Essays in Fiscal Federalism
- Welfare Competition and the Funding of Higher Education-

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Contents

Preface

This thesis consists of four essays that each relate to the horizontal interaction of governments. All essays address an issue that is currently the topic of a public debate in Germany. The first three chapters are concerned with the funding of higher education in federal states. In particular they center around the question of how the introduction of tuition fees might affect the quality of universities and the number of students in a federation. The fourth essay investigates whether the German counties are engaged in welfare competition.

In 2005 the German constitutional court lifted a ban that prevented the German states - which are responsible for the provision of higher education - from financing universities with the help of tuition fees. Immediately afterwards some states announced that they would make use of the possibility to introduce tuition fees, sparking a debate about the likely consequences of this decision. While advocates of tuition fees pointed out that additional revenue could be used to improve the quality of universities, opponents warned that raising the costs of higher education would lower enrollment rates. At the same time, a joined commission of the German parliament (*Bundestag*) and the Council of constituent states (*Bundesrat*) was put in place to reorganize the fiscal relations between the central and state governments. As part of the reform the commission strengthened the autonomy of the state governments over higher education policies. While the states welcomed this gain in autonomy some observers warned that the mobility of students would allow state governments to free-ride on each other's expenditure, thus undermining the incentives to invest into the quality of higher education.

These points of dispute show that there are two important dimensions along which the organization of university funding can differ: The composition of public- and private funds and the extent to which public funds are provided by the federal or sub-national governments.

The purpose of the first Chapter of this thesis is to assess theoretically how the composition of university funding and the degree of decentralization interact in determining the equilibrium higher education policy. The question of how tuition fees affect participation in higher education is currently not only in Germany the subject of a controversial debate. Despite this fact earlier work focussing on the funding of higher education in federal states has assumed that the number of students is independent of higher education policies (Gradstein and Justman 1995, Justman and Thisse 1997, Justman and Thisse 2000, Büttner and Schwager 2004, Kemnitz 2005, Schwager 2008). Particular emphasis is therefore given to the question of how variations in the institutional set-up of a federation affect the participation in higher education.

This question is addressed with the help of a simple model in which universities are operated and financed either by federal- or state governments. Governments make costly investments into the quality of universities. Depending on the institutional set-up, they are either restricted to finance universities out of public funds (pure public funding) or might be allowed to augment public funds by the introduction of a tuition fee.

Individuals are mobile before and after attending university. Accordingly, not all students pay taxes in the region where they graduated from university. Tax-payments therefore constitute a channel through which educational expenditure spills over to other regions and distorts the spending decisions of state governments.

The model allows me to draw a number of interesting conclusions. The first result concerns the introduction of tuition fees into a system of purely publicly funded universities and points to an effect that has often been overlooked in the public debate: If governments lack sufficient instruments to tax the high-skilled population the introduction of a tuition fee can raise the quality of universities as well as the number of students. This result even holds when governments seek to maximize revenue and their interests are thus not perfectly aligned with those of the students. The intuition for this result is quite simple: In the absence of tuition fees constraints on raising the income tax rate reduces a governments' incentive to invest into higher education as it does not participate sufficiently in the gains from doing so. In such a situation the availability of a tuition fee can help to circumvent this constraint by restoring the incentives to improve the quality of universities. Starting at low levels of quality the increase in income resulting from a better university education exceeds the tuition fee and thus leads to a higher net income and more students.

The model also shows that whether students fare better when the authority over the higher education policy is assigned to the federal or state governments depends on the relative strength of two effects: under decentralization the mobility of students creates an incentive for state governments to attract future tax-payers by choosing a policy that is favorable to students. On the other hand, not all graduates work in the region where they attended university which means that a part of any investment into higher-education spills over to other regions in the form of the tax-payments of mobile graduates. This effect therefore lowers the incentives to invest in high-quality tertiary education. Whether decentralization benefits students therefore depends on the relative strength of these effects.

The analysis also points to the perhaps surprising possibility that even when state governments implement a lower quality than the central government the number of students might actually be higher under decentralization. In the model this situation occurs if state governments are sufficiently eager to attract future tax-payers and therefore lower the tuition fee enough to outweigh the effect of an inferior quality.

The fact that students in a federation are mobile between states implies that some of them can escape the fee if some states do not make use of tuition fees. In this case the states which still provide universities entirely out of public funds might fear an inflow of students from the fee-states. This scenario corresponds exactly to the situation in Germany after seven out of the sixteen states introduced tuition fees in 2007. As a response, some of the non-fee states pondered the introduction of tuition fees only for out-of-state students in-order to prevent an inflow of students (Pieroth 2007).

Such preferential fee regimes are very common in the U.S. For instance, in the academic year 2007/2008 average tuition fees for out-of-state students (nonresidents) at state universities amounted to 13.183 $ while average fees for in-state students at state universities were only 5.201 $ (Washington Higher Education Coordinating Board 2008).

The welfare effects of preferential fee regimes are however 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 free-ride on the expenditure of other jurisdictions that are identified in the first Chapter. Given that the legitimacy of preferential fee regimes is currently ambiguous in Germany and awaits clarification by legal- or political decision makers, identifying the welfare effects of preferential fee regimes yields important policy recommendations.

To study the welfare consequences of allowing sub-national governments to set preferential fees affects the second Chapter extends the work in Chapter 1 by allowing governments to price-discriminate between in-state and out-of-state students.

The approach followed in the second Chapter is to take decentralized decision-making over higher education policies as given and to ask whether allowing governments to levy preferential fees to domestic students can function as a second-best policy which helps to move the decentralized policy outcome closer to the first-best.

The results however suggest that allowing governments to set different tuition fees for in-state and out-of-state students might be the opposite of a second-best policy.

It is shown that the mobility of students and graduates distorts the quality choice of state governments independently of whether they can set differentiated fees or not. When state governments can price-discriminate between students of different origin they 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 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.

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, it is shown that abandoning preferential fee regimes unambigously raises welfare in a federation.

The model presented in the second chapter of this thesis 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 (2004) and Schwager (2008) might be reduced if governments are allowed to set differentiated fees.

In the theoretical models presented in the first two chapters of this thesis participation in higher education depends on tuition costs and the quality of universities. Keeping quality constant, the models predict that tuition fees are negatively related to enrollment rates. However, in practice, the introduction of tuition fees has often been accompanied by subsidized loan schemes to mitigate potentially adverse effects on credit-constraint students. Moreover, many countries maintain sizeable student aid programs aimed at allowing low-income youth access to higher-education. In reality, the presence of these financial aid systems might cushion the effect of tuition fees on enrollment rates. Whether enrollment figures are really sensitive to prices - and if so the size of the effect - thus remains essentially an empirical question.

In Chapter 3 we therefore use the asymmetric introduction of tuition fees in Germany between 2006 and 2007 as a natural experiment to evaluate the impact of tuition fees on enrollment rates. Based on individual enrollment decisions of the full population of German high-school graduates between 2002 and 2007 we measure the effect of tuition fees by comparing the trend of high-school enrollment amongst residents in the states that introduced tuition fees relative to the high-school graduates in states in which access to university is still free of charge. With the help of this simple difference-in-difference methodology we are able to answer the counter-factual question: What would have been the enrollment rate in the fee states if tuition fees had not been introduced?

The results indicate that tuition fees had a small but significant effect on the enrollment-probabilities of high-school graduates in the fee states. We find that enrollment probabilities amongst the high-school graduates in the affected states would have been 2.76 percentage-points higher in 2007 if the fees had not been introduced.

Of course, one has to take into account that high-school graduates are at least partially mobile between states. This affects the interpretation of the results in two important ways. First, some of the high-school graduates in the fee states can escape tuition fees by migrating to a non-fee state. This possibility mitigates the effect on enrollment rates. Second, through the mobility of high-school graduates some of the treatment - here the introduction of tuition fees - might spill-over to the control group which introduces a bias into the difference-in-difference estimates. However, using the formal analysis of the enrollment decision developed in the first two Chapters we are able to show that the results from the difference-in-difference estimation should be interpreted as a lower bound of the true effect. Moreover, we use the results from the formal analysis to correct for this bias and uncover the true effect. The average treatment effect on the treated then rises from 2.76 to 4.8 percentage points, which is approximately in line with responses to financial incentives of a similar magnitude that have been found by earlier studies (Dynarski 2002).

The question of how the German universities are properly funded was not the only issue related to the intergovernmental relations that ranked high amongst the topics receiving public attention in the time this thesis was written. In 2007 there was a surge in anecdotal evidence that the German counties (*Kreise und Kreisfreie Städte*) would set certain welfare payments strategically in an attempt to reduce their case-load (Eberhardt 2007). Given that an important share of the expenditure within the *SGB II* (Hartz IV) social assistance scheme is financed and administered decentrally this claim is not entirely implausible. After all, earlier empirical studies have already provided evidence for the presence of welfare competition, albeit not for Germany (Figlio, Kolpin, and Reid 1999, Saavedra 2000, Brueckner 2001, Dahlberg and Edmark 2004, Fiva and Rattso 2006).

However, while there now exists some evidence that welfare competition does occur it has been harder to identify the exact channel through which this interaction emerges (Revelli 2005). With respect to welfare competition there are two alternative theoretical accounts which can explain an observed strategic interaction between different regions. The factor flow theory assumes that the migration decisions of mobile welfare recipients depend on welfare levels in a jurisdiction. Under this theory, generous welfare payments attract recipients from neighboring jurisdictions and thus raise marginal welfare costs. On the contrary, the yardstick competition hypothesis assumes that local electorates use the policy enacted in neighboring jurisdictions as a yardstick against which they assess the performance of local incumbents. In this theory an 'informational externality' is making the policy of two regions interdependent. As both theories give rise to the same empirical model it is not straightforward to discriminate between the two.

In Chapter 4 we estimate the best-response function of a representative county, using a rich data set on the welfare benefits administered within Germany's major welfare program Hartz IV. The data set includes monthly data on the average level of housing assistance (*Kosten für Unterkunft und Heizung*) in the 439 German counties (*Kreise and Kreisfreien Städte)* for the time between January 2006 and July 2007. What makes this data set unique is that average benefit levels are available by the size of the receiving household.

Assuming that smaller households are more mobile we are able to test whether the intensity of welfare competition is sensitive to the mobility of welfare recipients as predicted by the factor-flow, but not the yardstick competition hypothesis.

The empirical results are consistent with the hypothesis that factor-flows play a causal role in the welfare competition between the German counties. While our overall evidence for welfare competition in the time after the implementation of the reform is mixed, this evidence is confined to small households as one would expect if factor flows are a driving force of the competition.

A second objective of the Chapter is to identify this relationship between the degree of decentralization and the intensity of competition. To achieve this aim we use an institutional change of Germany's major welfare assistance scheme (*Sozialhilfe*) in 2005 which reduced the autonomy of local authorities over their welfare policies.

Using data on average benefit levels in the years 2000 and 2004 we find strong evidence for welfare competition in the years prior to the reform. Based on a simple before-after comparison we find that the intensity of competition is smaller after the reform. This result is consistent with the hypothesis that the move towards a less decentralized administration has reduced the intensity of competition.

The results presented in Chapter 4 have some direct policy implications. In December 2007 the German constitutional court decided that the current administration of the basic assistance scheme violates the autonomy of the counties and reminded politicians to reorganize the welfare administration by the end of 2010 (Bundesverfassungsgericht 2007). In general, it is expected that this reorganization will either encompass a move towards a complete centralization or decentralization of the administration. In the light of the findings presented in this study it is to be expected that - without a reorganization of the financing side - a decentralization will lead to a strengthening of welfare competition between the German counties.

Chapter 1

Educational Federalism: Do Tuition Fees Improve Quality and the Number of Students?

Recent international rankings of university performance consistently indicate that European universities lag behind their American counterparts (Aghion, Dewatripont, Hoxby, Andreu, and Sapir 2007). This situation is often attributed to differences in the way universities are funded. Two important dimensions along which the organization of university funding can differ are the composition of private and public funds and the extent to which public funds are provided by the federal (centralization) or sub-national governments (decentralization).

Concerning the first dimension it has often been pointed out that in the U.S. private contributions account for a much larger share of university funds than in Europe. Many observers have therefore called for a shift in the composition of university funding towards more private contributions (Jacobs and van der Ploeg 2005). Opponents of such a move warn however that an increase of private contributions could adversely affect high-school graduate's decision to seek higher education and thus reduce university enrolment (Hirsch 2008).

With respect to the second dimension one needs to take into account that the mobility of students and graduates across state borders can undermine the investment incentives of local governments. This problem for instance arises if mobile human capital educated in one region is used as a factor of production in another region. In this case, a region can free ride on the education expenditure of other regions, making the higher education policies interdependent.[1] Considered in isolation, this argument calls for the allocation

[1] Büttner and Schwager (2004) provide empirical evidence for this phenomenon by estimating the best-response function of the German states with respect to expenditure on higher education.

of funding authority to the central government. On the other hand, competition between local governments can foster investment into educational quality and help contain government rents or inefficient administration.

The purpose of this paper is to assess theoretically how the composition of university funding and the degree of decentralization interact in determining higher education policies in a federation. Particular emphasis is given to the question of how the institutional framework affects the number of students in a federation. This extends previous work which has mainly focused on the level of public investment into higher education or the quality of universities but treated the number of students as exogenously given.

To this end I develop a model in which universities are operated and financed either by federal- or state governments. Governments make costly investments into the quality of universities. Depending on the institutional set-up, they are either restricted to finance universities out of public funds (pure public funding) or might be allowed to augment public funds by the introduction of a tuition fee. All governments (federal and state) pursue the objective to maximize revenue. This assumption is motivated by a political economy consideration: as students make up only a small fraction of the population their interests differ from that of the median voter to which policy is geared. The government's objectives are therefore not perfectly aligned with the interest of the students.

While some of the results derived in this chapter depend on the assumption of a revenue-maximizing government, chapter 2 shows that central results continue to hold if governments are benelovent.

Individuals are mobile before and after attending university. Not all students will therefore pay taxes in the region where they graduated from university. Tax-payments therefore constitute a channel through which educational expenditure spills over to other regions. There is thus an additional force which prevents state governments from implementing an efficient policy.

Albeit the model presented in this paper is quite standard, it extends previous work in two aspects. Firstly, the number of students in the model is endogenously determined. Individuals, who differ in their individual costs of attending university, make an occupational choice based on a comparison of the income of a high-skilled relative to that of a less skilled individual. Any government policy that changes the net-income of a university graduate (either by changing quality or the level of tuition fees) therefore feeds back on the number of students in the economy. The model thus allows me to evaluate how variations in the way universities are funded affect participation in higher education. In particular, it is possible to address the question of how the introduction of a tuition fee into a system of purely publicly funded universities affects the number of students. Despite the fact that in many countries this question is currently at the heart of a controversial debate, existing work that examines the funding of universities in federal states has generally assumed that the number of students in a federation is exogenously given and thus policy independent. (Gradstein and Justman 1995, Justman and Thisse 1997, Justman and Thisse 2000, Büttner and Schwager 2004, Kemnitz 2005, Schwager 2008).

Secondly, in my model the share of public funds in expenditure for tertiary education is influenced by the level of an exogneously given income tax[2]. The composition of university funding can therefore be gradually varied between fully public and entirely private. Most research that dealt with the question of how the allocation of funding decisions to different levels of government affects the level of educational investment have either assumed that universities are entirely publicly funded (Justman and Thisse 1997, Justman and Thisse 2000) or that students bear the full costs of their education (Schwager 2008). Less emphasis has been placed on assessing to what extent the answer to this question depends on the composition of private and public funds. In my model the extreme cases of purely public and purely private funding are entailed as special cases.

The possibility to vary the extent to which universities are privately funded enables me to assess the robustness of previous results with respect the composition of public and private funds. In a recent paper Schwager (2008) demonstrates that if governments are allowed to levy a tuition fee, efficiency of the quality choice under decentralization is restored if universities are privately funded at the margin[3]. Under this assumption I obtain a similar result in my model, thus strengthening his argument. However, my results also show that this argument depends crucially on the assumption of purely privatly funded universities. In the model presented in this paper the quality choice of state governments remains distorted if part of the university funding comes from public sources.

Concerning the introduction of a tuition fee into a system of purely publicly funded universities, my results point to an effect that has often been overlooked in the public debate: If governments lack sufficient instruments to tax the high-skilled population (for instance because the electorate mandates the government to set a low income tax-rate) the introduction of a tuition fee can raise the quality of universities as well as the number of students. This situation occurs because at low tax-rates marginal increases in quality only lead to small increases in government revenue. Governments therefore have no incentive to provide high quality universities. In such a situation the availability of a

[2]Here the underlying assumption is that the income tax-rate is determined in a complex political process that primarily reflects distributional concerns. Meltzer and Richard (1981) discuss how the income tax-rate is influenced by distributional motives. Alesina and Giuliano (2009) discuss the role of historical experience for distributional preferences

[3]Schwager (2008) implicitly assumes that universities are funded with a lump-sum tax. However, because in his model graduates are not mobile there is no inherent difference of this instrument to the fees in my model. His model is therefore structurally similar to the one presented in this paper when universities are purely privatly funded.

tuition fee increases marginal government revenue and leads governments to enhance the quality of universities. Starting at low levels of quality the resulting increase in income exceeds the tuition fee, thus leading to a higher net income and more students.

Whether students fare better when the authority over the higher education policy is assigned to the federal or state governments depends on the relative strength of two effects: under decentralization the mobility of students creates an incentive for state governments to attract future tax-payers by choosing a policy that is favorable to students. This effect reduces government revenue and benefits students. On the other hand, not all graduates work in the region where they attended university which means that a part of any investment into higher-education spills over to other regions in the form of the tax-payments of mobile graduates. Governments therefore face lower incentives to invest in high-quality tertiary education. Whether decentralization helps to bring the government objective more in line with that of the students therefore depends on the relative strength of these effects.

This result depends again on the share of public funds in total expenditure on higher education. If tuition fees make up a large share of university funding the fiscal externality on the other region is small. The quality implemented by the central governments exceeds the one chosen by state governments only if graduates are very mobile. As the share of public funds increases the parameter range for which centralization yields a higher quality than decentralization expands.

The analysis also points to the perhaps surprising possibility that even when state governments implement a lower quality than the central government the number of students might actually be higher under decentralization. This will occur if state governments are sufficiently eager to attract future tax-payers and therefore lower the tuition fee enough to outweigh the effect of an inferior quality on the income of the high-skilled.

The rest of the paper is organized as follows: Section 1.1 describes the basic set-up of the model. In section 1.2 the efficient allocation is characterized. Section 1.3 analyzes the policies chosen by a federal government before section 1.4 studies the equilibrium policy vector reached in a non-cooperative game between state governments. Section 1.5 derives some policy recommendations for the status quo in Germany and concludes.

1.1 The model

The model considers a federation formed by two states $i, j \in \{A, B\}$. Both states are identical in every respect. Each state operates a university of quality $q_i \geq 0$. The quality of a university determines the wage $w(q_i)$ of its graduates. Higher quality increases the wage, but there are decreasing returns to quality; i.e. $w' > 0, w'' < 0$. We use the following normalization $w(0) = 0$.

Higher education is exclusively provided by the public sector. This assumption is arguably more accurate in some context (e.g. the EU) than in others (the U.S.). However, given that in OECD countries public funds account on average for 75,7% of university funding, this seems to be a valid simplification.

Naturally, the provision of higher education is costly. A government which provides higher education of quality q_i to s_i students incurs costs $C(s_i, q_i) = s_i c(q_i)$, where $c(q_i)$ is a convex per-capita cost function ($c' > 0, c'' \geq 0$) with $c(0) = 0$. This cost function keeps the model tractable and rules out scale effects in higher education which would only blur the focus of the analysis.

The important results in this paper hold for this general functional form. Some of these results will be illustrated at hand of specific exmaples. In this case we choose the wage function to be a CES function of the form $w(q) = q^{1-\zeta}/(1-\zeta)$ and the per-capita cost function to be linear $c(q) = q$.

Amongst the citizens in each state lives a continuum of high school graduates. Each graduate is entitled to attend a university in either state. The mass of high school graduates in each state is normalized to one. A graduate is of a type $(\theta, v) \in [-\overline{\theta}, \overline{\theta}] \times [0, \overline{v}] \subset \mathbb{R} \times \mathbb{R}$, where both parameters θ and v are independently and uniformly distributed. The parameter θ measures the migration costs that an individual faces when leaving his home state. In this model migration costs comprise non-monetary costs of living in a state other than the home state. These include for instance psychological factors such as the costs associated with giving up one's social networks. Note that migration costs can be positive to account for the fact that some individuals prefer ceteris paribus to live in a state different to their state of birth. The other parameter v represents ones individual costs of studying. These costs are interpreted as a combination of psychological costs of taking out a loan, opportunity costs of attending university or different degrees of ability which result in different effort levels necessary to successfully complete university. Individual costs of attending university are non-negative for all individuals. Note that the government knows the distributions of θ and v but not their realizations.

When leaving high school, graduates have to decide whether they want to attend a university and thereafter work in a high-skilled occupation, or whether they alternatively choose a low-skilled occupation. This occupational choice is driven by the high school graduates objective to maximize lifetime income. Assuming that utility is linear in net lifetime income y, the utility level reached by a high-school graduate of type (θ, v) from state $i \in \{A, B\}$ who attends university in state $j \in \{A, B\}$ is

$$V^H(y; \theta, v) = y + \mathbf{1}(i \neq j)\theta - v$$

where $\mathbf{1}(i \neq j)$ is an indicator variable that takes on the value one if $i \neq j$ and zero otherwise.

Without loss of generality we can normalize the income of an unskilled to zero. Therefore, if a high-school graduate decides not to attend university and works as an unskilled his lifetime utility V^L depends entirely on his migration decision.

$$V^L(\theta, v) = \mathbf{1}(i \neq j)\theta$$

The net lifetime income y of a high-skilled depends on the quality of higher education as well as on taxes and tuition fees. I assume that governments tax all income at a rate τ which is taken to be exogenously given by the federal as well as by state governments. The rationale for this assumption is twofold: Firstly, in many federations, the personal income tax-rate is set at the federal level and cannot be altered by sub-national governments[4]. Secondly, in reality, income tax-rates are set in a political process that reflect many aspects, such as re-distributional objectives and efficiency considerations. As this model focuses solely on the process of funding higher education under different institutional designs, these aspects lie outside the scope of the model. A seminal paper that discusses how the tax-rate is determined in a political process is that of Meltzer and Richard (1981).

