Competition for the International Pool of Talents: Differentiated Education Policy and Need for Centralized Coordination

Alexander Haupt * Tim Krieger† Thomas Lange‡

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Abstract

We present a model of two countries competing for the international pool of talented students from the rest of the world and provide a rationale for the regional differentiation of higher education policy. We demonstrate that one

*University of Plymouth, Plymouth Business School, Drake Circus, Plymouth, Devon, PL4 8AA, UK; E-Mail: alexander.haupt@plymouth.ac.uk; Phone: +44 1752 585655

†University of Paderborn, Department of Economics, Warburger Str. 100, D-33098 Paderborn, Germany; E-mail: tim.krieger@notes.uni-paderborn.de; Phone: +49 5251 60 2117

‡ifo Institute for Economic Research Munich & University of Konstanz, Department of Economics, Box D133, D-78457 Konstanz, Germany; E-Mail: thomas.lange@uni-konstanz.de; Phone: +49 7531 88 2305

region will offer high quality at high costs for students – the most talented ones study in this country – while the other one provides lower quality charging lower tuition fees. Compared to a globally efficient education policy, the decentralized solution might not only imply an inefficient allocation of foreign students to the two regions, but also quality levels deviating from a centralized optimum. The results call for a coordination of the education of the pool of international students.

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1 Introduction

The ongoing internationalization of higher education implies a fundamental change and represents a significant challenge for national education policies within the OECD area. The number of international students (i.e. students enrolled abroad) grew considerably over the last thirty years and growth accelerated especially over the last couple of years. Since the year 2000, the number of foreign students within OECD countries increased by more than 50 percent. It is four top-destinations, namely the U.S., the UK, Germany and France hosting about half of the entire international student body. Besides Korea and Japan, France and Germany are also the largest sending countries. Overall, Asia is by far the largest region of origin of foreign students. Apart from students from the OECD members Korea and Japan, especially students from China and India largely contribute to the group of international students. With 15.4 (China) and 5.4 percent (India), they represent the largest group of students from OECD partner countries enrolled within the OECD.[1]

In this paper, we are especially interested in this last mentioned phenomenon. While there is a small group of (western OECD) countries hosting a majority of international students, there is a considerable share of students originating from non-OECD countries. We analyze the competition of two large countries for a pool of heterogenous students from 'the rest of the world (ROW)', by which we especially mean less developed countries here. Countries can set education quality and tuition fees to maximize the rent from educating foreign students. In general, a country might be interested in attracting students from abroad for example in order to overcome national bottlenecks in finding qualified students, raise additional tuition fee revenue, benefit from research output by foreign graduate students or positive spillovers from foreign to domestic students, the university or the society as a whole.[2] Furthermore, given that part of the foreign students stays in their host country as graduates (see e.g. Baruch et al., 2007, Dreher and Poutvaara, 2005, Finn, 2003), makes attracting students a strategy to attract high skilled human capital. The fact that several OECD countries actually take measures (for example with regard to residency issues) to promote foreign students' national labor market access after graduation (see e.g. Tremblay, 2005), indicates that countries are aware of this option. In this paper, the positive effect of student immigration is mainly due to

[1]See OECD (2008, ch. C3).

[2]See for example Throsby (1991, 1998) for some cost-benefit considerations in the context of foreign student enrollment.

income tax revenue from those students who stay in the host country as graduates. The immigration policy is treated as exogenous.

Our analysis is intended to contribute to the literature on local public education policy with inter-regionally mobile students. In a fiscal competition setting, Del Rey (2001) demonstrates that countries tend to underinvest in public education if foreign students can free-ride the local education system, especially as they are all assumed to return to their country of origin after graduation and therefore do not pay income taxes in the host country. Buettner and Schwager (2004) state that positive external effects on non-resident students may cause local underprovision if policy makers only consider native students' utility when deciding on education quality. This justifies a tuition fee set on the federal level which effectively increases the incentive to provide quality in order to attract students who pay these fees. A contribution coming closer to our model is presented by Boadway et al. (1996). They analyze the competition of two private institutions by quality investments and tuition fees. In a symmetric equilibrium, these institutions may spend an inefficiently large amount of resources in order to attract students. While we will also consider both competition in prices (i.e. tuition fees) and in quality, our focus is on public higher education, implying that decision makers also account for expected benefits from graduates staying in the host country after graduation in the form of income tax revenue. A further important difference between our approach and the studies mentioned so far, is that the two countries in our model compete for the students from a *third* country (ROW) and not the students from the competitor's country while trying to retain domestic students. If ROW students do not have any ex ante country-specific preferences for one of the two regions and if both regions are exactly identical, students actually have to be regarded as perfectly mobile when it comes to their decision on the location of education. They will then only consider quality and tuition fee differences. As a consequence, a symmetric equilibrium will not exist and we will end up with one country providing higher quality and charging higher tuition fees than the other country, thereby also attracting the most talented students. The reason is that a differentiated policy effectively prevents a ruinous competition for the perfectly mobile pool of international talents.[3] Studies on the funding of higher education at the presence of student mobility also point to a potential differentiation, for example in tuition policy. However they usually assume an ex ante asymmetry in quality levels (e.g. Demange et al., 2008a,b and Fethke, 2005). In a model with imperfectly mobile households and capital mobility, Hoyt and Jensen (2001) provide a rationale for two cities offering differentiated public school quality which is financed by property tax revenue: the quality differentiation increases individuals' attachment to their residence and reduces cities' competition making both cities better off. De Fraja and Iossa (2002) analyze the competition of two ex ante identical universities within a country, which receive a fixed budget by the government and try to maximize their institution's 'prestige' by setting student admission standards. Only with low student mobility, a symmetric solution will exist. For high student mobility, if there is an equilibrium at all, it will be asymmetric

