DISCUSSION PAPER SERIES

IZA DP No. 2478

Public Education in an Integrated Europe: Studying to Migrate and Teaching to Stay?

Panu Poutvaara

December 2006

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

Public Education in an Integrated Europe: Studying to Migrate and Teaching to Stay?

Panu Poutvaara
University of Helsinki
and IZA Bonn

Discussion Paper No. 2478
December 2006

IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

IZA Discussion Paper No. 2478
December 2006

ABSTRACT

Public Education in an Integrated Europe: Studying to Migrate and Teaching to Stay?*

This paper analyzes public provision of internationally applicable and country-specific education, when job opportunities available to those with internationally applicable education are uncertain. Migration provides a market insurance in case labor market opportunities in the home country are poor. An increasing international applicability of a given type of education encourages students to invest more effort when studying. Governments, on the other hand, face an incentive to divert the provision of public education away from internationally applicable education toward country-specific skills. This would mean educating too few engineers, economists and doctors, and too many lawyers.

JEL Classification: H52, I28, F22, J24, J61

Keywords: public education, migration, brain drain and brain gain, European Union, common labor market

Corresponding author:

Panu Poutvaara
Department of Economics
University of Helsinki
P.O. Box 17 (Arkadiankatu 7)
FIN-00014 Helsinki
Finland
E-mail: panu.poutvaara@helsinki.fi

* Earlier versions of this paper were presented in 2004 in seminars at WZB in Berlin and in the conference Advanced Perspectives on Migration and Mobility in Bonn, in 2005 in seminars at the DG Employment, Social Affairs and Equal Opportunities in Brussels and in Dortmund, in the Annual Meeting of the Public Choice Society in New Orleans, Louisiana, in the CESifo Area Conference on Public Sector Economics in Munich, in a workshop in Rotterdam, and at the IIPF meeting in Jeju in South Korea, and in 2006 in the Nordic Workshop on Tax Policy and Public Economics in Bergen. I am grateful to Carlo Devillanova, C. Simon Fan, Kåre Hagen, Katarina Keller, Oded Stark, Silke Uebelmesser, two anonymous reviewers for the conference in Bonn, and seminar and conference participants for useful comments. All remaining errors are mine. I acknowledge financial support from the Danish Social Science Research Council and the Yrjö Jahnsson Foundation, without implicating the sponsors for the views expressed.

1. Introduction

There is wide political consensus within the European Union that decisions on public education should be left to individual member states. Benefits, however, accrue partly to other member states through migration. By providing skilled immigrants, investments in internationally applicable education generate positive externalities to other member states. As individual member states have no incentives to internalize these externalities, decentralized decision-making tends to lead into inefficiently low investments in internationally applicable degrees. Increased mobility of the highly educated generates incentives to scale back public financing, recently exemplified in the introduction of top-up fees in England. Before that Sweden replaced a system of income-contingent loans, in effect between 1989 and 2001, by ordinary annuity loans. (CSN 2006). Sweden abandoning its income-contingent loan system may reflect the pressures of increased labor mobility. Of all of those who graduate from Swedish universities, 15 percent emigrate. (Eklund 1998). Unlike income-contingent loans, annuity loans do not require cooperation from foreign tax authorities.

Emigration from the member states of the European Union is disproportionally large among the highly educated. Docquier and Marfouk (2004) define brain drain as the proportion of working-age individuals (aged 25 and over) with at least tertiary education, born in a given country but living elsewhere. In the 24 other EU member states but Cyprus, the emigration rate of those with tertiary education varied between 2.6 percent of Spain and 55.2 percent of Malta, exceeding 10 percent in Austria, Estonia, Hungary, Greece, Ireland, Latvia, Lithuania, Malta, Poland, Portugal, Slovakia, Slovenia, and the United Kingdom. The emigration rate of those with tertiary education is between 7 and 10 percent in the Czech Republic, Denmark, Finland, Germany, Italy, Luxembourg, and the Netherlands. The emigration rate of those with secondary education exceeds 10 percent only in Ireland, Malta, and Portugal, and is between 7 and 10 percent in Greece and the Slovakia. (Docquier and Marfouk 2004)

Brain drain literature, pioneered by Grubel and Scott (1966) and Bhagwati and

Hamada (1974), highlights the losses that emigration imposes on source countries. Justman and Thisse (1997) show that a government that maximizes the utility of immobile residents reduces investment in public education when the educated become mobile. Wildasin (2000) suggests that when the highly-skilled become mobile, tax competition tends to erode any taxes they have to pay. This shifts the burden of financing public education to immobile tax bases.

Even though the possibility of migration reduces the incentives of individual governments to provide internationally applicable education, it also encourages students to study more intensively, by increasing the expected private returns to human capital. (Mountford (1997) and Stark et al. (1997)) Beine et al. (2001) show that such a beneficial brain drain cannot be ruled out. Poutvaara (2004) studies the effects of graduate mobility on public incentives to provide different types of education in the absence of private investment in effort.

This paper examines the effects of migration on the provision of country-specific and internationally applicable public education when public and private investments in human capital are complements. Including these two aspects of human capital formation allows evaluation of whether the brain gain effect would swamp the brain drain effect in the public provision of education, so that an increased mobility would result in higher public investment. Country-specific skills may include both tertiary education with national emphasis, like degrees in law and certain humanities, and also secondary education which is less mobile. Correspondingly, internationally applicable education may include, in addition to science-based, commercial and other internationally applicable degrees in tertiary education, those fields in secondary education (like nurses) which are internationally mobile.

