Educational Federalism and the Quality Effects of Tuition Fees

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CESIFO WORKING PAPER NO. 3193
CATEGORY 5: ECONOMICS OF EDUCATION
SEPTEMBER 2010

CESifo *Working Paper No. 3193*

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Abstract

This paper investigates how the abolishment of a ban on tuition fees affects the quality of higher education with centralized and decentralized decision making. It is shown that a marginal introduction of tuition fees fully crowds out public funds under centralization, whereas educational quality improves under decentralization. However, if the government has full discretion about the tuition fee level, centralization leads to the efficient quality, fully extracting the income gains from the graduates, while decentralization typically induces inefficiently low spending levels.

JEL-Code: H77, I22, D78.

Keywords: higher education, federalism, tuition fees.

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September 2010
I would like to thank Kerstin Schneider and Lars-Erik Borge for valuable comments. The usual disclaimer applies.

1 Introduction

Does the introduction of tuition fees improve the quality of higher education? Numerous voices throughout Europe support this view, stating that fees are heavily needed to supplement public educational expenditures in order to bring funding back to internationally adequate levels (European Commission, 2005; HRK, 2005; Van der Ploeg and Veugelers, 2008; Ritzen, 2009).[1] On the contrary, critics argue that enhanced access to private financing sources would actuate a withdrawal of public funding, such that the effect on total educational spending would be low or even zero.This fear is fuelled by experiences in the UK and Australia after the introduction of tuition fees, succinctly summarized by Barr (2004, p. 342):

> *If fees are set by government, rising fee income can be offset by falling taxpayer contributions. ... Australia is a graphic example: government introduced centrally set fees 1989 to address a funding crisis; by 2000, the system was back in crisis. Equally, the introduction of fees in the UK did not net any extra money.*

This paper develops a simple model of higher education finance to address the question whether the option to implement tuition fees improves the quality of university education and to what extent crowding out of public funds occurs. This question is of particular importance for the debate in Germany, where, similar to the above-mentioned countries, fees were introduced gradually at levels determined by the political process. As a result, higher education funding rests on both public and private sources being controlled by the government. These features are typically neglected in models of university finance reform, which either focus on the polar alternatives of pure public vs. private spending (Garcia-Peñalosa and Wälde, 2000; Wildasin, 2000; Büttner and Schwager, 2004), or allow for individual adjustments of higher education quality (Andersson and Konrad, 2003).[2]

In many countries, including Germany, the dispute on university reform goes hand in hand with a discussion on the proper allocation of educational competencies, in particular between federal and regional levels. From a theoretical perspective, decentralization is often challenged due to a variety of interregional spill-overs, most notably graduate mobility undermining the incentives for public funding on a regional basis.[3] As this may constitute an argument why tuition fees may serve to crowd out particularly regional public spending,[4] we investigate

1 Of course, the discussion on the interrelation between financing sources and quality is just one aspect in the voluminous tuition fee debate. Other topics figuring prominently in public discussion include lifetime redistribution (Bevia and Iturbe-Ormaexte, 2002), and social selectivity due to financial constraints (De Fraja, 2001).

2 Therefore, our notion of "private funding" means paying for a government service of predetermined quality rather than private choice of educational quality.

3 See, e.g. Konrad (1995) and Wildasin (2000). However, things become more tricky when student mobility is added; see Lange (2009) and Krieger and Lange (2010).

how their possible introduction affects educational expenditures for both centralized and decentralized decision making.

On the one hand, this distinction is novel to the literature, which addresses the disposability of government instruments in terms of either different expenditure categories (Konrad, 1995; Poutvaara, 2004) or tax arrangements (Poutvaara, 2001). On the other hand, it is relevant for the German case where fees are set by the federal states.[5] Hence, lessons from countries with more centralized fees like Australia and the UK may not apply.

Gradualism is an important characteristic of university funding reform. In the above mentioned countries, tuition fees have been introduced at moderate levels before further increases.[6] We take account of this feature by investigating two scenarios: first, we consider the introduction of tuition fees at a marginal level; second, we allow for the government to have full discretion about the fee level.

We show that the effects of tuition fees depend on the degrees of both educational centralization and flexibility in setting the fee level. Regarding marginal fees, we find a full crowding out of fee revenues under centralization. Private funding simply substitutes public funding without any improvement of educational quality. However, with regional decision making, per capita spending on higher education increases when marginal tuition fees are charged. This difference originates in the higher fiscal appeal of attracting students to the region and has an important implication for the assessment of educational federalism. The option to utilize small scale fees can indeed provide an argument in favor of, rather than against a decentralization of educational competencies. Our analysis identifies situations where centralization leads to higher quality than decentralization when funding is restricted to be only public, but decentralization performs better when tuition fees are admitted.[7]

When policymakers have full discretion about tuition fee levels, the picture changes. While effects under decentralization are basically unaffected, a centralized government now has the

4 Schwager (2008) argues in favor of tuition fees as an instrument to correct for the above mentioned externalities efficiently.

5 In our model, we consider educational quality and expenditures as the policy instruments. There are manifold options how to conduct and evade regional education competition. Konrad (1995) stresses the encouragement of public infrastructure at the expense of public education, whereas Poutvaara (2004) argues that higher graduate mobility shifts public educational resources into internationally less applicable skills. Poutvaara (2001) shows that education is spurred by earmarking the tax payments of graduates to the region where education was undertaken. Richter and Kunze (2010) show that mobility does not necessarily affect the structure of optimal education policy.

6 However, recent experiences like in Austria and the German states of Hesse and Saarland where tuition fees were abolished after a short period of time highlight that increases are far from automatic.

7 This finding is rooted in a distortion of the incentives to support university education by the political process. Not attending university himself, the decisive voter recognizes only the indirect benefits of higher education and neglects the positive direct effects on students. This renders spending under centralization inefficient and opens up the possibility of a better provision by decentralization even though regions are symmetric. Hence, our mechanism differs significantly from Besley and Coate (2003), where a superiority of decentralized systems originates in the heterogeneity of individual preferences.

option to extract the entire private return from educational investment by setting an appropriate fee. Receiving the whole surplus of higher education, the government sets the efficient level of quality. Hence centralization becomes advantageous regarding efficiency.[8] Therefore, our analysis highlights that the question of educational centralization versus decentralization is highly sensitive with respect to the institutional environment: not only the general availability of funding instruments, but also detailed restrictions on their scope matter.

