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Heterogene Arbeit: Positive und Normative Aspekte der Qualifikationsstruktur der Arbeit

Thomas Lange

Local Public Funding of Higher Education when Students and Skilled Workers are Mobile

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The interregional mobility of high skilled workers might induce an underinvestment in local public higher education when sub-federal entities independently decide on education expenditures to maximize local output. This well-known result is due to interregional spillovers and provides a justification for coordinated education policy or rather a federal intervention. However, things might change completely when taking into account the interregional mobility of students. Now, local education expenditures not only affect labor migration (through wage differentials) but also student migration flows. The model in this paper then shows that local output maximization does not necessarily imply underprovision of higher education, since regions now have an incentive to attract students as future human capital. The stay rates of graduates in equilibrium and the sensitivity of wages to migration are key determinants of local policy. Furthermore, results depend on local government objectives or rather the weighting of natives relative to foreigners. Therefore, the paper also considers natives' preferred local policy.

JEL Klassifikation : I22, J61, H77
Schlüsselwörter : Higher education, student mobility, labor mobility, local public finance
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Local Public Funding of Higher Education when Students and Skilled Workers are Mobile

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Abstract

The interregional mobility of high skilled workers might induce an underinvestment in local public higher education when sub-federal entities independently decide on education expenditures to maximize local output. This well-known result is due to interregional spillovers and provides a justification for coordinated education policy or rather a federal intervention. However, things might change completely when taking into account the interregional mobility of students. Now, local education expenditures not only affect labor migration (through wage differentials) but also student migration

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Keywords: higher education, student mobility, labor mobility, local public finance

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1 Introduction

Public funds make up a major part of higher education expenditures in all OECD countries. This is especially true for several countries within the European Union where tertiary education is to a large extent publicly provided (e.g. Germany or France). But also in the U.S. where private universities play a much more important role, the states are subsidizing higher education. When there are no (or rather low) tuition fees, public education budgets mainly rely on income tax revenues. The interregional mobility of the highly skilled individuals and therefore an important part of the tax base, however, might put a downward pressure on local income tax rates (Poutvaara, 2000, 2001) and therefore funds. To some extent, the tax burden might be shifted to a more immobile factor like unskilled labor implying increasing inequality (Wildasin, 2000). The political support for public higher education expenditures by low-ability individuals not participating in the education system and older people basically preferring immobile public infrastructure investments to public education provision is potentially reduced at the presence of high skilled labor mobility (Poutvaara and Kanniainen, 2000, Konrad, 1995). Furthermore, countries might generally underinvest in public education due to regional spillovers from migration (Justman and Thisse, 1997, 2000) or rather provide an inefficiently low level of internationally applicable relative to country-specific education (Poutvaara, 2004, 2008). This underinvestment could either justify coordinated education policies or rather interventions at a federal level or call for the availability of adequate fiscal instruments like graduate taxes or tuition fees.

However, focussing on the mobility of high skilled university graduates alone only provides an incomplete picture of human capital mobility, since it is also student mobility becoming more and more relevant: the number of students enrolled outside their home country increased by about 50 percent from 2000 to 2005 and more than quadrupled over the last 30 years (OECD, 2007, p. 302). Recognizing the empirical evidence on the relationship between student migration and subsequent (high skilled) labor migration (e.g. Baruch, Budhwar and Khatri , 2007, Dreher and Poutvaara, 2005, Finn, 2003), countries might have an incentive to attract students as future human capital by means of education policy. The OECD (2007, p.303) supports this notion: "[in] the past few years, the rise of the knowledge economy and global competition for skills provided a new driver for the internationalisation of education systems in many OECD countries, whereby the recruitment of foreign students is part of a broader strategy to recruit highly skilled immigrants." Krieger and Lange (2008) demonstrate that considering student and labor mobility at the same time in a model with education policy and income tax competition between two countries produces some interesting new insights: increasing labor mobility allows in fact for higher income taxation and therefore revenues. This mainly comes from a reduction in the income elasticity of the number of students in a region meaning that the propensity to migrate as a student (who anticipates future tax policies and potential mobility restraints) in order to escape unfavorable taxation is reduced. An increasing student mobility, however, induces countries to engage in intensified tax and education policy competition implying an erosion of revenues.

The paper presented here contributes to the literature on education policy with interregionally mobile human capital in that it provides a more complete view on decentralized resource spending by considering two types of academic mobility simultaneously. It reconsiders the well-known underinvestment issue in this context and thereby extends Justman and Thisse's (2000) two-country, one-sector analysis by considering not only (imperfect) high skilled labor but also student mobility. I find that in a setting of local output maximizing governments, with a high enough incentive to attract students by means of productivity enhancing education expenditures, countries might even engage in excessive education funding. Results depend one the stay rate of graduates in their country of education and the sensitivity of wages to immigration. Furthermore, I consider the case of local governments only maximizing natives' utility. Depending on the stay rates of graduates *and* students, regions may either overinvest or underinvest in public education. The potential underinvestment is basically due to high student mobility and therefore a reduced marginal benefit from a region's public education investment. The results call for federal interventions which must anticipate local policy adjustments very carefully. The optimal intervention largely depends on student and labor migration propensities. Furthermore, federal initiatives to foster human capital mobility like for example the Bologna process and the Lisbon strategy of the European Union have to be assessed in respect of potentially undesirable reactions by means of education policy at the national level.

