The welfare effects of discriminating between in-state and out-of-state students

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The welfare effects of discriminating between in-state and out-of-state students

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Abstract

This paper considers the decentralized funding of public universities in a federation when students and graduates are mobile. In particular, I discuss whether local governments should be given the right to differentiate tuition fees between in-state and out-of-state students. I develop a model of decentralized decision making which allows me to draw conclusions about how such a price-discrimination affects welfare and the number of students in a federation. It is shown that local governments differentiate fees if allowed to do so and that this reduces the mobility of students and federal welfare. To assess the impact of differentiated fees on the number of students in the federation this paper extends previous work by endogenizing the number of students. The model predicts that when differentiated fees are used less individuals decide to attend university.

Keywords: fiscal federalism, funding of higher education, student mobility, tuition fees, preferential tax regimes
JEL Classification: H42, H72, H71, I22

1 Introduction

Since the early 1990s, the share of private sources in the funding of higher education institutions has risen in almost half of the OECD countries (Kärkkäinen 2006). Of-

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ten, these additional private contributions are collected in the form of tuition fees. In countries where higher education is provided decentrally tuition fees allow sub-national governments to introduce preferential fee regimes under which out-of-state students have to pay higher tuition fees than in-state students.

There are a number of examples showing that such a price setting behavior is indeed used in practice. In the U.K. a preferential fee regime is effectively in place as Scotland exempts most Scottish students from a tuition fee[1]. In Germany, some of the states (Länder) have recently introduced tuition fees. Other German states, fearing an inflow of students, now ponder the introduction of tuition fees only for out-of-state students. However, there is still considerable legal uncertainty about whether such a pricing scheme is in accordance with the constitution (Pieroth 2007). The issue of preferential fee regimes is particularly prevalent in the U.S. In the academic year 2007/2008 average tuition fees for out-of-state students (nonresidents) at state universities amounted to 13.183 USD while average fees for in-state students at state universities were only 5.201 USD (Washington Higher Education Coordinating Board 2008).

The welfare effects of preferential fee regimes are potentially ambiguous. On the one hand, some observers fear that preferential fee regimes reduce the mobility of students and thus overall welfare (Lang 2005). On the other hand, charging higher fees from out-of-state students might help to reduce the incentives of sub-national governments to underprovide higher education that arise from the possibility to free-ride on the expenditure of other jurisdictions (Justman and Thisse 1997). Given that the legitimacy of preferential fee regimes is currently ambiguous in some countries and awaits clarification by legal- or political decision makers, identifying the welfare effects of preferential fee yields important policy recommendations.

This article develops a formal model to explore how a system in which local governments are allowed to differentiate tuition fees between in- and out-of-state students performs relative to a system in which such a discrimination is not allowed. Performance is measured in terms of overall welfare of the population, the number of students in the federation and the quality of universities.

The model considers a federation in which state governments provide university education to their citizens. Universities are funded out of public and private sources. Public funds are raised with a linear income tax and private contributions are collected in form of tuition fees. The composition of public and private funds is determined by the level of an exogenously given tax-rate (this tax might for instance be specified in a federal tax code that cannot be modified by state governments).

A state's higher education policy consists of choosing the quality of its universities and tuition levels. When determining this policy, state governments seek to maximize the welfare of native citizens.

[1]This is achieved by making domestic students eligible to have their fees paid by the Students Awards Agency for Scotland

Students are mobile between states before and after graduation. This makes higher education policies of different states interdependent. As some graduates work and pay taxes outside the state where they graduated from university, educational expenditure in one state has a positive externality on the tax-revenue of other states.

While this effect suggests that the responsibility to fund higher education should be assigned to the federal government, in many countries this policy is determined at lower levels of government[2]. This might either be due to historical developments or simply reflect the fact that state governments regard centralization as an unacceptable loss of sovereignty. The approach followed in this paper is therefore to take decentralized decision-making over higher education policies as given and ask whether allowing governments to provide preferential treatment to domestic students can function as a second-best policy which helps to move the policy outcome closer to the first-best.

In many countries, raising participation in higher education has become a frequently stated policy objective. To assess whether or not the possibility to set differentiated tuition fees helps achieving this goal I assume that individuals sort endogenously into students (which later work in high-skilled occupations) and low-skilled workers. Individuals are heterogenous with respect to their private costs of attending university. Any policy that raises the lifetime income of a graduate will induce more individuals to attend university. This assumption extends previous work on the decentralized provision of higher education. Earlier studies have assumed that changes in the higher education policy of one state affect the distribution of students across states but not the overall size of the student body (Justman and Thisse 1997, Justman and Thisse 2000, Kemnitz 2005, Mechtenberg and Strausz 2008).

The main results of this paper can be summarized as follows: First, and as expected, the mobility of students and graduates distorts the quality choice of state governments and results in an inefficiently low level of university quality. The model thus indicates that previous results, obtained under the assumption that the number of students is exogenously given, also hold in the more general framework of this paper.

Furthermore, the result that universities are underfunded is obtained independently of whether local governments differentiate fees between in-state and out-of-state students. Allowing state governments to price discriminate between students of different origin does therefore not restore incentives to invest into higher education. Rather, local governments charge higher fees from out-of-state students and use the revenue to subsidize in-state students. This affects the locational decision of students and thus adds a second distortion: some students who would actually prefer to study abroad will refrain from doing so to benefit from lower tuition costs at home or not study at all. The equilibrium number of students under a preferential fee regime is therefore lower than under a regime where governments must levy equal fees to all students.

[2]In 2004, the share of regional funds in total expenditure on higher education was 84,6% in Spain, 78,8% in Germany, 76,2% in Belgium and 47,2% in the U.S. according to OECD figures (OECD, 2004)

A similar result holds for the welfare effects of preferential fee regimes. Allowing governments to set differentiated fees unambigously reduces federal welfare.

The results therefore suggest that allowing governments to set different tuition fees for in-state and out-of-state students would be the opposite of a second-best policy. Rather, I find that abandoning preferential fee regimes unambiguously raises welfare in a federation.

The clear-cut result that a restriction of preferential fee-regimes enhances welfare is in contrast to some of the literature on preferential tax-regimes. In an early paper, Keen (2001) has argued that a restriction of preferential tax-regimes is harmful as it reduces government revenue. Although this result has later been qualified by Janeba and Smart (2003) for the case that the average size of the tax-base is not fixed in the aggregate and by Haupt and Peters (2005) for tax-bases with a home bias, none of the studies provide unambigous support for the abolishment of preferential policy regimes. An exemption is Janeba and Peters (1999), but their setup is less applicable here, as they consider one tax-base that is fully mobile and one tax-base which is completely immobile.

The divergence in results between this literature and the present paper are mainly rooted in different assumptions about the objective of local governments. In the preferential-tax regime literature governments are assumed to maximize revenue. The incentive to grant tax preferences is therefore a result of different tax-base elasticities. Under this assumptions, it is possible that a restriction of preferential tax regimes leads governments to compete for other tax-bases in a less efficient way.

Under the welfare maximization objective considered in this paper a different mechanism is at work: local governments use the possibility to differentiate tuition fees to shift part of the financial burden of higher education to out-of-state students. As aggregate expenditure on higher education does not change, this merely adds a further distortion and unambiguously reduces welfare, calling for an abolishment of preferential fee-regimes.

The work presented in this paper is also related to the literature of publicly funded higher education in the presence of student mobility. Apart from the literature already mentioned the work closest to mine is that of Büttner and Schwager (2003) and Schwager (2007). Both papers argue that the introduction of a tuition fee can reduce the inefficiencies that arise from a decentralized provision of higher education. While Büttner and Schwager (2003) restrict the analysis to an exogenously given tuition fee, Schwager (2007) includes tuition fees into the set of instruments over which state governments compete and demonstrates that this restores the efficiency of decentralized decision making. Although he is not explicit about whether universities are initially funded by a tuition fee or a lump-sum tax his model is structurally similar to the model presented in this paper when universities are entirely privately funded. In this special case a similar result is obtained in the model presented here. However, being able to exogenously vary the composition of public and private funds, the present paper indicates that this argument might not extend to the more general case in which universities are partially publicly funded.

The model presented in this paper also shows that there are limits to the extension of instruments over which governments compete. In particular, the welfare gains associated with the introduction of a tuition fee that are identified by Büttner and Schwager (2003) and Schwager (2007) might be reduced if governments are allowed to set differentiated fees.

The remainder of the paper is organized as follows. Section 2 introduces the basic framework. Section 3 then characterizes the first-best solution that would be obtained if all decisions were made by the central government. Section 4 considers the non-cooperative solution with and without the possibility to set differentiated fees and Section 6 concludes.

2 The Model

Let us consider a federation which is composed out of two identical states $i \in \{A, B\}$. Each state provides a university of quality $q_i \geq 0$. A student who attends a university of quality q_i acquires $H(q_i)$ units of human capital. A better education increases the level of human capital $H'(q_i) > 0$ but with non-increasing marginal returns to quality $H''(q_i) \leq 0$.

Universities are operated by the public sector and there are no private alternatives to university education. This assumption is arguably more appropriate for some countries than for others but allows the analysis to focus on the effects of preferential fee regimes. A government which provides a university of quality q_i to a number of n_i students incurs costs $C(n_i, q_i) = n_i c(q_i)$, where $c' > 0, c'' \geq 0$. While this cost function is sufficiently general, it rules out economies of scale in the education of students.

Both states are inhabited by a continuum of families with mass one. Each family has one child of a type $(\theta, v) \in [\rho - \overline{\theta}, \rho + \overline{\theta}] \times [0, \overline{v}] \subset \mathbb{R} \times \mathbb{R}$ where $\rho \in [0, \overline{\theta}]$. The first parameter θ captures non-monetary costs of migrating from one state to the other, such as leaving social networks. These costs can be negative to account for the fact that some individuals prefer to migrate in order to benefit from amenities in the destination state. The parameter ρ captures a 'home bias' in children's migration decisions. If $\rho > 0$ then there will be more in-state than out-of-state students when both states pursue identical policies. Note that none of the results in this paper depends on the presence of a home bias. Introducing a home bias makes the model however more easily comparable to that of Haupt and Peters (2005) which facilitates the comparison of this model to the literature on preferential tax-regimes. The assumption that $\rho \leq \overline{\theta}$ ensures that there are at least some out-of-state students in the case when both states implement identical policies. The second parameter v measures individual specific costs of attending university. These costs can for instance be interpreted as capturing different levels of effort necessary to pass final exams. Both parameters, θ and v, are uniformly and independently distributed.

Children can either attend university and become high-skilled employees or work in a low-skilled occupation which does not require a university degree. This occupational choice is based on a comparison of utility reached in a high-skilled and low-skilled position.

Individual preferences are linear in lifetime income y.[3] All low-skilled individuals earn the same income which can be normalized to zero without loss of generality. The lifetime utility of a child (θ, v) who does not attend university is thus determined by its type alone:

$$V^L(\theta; v) = -\mathbf{1_M}\theta \tag{1}$$

where $\mathbf{1_M}$ equals one if the individual decides to migrate and zero if he stays in his home state. Similarly, lifetime utility of an individual who chooses to become high-skilled is

$$V^H(y, \theta, v) = y - \mathbf{1_M}\theta - v \tag{2}$$

Governments finance expenditure for higher education from two sources. Firstly, students pay a tuition fee which might vary across states. We denote by f_i (f_i^*) the tuition fees that an in-state (out-of-state student) pays in state i.

Additional funding comes from a linear income tax with tax-rate τ. To match the institutional set up of most federations, this tax-rate cannot be altered by sub-national governments. Note that under this assumption, the level of the income tax-rate determines the composition of public and private university funding. The model therefore entails purely fee-funded universities, as for instance considered by Schwager (2007) as a special case ($\tau = 0$).

Production takes place with a Ricardian-technology in a perfectly competitive labor-market. Each efficiency unit of human capital is remunerated with a wage that is normalized to one. Tuition fees and the quality of universities thus completely determine the lifetime income that a graduate from state i receives in a common labor market

$$y_i = (1 - \tau)H(q_i) - f_i \tag{3}$$

for in-state students and

$$y_i^* = (1 - \tau)H(q_i) - f_i^* \tag{4}$$

for out of state students. In the case that $y_A = y_B$ and $y_A^* = y_B^*$ we drop indices and simply write y and y^*.

Governments are benevolent and maximize the welfare of the children born in their state, regardless of where they work or study. The motivation underlying this assumption

[3]Note that all results derived in this paper also hold for the more general case in which utility is increasing and concave in income.

is that governments act in the interest of the immobile parents who care about the utility of their children, independently from where they live.