The paper is organized as follows. Section 2 sets up the basics of the model. Section 3 derives and compares spending levels under centralized and decentralized decision making when tuition fees are banned. In section 4, this ban is abolished, first allowing for marginal, then for generic fee levels. Section 5 offers some concluding remarks.

2 The Model

Consider a federation formed by two ex ante identical regions $i \in \{A, B\}$. In both regions, competitive firms employ capital and labor to produce the same output good by a constant-returns-to-scale technology. Perfect access to the international capital market pegs the interest factor at the level R for both individuals and firms. Hence, the wage per efficiency unit of labor w is constant as well.

In both regions, a mass of people - each normalized to unity - lives for two periods $t = 1, 2$. Individuals are heterogeneous in terms of the ability to benefit from higher education, a, and the costs of moving into the other region in period 1 and 2, denoted by μ_t, $t = 1, 2$.

The ability distribution is bimodal. In each region, the mass $A < 1$ of people is born with a high ability to benefit from university education ($a = 1$), whereas the rest $(1 - A)$ has no such talent ($a = 0$). Hence, the overall number of talented individuals is $2A$.

At the beginning of the each period, individuals are informed about their individual realization of the respective mobility cost. These costs reflect not only immediate moving costs, but also non-monetary implications of leaving a familiar environment. As these facets may be considered positive by some individuals, we allow for non-positive values of total mobility cost. For the sake of concreteness, costs are uncorrelated between periods and μ_t follows a uniform distribution in the interval: $\left[\underline{\mu}_t, \overline{\mu}_t\right]$ with $\underline{\mu}_t \leq 0, \overline{\mu}_t \geq 0$. Hence, the probability of facing a migration cost μ_t is $1/(\overline{\mu}_t - \underline{\mu}_t)$.

In period 1, people decide where to reside and whether to take up a study or not. Going to university augments the effective supply of labor in period 2 to:

$$1 + ah(e),$$

8 However, a full comparison would have to take into account how the government budget will be utilized.

where $h(\cdot)$ is a human capital production function with the usual properties ($h' > 0, h'' < 0, h'(0) = \infty$ and $h(0) = 0$). Human capital depends on total higher education expenditures or quality $e = g + f$, the sum of both public funds g and tuition fees f.[9] Taking into account income taxation at the rate τ and tuition cost gives lifetime net income:

$$I_H = \frac{(1-\tau)(1+ah(e))w}{R} - f.$$

Like Konrad (1995), Keen and Marchand (1997) and Poutvaara (2004), we treat the income tax rate τ as fixed throughout the paper. Hence, the paper focusses on the effect of mobility on educational and not on tax competition.[10]

Everyone who does not attend university supplies one efficiency unit of labor in both periods, providing net lifetime earnings:

$$I_L = (1-\tau)w\left(\frac{1+R}{R}\right).$$

The decision to study is determined by a comparison of lifetime incomes. While untalented individuals abstain from studying due to the opportunity cost, the talented attend university only if:

$$(1-\tau)w(\frac{h(e)}{R} - 1) \geq f, \tag{1}$$

that is, the increase in net earnings at least compensates for tuition cost. In what follows, we refer to (1) as the *student participation constraint*: only when (1) is fulfilled, $S = A$ while $S = 0$ otherwise.

Our efficiency criterion for subsequent comparisons is aggregate output:

$$2S\frac{1+h(e)}{R}w + 2(1-S)w\frac{1+R}{R} - 2Se.$$

This expression achieves its maximum either by having no higher education at all ($e = S = 0$) or by all talented going to university and receiving the same quality e^*, characterized by:

$$h'(e^*)w = R, \tag{2}$$

9 It is well known from the empirical literature that not only ressources but also organization is important for educational output (Wößmann, 2008; Van der Ploeg and Veugelers, 2008). However, we concentrate on the funding dimension, as our basic question is coined in these terms.

10 Krieger and Lange (2010) consider simultaneous tax and transfer competition among regions. However, taking educational quality as given, their approach differs severely from the present one.

the equality of the marginal returns to investment in human and physical capital. To make the problem meaningful, we posit that higher education is socially productive, that is, the aggregate surplus of the latter solution is higher than if no-one attended university:

$$(\frac{h(e^*)}{R} - 1)w > e^*. \tag{3}$$

Because aggregate production is concave in e, social productivity exists for all $e \in [\underline{e}, \bar{e}]$, both bounds of the interval solving the equation $(h(\bar{e}) - R)w = \bar{e}R$.

3 Public Funding of Higher Education

This section investigates spending on higher education when all funds are public, that is, tuition fees are not allowed: $f = 0$. The level of public spending results from the political process, which we assume to be characterized by Leviathan-type governments. Hence, the interest of the government is to extract as much resources as possible from university students and graduates.[11]

3.1 Centralization

Consider first a setting where education spending is set by a central government aiming at the maximization of the present value of net income tax revenues over both periods:

$$\bar{B} = T_1 + \frac{T_2}{R} - 2Sg, \tag{4}$$

where the bar refers to the no tuition fee-case. Period 1 taxes are collected from all non-students, whereas all workers pay the proportional income tax in period 2:

$$T_1 = 2(1 - S)\tau w, \quad T_2 = 2\tau w \left[S(1 + h(g)) + (1 - S)\right].$$

Plugging these equations into (4) gives the tax revenue as a function of educational spending in period 1:

$$\bar{B} \;=\; 2S\left[\tau w\left(\frac{h(g)}{R} - 1\right) - g\right] + 2w\frac{1+R}{R}, \tag{5}$$

11 This assumption which is popular in the literature (Andersson and Konrad, 2003) simplifies the analysis significantly without affecting the basic insights. Alternatively, all results regarding spending decisions could be reproduced in a more sophisticated OLG-model with a gerontocracy, that is the elderly have the political power (Konrad, 1995). Similar findings would arise if the decisive voter was an untalented individual, although his preferences for local spending would be affected by his own future mobility.

