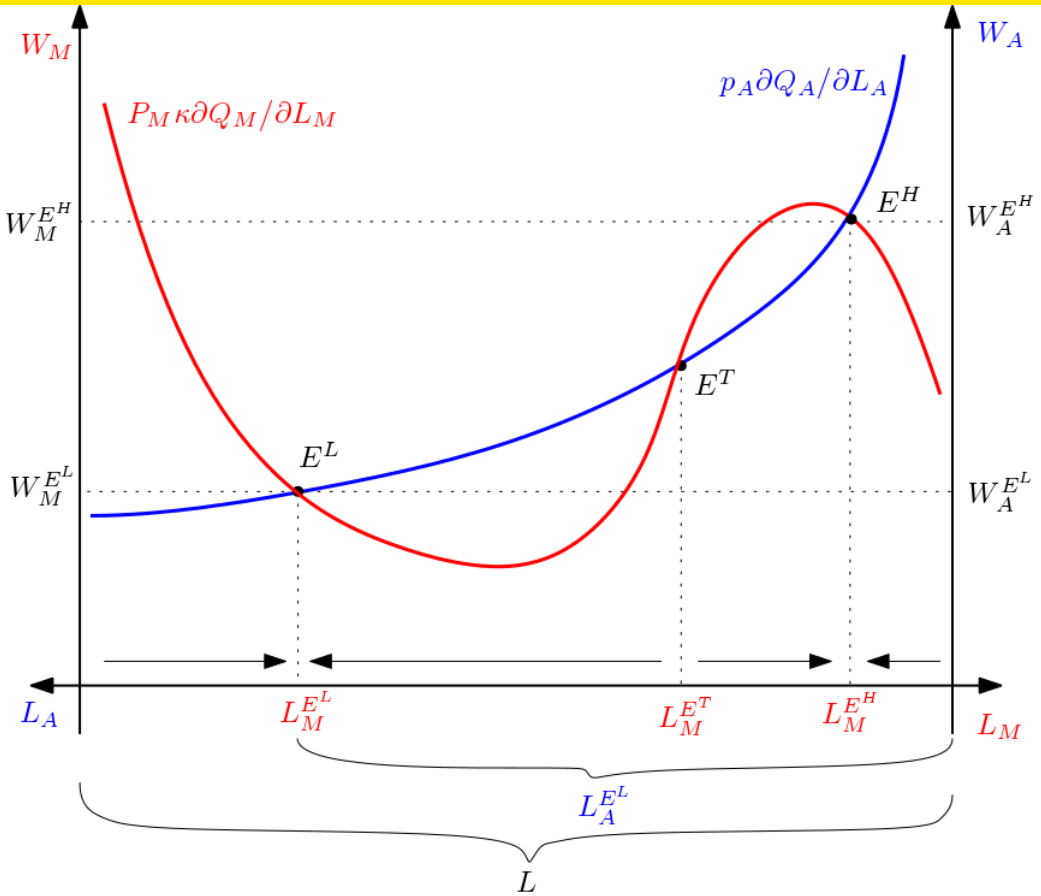

Figure: Allocation of labour between the two regions with increasing returns to scale in manufacturing

- The marginal productivity of labour is assumed to be decreasing only in agriculture, while in manufacturing there exists a range of increasing returns to scale, generally justified by the presence of fixed cost in the production of mass consumption goods.
- If the initial allocation of labour in manufacturing is below $L_M^{E^T}$, then the size of manufacturing is enough to exploit increasing returns to scale and the two regions converges to low-wage equilibrium E^L.

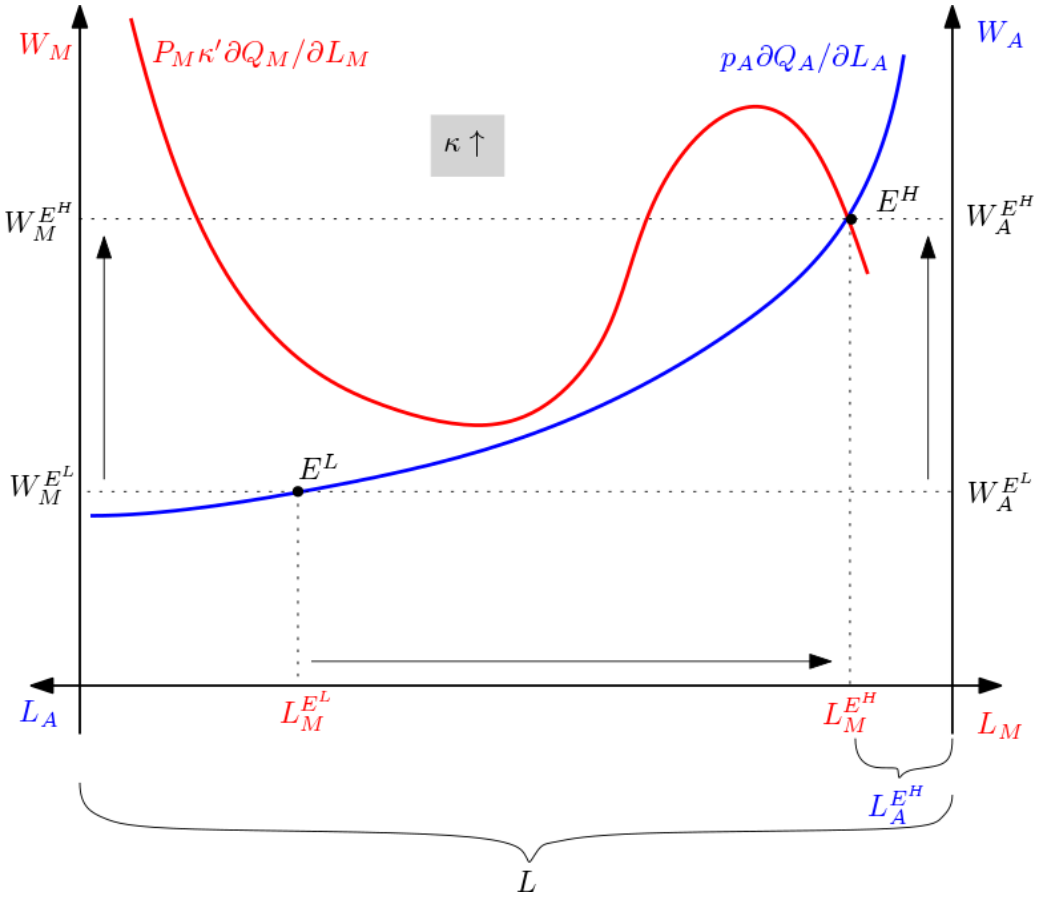

Figure: Reallocation of labour between the two regions when technological progress increases in manufacturing

- With the increase in the technological progress in manufacturing κ only the high-wage equilibrium E^H remains.
- There will be a strong migration from agricultural to manufacturing region, with an increase in wage paid in both regions. Such dynamics could happen in a very short time, as during the industrial revolution in many European countries.

Some final remarks:

- In the original model of Paul Krugman there are **high and low skilled workers** and only the former can migrate. This lead to differences in GDP per worker in the two regions, i.e. the model can explain regional specialization, migration, and **regional disparities**.

- **History** of a region, i.e. the size of labour markets and the type of production of a region, is the main determinant of the long-run outcome of the region itself. But also **expectations** can play a role in presence of increasing returns to scale, because the expectations of high returns in manufacturing which leads to a shift of workers in the sector/region could lead to a change in the long-run outcome.

- Also **policy**, e.g. in favour of a reallocation of workers from agriculture to manufacturing, can have a role in presence of multiple equilibria.