The framework used allows the member states of the common labor market, from now on referred to as federation, to differ in general productivity. The analysis considers both the case in which member states levy only wage taxes on their residents, and also a case in which member states levy also graduate taxes which are paid to the country which provided education independently of future domicile. Graduate tax is used to

denote a tax which is collected from university graduates, without a requirement that tax revenue collected from them would have to equal the costs of providing education. Such graduate taxes give the country which educated migrants a stake also in their productivity gains earned elsewhere. This study focuses on education targeted to young adults.[1]

While taxing the income of nationals living abroad may seem a radical proposal from the European perspective, it is already part of the Unites States tax code: American citizens living abroad are required to report their income also to the United States, and the income is taxed with certain exemptions and credits for taxes paid abroad. (See Desai et al. (2004) for an overview.) The graduate tax discussed in this paper bears certain similarities to the debate on taxing immigrants from the developing countries, following the seminal contribution by Bhagwati and Hamada (1974, 1982). There is also a link to Sinn's (1994) suggestion that young people would have to choose early in which redistribution system they want to participate, as well as to Richter's (2002) suggestion of delayed integration. A fraction of income that would be paid to the country which provided education in this paper would have its correspondence in Richter's transition period during which migrant would pay taxes to the previous home country.

The main results are the following. Whether the member states of a federation are symmetric or not, an increased international applicability increases private investment in internationally applicable education. However, if there are no graduate taxes and governments care only about the citizens who stay, then governments tend to reduce provision of internationally applicable education when its applicability increases. If a government attaches a sufficiently high positive weight also on the utility of emigrants, then it might increase provision of internationally applicable education when it becomes more mobile. Independently of the weight attached to emigrants and of the productivity differential between the two countries, replacing part of the current wage taxes by

[1] In the spirit of Tiebout (1956), parents valuing education may buy better education for their children by paying higher taxes. Such a mechanism is much weaker in higher education, as young adults may go to a university in a different city, or even country, than in which their parents pay taxes.

a graduate tax always leads to higher welfare and more efficient investment in internationally applicable education than the current system, provided that the aggregate tax rate does not increase. From the perspective of governments providing internationally applicable education, graduate tax is a Pigouvian subsidy: by transferring part of the returns to internationally applicable education to the government that provided it also in case of migration, it internalizes part of positive externalities that internationally applicable education gives to other member states through taxes that migrants pay there.

Private financing of education through tuition fees would be more efficient than tax-financed education in the framework of this study, as there are no market failures. However, this paper does not address the issue of whether education should be provided publicly. It takes as its starting point the stylized fact that education *is* predominantly provided publicly in the European Union, and then asks how increasing international applicability of certain types of education affects the incentives of governments to provide such education. In Austria, Denmark, Finland, Greece, and Poland, 100 percent of tertiary education is publicly financed. The share is at least 80 percent also in Belgium, the Czech Republic, France, Germany, Ireland, Italy, Portugal, the Slovak Republic and Sweden. In Hungary, the Netherlands, Spain and the United Kingdom the share of public financing is 70 to 80 percent. (OECD 2004)

This paper is organized as follows. Section 2 develops the model. Section 3 presents the results. Section 4 concludes.

2. The model

2.1. Game structure

A federation consists of two member states, labeled A and B. Both member states are populated by heterogeneous citizens who become educated and work. Each citizen lives for two periods, becoming educated in his or her member state of birth in the first period, and choosing where to live, work and pay taxes in the second period. All the production takes place in the second period. The paper focuses on a two-period model,

even though all the results could be generalized to an overlapping generations framework at the cost of notational complexity.[2] There are two types of education, labeled i and s. These subscripts refer to whether the education is internationally applicable (i) or country-specific (s). Only those with internationally applicable education may migrate. Students with ability-intensive internationally applicable education may also invest privately effort in their education. Such investment cannot be verified by the government. Furthermore, there is uncertainty related to labor market alternatives available with internationally applicable education, the realization being revealed only after education is completed.

The education is provided publicly. To focus on government decisions on what type of education to provide, it is assumed that the tax rates are exogenous and the same in the two member states.[3] The governments have two different tax instruments: A general wage tax rate τ_w is levied on all wage income generated domestically, while there may also be a graduate tax rate τ_g, paid by graduates to the member state which initially provided their education. In other words, also migrants pay their graduate taxes to their member state of origin. The total tax rate is then $\tau = \tau_w + \tau_g$, satisfying $\tau_w \geq 0, \tau_g \geq 0, \tau < 1$. Governments are benevolent, choosing the education that maximizes the after-tax consumption of their remaining citizens, and possibly attaching a positive weight also on their migrating citizens. Note that graduate tax revenue is not earmarked to the provision of education, but governments run integrated budgets. Thus, graduate tax revenue may exceed or fall short of the costs of providing education. The government budget constraint is balanced over the two periods by adjusting in the second period politically chosen transfers to a subset of those with country-specific skills. For example, this subset may consist of civil servants who would provide ordinary labor

[2]The analysis in the overlapping generations framework is available as CESifo Working Paper 1369, December 2004.

[3]Keen and Marchand (1997) use the same assumption when they study the effect of fiscal competition on the composition of public expenditure in the presence of mobile capital. They find that in a non-cooperative equilibrium, public expenditures are biased toward the provision of public inputs at the expense of local public goods benefiting immobile residents.