[3]As for example demonstrated by Boadway et al. (1996), asymmetric equilibria might also emerge in models with imperfect student mobility. However, and this is the main difference, in our setting an asymmetric equilibrium might be the only equilibrium that exists.

implying one university becoming an elite institution, setting higher standards and attracting only the best students.

We find that countries will provide a differentiated education policy in the competition for the international pool of talents. However, the allocation of students to the two countries is presumably inefficient and countries spend either too many or too little resources on education quality.

The paper is organized as follows. Section 2 sets up the basic model and analyzes a two-stage Nash competition in education quality and tuition fees. Section 2.3 presents some efficiency considerations and evaluates the decentralized equilibrium accordingly. The final section 3 concludes by briefly discussing our approach and some implications of results.

2 The model

The basic structure of our model is inspired by the IO models of vertical product differentiation.[4] An application to public finance which is partially comparable to our approach was recently presented by Zissimos and Wooders (2008). In a two-country model they analyze a two-stage Nash competition for firm settlements by means of production cost reducing public good provision and tax policy. When firms only differ in technology but do not have any ex ante country-specific location preferences, the decentralized equilibrium is characterized by differentiated public

[4]Shaked and Sutton (1982) is one of the standard references in this context. Tirole (1998, ch. 7.5.1) provides some plain textbook model based on this.

good and tax policy. An undifferentiated public good provision would imply fierce tax competition leaving both countries worse off. Within the context of our model, we will also demonstrate that the decentralized equilibrium is asymmetric, implying that one country provides higher education quality than the other.

2.1 Basic setting

Suppose there is a group of students from ROW with a high emigration propensity who want to study in one of two ex ante identical large (e.g. western industrialized) countries denoted by 1 and 2. We will refer to this group as the international pool of talents. Students are assumed to be heterogenous with respect to talent represented by parameter a, which is uniformly distributed over the unit interval and which captures an individual's capacity to exploit education quality. Students allocate themselves to the two regions in order to maximize their expected net benefit from studying abroad. Thereby, they consider expected net labor income as skilled workers in the future and fees to be payed for tuition. Net labor income in a western region consists of some base salary $\underline{w}$ and an education premium related to quality of education $q_i \geq \underline{q} > 0$, provided by region i, and individual talent to acquire human capital a. Talent and university quality are assumed to be complementary in the production of the education premium. Labor income is taxed at an exogenous rate τ. While assuming that labor incomes in the western regions exceed those in ROW, there might be some non-economic reasons for foreign students to return to their home countries as graduates. We capture this by an exogenous repatriation rate $(1-v)$ with v as the stay rate in the host region. Repatriation motives which are considered to be exogenous in our model are for example failure of social integration in the host country, private (e.g. family) issues in the country of origin, homesickness, problems with regard to the change of status from student to permanent immigrant in the host country, or labor market frictions. Repatriates are assumed to earn a fraction $\gamma < 1$ of western labor income in their home countries. At the student migration stage, individuals already anticipate that they will stay in the host country only with probability v, however information on whether they belong to the group of repatriates is not revealed before graduation. Expected net labor income of a graduate of type a then is

$$\mathrm{E}\{w_a\} = \rho(\underline{w} + aq_i), \quad \rho := v(1-\tau) + (1-v)(1-\tau_{\mathrm{ROW}})\gamma.$$

A student's choice of the location of education is determined by expected income given quality levels of the educational systems in both countries and tuition fees t_i. We do not restrict tuition fees to be positive, but perceive t_i as a net measure of tuition fees and subsidies per student. The student who is exactly indifferent between studying in one of both regions has talent $\hat{a}$, which is given by

$$\rho(\underline{w} + \hat{a}q_1) - t_1 = \rho(\underline{w} + \hat{a}q_2) - t_2 \qquad \Longleftrightarrow \qquad \hat{a} = \frac{t_2 - t_1}{\rho \Delta q}, \tag{1}$$

where $\Delta q = q_2 - q_1 \geq 0$ denotes the quality differential. Without loss of generality we suppose country 2 to have the high-quality education system. When it comes to the derivation of Nash equilibria in the education policy competition, however, we have to keep in mind that by simply reversing country indexes (remember that we assumed ex ante symmetric countries), we will get a second equilibrium beside the one presented in what follows. Highly talented students (i.e. those with $a > \hat{a}$) go for the high-quality educational system of region 2, while all others will allocate to region 1. Our migration model relies on some implicit assumptions. i) Ex ante, foreign students do not have any 'attachment' to one of the two regions (e.g. in the sense of country-specific preferences, existing social networks, language and geographical/cultural distance). ii) All students in the pool of talents can afford paying tuition fees when studying abroad (either because there are no credit constraints or because their initial endowment is sufficiently large). iii) Studying abroad is always preferred to studying/working in the country of origin.

