Dietmar Meyer[1]:

Human Capital and EU-Enlargement

The enlargement of the European Union is an almost everywhere accepted necessity, but at the same time of course also a compromise. Economies or regions of different economic, social, institutional, etc. development become united in Europe with a territory from the Atlantic to the Eastern borders of Poland, Slovakia and Hungary, from the Baltic Sea to the Mediterranean Sea.

This integration process going along with the worldwide globalisation will imply a new distribution, or a redistribution of the factors of production. First of all the human capital will be touched by this development.[2] One of the most important results found by social sciences in the 20th century is the realisation of the immense role played by human factors in the process of economic development. The extremely high efficiency of human capital and the high mobility could diminish the regional differences in the economic development and therefore in the social life. But even this is one reason for the mentioned re-allocation of the human capital.

In the frame of a very simple static model (See e. g. Bishi – Kopel [2002]) the flow of human capital between different regions – called the *European Union* and the *New Member States* – will be analysed. The introduction of search costs extends the field of policy-analysis.

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[1] Paper presented on the conference on "Institutional and Policy Diversity – Its role in Economic Development", Debrecen, Hungary, 3-5, November 2003. Meyer Dietmar is professor at Budapest University of Technology and Economic Sciences, Head of Department of Economics. E-mail: dmeyer@lucifer.kgt.bme.hu

[2] It should be remarked that human capital is not equivalent with the labor factor. Labor is – one – medium of technical progress, and therefore closely connected to human capital. But the geographical flow of human capital does not require the flow of labor, because the transfer of know-how can be realised by several technical means, as e. g. Internet, etc.

A Simple Model

As a consequence of the enlargement of the European Union the old member states as well as the new member states will have the opportunity to offer their human capital without any serious difficulties in the other sphere of the unified Europe. Let us denote by H_{ij} the human capital produced in region *i* and used in region *j*, with $i, j = E, M$ - *E* for the former European Union and *M* for the new member states. Both markets, that of the old Union and that of the enlarged Union, differ in several points, e. g. in the efficiency of production, in the demand conditions, etc. Assume first of all different demand for human capital, i. e. (in the form of inverse demand functions) for the European Union

$$p_E = a_E - b_E \left(H_{ME} + H_{EE} \right), \tag{1.1}$$

and in the case if the new member states

$$p_M = a_M - b_M \left(H_{MM} + H_{EM} \right). \tag{1.2}$$

Therefore we have for the revenues: in the Union

$$R_E = p_M H_{EM} + p_E H_{EE},$$

and in the new member states

$$R_M = p_M H_{MM} + p_E H_{ME}.$$

Taking into account that $H_E = H_{EM} + H_{EE}$, and $H_M = H_{MM} + H_{ME}$, the profit functions of the regions can be derived as

$$\Pi_E = \left[a_M - b_M \left(H_{MM} + H_{EM} \right) \right] H_{EM} + \left[a_E - b_E \left(H_{ME} + H_{EE} \right) \right] H_{EE} - C_E \left(H \right),$$

for the Union, and as

$$\Pi_M = \left[a_M - b_M \left(H_{MM} + H_{EM} \right) \right] H_{MM} + \left[a_E - b_E \left(H_{ME} + H_{EE} \right) \right] H_{ME} - C_M \left(H \right),$$

for the new member states, where $C_i(H), \quad i = E, M$, denote the regions' cost functions to specified later.

The production of a certain quantity of human capital requires real capital and labor. The technology applied in the production of human capital will be expressed by different production functions: $H_i = F_i(K_i, L_i), \quad i = E, M$. Let be both functions of *Cobb-Douglas*-type, but different efficiency should be expressed by different parameters, i. e. $H_i = A_i K_i^{\alpha_i} L_i^{\beta_i}, \quad \alpha_i + \beta_i = 1, \quad i = E, M$. Using these conditions the variable costs of the production of human capital can be calculated as

$$C_i^V(H_i) = H_i A_i^{-1}\left(\frac{\alpha_i w_i}{(1-\alpha_i)r_i}\right)^{-\alpha_i} \frac{1}{1-\alpha_i} w_i, \quad i = E, M,$$

where r_i and w_i, $i = E,M$, denote the regions' interest rates and wage rates, respectively.