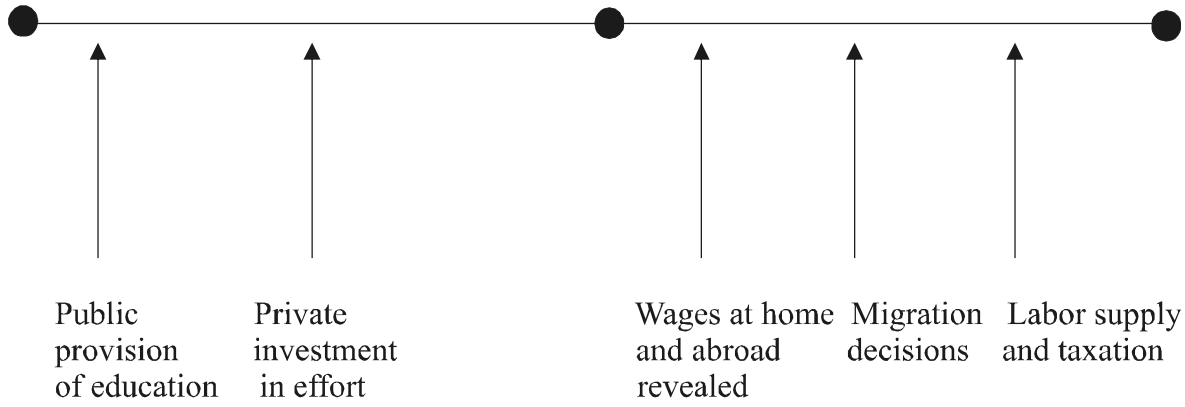

Figure 1: The timing of actions.

services but be paid more than their outside option.

The timing of actions is as follows. In the first stage, national governments decide what type of education they provide to their citizens. In the second stage, those becoming educated decide on their investment in effort. The first and the second stage take place during the first period. In the third stage, at the beginning of the second period, the educated learn what would be their labor market option at the home country and, if they have internationally applicable education, in the other member state. In the fourth stage, those with internationally applicable skills decide whether to migrate or not. In the fifth and final stage, the educated supply labor and pay taxes, and the government collects wage taxes, pays the debt accumulated in the first period to finance education, and uses the rest of the tax revenue to pay salaries for civil servants. The timing of actions is denoted as Figure 1.

2.2. Production

The production function is linear in the two types of human capital, with effective human capital defined below in section 2.5. Without loss of generality, it is assumed that productivity in member state B is fraction x, $0 < x \leq 1$, of productivity in member state B. This formulation allows for both a symmetric and an asymmetric federation.

Citizens differ in their productivity if they would complete education i, while they

have identical productivity if they would complete education s. Human capital of type i is a joint product of teaching and studying.[4] For a citizen with ability a and individual effort e, the individual human capital stock is before eventual migration

$$h_i(a, e) = a + e. \tag{1}$$

Human capital with education of type s is for all individuals normalized to unity: $h_s(a) = 1$.

The monetarized cost of effort e is $\frac{1}{2}\beta e^2$. This formulation of an increasing marginal cost guarantees a bounded investment in e. The resource cost for universities of education $k, k \in \{i, s\}$, is c_k in member state A and xc_k in member state B. The assumption that the government's costs of providing education in member state B are a multiplicative x of those in state A captures the stylized fact that as a significant part of the costs of providing education are wage costs, an increase in the general level of productivity also causes an increase in the cost of providing education.

Uncertainty related to returns to internationally applicable education takes a multiplicative form. Uncertainty is independently and identically distributed for each individual. We denote random factor for individual j by z_A^j in country A and z_B^j in country B. From now on, individual-specific indices will be omitted. For simplicity, z follows uniform distribution on unit interval in both countries for each individual. Random factors in the two countries are independent, and they could be interpreted as labor market uncertainty. In both countries, only fraction γ of human capital stock created in the other country is applicable.

Ability a follows, in both member states, a continuous distribution between 0 and $\overline{a}$, with density function $f(a)$ and cumulative distribution function $F(a)$. It is assumed that parameter values are such that both governments invest in both types of human capital. The utility of the educated is linear in their consumption, net of the monetarized effort cost of investment in education, and all consumption takes place in the second

[4] All results would hold if also human capital of type s would be a joint product of teaching and studying.

period.

2.3. Migration

An individual with internationally applicable education migrates from country A to country B if and only if

$$\gamma x z_B > z_A, \tag{2}$$

in which z_A denotes the rate of return to human capital if staying in A, and $\gamma x z_B$ denotes the rate of return to human capital available if migrating to B. The return to human capital in B is the product of the individual-specific labor market outcome parameter z_B, general productivity level x in B, and parameter γ which reflects to which extent human capital from one member state is applicable in another. Correspondingly, an individual with internationally applicable education migrates from country B to country A if and only if

$$\gamma z_A > x z_B. \tag{3}$$

The following Lemma is proved in the Appendix:

Lemma 1 *The probability that a citizen with education i migrates from A to B is $p_A = \frac{\gamma x}{2}$. The probability that a citizen with education i migrates from B to A, p_B, equals $\frac{\gamma}{2x}$ if $x \geq \gamma$ and $1 - \frac{x}{2\gamma}$ if $x < \gamma$. The average wage of those natives with education i who stay in A is:*

$$w_A^N = \frac{3 - \gamma^2 x^2}{6 - 3\gamma x}$$

and the average wage of those natives with education i who stay in B is

$$w_B^N = \begin{array}{c} x\frac{3-\gamma^2/x^2}{6-3\gamma/x} \text{ if } x \geq \gamma \\ \frac{2x}{3}, \text{ if } x < \gamma \end{array}.$$

The average wage rate of natives with education i from A who migrate to B is

$$w_B^M = \frac{2\gamma x}{3},$$

and the average wage rate of natives with education i from B who migrate to A is

$$w_A^M = \begin{array}{c} \frac{2\gamma}{3} \text{ if } x \geq \gamma \\ \frac{3\gamma^2 - x^2}{6\gamma - 3x}, \text{ if } x < \gamma \end{array}.$$