Depending on the institutional regime under consideration, governments may have another source of revenue, namely a tuition fee f_i levied on the students in state i. Students pay tuition fees in the state where they attend university. Income tax revenue is however collected by the government in which a university graduate works. The net-lifetime income y_i of a university graduate from state i is thus uniquely determined by the quality of the university he attends, the tuition fee f_i in that state and the income tax-rate τ:

$$y_i = (1 - \tau)w(q_i) - f_i \tag{1.1}$$

In the context of this paper the term $(1-\tau)w(q_i)$ represents the university skill premium.

The timing of the model is as follows: first, the government (federal or- state) decides upon the quality of the universities. In a regime where universities can be financed by private contributions the government also chooses the level of the tuition fee. All governments in the federation seek to maximize government revenue. After observing the policy parameters set by the government, the high school graduates make an occupational and locational choice, deciding where to live and whether to study or not. After graduation, the high-skilled are again mobile. Where a high-skilled individual works is determined in a labor market matching process in which an exogenously given fraction δ of the high-skilled are matched with a job in the state where they attended university. The remaining high-skilled have to work in the other state. Two assumptions warrant further discussion:

So far, the literature has either considered mobile students and immobile graduates (Büttner and Schwager 2004, Schwager 2008) or immobile students but mobile graduates

[4] A prime example for such an institutional set up is Germany.

(Wildasin 2000). The mobility of university graduates is however an empirically well established fact. 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) arrives at comparable results. He finds that 18 month after graduation about one fifth of the German students work in a city that is at least 200 kilometers away from where they completed their studies. In the light of these findings it therefore seems appropriate to account for different degrees of graduate mobility. We will see that the degree of graduate mobility has important implications on the policy decisions of the governments and therefore feeds back to the occupational choice. Note that this model entails immobile graduates ($\delta = 1$) as a special case.

The assumption of a revenue maximizing government is motivated by a political economy consideration. As students make up only a small fraction of the population their interests differ from that of the median voter to which policy is geared. Governments value the income of the high-skilled only in so far as it helps to finance expenditure that caters to the median voter. This argument of course abstracts from possible complementarities between the productivity of the high-skilled and less skilled population (Poutvaara and Kanniainen 2000).

Note that although it may seem as if investments into higher education are the only expendiures considered in this model, additional spending categories are implicitely captured by assuming that government revenue is spend on goods consumed by the median voter.

The model is now analyzed backwards, beginning with the occupational and locational choice of the high school graduates. Sections 1.2 to 1.4 then analyze the government decision in the first stage for different institutional regimes. Regimes differ by whether tuition fees are available to the governments (F) or whether universities have to be funded entirely out of public funds (NF). Furthermore, in each regime higher education is either centrally (C) or decentrally (D) provided. This leaves us with four regimes that need to be considered. To facilitate the exposition we will index variable names by the type of regime; i.e. by a sequence of characters $r \in \{C, D\} \times \{F, NF\}$. In this notation, the sequence 'CNF' for instance references a centralized regime in which universities are entirely publicly funded.

1.1.1 Occupational and Locational Choice

Given some arbitrary policy vector (q_A, q_B, f_A, f_B) set in the first stage of the game net income of a high-skilled who attended university in state $i \in \{A, B\}$ is fully determined. In the second stage high school graduates in state i therefore face a discrete choice problem with four alternatives: studying at home, studying abroad, working at home and working abroad. Utility achieved under each of the different alternatives for a state

i citizen of type (θ, v) is summarized in the following table

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

Assuming that each individual $(\overline{\theta}, v)$ chooses the alternative that maximizes his utility the results of the occupational and locational choice can be summarized graphically.

Figure 1.4 (page 43) shows the result of the occupational and locational choice of the high school graduates in state i, given that $y_i < y_j$. The areas labeled s_{ij} for $i, j \in \{A, B\}$ indicate those high school graduates from state i who study in state j. Similarly, high school graduates in state $i \in \{A, B\}$ who do not attend university and decide to work in state $j \in \{A, B\}$ are indicated by areas l_{ij}. Note that as far as the unskilled are concerned, only the migration costs θ matter for the locational choice. Students also base this choice on the difference in net incomes $y_j - y_i$.

It is possible to express the number of in- and out-of-state students in a state i as a simple functional form which only depends on income levels; i.e. $s_{ii} = s_{ii}(y_i, y_j)$ and $s_{ij} = s_{ij}(y_i, y_j)$.

Proposition 1 *Let y_i denote the lifetime income levels of an individual who graduated 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*

$$S_{ii}(y_i, y_j) = \begin{cases} \overline{\theta} y_i + (y_i - y_j) y_j + \frac{1}{2}(y_i - y_j)^2 & \text{if } y_j < y_i \\ \overline{\theta} y_i & \text{if } y_j = y_i \\ (\overline{\theta} + y_i - y_j) y_i & \text{else} \end{cases} \tag{1.2}$$

and

$$S_{ij}(y_i, y_j) = \begin{cases} (y_j - y_i + \overline{\theta}) y_j & \text{if } y_j < y_i \\ \overline{\theta} y_j & \text{if } y_j = y_i \\ \overline{\theta} y_j + (y_j - y_i) y_i + \frac{1}{2}(y_j - y_i)^2 & \text{else} \end{cases} \tag{1.3}$$

Proof See the appendix.

Note that s_{ii} and s_{ij} are continuously differentiable at $y_i = y_j$. The total number of students in state i is denoted by $s_i = s_{ii} + s_{ji} = 2s_{ii}$, where $s_{ii} = s_{ji}$ is directly obvious from (1.2) and (1.3).

1.1.2 Comparative Statics

We can now look at how a change in the income of university graduates from either state y_i, y_j affect the decisions of high school graduates in state i. In case graduates from state i can expect to earn a net lifetime income no lower than that of graduates from the other state; i.e. $y_i \geq y_j$ we have

$$\frac{\partial s_{ii}}{\partial y_i} = \overline{\theta} + y_i \qquad\qquad \frac{\partial s_{ij}}{\partial y_i} = -y_j \tag{1.4}$$

Not surprisingly, an increase in lifetime income of university graduates in state i lets more individuals decide to become high skilled. Empirical evidence that the university skill premium and the subsidy value have a positive impact on participation rates is for instance provided by Fredriksson (1997). Another effect concerns students' migration decisions. As the net income of university graduates in state i increases, more residents of state i decide to study at home. Similarly, in the case where $y_i < y_j$ we have

$$\frac{\partial s_{ii}}{\partial y_i} = \overline{\theta} + 2y_i - y_j \qquad\qquad \frac{\partial s_{ij}}{\partial y_i} = -y_i \tag{1.5}$$

Note that $s_{ii} \geq 0$ requires that $\overline{\theta} \geq y_j - y_i$.

With a description of the occupational and locational choice at the second stage of the game in place we can now turn to the analysis of how the number of students and quality levels that materialize in the first stage of the game depend on the institutional regime. To have a reference point for this analysis let us first characterize the quality level and income of the high skilled that maximizes gross-domestic product of the federation.

1.2 Efficient Solution

An efficient allocation is obtained by a social planner who chooses quality (q_A, q_B) and tuition fees (f_A, f_B) but takes the income tax-rate as given[5]. Income is then determined endogenously by (1.1). Equivalently, we can use (1.1) to write gross-domestic product (GDP) as a function of income and quality. In this case tuition fees are determined residually and GDP becomes a function of qualities and incomes. To facilitate the mathematical exposition we will frequently work with this latter approach. In the present context GDP is thus written as

$$GDP(y_A, y_B, q_A, q_B) = \sum_{i \in \{A,B\}} s_i(y_i, y_j)(w(q_i) - c(q_i))$$

[5]In the appendix (page 35) we show that this is equivalent to assuming that there is no income tax and the social planner chooses qualities and a lump-sum tax to finance higher education. If a tuition fee is available the assumption of an exogenous income tax-rate is therefore no restriction for the social-planner.

Maximizing this function with respect to income and quality levels yields the following first-order conditions

$$\frac{\partial s_i}{\partial y_i}(w(q_i) - c(q_i)) + \frac{\partial s_j}{\partial y_i}(w(q_j) - c(q_j)) = 0 \quad (1.6)$$

$$s_i(w'(q_i) - c'(q_i)) = 0 \quad (1.7)$$

As equation (1.7) shows, the output maximizing quality q^* is equal in both states and chosen in a way that maximizes net per-capita output of a high-skilled:

$$w'(q^*) = c'(q^*) \quad (1.8)$$

Using this result in (1.6) and assuming without loss of generality that $y_i \geq y_j$ it is straightforward to show that the first-order conditions on y_i and y_j can only be satisfied simultaneously if $y_i = y_j = y^*$. Tuition fees adjust to balance the budget:

$$\sum_{i \in \{A,B\}} s_i c(q_i) = \sum_{i \in \{A,B\}} s_i(\tau w(q_i) + f_i)$$

It then follows from (1.1) and the above that the income of the high-skilled equals their net contribution to gross-domestic product.

$$y^* = w(q^*) - c(q^*) \quad (1.9)$$

Using (1.2) this in turn implies that the number of students in each state equals

$$s^* = 2\overline{\theta} y^* \quad (1.10)$$

Note that from (2.8) and (1.9) we see that the social planner maximizes the income of the high-skilled. By equation (1.10) this also maximizes the number of students. Moreover, equation (1.9) shows that the social planner leaves all output to the high-skilled and sets tuition fees just at the level that covers the expenditure on higher education; i.e. $t + \tau w(q^*) = c(q^*)$.

The following sections deviate from the assumption that the higher education policy of the federation is chosen to maximize the net output in the economy. Instead, we consider revenue maximizing governments. The next section analyses this situation under the assumption that the responsibility for the education policy has been assigned to the central government. Section 1.4 then turns to the case where the higher education policy is set in a non-cooperative game between state governments.

1.3 Centralization

This section considers a revenue maximizing federal (central) government which determines the education policy of the federation. We first study the case where universities must be financed solely out of public funds (Section 1.3.1) and then consider how the introduction of a tuition fee affects the policy outcome (Section 1.3.2). By comparing higher education policies in both regimes we will be able to demonstrate that the introduction of tuition fees can benefit students even under the assumption that governments do not care about the welfare of the students.

1.3.1 Pure Public Funding

Consider first a federal government that is restricted to finance its universities solely out of public funds. Such a restriction might either come from a constitutional clause or it can be self imposed by a government which aims at guaranteeing equal entry to universities. In fact, it is a widely held conviction that an abandonment of private contributions to higher education would ensure higher participation rates. This section assesses this claim under the assumption that the higher education policy is set by the federal government.

Note that in the absence of a tuition fee the income of a graduate from state i depends only on the quality of the universities in that state $y_i = (1-\tau)w(q_i)$. The revenue collected by the federal government is thus a function of quality alone

$$R^{CNF} = \sum_{i \in \{A,B\}} s_i(q_i, q_j)[\tau w(q_i) - c(q_i)]$$

The, the first-order conditions characterizing the optimal quality level q_i for state $i \in \{A, B\}$ are

$$\frac{\partial y_i}{\partial q_i}\left(\frac{\partial s_i}{\partial y_i}\pi^{CNF}(q_i) + \frac{\partial s_j}{\partial y_i}\pi^{CNF}(q_j)\right) + s_i[\tau w'(q_i) - c'(q_i)] \;=\; 0 \qquad (1.11)$$

where $\pi^{CNF}(q_i) = \tau w(q_i) - c(q_i)$ is the net per-capita revenue received from a high-skilled who studied in state i. In the following we focus on the symmetric solution $q_A = q_B = q^{CNF}$ which is characterized by the following condition[6]:

$$w'(q^{CNF})\pi^{CNF}(q^{CNF}) + w(q^{CNF})[\tau w'(q^{CNF}) - c'(q^{CNF})] = 0 \qquad (1.12)$$

We see that quality is chosen to balance two effects. Firstly, in the absence of a tuition fee, a higher quality increases the income of the high skilled which induces more high-school graduates to attend university. Thus, by increasing quality the government can expand its tax-base and hence revenue. This is the first-term in the above equation. Secondly, while an increase in quality raises the number of students it also lowers per-capita revenue as it drives up per-capita costs of educating a student. This is the second term above. At the optimum, both effects just balance each other.

[6]The second-order condition holds at q^{CNF} as is shown in the appendix (page 35)

We now consider how the equilibrium quality depends on the exogenous parameters of the model, particularly on the tax-rate. Through its impact on the university wage premium quality also affects the number of students. There is thus also an indirect relationship between the tax-rate and the number of students which will be considered in Section 1.3.1.

Quality

To see how equilibrium quality depends on the tax-rate τ differentiate (1.12) to obtain

$$\frac{\partial q^{CNF}}{\partial \tau} = -\left(\frac{1}{R_{qq}^{CNF}}\right)[2w(q^{CNF}))w'(q^{CNF}))] > 0 \tag{1.13}$$

where $R_{qq}^{CNF} = \partial^2 R^{CNF}/\partial^2 q_i$ is the second order condition which is negative when evaluated at q^{CNF}[7].

Obviously, quality is zero in the absence of an income tax ($\tau = 0$) and increases with the tax-rate τ. The intuition for this result is rather simple: In the absence of tuition fees, taxes are the only means for the government to extract revenue from the high-skilled population. In fact, the higher the tax-rate under these circumstances, the higher marginal revenue from additional investments into higher education $\partial^2\pi^{CNF}/\partial q\partial\tau > 0$. Accordingly, a higher income tax-rate raises the incentives of the government to improve the quality of universities.

Under the revenue maximization objective quality chosen by the central government will in general be inefficient. The following lemma asserts that there is exactly one level of the tax-rate, $0 < \tau_0 \leq 1$ for which quality is chosen efficiently. For all other tax-rates $\tau \neq \tau_0$ the government sets an inefficient quality level.

Lemma 1 *Let*

$$\tau_0 = \frac{1}{2} + \frac{1}{2}\frac{c(q^*)}{w(q^*)} \tag{1.14}$$

Then the following holds: for all $0 \leq \tau < \tau_0$ *the quality level chosen by the central government is inefficiently low; i.e.* $q^{CNF} < q^*$. *If* $\tau_0 < \tau \leq 1$ *quality exceeds the optimal level. Quality is chosen efficiently if* $\tau = \tau_0$.

Proof By evaluating (1.12) at the efficient quality level q^*. ∎

[7] To see this set $\tau = 0$ in (1.12). Then optimal quality is characterized by $-w'(q)c(q) - w(q)c'(q) < 0$ which implies a corner solution $q = 0$.

Number of students

The relationship between the tax-rate and the number of students is more complex. Given that the federal government provides higher education at a level q^{CNF} in both states, the number of students in the federation in dependence of the tax-rate is

$$s^{CNF}(\tau) = 2\overline{\theta}y^{CNF} = 2\overline{\theta}(1-\tau)w(q^{CNF}) \tag{1.15}$$

Figure 1.1 (page 19) (right) plots the number of students against the tax rate for a specific example ($\theta = 1, \zeta = 0.5$). Here we see that the number of students at the extreme tax-rates $\tau \in \{0, 1\}$ is zero and has a unique maximum in between. The following lemma asserts that a similar relationship also holds in general.

Lemma 2 *The number of students s^{CNF} under centralization and in the absence of tuition fees is zero for $\tau \in \{0, 1\}$ and strictly greater than zero for intermediate tax-rates $\tau \in (0, 1)$. Furthermore, a sufficient condition for the existence of a unique maximum at $0 \leq \tilde{\tau} \leq 1$ is that the following holds for the function $w(\cdot)$:*

$$\frac{w''(q)}{w'(q)} < \frac{1 - \frac{\partial^2 q^{CNF}}{\partial^2 \tau}}{\frac{\partial q^{CNF}}{\partial \tau}} \tag{1.16}$$

Proof See the appendix

Note that the condition in (1.16) is not very restrictive. As the right hand side of (1.16) is bounded below on $0 \leq \tau \leq 1$ there is a wide range of CARA function for which this condition holds.

To understand the intuition behind Lemma 2 first consider the case $\tau = 0$. We have seen that in this case the government does not invest in quality ($q^{CNF} = 0$) as it doesn't have any instruments available to share the gains from providing higher education with the students. Attending university therefore doesn't lead to a higher-income but is costly for individuals. Hence, the number of students is zero at $\tau = 0$. Starting at $\tau = 0$ and increasing the tax-rate leads to rising investments into the quality of universities, as we have seen above. Initially, higher quality raises the net income of the high-skilled and more individuals enroll at university. However, this is only true until the tax-rate reaches a critical level $\tilde{\tau}$. For tax-rates above this level quality is still increasing as equation 1.13 shows, but the resulting increase in gross income is more than offset by higher taxes. With net income declining, the number of students is falling on $\tilde{\tau} < \tau \leq 1$.

From Figure 1.1 (page 19) (right) we can also see that the number of students is in general inefficient as there are at most two tax-rates $\tau_1, \tau_2 \in [0, 1]$ at which $s^{CNF} = s^*$ for an arbitrary s^*.

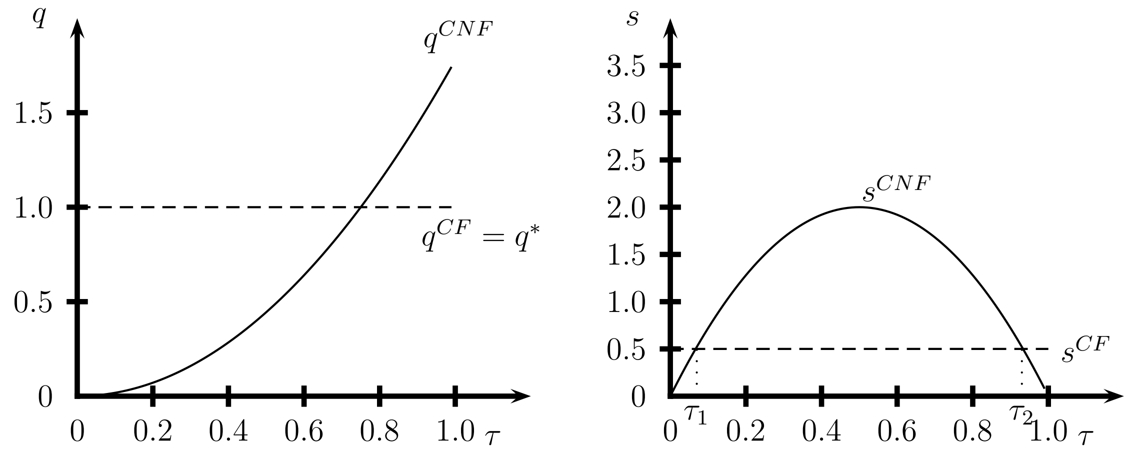

Figure 1.1: left) Quality under Centralization with fees (dashed curve) and without fees (solid curve). right) Number of students under centralization with fees (dashed curve) and without fees (solid curve). All curves are drawn for $\zeta = 0.5$ and $\theta = 0.5$.

This concludes the analysis of the higher education policy of a federal government which funds universities solely out of public funds. The next subsection considers how the higher education policy changes if this restriction is lifted.

1.3.2 Tuition Fees

In a centralized regime where the government can levy a tuition fee federal government revenue is

$$R^{CF} = \sum_{i=A,B,j\neq i} s_i(y_i, y_j)(\delta\tau w(q_i) + f_i - c(q_i)) + s_j(y_i, y_j)(1-\delta)\tau w(q_j)$$

where the first term in the sum corresponds to the government revenue generated by the students of state i net of the costs for higher education and spill-overs to state j. The second term are the taxes that are collected in a state j, but payed by high-school graduates educated in the other state.

Making use of (1.1) we can write government revenue as a function of quality and income

$$R^{CF} = \sum_{i=A,B} s_i(y_i, y_j)\pi^{CF}(q_i, y_i) \tag{1.17}$$

where $\pi^{CF}(q_i, y_i) = w(q_i) - c(q_i) - y_i$ is the net revenue from educating a student in state i. We see that quality determines the net output of a high-skilled $w(q_i) - c(q_i)$ and the variables y_i and y_j define how this output is split between the high-skilled and the government.

Maximizing (1.17) with respect to quality (q_A, q_B) and income (y_A, y_B) yields the following first-order conditions for $i \in \{A, B\}$:

$$\frac{\partial s_i}{\partial y_i}\pi^{CF}(q_i) - s_i + \frac{\partial s_j}{\partial y_i}\pi^{CF}(q_j) = 0 \tag{1.18}$$

$$s_i(w'(q_i) - c'(q_i)) = 0 \tag{1.19}$$

Comparing (1.9) with (1.19) shows that the government sets quality in both states to the efficient level; i.e. $q_A = q_B = q^*$.

Using this result in (1.18) and solving for a symmetric maximum we find that the income that the government leaves to the high-skilled equals

$$y^{CF} = \frac{w(q^*) - c(q^*)}{2} < y^* \tag{1.20}$$

We show in the appendix of this chapter (page 36) that the second-order condition holds at (1.18) and (1.19).

Comparing this to the efficient solution in (1.9) we find that the income of the high-skilled is strictly smaller than net per-capita output. Obviously, a revenue maximizing central government first chooses quality efficiently to maximize per-capita output of a high-skilled but then uses the tuition fee to extract some of that income. Recalling that the number of students in a federation is monotonically increasing in the income of the high-skilled – i.e. $s^{CF} = 2\overline{\theta}y^{CF}$ – the above result directly implies that there is an inefficiently low number of students. Let us summarize these findings to obtain the following

Result 1 *Under a centralized regime with tuition fees quality is set at the efficient level; i.e.* $q^{CF} = q^*$*, but the number of students is inefficiently low.*

As an immediate consequence of Result 1 and (1.14) we obtain that the introduction of a tuition fee increases the quality of universities unless the tax-rate exceeds a critical level $\overline{\tau} \in (0, 1)$.

Result 2 *For all tax-rates* $\tau < \overline{\tau} \equiv \frac{1}{2} + \frac{1}{2}\frac{c(q^*)}{w(q^*)}$ *the possibility to use a tuition fee leads the central government to improve the quality of universities.*

Figure 1.1 (page 19) (left) illustrates this result by plotting quality for a situation with and without tuition fees against the tax-rate.