The remaining of the paper is organized as follows. Section 2 introduces the main ingredients of the model, develops student and labor migration probabilities and derives the effect of a country's education policy on local human capital. Section 3 presents the globally optimal education policy which is compared to the local policy in a decentralized equilibrium for two different government objective functions analyzed in Section 4. Section 5 concludes.

2 The model

The model presented in this paper is closely related to Justman and Thisse's (2000) model in order to make results comparable as far as possible. The main difference – besides the consideration of student mobility of course – is in the modeling of migration flows. Here, I make use of a modified version of the approach recently presented by Krieger and Lange (2008), where interregional income differentials and individual mobility costs determine migration behavior both at the student and graduate migration stage.

2.1 Production and time structure

In each of two regions (i and j), the number of identical and perfectly competitive firms, which produce an aggregate output good by means of human capital (denoted by h) which is mobile between regions, an internationally immobile factor l which might be interpreted as unskilled labor and is in fixed supply, and the production function

$$y_x = f(h_x, l_x) = A h_x^{\alpha} l_x^{1-\alpha} \qquad x = i, j; \quad \alpha \in (0,1), \tag{1}$$

where $A \geq 1$ is some technology parameter, is normalized to one. The production function satisfies the Inada conditions. While the specific form of the production function is irrelevant for the results presented in this section, it is used for a numerical exercise when it comes to the evaluation of local optimal policy. A competitive factor market equilibrium implies that an efficiency unit of human capital as well as one unit of unskilled labor supply is rewarded according to its marginal product (goods prices are normalized to one):

$$f_1 \equiv \partial f / \partial h_x = w_x \qquad x = i, j \tag{2}$$

$$f_2 \equiv \partial f / \partial l_x = w_x^u \qquad x = i, j. \tag{3}$$

The regions are assumed to be identical with respect to production technology, endowment with the immobile factor and the size of population going for higher education, which is normalized to one. The human capital measure includes the number of skilled workers within a region (natives and foreigners), where each worker is weighted with the public expenditure on education (s) of the region where he graduated from university. This allows to interpret s as quality of education or rather effective labor supply. Following Justman and Thisse (2000), the expenditure is assumed to be lump-sum tax financed in order ro really focus on education policy. The simultaneous consideration of both tax and education policy competition is provided for example by Krieger and Lange (2008), Haupt and Janeba (2007) and Andersson and Konrad (2003). The determination of a region's h requires an analysis of students' and workers' migration decisions.

The time structure of the model is as follows: first, both regions simultaneously choose the public expenditure on higher education; then, students decide on the location of education (they are assumed to pass the entire duration of study at the chosen location); after graduating from university, individuals decide on whether staying at the location of education in order to supply labor or migrating to the other region (nature does not reveal the corresponding migration costs until the individual graduates from university); in a final step, the firms in both regions produce output using human capital and the immobile factor.

2.2 Individual migration decisions

An individual's lifetime utility is described by the following utility function:

$$U = s_x w_x - \delta m_0 - \theta m \qquad x = i, j \tag{4}$$

where the first term represents labor income (which is the product of effective labor supply s_x and the wage rate per unit of effective labor w_x). See that this formulation captures four different types of careers (let us take the perspective of an individual born in i): study in i and work in i (labor income$=s_i w_i$), study in i and work in j ($s_i w_j$), study in j and work in j ($s_j w_j$) and study in j and work in the country of origin i ($s_j w_i$). An implicit assumption here is that education is fully internationally applicable. The parameters δ and θ take the value of one if an individual migrates at the student migration stage ($\delta = 1$), at cost m_0, and/or the labor migration stage ($\theta = 1$), at cost m, and zero otherwise. Migration costs $m_0 \in [\underline{m}_0, \overline{m}_0]$ and $m \in [\underline{m}, \overline{m}]$ are uniformly distributed among individuals. The corresponding density functions are $f(m_0) = 1/\Delta m_0$ and $f(m) = 1/\Delta m$ with $\Delta m_0 = (\overline{m}_0 - \underline{m}_0)$ and $\Delta m = (\overline{m} - \underline{m})$. I do not restrict migration costs to be non-negative: in fact, I assume $\underline{m}_0, \underline{m} \leq 0$. Negative migration costs imply a strong individual migration propensity. While positive costs m_0 represent some kind of home attachment, positive costs m imply an attachment to the location of education (both of domestic and foreign students) reflecting social ties or rather networks in general, built up in the education period. In what follows, I assume $\overline{m} > |\underline{m}|$, implying that the expected value of m or rather the average mobility cost is positive ($\mathrm{E}\{m\} = \int_{\underline{m}}^{\overline{m}} m f(m) dm = \frac{1}{2}(\overline{m} + \underline{m}) > 0$). This is analogously assumed for m_0. The fact that there is no discounting between periods in this model does not change the results qualitatively.