where the first term is the net fiscal return from running a university system. For public spending on higher education to be appealing for the government, this expression must be positive, which imposes two prerequisites on the educational quality. First, quality must be such that the net fiscal return per student is non-negative. We call this condition:

$$\tau w \left(\frac{h(g)}{R} - 1 \right) - g \geq 0 \tag{6}$$

the *fiscal effectiveness constraint*. Second, the student participation constraint (1) must be met, which with pure public funding is tantamount to:

$$h(g)/R \geq 1. \tag{7}$$

The comparison of (6) and (7) reveals that fiscal effectiveness implies student participation under pure public funding. This holds because fiscal effectiveness requires the additional tax revenue from graduation to compensate the direct cost of education. Students, however, disregard both the direct cost and the taxation of earnings as the opportunity cost is tax deductible by construction. Hence, individuals perceive higher gains and lower costs of university education than the government does.

Maximizing (5), taking (6) into account, yields:

Proposition 1. *Centralized pure public funding is positive only when the tax rate is sufficiently high. Positive spending levels are characterized by the condition:*

$$\tau h'(\bar{g}^C) w = R. \tag{8}$$

For all $\tau < 1$, centralized pure public higher education is underfunded.

Proof. (8) results from the maximization of (5) when (6) is ineffective. According to (8), $\bar{g}^C$ decreases monotonously in τ and approaches zero as $\tau \to 0$. Therefore, there exists a critical tax rate τ_G for which the fiscal effectiveness constraint (6) binds when $\bar{g}^C$ is chosen. Hence, τ_G is given by:

$$\frac{\tau_G w}{R} \left(h(\bar{g}^C(\tau_G)) - 1 \right) = \bar{g}^C(\tau_G),$$

where we have denoted the tax rate dependency of quality explicitly by writing $\bar{g}^C(\tau_G)$. Regarding underfunding, we have $\bar{g}^C(1) = e^*$. Inefficiency for lower τ follows immediately from $\frac{d\bar{g}^C}{d\tau} > 0$ for $\tau \geq \tau_G$ and zero provision for $\tau < \tau_G$. □

The government's motive to provide higher education originates in the appropriation of the tax payments generated by university graduates. However, aggregate output increases by more than these tax payments whenever the tax rate is not confiscatory.[12] As in Konrad (1995), this renders the incentives to finance university education inferior.[13] For sufficiently low tax rates, higher education becomes even fiscally ineffective and is not provided at all.

12 To simplify the analysis, we have omitted any personal effort cost of attending university. Obviously, the presence of such a cost would destroy the incentives for university education for $\tau = 1$ such that centralized pure public education would never be efficient.

Funding higher education by general taxation is often criticized on grounds of regressive redistribution (Garcia-Peñalosa and Wälde, 2000). This property is present also in our model as the ratio between academic and non-academic lifetime incomes:

$$\frac{1+h(g)}{1+R} \tag{9}$$

increases monotonously in g. This is due to the fact that the government is not interested in intra- or intergenerational redistribution, but simply wants to enlarge the tax base.

3.2 Decentralization

Consider now a situation where policies are chosen autonomously at regional levels. Similar to the centralized case, the governments want to maximize the net tax payments to their region:

$$\bar{B}^i = \left[T_1^i + \frac{T_2^i}{R} - S^i g^i \right], \tag{10}$$

where i is the regional index. However, interregional mobility alters tax revenues and costs in three distinctive ways.

First, mobility in period 2 implies that not all graduates of a region will also pay their income taxes there. Graduate earnings being the same across regions due to the uniform income tax rate, all households with negative mobility costs move to the other region at the beginning of period 2. As a consequence, each region collects taxes from all its period-1 residents with positive old age mobility cost μ_2 and all period-1 residents of the other region with negative μ_2. Letting S^i denote the number of graduates in i, collected taxes in i are:

$$TC_2^i = \frac{\overline{\mu}_2}{\overline{\mu}_2 - \underline{\mu}_2}\tau(1+h(g^i))wS^i + \frac{-\underline{\mu}_2}{\overline{\mu}_2 - \underline{\mu}_2}\tau(1+h(g^j))wS^j + \tau w(1-S), \tag{11}$$

where $j \neq i$ and the last term is due to the fact that the number of non-academics with negative μ_2 is the same in both regions.

Second, fiscal equalization drives a wedge between the taxes collected in a region and the taxes actually received. Let $\delta \in [0,1]$ be the fraction of taxes that accrue to the region where they were collected, revenues for region i amount to:

$$T_2^i = \tau\delta TC_2^i + \tau(1-\delta)TC_2^j.$$

13 Similar results obtain in Wigger and von Weizsäcker (2001) and Bevia and Iturbe-Ormaexte (2002). Wigger and von Weizsäcker (2001) assume that the government maximizes a "tax dividend" in the form of future student earnings. However, they do not consider the problem of underfunding caused by an imperfect appropriation of investment returns. In Bevia and Iturbe-Ormaexte (2002), altruistic parents are willing to forego current tax revenue in order to finance higher education which fosters future redistribution among the offspring via a progressive income tax. In our model, tax revenues are simply conveyed to the general budget.

By using (11), this can be expressed as:

$$T_2^i = \tau(1-\pi)(1+h(g^i))S^i + \tau\pi(1+h(g^j))S^j + \tau w(1-S), \tag{12}$$

where:

$$\pi = \frac{\overline{\mu}_2 - \delta\left[\overline{\mu}_2 + \underline{\mu}_2\right]}{\overline{\mu}_2 - \underline{\mu}_2} \in [0,1]$$

is a measure of the fiscal externality or "leakage" of public investment due to graduate mobility and fiscal equalization: Region i ends up with only the fraction $1-\pi$ of the tax payments of its former students.

The third difference to centralization originates in the fact that the talented people born in i need not study at the local university. They do so only if their period 1 mobility cost exceeds the earnings differential arising from varying education qualities between regions:

$$\mu_1 \geq \frac{(1-\tau)w}{R}\left[h(g^j) - h(g^i)\right], \tag{13}$$

where, in order to simplify the exposition, (13) presumes the student participation constraint to be met in both regions.