Turning next to a comparison of the number of students under purely public funding and a funding scheme that allows governments to use a tuition fee, we arrive at the central result of this section. It is possible to demonstrate that when the higher education policy is carried out by the federal government there is a non-empty set of tax-rates $\mathcal{T}^C$ for which the introduction of a tuition fee raises the number of students.

Result 3 *When higher education policy is carried out by the federal government then there exists two critical tax-rates* $0 < \tau_1 < \tau_2 < 1$ *such that the introduction of tuition fees raises the number of students whenever* $\tau \in [0, \tau_1] \cup [\tau_2, 1] \equiv \mathcal{T}^C$.

Proof Thus follows simply from the fact that s^{CF} is independent of τ and strictly positive, $s^{CNF}(0) = s^{CNF}(1) = 0$ and Lemma 2. ▮

Figure 1.1 (page 19) (right) provides a graphical example of this result.

The intuition for this result follows directly from the preceding analysis. First, consider a situation with a low tax-rate and a government which is restricted to finance its universities merely out of public funds. We have seen above that in these circumstances the government has little incentive to invest in the quality of higher education. This in turn implies that the high-skilled earn an income which exceeds the one of the low-skilled only by a small margin. Accordingly, only a few high-school graduates with low individual costs of attending university will decide to become students. If a tuition fee becomes available in such a situation the government will use the fee to increase the revenue it receives from each student. The effect of the tuition fee is thus to increase the marginal revenue from providing an additional unit of quality. Quality will then jump to the efficient level as we have seen in Result 1. At low income tax-rates the increase in income resulting from higher quality exceeds the tuition fee, leaving the high-skilled with a higher income and causing the number of students to rise.

A similar intuition applies in the empirically less relevant case of very high tax-rates. We have seen that in such a situation the quality of universities is high and might even exceed the efficient level. However, despite a high gross income of the high-skilled, high tax-rates prevent most high-school graduates from attending university. In this situation, the government can use the tuition fee as a subsidy to increase the net-income of the high-skilled and the number of students. To see that this is indeed the case solve (1.20) for the tuition fee to obtain $f^{CF} = 0.5(w(q^{CF}) - c(q^{CF})) - \tau w(q^{CF})$. Thus, the tuition fee will become negative if

$$\tau > \frac{1}{2}\left(1 - \frac{c(q^{CF})}{w(q^{CF})}\right)$$

Perhaps the surprising point about Result 3 is that allowing the federal government to levy a tuition fee can actually increase the number of students and the quality of universities. This is for instance the case, if the government lacks sufficient instruments to tax the high-skilled population (i.e. because it is for other reasons committed to employ an income tax which is only little progressive). This finding runs counter to the widely held belief that the introduction of private contributions to higher education would necessary lower the participation in higher education and shows that such an argument cannot be made without taking the tax-system into account. We will re-encounter this effect in Section 1.4 when we assume that the higher education policy is assigned to state governments.

It is possible to strengthen Result 3 and show that whenever the introduction of a tuition fee leads to more students, there is a Pareto improvement for the economy.

To make this statement more precise, recall that our toy economy is inhabited by two groups of agents: There is the working population - comprising the high-skilled (students) and the workers (those who do not attend university) - and another homogeneous group of individuals which is not explicitly modeled but which constitutes the majority of the population. The latter group is represented by the median voter. It is then possible to show that if tax-rates in the economy are such that the introduction of a tuition fee increases the number of individuals who decide to enroll into higher education, the introduction of tuition fees benefits the median voter and some individuals in the working population, without making anyone worse off. This argument is summarized in the following proposition:

Result 4 *When the responsibility for the higher education policy has been delegated to the federal government and tax-rates are such that Result 3 holds, then the introduction of a tuition fee leads to a Pareto improvement.*

Note that in the ensuing proof we do not distinguish between the government and the individuals who are represented by the median voter.

Proof Let the tax-rate τ be such that the introduction of a tuition fee raises the number of students according to Result 3 and consider the introduction of a tuition fee by the federal government. We need to consider four groups of actors: those high-school graduates that decide to study before and after the introduction of the tuition fee. Call this group ss. Then there are those individuals who choose a low-skilled occupation regardless of whether there is a tuition fee in place or not. Call this group ll. A third group consists of those high-school graduates who only decide to attend university after a tuition fee is introduced. Let us refer to this group as ls. Note that we consider only situations in which the tax-rate is such that the introduction of a tuition fee increases the number of students. Hence, there are no individuals who study in the absence of a tuition fee but change that decision after the introduction of the fee. The last group comprises the government as the only actor. We need to show that allowing the government to levy a tuition fee makes the actors in some groups better off, but no one worse off. Starting with group ll it is easy to see that their utility V^L remains unaffected by the introduction of a fee. Individuals in group ls gain as they could always maintain their initial utility level, but choose not to do so and become students. Turning to group

ss it is easy to see that their income has to increase through the introduction of the tuition fee. Suppose, that this were not the case and income of the high skilled would be no higher than in the absence of the fee. Then the number of students would also not have increased. But this contradicts our assumption about the tax-rate. It remains to be shown that the government also gains by introducing the fee. But this is obvious, as it would always be feasible for the government not to make use of the fee and set $t = 0$. ∎

Furthermore, the results of this section depend crucially on the endogeneity of the demand for higher education. Equation (1.18) shows that the central government needs to take into account that a marginal increase in tuition fees leads to a reduction in the number of tax-payers. The threat of loosing high-skilled tax-payers forces the government to leave some rents to the students and limits the extent to which it can increase the tuition fee. In the model of Kemnitz (2005), where the number of students is exogenously given a different result is obtained. By not running the risk of reducing the number of tax-payers the central government can increase tuition fees up to a point where all students are indifferent between attending university or remaining unskilled. In this situation, the surplus generated by educating individuals is entirely captured by the central government.

1.4 Decentralization

Having analyzed the case in which universities are financed by the federal government this section now considers a situation where the higher education policy is determined by state governments in a non-cooperative game. Again, we first consider governments that are restricted to finance universities out of tax revenue. Thereafter we study how the introduction of a tuition fee affects the higher education policies of state governments.

1.4.1 Pure Public Funding

In the case where there are no tuition fees the income of a university graduate from state i is determined completely by the quality of the university he attends. Revenue accruing to the government in state i is therefore a function of quality in both states

$$R_i^{DNF}(q_i, q_j) = s_i(q_i, q_j)\pi^{DNF}(q_i) + s_j(q_i, q_j)(1-\delta)\tau w(q_j)$$

Note that only a fraction $\delta \in [0, 1]$ of the taxes paid by a graduate from state i ($\tau w(q_i)$) also remain in that state. A fraction $(1-\delta)$ of tax-revenue is lost due to the mobility of graduates. Accordingly, $\pi^{DNF}(q_i) = \delta\tau w(q_i) - c(q_i)$ is the revenue that state i receives from educating a student. By a similar argument the second term in the above revenue function then measures the spill-over of tax-revenue from other states.

Assume that state governments take the quality choice of the other state as given when determining the quality of their own universities. We then find that quality q^{DNF} in a symmetric equilibrium of this non-cooperative game is defined as the solution to the following equation

$$\left(\frac{\partial s_i}{\partial q_i}\pi^{DNF}(q_i) + s_i\frac{\partial \pi^{DNF}}{\partial q_i} + \frac{\partial s_j}{\partial q_i}(1-\delta)\tau w(q_j)\right)|_{q_i=q_j=q^{DNF}} = 0 \tag{1.21}$$

Showing that such an equilibrium does indeed exist is a rather tedious exercise. As this paper is rather more concerned with the equilibrium properties than with the existence of equilibrium let us assume that the equilibrium characterized by (1.21) exists. In the appendix I show for a concrete assumption on the specific form of $w(\cdot)$ and $c(\cdot)$ that this is indeed the case. In the proof I also argue that the existence of this equilibrium is unlikely to depend on the specific form assumption.

Note that our assumption on the existence of a symmetric equilibrium implies that the second-order condition $R^{DNF}_{q_iq_i} = \partial^2 R^{DNF}_i/\partial^2 q_i < 0$ holds at $q_i = q_j = q^{DNF}$.

Next, we study how the mobility of students and graduates affect the equilibrium level of quality.

Strategic effects

To see the strategic effects at work in the non-cooperative solution rearrange the first-order condition (1.21) to obtain

$$\frac{\partial R^{DNF}_i}{\partial q_i} = \frac{\partial R^{CNF}_i}{\partial q_i} - (1-\delta)\tau(\frac{\partial s_i}{\partial q_i}w(q_i) + s_i w'(q_i)) - \frac{\partial s_j}{\partial q_i}(\delta\tau w(q_j) - c(q_j)) \tag{1.22}$$

The first term on the right-hand side in this equation is identical to the first-order condition under centralization. The latter two terms correspond to the strategic effects in the non-cooperative equilibrium.

The second term on the right-hand side of (1.22) relates to a *disincentive effect* that arises from the mobility of graduates. It reflects the fact that a part of the tax revenue from providing an additional unit of quality spills over to the other state. Accordingly, this term is negative and increasing in the fiscal externality $\epsilon = (1-\delta)\tau$. In isolation this effect would cause the equilibrium number of students to be lower than under centralization.

However, there is also a second strategic effect associated with the last term in the above equation. This effect is a *competition effect* which arises from the possibility to attract students from abroad by setting a high quality. If graduates are sufficiently likely to remain in the state where they attended university (large δ) attracting students provides a means to broaden the tax base and to increase revenue. In this case, the competition effect is positive and tends to push the number of students above the level obtained under centralization. If university graduates are however sufficiently mobile; i.e. for small δ, attracting students does not pay off and the competition effect works in the same way as the disincentive effect. Whether there are more or less students under centralization thus depends on the relative strength of both effects.

Disincentive and competition effect both depend on the mobility of graduates, as measured by the term $(1-\delta)$. The more students become attached to the state where they attended university (and the lower is hence graduate mobility) the stronger is the competition effect and the weaker is the disincentive effect. Accordingly, the declining mobility of graduates, as measured by a larger value of the parameter δ, should be associated with higher equilibrium quality levels.

Total differentiation of the first-order condition (1.21) and evaluatinon at equilibrium quality allows us to see that this is indeed the case:

$$\frac{\partial q^{DNF}}{\partial \delta} = -\left(\frac{(\frac{\partial s_i}{\partial q_i} - \frac{\partial s_j}{\partial q_i})\tau w(q^{DNF}) + s_i \tau w'(q^{DNF})}{R^{DNF}_{q_i q_i}} \right)_{q_i = q^{DNF}} > 0$$

An important issue for the design of federal systems concerns the appropriate level of government at which higher education policies are determined. So far, the literature has mainly warned that the mobility of students or graduates distorts the policy choice of sub-national government and therefore leads to an inefficiently low level of higher education (Justman and Thisse 1997, Justman and Thisse 2000, del Rey 2001). In general, this literature has assumed that universities are entirely publicly funded. Our next step is to show that the present model entails a less clear-cut result, even when making a similar assumption on the funding of higher education. We will see that under certain conditions decentralized policy making actually leads to higher equilibrium quality.

Pure Public Funding: Decentralization vs. Centralization

The following lemma says that for sufficiently immobile graduates (large δ) the competition effect always outweighs the disincentive effect.

Lemma 3 (Quality under Centralization vs. Decentralization) *For all $\tau \in [0,1]$ there exists a $\delta_0^{DNF} \in [0,1)$ such that $q^{DNF} > q^{CNF}$ if and only if $\delta \geq \delta_0^{DNF}$.*

Proof See the appendix.

As a direct consequence of this Lemma we obtain that if δ is large enough governments will engage in a fierce competition for students that can drive equilibrium qualities beyond the efficient level.

Corollary 1 *Assume that* $\delta \geq \delta_0^{DNF}$*, where* δ_0^{DNF} *is defined in Lemma 3. Then there exists a* τ_0 *such that for all* $\tau \geq \tau_0$ *we have that* $q^{DNF} > q^*$*.*

Proof We have seen in Lemma 1 that there exists a τ_0 such that for all $\tau \geq \tau_0$ we have that $q^{CNF} > q^*$. Now, because $\delta \geq \delta_0^{DNF}$ it follows from Lemma 3 that $q^{DNF} > q^{CNF}$. Combining the two inequalities we obtain that $q^{DNF} > q^*$ for $\tau \geq \tau_0$. ∎

The argumentation underlying the preceding proof is illustrated by Figures 1.1 and 1.2. Figure 1.2 (page 28) (left) plots q^{CNF} and q^{DNF} against the attachment parameter δ. We see that quality under decentralization increases with δ and eventually exceeds q^{CNF}. This illustrates the assertion of Lemma 3. Note that while the curves in Figure 1.2 (page 28) are drawn for $\tau = 0.3$ Lemma 3 holds for all tax-rates. The assertion of Lemma 1 is illustrated by Figure 1.1 (page 19) (left) which shows that under centralization quality under pure public funding exceeds the efficient level for sufficiently high tax-rates.

In the absence of tuition fees, quality alone determines the net income of a university graduate and the number of students in each state. This implies that whenever decentralization leads to better quality than a centralized regime the number of students is also higher and vice versa:

Corollary 2 (No. of Students under Centralization vs. Decentralization) *For all* $\tau \in [0,1]$ *there exists a* $\delta_0 \in [0,1]$ *such that for all* $\delta \geq \delta_0$ *we have* $s^{DNF} > s^{CNF}$*.*

Proof Follows immediately from Lemma 3 and the fact that $s^{DNF} > s^{CNF} \Leftrightarrow q^{DNF} > q^{CNF}$. ∎

As we have argued above, most authors have so far warned that the mobility of students and graduates would enable sub-national governments to free-ride on each other's higher education expenditures. As a result, equilibrium investment into universities would be inefficiently low under decentralized policy making. This section has shown that this effect can also go in the opposite direction. If governments are able to attract potential tax-payers by investing into higher education equilibrium quality might also be inefficiently high.

The source of the diverging results lies in the assumption that students as well as university graduates are mobile. Earlier papers have considered only mobile students (Büttner and Schwager 2004) or mobile graduates (Justman and Thisse 1997), but not both.

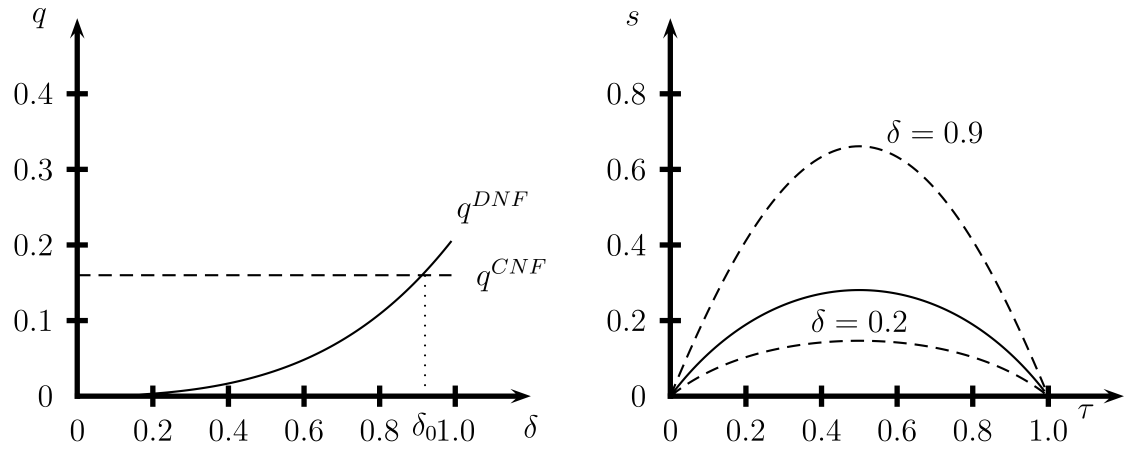

Figure 1.2: Pure Public Funding: Centralization vs. Decentralization. left) Quality under Decentralization (solid curve) and Centralization (dashed curve). right) Number of students under Decentralization (dashed curves) and Centralization (solid curve). The figure shows the number of students under decentralization for different degrees of graduate mobility ($\delta = 0.9$ and $\delta = 0.2$). All curves are drawn for $\zeta = 0.5$ and $\theta = 1$.

Mechtenberg and Strausz (2008) use an assumption that is structurally similar to the approach considered in this paper. They also identify a competition and a disincentive effect[8].

Change in migration costs

Having analyzed how the mobility of graduates affect equilibrium qualities let us now briefly turn to the mobility of students. In particular, we want to consider how a change in the support of the mobility costs $\overline{\theta}$ affects equilibrium policies. If these costs are drawn from a wider interval $[-\overline{\theta}, \overline{\theta}]$ the migration decision of high-school graduates becomes less elastic with respect to changes in the income of a university graduate from either region. To see this more formally consider the elasticity of the number of home students s_{ii} with respect to changes in y_i, $\varepsilon_s = \frac{\partial s_{ii}}{\partial y_i}\frac{y_i}{s_{ii}} = \frac{1}{2} + \frac{y_i}{2\overline{\theta}}$, which clearly decreases in $\overline{\theta}$. To assess how a change in student mobility affects equilibrium quality again differentiate (1.21) totally to obtain

$$\frac{\partial q^{DNF}}{\partial \overline{\theta}} = -\frac{(1-\tau)\left[w'(q)[\delta\tau w(q) - c(q)] + 2w(q)[\delta\tau w'(q) - c'(q)]\right]}{R_{q_i q_i}}$$

The sign of this expression depends on the likelihood δ that a university graduate pays taxes in the state where he attended university.

If this likelihood is large, we see from the first-order condition that the numerator of the above differential becomes negative. Obviously, if university graduates are not too

[8]To which they refer as a 'free-rider effect'

mobile, a decline in the strength of the competition effect (larger $\overline{\theta}$) lowers the incentives of local governments to attract students by providing good universities. The result is reversed if university graduates become very mobile (low δ). Now, anticipating the strong fiscal externality, state governments prefer that students are educated in the other state and reduce quality. When high-school graduates react less to changes in higher education policies (i.e. for larger values of $\overline{\theta}$) this effect is dampened and quality increases.

Recall that in the absence of a tuition fee the equilibrium number of students is monotonically increasing in quality. This implies that the latter result applies one-to-one to the number of students in the federation.

This concludes the analysis of state governments that are restricted to fund their universities solely out of tax-revenue. Under this restriction, we were able to discuss how the equilibrium policies depend on the level of government at which decisions are made. In the next subsection we will see that the main results of this section also hold if state governments are allowed to levy a tuition fee on the students they educate.

1.4.2 Tuition Fees

If a tuition fee is available to sub-national governments revenue accruing to the government in state $i \in \{A, B\}$ becomes

$$R_i^{DF} = s_i(y_i, y_j)\pi_i^{DF} + s_j(y_i, y_j)(1-\delta)\tau w(q_j)$$

where $\pi_i^{DF} = \delta\tau w(q_i) - c(q_i) + f_i$ is the net per-capita revenue from educating a student in state i. Using (1.1) to substitute out for tuition fees we obtain $\pi^{DF} = (1-\epsilon)w(q_i) - c(q_i) - y_i$ and R_i^{DF} is a function of quality and income. We now consider the policy decision of a state $i \in \{A, B\}$ that sets a policy vector (q_i, y_i) to maximize revenue R_i^{DF}, taking the policy (q_j, y_j) of the other state $j \neq i$ as given. The first-order conditions describing the best-response function of state i are

$$\frac{\partial s_i}{\partial y_i}\pi_i^{DF} - s_i + \frac{\partial s_j}{\partial y_i}(1-\delta)\tau w(q_j) = 0 \quad (1.23)$$

$$s_i \frac{\partial \pi_i^{DF}}{\partial q_i} = 0 \quad (1.24)$$

Provided that the migration decision of high-school graduates does not respond too elastically to changes in the policy of either state there is a unique symmetric equilibrium of the Nash-game.

Lemma 4 (Existence of equilibrium) *There exists a $\overline{\theta}_0 \in \mathbb{R}$ such that for all $\overline{\theta} > \overline{\theta}_0$ there exists a unique symmetric equilibrium of the non-cooperative game.*

Proof See the appendix.

In the remainder of this paper we will use the equilibrium outcome characterized by (1.23) and (1.24) to address two important issues. First, taking as given that governments finance higher education out of public and private funds, we will study how equilibrium quantities depend on whether higher education is provided centrally or decentrally. We then keep the degree of decentralization constant and ask how the introduction of a tuition fee affects quality and the number of students under decentralization.

1.4.3 Tuition Fees: Centralization vs. Decentralization

Equation (1.24) shows that governments choose quality to maximize per-capita revenue π_i^{DF} from the high-skilled that they have educated. Equilibrium quality is therefore determined by

$$c'(q^{DF}) = (1 - \epsilon)w'(q^{DF}) \tag{1.25}$$

Graduate mobility drives a wedge $(1 - \epsilon)$ between per-capita revenue and a students per-capita contribution to GDP. Accordingly, a comparison of (1.25) with (1.19) and (2.8) shows that under decentralization, the tax-spillover $\epsilon = \tau(1-\delta)$ distorts the choice of quality relative to the level obtained under centralization and the first-best. We thus obtain the following result

Result 5 (Quality: Centralization vs. Decentralization) *If the average perstudent tax-loss ϵ is greater than zero, quality under decentralization with fees is lower than under centralization with fees. Moreover, quality is under-provided relative to the efficient level.*

In the empirically relevant case where university graduates are not entirely immobile ($\delta < 1$) two interesting cases need to be distinguished.

As long as universities are not entirely privately funded ($\tau > 0$) this model suggests that laying the higher education policy into the hands of sub-national governments will lead to an erosion of quality. This result had already been derived under the more restrictive assumptions that universities are entirely funded out of public funds and for an exogenously given number of students (Justman and Thisse 1997, Justman and Thisse 2000). The results of this section therefore indicate that these results also hold if these assumptions are relaxed.

In the extreme case where universities are entirely privately funded ($\tau = 0$) equation (1.25) shows that state governments choose the efficient quality level. For this specific case our model corresponds essentially to the one of Schwager (2008) who argues that tuition fees can restore efficiency under decentralized decision making[9]. The results of this section therefore suggest that this argument might not generalize to the case where graduates are mobile ($\delta < 1$) and where universities are at least partially publicly funded ($\tau > 0$).