The model contains a special kind of transaction costs, the *search costs*, occurring after human capital had been produced and before coming into use. Simplifying the problem, one could consider a certain part of the search cost as expenditures when labor force – as the human capital's medium – is looking for a job. Search costs are assumed to be a non-linear, convex function of human capital, expressing that the more human capital had been produced, the lower are chances to find a job, and therefore the more expensive is it to be employed. But is has to be remarked that search costs interpreted here in a much more extensive sense include all financial burdens undertaken by the owners of human capital. From this point of view these costs could be considered as a measure for the cooperation between the institutions producing human capital and those using it – the better is the cooperation, the lower are the search costs, etc. Without exaggeration it can be assumed that lower search cost are generally related to higher developed economies, and vice versa, the lower developed is a society, the higher will be the human capital's search costs.

For the sake of simplicity let us assume that search costs are expressed by $w_i^S H_i^2$, $i = E,M$. Therefore, the total variable costs of human capital are

$$C_i^V(H_i) = H_i A_i^{-1}\left(\frac{\alpha_i w_i}{(1-\alpha_i)r_i}\right)^{-\alpha_i} \frac{1}{1-\alpha_i} w_i + w_i^S H_i^2, \quad i = E, M,$$

To these variable costs we have to add the fixed costs occurring in region *i*, and the costs of purchasing the human capital produced in the other region, i. e., the cost function of human capital is

$$C_i(H_i) = H_i A_i^{-1}\left(\frac{\alpha_i w_i}{(1-\alpha_i)r_i}\right)^{-\alpha_i} \frac{1}{1-\alpha_i} w_i + w_i^S H_i^2 + FC_i + w_j^H H_j, \quad i = E, M, \quad i \neq j,$$

where FC_i, $i = E,M$ denotes the fixed costs and w_i^H stands for the costs of 1 unit of human capital produced in region *i*. The corresponding marginal cost functions are of the form

$$MC_i(H) = A_i^{-1}\left(\frac{\alpha_i w_i}{(1-\alpha_i)r_i}\right)^{-\alpha_i} \frac{1}{1-\alpha_i} w_i + 2w_i^S H_i, \quad i = E,M, \quad i \neq j.$$

The profit function of region *i* is now given by

$$\Pi_i = \lfloor a_j - b_j(H_{jj} + H_{ij})\rfloor H_{ij} + \lfloor a_i - b_i(H_{ji} + H_{ii})\rfloor H_{ii} -$$

$$- H_i A_i^{-1}\left(\frac{\alpha_i w_i}{(1-\alpha_i)r_i}\right)^{-\alpha_i} \frac{1}{1-\alpha_i} w_i - w_i^S H_i^2 - FC_i - w_j^H H_j, \quad i = E, M, \quad i \neq j.$$

Both regions, the European Union and the new member states try to maximize the profit due to the quantity of human capital, i. e. they strive for that structure of human capital used in their own regions maximizing the profit. The condition is well-known: $\frac{\partial \Pi_i}{\partial H_{ij}} = 0$, $i, j = E, M$.

This means for the old European Union

$$\frac{\partial \Pi_E}{\partial H_{EM}} = a_M - b_M H_{MM} - 2b_M H_{EM} - A_E^{-1}\left(\frac{\alpha_E w_E}{(1-\alpha_E) r_E}\right)^{-\alpha_{Ei}} \frac{1}{1-\alpha_E} w_E - 2w_E^S H_E = 0 \quad (2.1)$$

and

$$\frac{\partial \Pi_E}{\partial H_{EE}} = a_E - b_E H_{ME} - 2b_E H_{EE} - A_E^{-1}\left(\frac{\alpha_E w_E}{(1-\alpha_E) r_E}\right)^{-\alpha_E} \frac{1}{1-\alpha_E} w_E - 2w_E^S H_E = 0. \quad (2.2)$$

Equation (2.1) yields

$$H_{EM} = \frac{a_M}{2b_M} - \frac{1}{2} H_{MM} - \frac{1}{2b_M} A_E^{-1}\left(\frac{\alpha_E w_E}{(1-\alpha_E) r_E}\right)^{-\alpha_E} \frac{1}{1-\alpha_E} w_E - \frac{w_E^S}{b_M} H_E,$$

and from Eq. (2.2) follows

$$H_{EE} = \frac{a_E}{2b_E} - \frac{1}{2} H_{ME} - \frac{1}{2b_E} A_E^{-1}\left(\frac{\alpha_E w_E}{(1-\alpha_E) r_E}\right)^{-\alpha_E} \frac{1}{1-\alpha_E} w_E - \frac{w_E^S}{b_E} H_E.$$