From the utility function and by means of backward induction, we can determine the individuals' migration decisions. After graduating from a university in i (j), an individual stays in i (j) if his

$$m > s_i(w_j - w_i) \qquad (m > s_j(w_i - w_j)), \tag{5}$$

i.e. if migration costs exceed the labor income differential between regions, given that the individual obtained a university degree in region i (j). At the student migration stage, an individual not only takes into account migration costs m_0 but also expectations about the migration costs m which are not revealed until the individual finishes his studies and which occur if the individual wants to leave the location of education. An individual born in region i compares his expected lifetime utility $\mathrm{E}\{U_i^i\}$ from staying in the home region in order to study there with the expected utility $\mathrm{E}\{U_j^i\}$ from studying in the other region. See that

$$\begin{aligned}\mathrm{E}\{U_i^i\} &= \Pr\{m > s_i(w_j - w_i)\}s_i w_i \\ &\quad + \Pr\{m < s_i(w_j - w_i)\}[s_i w_j - \mathrm{E}\{m|m < s_i(w_j - w_i)\}]. \end{aligned} \tag{6}$$

With probability $\Pr\{m > s_i(w_j - w_i)\}$ the individual stays in region i after graduating from university and earns labor income $s_i w_i$. With probability $\Pr\{m < s_i(w_j - w_i)\}$, however, the individual decides to work in j and to earn $s_i w_j$. The expected migration costs are $\mathrm{E}\{m|m < s_i(w_j - w_i)\}$. Alternatively, the individual born in i can also decide to study in j. The corresponding expected utility then is

$$\begin{aligned}\mathrm{E}\{U_j^i\} &= \Pr\{m > s_j(w_i - w_j)\}s_j w_j \\ &\quad + \Pr\{m < s_j(w_i - w_j)\}[s_j w_i - \mathrm{E}\{m|m < s_j(w_i - w_j)\}] - m_0. \end{aligned} \tag{7}$$

The main difference compared to the case of studying in i is that now, the individual has to bear the cost m_0 at the first stage. Then, an individual from region i decides to stay in i at the first stage if $\mathrm{E}\{U_i^i\} > \mathrm{E}\{U_j^i\}$. Using (6) and (7) yields after some manipulations the following migration decision: an individual from region i stays in i in order to attend university if his

$$\begin{aligned} m_0 &> (1/\Delta m)\{s_i(\underline{m}w_j - \overline{m}w_i) + s_j(\overline{m}w_j - \underline{m}w_i) \\ &\quad - (1/2)[s_i^2(w_j - w_i)^2 - s_j^2(w_i - w_j)^2]\}. \end{aligned} \tag{8}$$

From this condition and the assumption of uniformly distributed migration costs, we can derive the number of students within region i. It consists of the number of those individuals who are born in i and stay there at stage one (denoted by Γ_i) and of individuals born in j who decided not to study in their home region but in i $(1 - \Gamma_j)$. The number of students in i then is

$$\begin{aligned} \Psi_i &= \Gamma_i + (1 - \Gamma_j) \\ &= (1/\Delta m_0)\{\Delta m_0 + (1/\Delta m)[2s_i(\overline{m}w_i - \underline{m}w_j) - 2s_j(\overline{m}w_j - \underline{m}w_i) \\ &\quad + s_i^2(w_j - w_i)^2 - s_j^2(w_i - w_j)^2]\}. \end{aligned} \tag{9}$$

As can be inferred from the expression above, the number of students in a country depends on education policy. Calculating $d\Psi_i/ds_i$, evaluating this derivative at a symmetric equilibrium (implying $s_i = s_j = s$, $\Psi_i = \Psi_j = 1$, $h_i = h_j = h = s$ and $w_i = w_j = w$) and collecting terms yields

$$\left(\frac{d\Psi_i}{ds_i}\right)_{\text{equ.}} = \frac{2w}{\Delta m_0} + \frac{2(\overline{m} + \underline{m})s}{\Delta m \Delta m_0}\left(\frac{dw_i}{ds_i} - \frac{dw_j}{ds_i}\right)_{\text{equ.}}. \tag{10}$$

First of all, increasing education expenditures attracts additional students who benefit from higher expenditures in terms of higher income in the future. This effect is represented by the first summand in (10). The second term captures the effect of a change in the wage differential between countries which is influenced by labor migration flows subsequent to student flows. The more student immigration translates into subsequent residence (i.e. the larger $(\overline{m}+\underline{m})/\Delta m$), the more relevant becomes this wage effect.

2.3 Human capital

Using migration decisions and the distributions of migration costs among individuals, finally, human capital in region i can be written as

$$h_i = \frac{[\overline{m} - s_i(w_j - w_i)]}{\Delta m}\Psi_i s_i + \frac{[s_j(w_i - w_j) - \underline{m}]}{\Delta m}\Psi_j s_j, \tag{11}$$

where the first summand represents the number of students in i staying in i after graduating from university (weighted with the public education expenditure in i) and the second summand represents the number of individuals educated in region j and working in i (weighted with the education expenditure in region j).