Despite the fact that quality under decentralization is in general inefficiently low this does not necessarily mean that the high-skilled always gain from centralization. Rather, as we have already seen in the case where universities were purely publicly funded, the income of the high-skilled might be higher under decentralization if governments engage in a competition for the high-skilled workforce. To see that the same mechanisms apply in the case where tuition fees are available rewrite equation (1.23) to obtain

$$\frac{\partial R^{DF}}{\partial y_i} = \frac{\partial R^{CF}}{\partial y_i} - \epsilon \frac{\partial s_i}{\partial y_i} w(q_i) - \frac{\partial s_j}{\partial y_i}((1-\epsilon)w(q_j) - c(q_j) - y_j) = 0 \tag{1.26}$$

Comparing this to equation (1.18) we again see that whether income is higher under decentralization or centralization depends on the disincentive (second term on the right-hand side) and competition effect (third term on the right-hand side). We can prove a variant of Lemma 3 which asserts that for sufficiently immobile high-school graduates the competition effect is stronger than the disincentive effect.

Lemma 5 *For all $\tau \in [0,1]$ there exists a $\delta_0^{DF} \in [0,1)$ such that $y^{DF} > y^{CF}$ if and only if $\delta \geq \delta_0^{DF}$.*

Proof See the appendix.

Because participation in higher education increases linearly with income $s^{DF} = 2\overline{\theta} y^{DF}$ we obtain the following

Corollary 3 (No. of Students: Centralization vs. Decentralization) *For all $\tau \in [0,1]$ there exists a $\delta_0^{DF} \in [0,1)$ such that $s^{DF} > s^{CF}$ if and only if $\delta \geq \delta_0^{DF}$.*

In any case it is easy to show that the income of university graduates declines in the fiscal externality ϵ, which weakens the competition effect. To see this evaluate (1.23) at (1.24) and differentiate totally. We then obtain

$$\frac{\partial y^{DF}}{\partial \epsilon} = -\frac{R_{y\epsilon}^{DF}}{R_{yy}^{DF}} = -\frac{(\overline{\theta} + 2y) w(q^{DF})}{R_{yy}^{DF}} < 0 \tag{1.27}$$

Note that in order to sign the above expression we have made use of the fact that in equilibrium $R_{yy}^{DF} = \partial^2 R_i^{DF} / \partial^2 y_i y_i < 0$ as established in the proof of Lemma 4.

[9] Schwager (2008) assumes that universities are funded by a lump-sum tax. However, as in his model graduates are immobile this tax is similar to the tuition fees in this model.

This concludes the first part of our analysis, where we have taken the sources of funds for higher education as given and asked whether the policy outcome under centralization or decentralization is more favorable to students. The next step is to turn to the second dimension of the analysis, where we assume that the authority over higher education policy is assigned to sub-national governments. The question is then how the introduction of a tuition fee impacts the policy chosen by sub-national governments.

1.4.4 Decentralization: Fees vs. Pure Public Funding

We begin by looking at how the introduction of a tuition fee affects the quality of universities. For the case of centralized policy making we have seen in Section 1.3 that for certain tax-rates allowing governments to introduce a tuition fee leads to a higher equilibrium quality. As we will see, a similar argument also holds under decentralized provision of higher education. To demonstrate this formally we first show that in the absence of tuition fees quality increases with the tax-rate:

Lemma 6 *Assume that governments are restricted to finance universities purely out of public funds and higher education is provided by state governments. If in equilibrium not all individuals attend university; i.e.* $\overline{\theta} > w(q^{DNF}) - c(q^{DNF})$ *then i) quality under* q^{DNF} *is zero at* $\tau = 0$ *and ii) equilibrium quality is increasing in* τ*.*

Proof See the appendix.

The intuition behind this Lemma is essentially the same as under centralization. At higher tax-rates state governments have stronger incentives to invest into the quality of universities.

The effect of the prevailing tax-rate on the quality of universities depends on whether higher education is entirely publicly funded or not. Lemma 6 demonstrates that in the former case quality rises with the tax-rate. For the latter case equation (1.25) shows that quality depends negatively on the tax-rate. Figure 1.3 (page 33) (left) summarizes these results graphically. We can combine Lemma 6 with (1.27) to show that quality under purely public funding is higher if and only if the tax-rate exceeds a certain treshold $\tilde{\tau}$.

Lemma 7 (Decentralization: Pure Public Funding vs. Fees) *Assume that higher education policies are determined by state governments. Then for all* $\overline{\theta}$ *and* δ *there exists a* $\tilde{\tau}$ *such that the following holds*

$$q^{DF} > q^{DNF} \Leftrightarrow \tau \leq \tilde{\tau}$$

Proof See the appendix

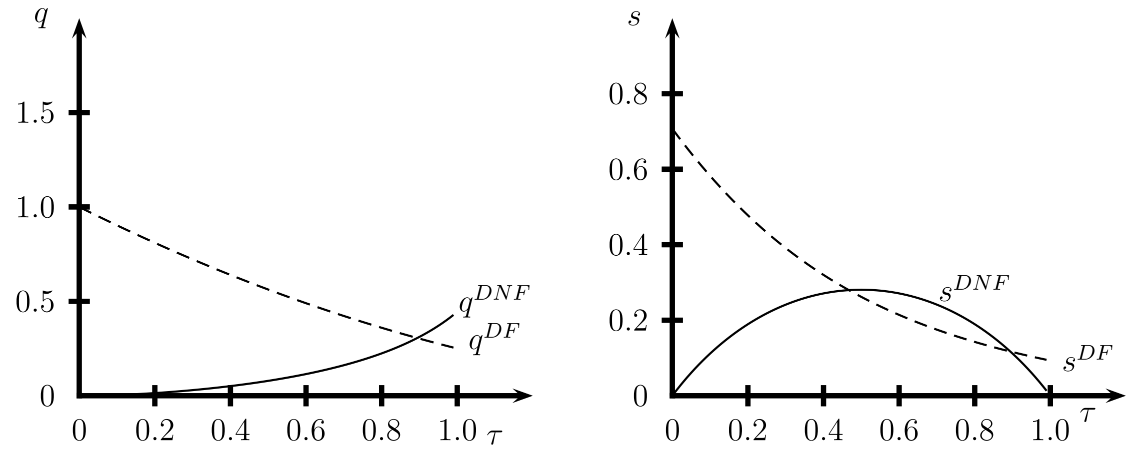

Figure 1.3: left) Decentralization: Fees vs. Pure Public Funding: Quality under Decentralization with fees (dashed curve) and without fees (solid curve). right) Number of students under Decentralization with fees (dashed curve) and without fees (solid curve). All curves are drawn for $\zeta = 0.5$, $\delta = 0.5$ and $\theta = 1$.

Concerning the number of students we can prove a decentralization-analog to Result 3. In particular, we are going to assert the existence of a nonempty set of tax-rates $\mathcal{T}^D = (0, \tau_1] \cup [\tau_2, 1)$ such that for $\tau \in \mathcal{T}^D$ the introduction of tuition fees leads to a higher equilibrium number of students. To give a graphical illustration of this result consider Figure 1.3 (page 33) (right) which plots the number of students under decentralization for the case with and without tuition fees. The figure also shows the set $\mathcal{T}^D$ for which the introduction of tuition fees increases the number of students.

Result 6 *When the higher education policy is carried out by state governments there exists two critical tax-rates* $0 < \tau_1 < \tau_2 < 1$ *such that the introduction of tuition fees raises the number of students whenever* $\tau \in [0, \tau_1] \cup [\tau_2, 1] \equiv \mathcal{T}^D$.

Proof See the appendix.

A graphical illustration can be obtained from Figure 1.3 (page 33) (left).

Note that Results 3 and 6 both assert the existence of a non-empty range $[0, \tau_1] \cup [\tau_2, 1] \subseteq [0, 1] \times [0, 1]$ for which the number of students increases if the governments are allowed to introduce a tuition fee. Nothing is said however, whether this range is larger under centralization or under decentralization.

1.5 Summary and Concluding Remarks

Germany and other countries have recently witnessed a considerable public debate about the putative effects of increasing the share of private contributions in the funding of higher education. At the heart of this debate stands the question of how such a reform would affect the number of students. Opponents warn that the introduction of tuition fees would reduce the number of students. Advocates of tuition fees however claim that raising private contributions would increase the quality of universities and that more attractive universities would, in turn, lead to more students. Another dimension of the discussion on the funding of universities concerns the allocation of funding responsibility to the proper level of government.

So far, the public finance literature provides little guidance if one wants to predict how a change along any of the two dimensions (public vs. private funding and decentralized vs. centralized decision making) affects the number of students. Most studies of the subject were either confined to an exogenously given number of students or considered only purely publicly funded universities.

To contribute to the understanding of this subject this paper developed a model where the number of students is the result of an occupational choice of heterogeneous individuals and thus endogenously determined. The analysis suggests that the effects of the introduction of a tuition fee cannot be studied independently from the tax system. If the government lacks sufficient instruments to tax the high-skilled population (e.g. low income tax rates) then the introduction of a tuition fee can raise both quality and the number of students. In this case the increase in student's income exceeds the tuition fee, yielding a higher net income for the high-skilled and makes studying more attractive. This effect has often been overlooked in the public debate.

Does centralized provision dominate decentralization as suggested by many prior studies (Justman and Thisse 1997, Büttner and Schwager 2004)? Here the model suggests that the answer depends on the mobility of graduates. Graduate mobility introduces a fiscal externality rooted in the fact that governments finance universities at least partly by taxing graduates. Investments in the quality of universities, which expand graduate income and hence the tax-base, spill over to other regions if graduates are mobile. This externality favors centralization over decentralization. However, if graduates are sufficiently likely to stay in the region where they completed their studies a high quality of universities or low tuition fees might attract additional taxpayers. In this case a "competition" for students tends to increase the quality of universities and participation in higher education. Whether there are more or less students under centralization therefore depends on the relative strength of these effects.

1.6 Mathematical Appendix

Proof of Proposition 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 high-school graduates (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

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

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

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

∎

Second-order condition under centralization without fees

We obtain the second-order condition by differentiating (1.11) with respect to q_i. We then have to show that

$$\begin{aligned} &(1-\tau) w''(q_i) \left(\frac{\partial s_i}{\partial y_i} \pi^{CNF}(q_i) + \frac{\partial s_j}{\partial y_i} \pi^{CNF}(q_j) \right) + s_i(\tau w''(q_i) - c''(q_i)) \\ &+ (1-\tau) w'(q_i)(\tau w'(q_i) - c'(q_i)(\overline{\theta} + y_i)) + \frac{\partial s_i}{\partial q_i}(\tau w'(q_i) - c'(q_i) < 0 \end{aligned} \tag{1.28}$$

where we have already used that in a symmetric solution ($q_i = q_j$) $\pi^{CNF}(q_i) - \pi^{CNF}(q_j) = 0$. The first two terms in the above equation are unambiguously negative. To see that this holds also for the latter two terms evaluate (1.28) at (1.11). We then obtain that

$$(\tau w'(q_i) - c'(q_i) = -\left((\overline{\theta} + y_i)\pi^{CNF}(q_i) - y_j\pi^{CNF}(q_j)\right) = \overline{\theta}\pi^{CNF} > 0$$

because in a symmetric equilibrium $q_i = q_j$ and $y_i = y_j$.

Characterization of the efficient solution

In Section 1.2 we have argued that the assumption of an exogenous income tax-rate is no limitation for the social planner as long as he can set tuition fees. To see this more formally let us look at a single nation case where a social planner sets a lump-sum tax T and the quality of universities q. Taxes are the only source of financing higher education; i.e. there are no tuition fees. In this case the number of students equals

$$s(q, T) = \frac{w(q) - T}{\overline{v}}$$

The objective of the social planner is to choose T and q to maximize gross-domestic product $G = s(T, q)(T - c(q))$. The first-order conditions are

$$\begin{aligned} \frac{w'(q)}{\overline{v}}(T - c(q)) &= c'(q)s \\ \frac{1}{\overline{v}}(T - c(q)) &= s \end{aligned}$$

Plugging the former into the latter equation we obtain directly that the optimal quality is characterized by $w'(q^*) = c'(q^*)$, which is similar to (2.8).

Proof of Lemma 2

Proof From equation (1.15) we see that $s^{CNF} = 0$ for $\tau = 1$. Furthermore, in Section 1.3.1 we have seen that quality is zero for $\tau = 0$. Together with the assumption that $w(0) = 0$ it follows from (1.15) that $s^{CNF} = 0$ for $\tau = 0$.

To study the number of students at intermediate tax-rates $\tau \in (0, 1)$ differentiate (1.15) with respect to τ to obtain

$$\frac{\partial s^{CNF}}{\partial \tau} = 2\overline{\theta}\left[(1 - \tau)\frac{\partial q^{CNF}}{\partial \tau}w'(q^{CNF}) - w(q^{CNF})\right] \tag{1.29}$$

Now,

$$\frac{\partial s^{CNF}}{\partial \tau}|_{\tau=0} = \frac{\partial q^{CNF}}{\partial \tau}w'(q^{CNF}) > 0 \text{ and } \quad \frac{\partial s^{CNF}}{\partial \tau}|_{\tau=1} = -2\overline{\theta}w(q^{CNF}) < 0 \tag{1.30}$$

Differentiating again (1.29), we obtain that $\frac{\partial^2 s^{CNF}}{\partial^2 \tau} < 0$ if (1.16) hold. ∎

Second-order condition for y^{CF}

Without loss of generality assume that $y_A \geq y_B$ (otherwise rename the states). Let $\Delta = w(q^{CF}) - c(q^{CF})$. Upon inserting q^{CF} into (1.18) we are left with the following to first-order conditions:

$$R_{y_A} = 2(\overline{\theta} + y_A)(\Delta - y_A) - s_A - 2y_B(\Delta - y_B) = 0 \quad (1.31)$$

$$R_{y_B} = 2(\overline{\theta} + 2y_B - y_A)(\Delta - y_B) - s_B - 2y_B(\Delta - y_A) = 0 \quad (1.32)$$

We need to show that the determinant of the Hessian matrix

$$H = \begin{pmatrix} R^{DF}_{y_A y_A} & R^{DF}_{y_A y_B} \\ R^{DF}_{y_B q_A} & R^{DF}_{y_B y_B} \end{pmatrix}$$

is positive at $y^{CF} = \Delta/2$; i.e. $det(H) = R_{y_A y_A} R_{y_B y_B} - R^2_{y_A y_B} > 0$. Evaluating at $y^{CF} = \Delta/2$ we obtain

$$R_{y_A y_A} = R_{y_B y_B} = \Delta - (\overline{\theta} + \frac{\Delta}{2})$$

$$R_{y_A y_B} = 0$$

We thus obtain that $det(H) = (\Delta - (\overline{\theta} + \frac{\Delta}{2}))^2 > 0$. ∎

Proof of Lemma 3

Proof We are going to evaluate the first-order condition on q^{DNF}, (1.11) at q^{DF}. Quality under decentralization is higher than under centralization, if and only if $\frac{\partial R_i^{CNF}}{\partial q_i}|_{q_i=q_j=q^{DNF}} > 0$. We will therefore show that $\frac{\partial R_i^{CNF}}{\partial q_i}|_{q_i=q_j=q^{DNF}} > 0$ if and only if $\delta < \delta_0^{DNF}$, for some $0 < \delta_0^{DNF} < 1$. Recalling that $\frac{\partial R_i^{DNF}}{\partial q_i}|_{q_i=q_j=q^{DNF}} = 0$ and evaluating (1.11) at q^{DF} yields

$$\frac{\partial R_i^{CNF}}{\partial q_i}|_{q_i=q_j=q^{DNF}} = \frac{\partial s_i}{\partial q_i}(1-\delta)\tau w(q_i) + \frac{\partial s_j}{\partial q_i}(\delta\tau w(q_j) - c(q_j)) + s_i(1-\delta)\tau w'(q_i) \quad (1.33)$$

$$= \chi\left[(\overline{\theta} + y^{DNF})(1-\delta)\tau - (1-\tau)(\delta\tau w(q) - c(q)) + 2\overline{\theta}(1-\delta)\tau\right] \quad (1.34)$$

$$= \chi\left[(3\overline{\theta} + y^{DNF})(1-\delta)\tau - (1-\tau)(\delta\tau w(q) - c(q))\right] \quad (1.35)$$

where $\chi = (1-\tau)w'(q)w(q)$. Note that in order to get from (1.33) to (1.34) we have made use of (1.4) and (1.5). Furthermore, in (1.33)-(1.35): $q = q^{DNF}$ and $y^{DNF} = (1-\tau)w(q^{DNF})$ to save space. Now, as $\chi > 0$ we have that $\frac{\partial R_i^{CNF}}{\partial q_i}|_{q_i=q_j=q^{DNF}} > 0$ if and only if

$$\delta < \frac{(3\overline{\theta} + y^{DNF})\tau + (1-\tau)c(q^{DNF})}{\tau(3\overline{\theta} + 2y^{DNF})} \equiv \delta_0^{DNF}$$

Note that we must have that $\tau w(q^{DNF}) - c(q^{DNF}) > 0$ for government revenue to be positive. This implies that $0 < \delta_0^{DNF} < 1$ which completes the proof. ∎

Proof of Lemma 4

Proof Let R_{xy}^{DF} denote $\frac{\partial^2 R_i^{DF}}{\partial x \partial y}$ for $x, y \in \{q_i, y_i\}$ and $i \in \{A, B\}$. Then it is sufficient to show that the determinant $det(H) = R_{q_iq_i}^{DF} R_{y_iy_i}^{DF} - R_{y_iq_i}^{DF} R_{q_iy_i}^{DF}$ of the Hessian

$$H = \begin{pmatrix} R_{q_iq_i}^{DF} & R_{q_iy_i}^{DF} \\ R_{y_iq_i}^{DF} & R_{y_iy_i}^{DF} \end{pmatrix}$$

is strictly positive when evaluated at (1.23) and (1.24). In this case, every solution to the first-order condition must be a maximum of R_i^{DF}. This implies that for an arbitrary strategy (q_j, y_j) of the opponent there is a unique interior maximum of R_i^{DF}. It follows in turn, that the best-response function of the government in state i is well defined which guarantees the existence of a unique symmetric equilibrium..

To this end note that $R_{q_iy_i} = R_{y_iq_i} = 0$ when evaluated at q^{DF}. It is straightforward to show that $R_{q_iq_i} < 0$. What remains to be shown is that $R_{y_iy_i}^{DF} < 0$ at (1.23) and (1.24). First, note that $s_i = \overline{\theta}(y_i + y_j) + \frac{1}{2}(y_i - y_j)^2$ for all $(y_i, y_j) \in \mathbb{R}^2$. Hence, we have that

$$R_{y_iy_i}^{DF} = \pi_i^D - (\overline{\theta} + y_i)$$

which is negative for a sufficiently large $\overline{\theta}$. Accordingly, there exists a $\overline{\theta}_0$ such that $det(H) = R_{q_iq_i}^{DF} R_{y_iy_i}^{DF} > 0$ for all $\overline{\theta} > \overline{\theta}_0$. ∎

Proof of Lemma 5

We are going to evaluate equation (1.26) at y^{CF} and q^{CF} to obtain

$$\frac{\partial R^{DF}}{\partial y_i}|_{y_i=y_j=y^{CF}} = -(1-\delta)\tau \frac{\partial s_i}{\partial y_i} w(q^{CF}) - \frac{\partial s_j}{\partial y_i}(\delta \tau w(q^{CF}) + f_j - c(q^{CF})) \tag{1.36}$$

To prove the lemma we need to show that there exists a δ_0^{DF} such that $\frac{\partial R^{DF}}{\partial y_i}|_{y_i=y_j=y^{CF}} < 0$ if and only if $\delta < \delta_0^{DF}$. Using (1.1) we can rewrite (1.36) to obtain

$$\frac{\partial R^{DF}}{\partial y_i}|_{y_i=y_j=y^{CF}} = -(1-\delta)\tau \frac{\partial s_i}{\partial y_i} w(q^{CF}) - \frac{\partial s_j}{\partial y_i}(1-\tau(1-\delta))w(q^{CF}) - c(q^{CF}) - y^{CF}) \tag{1.37}$$

Using (1.4) and (1.5) the right-hand side of equation (1.37) becomes

$$\begin{aligned} \frac{\partial R^{DF}}{\partial y_i}|_{y_i=y_j=y^{CF}} &= \overline{\theta}(1-\delta)\tau w(q^{CF}) + [2(1-\delta)\tau - 1]w(q^{CF})y^{CF} + y^{CF}[c(q^{CF}) + y^{CF}] \\ &= (1-\delta)w(q^{CF})\tau(\overline{\theta} + 2y^{CF}) + y^{CF}(c(q^{CF}) - w(q^{CF}) + y^{CF}) \end{aligned}$$

It follows that $\frac{\partial R^{DF}}{\partial y_i}|_{y_i=y_j=y^{CF}} < 0$ if and only if

$$\delta > \frac{\tau(\overline{\theta} + 2y^{CF})w(q^{CF}) + y^{CF}(c(q^{CF}) - w(q^{CF}) + y^{CF})}{\tau(\overline{\theta} + 2y^{CF})w(q^{CF})} \equiv \delta_0^{DF}$$

The fact that $\delta_0^{DF} < 1$ follows from $w(q^{CF}) - c(q^{CF}) - y^{CF} > 0$ which follows from (1.20). ∎

Proof of Lemma 6

Proof We first show that $q^{DNF} = 0$ at $\tau = 0$. To see this simply note that in this case $\frac{\partial R_i^{DNF}}{\partial q_i}|_{\tau=0} = -w'(q_i)c(q_i) - s_i c'(q_i) < 0$. Hence, at $\tau = 0$ there is a corner solution $q^{DNF} = 0$. Next we show that q^{DNF} is increasing in τ. We have that

$$\frac{\partial q^{DNF}}{\partial \tau} = -\frac{R_{q\tau}^{DNF}}{R_{qq}^{DNF}}$$

As $R_{qq}^{DNF} < 0$ it is sufficient to show that $R_{q\tau}^{DNF} > 0$. Using (1.4) and (1.5) in (1.21) and factoring out $(1-\tau)$ the condition characterizing symmetric equilibrium becomes

$$w'(q)\left[(\delta\tau w(q) - c(q))(\overline{\theta} + y) - y(1-\delta)\tau w(q)\right] + \overline{\theta}w(q)(\delta\tau w'(q) - c'(q)) = 0 \quad (1.38)$$

Differentiating this equation with respect to τ we obtain

$$R_{q\tau}^{DNF} = w(q)w'(q)[(\overline{\theta} + y)\delta + (1-\delta)\tau w(q) - y(1-\delta) - (\delta\tau w(q) - c(q) + \overline{\theta}\delta]$$

To show that $R_{q\tau}^{DNF} > 0$ it is therefore sufficient to demonstrate that

$$(2\tau - 1)(1 - 2\delta)w(q) + c(q) + 2\overline{\theta}\delta > 0 \quad (1.39)$$

where we have used that $y = (1-\tau)w(q)$. We now distinguish two cases. First consider the case where $\delta > 1/2$: As $(2\tau - 1)(1 - 2\delta) \geq -1$ it is sufficient to argue that $2\overline{\theta}\delta + c(q) - w(q) > 0$. In a symmetric equilibrium it must be that $\tau w(q) > c(q)$ (Otherwise we would have $R^{DNF} < 0$ which is not optimal for the government). From our assumption that $\overline{\theta} > (1-\tau)w(q)$ we thus obtain $\overline{\theta} > w(q) - c(q)$. It hence follows that

$$\overline{\theta} > \frac{w(q) - c(q)}{2\delta}$$

which shows that (1.39) holds. Let us now turn to the case where $\delta \leq 1/2$. Rearranging (1.38) we obtain

$$\tau w(q)w'(q)[2\overline{\theta}\delta + c(q) - (1-\tau)(2\delta - 1)w(q)] = A > 0$$

where $A = \overline{\theta}(w(q)c'(q) + w'(q)c(q)] + w'(q)w(q)c(q)$. Under the assumption that $\delta \geq 1/2$ this directly implies (1.39). ∎

Proof of Lemma 7

Proof We only need to show that at $\tau = 0$ we have that $q^{DF} > q^{DNF} = 0$ and at $\tau = 1$ it holds that $q^{DF} < q^{DNF}$. Then, from the fact that q^{DF} is monotonically decreasing in τ (see equation (1.27)) while q^{DNF} is monotonically increasing (Lemma 6) the Lemma follows.