Within the theoretical framework of this model it is possible that governments discriminate not only in tuition levels, but also in quality of higher-education provided to students of different origin. However, as such a discrimination is not observed in practice, it is assumed in the remainder of the paper that state governments can set differentiated tuition-, but not quality levels. The reason that universities do not set differentiated quality levels might for instance be due to the fact that such a policy would be extremely costly. To avoid, for instance, that out-of-state students benefit from highly qualified teachers, universities would have to offer separate lectures for in and out-of-state students. The additional administrative costs of separating students of different origin might outweigh any costs savings from providing lower quality to out-of-state students. Moreover, while states might have an incentive to pursue this policy, universities are likely to have diverging interests and want to realize positive peer-effects from highly able out-of-state students[4].

The timing of the model is as follows: First, state governments decide upon the quality of universities and the tuition fees charged from in- and out-of-state students. After observing the decisions of the government individuals make an occupational and locational choice deciding where to live and whether to study or not. After graduation, only an exogenously given fraction δ of students find a job in the state where they attended university. All other graduates are matched with a job in the other state. This assumption accounts for the empirically well established fact that graduates are mobile after completing university. Busch (2007), for instance, reports that ten years after graduation about 30% of the German graduates live in a state that is different to the state where they completed their studies. Mohr (2002) comes to similar conclusions. He finds that 18 month after graduation about one fifth of German students work in a city that is at least 200 kilometers away from where they completed their studies. One possible explanation for the observed labor market matching process is that students specialize in a certain field of their discipline while firms with a demand for these specific skills are located in other regions.

In the following, the game described above is analyzed backwards, beginning with the occupational and locational choice of the children.

2.1 Occupational and Locational Choice

Given an arbitrary policy $\{q_A, q_B, f_A, f_A^*, f_B, f_B^*\}$ set in the first stage of the game, utility of high and low skilled individuals is completely determined. An individual's decision over where to work or study and whether to become high-skilled or not therefore becomes

[4]For a more detailed analysis of diverging interest between public universities and state governments see Groen and White (2004).

a discrete choice between four alternatives: studying at home, studying abroad, working at home and working abroad. Using (1) to (4) we can summarize utility of a child of type (θ, v) who is born in state i under each of the four alternatives as follows:

	high-skilled	low-skilled
State i	$y_i - v$	0
State j	$y_j^* - v - \theta$	-θ

Assuming that all individuals choose their most preferred alternative it turns out that the number of in-state (out-of-state) students in state $i \in \{A, B\}$ can be expressed in a simple functional form which depends only on income levels; i.e. $s_{ii} = s_{ii}(y_i, y_j^*)$ and $s_{ij} = s_{ij}(y_i, y_j^*)$.

Proposition 2.1 *Let y_i, y_i^* denote lifetime income levels of individuals who graduate from university in state $i \in \{A, B\}$. Then, the number of in-state students in state i (out-of-state students in state j) equals $s_{ii} = max\{0, S_{ii}\}$ ($s_{ij} = max\{0, S_{ij}\}$), where*

$$S_{ii}(y_i, y_j^*) = \begin{cases} (\overline{\theta} + \rho)y_i + (y_i - y_j^*)y_j^* + \frac{1}{2}(y_i - y_j^*)^2 & \text{if } y_j^* < y_i \\ (\overline{\theta} + \rho + y_i - y_j^*)y_i & \text{else} \end{cases} \tag{5}$$

and

$$S_{ij}(y_i, y_j^*) = \begin{cases} (y_j^* - y_i + (\overline{\theta} - \rho))y_j^* & \text{if } y_j^* < y_i \\ (\overline{\theta} - \rho)y_j^* + (y_j^* - y_i)y_i + \frac{1}{2}(y_j^* - y_i)^2 & \text{else} \end{cases} \tag{6}$$

Proof See the appendix.

Note that both functions s_{ii} and s_{ij} are continuous and differentiable at $y_i = y_j^*$. We denote the total number of students in state i by $s_i = s_{ii} + s_{ji}$. It is illustrative to compare these functions to the tax-bases in Janeba and Smart (2003) and Haupt and Peters (2005). To this end, note that if there is a home-bias (i.e. $\rho > 0$) the number of in-state students at $y_i = y_i^*$ responds less elastic to changes in income than the number of out-of-state students[5]. Relating tuition fees in this paper to taxes in the literature in preferential fee regimes the number of in-state students corresponds to the less elastic tax-base in Janeba and Smart (2003) and to the FDI of foreign investors in Haupt and Peters (2005). As a byproduct, the model of demand for higher-education developed in this section therefore provides a micro-foundation for the allocation of the mobile factor in the work of Haupt and Peters (2005) and Janeba and Smart (2003).

Figure 1 depicts for given $y_i > y_j^*$ how all children born on region i sort endogenously into in-state and out-of-state students as well as in-state and out-of-state workers.

[5]From (5) and (6) we obtain at $y_i = y_i^*$: $\epsilon_{ii} = \frac{\partial s_{ii}}{\partial y_i}\frac{y_i}{s_{ii}} = 1 + \frac{y_i}{\overline{\theta}+\rho} < 1 + \frac{y_i^*}{\overline{\theta}-\rho} = \frac{\partial s_{ji}}{\partial y_i^*}\frac{y_i^*}{s_{ji}}$

We are now able to analyze how a marginal change in the income of the high-skilled affects the number of children in state i who attend university. Let us first-consider the case in which $y_i > y_j^*$. We then obtain from (5) and (6)

$$\frac{\partial s_{ii}}{\partial y_i} = (\overline{\theta} + \rho + y_i) > 0 \qquad \frac{\partial s_{ij}}{\partial y_i} = -y_j^* < 0$$

Obviously, if income for in-state students rises, there will be more individuals who decide to begin a study in their home state. At the same time, the number of children born in state i who study abroad $j \neq i$ declines. Changes in the income earned by out-of-state students who graduated in region j has the opposite effect on the occupational choice of children born in state i:

$$\frac{\partial s_{ii}}{\partial y_j^*} = -y_j^* < 0 \qquad \frac{\partial s_{ij}}{\partial y_j^*} = (2y_j^* - y_i + \overline{\theta} - \rho) > 0$$

If the income for out-of-state students, y_j^*, in state j increases some of the children in state i will study in $j \neq i$ rather than at home. Accordingly, the number of in-state students in state i declines while the number of state i children who study in state $j \neq i$ rises. Note that in order to sign the above derivatives we have used that $(y_j^* - y_i + \overline{\theta} - \rho) \geq 0$ and $(y_i - y_j^* + \overline{\theta} + \rho) \geq 0$ which must hold in order to guarantee a non-negative mass of in and out-of-state students. For the case that $y_i \leq y_j^*$ we obtain

$$\frac{\partial s_{ii}}{\partial y_i} = (\overline{\theta} + \rho + 2y_i - y_j^*) > 0 \qquad \frac{\partial s_{ij}}{\partial y_i} = -y_j^* < 0$$
$$\frac{\partial s_{ii}}{\partial y_j^*} = -y_i < 0 \qquad \frac{\partial s_{ij}}{\partial y_j^*} = (\overline{\theta} - \rho + y_j^*) > 0$$

Having analyzed how changes in the income of the high-skilled affects the number of students in the federation we can now look at the welfare changes associated with changes in income.

2.2 Welfare

Given income levels y_i, y_j, y_i^*, y_j^* welfare W^i of the children born in state $i \in \{A, B\}$, here taken as the sum of utilities of all children born in state i, is completely determined. It is convenient to express W^i in terms of income levels:

$$W^i = \begin{cases} \int_{\rho-\overline{\theta}}^{y_j^*-y_j} \int_0^{y_j^*} y_j^* - v - \theta dv d\theta \\ - \int_{\rho-\overline{\theta}}^{y_j^*-y_i} \int_{y_j^*}^{\overline{v}} \theta dv d\theta - \int_{y_j^*-y_j}^{0} \int_{v}^{\overline{v}} \theta dv d\theta & \text{if } y_j^* < y_i \\ + \int_{y_j^*-y_i}^{0} \int_0^{y_j^*+\theta} y_i - v dv d\theta + \int_0^{\rho+\overline{\theta}} \int_0^{y_i} y_i - v dv d\theta \\ \\ \int_{\rho-\overline{\theta}}^{0} \int_0^{y_j^*} y_j^* - v - \theta dv d\theta + \int_0^{y_j^*-y_i} \int_0^{y_j^*-\theta} y_j^* - v - \theta dv d\theta & \text{else} \\ + \int_{y_j^*-y_i}^{\rho+\overline{\theta}} \int_0^{y_i} y_i - v dv d\theta - \int_{\rho-\overline{\theta}}^{0} \int_{y_j^*}^{\overline{v}} \theta dv d\theta \end{cases} \tag{7}$$

The first and the fourth line in the above function is the sum of utilities of all state i children who study in state j. The aggregate utility of the out-of-state workers from state i is given by the second line and the last term in (7). The remaining terms describe aggregate utility of the in-state students.

It is a straightforward exercise to show that for all $(y_i, y_j^*) \in \mathbb{R} \times \mathbb{R}$ a marginal increase in the income of the in-state students in state i has the following impact on the welfare of state i citizens

$$\frac{\partial W^i}{\partial y_i} = s_{ii}$$

Marginal changes of the income of in-state students in state i leave the utility of individuals who are indifferent between studying and working or studying at home or abroad unaffected. Utility of the other in-state students changes one to one with income. In a similar way, a marginal change in the income of the out-of-state student in state j effects the welfare of state i citizens as follows:

$$\frac{\partial W^i}{\partial y_j^*} = s_{ij}$$

In this section we have seen how changes in the higher-education policy of one state affects the number of students and welfare in the federation. This concludes the analysis of the second stage of the game. Before we turn to the first stage, in which equilibrium policies are determined, let us briefly think about what a first-best policy would look like.

3 The First-Best Solution

This section studies the policy choice $\{q_A, q_B, f_A, f_A^*, f_B, f_B^*\}$ of a social planner who strives to maximize total ("federal") welfare $W = W^A + W^B$. This first-best policy is then used as a welfare benchmark against which we are going to evaluate the decentralized policy outcomes.

In choosing the optimal education policy the social planner has to ensure that expenditure on universities equals government revenue:

$$\begin{aligned} s_A c(q_A) + s_B c(q_B) &= \tau[s_A H(q_A) + s_B H(q_B)] \\ &+ f_A s_{AA} + f_A^* s_{BA} + f_B s_{BB} + f_B^* s_{AB} \end{aligned}$$

The first-order conditions characterizing the solution to the planner's optimization problem add little to our understanding and have therefore been moved to the appendix (page 40). The first-order conditions do however imply that quality in both states is chosen such that the marginal per-capita product of human capital equals marginal per-capita costs of quality:

$$H'(q^{FB}) = c'(q^{FB}) \tag{8}$$

It is also possible to show that it is optimal to finance educational investments without discriminating between in-state and out-of-state students.

Result 1 *In a symmetric solution the social planner chooses* $f = f^*$

Proof See the appendix.

Result 1 says that under the first-best policy the location decision of citizens is undistorted. Hence, all individuals with non-negative migration costs live in their home state while all other individuals (high-and low-skilled) move to the other region.

To obtain the number of students in the first-best note that tuition fees must balance the budget constraint. In equilibrium the number of students is identical in both states. The budget constraint therefore implies that $c(q^{FB}) = \tau H(q^{FB}) + f$. Inserting into (3) and (4) yields

$$y^{FB} = y^{FB*} = H(q^{FB}) - c(q^{FB}) \tag{9}$$

We see that every students bears the full costs of his education through taxes and tuition fees. Looking at equation (8) and (9) it becomes apparent that under the optimal policy the net income of the high-skilled is maximized. We can use y^{FB} and y^{FB*} to determine the number of students in each state of the federation as:

$$s^{FB} = 2\overline{\theta} y^{FB}$$

4 Non-cooperative equilibrium

In the previous section we analyzed the policy choice of a social planner who internalizes all fiscal externalities arising from the mobility of either students or graduates. Within the framework of this paper, where governments are benevolent, such a policy could in principle be obtained by assigning the authority over the choice of the higher education policy to the central government.

In fact, a number of papers have already outlined the inefficiencies likely to arise under decentralized policy making, where the mobility of students distorts the decision making of local governments (Justman and Thisse 1997, Justman and Thisse 2000, Kemnitz 2005, Mechtenberg and Strausz 2008). Although this argumentation speaks in favor of a centralization of higher education policies, there are still many countries in which these policies are set by sub-national governments. For instance, in Belgium, Germany and Spain, more than 75% of expenditure on higher education come out of regional funds (OECD, 2004). This suggest that in many countries the allocation of authority over higher education policies to sub-national governments has developed historically and cannot be changed in the short-run.