Obviously, h_i (as well as h_j of course) depends on the education policy in both regions. When it comes to the analysis of i's optimal (local) education policy, the effect of a marginal expenditure increase on the size of the human capital measure within both regions plays a decisive role. It is therefore necessary to determine dh_i/ds_i and dh_j/ds_i. See that

$$\begin{aligned} \frac{dh_i}{ds_i} &= \frac{\overline{m} - s_i(w_j - w_i)}{\Delta m}\left(\frac{d\Psi_i}{ds_i}s_i + \Psi_i\right) - \frac{(w_j - w_i)}{\Delta m}\Psi_i s_i \\ &\quad + \frac{\left(\frac{dw_i}{ds_i} - \frac{dw_j}{ds_i}\right)}{\Delta m}\left(\Psi_i s_i^2 + \Psi_j s_j^2\right) + \frac{[s_j(w_i - w_j) - \underline{m}]}{\Delta m}\frac{d\Psi_j}{ds_i}s_j. \end{aligned} \tag{12}$$

The human capital measure is not only directly affected by an increase in the education expenditure but also indirectly via its effect on the number of students and therefore – with a certain probability of students staying in the country of their education – on the number of workers in the country and via the change in the wage differential between countries. Using the fact that $d\Psi_j/ds_i = -d\Psi_i/ds_i$, in a symmetric equilibrium

$$\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} = \frac{\overline{m}}{\Delta m} + \frac{(\overline{m}+\underline{m})s}{\Delta m}\left(\frac{d\Psi_i}{ds_i}\right)_{\text{equ.}} + \frac{2}{\Delta m}\left(\frac{dw_i}{ds_i} - \frac{dw_j}{ds_i}\right)_{\text{equ.}} s^2. \quad (13)$$

The effect of an increase in the education expenditure on the wage rate differential depends on the effect of the expenditure increase on human capital. Evaluated at a symmetric equilibrium and using $(dh_j/ds_i)_{\text{equ.}} = 1 - (dh_i/ds_i)_{\text{equ.}}$,

$$\left(\frac{dw_i}{ds_i} - \frac{dw_j}{ds_i}\right)_{\text{equ.}} = f_{11}\left[2\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} - 1\right]. \quad (14)$$

Using this expression and the effect of a marginal expenditure increase on the number of students according to (10) in (13) and solving the equation for $(dh_i/ds_i)_{\text{equ.}}$ then finally yields

$$\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} = \frac{\frac{\overline{m}}{\Delta m} + \frac{2(\overline{m}+\underline{m})sf_1}{\Delta m\Delta m_0} - \frac{2s^2 f_{11}}{\Delta m}\left[\frac{(\overline{m}+\underline{m})^2}{\Delta m\Delta m_0}+1\right]}{1 - \frac{4s^2 f_{11}}{\Delta m}\left[\frac{(\overline{m}+\underline{m})^2}{\Delta m\Delta m_0}+1\right]}. \quad (15)$$

Recognizing that $\overline{m}/\Delta m$ represents the stay rate of graduates in the country of education in equilibrium (denoted by $p > 1/2$ in what follows) and with $(-\underline{m})/\Delta m = 1-p$ and $(\overline{m}+\underline{m})/\Delta m = 2p-1$,

$$\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} = \frac{p + \frac{2(2p-1)}{\Delta m_0}sf_1 - 2s^2 f_{11}\left[\frac{(2p-1)^2}{\Delta m_0} + \frac{1}{\Delta m}\right]}{1 - 4s^2 f_{11}\left[\frac{(2p-1)^2}{\Delta m_0} + \frac{1}{\Delta m}\right]}. \quad (16)$$

Stay rates smaller than one capture the fact that there are further (non-monetary) migration determinants beside income differentials. In order to illustrate the new insights from considering student mobility and as a benchmark, it seems useful to present $(dh_i/ds_i)_{\text{equ.}}$ from a simpler version of the model with immobile students (implying $d\Psi_i/ds_i = d\Psi_j/ds_i = 0$ and $\Psi_i = \Psi_j = 1$) which I indicate with a circle as superscript:

$$\left(\frac{dh_i}{ds_i}\right)^{\circ}_{\text{equ.}} = \frac{p - 2s^2 f_{11}/\Delta m}{1 - 4s^2 f_{11}/\Delta m} < 1. \tag{17}$$

This basically reproduces the expression presented by Justman and Thisse (2000, p. 252). The main difference comes from their explicit consideration of a worker's responsiveness to interregional income differentials. Implicitly, the individual responsiveness in the model presented here is one and therefore has the same weight as migration costs capturing non-wage migration determinants. The overall relevance of the 'wage effect' due to migration is therefore solely determined by the characteristics of the production function or rather f_{11}.

The consideration of student mobility is first of all reflected in the marginal benefit from attracting students by increased education expenditures (as represented by $(2(2p-1)/\Delta m_0)sf_1$ in (16)). The higher the stay rate of graduates, the more does an increase in the number of students translate into an increase of human capital and therefore the larger $(dh_i/ds_i)_{\text{equ.}}$. Secondly, the additional wage effect which can be traced back to student migration has to be considered (first term in brackets in the last summand of the numerator and the denominator respectively). Again, the higher the stay rate, the more relevant becomes this effect.