Evaluating (1.21) at q^{DF} and $\tau = 1$ demonstrates that at $\tau = 1$ we have $q^{DNF} > q^{DF}$:

$$\frac{\partial R_i^{DNF}}{\partial q_i}|_{\tau=1,q_i=q_j=q^{DF}} > 0 \Leftrightarrow w'(q^{DF})[\delta w(q^{DF}) - c(q^{DF})] > 0$$

From (1.25) it is furthermore obvious that $q^{DF} > 0$ for all $\tau < 1$. Hence it follows that $q^{DF} > q^{DNF} = 0$. Applying Lemma 6 in conjunction with (1.27) completes the proof. ∎

Proof of Result 6

Proof The proof consists of showing that under decentralized provision of higher education and if tuition fees cannot be used to finance higher education i) the number of students is zero at $\tau = 0$ and $\tau = 1$, ii) starting at $\tau = 0$ a marginal increase of τ raises the number of students and iii) starting at $\tau = 1$ and lowering the tax-rate leads to more students. Furthermore we are going to show that if tuition fees are available the number of students is strictly positive. In sum, we proof that the graph of the functions $s^{DF}(\tau)$ and $s^{DNF}(\tau)$ are of a form that equals the schematic depiction in Figure 1.6 (page 45).

First, we consider the case without tuition fees. because in equilibrium both states set the same quality, we obtain the number of students as

$$s^{DNF}(\tau) = 2\overline{\theta}(1-\tau)w(q^{DNF}) \tag{1.40}$$

We see immediately that the number of students is zero at $\tau = 1$. To verify that the number of students is also zero at $\tau = 0$ consider equation (1.21) at $\tau = 0$:

$$-w'(q)(\overline{\theta} + w(q))c'(q) - \overline{\theta}w(q)c'(q) < 0$$

because $w(0) = c(0) = 0$. This implies that in the absence of taxes ($\tau = 0$), governments set quality to zero (corner solution). This establishes i).

Next we study how the number of students changes with the tax-rate τ. Differentiating (1.40) we obtain

$$\frac{\partial s^{DNF}}{\partial \tau} = -w(q^{DNF}) + \frac{\partial q}{\partial \tau}(1-\tau)w'(q^{DNF})$$

Again, we see directly that a marginal reduction of the tax-rate increases the number of students if we start at $\tau = 1$; i.e. $\frac{\partial s^{DNF}}{\partial \tau}|_{\tau=1} = -w(q^{DNF}) < 0$. The second part of ii) ;i.e.

the case in which $\tau = 0$ requires some more work. Note that by totally differentiating (1.21) we obtain that in a symmetric equilibrium

$$\frac{\partial q^{DNF}}{\partial \tau}|_{\tau=0} = -\left(\frac{1}{R^{DNF}_{q_i q_i}}\right)[w'(q^{DNF})(\overline{\theta} + w(q^{DNF}))c'(q^{DNF}) + w(q^{DNF})\overline{\theta}x'(q^{DNF}) + w'(q^{DNF})w(q^{DNF})[\delta(\overline{\theta} + w(q^{DNF})) - (1-\delta)w(q^{DNF})]]$$

Recalling that $q^{DNF} = 0$ at $\tau = 0$ this becomes

$$\frac{\partial q^{DNF}}{\partial \tau}|_{\tau=0} = -\left(\frac{1}{R_{q_i q_i}}\right)\left[w'(q^{DNF})(\overline{\theta} + w(q^{DNF}))c'(q^{DNF})\right] > 0 \qquad (1.41)$$

because in equilibrium $R_{q_i q_i} = \frac{\partial^2 R_i^{DNF}}{\partial^2 q_i} < 0$. Now, using (1.41) in (1.40) we obtain that $\frac{\partial s^{DNF}}{\partial \tau}|_{\tau=1} < 0$. Summarizing, we have so far shown that $s^{DNF}(0) = s^{DNF}(1) = 0$ as well as $\frac{\partial s^{DNF}}{\partial \tau}|_{\tau=1} < 0$ and $\frac{\partial s^{DNF}}{\partial \tau}|_{\tau=0} > 0$.

Turning to the number of students under decentralization with tuition fees note that evaluating (1.23) at $y = 0$ yields $R^{DF}_{q,q} = \overline{\theta}\pi > 0$. This implies that for $\tau = 0$ we have $y^{DF} > 0$ and hence $s^{DF} > 0$. By (1.27) we furthermore know that y^{DF} declines in τ. This concludes the proof. ∎

Proof that an equilibrium exists for $c(q) = q$ and $w(q) = \sqrt{q}$

The proof consists of showing that for a state $i \in \{A, B\}$ playing $q_i = q^{DNF}$ is a best-response to $q_j = q^{DNF}$. Let us first define the function $r(q; \overline{\theta}) = R_i^{DNF}(q, q^{DNF})$, which gives for any $q \in \mathbb{R}_+$ the revenue of state i, given that state $j \neq i$ sets quality according to (1.21). We need to show that q^{DNF} is a global maximum of $r(q; \overline{\theta})$. The proof is non-trivial, because $r(q; \overline{\theta})$ is not concave. To see this note that

$$\frac{\partial r}{\partial q}|_{q=0} = -(1-\tau)^2 w'(0) w(q^{DNF})^2 (1-\delta)\tau < 0$$

and

$$\lim_{q \to \infty} r(q) = -\infty$$

From (1.21) we know that there exists at least one extremum of r on $[0, \infty)$. But then the analysis above implies that there must be at least two extrema on that interval. In the following Lemma I am going to show that q^{DNF} is a local maximum of $r(q)$, provided that $\overline{\theta}$ is large enough. Thereafter, I show that under the assumptions of this lemma this is indeed the only maximum on $(0, \infty)$. In sum, the proof establishes that for large enough $\overline{\theta}$ the revenue function for state i takes the form depicted in Figure

1.5 (page 44), given that the other state sets quality q^{DNF}. The following Lemma takes into account that the function $r(q;\overline{\theta})$ is piecewise defined (see equations (1.2) and (1.3)), with a potential discontinuity at $q_i = q_j$.

Lemma 8 *There exists an $\tilde{\theta}_1$ such that for all $\overline{\theta} \geq \tilde{\theta}_1$ we have*

$$\frac{\partial^2 r(q^{DNF};\overline{\theta})}{\partial^2 q} = \frac{\partial^2 R_i^{DNF}}{\partial^2 q_i}|_{q_i=q_j=q^{DNF}} < 0$$

Proof First, define

$$r_q^-(q;\overline{\theta}) = \lim_{\epsilon\to 0} \frac{r(q;\overline{\theta}) - r(q-\epsilon;\overline{\theta})}{\epsilon} \qquad r_q^+(q) = \lim_{\epsilon\to 0} \frac{r(q+\epsilon;\overline{\theta}) - r(q;\overline{\theta})}{\epsilon}$$

and

$$r_{qq}^-(q) = \lim_{\epsilon\to 0} \frac{r_q^-(q;\overline{\theta}) - r_q^-(q-\epsilon;\overline{\theta})}{\epsilon} \qquad r_{qq}^+(q) = \lim_{\epsilon\to 0} \frac{r_q^+(q+\epsilon;\overline{\theta}) - r_q^+(q;\overline{\theta})}{\epsilon}$$

Then note that from (1.2) and (1.3) we have $r_q^-(q^{DNF};\overline{\theta}) = r_q^+(q^{DNF};\overline{\theta})$ and $r_{qq}^-(q^{DNF};\overline{\theta}) = r_{qq}^+(q^{DNF};\overline{\theta})$. Hence, it is sufficient to show that $r_{qq}^+(q^{DNF};\overline{\theta}) < 0$ at (1.21). Evaluating the second order-condition at (1.21) yields

$$r_{qq}^+(q^{DNF};\overline{\theta}) = \mathcal{A}\underbrace{\left(\frac{\partial^2 y}{\partial^2 q} - \frac{\left(\frac{\partial y}{\partial q}\right)^2}{s} 2(\overline{\theta}+y)\right)}_{<0} + \left(\frac{\partial y}{\partial q}\right)^2 \pi^{DNF}(q^{DNF}, q^{DNF})$$

where $\mathcal{A} = \left[\overline{\theta}\pi^{DNF} + y^{DNF}(2\delta-1)\tau w(q^{DNF}) - c(q^{DNF})\right]$ and $y = (1-\tau)w(q^{DNF})$, $\frac{\partial y}{\partial q} = \frac{\partial y_i}{\partial q_i}|_{q_i=q^{DNF}} = (1-\tau)w'(q^{DNF})$ as well as $s = s_i(q^{DNF}, q^{DNF})$. We then see that there exists a $\tilde{\theta}_1$ such that for all $\overline{\theta} \geq \tilde{\theta}_1$ we have that $\mathcal{A}$ is sufficiently large such that $r_{qq}^+(q^{DNF};\overline{\theta}) < 0$ holds. ∎

Hence, q^{DNF} is at least a local maximum of $r(q;\overline{\theta})$. Next, we show that there are no more than two extrema on $(0,\infty)$. This will be established by showing that

$$\begin{aligned} r_q(q;\overline{\theta}) &= \frac{\partial R_i^{DNF}(q, q^{DNF})}{\partial q_i} \\ &= \left(\frac{\partial s_i}{\partial q_i}\pi^{DNF}(q) + s_i\frac{\partial \pi^{DNF}}{\partial q_i} + \frac{\partial s_j}{\partial q_i}\epsilon H(q_j)\right)_{q_i=q_j=q} \end{aligned}$$

has at most two solutions on $q \in (0, \infty)$. This is the stage where the assumption of the specific forms $w(q) = \sqrt{q}$ and $c(q) = q$ enter. Defining $\sqrt{q} \equiv z$ the functions r^+ and r^- become polynomials of second order in z. To see this note that $\frac{\partial s_i}{\partial q_i}$ and $\frac{\partial s_j}{\partial q_i}$ are of degree zero. $\frac{\partial \pi_i^{DNF}}{\partial q_i}$ is of degree -1 and π_i^{DNF} is of second-order, while s_i is of first-order. Hence, $r_q(q;\overline{\theta})$ is of second-order and there can be at most two solutions of $r(q;\overline{\theta}) = 0$ on $[0, q^{DNF}]$ and two solutions on $[q^{DNF}, \infty)$. We have already established that there is a local maximum of r at q^{DNF}. So there can be at most three extrema on $(0, \infty)$. However, our analysis of the behavior of r for $\lim q \to 0$ and $\lim q \to \infty$ is only consistent with an even number of extrema. Hence, there must be two extrema, one maximum and one minimum, on $(0, \infty)$. This proves that there is only one local maximum of $r(q;\overline{\theta})$ on $q > 0$. Note that so far we have established that the revenue function if of the form characterized in Figure 1.5 (page 44). The next lemma shows that for sufficiently large $\overline{\theta}$ it is better to choose a quality q^{DNF} rather than to provide no quality.

Lemma 9 *Consider a state $i \in \{A, B\}$. Then there exists a $\tilde{\theta}_2 \geq 0$ such that if state $j \neq i$ sets quality according to (1.21); i.e. $q_j = q^{DNF}$ then it is a best response of state i to set the same quality if $\theta \geq \tilde{\theta}_2$.*

Proof Given our previous analysis it is sufficient to show that there exist a $\tilde{\theta}_2$ such that for all $\theta \geq \tilde{\theta}_2$ the following holds

$$r(q^{DNF};\overline{\theta}) > r(0;\overline{\theta}) \tag{1.42}$$

Let s denote again $s_i(q^{DNF}, q^{DNF})$. Then (1.42) is equivalent to

$$s\pi^{DNF}(q^{DNF}) + (s - s_j(0, q^{DNF}))\epsilon w(q^{DNF})$$

Noting that $(s - s_j(0, q^{DNF})) = -1/2(1-\tau)w(q^{DNF})$ the assertion follows for $\tilde{\theta}_2 \equiv \frac{(1-\tau)w(q^{DNF})}{\pi^{DNF}(q^{DNF})}$. ∎

This establishes that the symmetric equilibrium exists if $\overline{\theta} > \max\{\tilde{\theta}_1, \tilde{\theta}_2\}$. ∎

1.7 Figures

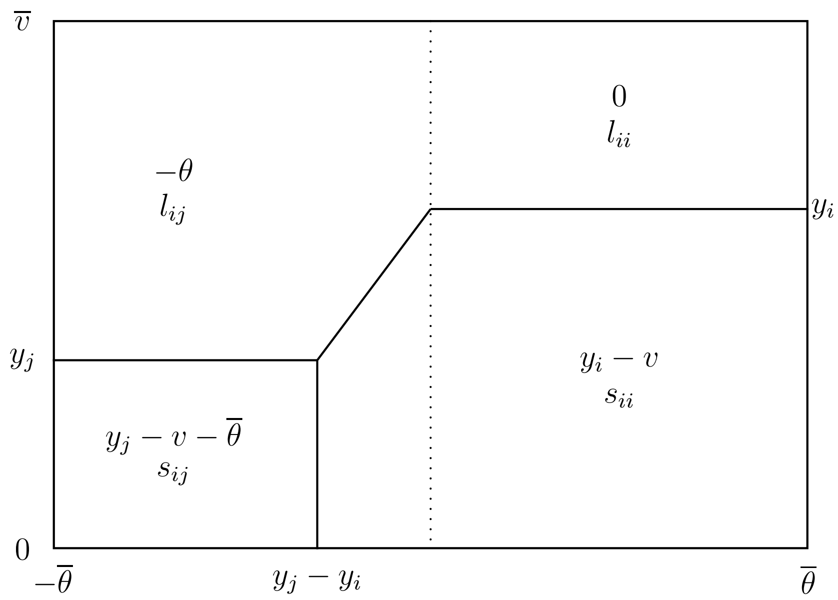

Figure 1.4: Occupational and locational choice of the high school graduates in state i, given that $y_i > y_j$

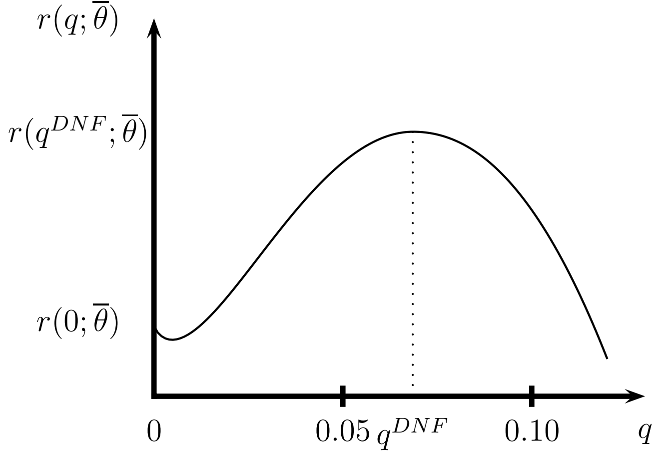

Figure 1.5: Revenue of state $i \in \{A, B\}$ given that the other state sets $q_{-i} = q^{DNF}$. The figure is drawn for the parameters $\tau = 0.5$,$\delta = 0.5$,$\overline{\theta} = 0.32$.

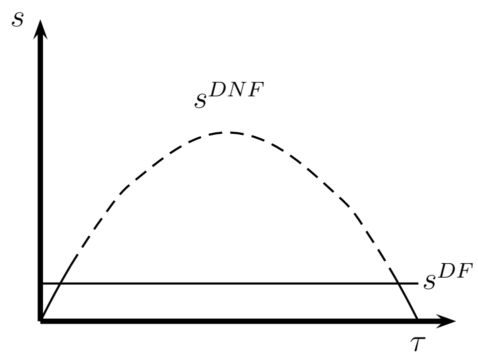

Figure 1.6: Schematic figure of the number of students under decentralization with and without tuition fees

Chapter 2

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

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). Often, these additional private contributions are collected in 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

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

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.

In this chapter we develop 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.

Chosing a different government objective as in the first chapter has two benefits: First, it makes it possible to show that a central result of the first-chapter, namely the inefficieny of decentralized decision making, is robust to variations of the government objective. Second, in line with empirical observations, benelovent governments use preferential fee regimes to discriminate against out-of-state students. This would not necessarily be the case for revenue-maximizing governments.

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 chapter is therefore to take decentralized decision-making over higher education policies as given and ask whether allowing

[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)

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 accross 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 chapter 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 chapter.

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.

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 unambigously 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 chapter 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 chapter 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 unambigously reduces welfare, calling for an abolishment of preferential fee-regimes.

The work presented in this chapter 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 (2004) and Schwager (2008). 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 (2004) restrict the analysis to an exogenously given tuition fee, Schwager (2008) 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 chapter when universities are entirely privately funded[3]. In this special case a similar result is obtained in my model. However, being able to exogenously vary the composition of public and private funds, the present chapter indicates that this argument might not extend to the more general case in which universities are partially publicly funded.

The model presented in this chapter 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 (2004) and Schwager (2008) might be reduced if governments are allowed to set differentiated fees.

The remainder of the chapter is organized as follows. Section 2.1 introduces the basic framework. Section 2.2 then characterizes the first-best solution that would be obtained

[3]The reason is that in his model graduates are immobile. Under this assumption there is no difference between a lump-sum tax in his model and tuition fee in the present model.

if all decisions were made by the central government. Section 2.3 considers the non-cooperative solution with and without the possibility to set differentiated fees and Section 2.5 concludes.

2.1 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[4]. 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:

$$V^L(\theta; v) = -\mathbf{1_M}\theta \tag{2.1}$$

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

$$V^H(y, \theta, v) = y - \mathbf{1_M}\theta - v \tag{2.2}$$

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 (2008) 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

$$y_i = (1 - \tau)H(q_i) - f_i \tag{2.3}$$

for in-state students and

$$y_i^* = (1 - \tau)H(q_i) - f_i^* \tag{2.4}$$

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 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

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

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[5].

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.

2.1.1 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 a discrete choice between four alternatives: studying at home, studying abroad, working at home and working abroad. Using (2.1) to (2.4) 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:

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

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

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 *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*

$$S_{ii}(y_i, y_j^*) = \begin{cases} (\overline{\theta} + \rho)y_i + (y_i - y_j^*)y_j^* + \frac{1}{2}(y_i - y_j^*)^2 & \text{if } y_j^* < y_i \\ (\overline{\theta} + \rho + y_i - y_j^*)y_i & \text{else} \end{cases} \tag{2.5}$$

and

$$S_{ij}(y_i, y_j^*) = \begin{cases} (y_j^* - y_i + (\overline{\theta} - \rho))y_j^* & \text{if } y_j^* < y_i \\ (\overline{\theta} - \rho)y_j^* + (y_j^* - y_i)y_i + \frac{1}{2}(y_j^* - y_i)^2 & \text{else} \end{cases} \tag{2.6}$$

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[6]. 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 2.1 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.

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 (2.5) and (2.6)

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

[6]From (2.5) and (2.6) we obtain at $y_i = y_i^*$: $\epsilon_{ii} = \frac{\partial s_{ii}}{\partial y_i}\frac{y_i}{s_{ii}} = 1 + \frac{y_i}{\overline{\theta}+\rho} < 1 + \frac{y_i^*}{\overline{\theta}-\rho} = \frac{\partial s_{ji}}{\partial y_i^*}\frac{y_i^*}{s_{ji}}$

Obviously, if income for in-state students rises, there will be more individuals who decide to begin studying 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.

2.1.2 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:

$$W^i = \begin{cases} \int_{\rho-\overline{\theta}}^{y_j^*-y_j} \int_0^{y_j^*} y_j^* - v - \theta dv d\theta \\ - \int_{\rho-\overline{\theta}}^{y_j^*-y_i} \int_{y_j^*}^{\overline{v}} \theta dv d\theta - \int_{y_j^*-y_i}^{0} \int_{v}^{\overline{v}} \theta dv d\theta & \text{if } y_j^* < y_i \\ + \int_{y_j^*-y_i}^{0} \int_0^{y_j^*+\theta} y_i - v dv d\theta + \int_0^{\rho+\overline{\theta}} \int_0^{y_i} y_i - v dv d\theta \\ \\ \int_{\rho-\overline{\theta}}^{0} \int_0^{y_j^*} y_j^* - v - \theta dv d\theta + \int_0^{y_j^*-y_i} \int_0^{y_j^*-\theta} y_j^* - v - \theta dv d\theta & \text{else} \\ + \int_{y_j^*-y_i}^{\rho+\overline{\theta}} \int_0^{y_i} y_i - v dv d\theta - \int_{\rho-\overline{\theta}}^{0} \int_{y_j^*}^{\overline{v}} \theta dv d\theta \end{cases} \tag{2.7}$$

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 (2.7). 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.