The number of students in the low(er)-quality country 1 then is

$$\Psi_1 = N \times \begin{cases} \hat{a} & \text{if} \quad \hat{a} \in [0,1], \\ 1 & \text{if} \quad \hat{a} > 1, \\ 0 & \text{if} \quad \hat{a} < 0. \end{cases} \tag{2}$$

where $N > 0$ denotes the size of the pool of talents. The number of students in country 2 then is $\Psi_2 = N - \Psi_1$. For equal quality levels in both countries, i.e. $\Delta q = 0$, the size of the foreign student body in each country can no longer be determined by the migration decision as reflected by (1). As students are assumed not to have any a priori preference for one of the two large regions (in other words the pool of international students is perfectly mobile), for equal qualities, all students will go for the country charging lower tuition fees. If both countries offer an identical education package in terms of quality *and* tuition fees, students are assumed to allocate themselves randomly, both countries ending up with an overall number of foreign students of $N/2$ and facing identical demand from all ability types in the distribution of talents. I.e. for $\Delta q = 0$,

$$\Psi_i|_{(\Delta q=0)} = \begin{cases} 0 & \text{if} \quad t_i > t_j, \\ N/2 & \text{if} \quad t_i = t_j, \\ N & \text{if} \quad t_i < t_j, \quad i \neq j. \end{cases} \tag{3}$$

Governments in the large regions are supposed to maximize net benefits or rather rents from offering an international study program. We consider three components on the benefit side. i) The fraction v of foreign students who stay in the country of education as graduates generates tax revenue. We assume that income is proportionally taxed at rate τ. ii) Foreign students pay tuition fees. iii) As domestic students may also (at least partially) benefit from an investment in quality (e.g. in the sense of hiring good professors), we consider a corresponding spillover term $s(q_i)$ with $s_{q_i} := (\partial s / \partial q_i) > 0$, $i \in \{1, 2\}$. When a quality investment also increases domestic students' productivity, the government could for example consider the additional tax income from domestic workers in the future. So s could then for example be $s(q_i) = \delta v_d D \tau(\underline{w} + a_d^{av} q_i)$, where $\delta > 0$ captures the degree of the spillover, v_d is domestic students' stay rate, D is the size of the domestic student body and a_d^{av} is the domestic students' average talent.[5] From now on, like in this specification, we will assume that s_{q_i} is constant (i.e. $s_{q_i q_i} := (\partial^2 s / \partial q_i^2) = 0$). As it comes to the cost side, we assume that there are some variable costs $c(q_i) = \alpha q_i$, $\alpha \geq 0$, of providing quality per student and some fix costs $F(q_i)$ with $F_{q_i} := (\partial F / \partial q_i)$, $F_{q_i q_i} := (\partial^2 F / \partial q_i^2) > 0$.

[5] An implicit assumption here is that all domestic students study in their home country.

The objective function of government 1 then reads

$$R_1 = \tau W_1 + \Psi_1[t_1 - c(q_1)] + s(q_1) - F(q_1), \tag{4}$$

where the wage sum or rather the (foreign born) tax base is

$$W_1 = vN \int_0^{\hat{a}} (\underline{w} + aq_1)da = v\Psi_1 \left[\underline{w} + \frac{1}{2}\frac{(t_2 - t_1)}{\rho\Delta q} q_1\right],$$

so that the rent from educating foreign students can be explicitly decomposed in a variable part depending on the number of students on the one hand, and the spillover effect and fix costs which are independent of the number of foreign students on the other hand:

$$R_1 = \Psi_1 \left\{\lambda\underline{w} + \frac{\lambda}{2}\frac{(t_2 - t_1)}{\rho\Delta q} q_1 + [t_1 - c(q_1)]\right\} + s(q_1) - F(q_1); \quad \lambda := v\tau. \tag{5}$$

The parameter λ basically represents a country's effective rate of return to a marginal increase of a rise in foreign students' incomes. Analogously, the objective function for region 2 is given by

$$R_2 = \Psi_2 \left\{\lambda\underline{w} + \frac{\lambda}{2}\left(1 + \frac{t_2 - t_1}{\rho\Delta q}\right) q_2 + [t_2 - c(q_2)]\right\} + s(q_2) - F(q_2), \tag{6}$$

where we used

$$W_2 = vN \int_{\hat{a}}^{1} (\underline{w} + aq_2)da = v\Psi_2 \left[\underline{w} + \frac{1}{2}\left(1 + \frac{t_2 - t_1}{\rho\Delta q}\right) q_2\right].$$

2.2 Quality and tuition fee competition

We suppose both regions to engage in a two-stage Nash-type competition. In a first stage, both regions simultaneously choose quality levels q_i, while tuition fees t_i are determined in a second stage. This is consistent with the procedure not only in the standard IO models with price and quality competition, but also in the context of education policy, as for example in the analysis by Boadway et al. (1996) on private schools' quality and tuition fee competition. We solve the game recursively.