3 Global output maximizing policy

The centralized solution with respect to education policy serves as a benchmark when it comes to an evaluation of the decentralized outcome. A federal institution would maximize global output or rather the wage sum of residents (the equivalence is due to firms' zero net profitability conditions in a competitive market equilibrium) net of public expenditures on higher education in both regions by choosing an education policy which equates the human capital's marginal product and the marginal cost of spending resources on higher education in each region. I assume resource costs following the cost function $c_i(s_i) = cs_i$ here. As in the model of Justman and Thisse (2000, p. 252), the first order condition for the global output maximizing expenditure then is

$$f_1(h_x, l_x) = c \qquad x = i, j \tag{18}$$

or rather

$$f_1(s, l) = c \tag{19}$$

in a symmetric solution (i.e. $h_i = h_j = s_i = s_j = s$).

4 Decentralized education policy

Strategic interaction in decentralized policy making in the context of public education funding or rather expenditure competition can generally occur for example on the state or country level. In any case, the relative weight of 'foreigners' in local authorities' decision making might vary. Therefore, following especially Justman and Thisse (2000), I will deal with two cases: in section 4.1 local governments are assumed to care only about residents (skilled and unskilled workers independently of their origin), while in section 4.2 they only consider natives' interests (independently of their residence).

4.1 Maximizing residents' wage sum

Decentralized education policy making in a setting of local governments maximizing the wage sum of local workers (natives and foreigners), implies competition for human capital. Let the regions maximize local output (which is equal to the local wage sum) net of education expenditures, i.e. region i faces the following optimization problem, where it takes region j's policy as given:

$$\max_{s_i} \quad \Phi^{LO} = f(h_i, l_i) - cs_i. \tag{20}$$

The corresponding first order condition in a symmetric Nash equilibrium then is

$$f_1(s, l) \times \left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} = c. \tag{21}$$

Comparing the centralized and the decentralized solution, with $(dh_i/ds_i)^{\circ}_{\text{equ.}} < 1$ and $f_{11} < 0$, the well-known underinvestment result (as presented in Justman and Thisse, 2000, p. 253) emerges unambigously: as a country's marginal increase of education expenditure does not translate one-to-one into an increase of human capital, there is a reduced incentive to provide public education locally compared to the centralized solution. This, however, needs no longer to be the case if there is an additional benefit from increasing expenditure via the attraction of students as future human capital.

With labor *and* student mobility, results are ambiguous and an analytical solution cannot be derived. Therefore, the main insights are presented by means of intuition and an illustrative numerical exercise here. I am mostly interested in two parameters basically driving the results: the stay rate of graduates in equilibrium p and α from the production function, which determines the sensitivity of wages on changes in the size of the labor force or rather migration flows. The other parameters in the example are chosen as follows: $A = 1.4$, $l = 1$, $c = 1$, $\Delta m = \Delta m_0 = 1$. Using the functional form of the production function as presented in (1) in the local first order condition, allows to find optimal values for the local education expenditure depending on p and α by using a numerical solver.[1]

As can be seen from Figure 1, expenditures increase both in the graduates' stay rate and α. The higher stay rates, the higher the 'return' to education expenditures from the local perspective and therefore the higher the incentive to invest. For the parameter range of α in the diagram, the sensitivity of wages to a human capital increase decreases, i.e. $d|f_{11}|/d\alpha < 0$. The smaller the wage effect, i.e. the smaller $|f_{11}|$, the larger $(dh_i/ds_i)_{\text{equ.}}$ and therefore s. See that $p > 0.5$ is already sufficient

[1]Using the functional form of the production function, the local first order condition for the education expenditure is

$$A\alpha s^{\alpha-1}\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} = c.$$

Using (16) and rewriting the equation yields

$$A\alpha p + 4A\alpha(\alpha-1)\eta cs - cs^{1-\alpha} + 2A^2\alpha^2\left[\frac{(2p-1)}{\Delta m_0} + (1-\alpha)\eta\right]s^{\alpha} = 0,$$

where $\eta \equiv (2p-1)^2/\Delta m_0 + 1/\Delta m$.

for $\partial[(dh_i/ds_i)_{\text{equ.}}]/\partial|f_{11}| < 0$.

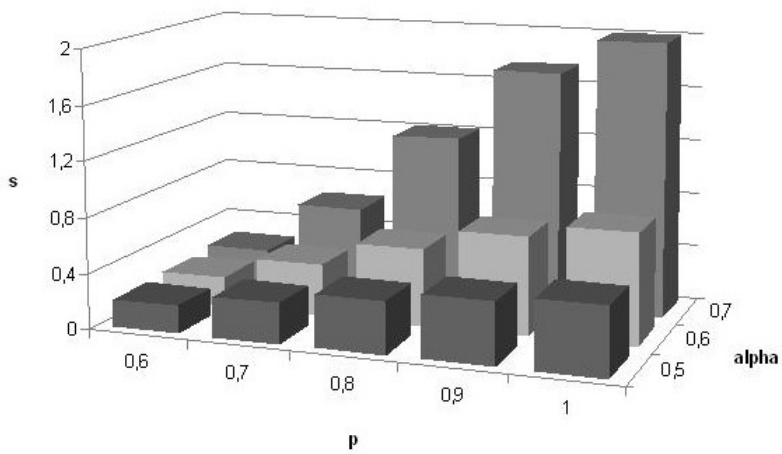

Figure 1: Sensitivity of the local expenditure to p and α

With the additional benefit from a marginal increase of the local education expenditure in a world with student mobility compared to a setting as presented for example by Justman and Thisse (2000), the question arises whether for local entities there is still an incentive to underinvest in education compared to the centralized solution. If $(dh_i/ds_i)_{\text{equ.}}$ was equal to one, local entities would choose the globally optimal level of education resources. Figure 2 first of all illustrates that there really exist combinations of stay rates and α's for which local and central expenditure levels coincide (black curve in the diagram). The functional form of this curve is implicitly given by