2.2 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 85). 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:

$$H'(q^{FB}) = c'(q^{FB}) \tag{2.8}$$

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

Proof See the appendix.

Result 7 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 (2.3) and (2.4) yields

$$y^{FB} = y^{FB*} = H(q^{FB}) - c(q^{FB}) \tag{2.9}$$

We see that every students bears the full costs of his education through taxes and tuition fees. Looking at equation (2.8) and (2.9) 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:

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

2.3 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 2.7 we show that this also holds in a simplified version of the model presented in this paper.

In the following we leave aside the political economy approach and and continue to assume that governments are benelovent. Based on this assumption we 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.

2.3.1 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:

$$c(q_i) = \tau\delta H(q_i) + (1-\delta)\tau\frac{s_j}{s_i}H(q_j) + f_i \tag{2.10}$$

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 (2.10) 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 (2.10).

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

$$(1-\tau)H'(q_i)s_{ii} = -\lambda(1-\delta)\tau\frac{\partial s_j/s_j}{\partial q_i}H(q_j) + \lambda(c'(q_i) - \tau\delta H'(q_i)) \tag{2.11}$$

$$-s_{ii} = -\lambda(1-\delta)\tau\frac{\partial s_j/s_i}{\partial f_i}H(q_j) - \lambda \tag{2.12}$$

where λ is the Lagrange multiplier. 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 state's policy and uniquely defined by

$$c'(q^{ND}) = (1-\tau(1-\delta))H'(q^{ND}) \tag{2.13}$$

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

Proposition 3 *There exists a unique and symmetric Nash equilibrium in which both states choose quality according to (2.13).*

Proof See the appendix.

Equation (2.13) 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 (2.8) and (2.13) 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 [7]. 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 2008). 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 (2.13), 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 (2.8) and (2.13) 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 *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.*

2.3.2 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

[7] 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:

$$\begin{aligned}(1-\tau)H'(q_i)s_{ii} = \lambda &\frac{\partial(s_{ii}+s_{ji})}{\partial q_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\ - \lambda &\frac{\partial(s_{jj}+s_{ij})}{\partial q_i}((1-\delta)\tau H(q_j) - f_i^*) + \lambda(c'(q_i) - \delta\tau H'(q_i))\end{aligned} \tag{2.14}$$

$$\begin{aligned}-s_{ii} = \lambda &\frac{\partial s_{ii}}{\partial f_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\ - \lambda &\frac{\partial s_{ij}}{\partial f_i}(1-\delta)\tau H(q_j)) - \lambda s_{ii}\end{aligned} \tag{2.15}$$

$$\begin{aligned}0 = \lambda &\frac{\partial s_{ji}}{\partial f_i^*}(c(q_i) - \tau\delta H(q_i) - f_i^*) \\ - \lambda &\frac{\partial s_{jj}}{\partial f_i^*}(1-\delta)\tau H(q_j)) - \lambda s_{ji}\end{aligned} \tag{2.16}$$

Upon adding (2.15) and (2.16) and inserting the result into (2.14) we find that the quality choice q^D of state i is independent of the other state's strategy and determined by

$$c'(q^D) = (1 - \tau(1-\delta))H'(q^D) \tag{2.17}$$

Again, the outflow of graduates distorts the quality choice of state governments. Yet, comparing (2.17) with (2.13) 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

$$c(q^D) - \tau\delta H(q^D) - f_i^* = (1-\delta)\tau\frac{s_j}{s_i}H(q^D) + \frac{s_{ii}}{s_i}(f_i - f_i^*) \tag{2.18}$$

Using (2.18) in (2.16) 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 (2.15) and (2.16) 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 (2.16) 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[8] 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)[9]

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."[10]

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 (2.15). 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 (2.18) into (2.3) and (2.4). We then obtain the following equilibrium income levels for in and out-of-state students:

$$y_i = H(q^D) - c(q^D) + \frac{s_{ji}}{s_i}\Delta \tag{2.19}$$

$$y_i^* = H(q^D) - c(q^D) - \frac{s_{ii}}{s_i}\Delta \tag{2.20}$$

[8] *Imperatives for the future: A plan for Pennsylvania's state system of higher education*
[9] Quote from Noorbakhsh and Culp (2002)
[10] Quote from Glater (2008)

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 $q^{ND} = q^D$ 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.

2.3.3 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 10 *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 4 *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 10 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 self-enforcing. 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.

2.3.4 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 2.2 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 2.2 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 2.2.

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 2.2.

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 11 *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 11 to obtain the following Corollary.

Corollary 5 *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 11 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.

2.3.5 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[11]. 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

[11]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

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 influence the level of discrimination via the home bias Δ (see equations 2.15 and 2.16). 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.

2.4 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[12]. 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

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

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 $\lim_{q_j \to \infty} \delta_i = 0$[13].

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 university graduates (see page 56) the first-best quality remains unchanged and is still characterized by (2.8). Accordingly Result 7 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 (2.10) 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

$$\begin{aligned}(1-\tau)H'(q_i)s_{ii} = & -\lambda(1-\delta)\tau \frac{\partial s_j/s_j}{\partial q_i} H(q_j) + \lambda(c'(q_i) - \tau\delta H'(q_i)) \\ & - \lambda\tau H(q_i)\frac{\partial \delta_i}{\partial q_i} + \lambda\tau H(q_j)\frac{\partial \delta_j}{\partial q_i}\end{aligned} \tag{2.21}$$

$$-s_{ii} = -\lambda(1-\delta)\tau \frac{\partial s_j/s_i}{\partial f_i} H(q_j) - \lambda \tag{2.22}$$

Using equation (2.22) in (2.21) we find that quality $\tilde{q}^{ND}$ in a symmetric equilibrium is characterized by

$$c'(\tilde{q}^{ND}) = (1 - \tau(1-\delta_i))H'(\tilde{q}^{ND}) + 2\tau H(\tilde{q}^{ND})\frac{\partial \delta_i}{\partial q_i} \tag{2.23}$$

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 (2.23). 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 (2.8). However, it is now possible that quality in equilibrium is inefficiently high.

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

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 2.3.1).

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

$$s_i c(q_i) = \tau[\delta_i(q_i, q_j) s_i H(q_i) + (1 - \delta_j(q_i, q_j)) s_j H(q_j)] + s_{ii} f_i + s_{ji} f_i^* \tag{2.24}$$

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

$$\begin{aligned} (1-\tau)H'(q_i)s_{ii} = {} & \lambda \frac{\partial (s_{ii} + s_{ji})}{\partial q_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\ & - \lambda \frac{\partial (s_{jj} + s_{ij})}{\partial q_i}((1-\delta)\tau H(q_j) - f_i^*) \\ & + \lambda(c'(q_i) - \delta\tau H'(q_i)) - \lambda\tau(H(q_i)\frac{\partial \delta_i}{\partial q_i} - H(q_j)\frac{\partial \delta_j}{\partial q_i}) \end{aligned} \tag{2.25}$$

$$\begin{aligned} -s_{ii} = {} & \lambda \frac{\partial s_{ii}}{\partial f_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\ & - \lambda \frac{\partial s_{ij}}{\partial f_i}(1-\delta)\tau H(q_j)) - \lambda s_{ii} \end{aligned} \tag{2.26}$$

$$\begin{aligned} 0 = {} & \lambda \frac{\partial s_{ji}}{\partial f_i^*}(c(q_i) - \tau\delta H(q_i) - f_i^*) \\ & - \lambda \frac{\partial s_{jj}}{\partial f_i^*}(1-\delta)\tau H(q_j)) - \lambda s_{ji} \end{aligned} \tag{2.27}$$

After inserting (2.26) and (2.27) into (2.25) it turns out that in a symmetric equilibrium of the non-cooperative game quality $\tilde{q}^D$ is determined by

$$c'(\tilde{q}^D) = (1 - \tau(1-\delta_i))H'(\tilde{q}^D) + 2\tau H(\tilde{q}^D)\frac{\partial \delta_i}{\partial q_i} \tag{2.28}$$

Comparing this to equation (2.23) 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 61 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 10 and 11 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.

2.5 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.

2.6 Mathematical Appendix

Proof of Proposition 2

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

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

∎

Proof of Result 7

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 (2.30) and (2.31) 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 (2.31) for λ and inserting into (2.30) 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 $f^* - f$. ∎

Proof of Proposition 3

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 state's objective function.

For the first step, we show that $f_A = f_B$ if quality in both states is set according to (2.13). Let us therefore assume that quality is equal in both states and chosen according to (2.13). 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

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

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

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

and in fact

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

The first term vanishes because $\mathcal{L}_{q_if_i} = -(1-\tau)H'(q^{ND})\mathcal{L}_{f_iq_i}$ at f^{ND}, q^{ND}. By differentiating (2.11) and (2.12) 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. ∎

Proof of Lemma 10

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

$$sc(q) = s_{AA}f + s_{BA}f^* + s\tau H(q) \tag{2.32}$$

which can be rearranged to give

$$c(q) - \tau H(q) - f = \frac{s_{BA}}{s_A}(f^* - f) \tag{2.33}$$

$$c(q) - \tau H(q) - f^* = -\frac{s_{AA}}{s_A}(f^* - f) \tag{2.34}$$

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 (2.32) 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 (2.33) and (2.34). 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. ∎

Proof of Lemma 11

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

$$c(q) - \tau H(q) = \frac{s_{ji}}{s_i}f_i^{*} + \frac{s_{ii}}{s_i}f_i \tag{2.35}$$

Using (2.35) in (2.3) and (2.4) we obtain

$$y_i = H(q) - c(q) + \frac{s_{ji}}{s}\Delta \tag{2.36}$$
$$y_i^{*} = H(q) - c(q) - \frac{s_{ji}}{s}\Delta \tag{2.37}$$

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 (2.5) and (2.6) 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,

$$2\overline{\theta}(s'_{ii} - s'_{ji})\Delta > s'_i\Delta(\Delta + 2\rho) \tag{2.38}$$

We need to distinguish two cases.
Case I: $\Delta > 0$. Plugging (2.5) and (2.6) into (2.38) 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 (2.36) and (2.37), this inequality can be rewritten as follows:

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

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 (2.5) and (2.6) in (2.38) 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,

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

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

Figures

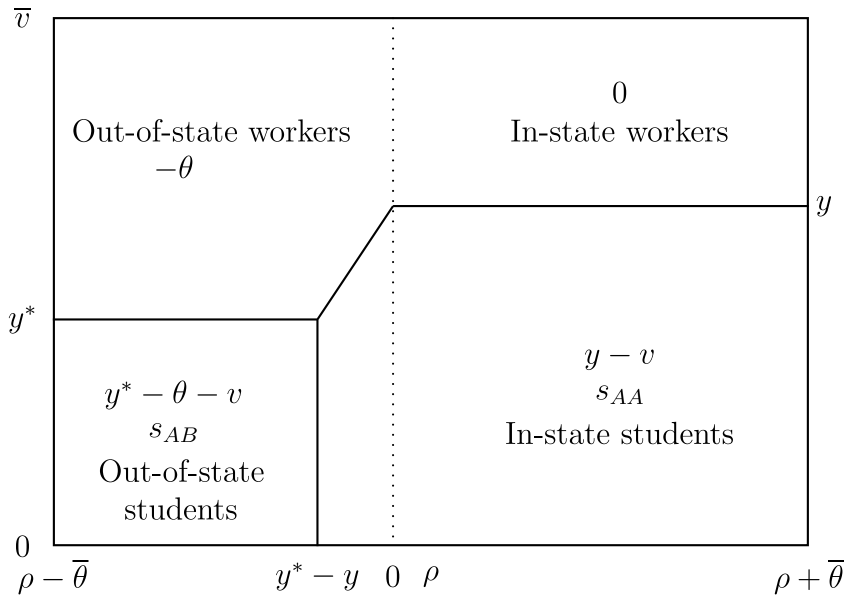

Figure 2.1: Occupational Choice, given that $y^* < y$

2.7 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 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 a locational choice.

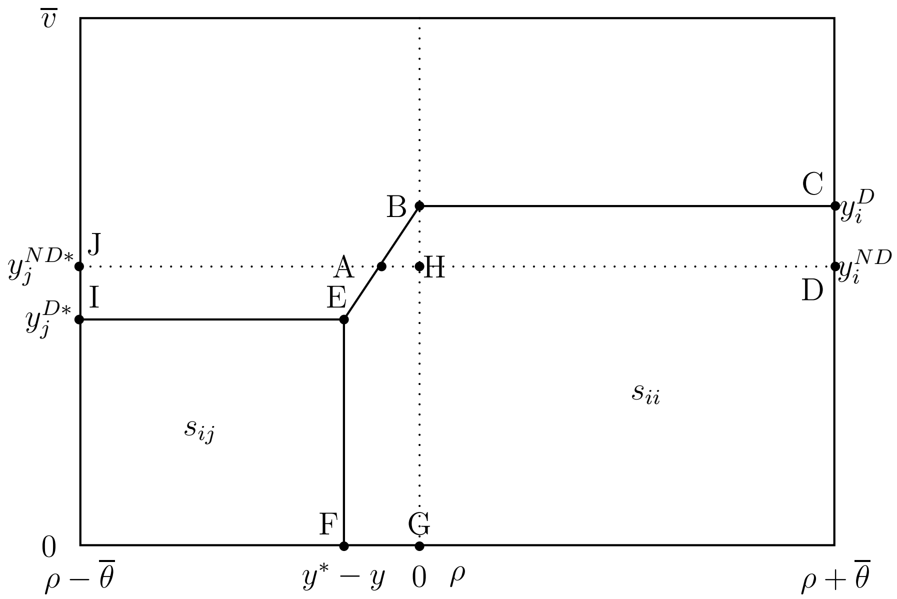

Figure 2.2: Effects of preferential fee regime on occupational and locational choice of high-school graduates in state i. Area ABCD refers to the increase in in-state students due to a reduction in fees for that group of students. Area AHEIJ shows those individuals who were out-of-state students without fee preferences but decide to work abroad under a preferential fee regime.

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

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

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

$$s_{ii} = \frac{\overline{\theta} + \rho - (1-\tau)(w(q_j) - w(q_i)) - f_i + f_j^*}{2\overline{\theta}} \tag{2.39}$$

$$s_{ji} = \frac{(1-\tau)(w(q_i) - w(q_j)) + f_j - f_i^* - (\rho - \overline{\theta})}{2\overline{\theta}} \tag{2.40}$$

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.

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.

Benelovent government

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

$$W^C = \frac{1}{2}W^A(q_A, q_B, f, f^*) + \frac{1}{2}W^B(q_A, q_B, f, f^*) \tag{2.41}$$

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 (2.41) 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 (2.41) 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 (2.41) with respect to f_i, f_j^*, q_i for $i \in \{A, B\}$ yields the first-order conditions

$$\begin{aligned}(1-\tau)w'(q_i)(s_{ii} + s_{ji}) = {} & \lambda \left(\frac{\partial s_{ii}}{\partial q_i} + \frac{\partial s_{ji}}{\partial q_i} \right) g(q_i) + \left(\frac{\partial s_{ij}}{\partial q_i} + \frac{\partial s_{jj}}{\partial q_i} \right) g(q_j) \\ & - \lambda \frac{\partial s_{ii}}{\partial q_i} f_i - \lambda \frac{\partial s_{jj}}{\partial q_i} f_j - \lambda \frac{\partial s_{ij}}{\partial q_i} f_j^* - \frac{\partial s_{ji}}{\partial q_i} f_i^* \\ & - \lambda s_i(c'(q_i) - \tau w'(q_i))\end{aligned} \tag{2.42}$$

$$-s_{ii} = \lambda(\frac{\partial s_{ii}}{\partial f_i} g(q_i) + \lambda(\frac{\partial s_{ij}}{\partial f_i} g(q_j) - \lambda \frac{\partial s_{ij}}{\partial f_i} f_j^* - \lambda \frac{\partial s_{ii}}{\partial f_i} f_i - \lambda s_{ii} \tag{2.43}$$

$$-s_{ji} = \lambda(\frac{\partial s_{ji}}{\partial f_i^*} g(q_i) + \lambda(\frac{\partial s_{jj}}{\partial f_i} g(q_j) - \lambda \frac{\partial s_{ji}}{\partial f_i^*} f_i^* - \lambda \frac{\partial s_{jj}}{\partial f_i^*} f_i - \lambda s_{ji} \tag{2.44}$$

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 7 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.

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[14]. 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 86. These conditions can be simplified to

$$\begin{aligned}(1 - \tau) w'(q_A)[\beta s_{AA} + (1 - \beta) s_{BA}] = & \frac{\lambda(1 - \tau) w'(q_A)}{\overline{\theta}}[g(q_A) - g(q_B)] \\ & + \lambda s_A (c'(q_A) - \tau w'(q_A))\end{aligned} \tag{2.49}$$

[14]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)

$$(1-\tau)w'(q_B)[\beta s_{AB}+(1-\beta)s_{BB}] = \frac{\lambda(1-\tau)w'(q_B)}{\overline{\theta}}[g(q_B)-g(q_A)] + \lambda s_B(c'(q_B)-\tau w'(q_B)) \tag{2.50}$$

$$-(\beta s_{AA}+(1-\beta)s_{BB}) = \frac{\lambda}{\overline{\theta}}(f-f^*)-\lambda(s_{AA}+s_{BB})=0 \tag{2.51}$$

$$-(\beta s_{AB}+(1-\beta)s_{BA}) = -\frac{\lambda}{\overline{\theta}}(f-f^*)-\lambda(s_{AB}+s_{BA})=0 \tag{2.52}$$

We can solve the last two equations for λ to obtain $\lambda = 0.5$. Inserting this back into (2.51) yields

$$(2\beta-1)(1-\tau)(w(q_B)-w(q_A)) = f-f^* \tag{2.53}$$

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 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 8 *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 (2.53) 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 (2.49) and (2.50) 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 2.3 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 8). 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.

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.

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.

$$\begin{aligned}(1-\tau)H'(q_i)s_{ii} = {} & \lambda \frac{\partial(s_{ii}+s_{ji})}{\partial q_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\ & - \lambda \frac{\partial(s_{jj}+s_{ij})}{\partial q_i}((1-\delta)\tau H(q_j) - f_i^*)\end{aligned} \tag{2.54}$$

$$
\begin{aligned}
-s_{ii} = \lambda \frac{\partial s_{ii}}{\partial f_i}(c(q_i) - \tau\delta H(q_i) - f_i) \\
- \lambda \frac{\partial s_{ij}}{\partial f_i}(1-\delta)\tau H(q_j)) - \lambda s_{ii}
\end{aligned}
\tag{2.55}
$$

$$
\begin{aligned}
0 = \lambda \frac{\partial s_{ji}}{\partial f_i^*}(c(q_i) - \tau\delta H(q_i) - f_i^*) \\
- \lambda \frac{\partial s_{jj}}{\partial f_i^*}(1-\delta)\tau H(q_j)) - \lambda s_{ji}
\end{aligned}
\tag{2.56}
$$

Applying the same steps as in Chapter 2.3.2 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 (2.55) and (2.56). Aggregate welfare in this decentralized equilibrium can be obtained by solving for f_A, f_B, f_A^* and f_B^* and inserting into (2.41).

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 2.7 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

$$(1-\tau)H'(q_i)s_{ii} = -\lambda(1-\delta)\tau\frac{\partial s_i/s_j}{\partial q_i}H(q_j) + \lambda(c'(q_i) - \tau\delta H'(q_i)) \tag{2.57}$$

$$-s_{ii} = \lambda(1-\delta)\tau\frac{\partial s_i/s_j}{\partial f_i}H(q_j) - \lambda \tag{2.58}$$

Again, after inserting (2.58) into (2.57) 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 (2.41).

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.

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 2.4 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 2.4 shows, displaying the relatively small differences in welfare levels graphically is difficult. Table 2.1 therefore also presents numerically computed welfare levels, albeit for different parameters. The upper table shows essentially the same result as Figure 2.4: For a sufficiently strong home bias, decision making in a central legislature yields most inefficient outcome. The lower part of Table 2.1 illustrates that the area in parameter space for which decentralization is superior vanishes as bargaining powers in the legislature become more equal.

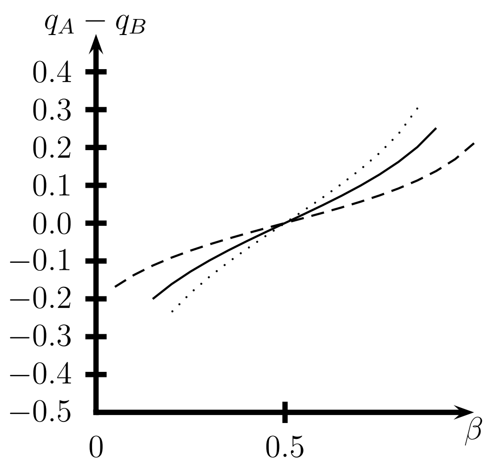

Figure 2.3: Difference between q_A and q_B when policies are determined in a central legislature. The parameter β denotes the bargaining power of the representative of state A. The figure shows the difference $q_A - q_B$ for $\overline{\theta} = 0.5$, $\rho = 0.2$ (dashed curve), $\rho = 0.35$ (solid curve) and $\rho = 0.5$ (dotted curve).