Utilizing the uniform distribution property of μ_1 gives the number of children born and studying in i:

$$S_i^i = \frac{S}{\overline{\mu}_1 - \underline{\mu}_1} \cdot \left[\overline{\mu}_1 - \frac{(1-\tau)w}{R}\left[h(g^j) - h(g^i)\right]\right], \tag{14}$$

the subscript referring to the region of origin and the superscript to the region of study. Accordingly, the number of students in i originating from j is $1 - S_j^i$, such that the total number of students in i becomes:

$$S^i = S\left[1 + 2\frac{(1-\tau)w}{M_1}\frac{h(g^i) - h(g^j)}{R}\right].$$

with $M_1 = \overline{\mu}_1 - \underline{\mu}_1$. Obviously, educational quality attracts students:

$$\frac{\partial S^i}{\partial g^i} = 2S\frac{(1-\tau)w}{M_1}\frac{h'(g^i)}{R} > 0, \frac{\partial S^j}{\partial g^i} = -2S\frac{(1-\tau)w}{M_1}\frac{h'(g^j)}{R} < 0.$$

At last, everyone not attending university gets the same period 1 income in both regions. Accordingly, only those with negative mobility cost move. Since the interregional net flow of non-students is zero, period 1 tax revenue is independent of the degree of educational federalism: like in period 2, each region has $(1-S)$ non-academic residents so tax revenues amount to $T_1^i = (1-S)\tau w$.

Therefore, the problem of the government of region i is to maximize (10) with respect to g^i, taking g^j as given. In addition, student participation and fiscal effectiveness have to hold at the regional level. Fiscal effectiveness requires:

$$\tau w \left[\frac{(1-\pi)h(g^i)}{R} - 1 \right] - g^i \geq 0.$$

Because of fiscal leakage, this condition is stricter than (6), whereas the student participation constraint (7) is structurally unaffected. Therefore, we can conclude that, if at all, only the fiscal effectiveness constraint will be binding under decentralization as well.

The respective maximization gives the first-order condition:[14]

$$\begin{aligned} \frac{\partial \bar{B}^i}{\partial g^i} &= S^i \Big[(1-\pi)\tau w h'(g^i) - R \Big] \\ &+ \frac{\partial S^i}{\partial g^i} \Big[\tau(1-\pi)(1+h(g^i))w - g^i R \Big] + \pi\tau(1+h(g^j))w \frac{\partial S^j}{\partial g^i} \leq 0, \end{aligned} \tag{15}$$

with strict inequality for $g^i = 0$. This equation highlights the three budgetary effects of increasing educational expenditures at the regional level. First, it affects the marginal return per resident student, the difference between marginal tax revenues and cost. Second, it attracts additional students who generate both tax revenue and cost. And third, the reduction of students in the other region impinges on tax revenues to the extent of fiscal leakage.

Both countries being identical, we concentrate on a symmetric equilibrium where $g^i = g^j, S^i = S^j$, and $\frac{\partial S^j}{\partial g^i} = -\frac{\partial S^i}{\partial g^i}$. Rearranging (15), the equilibrium spending level in both regions is either $\bar{g}^D$ solving:

$$\begin{aligned} \bar{\Omega}^D &= \big[(1-\pi)\tau h'(\bar{g}^D)w - R \big] \\ &+ 2\frac{(1-\tau)w}{M_1} \frac{h'(\bar{g}^D)}{R} \big[\tau(1-2\pi)(1+h(\bar{g}^D))w - \bar{g}^D R \big] = 0, \end{aligned} \tag{16}$$

or zero, depending on whether $\bar{g}^D$ is fiscally effective or not:

$$\tau w \left[\frac{(1-\pi)h(\bar{g}^D)}{R} - 1 \right] - \bar{g}^D \gtreqless 0. \tag{17}$$

Equation (16) can be interpreted along the same lines as (15) with the slight modification that the second term denotes the regional fiscal gain from attracting a student adjusted for the fiscal externality. Depending on the level of π, this gain can be positive or negative. However, according to (16), a positive regional fiscal gain from attracting students implies a negative marginal return per resident student and vice versa.

14 We take the respective second order condition:

$$\begin{aligned} \frac{\partial^2 \bar{B}^i}{\partial (g^i)^2} &= S^i(1-\pi)\tau h''(g^i)w + 2\frac{\partial S^i}{\partial g^i} \Big[-R + \tau(1-\pi)h'(g^i)w \Big] \\ &+ \frac{\partial^2 S^i}{\partial (g^i)^2} \Big[\tau(1-\pi)(1+h(g^i))w - Rg^i \Big] < 0 \end{aligned}$$

as fulfilled. This can be ensured by a sufficiently low sensibility of location choice with respect to quality differentials: If M_1 is sufficiently high, the (negative) first term dominates the possibly positive second term. Note that the third term is always negative when education is fiscally effective.

For the following analysis, we posit that $\frac{\partial^2 \bar{\Omega}^D}{\partial (\bar{g}^D)^2} < 0$ in equilibrium, in order to exclude economically dubious implications.[15] To illustrate the importance of that assumption, consider an increase in the interest rate. Increasing the opportunity cost of educational funding, quality should decline. However, this occurs only when the above postulate holds:[16]

$$\left.\frac{d\bar{g}^D}{dR}\right|_{\pi=0} = -\frac{1}{\partial^2 \bar{\Omega}^D / \partial (\bar{g}^D)^2} \cdot \left[-1 - 2\frac{(1-\tau)h'(\bar{g}^D)w}{(\overline{\mu}_1 - \underline{\mu}_1)R^2}\tau(1+h(\bar{g}^D))w \right] < 0 \iff \frac{\partial^2 \bar{\Omega}^D}{\partial (\bar{g}^D)^2} < 0.$$

The next two propositions summarize the main properties of the equilibrium. We start with the tax rate perspective:

Proposition 2a. *In the absence of fiscal externalities, decentralized pure public funding is positive only if the tax rate is sufficiently high. A tax rate increase produces ambiguous effects on the higher education quality level, unless student mobility is sufficiently low.*

Proof. When $\pi = 0$, (16) becomes $h'(g)w - R = 0$ for $\tau = 1$. This is solved by the (positive) efficient quality. For $\tau = 0$, all terms in (16) are negative, hence zero quality maximizes revenue.