2.4. Private investment in education

A student in education i in member state A chooses private effort e_A to maximize

$$\rho(1-\tau)(1-p_A)(a+e_A)w_A^N + \rho(1-\tau)p_A(a+e_A)w_B^M - \frac{1}{2}\beta e_A^2.$$

The first two terms are the discounted value of the expected future after-tax income, with an individual discount factor ρ, $0 < \rho \leq 1$. The third term is the immediate effort cost. This formulation results in the optimal effort choice

$$e_A = \frac{(1-\tau)\rho((1-p_A)w_A^N + p_A w_B^M)}{\beta} = \frac{(1-\tau)\rho(3+\gamma^2 x^2)}{6\beta}. \tag{4}$$

Correspondingly, a student receiving education i in member state B would choose effort e_B to maximize

$$\rho(1-\tau)(1-p_B)(a+e_B)w_B^N + \rho(1-\tau)p_B(a+e_B)w_A^M - \frac{1}{2}\beta e_B^2,$$

resulting in the optimal effort choice in member state B

$$e_B = \frac{(1-\tau)\rho((1-p_B)w_B^N + p_B w_A^M)}{\beta} = \begin{array}{l} \frac{(1-\tau)\rho(3x+\frac{\gamma^2}{x})}{6\beta} \text{ if } x \geq \gamma \\ \frac{(1-\tau)\rho(\frac{x^2}{\gamma}+3\gamma)}{6\beta} \text{ if } x < \gamma \end{array}. \tag{5}$$

The equations (4) and (5) imply that the investment in effort by students receiving education i is increasing in x and in γ in both member states. Note also that $e_B < e_A$ when $x < 1$ and $\gamma < 1$. Thus, private effort invested in education is higher in the country in which production technology is more efficient if internationally applicable education is not fully applicable in the other member state. Higher applicability of internationally applicable education increases private investment in effort in both countries.

2.5. Public education and aggregate production

The government has access to entrance examinations which allow it to screen applicants to the ability-intensive education. While not used in all countries, entrance examinations or results from end-of-school tests are commonly used to select those who

are admitted. The cutoff level of ability chosen by the government j, $j \in \{A, B\}$, is denoted by a_j, below which citizens are educated in field s and above which in field i. Thus, the stock of human capital s in member state j is $H_s^j = F(a_j)$, and the pre-migration stock of human capital i is in member state j

$$\widetilde{H}_i^j = \int_{a_j}^{1} f(a)ada + [1 - F(a_j)]\, e_j.$$

The first term on the right-hand side reports that part of pre-migration human capital i which depends on individual ability, and the second term the part determined by individual effort. Post-migration internationally applicable effective stock of human capital in member state j consists of share $(1 - p_j)$ of domestically created human capital with average wage rate w_j^N and human capital of those who have immigrated from member state k, $k \neq j$, with average wage rate w_j^M:

$$H_i^j = (1 - p_j) w_j^N \widetilde{H}_i^j + p_k w_j^M \widetilde{H}_i^k.$$

The government in each member state collects wage taxes at rate τ_w and graduate taxes at rate τ_g from the educated to finance exogenous public consumption G_j, public education, and the budget-balancing endogenous transfer, T_j, to some or all of citizens with country-specific skills.[5] The government's intertemporal budget constraint reads in member state A as

$$\begin{aligned} & \rho\tau_w(H_s^A + H_i^A) + \rho\tau_g[H_s^A + (1 - p_A) w_A^N \widetilde{H}_i^A + p_A w_B^M \widetilde{H}_i^A)] \\ = \;& \rho G_A + c_s F(\widehat{a}_A) + c_i(1 - F(\widehat{a}_A)) + \rho T_A \end{aligned}$$

and in member state B as

$$\begin{aligned} & \rho\tau_w(xH_s^B + H_i^B) + \rho\tau_g[xH_s^B + (1 - p_B) w_B^N \widetilde{H}_i^B + p_B w_A^M \widetilde{H}_i^B)] \\ = \;& \rho G_B + xc_s F(\widehat{a}_B) + xc_i(1 - F(\widehat{a}_B)) + \rho T_B. \end{aligned}$$

[5] Assuming the government to distribute the budget surplus to all citizens would complicate migration decisions, tilting migration somewhat towards the country with higher budget surplus. With symmetric member states, the budget surplus per citizen would be identical in equilibrium, and would thus not distort migration. Finally, note that exogenous public consumption can be set at a level in which transfers are initially zero.

The left-hand side is the government budget revenue. The first term gives wage tax revenue from the educated residing in the country, and the second term graduate tax revenue from those who received their education in the country. The right-hand side reports the expenditures, consisting of the exogenous revenue requirement, the costs of providing the two types of education, and the budget-balancing endogenous transfer, T_j. All second-period expenses are discounted to the first period, using the same discount factor ρ as citizens use.

Even when restricting the analysis to a utilitarian government, one has to specify to what extent the government values the utility of emigrants and immigrants. The analysis proceeds under the following assumptions. The government values the after-tax income of its emigrating citizens, compared to the income of remaining citizens, at rate α, $0 \leq \alpha \leq 1$. The government weights the graduate tax revenue that it is able to collect from emigrants in the same way as it values the income of its remaining citizens. The privately chosen effort cost of students with internationally applicable education does not enter into government decision-making. The government attaches a zero weight to immigrants.[6] The social welfare function is given by

$$SWF_A = \rho \left[(1-\tau) H_s^A + (1-p_A)(1-\tau) w_A^N \widetilde{H}_i^A + \alpha p_A (1-\tau) w_B^M \widetilde{H}_i^A + T_A \right].$$

The first two terms inside the brackets give the after-tax income of the educated who stay, the third term is the social valuation of the utility of the educated who emigrate, and the fourth term is the transfer. Correspondingly, for member state B

$$SWF_B = \rho \left[(1-\tau) x H_s^B + (1-p_B)(1-\tau) w_B^N \widetilde{H}_i^B + \alpha p_B (1-\tau) w_A^M \widetilde{H}_i^B + T_B \right].$$

[6]Importantly, the results are independent of whether the government also values the utility of immigrants or not. The assumption of zero weight simplifies notation.