$$\frac{p + 2A\alpha s^{\alpha}\{\frac{(2p-1)}{\Delta m_0} - (\alpha-1)[\frac{(2p-1)^2}{\Delta m_0} + \frac{1}{\Delta m}]\}}{1 - 4A\alpha(\alpha-1)s^{\alpha}[\frac{(2p-1)^2}{\Delta m_0} + \frac{1}{\Delta m}]} \quad = \quad 1, \tag{22}$$

where $s = (A\alpha/c)^{1/(1-\alpha)}$ is the optimal education policy. Furthermore, with the local s increasing in p and α as illustrated in Figure 1, we can also determine areas of under- and overinvestment: the higher stay rates and the lower the effect of migration on wages, i.e. the higher α, the larger the tendency to overinvest in local education. While combinations located in the north-east of the ‘global-optimality-line’ imply a local overinvestment incentive, combinations in the south-west mean underinvestment.

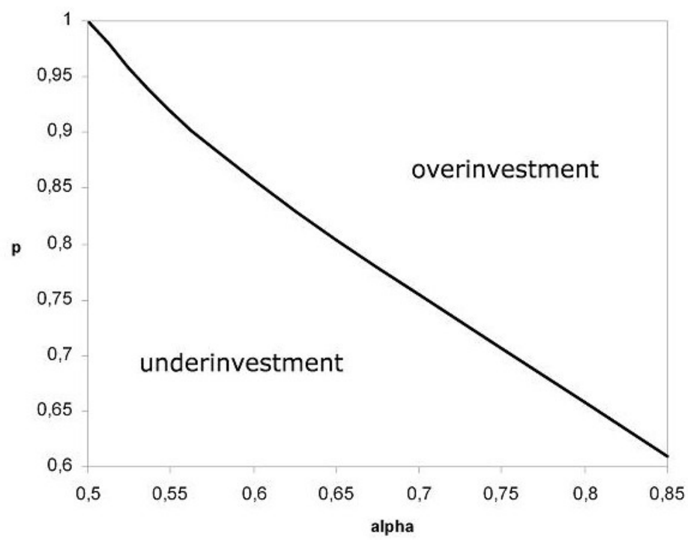

Figure 2: Areas of over-, under- and globally optimal investment at the local level

At this stage it seems indicated to briefly reconsider the assumption on the resource cost function $c_i(s_i)$. I simply assumed a constant marginal cost of using resources here. This seems justifiable at least at the country or state level where politicians decide on educational budgets. One might argue, however, that there are costs $c_i = c(\Psi_i)s_i$ depending (positively) on the number of students enrolled. In that case – provided that overall $d\Psi_i/ds_i > 0$ – from the point of view of a local entity there is an additional cost of attracting students by means of increasing resources, namely $c'(d\Psi_i/ds_i)s_i$. If there was nothing to gain from the attraction of foreign students, countries would clearly underinvest in education compared to the centralized solution. Del Rey (2001) makes this point in a model where students always pay taxes in their home countries and there are no discriminatory tuition fees. In the context presented here, the stronger the marginal cost effect is relative to the additional benefit from attracting students as future human capital, the more likely the underinvestment result will emerge. Nevertheless, variable costs probably play a more important role at the university than the state or country level in which I am interested here.

4.2 Maximizing natives' wage sum

Justman and Thisse's (2000) explanation for a potential source of underinvestment in public education, namely high skilled labor mobility, is not the only lesson to learn from their analysis. The demonstration that assumptions on local government objectives drive the results is just as important. In their model, "[decentralization] leads to under-investment in education when political interests are predominantly defined in geographic terms and local governments act to maximize regional output, but may over-invest when political interests of native-born highly educated are well presented" (Justman and Thisse, 2000, p. 255). Reassessing this issue in the context of the extended model presented here as well seems worthwhile.

Think of an objective function which considers only the native-born skilled population – which studies and works either in the home country or abroad – and the immobile factor or rather respective factor incomes. The optimization problem then becomes

$$\max_{s_i} \quad \Phi^N = P_i^{ii} s_i f_1(h_i, l_i) + P_i^{ij} s_i f_1(h_j, l_j) + P_i^{ji} s_j f_1(h_i, l_i) + P_i^{jj} s_j f_1(h_j, l_j) + l_i f_2(h_i, l_i) - c s_i. \tag{23}$$