Moreover, the assumption that a central government would implement the first-best solution rests on some implicit assumptions. In particular, it requires that decisions in the central government are made by benevolent politicians who maximize the sum of utilities in the federation. Recent literature has however begun to explore the implications of alternative assumptions. In this respect the work of (Besley and Coate 2003) and (Lockwood 2002) have received wide attention. Both authors adopt a political economy approach of fiscal decentralization. The key difference of these models to the earlier literature is to assume that decisions in the central government are no longer made by benevolent politicians, but by a legislature whose representatives have diverging interests over local policies. One way to incorporate this view into models of fiscal federalism is to assume that the central legislative is composed out of representatives which are benvolent in the sense that they perfectly act in the interest of the voters of the region from which they are elected. Under these circumstances, members of the legislative have conflicting interests over higher education policies . The implemented policy will then depend on the legislative bargaining process in which these conflicts are resolved. In this case it is no longer true that centralized decision making is superior to decentralized decision making (see Lockwood (2006) for a survey). In appendix B we show that this also holds in a simplified version of the model presented in this paper.

In the following we therefore carry out a 'context dependent' analysis which takes as given that, for historical or other reasons, higher education policies are set by sub-national governments. The aim of the analysis is then to assess whether sub-national governments should be allowed to compete in an unconstrained manner over their higher-education policies or whether this competition should be restricted by federal legislation; i.e. by ruling out preferential fee-regimes.

We now assume that the higher education policy is controlled by state governments. A government in state $i \in \{A, B\}$ chooses tuition fees $\{f_i, f_i^*\}$ and the quality of universities $\{q_i\}$ to maximize the utility of its own citizens W^i, taking the policy $\{q_j, f_j, f_j^*\}$ of the other state as given.

4.1 No discrimination

We begin by analyzing the policies of state governments under the constraint that governments are not allowed to set different levels of tuition fees for in-state and out-of-state students ($f_i = f_i^*$). In this case a balanced budget in state $i \in \{A, B\}$ requires:

$$c(q_i) = \tau\delta H(q_i) + (1-\delta)\tau\frac{s_j}{s_i}H(q_j) + f_i \tag{10}$$

We see that the revenue necessary to cover the per-capita costs of higher education in region i is given by a sum of three terms. The first term on the right hand side in (10) corresponds to the tax-payments of graduates from region i who also work in that region. Note that because graduates are mobile, this is only a fraction δ of the tax-payments of all students educated in state i. The second term on the right corresponds to the tax-payments of region j graduates that spill over to region i. The remaining per-capita expenditure has to be financed out of tuition fees, hence the third term on the right-hand-side of (10).

The first-order conditions for the optimal choice of the two instruments q_i and f_i are

$$(1-\tau)H'(q_i)s_{ii} = -\lambda(1-\delta)\tau\frac{\partial s_j/s_j}{\partial q_i}H(q_j) + \lambda(c'(q_i) - \tau\delta H'(q_i)) \tag{11}$$

$$-s_{ii} = -\lambda(1-\delta)\tau\frac{\partial s_j/s_i}{\partial f_i}H(q_j) - \lambda \tag{12}$$

Making use of the fact that $\frac{\partial s_i/s_j}{\partial q_i} = -(1-\tau)H'(q_i)\frac{\partial s_i/s_j}{\partial f_j}$ and inserting the former into the latter equation we find that the quality-choice q^{ND} of state i is independent of the other states policy and uniquely defined by

$$c'(q^{ND}) = (1-\tau(1-\delta))H'(q^{ND}) \tag{13}$$

Next, we ensure the existence of a Nash-equilibrium.

Proposition 4.1 *There exists a unique symmetric Nash equilibrium in which both states choose quality according to (13).*

Proof See the appendix.

Equation (13) indicates that the mobility of graduates lowers the return of educational investments. As only a fraction δ of the graduates pay taxes in the state where they attended university, each state is only able to collect a fraction $(1-\delta)$ of the tax-revenue from the students it has educated. Comparing (8) and (13) we see that state governments, who anticipate the spill-over of tax-revenue to other states, choose an inefficiently low level of quality. This is the familiar result that decentralization of higher education policies distorts investment decisions of sub-national governments, which had been obtained earlier under the assumption that the number of students was independent of the higher education policy (Justman and Thisse 1997).

Note that this analysis contains purely privately financed universities as a special case ($\tau = 0$). In the absence of public funds there is no spill-over of tax-revenue to other regions and state governments choose the quality of universities efficiently. In this special case the model presented in this paper is structurally similar to that of Schwager [6]. My results therefore reinforce the argument that that the quality choice under decentralization can be efficient if state governments can freely decide on the level of a tuition fee (Schwager 2007). However, in the more general framework of this paper, we are also able to see that this argument does necessarily generalize to the more general case where universities are at least partially publicly funded. At least in this model, the decentralized quality choice remains distorted if there is a positive level of public funds ($\tau > 0$) and graduates are not completely immobile ($\delta < 1$).

To obtain the number of students in the non-cooperative equilibrium note that, given equilibrium quality as defined in (13), tuition fees must adjust to balance the budget. From the budget constraint we thus obtain the equilibrium income of in-state and out-of-state students as $y^{ND} = H(q^{ND}) - c(q^{ND})$. From (8) and (13) we obtain that $y^{ND} \leq y^{FB}$, where the inequality is strict when the quality choice is distorted; i.e. when $\delta < 1$ and $\tau > 0$. The number of students under decentralization without discrimination in each state is then

$$s^{ND} = 2\overline{\theta} y^{ND} \leq s^{FB}$$

For $\delta < 1$ and $\tau > 0$ welfare is therefore clearly lower than in the first-best. To see this note that individuals who decide to become high-skilled under decentralized decision-making would also do so under the first-best policy (since $y^{FB} \geq y^{ND}$). Individuals who would attend university under the first-best policy but would decide to remain low-skilled in the present setting are also worse off under decentralization. Finally, utility of individuals who remain low-skilled in the first-best and under decentralization is equal under both policies. This establishes that $W^{FB} \geq W^{ND}$. This conclusion is summarized in the following Proposition.

Proposition 4.2 *If preferential fee regimes are banned, $\delta < 1$ and universities are not entirely privately funded; i.e. $\tau > 0$, then the following holds: i) welfare is higher under centralization than under decentralization and ii) The number of students under decentralization is lower than under centralization.*

4.2 Discrimination

We now turn to the situation in which state governments compete unrestricted over higher-education policies. In particular, they are allowed to set differentiated tuition fees

[6] Albeit he is not explicit about whether in his model universities are funded by a lump-sum tax or a tuition fee and there is no conceptual difference between the two instruments.

for in-state and out-of-state students. The budget constraint faced by a state $i \in \{A, B\}$ now becomes

$$s_i c(q_i) \;=\; \tau[\delta s_i H(q_i) + (1-\delta)s_j H(q_j)] + s_{ii} f_i + s_{ji} f_i^*$$

Again, each local government sets the level of tuition fees $\{f_i, f_i^*\}$ and the quality of the universities $\{q_i\}$ in its state, taking the policy $\{q_j, f_j, f_j^*\}$ of the other government as given. The first-order conditions defining the best-response function of state i are:

$$\begin{aligned}(1-\tau)H'(q_i)s_{ii} = \lambda&\frac{\partial(s_{ii}+s_{ji})}{\partial q_i}(c(q_i) - \tau\delta H(q_i) - f_i)\\ -\lambda&\frac{\partial(s_{jj}+s_{ij})}{\partial q_i}((1-\delta)\tau H(q_j) - f_i^*) + \lambda(c'(q_i) - \delta\tau H'(q_i))\end{aligned} \tag{14}$$

$$\begin{aligned}-s_{ii} = \lambda&\frac{\partial s_{ii}}{\partial f_i}(c(q_i) - \tau\delta H(q_i) - f_i)\\ -\lambda&\frac{\partial s_{ij}}{\partial f_i}(1-\delta)\tau H(q_j)) - \lambda s_{ii}\end{aligned} \tag{15}$$

$$\begin{aligned}0 = \lambda&\frac{\partial s_{ji}}{\partial f_i^*}(c(q_i) - \tau\delta H(q_i) - f_i^*)\\ -\lambda&\frac{\partial s_{jj}}{\partial f_i^*}(1-\delta)\tau H(q_j)) - \lambda s_{ji}\end{aligned} \tag{16}$$

Upon adding (15) and (16) and inserting the result into (14) we find that the quality choice q^D of state i is independent of the other states strategy and determined by

$$c'(q^D) = (1-\tau(1-\delta))H'(q^D) \tag{17}$$

Again, the outflow of graduates distorts the quality choice of state governments. Yet, comparing (17) with (13) we find that in this model, permitting state governments to price-discriminate between their own students and students from other states has no further effect on the level of investment into higher education.

This is despite the fact, that local governments will make use of price-discrimination once they are given the opportunity to do so. To see this, note that a balanced-budget constraint in state i implies

$$c(q^D) - \tau\delta H(q^D) - f_i^* = (1-\delta)\tau\frac{s_j}{s_i}H(q^D) + \frac{s_{ii}}{s_i}(f_i - f_i^*) \tag{18}$$

Using (18) in (16) we obtain

$$\frac{\partial s_{ji}}{\partial f_i^*}\left[(1-\delta)\tau\frac{s_j}{s_i}H(q^D) + \frac{s_{ii}}{s_i}(f_i - f_i^*)\right] - \frac{\partial s_{jj}}{\partial f_i^*}(1-\delta)\tau H(q^D) - s_{ji} = 0$$

As the last two terms of this equation are negative and $\frac{\partial s_{ji}}{\partial f_i^*} < 0$ it must be that $\Delta \equiv f_i^* - f_i > 0$. Looking at equation (15) and (16) we see that state governments set higher fees for out-of-state students in order to shift the financial burden of higher education to citizens of the other state. In fact, the first-order equation (16) shows that the government in state i sets tuition fees for out-of-state students to maximize the net revenue it receives from state $j \neq i$ citizens. This revenue is composed out of the net revenue from out-of-state students in state i; i.e. $s_{ji}(c(q) - \tau\delta H(q) - f_i^*)$ and the spill-over of taxrevenue from in-state students in state j, $s_{jj}(1-\delta)\tau H(q)$.

It is interesting to note that there is anecdotal evidence that policymakers are indeed aware of the possibility to set fees for out-of-state students at revenue maximizing levels. Between 1990 and 1996 Pennsylvania almost doubled tuition fees for non-resident students at state universities from 4312 USD to 8566 USD. As a result, Pennsylvania's state universities lost a significant part of their non-resident students. In 1996 Pennsylvania's State System of Higher Education therefore published a report[7] in which it recommended to

> "Review [...] the current out-of-state tuition rates, to determine if additional revenue that could be generated from increasing the number of non-resident students at some universities warrants adjustments in existing policies." (p. 18)[8]

In a similar vein, a member of the board of regents of Wisconsin's state university describes the factors that determine tuition fees for out-of-state students as follows:

> "The tuition that a nonresident student pays not only covers the cost of that student's education but it actually produces a profit, if you want to call it that. [...] We're able to use the profit that we make on the out-of-state funds to educate more Wisconsin students."[9]

While tuition levels for out-of-state students are chosen to maximize revenue state governments take into account that higher fees for in-state students not only increases revenue, but also reduce welfare of their citizens (15). This explains why higher fees are charged from out-of-state students. The way preferential fees are used to redistribute from in-state to out-of-state students can be seen more directly when inserting (18) into (3) and (4). We then obtain the following equilibrium income levels for in and out-of-state students:

$$y_i = H(q^D) - c(q^D) + \frac{s_{ji}}{s_i}\Delta \tag{19}$$

$$y_i^* = H(q^D) - c(q^D) - \frac{s_{ii}}{s_i}\Delta \tag{20}$$

It is apparent that for positive levels of discrimination $\Delta > 0$, which prevail in equilibrium, in-state students earn more than their net-contribution to GDP (and as $q^{ND} = q^D$

[7] *Imperatives for the future: A plan for Pennsylvania's state system of higher education*

[8] Quote from Noorbakhsh and Culp (2002)

[9] Quote from Glater (2008)

also more than if preferential fee regimes were banned). The higher income for in-state students comes at the expense of out-of-state students, who end up consuming less than their net-output.

4.3 Welfare under discrimination

How does welfare under this regime compare to a situation with decentralized provision of higher education where price-discrimination is not possible? To answer this question it is useful to introduce some terminology.

Definition A *policy vector* is a vector $(q_A, q_B, f_A, f_B, f_A^*, f_B^*) \in \mathbb{R}^6$, describing a policy (q_i, f_i, f_i^*) for each state $i \in \{A, B\}$ which is consistent with a balanced budget in both states.