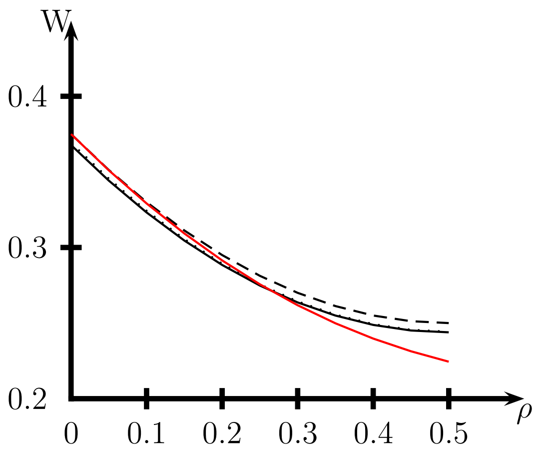

Figure 2.4: Welfare in dependence on the home bias ρ for different institutional regimes: Centralization (dashed), Central Legislature (red), Decentralization without discrimination (dotted) and Decentralization (solid). We see that for large enough ρ a central legislature implements a policy that is 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 $c(q) = q$.

$$
\begin{aligned}
(1-\tau)H'(q_A)(s_{AA}+s_{BA}) = {} & \lambda\left[\left(\frac{\partial s_{AA}}{\partial q_A}+\frac{\partial s_{BA}}{\partial q_A}\right)(c(q_A)-\tau H(q_A))+\left(\frac{\partial s_{BB}}{\partial q_A}+\frac{\partial s_{AB}}{\partial q_A}\right)(c(q_B)-\tau H(q_B))\right] \\
& -\lambda\left[\left(\frac{\partial s_{AA}}{\partial q_A}f_A+\frac{\partial s_{AB}}{\partial q_A}f_B^*+\frac{\partial s_{BA}}{\partial q_A}f_A^*+\frac{\partial s_{BB}}{\partial q_A}f_B\right)\right] \\
& +\lambda\left[s_A c'(q_A)-\tau s_A H'(q_A)\right]
\end{aligned} \tag{2.29}
$$

$$
-s_{AA} = \lambda\left[\frac{\partial s_{AA}}{\partial f_A}(c(q_A)-\tau H(q_A)-f_A)+\frac{\partial s_{AB}}{\partial f_A}(c(q_B)-\tau H(q_B)-f_B^*)\right]-\lambda s_{AA} \tag{2.30}
$$

$$
-s_{BA} = \lambda\left[\frac{\partial s_{BA}}{\partial f_A^*}(c(q_A)-\tau H(q_A)-f_A^*)+\frac{\partial s_{BB}}{\partial f_A^*}(c(q_B)-\tau H(q_B)-f_B)\right]-\lambda s_{BA} \tag{2.31}
$$

$$(1-\tau)w'(q_A)[\beta s_{AA} + (1-\beta)s_{BA}] = \lambda\left[\left(\frac{\partial s_{AA}}{\partial q_A} + \frac{\partial s_{BA}}{\partial q_A}\right)g(q_A) + \left(\frac{\partial s_{AB}}{\partial q_A} + \frac{\partial s_{BB}}{\partial q_A}\right)g(q_B)\right] - \lambda\left[\left(\underbrace{\frac{\partial s_{AA}}{\partial q_A} + \frac{\partial s_{BB}}{\partial q_A}}_{=0}\right)f + \left(\underbrace{\frac{\partial s_{AB}}{\partial q_A} + \frac{\partial s_{BA}}{\partial q_A}}_{=0}\right)f^*\right] \tag{2.45}$$

$$(1-\tau)w'(q_B)[\beta s_{AB} + (1-\beta)s_{BB}] = \lambda\left[\left(\frac{\partial s_{AA}}{\partial q_B} + \frac{\partial s_{BA}}{\partial q_B}\right)g(q_A) + \left(\frac{\partial s_{AB}}{\partial q_B} + \frac{\partial s_{BB}}{\partial q_B}\right)g(q_B)\right] - \lambda\left[\left(\underbrace{\frac{\partial s_{AA}}{\partial q_B} + \frac{\partial s_{BB}}{\partial q_B}}_{=0}\right)t + \left(\underbrace{\frac{\partial s_{AB}}{\partial q_B} + \frac{\partial s_{BA}}{\partial q_B}}_{=0}\right)t^*\right] \tag{2.46}$$

$$-(\beta s_{AA} + (1-\beta)s_{BB}) = -\lambda\left[\left(\frac{\partial s_{AA}}{\partial f_A} + \frac{\partial s_{BB}}{\partial f_B}\right)t + \left(\frac{\partial s_{AB}}{\partial f_A} + \frac{\partial s_{BA}}{\partial f_B}\right)t^*\right] - \lambda(s_{AA} + s_{BB}) = 0 \tag{2.47}$$

$$-(\beta s_{AB} + (1-\beta)s_{BA}) = -\lambda\left[\left(\frac{\partial s_{AA}}{\partial f_A^*} + \frac{\partial s_{BB}}{\partial f_B^*}\right)t + \left(\frac{\partial s_{AB}}{\partial f_A^*} + \frac{\partial s_{BA}}{\partial f_B^*}\right)t^*\right] - \lambda(s_{AB} + s_{BA}) \tag{2.48}$$

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 2.1: 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 $\tau = 0.5$.

Chapter 3

Do tuition fees affect enrollment behavior? Evidence from a ’natural experiment’ in Germany

The last two decades have witnessed profound changes of the higher education systems in almost all OECD countries. Most prominent amongst these changes is a trend towards a decline in public funding. Since the 1990s the share of private funds in higher education has risen in almost half of the OECD countries (Kärkkäinen 2006) in an attempt to finance increased demand for higher education. Often, rising private contributions went along with the introduction of tuition fees (e.g. Australia in 1989, Great Britain in 1998 and Germany in 2007).

Contemporary observers have not hesitated to claim that tuition fees raise barriers of entry into higher education and thus run counter to the frequently stated policy objective to increase participation in higher education (Hirsch 2008). Whether enrollment figures are really sensitive to prices remains however an open question. Advocates of tuition fees for instance argue that if fees are used to improve the quality of universities enrollment might even increase. Moreover, the introduction of tuition fee has often been accompanied by the introduction of sizeable subsidized loan schemes to mitigate potentially adverse effects on credit-constrained students. Whether tuition fees reduce enrollment probabilities therefore remains essentially an empirical question.

Generally, it is difficult to evaluate the impact of tuition fees on enrollment rates because they are often implemented nationwide and simultaneously (as for instance in case of the UK and Australia). Empirical studies have therefore tried to exploit cross-state and cross-time variations in tuition fees to estimate their impact on enrollment rates. In this approach it is however hard to control for all possible confounding factors. On the one hand, estimates based on cross-sectional variations might be biased if there are unobservable differences in preferences for higher education across states. In this case observation of low tuition rates and high university enrollment need not reflect a causal relationship, but might simply result from higher preferences for education, as pointed out by Dynarski (2000). On the other hand, using variation across time it is possible to control for state fixed effects, such as preferences for education, but this approach is vulnerable to changes in macro-aggregates or social norms over time for which it is again hard to control.

In Germany, tuition fees were banned by federal law (*Hochschulrahmengesetz*) since 1976. But in 2005 the German Constitutional Court abolished this ban, arguing that the law would interfere with the state's right to determine their higher education policies autonomously. Soon after this decision had been made, seven out of the sixteen German states introduced tuition fees at a uniform level of 1000 Euros per year. In the other states, access to public universities remained free of charge,

In this chapter we use the introduction of tuition fees in Germany between 2006 and 2007 as a natural experiment to evaluate the impact of tuition fees on enrollment rates. Based on individual enrollment decisions of the full population of German high-school graduates between 2002 and 2007 we measure the effect of tuition fees by comparing the trend of high-school enrollment amongst residents in the states that introduced tuition fees (henceforth 'fee states') relative to the high-school graduates in states in which access to university is still free of charge ('non-fee states'). This simple difference-in-difference methodology allows us to answer the counter-factual question: What would have been the enrollment rate in the fee states had tuition fees not been introduced? By using high-school graduates in the non-fee states as a control group all unobserved secular trends in enrollment behavior over time as well as state fixed effects are netted out. Our estimation strategy is therefore less prone to the aforementioned difficulties associated with alternative approaches. However, unlike these studies, which are able to capture a long-run effect of tuition fees on enrollment, we seek to identify a short-run effect of the policy shock.

The difference-in-difference strategy applied in this chapter requires the assumption that only the enrollment behavior in the treatment group is affected by the policy intervention. If we assume that some college graduates in the non-fee states have a preference for studying in a fee-state then it is not clear whether this hypothesis can be maintained without qualification. Based on a formal model of the decision to enroll into higher education we are however able to show that as long as there is a home bias in college graduates migration decisions the difference-in-difference estimator will provide us with a lower bound of the true effect and measures the full effect if college graduates are completely immobile.

Interpreting the results obtained from the difference-in-differences analysis as a lower bound we find that the enrollment rate amongst college graduates in the fee states was at least 2.76 percentage points lower in 2007 than it would have been in the absence of tuition fees. Expressed in actual enrollment figures this means that in 2007 there would have been approximately 5000 more high-school graduates in the fee states enrolling at university had tuition fees not been introduced. Using the structural model to account for the estimation bias we find that the full effect reduced enrollment probabilities of high-school graduates in the fee states by 4.8 percentage points. To account for the possibility that it was the announcement rather then the actual introduction of tuition fees that influenced enrollment behavior we try alternative specifications of the treatment period. We also find similar effects for males and females which shows that our results are not confounded by variations in the number of conscriptions to military or civil service.

3.1 The Literature

Economists often view the decision to enroll into higher education as an investment in human capital. According to the standard human capital theory going back to Becker (1962), each individual chooses a level of schooling to maximize the discounted present value of lifetime earnings, net of education costs. At the optimal level of education, the marginal costs of an additional year of schooling equals the net present value of the income gain associated with an additional year of education. Within this framework marginal costs of schooling comprise net opportunity costs from foregone earnings as well as direct costs, such as tuition fees.

This simple model makes several predictions. Firstly, higher costs of educational investment lead to a lower optimal level of education. Accordingly, increases in direct costs, such as tuition fees are associated with lower investment in human capital. Likewise, a reduction of marginal costs, caused for instance by loan subsidies or public grants would lead to rising education levels. Secondly, a rising skill-premium raises the return to educational investment and is hence associated with a higher optimal level of schooling.

The predictions of this model have been subject of a large body of empirical work, mostly based on data for the U.S. Some of these studies undertaken before the beginning of the 1990s are summarized by McPherson and Shapiro (1991) and Leslie and Brinkman (1987). A review of more recent U.S. studies is provided by Heller (1997), who reports that, for the studies considered in his review, an increase in tuition fees by $ 100 is consistent with a drop in enrollment between 0.5 and 1 percentage points.

Amongst the more recent studies Kane (1994), who investigates college enrollment of 18-19 year-old high school graduates in the U.S., has received wide attention. Using within- and between state variation in tuition levels he finds that a 1000$ increase in net direct college costs is associated with a five percentage point decline in the likelihood of college enrollment. The effect depends on race as well as parental income and is strongest for low-income youth. Interestingly, he finds no significant influence of financial aid on enrollment decisions.

Further econometric support for the claim that tuition fees affect enrollment comes from McPherson and Shapiro (1991) who use data from the Current Population Survey (CPS) between 1974 and 1984 to examine how aggregate enrollment rates of different population subgroups depend on the net costs of higher education. Their results are somewhat surprising. As expected, an increase in the net costs of higher education by 100$ is found to reduce enrollment rates of low income youth by 0.68 percentage points. For middle and high income groups this effects reverses its sign. Enrollment rates of middle (high) income groups increase by 0.23 (0.87) percentage points if net costs rise by 100$. The authors attribute this finding to changing supply rather than demand effects, arguing that rising tuition costs were a response to rising demand from middle and high income groups.

The evidence that tuition fees affect enrollment into higher education is however not as clear-cut as one might think in the light of the literature reviewed so far. There are also a number of studies who find no significant influence of tuition costs on enrollment. Two of these studies use data from the Netherlands: Huijsman, Kloek, Kodde, and Ritzen (1986) find that enrollment rates of Dutch first-year students over the period from 1950 until 1982 were positively affected by financial aid but no significant influence was found for tuition fees. This result is reinforced by Canton and de Jong (2005) who study enrollment of students as a percentage of the number of qualified secondary school graduates over the period 1950-1999. While financial support for students is shown to have a positive impact on enrollment rates no significant influence is found for tuition fees.

In their comprehensive analysis of post-war enrollment trends in the U.S. Card and Lemieux (2000) use CPS data to study enrollment rates for specific age groups at the state level. Albeit higher college tuition is found to reduce the probability of college attendance for 19-21 year old youth this effect is not significant.

For Germany where tuition fees did not exist until very recently research on the relationship between costs of higher education and enrollment behavior of college graduates has focused on evaluating the federal student aid system BAfoeG. Based on data from the German Socio Economic Panel (SOEP) Baumgartner and Steiner (2005) use a difference-in-difference approach to find that the move from a full-loan to a partial loan system in 1991 had no significant impact on enrollment rates. Using the same methodology to evaluate the BAfoeG reform in 2001 which raised the aid entitlement of eligible students Baumgartner and Steiner (2006) also do not find a significant impact on enrollment behavior. Employing a different identification strategy and taking into account the endogeneity of student's enrollment decisions and the eligibility of financial aid Steiner and

Wrohlich (2008) find a small but significantly positive effect of the reform on enrollment into higher education.

While in the aforementioned studies great care is taken to make the best use of the available data some problems remain. Firstly, studies relying on variation of tuition fees over time, such as Canton and de Jong (2005), Huijsman, Kloek, Kodde, and Ritzen (1986), Card and Lemieux (2000) and Kane (1994) need to maintain the assumption that enrollment decisions were not affected by structural changes over time other than those that can be controlled for.

Secondly, studies which use across-state variation in tuition fees or within-state variation over time to identify the effects of tuition fees on enrollment rates often implicitly assume that students are not mobile across state borders. This point is best illustrated by looking at a typical structural equation. Card and Lemieux (2000) for instance fit the following model with U.S. data

$$P_{kt} = \beta X_{kt} + \gamma_k + \nu_t + \epsilon_{kt} \tag{3.1}$$

in which P_{kt} is the average enrollment rate for a specific age group in state k at time t, ν_t and γ_k are year and state fixed effects and X_{kt} controls for time- and state-specific determinants of enrollment behavior. Most importantly, X_{kt} includes a measure of the average tuition costs in state k at time t. However, if we assume that some youth in a state k have a strong preference for studying in another state $j \neq k$, then their decision to enroll at a university will also depend on the tuition fees levied at their preferred destination state j. To illustrate this argument suppose, for example, that a high-school graduate in a state k wants to study a subject that is only offered by a university in a state $j \neq k$. If this youth prefers studying to not entering into higher education only in case he can afford to study his preferred subject then his enrollment decision will primarily depend on tuition fees in state j.

Hence, if proper account is taken for the possibility that students are mobile between states then the average enrollment rate in a state does not only depend on tuition levels in that state but also on average tuition levels in neighboring states. Data from the National Center for Education Statistics show that student mobility in the U.S. is in fact sizeable. In 1996 the percentage of college freshmen who attended an out-of-state public or private not-for-profit college was 26%. This figure remained fairly stable over time and was 25% in 2006 (Planty, Snyder, Provasnik, Kena, R., Ramani, and Kemp 2008). The mobility of German students is comparable. In 2003 approximately 32% of the German students were out-of-state students (Kultusministerkonferenz 2005). We will return to the issue of student mobility below, when we analyze the enrollment decision in a simple discrete choice framework. Empirical evidence that between state differences in tuition costs matter in enrollment decisions is provided by Noorbakhsh and Culp (2002).

As a minor point, note that samples in studies which are based on longitudinal data such as the CPS are often quite small. The samples used in Kane (1994) comprise on average 4200 observations for each year, which translates into less than 100 observations per state.

To overcome some of the limitations of earlier studies we use the simultaneous introduction of tuition fees in 7 of the 16 German states in 2007 as a natural experiment. By comparing the change of enrollment rates amongst high-school graduates in the states that introduced tuition fees to the development of enrollment rates in the other states we are able to single out the effect of tuition fees on enrollment behavior. In particular, by using the non-fee states as a control group any changes in enrollment behavior over time as well as unobserved differences between states are netted out.

To take proper account of the mobility of freshmen, we analyze the decision to enroll at an in-state or out-of-state university at hand of a simple model developed in (Hübner 2009). Based on these theoretical predictions we will be able to correctly interpret the coefficients of our difference-in-difference estimate.

Furthermore, using information on the enrollment decisions of the full population of German high-school graduates we are able to calculate the coefficients of interest in the difference-in-difference equation by population means, rather than sample averages, thus overcoming the small sample problems of earlier studies.

3.2 Institutional Background

In Germany, tuition fees were legally banned by federal legislation since the implementation of the Hochschulrahmengesetz 1976. In 2005 the German constitutional court ruled that this law interferes with the rights of the German states (*Länder*) to determine their higher education policies autonomously. While the court explicitly stated that a ban of tuition fees were not in conflict with the constitution in general, it required that legislation concerning tuition fees has to be passed by state parliaments.

Soon after this decision had been made, some German states (Niedersachsen (*Lower Saxony*), Hamburg, Hessen (*Hesse*), Baden-Württemberg, Bayern (*Bavaria*), Saarland and Nordrhein-Westfalen (*North Rhine-Westphalia*)) passed a law which introduced tuition fees at state universities.

In Germany, high-school graduates are awarded their degrees which grant them admission to university (*Hochschulzugangsberechtigung*) in May or June. The academic year in Germany starts in October and is divided into an autumn (October to March) and spring term (April to September). Although it is theoretically possible to enter university in the spring term, this rarely happens in practice. For the vast majority of students their university education begins in October.

In most states, tuition fees had to be paid for the first-time in the spring-term of 2007, the only exceptions being the Saarland and Lower Saxony. In the Saarland, students began paying tuition fees in the autumn term 2007 while newly enrolled student in Lower Saxony and North Rhine-Westphalia had to pay tuition fees already in the autumn term 2006. Table Table 3.6 summarizes information about fee levels in each state and the date at which the respective legislation was passed. Note that the introduction of tuition fees proceeded rather simultaneously between the autumn terms 2006 and 2007. Hence, the first cohort that was affected by the policy change were those graduating from high-school in 2007.

Tuition levels are rather uniform across the states that introduced fees as well as between universities within states. In five states (Baden-Württemberg, Hamburg, Hesse, Lower Saxony and Saarland) all students at state universities have to pay tuition fees of 500 Euro per term; i.e. 1000 Euro annually. In Bavaria and North Rhine-Westphalia fee levels can vary between universities. In practice however, all fees lie within the range of 300-500 Euro and the vast majority of students pays 500 Euro per term. There are a few exceptions in North Rhine-Westfalia where some universities do not charge fees. However, apart from the University in Münster these are very small institutions with a negligible number of students. Tables 3.7 and 3.8 show tuition fees at Universities in Bavaria and North Rhine-Westphalia for the years 2007 and 2008 as well as the total number of students enrolled at each university in 2005. Based on this information it is possible to calculate the weighted average of tuition fees displayed in Table 3.6. The calculations show that the average tuition fee paid by a student in Bavaria or North Rhine-Westphalia was approximately 450 Euros in the autumn term 2007 and thus of a similar amount as the 500 Euros charged in the other fee states.

A distinctive feature of Germany's higher education system is the insignificant role played by private universities. In 2005, only two per cent of the students in Germany were enrolled at private universities (Statistisches Bundesamt 2005). This means that tuition rates summarized in Table 3.6 practically apply to all students in Germany.

In sum, seven out of the sixteen German states have made almost simultaneous use from the possibility to introduce tuition fees. We have seen that the financial burden associated with these fees is almost identical for students in the fee states and only very few students can substitute public for private higher education. These features allow us to interpret the described policy intervention as a 'natural experiment' well suited to test whether enrollment into higher education is sensitive to tuition prices.

To get an impression of the total financial burden associated with tuition fees note that the average time students in Germany are enrolled at university until they obtain their first degree (*Diploma*) was 11.1 terms (approximately 5.5 years) in 2006. At technical colleges this time was slightly shorter with an average of only 8.5 terms (4 years) until students completed their studies. Students entering university in 2007 in a fee-state could therefore expect to pay an average of 5500 Euro during the course of their studies (4250 Euro at technical colleges) (Statistisches Bundesamt 2008b). It is however generally expected that the average time to a first degree in Germany will decline with the introduction of the Bachelor degree.

To avoid that liquidity constrained students are prevented from enrolling at university because they do not find money to finance tuition fees all fee-states have introduced a subsidized loan scheme. Although the loan schemes vary in some of the details they share many common features. Most importantly, they entitle students to take out a loan that exactly covers tuition costs for the typical time necessary to obtain a first degree at university (*Regelstudienzeit*).Loans are provided to students by private banks or by the publicly owned state banks but the default risk is born by the states. To ensure that loans are only used to finance tuition costs they are generally payed out directly to universities. Students can delay the repayment of the loan by no more than two years after leaving university. However, there is typically a cap on the maximum amount that has to be redeemed. Currently this cap is at 10000 Euros in North-Rhine Westphalia and 15000 Euros in Hessen. Furthermore, persons with low incomes can defer redemption of the loan[1]. As a last point, note that students are not constrained to make use of the loan scheme in the state where they attend university but are also eligible under the other schemes[2].

3.3 Data and Empirical Strategy

3.3.1 Data

The empirical analysis is based on individual enrollment decisions of all German college graduates in the years 2002 until 2007. This information is based on administrative data from universities. In fact, each term, universities have to report individual information on all enrolled students to the Federal Statistical Office of Germany (*Statistisches Bundesamt*), which publishes various summary information taken from these individual data. The data include personal information (Sex, Age, Nationality and the city where the student completed high-school) for each student as well as information related to a students academic history, such as the degree pursued and the subject of study.

The Statistical Offices combines these data with data on all high-school graduates in Germany (Statistisches Bundesamt 2008a). Amongst other statistics it then publishes

[1]Currently this is a case for individuals with a monthly income below 1024 Euros.

[2]It is however not possible to make use of more than one loan scheme.

information about the number n_{kt} of individuals who earn a university admission degree in a given year t and state k. Furthermore, we know how many of these high-school graduates enroll into higher education in year $t + \delta$, where $\delta = 0, \ldots, 5$. Let us denote these numbers as $h_{kt+\delta}$. From these figures we obtain the shares of high-school graduates who enroll at university in the year in which they obtain their high-school degree from which we calculate the difference-in-difference estimates. The reason why we focus on immediate transitions into higher education is that tuition fees were introduced in 2007 and the data ends in 2008. So the only students in the data who are affected by tuition fees at the time of enrollment are those who obtained their high-school degree in 2007 and made an immediate transition into higher education. The number of high-school graduates by state and year as well as the number of graduates who make an immediate transition to high-school are shown in Table 3.5.