Summing up the last two expressions, one obtains the equations of the European Union's reaction curves due to the new member states:

$$H_E = \frac{1}{2}\frac{b_M b_E}{b_M b_E + w_E^S (b_M + b_E)}\left[\frac{a_M}{b_M} + \frac{a_E}{b_E} - \frac{1}{A_E}\left(\frac{1}{b_M} + \frac{1}{b_E}\right)\left(\frac{\alpha_E w_E}{(1-\alpha_E) r_E}\right)^{-\alpha_E} \frac{1}{1-\alpha_E} w_E\right] -$$

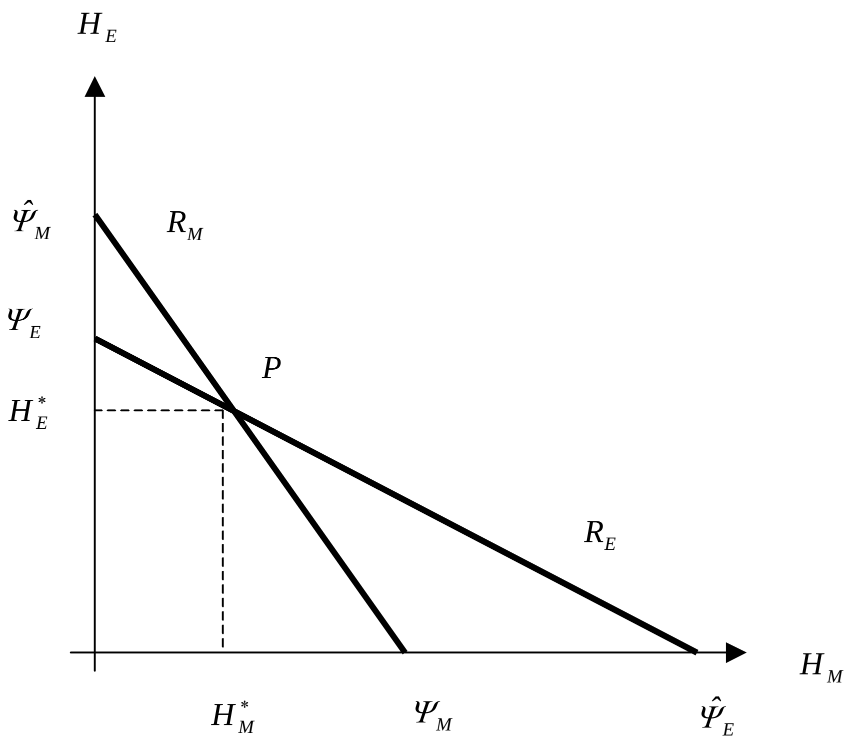
$$- \frac{1}{2}\frac{b_M b_E}{b_M b_E + w_E^S (b_M + b_E)} H_M, \quad (3.1)$$

Similarly we can derive for the new member states:

$$H_M = \frac{1}{2}\frac{b_M b_E}{b_M b_E + w_M^S (b_M + b_E)}\left[\frac{a_M}{b_M} + \frac{a_E}{b_E} - \frac{1}{A_M}\left(\frac{1}{b_M} + \frac{1}{b_E}\right)\left(\frac{\alpha_M w_M}{(1-\alpha_M) r_M}\right)^{-\alpha_M} \frac{1}{1-\alpha_M} w_M\right] -$$

$$-\frac{1}{2}\frac{b_M b_E}{b_M b_E + w_M^S\left(b_M + b_E\right)} H_E . \tag{3.2}$$

From the assumed Cobb-Douglas-technology follows the linearity of the cost functions, and therefore the linearity of the reaction curves. Their slopes depend on the search costs. According to an earlier remark it should be assumed that the search costs if higher developed economies will be lower, implying that the corresponding reaction curve is flatter than in the case of lower developed regions. With this in mind the graphic of the reaction curves has the following form:



Graphic No. 1
The reaction curves of the European Union and of the new member states