Definition A *symmetric policy vector* is a policy vector $p = (q_A, q_B, f_A, f_B, f_A^*, f_B^*)$ which prescribes identical policies for each state; i.e. $q_A = q_B = q, f_A = f_B = t$ and $f_A^* = f_B^* = f^*$. We denote such a vector as $p = (q, f, f^*)$.

The following lemma shows that welfare is higher when price-discrimination is not possible.

Lemma 1 *Let $p = (q, f, f^*)$ and $p' = (q, f', f^{*'})$ be two symmetric policy vectors. Assume further, that i) p describes a policy which discriminates between in-state and out-of-state students; i.e. $f^* = f + \Delta$, $\Delta \neq 0$ and ii) in-state and out-of-state students are treated equally under p'; i.e. $f^{*'} = f'$. Then welfare in the federation is strictly higher under p' than under p.*

Proof See the appendix.

Corollary 1 *Welfare under decentralization decreases if local governments are allowed to price-discriminate.*

Proof Under decentralized decision making, when discrimination is not possible, the policy vector describing equilibrium policies is $p = (q^{ND}, q^{ND}, f, f, f, f)$. If price discrimination is possible, the resulting equilibrium policy vector is $p' = (q^D, q^D, f, f, f^*, f^*)$ with $f < f^*$. As $q^{ND} = q^D$ we can apply Lemma 1 to prove the proposition. ∎

We therefore arrive at the following welfare ranking.

$$W^{FB} \geq W^{ND} > W^D$$

Obviously, preferential fee regimes do not change incentives for state governments to invest into the quality of universities, but only distort student's migration decisions.

The welfare analysis of this section therefore indicates that state governments have an incentive to coordinate their behavior and mutually commit not to price-discriminate between in-state and out-of-state students. However, the foregoing analysis shows that charging higher fees for out-of-state students is always a best-strategy, regardless of the tuition fees charged in the other state. A mutual commitment not to engage in price-discrimination will thus not be binding. This result has important policy implications for countries that prefer to determine their higher education policies at the sub-national level. In these countries inefficiencies arising from the decentralized provision of higher education can be reduced if independent federal legislation prevents state governments from setting different tuition fees for in-state and out-of-state students.

4.4 Number of students under Discrimination

In recent years increasing the participation in higher education has ranked high amongst policy maker's objectives in many countries. It is therefore interesting to extend the present analysis and investigate how the introduction of preferential fee regimes affects the number of students in a federation.

In the previous section we have seen that, when allowed to set differentiated fees, state governments will charge higher fees from out-of-state students, such that $f_i^* = f_i + \Delta$ for $\Delta > 0, i \in \{A, B\}$. Figure 2 shows how allowing state governments to make use of preferential fee regimes affects the occupational and locational choice of high-school graduates in state $i \in \{A, B\}$. In this figure $y_i^{ND} = y_j^{ND*}$ denotes income for in and out-of-state students in an equilibrium where price discrimination is not possible. Furthermore, $y_i^D > y_j^{D*}$ denote equilibrium income levels under a preferential fee regime. As $q^D = q^{ND}$ we know that $y^D < y^{ND} < y^{ND*}$. Looking at Figure 2 shows that, starting from a fiscal arrangement without fee preferences and allowing governments to engage in price-discrimination, results in three effects on occupational and locational choices of high-school graduates in both states.

Firstly, as fee preferences lead to a higher income for in-state students, there will be some additional high-school graduates who decide to attend higher education at home. These individuals correspond to area ABCD in Figure 2.

Secondly, the fact that a preferential fee regime raises fee levels for out-of-state students but leads to lower fees for in-state students distorts the locational choice. Some students with a preference to live abroad ($\theta < 0$) will now become in-state students in order to benefit from lower tuition levels. These students correspond to area AHGFE in Figure 2.

A third effect concerns the number of high-school graduates from state i who decide to attend a university in state $j \neq i$. Under a preferential fee regime, lifetime income of out-of-state students declines. Some individuals, with a preference to live in state $j \neq i$ who initially decided to attend university in state j will now decide to work in state j.

These individuals are indicated by area AEIJ.

While the second effect leaves the total number of students born in state i unaffected, the other two effects exert an opposing influence on the occupational choice. The first effect tends to increase the number of students, but the second effect works in the opposite direction.

It can be shown that the third effect always dominates the first. For any level of discrimination $\Delta > 0$ in which the budget in states is balanced, the decline in the number of out-of-state students in the federation exceeds the increase in the number of in-state students.

This is summarized by the following Lemma which asserts that there is a negative relationship between the level of discrimination and the number of students in the economy.

Lemma 2 *Let $p = (q, f, f^*)$ and $p' = (q, f', f^{*'})$ be two symmetric policiy vectors where the policiy described by p does not differentiate fees between in and out-of-state students; i.e. $f = f^*$, but $f^{*'} = f' + \Delta$, for $\Delta \neq 0$. Then the number of students under p is higher than under p'.*

Proof See the appendix.

This lemma shows that financing a given quality $\tilde{q}$ without differentiating tuition fees for students of different origin leads to a higher total number of students. Recalling that the equilibrium quality in a non-cooperative game is independent of whether price-discrimination is used or not and that local governments will make use of price-discrimination once they are allowed to do so, we can apply Lemma 2 to obtain the following Corollary.

Corollary 2 *The number of students in a federation is higher, if preferential fee regimes are banned.*

Proof Noting that $q^{ND} = q^D$ and that $f^{D*} > f^D$ if discrimination is possible we can directly apply Lemma 2 with $\tilde{q} = q^{ND} = q^D$. ▮

This argument entails the following ranking of the equilibrium number of students under the two regimes considered in this paper: $s^{FB} \geq s^{ND} > s^D$. While under decentralized decision making over higher education policies the number of students is already lower than in the first-best this inefficiency is further aggravated by allowing state governments to set preferential fees.

4.5 Relation to the literature on preferential tax regimes

In the foregoing section we have seen that a ban of preferential fee regimes has an unambiguously positive effect on federal welfare and the number of students in the economy. This result is in contrast to some of the related work on preferential tax regimes. Keen (2001), for instance, shows that a complete ban of preferential fee regimes is not desirable. In two later papers Janeba and Smart (2003) and Haupt and Peters (2005) have shown that this result can be reversed if the size of the tax-bases is not fixed in the aggregate or when tax-bases have a home bias. However, none of these studies lend unambiguous support to the claim that preferential fee regimes always reduce welfare.

The contrasting conclusions of the present paper are obtained despite the close similarity between the tax-bases in (Janeba and Smart 2003) and (Haupt and Peters 2005) and the number of in and out-of state students in this paper[10]. It is therefore worthwhile to briefly identify the reasons driving these different results.

We have already seen that the reason why state governments make use of preferential fee regimes stems from the intention to redistribute income from out-of-state students to in-state students. In contrast, in the work on preferential tax regimes, differences in tax-rates arise from differences in the elasticities of tax-bases. Keen (2001) considers two bases that differ in their international mobility. Janeba as well as Haupt, consider two tax-bases that are equally mobile internationally, but respond differently to changes in the tax instruments of a given country. In Haupt and Peters (2005), the difference in the elasticity of the tax-bases comes from a home bias which makes domestic investments in a country less elastic than foreign direct investment. In all three papers governments choose to tax the more mobile base at a lower rate.

The differences in results between the present paper and related work is rooted in different assumptions on the government objective. If governments in this model were to follow a similar objective as in (Janeba and Smart 2003) or (Haupt and Peters 2005) and maximize revenue from tuition fees $R_i = f_i s_{ii} + f_i^* s_{ji}$, the present model would yield similar results. To see this it is sufficient to note that the home bias of capital in the model of Haupt and Peters (2005) is identical to the home bias of high-school graduates in the present paper. Consequently, as in Haupt and Peters (2005), the number of in-state students responds less elastically to changes in income, than the number of out-of-state students. Assuming that quality is equal across states, as is the case in equilibrium, the number of in-state students s_{ii} in this model has therefore similar properties than the domestic base in Haupt and Peters (2005).

As the mobile factor is modeled in a similar way in both approaches this leaves the different government objectives as the only source for the divergent conclusions. In this context, note that in this paper the elasticity of demand for higher-education does

[10] Unlike in the model of Haupt and Peters (2005), but similar to Janeba and Smart (2003), the number of students in this paper is not fixed in the aggregate

influence the level of discrimination via the home bias Δ (see equations 15 and 16). However, this force is dominated by the state governments motive to shift the financial burden of higher-education to citizens of the other state.

The home bias of capital in the model of Haupt and Peters (2005) is identical to the home bias of high-school graduates in the present paper. Consequently, as in Haupt and Peters (2005), the number of in-state students responds less elastically to changes in income, than the number of out-of-state students. Assuming that quality is equal across states, as is the case in equilibrium, the number of in-state students s_{ii} in this model has therefore similar properties than the domestic base in Haupt and Peters (2005).

In essence, under the welfare maximization objective considered in this paper, results are driven by the intention to redistribute from in to out-of-state students. Under the revenue-maximization objective in the other work considered in this section, differences in the elasticities of tax-bases are at the heart of the results.

5 Extensions

So far, we have treated the fraction of university graduates who migrate after obtaining their degree as exogenously given. This section shows that the results obtained in earlier sections of this article also hold when this assumption is relaxed.

In the following we assume that the parameter δ depends endogenously on the quality of higher education in both regions[11]. The rationale for this assumptions is that investments into the quality of higher education not only increase the income of university graduates but also benefit local industries. Jaffe (1989) for instance provides empirical evidence that expenditure on university research has a positive effect on corporate patents. One might also assume that investments into higher-education helps to attract new businesses and increases the employment opportunities for high-skilled labor. If this is the case increases in the quality of universities in a state i make it more likely that a university graduate educated in either region is matched with a job in that state. Conversely, if the other state $j \neq i$ raises its quality the probability that a university graduate remains in state i decreases. We model this relationship by assuming that the attachment parameter of state i is a function of the quality of higher education in both states: $\delta_i = \delta_i(q_i, q_j)$. We need to require that $-\frac{\partial \delta_i}{\partial q_j} = \frac{\partial \delta_i}{\partial q_i} > 0$ as well as $\lim_{q_i \to \infty} \delta_i = 1$ and $\lim_{q_j \to \infty} \delta_i = 0$[12].

In the following we argue that this extension does not alter the main results of the paper.

Let us first consider the efficient allocation in this extended setup. Because the budget-constraint of the social planner is independent of the migration decisions of

[11] I thank Christina Kolerus and Thomas Lange for pointing this out to me.

[12] The function $\delta_i(q_i, q_j) = \frac{e^{qi}}{e^{q_i} + e^{q_j}}$ has these properties.

university graduates (see page 11) the first-best quality remains unchanged and is still characterized by (8). Accordingly Result 1 remains to hold and it is still efficient to set identical fees for in-state and out-of-state students.

Turning next to the case where the higher education policies are determined by state governments who are not allowed to price-discriminate the budget-constraint of state i (10) now becomes

$$c(q_i) = \tau\delta_i(q_i, q_j)H(q_i) + (1 - \delta_j(q_i, q_j))\frac{s_j}{s_i}H(q_j) + f_i$$

As first-order conditions defining the best-response function of state i we obtain

$$\begin{aligned}(1-\tau)H'(q_i)s_{ii} = &- \lambda(1-\delta)\tau\frac{\partial s_j/s_j}{\partial q_i}H(q_j) + \lambda(c'(q_i) - \tau\delta H'(q_i))\\ &- \lambda\tau H(q_i)\frac{\partial\delta_i}{\partial q_i} + \lambda\tau H(q_j)\frac{\partial\delta_j}{\partial q_i}\end{aligned} \tag{21}$$

$$-s_{ii} = -\lambda(1-\delta)\tau\frac{\partial s_j/s_i}{\partial f_i}H(q_j) - \lambda \tag{22}$$

Using equation (22) in (21) we find that quality $\tilde{q}^{ND}$ in a symmetric equilibrium is characterized by

$$c'(\tilde{q}^{ND}) = (1 - \tau(1-\delta_i))H'(\tilde{q}^{ND}) + 2\tau H(\tilde{q}^{ND})\frac{\partial\delta_i}{\partial q_i} \tag{23}$$

Equilibrium quality is now determined by two effects: first, the mobility of graduates still reduces the incentives of state governments to invest into higher education. This is the first term on the right-hand side of (23). However, there is now an additional term reflecting the fact that state governments can attract mobile university graduates by investing in quality. Unlike the former effect this tends equilibrium quality to be higher than in the first-best.