Stage 2: choice of tuition fees Region 1 chooses t_1 to maximize R_1 taking the other region's policy t_2 and quality levels (q_1, q_2), already determined at the first stage, as given. The corresponding first order condition is

$$-\left\{\lambda \underline{w} + \frac{\lambda}{2}\frac{(t_2 - t_1)}{\rho\Delta q}q_1 + [t_1 - c(q_1)]\right\}\frac{N}{\rho\Delta q} + \Psi_1\left(1 - \frac{\lambda q_1}{2\rho\Delta q}\right) = 0. \tag{7}$$

This condition captures the tradeoff between the marginal costs and benefits of charging tuition fees, considering the direct revenue effect and the effect on the number of students and therefore also the number of subsequent high skilled foreign workers supposed to be tax payers in the host country. The condition can be rewritten as

$$t_1\left(\frac{\lambda q_1}{\rho\Delta q} - 2\right) - t_2\left(\frac{\lambda q_1}{\rho\Delta q} - 1\right) - \lambda\underline{w} + c(q_1) = 0, \tag{8}$$

from which we can directly derive the best response function $t_1 = t_1^{\text{br}}(t_2; q_1, q_2)$

$$t_1 = \theta_1 t_2 + \frac{\lambda\underline{w} - c(q_1)}{\frac{\lambda q_1}{\rho\Delta q} - 2}; \quad \theta_1 := \frac{\frac{\lambda q_1}{\rho\Delta q} - 1}{\frac{\lambda q_1}{\rho\Delta q} - 2}. \tag{9}$$

The first order condition for the tuition fee chosen by region 2 and the best response function $t_2 = t_2^{\text{br}}(t_1; q_1, q_2)$ can analogously be determined as

$$t_1\left(\frac{\lambda q_2}{\rho\Delta q} + 1\right) - t_2\left(\frac{\lambda q_2}{\rho\Delta q} + 2\right) - \lambda\underline{w} + c(q_2) + \rho\Delta q = 0 \tag{10}$$

and

$$t_2 = \theta_2 t_1 + \frac{\rho\Delta q + c(q_2) - \lambda\underline{w}}{\frac{\lambda q_2}{\rho\Delta q} + 2}; \quad \theta_2 := \frac{\frac{\lambda q_2}{\rho\Delta q} + 1}{\frac{\lambda q_2}{\rho\Delta q} + 2}. \tag{11}$$

The equilibrium tuition fees (t_1^c, t_2^c) simultaneously solve $t_1^c = t_1^{\text{br}}(t_2^c; q_1, q_2)$ and $t_2^c = t_2^{\text{br}}(t_1^c; q_1, q_2)$ for given quality levels (q_1, q_2):

$$t_1^c = \frac{1}{1-\theta_1\theta_2}\left[\frac{\lambda\underline{w} - c(q_1)}{\frac{\lambda q_1}{\rho\Delta q} - 2} + \theta_1 \frac{\rho\Delta q + c(q_2) - \lambda\underline{w}}{\frac{\lambda q_2}{\rho\Delta q} + 2}\right], \tag{12}$$

$$t_2^c = \frac{1}{1-\theta_1\theta_2}\left[\theta_2 \frac{\lambda\underline{w} - c(q_1)}{\frac{\lambda q_1}{\rho\Delta q} - 2} + \frac{\rho\Delta q + c(q_2) - \lambda\underline{w}}{\frac{\lambda q_2}{\rho\Delta q} + 2}\right]. \tag{13}$$

The tuition fee differential (which can then be calculated from these expressions, using the definitions of θ_1 and θ_2 and simplifying)

$$(t_2^c - t_1^c) = \frac{\rho}{(\lambda + 3\rho)}[c(q_2) - c(q_1) + \rho\Delta q] = \frac{\rho\Delta q}{(\lambda + 3\rho)}(\alpha + \rho) > 0 \tag{14}$$

reflects the fact that the region providing higher quality also charges higher tuition fees. First of all this is because the country with the higher quality has a larger 'market power' allowing to charge higher fees, since for given tuition fees, the demand for an education system increases in its quality. Furthermore, the higher fees in country 2 reflect the higher costs per student which are (partially) passed on to students. The larger α, the more relevant becomes this effect and the higher the difference in tuition fees.

The second order conditions for optimal tuition fees in the two countries are

$$\lambda q_1 - 2\rho\Delta q < 0, \quad -\lambda q_2 - 2\rho\Delta q < 0. \tag{15}$$

In what follows, we assume the second order condition for the optimal t_1 (depending on the quality level in country 1 and the degree of quality differentiation between countries) to hold. The second order condition for t_2 holds anway.