The ambiguity of the tax rate effect on $\bar{g}^D$ becomes obvious from considering:

$$\begin{aligned} \frac{d\bar{\Omega}^D}{d\tau} &= (1-\pi)h'(\bar{g}^D) + 2\frac{(1-\tau)w}{M_1}\frac{h'(\bar{g}^D)}{R}(1-2\pi)(1+h(\bar{g}^D))w \\ &\quad -\frac{2w}{M_1}\frac{h'(\bar{g}^D)}{R}\left[\tau(1-2\pi)(1+h(\bar{g}^D))w - \bar{g}^D R\right]. \end{aligned} \tag{18}$$

Working in different directions under many circumstances, including $\pi = 0$, the second and third term are dominated by the first term when M_1 is sufficiently high. □

The indeterminacy of the reaction of the educational quality on the tax rate can be traced back to the interplay of three effects. First, a higher tax rate is beneficial for quality as the marginal fiscal return extracted from resident students increases. Second, the regional fiscal gain from attracting a student is affected. However, the sign of this effect depends on the extent of fiscal leakage, which determines whether it is better to have one taxpayer more in the own or in the other region ($\pi \lessgtr 1/2$). Third, a higher tax rate makes the students in both regions less sensitive to quality differentials, for the private return from moving abroad declines. Whether this lower responsiveness is beneficial of harmful, depends again on the degree of fiscal leakage weighing the net gains from attracting another student relative to relying on the fiscal externality. Only when student mobility is sufficiently low, will the last two effect be of minor importance.

This ambiguity has an impact on the efficiency performance of decentralized higher education:

Corollary 1. *Under decentralization, quality overprovision results if and only if educational*

15 Also this condition can be ensured by a sufficiently low response of students to quality differentials.

16 For the sake of brevity, we present the respective condition only for the case $\pi = 0$.

quality is maximal for a tax rate lower than unity. Otherwise, underprovision obtains for all $\tau < 1$ *and/or* $\pi > 0$*.*

Proof. Due to $\frac{d\bar{g}^D}{d\pi} < 0$, $\bar{g}^D$ reaches the maximum level for any given tax rate when $\pi = 0$. If $\pi = 0$ and $\tau = 1$, (16) becomes $(1-\pi)h'(\bar{g}^D)w - R = 0$, solved by e^*. Hence efficient quality is overmatched if and only if maximum quality obtains for a $\tau < 1$. Otherwise, underfunding results for all $\tau < 1$ or $\pi > 0$. □.

For a confiscatory tax rate, student mobility and hence quality competition become irrelevant. Therefore, each region would invest efficiently in education if fiscal leakage was absent. As a consequence, decentraization leads to overprovision only when incentives to attract students are even stronger. A tax rate below 100% is a necessary, but not sufficient condition for this to occur.

Let T denote the (probably non-closed) set of tax rates for which a positive quality is provided under decentralization in the absence of fiscal leakage. Then we have the following result:

Proposition 2b. *For every* $\tau \in T$*, there exists a degree of fiscal leakage* $\bar{\pi} \in [0, 1]$*, such that equilibrium spending under decentralized pure public funding is positive for* $\pi \in [0, \bar{\pi}]$ *and zero for* $\pi \in [\bar{\pi}, 1]$*. For* $\pi < \bar{\pi}$*, quality is decreasing in* π*. Moreover, there exists a level of fiscal leakage* $\tilde{\pi} < 1/2$*, such that educational quality is higher under decentralization than under centralization if* $\pi < \tilde{\pi}$*.*

Proof. When education is fiscally effective, quality is given by (16). Applying the implicit function gives:

$$\frac{d\bar{g}^D}{d\pi} = -\frac{-\tau h'(\bar{g}^D)w - 4\tau(1 + h(\bar{g}^D))\frac{(1-\tau)w^2}{M_1 R}}{\partial^2 \bar{\Omega}^D / \partial(\bar{g}^D)^2} < 0.$$

Moreover, $\bar{g}^D$ approaches zero for $\pi \to 1$, hence (17) becomes binding for some $\bar{\pi} < 1$. Higher fiscal leakage leads to zero provision.

For $\pi = 0$ and $\tau < 1$, the second term in (16), the regional fiscal gain from attracting a student, becomes unambiguously positive. By (8), (16) can only be fulfilled for $\bar{g}^D > \bar{g}^C$. As $\bar{g}^D$ is continuously decreasing in π, some $\tilde{\pi} > 0$ must exist for which $\bar{g}^D = \bar{g}^C$. However, $\pi = 1/2$ renders the regional fiscal gain from attracting a student negative, from which $\bar{g}^D < \bar{g}^C$ follows. When $\tau = 1$, the second term in (16) is zero, hence $\tilde{\pi} = 0$ in this case. □

While the negative effect of fiscal leakage on educational investment is straightforward, the relative performance of decentralization is easily explained in terms of the strategic interrelation between spending levels. From (15), we get:

$$\frac{dg^i}{dg^j} = \frac{-1}{\partial^2 \bar{B}^i / \partial(g^i)^2} \left[\frac{\partial S^i}{\partial g^i}(\tau w(1-\pi)h'(g^i) - R) + \frac{\partial S^j}{\partial g^i}\pi\tau w h'(g^j) \right]. \tag{19}$$

The sign of this expression equals the sign of the square bracketed term in the numerator, which captures the basic educational tradeoff faced by each region. On the one hand, it

has an incentive to attract students (that is, later taxpayers) by providing a better quality than the competitor. This creates a strategic complementarity between local educational expenditures. On the other hand, there is also a substitutability because each region can free ride on the efforts of the other region. The relative importance of these effects is determined by the extent of the fiscal leakage. When $\pi = 0$, regions appropriate all later tax revenues of their students and compete fiercely for them such that expenditures are higher than with centralization, possibly exceeding the efficient level. Algebraically, (19) is positive and strategic complementarity prevails. However, for $\pi = 1$ own educational investments would only benefit the other region. Therefore, an intermediate level of fiscal leakage exists for which centralization and decentralization yield identical quality.