3. Results

3.1. International applicability and education policy

Governments choose the cutoff levels of ability that maximize their objective functions. Differentiating SWF_A with respect to a_A gives as the first-order condition

$$\rho - c_s = \rho \left[(1-p_A)w_A^N + p_A w_B^M (1-\tau)\alpha + p_A w_B^M \tau_g\right](a_A + e_A) - c_i.$$

On the left-hand side, we have the marginal social benefit of a student receiving country-specific education. This is independent of ability. On the right-hand side, we have the expected marginal social benefit of a student receiving internationally applicable education. This value is increasing in the student's ability. The first-order condition allows us to solve for the cutoff level of ability below which the government provides country-specific education, and above which internationally applicable education:

$$\widehat{a}_A = \frac{\rho - c_s + c_i}{\rho\left[(1-p_A)w_A^N + p_A w_B^M (1-\tau)\alpha + p_A w_B^M \tau_g\right]} - e_A. \tag{6}$$

Comparative statics yield that investment in education i is increasing in c_s and α and decreasing in c_i and β, as $\partial e_A/\partial\beta < 0$. Correspondingly, the first-order condition of the SWF_B allows to solve as the cutoff ability level

$$\widehat{a}_B = \frac{x\rho - xc_s + xc_i}{\rho\left[(1-p_B)w_B^N + p_B w_A^M (1-\tau)\alpha + p_B w_A^M \tau_g\right]} - e_B. \tag{7}$$

An increase in international applicability of human capital encourages private investment in it. Given that private and public investments are complementary, this would leave the effect of an increased international applicability of education i on public investment in it a priori unclear. On one hand, brain drain effect would push the government to reduce public investment in it, while brain gain effect would render investing in it more attractive. Remarkably, the analysis based on equations (6) and (7) finds that the brain drain effect always dominates in public investment, provided that the government cares only about its citizens staying and there are no graduate taxes:

Proposition 1 *If the governments attach a zero weight on emigrants and there are no graduate taxes, then governments always reduce investment in internationally applicable education when its applicability increases.*

Proof. See Appendix. ■

With current tax rules in the European Union, incentives of citizens and those of governments would diverge if, e.g., Bologna process leads into increased international applicability of education. Students would find incentives to study more in internationally applicable degree programs, thanks to an increase in the expected earnings elsewhere. Governments, on the other hand, would face incentives to educate students to stay, by offering too few internationally applicable education, and too many country-specific skills. Similar logic applies to other publicly supported investments in internationally mobile capital, like R&D. Knowledge spillovers between member states imply that decentralized investments are likely to be inefficiently low. Due to the presence of the brain gain effect, however, the aggregate stock of internationally applicable human capital may either increase or decrease when its international applicability increases:

Proposition 2 *If the governments attach a zero weight on emigrants and there are no graduate taxes, then an increase in the applicability of internationally applicable education may result in either a larger or smaller pre-migration stock of it.*

Proof. See Appendix. ■

The proof of Proposition 2 suggests that in addition to the cost of private effort, β, also ability distribution plays an important role in determining whether an increase in international applicability of internationally applicable human capital increases or decreases its formation. The intuition is as follows. If the density of abilities around the cutoff level above which the government provides internationally applicable education is low, then the negative effect at the extensive margin from reduced public provision is small, and the positive effect from the increased private effort at the intensive margin dominates. On the other hand, if the density of abilities around the cutoff level is high,

then an increase in the minimum ability above which the government provides internationally applicable education excludes a large number of students, and the extensive margin may dominate.

The results of this analysis arise from a common labor market of two countries, whether the countries are symmetric or not. Previous literature on brain drain and brain gain has focused on migration from a less developed country to a more developed country. (See Mountford (1997), Stark et al. (1997), Beine et al. (2001) and Stark and Wang (2002))

Importantly, an increased mobility of labor need not always reduce total resources used to finance education. Whether this is the case or not depends on which type of education is more expensive. Also when internationally applicable education is less expensive, an increased probability of migration reduces individual government's incentives to invest in it.

When the government attaches the same weight to emigrants as to citizens staying, increased mobility may lead to either a larger or smaller investment in internationally applicable education. On the one hand, efficiency gains from brain exchange for emigrants encourage governments to invest more in internationally applicable education. On the other hand, governments are pushed toward less investment because they lose tax revenue from emigrants.

Proposition 3 *If the governments attach a sufficiently high weight on emigrants, they may increase investment in internationally applicable education when its applicability increases, provided that wage tax rate is not too high.*

Proof. To prove that investments in education may increase, set $\tau_w = 0$, $c_s = c_i$, $x = 1$ and $\alpha = 1$ in (6), after inserting (4). Then differentiating yields $\partial \widehat{a}_A / \partial \gamma < 0$. ■

3.2. Welfare effects of graduate taxes

Previous subsection showed that public provision of internationally applicable education tends to be reduced at the very time its international applicability increases. By

giving the member states that provided internationally applicable education a stake also in efficiency gains created elsewhere, a graduate tax allows to alleviate such problem:

Proposition 4 *Governments invest more in internationally applicable education with graduate taxes than with only domicile-based taxation. Investment in internationally applicable education is increasing in the graduate tax rate.*