Given $q_2 = q_1 = q$ as a hypothetical result on the first stage, countries will end up in an intense tuition fee competition for the entire pool of international students. This of course requires that there is something to gain from this policy (we will assume this to hold), i.e. for given tuition fees t, the expected future tax revenue plus the university profit (the variable part of a country's rent from educating foreign students, which we will denote by r_i, $i \in \{1, 2\}$, in what follows) must be larger or equal than zero:

$$r_i = \tau W_i + N[t_i - c(q)] \geq 0 \quad \Longleftrightarrow \quad \lambda(\underline{w} + q/2) + t_i - \alpha q \geq 0.$$

See that for $q_1 = q_2 = q$, the variable rent (i.e. the part of the rent depending on the number of foreign students)

$$r_i = \begin{cases} \tau W + N(t_i - c(q)) & \text{if} \quad t_i < t_j, \\ \frac{1}{2}[\tau W + N(t_i - c(q))] & \text{if} \quad t_i = t_j, \\ 0 & \text{if} \quad t_i > t_j, \end{cases}$$

where $W = vn \int_0^1 (\underline{w} + aq) da = vN(\underline{w} + q/2)$. The fix costs of providing quality are already sunk and therefore irrelevant for tuition fee competition. The same holds for the quality spillover. Countries have an incentive to undercut their competitor in order to attract all foreign students as long as r_i is still non-negative, thereby engaging in a race-to-the-bottom which results in tuition fees $t_1 = t_2 = \alpha q - \lambda(\underline{w} + q/2)$ in both countries, $r_i = 0$ and overall rents $R_i = s(q) - F(q)$. As tuition fees fall short of variable education costs per student $c(q) = \alpha q$, countries effectively subsidize the foreign students' education. See that we also do not restrict tuition fees to be positive here, but generally also allow for subsidies which might even exceed the per student cost of education in order to attract students.

Stage 1: choice of qualities At the first stage, regions decide on quality investments. Thereby, they anticipate the outcome of the tuition fee competition at the second stage. Given the equilibrium on stage 2, countries' objective functions are

$$R_i(q_1, q_2) = \begin{cases} r_i(q_1, q_2) + s(q_i) - F(q_i) & \text{if} \quad q_1 < q_2 \\ \\ s(q_i) - F(q_i) & \text{if} \quad q_1 = q_2, \quad i \in \{1, 2\} \end{cases} \tag{16}$$

where $r_i(q_1, q_2)$ denotes the variable part of country i's rent from educating foreign students given t_1^c and t_2^c from above for $\Delta q > 0$. With $q_1 = q_2$ we demonstrated this part of the rent to be reduced to zero due to fierce tuition fee competition. As we prove in the Appendix, $r_1(q_1, q_2)$ and $r_2(q_1, q_2)$ are both strictly positive and therefore $q_1 = q_2$ cannot be an equilibrium of the quality competition. We abstain from explicitly considering $q_1 > q_2$ here as well in favor of a more clear presentation of the main insight. First of all a symmetric solution would still be dominated by quality differentiation and second, with reversed country indexes and the symmetric country assumption, we can easily infer on a second Nash equilibrium later on from what we will present below.

An interior solution to a country's optimization problem balances marginal costs and benefits of providing education quality. Decision makers thereby consider not only direct effects but also the consequences of an increased number of students and therefore graduates on the benefit as well as on the cost side (cet. par. higher tax and tuition fee revenue vs. higher variable costs of tuition) and the effect on tuition fees $t_i^c(q_i)$ that can be charged in price competition on the subsequent stage of the game. The first order condition for the optimal quality level in region 1 then reads

$$\Psi_1(t_1^c, t_2^c)\left[\frac{\lambda}{2}\hat{a}(t_1^c, t_2^c) + t_{1q_1}^c - c_{q_1}\right] + s_{q_1} - F_{q_1} = 0, \tag{17}$$

where subscripts again denote first partial derivatives. This condition can be reduced to

$$-\frac{N}{2}\frac{(\lambda+2\rho)}{(\lambda+3\rho)^2}(\alpha+\rho)^2 + s_{q_1} - F_{q_1} = 0. \tag{18}$$

We denote the quality level solving this condition by q_1^*. The equilibrium quality therefore is $q_1^c = \max(\underline{q}, q_1^*)$, depending on whether the minimum-quality constraint is binding or not. Analogously, the first order condition for the optimal quality of education in region 2 is

$$\Psi_2(t_1^c, t_2^c)\left\{\frac{\lambda}{2}[1 + \hat{a}(t_1^c, t_2^c)] + t_{2q_2}^c - c_{q_2}\right\} + s_{q_2} - F_{q_2} = 0, \tag{19}$$

or rather

$$\frac{N}{2}\frac{(\lambda+2\rho)}{(\lambda+3\rho)^2}(\lambda+2\rho-\alpha)^2 + s_{q_2} - F_{q_2} = 0. \tag{20}$$

The quality level satisfying this condition is denoted by q_2^*. Comparing first order conditions for the quality levels in both countries immediately confirms that country 2 is the high-quality country, i.e. $q_2^* > q_1^*$. The equilibrium quality in region 2 is $q_2^c = \max(\underline{q}, q_2^*)$. Second order conditions for rent maximizing quality levels hold in both countries due to $F_{q_i q_i} > 0$.

The optimality conditions reveal that a marginal quality increase has a negative effect on the variable part of the rents in country 1, while it has a positive effect in country 2. This also implies that the degree of quality differentiation between both countries, i.e. Δq, increases in the size of the international pool of talents, which might be highlighted as especially interesting given the increasing trend of international student mobility (as reported by the OECD, 2008, ch. C3).