The P's represent the number of workers who are born in i (subscript) and who have either studied in i or j (first superscript) and work either in i or j (second superscript). See that

$$P_i^{ii} \equiv \frac{[\overline{m} - s_i(w_j - w_i)]}{\Delta m}\Gamma_i \ , \qquad P_i^{ij} \equiv \frac{[(w_j - w_i)s_i - \underline{m}]}{\Delta m}\Gamma_i \ ,$$

$$P_i^{ji} \equiv \frac{[(w_i - w_j)s_j - \underline{m}]}{\Delta m}(1 - \Gamma_i) \ , \qquad P_j^{jj} \equiv \frac{[\overline{m} - s_j(w_i - w_j)]}{\Delta m}(1 - \Gamma_i).$$

The maximization's first order condition reads

$$\begin{aligned} \frac{d\Phi^N}{ds_i} &= \frac{dP_i^{ii}}{ds_i} s_i f_1(h_i, l_i) + P_i^{ii} f_1(h_i, l_i) + P_i^{ii} s_i f_{11} \frac{dh_i}{ds_i} \\ &+ \frac{dP_i^{ij}}{ds_i} s_i f_1(h_j, l_j) + P_i^{ij} f_1(h_j, l_j) + P_i^{ij} s_i f_{11} \frac{dh_j}{ds_i} \\ &+ \frac{dP_i^{ji}}{ds_i} s_j f_1(h_i, l_i) + P_i^{ji} s_j f_{11} \frac{dh_i}{ds_i} \\ &+ \frac{dP_i^{jj}}{ds_i} s_j f_1(h_j, l_j) + P_i^{jj} s_j f_{11} \frac{dh_j}{ds_i} \\ &+ l_i f_{21} \frac{dh_i}{ds_i} - c \quad = \quad 0. \end{aligned} \tag{24}$$

Calculating the derivatives (please refer to the Appendix), evaluating the whole condition at a symmetric equilibrium, using $(dh_i/ds_i)_{\text{equ.}}$ and $(dh_j/ds_i)_{\text{equ.}}$ from section 2 and the properties of the production function (especially $f_{21} = f_{12}$ and $hf_{11}(h,l) + lf_{12}(h,l) = 0 \Leftrightarrow lf_{12}(s,l) \overset{\text{(equ.)}}{=} -sf_{11}(s,l)$), we finally end up with

$$f_1 p_0 + s f_{11} \underbrace{(2pp_0 - p - p_0)}_{(-)} \left[2\,(dh_i/ds_i)_{\text{equ.}} - 1\right] = c, \tag{25}$$

where $p_0 \equiv \Gamma_{\text{equ.}} = \overline{m}_0/\Delta m_0$ and $(1-p_0) \equiv (1-\Gamma_{\text{equ.}}) = -\underline{m}_0/\Delta m_0$ refer to students' migration propensities in equilibrium. Again, a numerical example helps to illustrate the results. The specification is as follows: $A = 1.4$, $\alpha = 0.7$, $\Delta m_0 = \Delta m = 1$, c=1. As can be seen in Figure 3 where the light-colored plain indicates the globally optimal expenditure level, again, both scenarios – over- and underinvestment – may result from decentralized education policy.

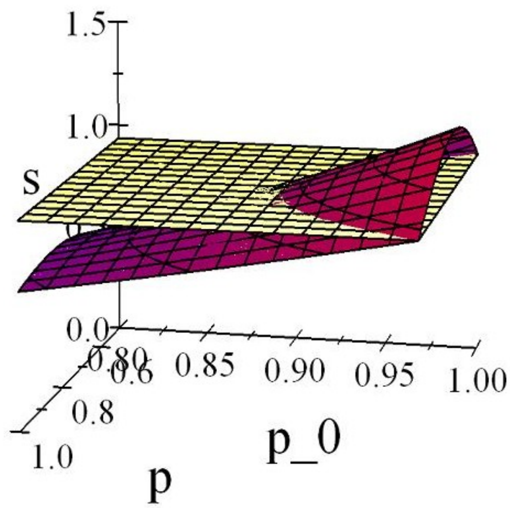

Figure 3: Centralized vs. local policy in native product maximization

See that now, students' migration behavior plays a decisive role. For $p_0 = 1$, i.e. no student migration in equilibrium, the local first order condition coincides with the one presented by Justman and Thisse (2000, p. 256) and we come up to the overinvestment result for all stay rates in the assumed parameter range $0.5 < p < 1$:

$$f_1 - \underbrace{sf_{11}\left\{(1-p)\left[2\left(dh_i/ds_i\right)_{\text{equ.}} - 1\right]\right\}}_{(-)} = c. \tag{26}$$

Please note that $p_0 = 1$ does not mean there is no student migration at all. It only says that there are no other than income motives for student migration. In order to understand why there might also exist an underinvestment incentive, it is helpful to abstain from the wage effect for a moment to spot the crucial mechanism at work. If the wage differential between countries was not affected by a change in education policy, the local first order condition would reduce to

$$f_1 p_0 = c. \tag{27}$$

Since only those natives benefit from the increased expenditure in their home region who stay there as students, a stay rate p_0 smaller than one implies that regions (maximizing only natives' incomes) only gain part of the investment's marginal benefit while bearing the entire marginal cost. Compared to the centralized solution where both domestic and foreign residents are considered, this generates the underinvestment result following from (27) due to $f_1 > c$ and the assumptions on production technology. This is in line with the argument presented by Büttner and Schwager (2004) in a model with interregionally mobile students in a federation, calling for tuition fees at the federal level.