We see that in general quality in a non-cooperative equilibrium is still inefficient. In particular, there is at most one tax-rate $\tilde{\tau} \in [0,1]$ for which equilibrium quality corresponds to (8). However, it is now possible that quality in equilibrium is inefficiently high.

Whenever quality $\tilde{q}^{ND}$ deviates from the first-best level q^* the income of university graduates $w(\tilde{q}^{ND}) - c(\tilde{q}^{ND})$ is lower than in the first-best. It follows that the number of students under decentralization is inefficiently low whenever $\tau \neq \tilde{\tau}$. This result was already obtained for $\tilde{\tau} = 0$ in the case where δ was exogenously given (see Section 4.1).

Next, we turn to the case where state governments can set preferential fees. Under the specific assumptions of this section the government in state i now faces a budget-constraint

$$s_i c(q_i) = \tau[\delta_i(q_i, q_j)s_i H(q_i) + (1 - \delta_j(q_i, q_j))s_j H(q_j)] + s_{ii}f_i + s_{ji}f_i^* \tag{24}$$

We assume again that the government in state i takes the policy $\{q_j, f_j, f_j^*\}$ as given when choosing its own policy. As first-order conditions defining the best-response function of state i we obtain

$$\begin{aligned}(1-\tau)H'(q_i)s_{ii} = {} & \lambda\frac{\partial(s_{ii}+s_{ji})}{\partial q_i}(c(q_i)-\tau\delta H(q_i)-f_i) \\ & -\lambda\frac{\partial(s_{jj}+s_{ij})}{\partial q_i}((1-\delta)\tau H(q_j)-f_i^*) \\ & +\lambda(c'(q_i)-\delta\tau H'(q_i))-\lambda\tau(H(q_i)\frac{\partial\delta_i}{\partial q_i}-H(q_j)\frac{\partial\delta_j}{\partial q_i})\end{aligned} \tag{25}$$

$$\begin{aligned}-s_{ii} = {} & \lambda\frac{\partial s_{ii}}{\partial f_i}(c(q_i)-\tau\delta H(q_i)-f_i) \\ & -\lambda\frac{\partial s_{ij}}{\partial f_i}(1-\delta)\tau H(q_j))-\lambda s_{ii}\end{aligned} \tag{26}$$

$$\begin{aligned}0 = {} & \lambda\frac{\partial s_{ji}}{\partial f_i^*}(c(q_i)-\tau\delta H(q_i)-f_i^*) \\ & -\lambda\frac{\partial s_{jj}}{\partial f_i^*}(1-\delta)\tau H(q_j))-\lambda s_{ji}\end{aligned} \tag{27}$$

After inserting (26) and (27) into (25) it turns out that in a symmetric equilibrium of the non-cooperative game quality $\tilde{q}^D$ is determined by

$$c'(\tilde{q}^D) = (1-\tau(1-\delta_i))H'(\tilde{q}^D) + 2\tau H(\tilde{q}^D)\frac{\partial\delta_i}{\partial q_i} \tag{28}$$

Comparing this to equation (23) we see that the possibility to differentiate tuition fees has no effect on equilibrium quality. This was also a main result of our earlier analysis and still holds in this extended setting.

Following the same steps as on page 15 to show that state governments levy a higher fee on out-of-state students; i.e. $\tilde{f}^{D*} > \tilde{f}^D$.

To compare welfare under discrimination with a regime where equal fees must be charged from in-state and out-of-state students we can apply Lemma 1 and 2 to the policy vectors $(\tilde{q}^D, \tilde{f}^{D*}, \tilde{f}^D)$ and $(\tilde{q}^{ND}, \tilde{f}^{ND}, \tilde{f}^{ND})$. As before, we thus find that the possibility to set preferential fees unambiguously reduces welfare and the number of students in the federation.

In sum, we have seen that the results of earlier sections in this paper are robust to endogenizing the attachment parameter δ.

6 Conclusion

This paper explored the consequences of allowing sub-national governments to implement preferential fee regimes with respect to federal welfare and individuals decisions to pursue a university education. The analysis indicates that subnational governments have an incentive to use such preferential policies to shift a part of the financial burden of higher education to out-of-state students. It was shown that this distorts the migration decision of high school graduates and reduces welfare. In addition, higher costs of attending university in other states prevents those students from attending university who have a strong negative home attachment, resulting in a reduction of the number of students in the federation. The issue of how different fiscal arrangements (here the possibility to use preferential fee regimes) feeds back on the number of students could not be addressed in earlier models, where the number of students was independent of the higher education policy.

The results of this analysis lead to some policy recommendations. In countries with a strong preference for a decentralized provision of higher education federal legislation should nevertheless constrain independent policy making of state governments by requiring them to levy equal tuition fees to in-state and out-of-state students. This result might also affect legal decision making in some countries. In Germany for instance, there is currently considerable legal uncertainty about whether the introduction of preferential fee regimes (*Landeskinderregelungen*) would be in accordance with constitutional statues (Pieroth 2007).

This research could be extended in a variety of ways in the future. While the present analysis considers the higher education policy of sub-national governments within a federation it might be useful to shift the focus of the analysis to an international setting. In such a set-up one might want to assume that governments can also determine the tax-rate on labor income generated within its jurisdiction. This type of analysis would become interesting, once the Bologna process increases the mobility of students between the member states of the EU.

In addition, to make the analysis more tractable, I have assumed that countries are symmetric. However, on a state as well as on a European level, there are considerable size differences between the jurisdictions engaged in higher-education policy making. It would therefore be interesting to find out more about the effect of preferential fee-regimes when there is heterogeneity in the size of the jurisdictions.

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A Mathematical Appendix

A.1 Proof of Proposition 2.1

To obtain the number of in-state and out-of-state students for given income levels y_i and y_j^* let $\mathcal{I}_i$ denote the set of all in-state students in state $i \in \{A, B\}$. This set comprises all children (θ, v) who prefer studying at home to studying in state $j \neq i$ $(\theta \geq y_j^* - y_i)$ as well as to working at home $(v \leq y_i)$ and to working abroad $(y_i - v \geq -\theta)$. More formally, $\mathcal{I}_i = \{(\theta, v) | \theta \geq y_j^* - y_i \wedge y_i - v \geq -\theta \wedge v \leq y_i\}$. The number of in-state students in region i, s_{ii}, is then equal to the mesure of the set $\mathcal{I}_i$. To express this measure in terms of y_i and y_j^* let us first define the set of all state i children who prefer studying at home to studying in the other state and to working at home as $\mathcal{I}'_i = \{(\theta, v) | \theta \geq y_j^* - y_i \wedge v \leq y_i\} \supseteq \mathcal{I}_i$. In case $y_i \leq y_j^*$ we have that $\mathcal{I}_i = \mathcal{I}'_i$. Recalling that θ and v are uniformly and independently distributed we then obtain $|\mathcal{I}_i| = |\mathcal{I}'_i| = max\{\int_{y_j^* - y_i}^{\overline{\theta}} \int_0^{y_i} dv d\theta, 0\} = max\{(\overline{\theta} - y_j^* + y_i) y_i, 0\}$. When $y_i > y_j^*$ we need to take into account that some children in the set $\mathcal{I}'_i$ actually prefer working abroad to working and studying at home. In this case the set of all in-state students in i becomes $\mathcal{I}_i = \mathcal{I}'_i - (\mathcal{I}'_i \cap \{(\theta, v) | y_i - v < -\theta\})$. We thus obtain $|\mathcal{I}_i| = max\{|\mathcal{I}'_i| - \int_{y_j^* - y_i}^{0} \int_{y_i + \theta}^{y_i} dv d\theta, 0\} = max\{|\mathcal{I}'_i| - \frac{1}{2}(y_j^* - y_i)^2, 0\}$ for $y_i > y_j^*$. Summing up, we obtain the number of in-state students in state i as a function of y_j^* and y_i as $s_{ii} = |\mathcal{I}_i| = max\{0, S_{ii}\}$, where

$$S_{ii}(y_i, y_j^*) = \begin{cases} (\overline{\theta} + \rho)y_i + (y_i - y_j^*)y_j^* + \frac{1}{2}(y_i - y_j^*)^2 & \text{if } y_j^* < y_i \\ (\overline{\theta} + \rho)y_i + (y_i - y_j^*)y_i & \text{else} \end{cases}$$

In a similar way, we obtain the number of out-of-state students in state j as $s_{ij} = max\{0, S_{ij}\}$, where

$$S_{ij}(y_i, y_j^*) = \begin{cases} (y_j^* - y_i + (\overline{\theta} - \rho))y_j^* & \text{if } y_j^* < y_i \\ (\overline{\theta} - \rho)y_j^* + (y_j^* - y_i)y_i + \frac{1}{2}(y_j^* - y_i)^2 & \text{else} \end{cases}$$

■

A.2 Proof of Result 1

In a symmetric solution the following holds $f_A = f_B = f$ and $f_A^* = f_B^* = f^*$. The proof consists of showing that the first-order conditions (30) and (31) can only hold if $f = f^*$. In the following, g denotes the per-capita expenditure on higher education that needs to be financed out of tuition fees $g = c(q^C) - \tau H(q^C)$. Solving (31) for λ and inserting into (30) yields

$$\frac{-s_{ii}}{\frac{\partial s_{ii}}{\partial f_i}(g - f) + \frac{\partial s_{ij}}{\partial f_i}(g - f^*) - s_{ii}} = \frac{-s_{ji}}{\frac{\partial s_{ji}}{\partial f_i^*}(g - f^*) + \frac{\partial s_{jj}}{\partial f_i^*}(g - f) - s_{ji}}$$

Now, note that if the central governments budget is balanced the following holds: $g - f = \frac{s_{ji}}{s_i}(f^* - f)$. Similarly, we have $g - f^* = -\frac{s_{ii}}{s_i}(f^* - f)$. Upon inserting into the above equation we obtain

$$s_{ji}(f^* - f)\left[\frac{\partial s_{ii}}{\partial f_i}\frac{s_{ji}}{s_i} - \frac{\partial s_{ij}}{\partial f_i}\frac{s_{ii}}{s_i}\right] = s_{ii}(f^* - f)\left[\frac{\partial s_{jj}}{\partial f_i^*}\frac{s_{ii}}{s_i} - \frac{\partial s_{ji}}{\partial f_i^*}\frac{s_{jj}}{s_i}\right]$$

The square bracketed term on the left is non-positive while the square bracketed term on the right is non-negative. The last equation can therefore only be fulfilled if $f^* - f$. ■

A.3 Proof of Proposition 4.1

The proof consists of two steps: first, we show that there is a unique solution to the first-order conditions and then we demonstrate that this solution corresponds to a maximum of a states objective function.

For the first step, we show that $t_A = t_B$ if quality in both states is set according to (13). Let us therefore assume that quality is equal in both states and chosen according to (13). Then the budget constraints in both states require that

$$\begin{aligned} c(q^i) - \tau\delta H(q_i) - f_i &= \tau(1 - \delta)H(q_j)\frac{s_j}{s_i} \\ c(q_j) - \tau\delta H(q_j) - f_j &= \tau(1 - \delta)H(q_i)\frac{s_i}{s_j} \end{aligned}$$

Now, subtracting the latter from the former equation we obtain

$$f_j - f_i = \tau(1-\delta)H(q_j)(\frac{s_j}{s_i} - \frac{s_j}{s_i})$$

Assume without loss of generality that $f_i < f_j$. Then the left-hand side of the above equation is positive but the right-hand side is negative which is a contradiction. Hence, it must hold that $f_A = f_B$.