A political economy complement to the welfare-theoretic findings by Lange (2009), our result puts some caution on the popular finding that decentralized education policies are inferior to centralized ones. Konrad (1995), Justman and Thisse (1997) and Del Rey (2001) establish a respective finding based on the mobility of graduates, but disregarding any beneficial effects of attracting students to a region. In a model with student mobility only, Büttner and Schwager (2004) find educational expenditures to be strategic substitutes between regions. However, this result is driven by the assumption that each region cares for the earnings of all its citizens irrespective of residence. Obviously, this downplays the fiscal effect of graduates remaining abroad.[17]

In contrast, Gradstein and Justman (1995) have shown that decentralization raises spending levels. However, their argument is set up in terms of human capital investment of immobile residents in order to attract mobile physical capital. In our model, educational spending is a tool to attract students and their future tax payments. Moreover, decentralized spending is always excessive in Gradstein and Justman (1995) because - in contrast to our model - centralization would be efficient.[18]

Nevertheless, centralization leads to better quality than decentralization in a number of cases, including $\pi = 1/2$. Also, decentralization can even fail to supply of higher education, although a centralized university system would exist ($\pi > \tilde{\pi}$).

4 Allowing for Tuition Fees

We now consider a setting where higher education can be financed by both public and private funds, such that $e = g + f$. In line with recent real-world reforms, we posit that the level of tuition fees is set by the government and distinguish between two settings: the introduction

17 Moreover, the opposite result obtains with this regional target function once only graduates are allowed to be mobile (Justman and Thisse, 2000).

18 In the same spirit, Konrad (1995) arrives at overprovision of public infrastructure in order to capture mobile labor.

of small-scale fees on the one hand and full freedom of scope regarding fee levels on the other hand. With all individuals having access to the perfect capital market and no uncertainty about educational success, the well known problems of wealth-biased demand for privately funded education are absent and require no further state intervention.[19] As a consequence, the analysis can concentrate on efficiency issues.

4.1 Small Scale Fees

As argued above, tuition fees are often phased in with low initial levels. In order to analyze these (possibly short term) effects, this subsection considers the marginal introduction of fees to the model of section 3. In general, there are two questions at hand: First, how do such fees affect educational quality? And second, what about the incentives to utilize tuition fees? We find the degree of educational federalism to matter substantially for both questions.

4.1.1 Centralization

The problem of the government is to maximize:

$$B = 2S\left[\tau w\left(\frac{h(e)}{R} - 1\right) - (e - f)\right] + 2w\frac{1+R}{R}, \tag{20}$$

with respect to e and f subject to student participation (1) and fiscal effectiveness:

$$\tau w\left(\frac{h(e)}{R} - 1\right) - (e - f) \geq 0. \tag{21}$$

According to (21), the educational quality required to meet fiscal effectiveness diminishes in f: with quality unchanged, tuition fees improve the public budget. As the quality ensuring student participation rises with the fee level, there exist thresholds:[20]

$$\hat{f} = (1 - \tau)w\left[\frac{h(\bar{e})}{R} - 1\right], \tag{22}$$

such that fiscal effectiveness implies student participation for lower fees whereas the opposite holds for higher fees. As $\hat{f}$ is strictly positive, only (21) needs to be considered when analyzing the marginal introduction of fees. The according maximization of (20) yields:

Proposition 3. *Under centralization, the government has an incentive to introduce tuition fees whenever education expenditures are positive under pure public funding. However, the*

19 As pointed out by Garcia-Peñalosa and Wälde (2000), the precise form of fee repayment facilities matters for student risk taking under uncertainty. See Poutvaara (2004) for an extension of the analysis of tuition fee designs to the presence of graduate mobility.

20 (22) results from equating (21) and (1). Intuitively, the student participation and the fiscal effectiveness constraints are binding simultaneously, if the aggregate surplus from higher education is zero, that is (3) holds. Hence, there are two (positive) solutions to (22).

marginal introduction of fees does not improve educational quality. There is full crowding out of public funds.

Proof. The first order condition of the problem is:

$$h'(e)w = \frac{R}{\tau}, \tag{23}$$

with the solution $\bar{g}^D$. The incentive to introduce fees is due to:

$$\left.\frac{dB}{df}\right|_{f=0} = S.$$

As fees improve the budget, fiscal effectiveness of $\bar{g}^D$ carries over to the presence of marginal fees. □.

The intuition behind this result is as follows. Under pure public funding, students enjoy a rent from higher education, for the student participation constraint is not binding. A marginal tuition fee skims off some of that rent and increases the net revenue of the government without affect the marginal return or the marginal cost of quality. As a consequence, the model provides some support to the assertion that allowing for state regulated tuition fees is not conducive to the quality of higher education. The next section investigates to what extent this argument applies to decentralization.

4.1.2 Decentralization

While the presence of tuition fees does not affect the mobility of graduates in period 2, they influence the location choices of students in period 1. A talented child born in i attends the university in its region of birth only if the migration cost exceeds the earnings differential net tuition cost differentials between i and j:

$$\mu_1 \geq \frac{(1-\tau)w}{R}\left[h(e^j) - h(e^i)\right] - \left[f^i - f^j\right].$$

Consequently, the total number of students in region i becomes dependant on qualities and fees:

$$S^i = S\left[1 + \frac{2}{M_1}\left(\frac{(1-\tau)w[h(e^i) - h(e^j)]}{R} + f^j - f^i\right)\right], \tag{24}$$

a higher quality increasing and a higher fee deterring enrolment:

$$\frac{\partial S^i}{\partial e^i} = 2S\frac{(1-\tau)w}{M_1}\frac{h'(e^i)}{R} > 0, \frac{\partial S^i}{\partial f^i} = \frac{-2S}{M_1} < 0.$$

Under these premises, each regional government maximizes:

$$\begin{aligned} B^i &= S^i\left(\frac{(1-\pi)\tau w\left[1+h(e^i)\right]}{R} - (e^i - f^i)\right) + S^j\frac{\pi\tau w\left[1+h(e^j)\right]}{R} \\ &\quad +2(1-S)\tau w\frac{1+R}{R}, \end{aligned} \tag{25}$$

with respect to e^i and f^i, taking regional fiscal effectiveness:

$$\tau w \left((1-\pi)\frac{h(e)}{R} - 1 \right) - (e-f) \geq 0, \tag{26}$$

into account. Due to the arguments of the above sections, the student participation constraint can be omitted from the problem.