Here

$$\Psi_i = \frac{1}{2}\frac{b_i b_j}{b_i b_j + w_i^S\left(b_i + b_j\right)}\left[\frac{a_i}{b_i} + \frac{a_j}{b_j} - \frac{1}{A_i}\left(\frac{1}{b_i} + \frac{1}{b_j}\right)\left(\frac{\alpha_i w_i}{(1-\alpha_i)r_i}\right)^{-\alpha_i}\frac{1}{1-\alpha_i} w_i\right],$$

and

$$\hat{\Psi}_i = \left[\frac{a_i}{b_i} + \frac{a_j}{b_j} - \frac{1}{A_i}\left(\frac{1}{b_i} + \frac{1}{b_j}\right)\left(\frac{\alpha_i w_i}{(1-\alpha_i)r_i}\right)^{-\alpha_i}\frac{1}{1-\alpha_i} w_i\right] \quad i = E, M ,$$

denote the point of intersection between the reaction curves and the axes; point *P* is the well-known Cournot-equilibrium, H_M^* and H_E^* denote the equilibrium quantities of human capital with

$$H_M^* = \frac{1}{2}\frac{b_E b_M \hat{\Psi}_M}{b_E b_M + w_M^S(b_E + b_M)}\left[1 - \frac{(b_E b_M)^2}{4[b_E b_M + w_E^S(b_E + b_M)][b_E b_M + w_M^S(b_E + b_M)] - (b_E b_M)^2}\right] -$$

$$- \frac{(b_E b_M)^2 \hat{\Psi}_E}{4[b_E b_M + w_E^S(b_E + b_M)][b_E b_M + w_M^S(b_E + b_M)] - (b_E b_M)^2}, \qquad (4.1)$$

and

$$H_E^* = \frac{2(b_E b_M + w_M^S(b_E + b_M))}{4[b_E b_M + w_E^S(b_E + b_M)][b_E b_M + w_M^S(b_E + b_M)] - (b_E b_M)^2} b_E b_M \hat{\Psi}_E -$$

$$- \frac{(b_E b_M)^2}{4[b_E b_M + w_E^S(b_E + b_M)][b_E b_M + w_M^S(b_E + b_M)] - (b_E b_M)^2}\hat{\Psi}_M \qquad (4.2)$$

Analysis of the model

It can be seen that the search costs play an important role in the qualitative and quantitative determination of the Cournot-equilibrium. If these costs would be equal in both regions, the slopes of the reaction curves are $-\frac{1}{2}$. Therefore, the curves coincide, if $\Psi_E = \Psi_M$, and they have no joint point $\Psi_E \neq \Psi_M$. In the earlier case, all combinations of the different region's human capitals satisfying one of the above conditions are optimal, while in the latter case such an optimum does not exist. From this point of view, different search cost are conditions for an economically meaningful solution of the model.

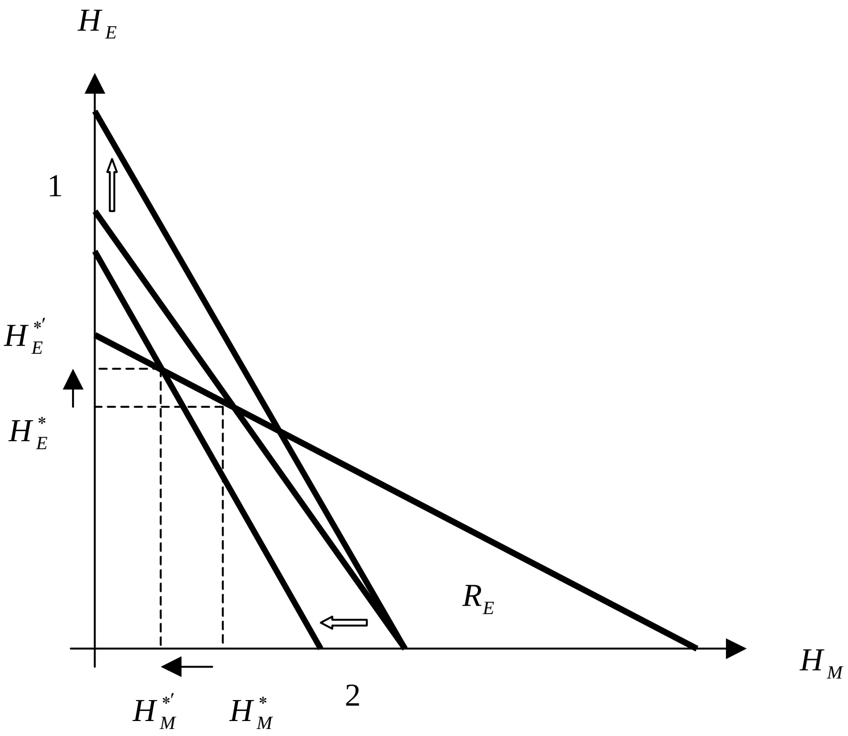
Increasing search costs will change the slope of the reaction curves. Assuming that the search costs in the new member states grow up, the intersection of the new member states' reaction curve and the vertical axis will move upwards, and at the same moment Ψ_M will decrease (Eq. (3.2)), i. e. the curve shifts to the origin. The first effect implies a lower production level of human capital in the new member state, the second effect, however, acts in the direction of an increasing production of human capital in the mentioned area. The final consequence, of course, is depending on the relative strength of these effects.