Further inspection of (25) indicates that an increase of the wage effect (i.e. $d|f_{11}| > 0$) – ceteris paribus – increases the local provision of resources, if $(dh_i/ds_i)_{\text{equ.}} > 1/2$.

5 Conclusion

The analysis presented here is inspired by the increasing relevance of student mobility and the potential interest of countries to attract foreign students as future human capital. Increasing efforts of OECD countries to facilitate foreign students' passover from university to the domestic labor market after graduation (see e.g. Tremblay, 2005) support the view that countries are aware of this option. When public resources spent on higher education attract foreign students due to their productivity enhancing effect, the well-known underinvestment result from models exclusively focussing on labor mobility does not necessarily carry over to settings where there is something to gain from attracting students. I find that local output maximizing countries tend to overinvest in higher education if equilibrium stay rates of graduates are sufficiently high and the wage effect from immigration is only modest. In a model of two private schools or rather universities maximizing profits by means of both resources and tuition fees with a pool of mobile students, Boadway, Marceau and Marchand (1996) find that – under certain conditions – institutions overinvest in terms of resources spent on institutions' quality in a symmetric decentralized Nash equilibrium compared to a planner's solution. In fact, there is some analogy between our models: while it is universities benefitting from attracting students in terms of increasing revenue from tuition fees in their framework, I presented countries benefitting from student immigration via subsequent human capital 'immigration'. The latter concept is also presented by Kemnitz (2005) who shows that a sufficiently low fiscal 'leakage' of the local education investment in a federation which is not only due to graduate mobility but also fiscal equalization could induce an excessive local spending.

In the light of Justman and Thisse's (2000) insight that local objective functions or rather the relative weight of foreigners in the objective function crucially determine education policy, I consider not only residents' but also natives' utility maximization at the local level. When policy is only driven by natives' interests, students' migration propensity comes into play: basically, the lower student stay rates in equilibrium, the lower a country's marginal benefit from resource spending and therefore the larger the tendency to underinvest in education. A priori, results are ambiguous again.

The results – and especially the ambiguity of results – advise against overhasty calls for specific forms of federal intervention in education policy. Depending on government objectives and human capital migration propensities, the use of federal subsidies for local educational systems or tuition fees could cause undesirable outcomes. Federal interventions of course need not be limited to the use of fiscal instruments. The European Union could serve as an example here: while the design of public education policy is left to the member states, there are initiatives at the Union level like the Bologna process and the Lisbon strategy intended to enhance (academic) mobility. Although these programs are probably not primarily aimed at the correction of national policies, against the background of the analysis presented here, these efforts could lead to a convergence of decentralized education policy to a common optimum – but they need not. In general, a targeted federal intervention premises first of all knowledge of the kind of discrepancy between local and globally optimal policy (i.e. over- vs. underinvestment) and second the reaction of strategically interacting local entities to parameter changes within their sphere of authority.

Appendix

Calculating the derivatives of the P's with respect to s_i and then using the equilibrium conditions yields

$$\left(\frac{\partial P_i^{ii}}{\partial s_i}\right)_{\text{equ.}} = \frac{f_{11}}{\Delta m}\left[2\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} - 1\right] s\frac{\overline{m}_0}{\Delta m_0} + \frac{\overline{m}}{\Delta m}\left(\frac{\partial \Gamma_i}{\partial s_i}\right)_{\text{equ.}},$$

$$\left(\frac{\partial P_i^{ij}}{\partial s_i}\right)_{\text{equ.}} = -\frac{f_{11}}{\Delta m}\left[2\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} - 1\right] s\frac{\overline{m}_0}{\Delta m_0} - \frac{\underline{m}}{\Delta m}\left(\frac{\partial \Gamma_i}{\partial s_i}\right)_{\text{equ.}},$$

$$\left(\frac{\partial P_i^{ji}}{\partial s_i}\right)_{\text{equ.}} = \frac{f_{11}}{\Delta m}\left[2\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} - 1\right] s\left(\frac{-\underline{m}_0}{\Delta m_0}\right) - \frac{\underline{m}}{\Delta m}\left(\frac{\partial (1-\Gamma_i)}{\partial s_i}\right)_{\text{equ.}},$$

$$\left(\frac{\partial P_i^{jj}}{\partial s_i}\right)_{\text{equ.}} = \frac{f_{11}}{\Delta m}\left[2\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} - 1\right] s\frac{\underline{m}_0}{\Delta m_0} + \frac{\overline{m}}{\Delta m}\left(\frac{\partial (1-\Gamma_i)}{\partial s_i}\right)_{\text{equ.}}.$$

Furthermore, see that

$$\left(\frac{\partial \Gamma_i}{\partial s_i}\right)_{\text{equ.}} = \frac{1}{\Delta m_0}\left\{f_1 + \frac{(\overline{m}+\underline{m})}{\Delta m} s f_{11}\left[2\left(\frac{dh_i}{ds_i}\right)_{\text{equ.}} - 1\right]\right\} = -\left(\frac{\partial (1-\Gamma_i)}{\partial s_i}\right)_{\text{equ.}},$$

which however cancels out in the first order condition anyway.

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