For the second part of the proof we show that the determinant of the bordered Hessian is strictly positive when evaluated at the first-order conditions. It is helpful to introduce some notation. Let us write the Lagrangian of state i as $\mathcal{L} = W^i(q_i, f_i) - \lambda BC(q_i, f_i)$, where $BC(q_i, f_i; q_j, f_j) = s_i(c(q_i) - \tau H(q_i)) - s_i f_i - s_j(1-\delta)\tau H(q_j)$. Furthermore, abbreviate $\partial BC/\partial x$ as BC_x for $x \in \{q_i, f_i\}$. Similarly, write $\mathcal{L}_{xy}$ for $\partial^2\mathcal{L}/\partial x \partial y$ and $x, y \in \{q_i, f_i\}$. The bordered Hessian then becomes

$$H = \begin{pmatrix} 0 & BC_{q_i} & BC_{f_i} \\ BC_{q_i} & \mathcal{L}_{q_i q_i} & \mathcal{L}_{q_i f_i} \\ BC_{f_i} & \mathcal{L}_{f_i q_i} & \mathcal{L}_{f_i f_i} \end{pmatrix}$$

Making use of the fact that $BC_{q_i} = -(1-\tau)H'(q_i)BC_{f_i}$, if evaluated at q^{ND} and f^{ND}, we may write

$$\begin{aligned} det(H) = BC_{f_i}\big[&(1-\tau)H'(q^{ND})(BC_{q_i}\mathcal{L}_{f_i f_i} - BC_{f_i}\mathcal{L}_{q_i f_i}) \\ &+ (BC_{q_i}\mathcal{L}_{f_i q_i} - BC_{f_i}\mathcal{L}_{q_i q_i})\big] \end{aligned}$$

and in fact

$$\begin{aligned} det(H) = -(BC_{f_i})^2(1-\tau)\big[&H'(q^{ND})(\underbrace{((1-\tau)H'(q^{ND})\mathcal{L}_{f_i f_i} + \mathcal{L}_{q_i f_i})}_{=0}) \\ &+ H'(q^{ND})\mathcal{L}_{f_i q_i} + \mathcal{L}_{q_i q_i}\big] \end{aligned}$$

The first term vanishes because $\mathcal{L}_{q_i f_i} = -(1-\tau)H'(q^{ND})\mathcal{L}_{f_i q_i}$ at f^{ND}, q^{ND}. By differentiating (11) and (12) and evaluating at q^{ND} and f^{ND} we obtain

$$\begin{aligned} det(H) = -(BC_{f_i})^2 \big(&(1-\tau)H''(q^{ND})s_{ii} \\ &- \lambda(c''(q^{ND}) - \tau\delta H''(q^{ND}))\big) > 0 \end{aligned}$$

which completes the proof. ∎

A.4 Proof of Lemma 1

It is sufficient to consider only state A as all results also hold for state B. First, note that we are considering identical policies in both states. Hence we have $s_A = s_B = s$, $s_{AA} = s_{BB}$ and $s_{AB} = s_{BA}$. A balanced budget therefore implies that

$$sc(q) = s_{AA}f + s_{BA}f^* + s\tau H(q) \tag{32}$$

which can be rearranged to give

$$c(q) - \tau H(q) - f = \frac{s_{BA}}{s_A}(f^* - f) \tag{33}$$

$$c(q) - \tau H(q) - f^* = -\frac{s_{AA}}{s_A}(f^* - f) \tag{34}$$

We are going to show, that welfare of all citizens born in state A has a unique maximum at $f = f^*$. Maximizing $W^A(\overline{q}, \overline{f}, \overline{f}^*)$ subject to (32) and noting that policies in both states change in exactly the same way yields the following first-order conditions.

$$-s_{AA} = \lambda \left[\frac{\partial s_{AA}}{\partial \overline{f}} \frac{s_{BA}}{s}(\overline{f}^* - \overline{f}) - \frac{\partial s_{BA}}{\partial \overline{f}} \frac{s_{AA}}{s}(\overline{f}^* - \overline{f}) - s_{AA} \right]$$

$$-s_{BA} = \lambda \left[\frac{\partial s_{AA}}{\partial \overline{f}^*} \frac{s_{BA}}{s}(\overline{f}^* - \overline{f}) - \frac{\partial s_{BA}}{\partial \overline{f}^*} \frac{s_{AA}}{s}(\overline{f}^* - \overline{f}) - s_{BA} \right]$$

where we have already used (33) and (34). Solving the latter equation for λ and inserting into the former yields after some rearrangements

$$\left[\frac{\partial s_{AA}}{\partial \overline{f}} \frac{s_{BA}}{s} - \frac{\partial s_{BA}}{\partial \overline{f}} \frac{s_{AA}}{s} \right] (\overline{f}^* - \overline{f}) = \left[\frac{\partial s_{AA}}{\partial \overline{f}^*} \frac{s_{BA}}{s} - \frac{\partial s_{BA}}{\partial \overline{f}^*} \frac{s_{AA}}{s} \right] (\overline{f}^* - \overline{f})$$

As the square-bracketed term on the lhs is negative, while the square-bracketed term on the right is positive it must be that $\overline{f}^* = \overline{f}$ for welfare to be maximal. ∎

A.5 Proof of Lemma 2

Let s_i (s'_i) be the number of students in state $i \in \{A, B\}$ under policy vector p (p'). Similarly, s_{ii} and s_{ji} (s'_{ii} and s'_{ji}) denote the number of in- and out-of-state students under p (p'). Then, because we are considering symmetric policies, we have $s_A = s_B = s$ ($s'_A = s'_B =' s$), $s_{AA} = s_{BB}$ ($s'_{AA} = s'_{BB}$) and $s_{AB} = s_{BA}$ ($s'_{AB} = s_{BA}$'). The budget constraint in region i then becomes

$$c(q) - \tau H(q) = \frac{s_{ji}}{s_i} f_i^* + \frac{s_{ii}}{s_i} f_i \tag{35}$$

Using (35) in (3) and (4) we obtain

$$y_i = H(q) - c(q) + \frac{s_{ji}}{s}\Delta \tag{36}$$

$$y_i^* = H(q) - c(q) - \frac{s_{ji}}{s}\Delta \tag{37}$$

and similarly we obtain y'_i and $y_i^{*'}$ for policy vector p'. We want to show that $s > s'$ for all $\Delta \neq 0$ for which the number of in- and out-of-state students is non-negative. This means that we can restrict attention to those Δ for which $\overline{\theta} - \rho > \Delta > -(\overline{\theta} + \rho)$. By (5) and (6) we have that $s > s'$ holds if and only if

$$2\overline{(}H(q) - c(q)) > 2\overline{\theta}(H(q) - c(q)) + \overline{\theta}\frac{s'_{ji} - s'_{ii}}{s'_i}\Delta + \frac{1}{2}\Delta^2 + \rho\Delta$$

or,

$$2\overline{\theta}(s'_{ii} - s'_{ji})\Delta > s'_i\Delta(\Delta + 2\rho) \tag{38}$$

We need to distinguish two cases.
Case I: $\Delta > 0$. Plugging (5) and (6) into (38) we obtain

$$2\overline{\theta}[(\overline{\theta} + \rho)y' + \Delta y^{*'} + \frac{1}{2}\Delta^2 - (\overline{\theta} - \Delta - \rho)y^{*'}] > (\Delta + 2\rho)[\overline{\theta}(y' + y^{*'}) + \frac{1}{2}\Delta^2 + \rho\Delta]$$

Using, that $y - y^* = \Delta$, which we obtain from (36) and (37), this inequality can be rewritten as follows:

$$\begin{aligned} & \overline{\theta}\Delta(y' + y^{*'}) + 2\overline{\theta}\Delta(\overline{\theta} - \Delta) + \Delta^2\overline{\theta} - (2\rho + \Delta)(\frac{1}{2}\Delta^2 + \rho\Delta) > 0 \\ \Leftrightarrow \quad & \overline{\theta}\Delta(y' + y^{*'}) + (\overline{\theta} - \Delta)(2\overline{\theta}\Delta + \Delta^2) + \frac{1}{2}\Delta^3 - 2\rho(\Delta + \rho)\Delta > 0 \\ \Leftrightarrow \quad & \overline{\theta}\Delta(y' + y^{*'}) + \frac{1}{2}\Delta^3 + 2\Delta(\overline{\theta} + \rho)(\overline{\theta} - \rho - \Delta) + \Delta^2(\overline{\rho} - \Delta) > 0 \end{aligned}$$

Recalling that $\overline{\theta} - \rho - \Delta$, if the number of out-of-state students is positive, we see immediately that the last inequality holds.
Case II: $\Delta < 0$. Again, unsing (5) and (6) in (38) we obtain

$$2\overline{\theta}[(\overline{\theta} + \rho)y + \Delta y + \frac{1}{2}\Delta^2 - (\overline{\theta} - \rho)y^{*'} + \Delta y'] < (\Delta + 2\rho)[\overline{\theta}(y' + y^{*'}) + \frac{1}{2}\Delta^2 + \rho\Delta]$$

or,

$$\begin{aligned} & \overline{\theta}\Delta(y' + y^{*'}) + 2\overline{\theta}\Delta(\overline{\theta} + \Delta) - \Delta^2\overline{\theta} - (\Delta + 2\rho)(\frac{1}{2}\Delta^2 + \rho\Delta) < 0 \\ \Leftrightarrow \quad & \overline{\theta}\Delta(y' + y^{*'}) - \overline{\theta}\Delta^2 + 2\Delta[(\overline{\theta} - \rho)(\overline{\theta} + \rho + \Delta)] - \Delta^2(\overline{\theta} + \Delta) < 0 \end{aligned}$$

Again, this holds as $\overline{\theta} + \rho + \Delta > 0$. ∎

A.6 Figures

B A political economy version of the model

In this section we consider a simplified version of the model in which high-school graduates differ only with respect to migration costs but individual costs of attending university are normalized to zero for all individuals. This simplification allows us to analyze

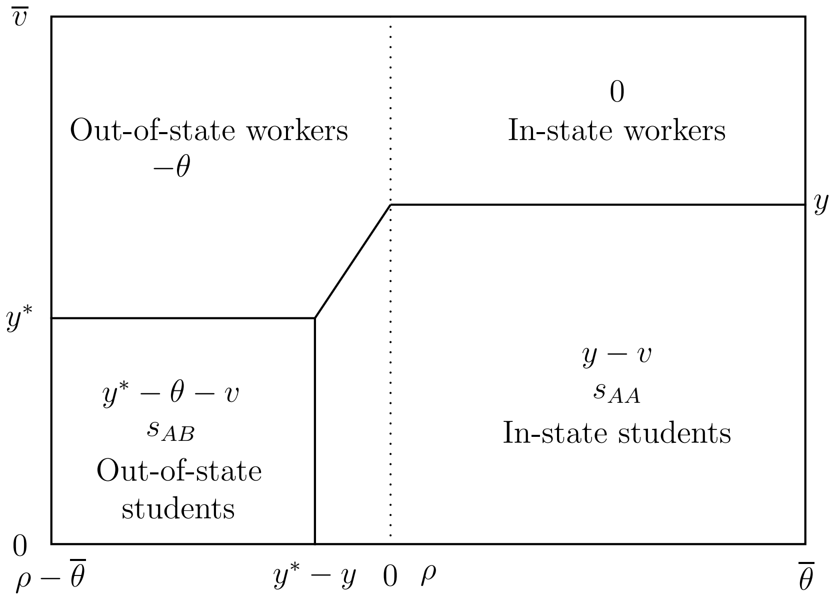

Figure 1: Occupational Choice, given that $y^* < y$

a more complex political process in which the higher-education policies are made by a central legislature that is not fully benelovent. Rather, we assume that each state is represented in the legislature trough a delegate who acts perfectly in the interest of his voters. Delegates are assumed to bargain over the implemented policy. This implies that, unless all representatives have an equal bargaining power, the policy implemented under centralization will favor the citizens in the state who was more successful in the bargaining process. As we will see, the policy implemented under centralization will therefore in general not be efficient. Moreover, based on numerical approximations of federal welfare achieved under centralization and decentralization, we are able to see that under certain parameter constellation welfare under centralization will be lower than under decentralization even when states can use preferential fee regimes.

The simplified version of the model considered here is identical to the baseline model except that individual costs of attending university are zero for all individuals. This implies that all high-school graduates attend university as long as the wage-premium is positive. The individual decision problem in the second stage of the game thus reduces to an occupational choice.

B.1 Occupational Choice

Given the policies (q_i, f_i, f_j^*) for $i \neq j \in \{A, B\}$ set in the first stage of the game a resident of state i studies at home if

$$\theta \leq (1-\tau)(w(q_j) - w(q_i)) + f_i - f_j^*$$

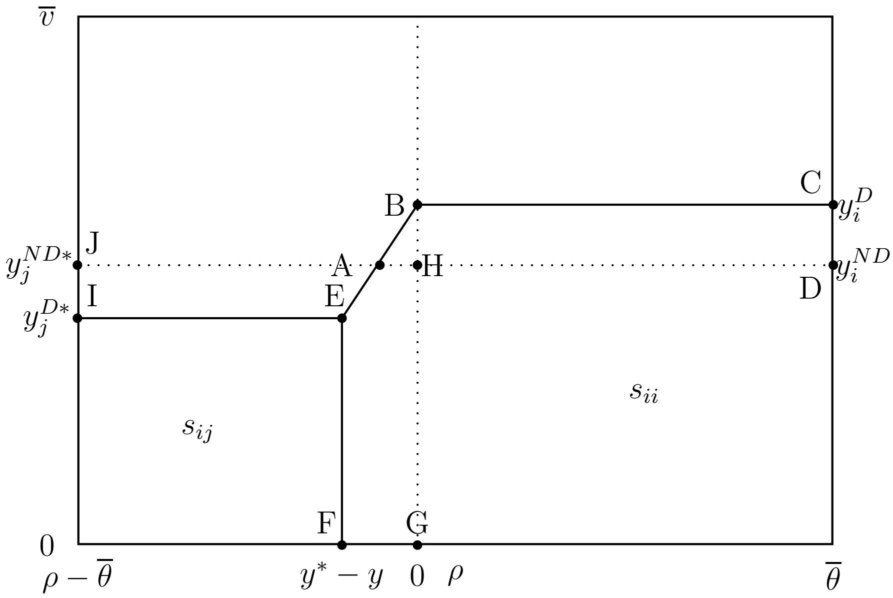

Figure 2: Effects of preferential fee regime on occupational and locational choice of high-school graduates in state i. Area ABCD refers to the increase in in-state students due to a reduction in fees for that group of students. Area AHEIJ shows those individuals who were out-of-state students without fee preferences but decide to work abroad under a preferential fee regime.