Proof. Insert (4) into (6) and (5) into (7). The first terms on the right-hand side of the resulting expressions are decreasing in τ_g, while the second terms are independent of it. ■

Notice that this result is independent of the weight assigned to emigrants, and of the relative importance of private investment in effort. A central result is then:

Proposition 5 *Allowing member states to levy graduate taxes is welfare improving.*

Proof. See Appendix. ■

With benevolent governments analyzed so far, there would be no efficiency justification for a system of voluntary income-contingent loans, as opposed to compulsory system of graduate taxes, collected independently of domicile. Nonetheless, there are three reasons why a system of income-contingent loans might be preferable. First, voluntary contracts on income-contingent loans would protect citizens against Leviathan governments. Second, even benevolent governments may suffer from time-consistency problem. Andersson and Konrad (2003) and Thum and Uebelmesser (2003) suggest that labor mobility could increase investment in education as it serves as a commitment device to low taxation. Such mechanism could be preserved with voluntary income-contingent loans, but not with graduate taxes that could not be avoided. Third, Keen and Kotsogiannis (2002) argue that fiscal federalism may lead to overtaxation when several jurisdictions draw on the same tax base, each causing a negative externality to each other by increasing distortions arising from taxation. Also this could be avoided by relying on voluntary income-contingent loans, giving students an option to opt out of unattractive arrangements suggested by their government. The idea is not new in

the absence of migration: already Friedman and Kuznets (1945) suggested financing professional education by students selling shares in their future earnings.

4. Conclusion

This paper shows that decentralized decision-making encourages the member states of the European Union to distort the provision of public education away from internationally applicable education, toward country-specific skills. If governments focus on the utility of those citizens (and voters) who stay and there are no graduate taxes, the governments reduce the provision of internationally applicable education when its applicability increases, at the same time as students increase complementary private investment in effort. As a remedy, this study suggests introducing graduate taxes or income-contingent loans, paid according to the same rules independently of future domicile. Giving member states a stake in efficiency gains earned elsewhere would serve as a Pigouvian subsidy, encouraging governments to invest more in human capital benefiting also the other member states.

This analysis relies on several simplifying assumptions. The assumption that production technologies are linear should not affect any qualitative results. This paper analyzes the effects of marginal changes in international applicability or graduate tax rates. Any changes in the relative wage rates are induced effects of changes in the relative stocks, and are thus induced second-order effects. A quantitative analysis of non-marginal changes should, naturally, aim at capturing complementarities and substitutabilities in production. Furthermore, it was assumed that students are risk-neutral. Risk aversion on the part of students could provide an efficiency justification for public provision of education in the first place. Another topic for further research is to model imperfectly competitive labor markets. With labor unions aiming at compressing the wage distribution, an increase in the marginal productivity of one worker need not be fully reflected in his or her wage rate. Also this could provide an efficiency motivation for public participation in financing education.

Perhaps the most important assumption is that the governments are benevolent, and

do not suffer from the time-consistency problem. Tax rates are taken as given, following Keen and Marchand (1997). Endogenizing tax rates is left for future research. In the analyzed model with benevolent governments and without the commitment problem, there is no motivation for relying on income-contingent loans, as opposed to graduate taxes. Allowing for a commitment problem or governments which are not entirely benevolent would likely change this. In a world where the benevolence of governments is not universally guaranteed, constitutional design has to trade-off the adverse selection problem and the need to tame Leviathan governments. Accepting a certain degree of adverse selection would then be optimal, and could be interpreted as a federation's insurance premium against potential abuses by governments. Voluntary contracts would also solve the time-consistency problem that may arise even when governments are benevolent.

Appendix A.

Proof of Lemma 1.

Migration probability p_A follows from (2) when taking into account that z_A and z_B are distributed uniformly between 0 and 1 independently of each other:

$$p_A = \int_{z_A=0}^{\gamma x} P(z_A < \gamma x z_B) dz_A = \frac{\gamma x}{2}.$$

Migration probability p_B can be solved similarly from (3). However, the probability has to be solved separately when $x \geq \gamma$ and when $x < \gamma$:

$$p_B = \begin{array}{c} \int_{z_B=0}^{\gamma/x} P(x z_B < \gamma z_A) dz_B = \frac{\gamma}{2x}, \text{ when } x \geq \gamma \\ \int_{z_B=0}^{1} P(x z_B < \gamma z_A) dz_B = 1 - \frac{x}{2\gamma}, \text{ when } x < \gamma \end{array}.$$

The average wage of those natives who stay in A is:

$$w_A^N = \frac{1}{1-p_A}\left[\int_{z_A=0}^{\gamma x} z_A P(z_A \geq \gamma x z_B) dz_A + \int_{z_A=\gamma x}^{1} z_A dz_A\right] = \frac{3-\gamma^2 x^2}{6-3\gamma x}.$$

The average wage of those natives who stay in B is when $x \geq \gamma$:

$$w_B^N = \frac{x}{1-p_B}\left[\int_{z_B=0}^{\gamma/x} z_B P(x z_B \geq \gamma z_A) dz_B + \int_{z_B=\gamma/x}^{1} z_B dz_B\right] = x\frac{3-\gamma^2/x^2}{6-3\gamma/x}.$$

The average wage of those natives who stay in B is when $x < \gamma$:

$$w_B^N = \frac{x}{1-p_B}\int_{z_B=0}^{1} z_B P(xz_B \geq \gamma z_A)dz_B = \frac{2x}{3}.$$