After some calculations we would obtain for the change of the optimum quantities of human capital as a function of varying search costs the following condition:

$$\frac{dH_M^*}{dw_M^S} \quad \begin{cases} >0, & 8\hat{\Psi}_M\left(b_E b_M + w_E^S\right) < b_E b_M \hat{\Psi}_E \\ =0, & 8\hat{\Psi}_M\left(b_E b_M + w_E^S\right) = b_E b_M \hat{\Psi}_E \\ <0, & 8\hat{\Psi}_M\left(b_E b_M + w_E^S\right) > b_E b_M \hat{\Psi}_E \end{cases}.$$

Since $\hat{\Psi}_i$ represents that amount of human capital produced in region j if the production of human capital in region i is zero, the economically acceptable condition will be $\frac{dH_M^*}{dw_M^S} < 0$, because any other relation would mean that in the new member states at least eight times so much human capital has to be produced if the production of human capital in the European Union would be 0, as human capital would have to be produced in the EU-region, if the new member states would not produce any human capital.

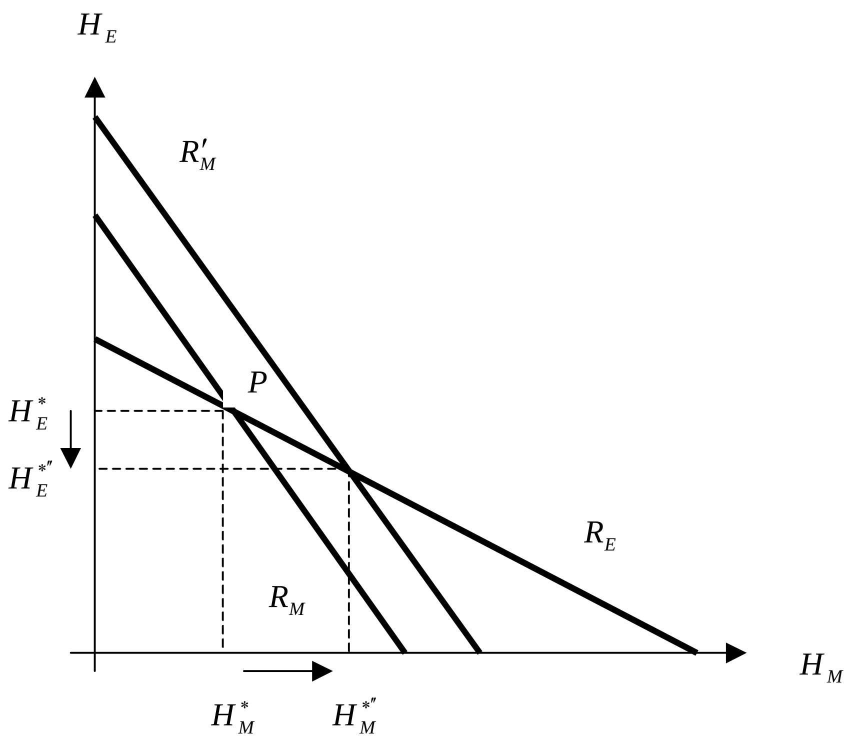
As a final consequence it could be said, that increasing search costs in the region of the new member states will imply a fall of the optimal quantity of human capital from H_M^* to $H_M^{*'}$, while the human capital in the EU-region will increase – even under unchanged behavior in this region - from H_E^* to $H_E^{*'}$. (See Graphic No. 2)



Graphic No. 2
The change of the optimal quantities of human capital when search costs increase in the lower developed area

On the other hand, lower search costs could increase the production of human capital, and this could imply a higher rate of economic growth. For economies to which this possibility is given, an administrative intervention of this kind may be very useful.