Given that the values for (q_1^c, q_2^c) as presented here are a Nash equilibrium in the quality competition game (and (t_1^c, t_2^c) on the tuition fee competition stage), as already mentioned before, there is a second equilibrium in which country indexes are reversed and country 1 is the high-quality country charging high(er) tuition fees. For what follows, we will stick to the scenario in which country 2 is the high-quality country.

2.3 Efficiency considerations

In this section we want to analyze whether the outcome of competitive education policy deviates from an 'efficient' solution considering the rents or rather utility of the agents involved within our model. Suppose a central planner who maximizes the joint rent, i.e. tax revenues in both countries, the profits of both universities, the expected utility of foreign students and the spillovers from quality investments within both countries net of fix costs of providing quality. He would allocate the students to both countries and determine quality levels in a way to maximize the following objective function. The planner's choice variables are indicated by an E.

$$\begin{aligned} Z &= (\lambda+\rho)N\left[\underline{w} + \frac{q_2^E}{2} - \frac{(\hat{a}^E)^2}{2}(q_2^E - q_1^E)\right] - N\alpha[q_2^E - \hat{a}^E(q_2^E - q_1^E)] \\ &\quad + \sum_{i\in\{1,2\}}[s(q_i^E) - F(q_i^E)]. \end{aligned} \tag{21}$$

The first order conditions for the optimal values of $\hat{a}^E$, q_1^E and q_2^E (provided there are interior solutions) are

$$\begin{aligned} -(\lambda+\rho)\hat{a}^E + \alpha &= 0 & (22)\\ \frac{(\lambda+\rho)N}{2}(\hat{a}^E)^2 - N\alpha\hat{a}^E + s_{q_1} - F_{q_1} &= 0 & (23)\\ \frac{(\lambda+\rho)N}{2}(1-(\hat{a}^E)^2) - N\alpha(1-\hat{a}^E) + s_{q_2} - F_{q_2} &= 0. & (24) \end{aligned}$$

At the solution values, the Hessian matrix of $Z = Z(\hat{a}^E, q_1^E, q_2^E)$ can easily be verified to be negative-definite, i.e. the solution really represents a local *maximum* of the objective function. Furthermore, using the optimal $\hat{a}^E$ in the first order conditions for the quality levels and comparing those, reveals after some manipulations that $q_2^E > q_1^E$ if $(\lambda+\rho-\alpha)^2 + \alpha^2 > 0$, which always holds.

See that if there were no variable costs of providing education quality (i.e. $\alpha = 0$), the central planner would allocate the entire pool of international students to one country, namely country 2. The reason is that students' labor incomes (and therefore tax revenue and students' utility) increase in quality, which is higher in country 2 than in country 1. Allocating students to region 1 would therefore reduce the overall rent. This is captured by the term $(\lambda+\rho)N(\hat{a}^E)^2(q_2^E - q_1^E)/2$ in the objective function Z. With positive variable costs ($\alpha > 0$), however, an allocation of students to country 1 becomes worthwhile, since lower quality also means lower costs per student (the cost saving is captured by $N\alpha\hat{a}^E(q_2^E - q_1^E)$). The optimal $\hat{a}^E$ balances both effects at the margin.

Comparing now the decentralized equilibrium $(t_1^c, t_2^c, p_1^*, p_2^*)$ derived before with the efficient solution, we can identify basically two potential sources of local outcome inefficiency.[6] First, as a result of the competition for students, see that the allocation to the two countries might not be optimal:

$$\hat{a} \begin{cases} \leq \hat{a}^E & \text{if} \quad \alpha \geq (\lambda+\rho)/2, \\ > \hat{a}^E & \text{if} \quad \alpha < (\lambda+\rho)/2. \end{cases} \tag{25}$$

Second, even for an efficient allocation of students, the decentralized equilibrium is inefficient.[7] Suppose that $\alpha = (\lambda + \rho)/2$ and therefore $\hat{a} = \hat{a}^E = 1/2$. From first order conditions for the quality level in country 2 then follows that $q_2 > q_2^E$. The high-quality country makes excessive use of resources in the competition for talented students and wastes resources compared to the efficient solution. The discrepancy originates from the fact that the marginal benefit from a quality increase in country 2 (for identical given marginal cost and for the identical marginal benefit in form of the attraction of students as taxpayers in the future – the identity is due to the equal number of students) differs between the local and the planner's perspective. While the local government considers the effect of a marginal quality increase on increased tuition revenue (represented by $2N\rho(\rho+\alpha)(1-\hat{a})(\lambda+3\rho)^{-1}$), the planner considers the increased utility of foreign students (represented by $N\rho(1-(\hat{a}^E)^2)/2$).

---

[6] For what follows, it is worthwile rewriting first order conditions for quality levels in the decentralization setting:

$$\begin{aligned} \frac{\lambda N}{2}\hat{a}^2 + \frac{N\rho(2\alpha-\rho-\lambda)}{(\lambda+3\rho)}\hat{a} - N\alpha\hat{a} + s_{q_1} - F_{q_1} &= 0, \\ \frac{\lambda N}{2}(1-\hat{a}^2) + \frac{2N\rho(\rho+\alpha)}{(\lambda+3\rho)}(1-\hat{a}) - N\alpha(1-\hat{a}) + s_{q_2} - F_{q_2} &= 0. \end{aligned}$$

[7] The Appendix presents some hints for the calculation of what follows.