When calculating the average wage rate of migrants from A to B, notice that the average wage rate corresponding to migration with any value of z_A is the average between this wage rate and the highest wage rate that migrants can reach in B, namely γx. The average wage rate of natives from A who migrate to B is thus

$$w_B^M = \frac{1}{p_A}\int_{z_A=0}^{\gamma x} \frac{z_A+\gamma x}{2} P(z_A < \gamma x z_B)dz_A = \frac{2\gamma x}{3}.$$

The average wage rate of natives from B who migrate to A is when $x \geq \gamma$:

$$w_A^M = \frac{1}{p_B}\int_{z_B=0}^{\gamma/x} \frac{z_B x+\gamma}{2} P(\gamma z_A > x z_B)dz_B = \frac{2\gamma}{3}$$

and when $x < \gamma$:

$$w_A^M = \frac{1}{p_B}\int_{z_B=0}^{1} \frac{z_B x+\gamma}{2} P(\gamma z_A > x z_B)dz_B = \frac{3\gamma^2-x^2}{6\gamma-3x}.$$

Proof of Proposition 1.

Analyze first policy in country A. Using Lemma 1, inserting (4) and setting $\alpha = 0$ and $\tau_g = 0$ in (6),

$$\widehat{a}_A = \frac{6(\rho - c_s + c_i)}{\rho(3-\gamma^2x^2)} - \frac{(1-\tau)\rho(3+\gamma^2x^2)}{6\beta}. \tag{A1}$$

Differentiate

$$\frac{\partial \widehat{a}_A}{\partial \gamma} = \frac{12\gamma x^2(\rho - c_s + c_i)}{\rho(3-\gamma^2x^2)^2} - \frac{2\gamma x^2(1-\tau)\rho}{6\beta}. \tag{A2}$$

Notice that when both types of education are provided, social surplus from providing education s has to exceed that from providing education i with $a = 0$. By (A1),

$$\frac{6(\rho - c_s + c_i)}{\rho(3-\gamma^2x^2)} > \frac{(1-\tau)\rho(3+\gamma^2x^2)}{6\beta}.$$

Evaluating the first term on the right-hand side of (A2) downwards, a sufficient condition for the right-hand side of (A2) to be positive is

$$\frac{(1-\tau)\rho(3+\gamma^2x^2)}{6\beta}\frac{2\gamma x^2}{(3-\gamma^2x^2)}-\frac{2\gamma x^2(1-\tau)\rho}{6\beta}>0.$$

Simplifying yields $\frac{3+\gamma^2x^2}{3-\gamma^2x^2}-1>0$. This holds always.

Analyze next policy in country B when $x\geq\gamma$. Using Lemma 1, inserting (5) and setting $\alpha=0$ and $\tau_g=0$ in (7),

$$\widehat{a}_B=\frac{6x(\rho-c_s+c_i)}{\rho(3x-\frac{\gamma^2}{x})}-\frac{(1-\tau)\rho(3x+\frac{\gamma^2}{x})}{6\beta}.$$

Differentiate

$$\frac{\partial\widehat{a}_B}{\partial\gamma}=\frac{12\gamma(\rho-c_s+c_i)}{\rho(3x-\frac{\gamma^2}{x})^2}-\frac{2\frac{\gamma}{x}(1-\tau)\rho}{6\beta}. \tag{A3}$$

Use again the requirement that when both types of education are provided, social surplus from providing education s has to exceed that from providing education i with $a=0$. Thus, a sufficient condition to (A3) to be positive is that

$$\frac{(1-\tau)\rho(3x+\frac{\gamma^2}{x})}{6\beta}\frac{2\frac{\gamma}{x}}{(3x-\frac{\gamma^2}{x})}-\frac{2\frac{\gamma}{x}(1-\tau)\rho}{6\beta}>0.$$

Simplifying yields $\frac{3x+\frac{\gamma^2}{x}}{3x-\frac{\gamma^2}{x}}-1>0$. Also this always holds.

Assume finally that $x<\gamma$. Using Lemma 1, inserting (5) and setting $\alpha=0$ and $\tau_g=0$ in (7),

$$\widehat{a}_B=\frac{3\gamma(\rho-c_s+c_i)}{\rho x}-\frac{(1-\tau)\rho(\frac{x^2}{\gamma}+3\gamma)}{6\beta}.$$

Differentiate

$$\frac{\partial\widehat{a}_B}{\partial\gamma}=\frac{3(\rho-c_s+c_i)}{\rho x}-\frac{(1-\tau)\rho(-\frac{x^2}{\gamma^2}+3)}{6\beta} \tag{A4}$$

Use again the requirement that when both types of education are provided, social surplus from providing education s has to exceed that from providing education i with $a=0$. Thus, a sufficient condition to (A4) to be positive is that

$$\frac{(1-\tau)\rho(\frac{x^2}{\gamma^2}+3)}{6\beta}-\frac{(1-\tau)\rho(-\frac{x^2}{\gamma^2}+3)}{6\beta}>0.$$

Simplifying we see that this always holds.

Proof of Proposition 2.