Analysing the effect of a change in the technology parameter A_i, it can be seen that an increase of this parameter in the region of new members will shift the reaction curve in the NE-direction, meaning that the new member states' more efficient technology let not only grow up the level of human capital's production, but the distribution between human capitals produced in the different areas will also change for the benefit of the lower developed region. (See Graphic No. 3)



Graphic No. 3
The effect of the technology parameter on the quantities of human capital

Similarly we could investigate the effects of growing interest rates and of an increasing wage rate. The results can summarized as follows[3]:

- An increase (decrease) of the interest rate in region *i* causes in this area a lower (higher) production level of human capital; in region *j* the effect will be a higher (lower) production level of human capital.

[3]For detailed discussion see Meyer 2003.

- An increasing wage rate will imply a higher production level of human capital, if the capital elasticity in this region is higher than the labor elasticity; otherwise the production level of human capital will fall, if wages grow up.

Until this point it had been assumed that demand for human capital is given and unchanged. Now it should be analysed how a change in demand will touch the production and the distribution of human capital. Let us assume that a new member states will be faced by a higher demand for human capital produced in their region, i. e. let a_M increase.[4] From Eq. (4.1) one obtains

$$\frac{dH_M^*}{da_M} = \frac{1}{2}\frac{b_E b_M}{\Phi_M}\left[1 - \frac{(b_E b_M)^2}{4\Phi_E\Phi_M - (b_E b_M)^2}\right]\frac{d\hat{\Psi}_M}{da_M} - \frac{(b_E b_M)^2}{4\Phi_E\Phi_M - (b_E b_M)^2}\frac{d\hat{\Psi}_E}{da_M},$$

where $\Phi_i = b_E b_M + w_i^S (b_E + b_M),\ i = E, M$. Since $\frac{d\hat{\Psi}_i}{da_M} = \frac{1}{b_M},\ i = E, M$, we have

$$\frac{dH_M^*}{da_M} = \frac{1}{2}\frac{b_E}{\Phi_M}\left[1 - \frac{2(b_E b_M)^2 - b_E b_M \Phi_M}{2\left[4\Phi_E\Phi_M - (b_E b_M)^2\right]}\right].$$

It can be shown that $\frac{dH_M^*}{da_M} > 0$, therefore increasing demand in the new member states implies a higher production level of human capital in this region.

On the other hand, however, a higher demand for human capital in the lower developed region will influence the production of human capital in the EU-region too. From Eq. (4.2) it can be derived that $\frac{dH_E^*}{da_M} = \frac{b_E\left[2\Phi_M - b_E b_M\right]}{4\Phi_E\Phi_M - (b_E b_M)^2} > 0$.

A generalisation of the model and the problem of stability

Present analysis can summarised with a very obvious formulation: In almost every situation the enlargement of the European Union will be advantageous for the production of human capital in the new member states, and therefore advantageous also for their economic development and welfare. It could be shown that under economically acceptable conditions an equilibrium solution does exist. But what will happen, if the initial distribution of human capital is a disequilibrium one? Does there exist a mechanism ensuring the equilibrium, i. e. will the pairs of human capitals $(H_E(t), H_M(t))$ tend to the equilibrium values (H_E^*, H_M^*) as $t \to \infty$?

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[4] This would be not only a simple price-independent change in demand. Since demand for human capital in region *i* has been described only as a function of the price p_i, a probably change in the price for the human capital in the other region, i. e. a change of p_j, will also be reflected by parameter α_i.

It has been proved that the solution of Cournot's duopoly is for a linear demand function stable, if the second derivative of the cost function is positive. (See e. g. Fisher 1961, Hahn 1962) In the present model, this condition is satisfied by using a convex function representing the search costs. With other words: lower search cost are advantageous for the development of the economies, but – on the other side – the higher are the search costs, the more probably is the stability of the solution. These – from some points of view – inconsistent results could be escaped by a more efficient technology, exactly spoken: by using production functions with a degree of homogeneity higher than 1. (Meyer 2003) The implication for economic policy seems to be clear: the new member states have to produce their human capital with an efficiency as high as possible. To do that they have to use the best qualified human capital wherever this had been produced. May be that a possible strategy is to hinder the human capital of the new member states to leave them – e. g. by introducing high search costs – and to stimulate human capital produced in the EU-region to come to the lower developed region – by lower search cost, tax allowances, etc?

May be that there is nothing new under the sun? A similar concept had been suggested by Friedrich List – 170 years ago – arguing that the integration of Germany into the European Economy will be successful only after having developed the German railway-system; before that it would be wise to protect the German industry… (List 1961)

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