At $\hat{a} = \hat{a}^E$, the incentive to increase quality in order to raise additional tuition revenue exceeds the incentive to do so in order to increase students' utility. This is not the case in the low-quality country. Comparing the first order condition of the efficient solution with the decentralized equilibrium, we find that country 1 spends too little resources on quality, i.e. $q_1 < q_1^E$.

What we assumed here is that the constraint $q_i \geq \underline{q}$ is binding neither in country 1 nor country 2. Especially in the low-quality country, the constraint might be considered to be more likely binding. From the first order conditions for q_1 or rather q_1^E we can directly infer that the quality level will be set to the minimum $\underline{q}$, if the spillover from the quality investment to domestic students is zero or rather is not too large. If the constraint is binding in the optimization of both the planner and the local decision maker in country 1, we end up with $q_1 = q_1^E = \underline{q}$.

If there were no variable costs of educating students (i.e. $\alpha = 0$), the number of students in high-quality country 2 would fall short of the efficient level. As illustrated before, the planner would allocate all students to the high-quality country. In the decentralized solution, however, there is also a demand for the low-quality education system in country 1. As can be easily verified, country 2 would then underinvest in education quality, i.e. $q_2 < q_2^E$. Given that the minimum quality constraint is not binding in any decision maker's optimization, country 1 would also spend too little resources on quality.

Overall, depending on the relevance of variable costs in education systems and the return migration propensities of the international students, education quality in both countries may either be too low or too high compared to the efficient solution.[8] Therefore, our model provides a justification for centralized/coordinated education policy. We will briefly elaborate on this in the concluding section below.

A further source of inefficiency could show up if the planner also considered the external effect of an increase of quality on the sending countries' tax base when part of the international students return, which we neglected here.

3 Discussion and concluding remarks

Our paper starts from the observation that a relatively small number of top-destinations for international students also host a considerable share of students from countries like China and India going for higher education in one of the western developed countries. We reduce this observation to a competition of two large western regions for the international pool of talents from a third region or rather ROW. As already argued, there are good reasons for host countries to attract those students by means of their education system. Especially the prospect of thereby attracting future high skilled individuals if some of the international students stay in their host countries deserves special attention. We find that ex ante identical countries will end up in an equilibrium characterized by differentiated education policy in the sense of one country offering a high-quality-high-price education for the most

[8] In both illustrating scenarios presented here, the result for quality in country 1 (given non-binding minimum quality constraint) was unambiguously underinvestment on the local level. However, without further assumptions we cannot exclude a possible overinvestment.

talented students while the other country charges lower tuition fees for a low(er)-quality education attracting less talented students. The differentiation is not due to an ex ante asymmetry of countries, but an outcome of the competition as presented in the course of the paper. Furthermore we argued that the allocation of students to the two regions and the locally chosen quality levels are inefficient.

In some sense, our analysis might be interpreted in the light of the competition of the U.S. or rather North America on the one side and Europe on the other side for the talents from ROW. While especially the U.S. – being much more successful in attracting the most talented students and skilled workers from all over the world – relies heavily on tuition fees in order to finance higher education, private funding plays a more subordinate role within the European countries. Furthermore, at least the top universities in the U.S. could be supposed to provide a comparatively high quality (according to the Shanghai ranking 2007 for example, there are 17 U.S. universities among the top 20 institutions worldwide[9]). Although our model does not exactly rebuild the Europe-vs-North America setting, as we analyze a pure *public* education policy competition, the rationale for quality differentiation should at least to some extent still hold. In a more privately organized education system, direct university profits might play a more dominant role (by the way see that the regions in our model consider profits as well). However there might also be some long-term perspective in private institution executives' decision making: while it is income tax revenues positively depending on students'/graduates'productivity in

[9]See http://www.arwu.org/.

our model, private universities might consider potential donations from students to their alma mater which probably also depend on graduates' incomes and which play a much more important role in North America than in Europe.

We should also mention that our extreme assumption of perfect student mobility might not hold in reality. If students in the international pool of talents had some country-specific preferences implying imperfect mobility, competition would be weakened and the quality differentiation might be less extreme. However, compared to a two-country setting in which each country tries to attract students from the other jurisdiction, students from a third country or rather ROW as in our model going for education in Europe, Australia or North America should have much weaker country-specific preferences in location choice.

While our analysis would justify a centralized policy when it comes to the education of the international pool of talents, the question of feasibility of such a policy arises. In a European context this is probably much easier than in a 'transatlantic' one. The European Union could be considered as the federal level to mitigate/abandon undesirable consequences of the competition for international students among member states. The usual concern that a centralized education policy threatens local cultural identities would not apply to the education of non-EU students, the more so as countries often offer special study programs for international students apart from the regular curriculum. A more severe problem might arises with regard to the question of which country/countries will be the high-quality one(s). If the differentiation of quality also implies regional inequality in rents from educating foreign students, there should be some compensating transfers between countries or maybe also some contribution by foreign students. From our model we cannot unambiguously conclude that the high-quality country will necessarily be better off than the low-quality one. Especially the specification of the cost of providing education quality and the allocation of students play an important role here. Last but not least, related to our definition of efficiency, the question arises whether the EU as the central planner would consider foreign students' utility. This presumes that the EU for example has some commitment to foreign aid which does not exist on a national level.