To prove the existence of both claimed situations, if suffices to prove that either can arise if $x \geq \gamma$. It is useful to write the stock of internationally applicable human capital explicitly as a function of γ :

$$\begin{aligned}
\widetilde{H}_i^A &= \int_{\widehat{a}_A(\gamma)}^1 f(a)ada + [1 - F(\widehat{a}_A(\gamma))] \frac{(1-\tau)\rho(3+\gamma^2 x^2)}{6\beta} \\
\widetilde{H}_i^B &= \int_{\widehat{a}_B(\gamma)}^1 f(a)ada + [1 - F(\widehat{a}_B(\gamma))] \frac{(1-\tau)\rho(3x+\frac{\gamma^2}{x})}{6\beta}.
\end{aligned}$$

Differentiation with respect to γ yields

$$\begin{aligned}
\frac{\partial \widetilde{H}_i^A}{\partial \gamma} &= \left[-\widehat{a}_A(\gamma) - \frac{(1-\tau)\rho(3+\gamma^2 x^2)}{6\beta}\right] f(\widehat{a}_A(\gamma)) \frac{\partial \widehat{a}_A(\gamma)}{\partial \gamma} \\
&\quad + [1 - F(\widehat{a}_A(\gamma))] \frac{(1-\tau)\rho\gamma x^2}{3\beta} \\
\frac{\partial \widetilde{H}_i^B}{\partial \gamma} &= \left[-\widehat{a}_B(\gamma) - \frac{(1-\tau)\rho(3x+\frac{\gamma^2}{x})}{6\beta}\right] f(\widehat{a}_B(\gamma)) \frac{\partial \widehat{a}_B(\gamma)}{\partial \gamma} \\
&\quad + [1 - F(\widehat{a}_B(\gamma))] \frac{(1-\tau)\rho\frac{\gamma}{x}}{3\beta}.
\end{aligned}$$

In both expressions, the first term on the right-hand side is negative as $\partial \widehat{a}_j(\gamma)/\partial\gamma > 0$ by Proposition 1 and the second positive. For $j \in \{A, B\}$, if $f(\widehat{a}_j(\gamma)) \to 0$, the first term vanishes. Then the second term dominates, and $\partial \widetilde{H}_i^j/\partial\gamma > 0$. If $\beta \to \infty$, then $\partial \widetilde{H}_i^j/\partial\gamma < 0$ by Proposition 1.

Proof of Proposition 5.

Welfare effects of education policy of either member state can be divided into internalized effects and externalities on the other member state. Country-specific education does not generate externalities, while internationally applicable education generates a positive externality to the other member state as the other member state benefits from migrants who pay wage taxes there. By Proposition 4, an increase in the graduate tax rate increases the provision of internationally applicable education. As either country could have left its education policy unchanged, both countries perceive their own social

welfare to increase as a result of providing more internationally applicable education. But as this increases also the welfare of the other member state, it clearly increases the sum of welfare in the two member states.

References

[1] Andersson, F. and K.A. Konrad. (2003). Globalization and Risky Human-Capital Investment. *International Tax and Public Finance* 10, 211-228.

[2] Beine, M., F. Docquier, and H. Rapoport. (2001). Brain Drain and Economic Growth: Theory and Evidence. *Journal of Development Economics* 64, 275-289.

[3] Bhagwati, J. and K. Hamada. (1974). The Brain-Drain, International Integration of Markets for Professionals and Unemployment. *Journal of Development Economics* 1, 19-42.

[4] Bhagwati, J. and K. Hamada. (1982). Tax Policy in the Presence of Emigration. *Journal of Public Economics* 18, 291-317.

[5] CSN (2006). http://www.csn.se/english/default.asp. Keyword "Repayers". Checked on November 27, 2006.

[6] Desai, M. A., D. Kapur and J. McHale. (2004). Sharing the Spoils: Taxing International Human Capital Flows. *International Tax and Public Finance* 11, 663-693.

[7] Docquier, F. and A. Marfouk. (2004). Measuring the International Mobility of Skilled Workers (1990-2000): Release 1.0. World Bank Policy Research Working Paper 3381.

[8] Eklund, K. (1998). *Jakten på den försvinnande skatten.* In Swedish. SNS Förlag, Stockholm.

[9] Friedman, M. and S. Kuznets. (1945). *Income from Individual Professional Practise*. NBER.

[10] Grubel, H.B. and A.D. Scott. (1966). The International Flow of Human Capital. *American Economic Review* 56, 268-274.

[11] Justman, M. and J. Thisse. (1997). Implications of the Mobility of Skilled Labor for Local Public Funding of Higher Education. *Economics Letters* 55, 409-412.

[12] Keen, M., and C. Kotsogiannis. (2002). Does Federalism Lead to Excessively High Taxes? *American Economic Review* 92, 363-370.

[13] Keen, M. and M. Marchand. (1997). Fiscal Competition and the Pattern of Public Spending. *Journal of Public Economics* 66, 33-53.

[14] Mountford, A. (1997). Can a Brain Drain be Good for Growth in the Source Economy? *Journal of Development Economics* 53, 287-303.

[15] OECD. (2004). Education at a Glance. 2004 edition, p. 230.

[16] Poutvaara, P. (2004). Educating Europe: Should Public Education be Financed with Graduate Taxes or Income-Contingent Loans? *CESifo Economic Studies* 50, 663-684.

[17] Richter, W.F. (2002). Social Security and Taxation of Labour Subject to Subsidiarity and Freedom of Movement. *Swedish Economic Policy Review* 9, 47-74.

[18] Sinn, H.-W. (1994). How Much Europe? Subsidiarity, Centralization and Fiscal Competition. *Scottish Journal of Political Economy* 41, 85-107.

[19] Stark, O., C. Helmenstein, and A. Prskawetz. (1997). A Brain Gain with a Brain Drain. *Economics Letters* 55, 227-234.

[20] Stark, O. and Y. Wang. (2002). Inducing Human Capital Formation: Migration as a Substitute for Subsidies. *Journal of Public Economics* 86, 29-46.

[21] Thum, C. and S. Uebelmesser. (2003). Mobility and the Role of Education as a Commitment Device. *International Tax and Public Finance* 10, 549-564.

[22] Tiebout, C.M. (1956). A Pure Theory of Local Expenditures. *Journal of Political Economy* 64, 416-424.

[23] Wildasin, D. E. (2000). Labor Market Integration, Investment in Risky Human Capital, and Fiscal Competition. *American Economic Review* 90 (1), 73-95.