The resulting first order conditions are:[21]

$$\begin{aligned} \frac{\partial B^i}{\partial e^i} &= S^i\Big[(1-\pi)\tau w h'(e^i) - R\Big] \\ &\quad + \frac{\partial S^i}{\partial e^i}\Big[\tau(1-\pi)(1+h(e^i))w - (e^i - f^i)R\Big] + \pi\tau(1+h(e^j))w\frac{\partial S^j}{\partial e^i} \leq 0, \end{aligned} \tag{27}$$

$$\begin{aligned} \frac{\partial B^i}{\partial f^i} &= RS^i + \frac{\partial S^i}{\partial f^i}\Big[\tau(1-\pi)(1+h(e^i))w - (e^i - f^i)R\Big] \\ &\quad + \pi\tau(1+h(e^j))w\frac{\partial S^j}{\partial f^i} \leq 0, \end{aligned} \tag{28}$$

with strict inequality for $e^i = 0$ and $f^i = 0$, respectively.

The interpretation of (27) is analogous to (15). Regarding (28), each region trades off tuition fees' fiscal return on remaining students with the financial consequences of lower enrolment. These consequences are ambiguous for the loss in return from student emigrants is mitigated by the taxes paid by additional graduate immigrants.

Imposing symmetry gives:

$$\begin{aligned} \Omega_e^D &= -R + \tau(1-\pi)h'(e)w \\ &\quad + \frac{2(1-\tau)h'(e)w}{M_1 R}\left[\tau(1-2\pi)(1+h(e))w - (e-f)R\right] \leq 0 \end{aligned} \tag{29}$$

$$\Omega_f^D = R - \frac{2}{M_1}\left[\tau(1-2\pi)(1+h(e))w - (e-f)R\right] \leq 0. \tag{30}$$

We are now in the position to answer to the questions raised in the introduction to this section.

Proposition 4. *Under decentralization, the marginal introduction of fees improves educational quality. However, tuition fees will only be utilized when:*

$$h'(\bar{g}^D)w > \frac{R}{1-\pi\tau}. \tag{31}$$

Proof. The effect of marginal fees on quality results from:

$$\left.\frac{de}{df}\right|_{\Omega_e^D, f=0} = \frac{2(1-\tau)h'(\bar{g}^D)w}{M_1} > 0.$$

21 Under the same assumptions as under pure public funding, B^i is concave in e^i. Moreover, B^i is unambiguously concave in f^i. In what follows, we consider the global optimality condition $\frac{\partial^2 b^i}{\partial e^{i2}}\frac{\partial^2 b^i}{\partial f^{i2}} > \left(\frac{\partial^2 b^i}{\partial e^i \partial f^i}\right)^2$ fulfilled.

Fees are introduced when $\Omega_f^D > 0$ for $f = 0$, which is equivalent to:

$$R > \frac{2}{M_1}\left[\tau(1-2\pi)(1+h(\bar{g}^D))w - R\bar{g}^D\right].$$

By exploiting (29), this condition can be stated as (31). □.

The quality increase is due to the simple fact that tuition revenues make resident students more lucrative. Spurring the gain from increasing enrolment, quality competition intensifies.

However, the marginal introduction of tuition fees requires the fiscal return from resident students to exceed the reduction of the regional fiscal gain due to deterring students. This is tantamount to the ratio between the marginal return per resident student and the change in enrolment from increasing the fee to exceed the regional fiscal gain from attracting a student. As educational quality is chosen such as to equate the regional fiscal gain from attracting a student with the marginal return per resident student and the change in enrolment from quality improvements, the condition for the introduction of fees can be stated as:[22]

$$\frac{R}{\tau(1-\pi)h'(\bar{g}^D)w - R} > -\frac{2/M_1}{2/M_1 \cdot (1-\tau)h'(\bar{g}^D)w}. \tag{32}$$

The ratio between the marginal return per resident student and the change in enrolment must be higher for fee increases than for quality increases. This condition is easily transformed into (31). Whether it is fulfilled depends on τ and π, which shape directly and indirectly (via $h'(\bar{g}^D)$) the marginal return and enrolment change due to a quality increase. While (31) shows that marginal tuition fees are worthwhile in the absence of fiscal leakage, we are unable to show the generality of this property: while a stronger fiscal externality increases students' responsiveness to quality increases, it produces ambiguous results on the marginal tax return. The same applies for the tax rate the quality implications of which are ambiguous. However, as regions rely on tuition fees for both very high and very low fiscal externalities, our results do not raise too much concern that regional deterrence effects scare regions off from utilizing fees.[23]

Irrespective of that possible ambiguity, we have:

Proposition 5. *The availability of marginal tuition fees tends to make educational decentralization preferable to centralization: there exists a level of fiscal leakage $\tilde{\tilde{\pi}} \geq \tilde{\pi}$, such that educational quality is higher under decentralization than under centralization if $\pi < \tilde{\tilde{\pi}}$.*

22 This condition encompasses the case of fiscal leakage being so high that the regional fiscal gain from attracting a student is negative. In that case, fees involve no trade off, as it is better for the region to deter than to attract students. Formally, the fraction on the left hand side in (32) is unambiguously positive as $\tau(1-\pi)h'(\bar{g}^D)w > R$, whereas the right hand side is negative.

23 A constellation where tuition fees will be definitely be dispensed with is quality overprovision. Then, regions would rather want to pay transfers to students than charging fees. In order not to overburden the analysis, we abstract from the possibility that regions engage in transfer (=negative fee) competition; see Krieger and Lange (2010) on that topic.