The number of in-state and out-of-state students in state $i \in \{A, B\}$ is thus

$$s_{ii} = \frac{\overline{\theta} + \rho - (1-\tau)(w(q_j) - w(q_i)) - f_i + f_j^*}{2\overline{\theta}} \tag{39}$$

$$s_{ji} = \frac{(1-\tau)(w(q_i) - w(q_j)) + f_j - f_i^* - (\rho - \overline{\theta})}{2\overline{\theta}} \tag{40}$$

With the occupational choice in the second stage of the game in place we can turn to the first stage of the game in which the higher education policies are determined. We first introduce a new institutional variant in which policies are determined by a central legislature. Thereafter, we briefly analyze the by now familiar regimes of decentralization with and without the possibility to discriminate tuition fees.

B.2 Centralization

We begin by assuming that higher education policies are determined by a central government. Starting with the familiar case where this government is fully benelovent and maximizes aggregate welfare in the federation we then turn to the case where the central government is composed out of representatives of the two states.

B.2.1 Benelovent government

A benelovent government maximizes the sum of utilities of all individuals in the economy

$$W^C = \frac{1}{2}W^A(q_A, q_B, f, f^*) + \frac{1}{2}W^B(q_A, q_B, f, f^*) \tag{41}$$

subject to the budget constraint

$$s_A g(q_A) + s_B g(q_B) = s_{AA} f_A + s_{BB} f_B + s_{BA} f_A^* + s_{AB} f_B^*$$

where $g(q) = c(q) - \tau w(q)$ denotes the amount of educational per-capita expenditure that has to be financed out of tuition fees. Furthermore, in equation (41) W^i denotes the welfare of the citizens of state i. That is, we have

$$W^i = \int_{\rho-\overline{\theta}}^{y_j^*-y_i} y_j^* - \overline{\theta} d\theta + \int_{y_j^*-y_i}^{\rho+\overline{\theta}} y_i d\theta$$

where the first term is the sum of utilies of the out-of-state students and the latter term is the utility of the students who stay at home. Note that in (41) we have multiplied the welfare function by 0.5 which does not affect the results but makes equilibrium welfare levels comparable to the case where decisions are made by a central legislature.

Maximization of (41) with respect to f_i, f_j^*, q_i for $i \in \{A, B\}$ yields the first-order conditions

$$\begin{aligned}(1-\tau)w'(q_i)(s_{ii}+s_{ji}) = \lambda\left(\frac{\partial s_{ii}}{\partial q_i} + \frac{\partial s_{ji}}{\partial q_i}\right) g(q_i) + \left(\frac{\partial s_{ij}}{\partial q_i} + \frac{\partial s_{jj}}{\partial q_i}\right) g(q_j) \\ - \lambda\frac{\partial s_{ii}}{\partial q_i} f_i - \lambda\frac{\partial s_{jj}}{\partial q_i} f_j - \lambda\frac{\partial s_{ij}}{\partial q_i} f_j^* - \frac{\partial s_{ji}}{\partial q_i} f_i^* \\ - \lambda s_i(c'(q_i) - \tau w'(q_i))\end{aligned} \tag{42}$$

$$-s_{ii} = \lambda(\frac{\partial s_{ii}}{\partial f_i} g(q_i) + \lambda(\frac{\partial s_{ij}}{\partial f_i} g(q_j) - \lambda\frac{\partial s_{ij}}{\partial f_i} f_j^* - \lambda\frac{\partial s_{ii}}{\partial f_i} f_i - \lambda s_{ii} \tag{43}$$

$$-s_{ji} = \lambda(\frac{\partial s_{ji}}{\partial f_i^*} g(q_i) + \lambda(\frac{\partial s_{jj}}{\partial f_i} g(q_j) - \lambda\frac{\partial s_{ji}}{\partial f_i^*} f_i^* - \lambda\frac{\partial s_{jj}}{\partial f_i^*} f_i - \lambda s_{ji} \tag{44}$$

Upon adding the latter two equations and inserting into the former we see that the central government implements the efficient quality q^* in both states.

$$c'(q^*) = w'(q^*)$$

Following the proof of Result 1 it can also be shown that a benelovent government does not distort the locational choice of students; i.e. $f_A = f_B = f_A^* = f_B^*$. Accordingly, a balanced budget requires that $f_i = f_i^* = g(q^*)$. We see that this simplified version of the model yields essentially the same results with respect to quality and tuition fees as the full model.

We now turn to the case where the policy is implemented by a central legislature.

B.2.2 Legislative bargaining

Unlike in the baseline model the central government considered in this subsection does no longer consist of benelovent politicians. Rather, we assume that each state sends a delegate into the federal government who seeks to implement a policy that maximizes the welfare of his home region[13]. The order of events is thus similar to the one in Besley and Coate (2003): First, all citizens in a state elect a policy maker who represents this state in the national legislature. The representatives of both states bargain over the higher education policy $(q_A, q_B, f_A, f_B, f_A^*, f_B^*)$. If we assume that the bargaining power of region A is $\beta \in [0, 1]$ then the central legislature maximizes the following objective function

$$W^{CB} = \beta W^A(q_A, q_B, f, f^*) + (1-\beta) W^B(q_A, q_B, f, f^*)$$

subject to the budget constrained

$$s_A g(q_A) + s_B g(q_B) = (s_{AA} + s_{BB}) f + (s_{BA} + s_{AB}) f^*$$

We furthermore require that the central governments can discriminate between in-state and out-of-state students but not between students of different origin. Hence, we impose that $f_A = f_B = f$ and $f_A^* = f_B^* = f^*$.

The first-order conditions characterizing the policy implemented by the central legislature are shown on page 41. These conditions can be simplified to

$$(1-\tau) w'(q_A)[\beta s_{AA} + (1-\beta) s_{BA}] = \frac{\lambda(1-\tau) w'(q_A)}{\overline{\theta}}[g(q_A) - g(q_B)] + \lambda s_A (c'(q_A) - \tau w'(q_A)) \quad (49)$$

$$(1-\tau) w'(q_B)[\beta s_{AB} + (1-\beta) s_{BB}] = \frac{\lambda(1-\tau) w'(q_B)}{\overline{\theta}}[g(q_B) - g(q_A)] + \lambda s_B (c'(q_B) - \tau w'(q_B)) \quad (50)$$

$$-(\beta s_{AA} + (1-\beta) s_{BB}) = \frac{\lambda}{\overline{\theta}}(f - f^*) - \lambda(s_{AA} + s_{BB}) = 0 \quad (51)$$

$$-(\beta s_{AB} + (1-\beta) s_{BA}) = -\frac{\lambda}{\overline{\theta}}(f - f^*) - \lambda(s_{AB} + s_{BA}) = 0 \quad (52)$$

We can solve the last two equations for λ to obtain $\lambda = 0.5$. Inserting this back into (51) yields

$$(2\beta - 1)(1-\tau)(w(q_B) - w(q_A)) = f - f^* \quad (53)$$

This equation already indicates that the representative with the higher bargaining power pushes for a policy that enables his voters to migrate into the state in which universities

[13]Note that this is a deviation from Besley and Coate (2003) who assumes that each representative seeks to implement his preferred policy. We therefore rule out any effect of strategic voting identified by Besley and Coate (2003)

are of a higher quality. Assume for instance that $\beta > 0.5$ and hence the representative of region A has the greater bargaining power. Then, if quality is higher in A, the implemented policy will have that $f < f^*$ as state A residents gain from studying at home. Conversely, if $q_B > q_A$ the implemented policy entails that $f > f^*$ in order to enable state A residents to attend the better universities in B/

As a first result we show that in general the central legislature implements an inefficient policy.

Result 2 *Assume that $\beta \neq 0.5$. Then the policy implemented by the central legislature entails $q_A \neq q_B \neq q^*$.*

Proof The proof is by contradiction. Assume that $q_A = q_B = q$. Then it follows from (53) that $f = f^*$. Accordingly, we have that $s_{ii} = \frac{\rho+\overline{\theta}}{2\overline{\theta}}$ and $s_{ij} = \frac{\rho-\overline{\theta}}{2\overline{\theta}}$ for $i \neq j \in \{A, B\}$. Furthermore, it is easy to see that the right hand sides of (49) and (50) must be equal. The left hand-sides however reduce to $\frac{1}{2\overline{\theta}}(\overline{\theta}-(1-2\beta)\rho)$ and $\frac{1}{2\overline{\theta}}(\overline{\theta}+(1-2\beta)\rho)$ respectively, which yields a contradiction. ∎

Having seen that for $\beta \neq 0.5$ quality will differ between states the question is: in which state will quality be higher? To answer this question assume that the representative of state A has the greater bargaining power. Will he push for a higher- or lower quality of universities in state A? It is hard to obtain an analytical answer to this question just by manipulating the first-order conditions. It is however plausible to conjecture that if high-school graduates have a home bias ($\rho > 0$) it would be optimal to implement a higher quality in state A and then enable state A citizens cheap access to their home universities by setting $f < f^*$. This argument is summarized in the following

Conjecture 1 *Assume that $\rho > 0$ then the policy implemented by the central legislature will contain that $q_A > q_B$ if $\beta > 0.5$. For $\beta < 0.5$ quality will be higher in state B; i.e $q_A < q_B$. The first-best policy q^* will be implemented in both states if $\beta = 0.5$.*

Figure 3 plots a numerical solution of the model which is consistent with our conjecture. The figure shows the difference in qualities $q_A - q_B$ in dependence of the bargaining power β. We see that the quality in state A rises relative to the one in state B as the bargaining power of state A increases. In particular, we have that $q_A < q_B$ if $\beta < 0.5$ and $q_A > q_B$ if $\beta > 0.5$ which is consistent with Conjecture 1.

So far, we have shown a first major result of this Section: If policy under centralization is determined in a legislature the outcome will in general be inefficient (Result 2). This provides us with a first hint as to why higher-education policies might be implemented decentrally in some countries despite the seeming superiority of the centralized solution. To complete this argument, we still have to show that the outcome of the legislative process might also be worse than the policy obtained in a decentralized system. To see that this situation occurs in the present model we have to characterize briefly the decentralized outcome. In doing so we will see that equilibrium quality levels under decentralization do not differ from those obtained in the full model.

B.3 Decentralization

Under decentralization, both states determine their policies (q_i, f_i, f_i^*) simultaneously, taking the policy of the other state as given. The objective of the government in state $i \in \{A, B\}$ is to maximize welfare of its own citizens; i.e the government of state i maximizes $W^i(q_i, q_j, f_i f_j, , f_i^*, f_j^*)$ subject to the budget constraint

$$s_i c(q_i) = \tau[\delta s_i H(q_i) + (1-\delta) s_j H(q_j)] + s_{ii} f_i + s_{ji} f_i^*$$

We begin with the case where states can set preferential fees and then turn to the situation where price-discrimination is not possible.

B.3.1 Discrimination

Assuming that state governments are allowed to levy different fees on in-state and out-of-state students the first-order conditions characterizing the best-response function of state i are then similar to those obtained in the full model; i.e.

$$\begin{aligned}(1-\tau)H'(q_i)s_{ii} = {} & \lambda \frac{\partial(s_{ii}+s_{ji})}{\partial q_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\ & - \lambda \frac{\partial(s_{jj}+s_{ij})}{\partial q_i}((1-\delta)\tau H(q_j) - f_i^*)\end{aligned} \tag{54}$$

$$\begin{aligned}-s_{ii} = {} & \lambda \frac{\partial s_{ii}}{\partial f_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\ & - \lambda \frac{\partial s_{ij}}{\partial f_i}(1-\delta)\tau H(q_j)) - \lambda s_{ii}\end{aligned} \tag{55}$$

$$\begin{aligned}0 = {} & \lambda \frac{\partial s_{ji}}{\partial f_i^*}(c(q_i) - \tau\delta H(q_i) - f_i^*) \\ & - \lambda \frac{\partial s_{jj}}{\partial f_i^*}(1-\delta)\tau H(q_j)) - \lambda s_{ji}\end{aligned} \tag{56}$$

Applying the same steps as in Chapter 4.2 we find that quality in a non-cooperative equilibrium is given by

$$c'(q^D) = (1 - \tau(1-\delta))H'(q^D)$$

The level of tuition fees f_i and f_i^* is then defined as the solution of (55) and (56). Aggregate welfare in this decentralized equilibrium can be obtained by solving for f_A, f_B, f_A^* and f_B^* and inserting into (41).