Our analysis points to some issues for future research. While we assumed simultaneous moves for example, there could also be a sequential decision on quality levels or rather entrance in the competition for international students (e.g. by launching international study programs). Countries then have an incentive to spend resources to lead the way and obtain a first-mover advantage by choosing the more profitable quality level. Furthermore, it would be worthwhile considering an endogenous immigration policy targeting stay rates of graduates. Countries could try to support the success of social integration and exert some effort to facilitate graduates' labor market access (e.g. by promoting permanent residency). More and more OECD countries already make use of this option and it would be interesting to elaborate more on the strategic aspects of immigration policy in the context of the competition for the international pool of talents. Including admission standards to the choice set of countries, like for example in De Fraja and Iossa (2002), might also enrich the analysis.

Appendix

Non-existence of an undifferentiated equilibrium (Section 2.2) We want to prove that $r_i(q_1, q_2) \equiv \tau W_i + \Psi_i[t_i - c(q_i)] > 0$, $i \in \{1, 2\}$. First of all, using the definitions for θ_1 and θ_2 we can rewrite equilibrium tuition fee levels t_1^c and t_2^c as follows:

$$
\begin{aligned}
t_1^c &= (\lambda + 3\rho)^{-1}\rho[\rho\Delta q - \lambda q_1 + \alpha(q_2 + 2q_1)] - \lambda \underline{w}, \\
t_2^c &= (\lambda + 3\rho)^{-1}\rho[2\rho\Delta q - \lambda q_1 + \alpha(q_1 + 2q_2)] - \lambda \underline{w}.
\end{aligned}
$$

Using these expressions and the equilibrium allocation of students $\hat{a} = (\alpha + \rho)/(\lambda + 3\rho)$ in the variable rent functions of the two countries yields

$$
\begin{aligned}
r_1(q_1, q_2) &= N\hat{a}\left\{\frac{\lambda}{2}\frac{(\alpha + \rho)}{(\lambda + 3\rho)}q_1 + \frac{\rho[\rho\Delta q - \lambda q_1 + \alpha(q_2 + 2q_1)]}{(\lambda + 3\rho)} - \alpha q_1\right\}, \\
r_2(q_1, q_2) &= N(1 - \hat{a})\left\{\frac{\lambda}{2}\left[1 + \frac{(\alpha + \rho)}{(\lambda + 3\rho)}\right]q_2 + \frac{\rho[2\rho\Delta q - \lambda q_1 + \alpha(q_1 + 2q_2)]}{(\lambda + 3\rho)} - \alpha q_2\right\}.
\end{aligned}
$$

For a positive demand for both educational systems (i.e. $0 < \hat{a} < 1$), we can show that

$$
\begin{aligned}
r_1(q_1, q_2) &> 0 \quad \text{if} \quad \lambda q_1 - 2\rho\Delta q < 0, \\
r_2(q_1, q_2) &> 0 \quad \text{if} \quad (\lambda q_2/2 + \rho\Delta q)(\lambda + 2\rho - \alpha) > 0.
\end{aligned}
$$

While the second order condition for the optimal t_1^c guarantees $r_1(q_1, q_2) > 0$ to hold, the positive demand for education in country 2 (see that $(1-\hat{a}) = (\lambda+3\rho)^{-1}(\lambda+2\rho-\alpha)$) ensures $r_2(q_1, q_2) > 0$. Therefore, we proved that the variable rent from educating foreign students is for both countries larger for quality differentiation than for an identical education quality. A race-to-the-bottom in tuition fees in case of $q_1 = q_2$ would drive this rent down to zero.

Local education policy and efficiency (Section 2.3) Consider country 2. In the text above, we analyze two scenarios. First, let us assume that the decentralized allocation of students is efficient, i.e. $\hat{a} = \hat{a}^E = 1/2$. The local quality level q_2 exceeds the efficient level if

$$\frac{N\rho(\rho+\alpha)}{(\lambda+3\rho)} > \frac{3N\rho}{8}$$

Recognizing that $\alpha = (\lambda+\rho)/2$ in case of $\hat{a} = \hat{a}^E$, this condition reduces to $\lambda+3\rho > 0$, which always holds, i.e. we proved that country 2 overinvests in quality. Second, we analyzed a situation in which $\alpha = 0$. The efficient quality level then exceeds the local level if

$$\frac{N(\lambda+\rho)}{2} - \frac{N\lambda}{2}\left[1 - \frac{\rho^2}{(\lambda+3\rho)^2}\right] - \frac{2N\rho^2}{(\lambda+3\rho)}\left[1 - \frac{\rho}{(\lambda+3\rho)}\right] > 0,$$

which reduces to $\lambda^2+3\lambda\rho+\rho^2 > 0$ and therefore always holds. Country 2 underinvests in quality.

An analog exercise for country 1 immediately proves the underinvestment in cases $\hat{a} = \hat{a}^E$ and $\alpha = 0$.

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