Proof. $\tilde{\tilde{\pi}} < \tilde{\pi}$ is precluded by the fact that centralized quality does not change whereas decentralized quality remains either constant or improves. $\tilde{\tilde{\pi}} > \tilde{\pi}$ holds whenever regions introduce fees for $\tilde{\pi}$. Because of $\bar{g}^D = \bar{g}^C$, this is tantamount to: $h'(\bar{g}^C)w > \frac{R}{1-\tau\tilde{\tilde{\pi}}}$, which by using (8) becomes:

$$\tilde{\pi} < \frac{1-\tau}{\tau}. \tag{33}$$

Due to $\tilde{\pi} < 1/2$, a sufficient condition for (33) to hold is $\tau < 2/3$. □.

Tuition fees address the underfunding problem under decentralization but not under centralization. As a consequence, the relative performance of decentralized higher education improves whenever marginal fees are introduced and the availability of tuition fees recommends a shift from centralization to decentralization on efficiency grounds for some levels of fiscal externalities.

4.2 Full Discretion

In this subsection, we address the educational policy when governments can choose any non-negative tuition fee level desired.

We start with the case of decentralization. The first-order conditions characterizing regional quality-/fee competition continue to be given by (29) and (30).

Proposition 6. *Under full flexibility of fees, decentralization implies positive educational quality when the tax rate and the fiscal externality are sufficiently low. Fees are positive when (31) holds. In that case, quality is characterized by*

$$h'(e^D)w = \frac{R}{1-\tau\pi}. \tag{34}$$

When fees are zero, quality is the same as with pure public funding: $e^D = \bar{g}^D$.

Proof. Solving (29) and (30) holding with equality gives (34). The condition for the introduction of fees is still provided by (31). For $\tau\pi \to 1$, $e^D \to 0$ according to (34). As this violates both (1) and (26), zero provision becomes optimal. □.

For positive fees, the marginal gains from increasing fees and quality are equated. While this leads to a quality improvement relative to the marginal introduction, underprovision prevails whenever fiscal externalities are present. However, tuition fees are no remedy for overprovision under pure public funding, as they will not be utilized in that case. As argued above for the marginal introduction, governments would rather offer subsidies than fees in such a situation.

Things are different when higher education is centralized.

Proposition 7. *Under full flexibility of fees, centralization leads to efficient quality. The tuition fee amounts to the lifetime earnings differential between academics and non-academics.*

Proof. Due to $\frac{dB}{df} = S > 0$, (1) must be binding for any optimal solution. Hence $f = (1-\tau)w(\frac{h(e)}{R} - 1)$ for any e. Using that property, the maximization problem can be stated as:

$$\max_e 2S\left[\tau w\left(\frac{h(e)}{R} - 1\right) - e + (1-\tau)w(\frac{h(e)}{R} - 1)\right] + 2w\frac{1+R}{R},$$

the solution to which is e^*. □.

Attempting to skim off as much private educational rent as possible, the fee will be set such that the student participation constraint becomes binding. Receiving both the tax and the net of tax return, the government becomes a kind of residual claimant to educational investment. Hence the incentive to spend efficiently.

This result has consequences for the design of educational federalism.

Proposition 8. *Under full flexibility of fees, centralization leads to higher education quality than decentralization when fiscal externalities exist. Decentralization is preferable from the students' perspective.*

Proof. The first assertion follows from comparing e^* and the solution to (34). Students enjoy no educational rent under centralization, because the student participation constraint is binding. □.

This finding highlights a possible conflict between efficiency and distribution. A full comparison between centralization and decentralization would have to consider the designated use of public revenues.

5 Conclusion

This paper has shown that the quality effects of state regulated tuition fees depend crucially on the degree of educational decentralization and the freedom of scope regarding fee levels. We have shown that scepticism about the quality improvement argument can be justified, but is limited to small-scale centralized fees, which is broadly consistent with the above-quoted experiences in Australia and the UK. Federal competition precludes a similar development under decentralized decision-making. Therefore, the availability of fees can make a shift from a centralized to a decentralized system of university finance worthwhile. However, centralization performs better in terms of quality when fees are fully flexible, so the question about the optimal degree of centralization depends on the existence of upper ceilings for fee levels.

As it stands, the model has used a number of simplifying assumptions. First, we have concentrated on symmetric equilibria under decentralization. Certainly, the possibility of regional disparities, possibly produced by differences in regional endowments, requires further investigation. However, it should be stressed that heterogeneity affects both decentralized

and centralized decisions (Besley and Coate, 2003).

Second, we have assumed that all students have the same ability to benefit from higher education. With heterogenous abilities, tuition fees would affect the size and the productivity of the student body. Allowing for this would mostly affect the results under centralization. Unless the government can charge tuition fees perfectly tailored to individual ability, it can not appropriate the whole educational rent and the efficiency result under full discretion is no longer valid. This possibly strengthens the case for decentralization. Regarding the marginal introduction, our crowding out result remains intact whenever the student with the lowest ability enjoys some positive rent under pure public funding. With free university access, such a rent would not exist for the marginal student would be indifferent between going to university or not. However, this reasoning ignores the widespread use of admission standards. Indeed, a revenue-maximizing government has an incentive to keep individuals of lower ability off university in order to concentrate educational expenditures on the most able. Hence, for all students admitted, the student participation constraint would not be binding for pure public funding.

And third, we have not addressed the issue of regional tax competition. A number of studies has shown that the strive for mobile graduates puts a downward pressure on regional taxes (Anderson and Konrad, 2003), which would weaken incentives to provide pure public education under decentralization. However, the effects in the presence of tuition fees are not straightforward.[24] First, a lower tax rate slackens the student participation constraint for given expenditures and fees. Second, tax competition can be mitigated as fees make up for a financing source independent of future student residence. And third, the fundamental difference in incentives to substitute public funds for tuition fees derived above still applies. In general, we expect that the overall result depends on the division of educational and tax responsibilities between local and federal governments, an issue that we leave for future research just like the related question whether results could be improved by university autonomy.

24 See Krieger and Lange (2010) for a respective analysis where educational quality is constant.

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