B.3.2 No Discrimination

One of the central results obtained in the full model was that allowing state governments to set preferential fees does not affect investments into higher education. All we need to do in order to see that this also holds in the reduced model is to repeat the analysis of

Section B.3.1 under the constraint that tuition fees must be equal for in- and out-of-state students; i.e. $f_i = f_i^*$. The first-order conditions describing the best-response function of state i are then

$$(1-\tau)H'(q_i)s_{ii} = -\lambda(1-\delta)\tau\frac{\partial s_i/s_j}{\partial q_i}H(q_j) + \lambda(c'(q_i) - \tau\delta H'(q_i)) \tag{57}$$

$$-s_{ii} = \lambda(1-\delta)\tau\frac{\partial s_i/s_j}{\partial f_i}H(q_j) - \lambda \tag{58}$$

Again, after inserting (58) into (57) and carrying out some straightforward algebra we find that quality in the symmetric equilibrium is given by

$$c'(q^{ND}) = (1-\tau(1-\delta))H'(q^{ND})$$

which is the same condition as in the case where states can levy preferential fees. As $f_i = f_i^* = t = f^{ND}$ a balanced budget implies that $f^{ND} = g(q^{ND})$. Welfare under decentralization without the possibility to levy preferential fees can then be obtained as before by inserting q^{ND} and t^{ND} into (41).

In the next section we use these results to show that policies determined by a central legislature might be welfare inferior to policies implemented under decentralization.

B.4 Welfare comparison

As it is infeasible to solve for equilibrium welfare in all regimes analytically we follow a much simpler approach and show numerically that there exists plausible parameter constellations under which decentralization outperforms centralized decision making.

Figure 4 shows equilibrium welfare under all four regimes (Centralization benelovent/legislative bargaining and Decentralizaion with/without discrimination) in dependence of the home bias ρ for some plausible assumptions on the functional form of $w(q)$ and $c(q)$ as well as on the values for the parameters $\overline{\theta}$ and δ. Two points are worth noting. First, welfare is declining in the home bias under all regimes. This is simply due to the fact that in any equilibrium the number of in-state students increases with the home bias. For out-of-state students, the preference for living abroad enters the utility additively through the migration costs $-\theta$. For in-state students this preference does not enter the utility function. Consequently, welfare is ceteris paribus higher if more students study abroad. The fact that welfare is falling in ρ is thus a mere side-effect of our modelling assumption and could easily be changed if migration costs would enter the utility function symmetrically for in- and out-of-state students.

Second, for a sufficiently strong home bias, welfare under the policy implemented by a central legislature is inferior to equilibrium under all other institutional regimes. This is the central result of this section. Note that this result is not specific to the chosen parameters. In general, the parameter range for which the policy of the central legislature is less efficient than those obtained under decentralization increases with the parameter δ. Intuitively this is due to the fact that smaller values of δ increase the spill-overs under decentralization which reduces equilibrium welfare. Hence, as δ increases the curves corresponding to welfare under the decentralized regimes are shifted up, while welfare under centralization remains unaffected.

As a look on Figure 4 shows, displaying the relatively small differences in welfare levels graphically is difficult. Table 1 therefore also presents numerically computed welfare levels, albeit for different parameters. The upper table shows essentially the same result as Figure 4: For a sufficiently strong home bias, decision making in a central legislature yields most inefficient outcome. The lower part of Table 1 illustrates that the area in parameter space for which decentralization is superior vanishes as bargaining powers in the legislature become more equal.

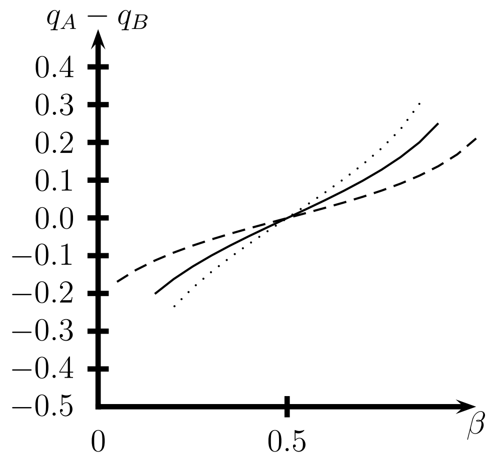

Figure 3: Difference between q_A and q_B when policies are determined in a central legislature. The parameter β denotes the bargaining power of the representative of state A. The figure shows the difference $q_A - q_B$ for $\overline{\theta} = 0.5$, $\rho = 0.2$ (dashed curve), $\rho = 0.35$ (solid curve) and $\rho = 0.5$ (dotted curve).

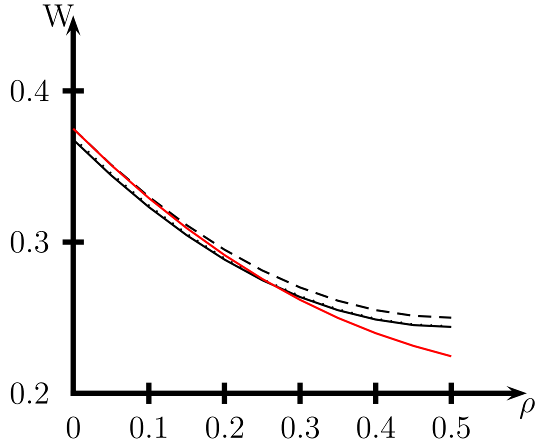

Figure 4: Welfare in dependence on the home bias ρ for different institutional regimes: Centralization (dashed), Central Legislature (red), Decentralization without discrimination (dotted) and Decentralization (solid). We see that for large enough ρ a central legislature implements a policy that is inferior to all other regimes, in particular decentralization. The results were obtained under the assumption that $\overline{\theta} = 0.5$, $\tau = 0.5$, $\delta = 0.7$ and $\beta = 0.2$. Furthermore, the following functional forms were used: $w(q) = \sqrt{(}q)$ and $c(q) = q$.

$$
\begin{aligned}
(1-\tau)H'(q_A)(s_{AA}+s_{BA}) &= \lambda\left[(\frac{\partial s_{AA}}{\partial q_A}+\frac{\partial s_{BA}}{\partial q_A})(c(q_A)-\tau H(q_A))+(\frac{\partial s_{BB}}{\partial q_A}+\frac{\partial s_{AB}}{\partial q_A})(c(q_B)-\tau H(q_B))\right] \\
&\quad -\lambda\left[(\frac{\partial s_{AA}}{\partial q_A}f_A+\frac{\partial s_{AB}}{\partial q_A}f_B^*+\frac{\partial s_{BA}}{\partial q_A}f_A^*+\frac{\partial s_{BB}}{\partial q_A}f_B)\right] \\
&\quad +\lambda\left[s_A c'(q_A)-\tau s_A H'(q_A)\right]
\end{aligned} \tag{29}
$$

$$
-s_{AA} = \lambda\left[\frac{\partial s_{AA}}{\partial f_A}(c(q_A)-\tau H(q_A)-f_A)+\frac{\partial s_{AB}}{\partial f_A}(c(q_B)-\tau H(q_B)-f_B^*)\right]-\lambda s_{AA} \tag{30}
$$

$$
-s_{BA} = \lambda\left[\frac{\partial s_{BA}}{\partial f_A^*}(c(q_A)-\tau H(q_A)-f_A^*)+\frac{\partial s_{BB}}{\partial f_A^*}(c(q_B)-\tau H(q_B)-f_B)\right]-\lambda s_{BA} \tag{31}
$$

$$
\begin{aligned}
(1-\tau)w'(q_A)[\beta s_{AA} + (1-\beta)s_{BA}] = \lambda \left[\left(\frac{\partial s_{AA}}{\partial q_A} + \frac{\partial s_{BA}}{\partial q_A} \right) g(q_A) + \left(\frac{\partial s_{AB}}{\partial q_A} + \frac{\partial s_{BB}}{\partial q_A} \right) g(q_B) \right] \\
-\lambda \left[\left(\underbrace{\frac{\partial s_{AA}}{\partial q_A} + \frac{\partial s_{BB}}{\partial q_A}}_{=0} \right) f + \left(\underbrace{\frac{\partial s_{AB}}{\partial q_A} + \frac{\partial s_{BA}}{\partial q_A}}_{=0} \right) f^* \right]
\end{aligned} \tag{45}
$$

$$
\begin{aligned}
(1-\tau)w'(q_B)[\beta s_{AB} + (1-\beta)s_{BB}] &= \lambda \left[\left(\frac{\partial s_{AA}}{\partial q_B} + \frac{\partial s_{BA}}{\partial q_B} \right) g(q_A) + \left(\frac{\partial s_{AB}}{\partial q_B} + \frac{\partial s_{BB}}{\partial q_B} \right) g(q_B) \right] \\
&- \lambda \left[\left(\underbrace{\frac{\partial s_{AA}}{\partial q_B} + \frac{\partial s_{BB}}{\partial q_B}}_{=0} \right) t + \left(\underbrace{\frac{\partial s_{AB}}{\partial q_B} + \frac{\partial s_{BA}}{\partial q_B}}_{=0} \right) t^* \right]
\end{aligned} \tag{46}
$$

$$
\begin{aligned}
-(\beta s_{AA} + (1-\beta)s_{BB}) &= -\lambda \left[\left(\frac{\partial s_{AA}}{\partial f_A} + \frac{\partial s_{BB}}{\partial f_B} \right) t + \left(\frac{\partial s_{AB}}{\partial f_A} + \frac{\partial s_{BA}}{\partial f_B} \right) t^* \right] \\
&- \lambda(s_{AA} + s_{BB}) = 0
\end{aligned} \tag{47}
$$

$$
\begin{aligned}
-(\beta s_{AB} + (1-\beta)s_{BA}) &= -\lambda \left[\left(\frac{\partial s_{AA}}{\partial f_A^*} + \frac{\partial s_{BB}}{\partial f_B^*} \right) t + \left(\frac{\partial s_{AB}}{\partial f_A^*} + \frac{\partial s_{BA}}{\partial f_B^*} \right) t^* \right] \\
&- \lambda(s_{AB} + s_{BA})
\end{aligned} \tag{48}
$$

Equilibrium Welfare under different institutional regimes				
ρ	C - Pol. Econ	Centr.	Discr. (D)	No Discr. (D)
		$\delta = 0.5, \beta = 0.2$		
0	0.375	0.375	0.359375	0.375
0.05	0.351	0.35125	0.336	0.35125
0.1	0.32913	0.33	0.314375	0.33
0.15	0.309275	0.31125	0.295625	0.31125
0.2	0.2915	0.295	0.279375	0.295
0.25	0.2756	0.28125	0.265625	0.28125
0.3	0.261798	0.27	0.254375	0.27
0.35	0.249863	0.26125	0.24625	0.26125
0.4	0.2398	0.255	0.239375	0.255
0.45	*0.2314*	0.25125	0.235625	0.25125
0.5	*0.2245*	0.25	0.234375	0.25
		$\delta = 0.5, \beta = 0.35$		
0	0.375	0.375	0.359375	0.375
0.05	0.351209	0.35125	0.335625	0.35125
0.1	0.329836	0.33	0.314375	0.33
0.15	0.31088	0.31125	0.295625	0.31125
0.2	0.294341	0.295	0.279375	0.295
0.25	0.28	0.28125	0.265625	0.28125
0.3	0.26851	0.27	0.2543	0.27
0.35	0.259216	0.26125	0.245625	0.26125
0.4	0.252334	0.255	0.239375	0.255
0.45	0.247862	0.25125	0.235625	0.25125
0.5	0.246798	0.257	0.234375	0.25

Table 1: The table shows equilibrium welfare for different parameter constellations and institutional regimes. Welfare under the political economy approach under centralization is in the first column. The second column shows welfare under centralization with a benelovent government. Columns three and four show welfare under decentralization for the case with and without preferential fee regimes. Welfare levels are printed in italics if the legislative bargaining solution is inferior to the decentralized solution. All solutions were obtained under the assumption that $w(q) = \sqrt{q}$, $c(q) = q$ and $\tau = 0.5$.