In a strict sense, we are therefore not able to distinguish between two alternative explanations for an observed decline in enrollment probabilities in the fee states. Such a change in enrollment rates can be caused because some youth decide to abstain permanently from enrolling at a university or simply mean that the introduction of tuition fees caused some youth to delay enrollment. However, the latter interpretation seems hard to rationalize. After all, postponing enrollment would raise the costs of attending university in the form of foregone earnings and thus aggravate the price effect of tuition fees [3].

Immediate transitions into higher education are therefore a reasonable proxy for enrollment probabilities. Furthermore, our measure of university enrollment is comparable to those used in the related literature. Kane (1994) for instance proxies enrollment probabilities by the share of 18-19 old youth enrolled in higher education. Results based on this measure suffer from the same problem as it is not possible to determine whether declining enrollment rates are caused by postponing entry into higher education until the age of 20.

Average transition rates for students in fee and non-fee states are plotted in Figure 3.1 (page 98). We see that transition probabilities in the group of states that introduced tuition fees in 2007 lie above transition rates in the no-fee states over the entire observation period. Furthermore, enrollment rates in both groups move in lockstep until 2006 when tuition fees were introduced. Thereafter, they decline in the fee states and show a slight upward trend in the other states, which gives a first indication that tuition fees might have reduced enrollment probabilities.

[3] One could argue that students who are credit constrained might decide to work after finishing high-school in order to finance their further education. Note however, that all students who pay tuition fees are entitled to take out a state guaranteed loan at subsidized interest rates. Ignoring the possibility that students dislike debt as such this should cancel out any tightening of credit constraints due to the introduction of tuition fees.

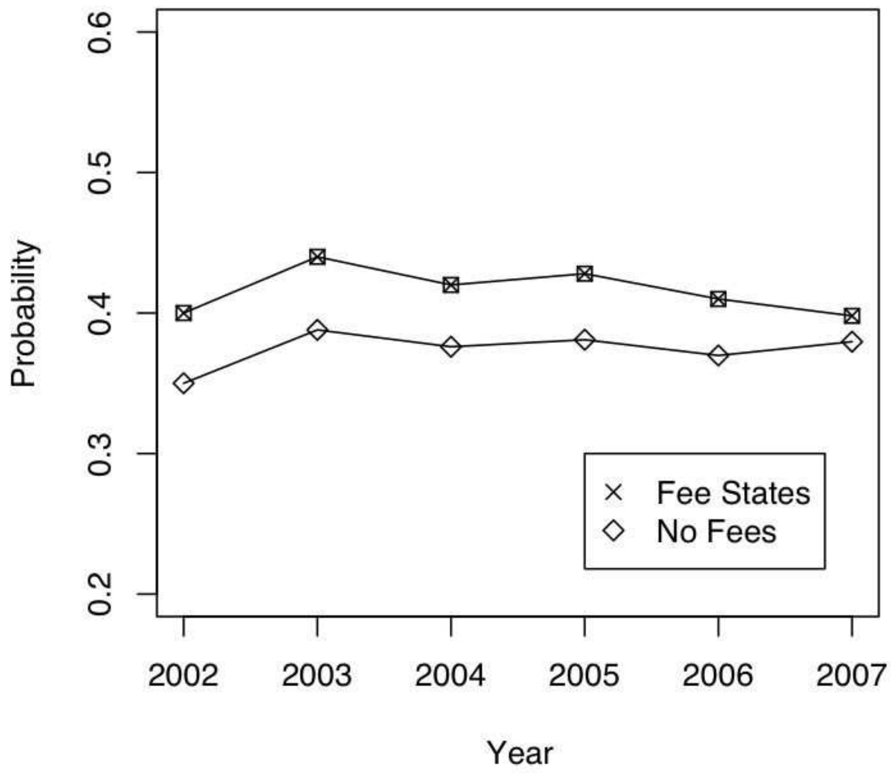

Figure 3.1: Enrollment probabilities for fee and no fee states between 2002 and 2007

Data on tuition levels at German state universities, such as shown in Table 3.6, and the date when state governments passed legislation which introduced these fees were collected by consulting legal texts.

3.3.2 Estimation Strategy

The empirical approach used in this chapter is to use the simultaneous introduction of almost uniform tuition fees in some German states as a natural experiment. Examining changes in enrollment rates in the fee states over time we expect to find a discontinuity between 2006 and 2007 when tuition fees were introduced. To net out any secular trends in enrollment behavior we use the non-fee states as a control group.

1 This difference-in-difference strategy assumes that the enrollment status P_i of high-

school graduates in fee states and the comparison group can be written as

$$P_i = \beta_0 + \beta_1 D_i After_i + \beta_2 After_i + \beta_3 D_i + \epsilon_i \tag{3.2}$$

where $E[\epsilon_i|D, After] = 0$ and D_i and $After_i$ are dummy variables indicating residence in a fee state and observations in 2007. Note that throughout this chapter we index individuals by i and states by j and k. Differencing enrollment rates across both group of states and time gives

$$\begin{aligned} DD =& (E[P_i|D_i = 1, After_i = 0] - E[P_i|D_i = 1, After_i = 1]) \\ & -(E[P_i|D_i = 0, After_i = 0] - E[P_i|D_i = 0, After_i = 1]) = \beta_1 \end{aligned} \tag{3.3}$$

This quantity is also referred to as the 'average treatment effect on the treated' (Imbens and Angrist 1994). It allows us to infer the counter-factual enrollment rate in the fee states; i.e. what the enrollment rate in these states would have been had tuition fees not been introduced. We expect this coefficient to be negative.

Note that we obtain the coefficient β_1 by using population means in (3.3). For instance, using the notation introduced earlier, we calculate the last term in (3.3) as

$$E[P_i|D_i = 0, After_i = 1] = (\sum_{k \notin F} h_{k2007+0})/(\sum_{k \notin F} n_{k2007})$$

where F denotes the set of all fee states.

The interpretation of β_1 as the effect on the treated rests on a key identifying assumption: First, we must maintain that the coefficient on the interaction term $D_i After_i$ is zero in the absence of the policy intervention; i.e. the introduction of tuition fees. This means that we need to rule out that there are factors other than tuition fees which affect enrollment rates in the control- and treatment group differently. One way to ensure this is to compare trends in enrollment rates before tuition fees were introduced in some states. Figure 3.1 (page 98) shows a very similar pattern of enrollment rates in both groups of states before 2007 which warrants the assumption that enrollment rates had continued to develop in parallel if tuition fees had not been introduced.

There are two potentially confounding effect that we do not capture by this method. In 2005 the German federal and state governments passed the so called 'excellence initiative' aimed at making Germany a more attractive research location. Between 2006 and 2011 the initiative provides a total of 1,9 billion Euros in additional funding to selected research institutions. Universities can submit funding proposals in three funding lines (graduate schools, excellence clusters and flag-ship universities) which are then reviewed by international experts. Decisions in the first and second round of the initiative have been made in October 2006 and October 2007. Table 3.9 shows the universities that were awarded funding within any of the three funding lines. As can be seen most universities that received additional funding are located in the fee states. We cannot entirely rule out that the excellence initiative has influenced the enrollment decision of the high-school graduates in both group of states differently. However it is unlikely that the financial resources from the initiative have lead to an immediate rise in quality. Some funding lines, such as the financial support for Graduate schools even do not benefit freshmen at all. Moreover, a positive effect on quality would counteract any price effect of tuition fees on enrollment probabilities. If at all, any quality effect of the excellence initiative would therefore lead to an underestimation of the true effect of tuition fees.

A second issue concerns the implementation of the Bologna Process in which 29 European countries commited themselves to enact structural reforms of their higher education systems in an attempt to create a uniform European higher education area. As a major building block the countries agreed to introduce the Bachelor/Master - degree system. For Germany, which has traditionally awarded a Diploma/Magister (roughly equivalent to a Masters degree) as a first degree this meant a major change of academic practice. If there are systematic differences between the fee and non-fee states with respect to the progress made in implementing the new degrees this might violate our key identifying assumption. The latest available statistics on the implementation of the new degrees however indicate that the differences between the two groups of states are rather small. At the beginning of 2009, 76 per cent of the freshmen in Germany enrolled in courses that lead to a Bachelor or Masters degree. The fee states have been slightly slower in the introduction of the new degrees. In these states 73.69 per cent of the courses offered to new students fall into the Bachelor/Master-category. In the non-fee states this figure is 82.46 per cent (schulrektorenkonfe renz 2009).

As a further assumption we need to maintain that individual enrollment probabilities in the control group are not affected by the introduction of a tuition fee in the treatment group. We have argued above that the mobility of students between states might potentially undermine this assumption. However, a formal analysis of individuals enrollment decision reveals that under very plausible assumptions on the mobility of high-school graduates both groups are sufficiently differently affected by the introduction of tuition fees, such that the difference-in-difference strategy yields a lower bound of the true effect. Furthermore, as we show in the following Section it is possible to use the results of a structural model to correct for the bias and to recover the size of the true effect. It is this analysis that we now turn to.

3.3.3 A model of university enrollment

To analyze the demand for higher education in a federation we draw on the model developed in the first chapters of this thesis. The model considers a federation consisting of two states A and B. Within the context of this chapter a natural interpretation is to think of these jurisdictions as the group of fee and non-fee states. We refer to the group of fee-states as the treatment group $T \in \{A, B\}$ and to the non-fee states as control group $C \in \{A, B\} \setminus \{T\}$. Each state is inhabited by a continuum of youth who leave high-school and have to decide whether they enroll at a university or start working. Each youth in a state $k \in \{A, B\}$ chooses between four alternatives. He can enroll at a university in state $k \in \{A, B\}$ which gives him utility $u = w^H - f_k - v$. Alternatively, he can become a non-resident student in state $j \neq k$. In this case he experiences a utility $u^* = w^H - f_j - v - \theta$. Here, f_k denotes tuition fees in state k and w^H is the wage for high-skilled individuals. The parameters v and θ are random variables which are uniformly and independently distributed over individuals in each state. We assume that these variables are drawn from a support $[0, \overline{v}] \times [\rho - \overline{\theta}, \rho + \overline{\theta}] \subseteq \mathbb{R}^2$ and their realization is not observed. The interpretation of these variables as follows: v measures individual specific costs of attending university. The second variable θ represents migration costs of an individual as are for instance associated with leaving ones social networks. These costs can be negative to account for the fact that some youth might actually have a preference for studying abroad. Of importance is the parameter ρ which introduces a home bias into individual migration decisions. If $\rho > 0$ then, given identical fees in both states ($f_A = f_B$), the fraction of students who study in their home state $\frac{\overline{\theta}+\rho}{2\overline{\theta}}$ is larger than the fraction of youth who study abroad $\frac{\overline{\theta}-\rho}{2\overline{\theta}}$. For $\rho = \overline{\theta}$ all youth are completely immobile and enroll in their home state.

In addition to the migration decision individuals also make an occupational choice. They can decide to attend university or to work in a low skilled occupation. In this case they earn a wage w^L which we normalize to zero. If a youth in state k decides to begin working in that state he enjoys utility $u = w^L$, while if he works in state $j \neq k$ his utility is $u^* = w^L - \theta$.

If all individuals behave optimally and choose the alternative giving them highest utility it can be shown that the number of in-state students in state k, is a function of tuition fees $s_{kk} = s_{kk}(f_k, f_j)$. Similarly, as shown in (Hübner 2009), the number of youth in a state k who decide to become non-resident students in j is also a function of tuition fees: $s_{kj} = s_{kj}(f_k, f_j)$. Normalizing the number of youth in each state to one, the expected probability P_i^k that a youth in state k enrolls into higher education can be written as $P_i^k(f_k, f_j) = s_{kk}(f_k, f_j) + s_{kj}(f_k, f_j)$.

What is important here is that the enrollment of state k residents depends not only on tuition fees in their home state but also on tuition fees in the rest of the federation. Herein lies the explanation for our earlier claim that when investigating enrollment into higher education on the basis of state-level data it is necessary to control for tuition costs in neighboring states.

Let us now consider how the introduction of tuition fees in the treatment group T

affects enrollment probabilities in the control and treatment group. Differentiating the functions for s_{kk} and s_{kj} in (Hübner 2009) by f_T and starting in a situation in which neither state levies a tuition fee ($f_T = f_C = 0$) we find that if a tuition fee is introduced in the treatment states T the expected enrollment probability of a youth in these states declines by

$$\frac{\partial P_i^T}{\partial f_T}|_{f_T=f_C=0} = -(\overline{\theta} + \rho) \tag{3.4}$$

Enrollment probabilities in the control group C are affected in the following way

$$\frac{\partial P_i^C}{\partial f_T}|_{f_T=f_C=0} = -(\overline{\theta} - \rho) \tag{3.5}$$

This analysis highlights two important points: First, the mobility of high-school graduates mitigates the effect of tuition fees on enrollment probabilities in the treatment group. We see that the size of the marginal effect in (3.4) increases with the home bias ρ. Further below we use the results of this theoretical analysis to approximate the effect of tuition fees for the hypothetical situation in which high-school graduates are immobile ($\rho = \overline{\theta}$).

Second, as long as there is a home bias in student's migration decisions; i.e. $\rho > 0$ the introduction of a tuition fee in the fee states reduces the enrollment rate in the treatment states more than in the control states. The difference in the reaction of enrollment rates is stronger the larger the home bias (i.e. the larger ρ). In the extreme case where freshmen are completely immobile ($\rho = \overline{\theta}$) only the enrollment rate in the state introducing the fee is affected.

What is the intuition for this result? To illustrate the underlying mechanism Figure 3.2 (page 103) shows the optimal choice of high-school graduates in the fee-states $T \in \{A, B\}$ in dependence of their type (θ, v). Because of our distributional assumption it is possible to display all individuals as a point in a rectangular area in the following way: The individual with the lowest individual costs of attending university and minimal migration costs is located in the south-west corner. Moving to the east, migration costs of individuals increase. Individuals with higher costs of attending university are placed further north. We denote by $y = w^H - f_T$ the net present value of lifetime income of an in-state student in the fee-states and by $y^* = w^H$ the net present value of lifetime income of an out-of-state student in the control group.

The left part of Figure 3.2 (page 103) shows a 'status quo' in which neither group of states levies a tuition fee. Net present value of life-time income of a student from the control group is thus independent of where he attends university ($y = y^* = w^H$). Given these income levels individuals with negative migration costs migrate to the fee states T. Amongst the movers individuals with low costs of attending university become students (s_{CT}) and the remaining movers decide to work (l_{CT}). Similarly, individuals who stay

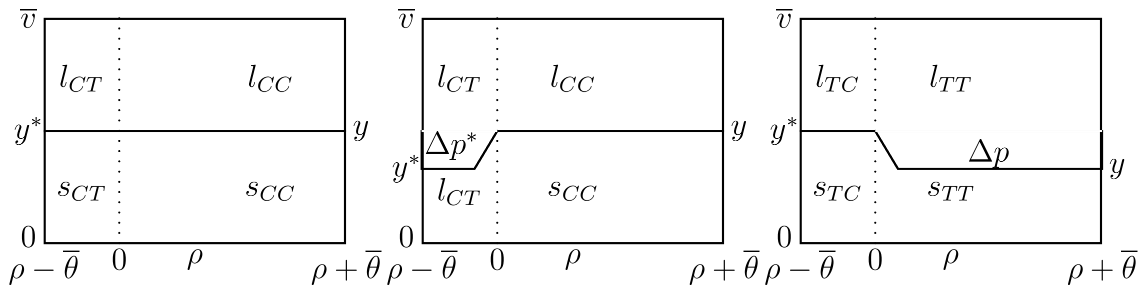

Figure 3.2: Choices of youth in state C in case no state levies a tuition fee (left). In this case net present value of income of university graduates is $y = y^* = w^H$, regardless whether individuals study in T or C. If state T introduces a tuition fee f_T, income of university graduates in that state declines to $y = y^* = w^H - f_T$ (middle). As a consequence, the number of students in state C who enroll into higher education shrinks by Δp^* (middle). The number of students in state T falls by Δp (right). The decline is stronger than in state C.

at home also sort into students (s_{CC}) and laborers (l_{CC}) depending on their costs of attending university. The enrollment probability of a resident in the treatment group drawn at random from the population corresponds to the area $s_{CC} + s_{CT}$. Furthermore, note that the number of migrating students (area s_{CT}) gets smaller as the home bias ρ increases.

How does the introduction of a tuition fee f_T in the fee-states change enrollment behavior in the control group? To see what happens in this case look at Figure 3.2 (page 103) (middle): We see that only those individuals with a high preference for moving to the treatment states T are affected by this change. The tuition fee reduces income y^* from studying abroad. As a result, some individuals with negative migration costs decide to work in T rather to study abroad, causing the enrollment probability of state C residents to decline by Δp^*.

A similar response is observed in the treatment states. Now, individuals with high migration costs are affected by the policy intervention as income y of the students staying in the fee-states declines. Consequently, more individuals in the treatment states choose to work and the enrollment probability amongst the residents of these states shrinks by the area Δp.

The analysis demonstrates that a change in the level of tuition fees in a given state affects enrollment probabilities of all high-school graduates who have a strong preference for living in that state and not only the behavior of its own residents.

Figure 3.2 (page 103) also explains why, given a home bias, enrollment probabilities of residents are more strongly affected by the introduction of a tuition fee than those of non-resident students; i.e. $\Delta p > \Delta p^*$. It is simply that in the status quo (Figure 3.2 (page 103), left) the fraction of individuals who prefer to live at home is larger than the number of individuals who prefer to migrate. While the first group is affected by a change in the domestic tuition fee the latter group's enrollment decisions are affected by tuition fees abroad. As the first group is also larger the enrollment probability of a randomly drawn individual is more likely to be affected by a change in the domestic fee than by a variation of the fee in the other state.

The foregoing analysis has some implications for the interpretation of the difference-in-difference estimator in (3.3). In case high-school graduates are completely immobile ($\rho = \overline{\theta}$), β_1 captures the full average treatment effect on the treated. For $0 < \rho < \overline{\theta}$ the introduction of tuition fees affects both control and treatment group, albeit the effect on the latter is stronger. As a consequence the parameter β_1 does not capture the full treatment effect on the treated. Estimating equation (3.2) we will then only be able to obtain a lower bound for the effect of tuition fees. Note however that the estimated coefficient will be the closer to the full effect the stronger the home bias of high-school graduates.

To see this more formally note that if some of the treatment spills-over to the control group the enrollment probability of an individual i can be written as

$$P_i = \beta_0 + \beta_1 D_i After_i + s(1 - D_i)After_i + \beta_2 After_i + \beta_3 D_i + \epsilon_i \tag{3.6}$$

where s denotes the size of the spill-over effect. Applying the difference-in-difference estimator (3.3) to (3.6) yields the observed effect $DD' = \beta_1 - s$. Letting $DD = \beta_1$ denote the full (albeit unobserved) effect we see that the difference-in-difference strategy underestimates the true effect, or

$$DD = DD' + s \tag{3.7}$$

Making use of the marginal effects in (3.4) and (3.5) wee see that the size of the spillover effect for a small change in tuition fees in the treatment states Δf_T is $s = \Delta P_i^C = -(\overline{\theta} - \rho)\Delta f_T$. Moreover, the size of the true effect is $DD = \Delta P_i^T = -(\overline{\theta} + \rho)\Delta f_T$.

It then follows from (3.7) that the observed effect DD' equals 2ρ. We thus fail to identify any effect if students are fully mobile ($\rho = 0$). A lower bound of the true effect is identified if there is a home bias in students migration decisions ($0 < \rho < \overline{\theta}$). For completely immobile students $\rho = \overline{\theta}$ we identify the true effect $DD = \Delta P_i^T = -2\overline{\theta}\Delta f_T$.

In Germany, students are mobile between states, but the home bias in student's migration decisions is sizable. In 2003 only 31% of the students in Germany were enrolled in a state that was different to the state where they graduated from high-school (Kultusministerkonferenz 2005). This implies for the following estimation that any treatment effect found in the next section will underestimate the true effect only modestly.

We can however also use the structural model to recover the true effect from the observed effect if we can establish a relationship between the two parameters $\overline{\theta}$ and ρ. This is however no problem as we know that in the time before tuition fees were introduced in the fee states roughly 70 per cent of the students attended university in their home state. This figure tells us that the fraction of students who study at home $\frac{\overline{\theta}+\rho}{2\overline{\theta}}$ must equal 0.7, or $\rho = 0.4\overline{\theta}$. Using $DD' = -2\rho$ we then obtain $\overline{\theta} = -\frac{5}{4}DD'$. The true effect on the treated $DD = -(\overline{\theta} + \rho)\Delta f_T$ is thus larger than the observed effect and equals $-1.4\overline{\theta} = \frac{7}{4}DD'$.

By a similar reasoning we can also approximate the effect on enrollment probabilities of high-school graduates in the non-fee states. Recalling that the spillover effect is $s = -(\overline{\theta} - \rho)\Delta f_T$ and making use of $\rho = 0.4\overline{\theta}$ we find that the marginal effect on enrollment probabilities in the non-fee states is $s = \Delta P_i^C = \frac{3}{4}DD'$.

Based on this formal considerations we are now able to properly interpret the results of the empirical analysis.

3.4 Estimation Results

Table 3.1 shows enrollment rates for youth that are residents in fee and non-fee states. The first row presents average enrollment rates in the fee states before and after the intervention (Columns 1 and 2). The second row contains the same information for the other group of states. Column 3 shows the changes in enrollment rates over time. We see that enrollment declines amongst high-school graduates in the fee states after the introduction of tuition fees, while enrollment probabilities remained almost constant in the control group.

These two differences are differenced in the third row of Table 3.1. The implied effect of tuition fees on enrollment probabilities is 2.74 percentage points. Given that the enrollment probability in the fee states was 39.7 per cent in 2007 the results imply that attendance rates in the fee states would have been 6.9% higher had tuition fees not been introduced. However, against the background of our discussion in Section 3.3.3 this estimate has to be seen as a lower bound for the true effect.

Bearing in mind that the marginal effects (3.4) and (3.5) depend on the distributional assumption for the parameters θ and v we can carefully use the formal analysis from Section 3.3.3 we to correct for this bias. As an approximation of the 'true' average treatment effect on the treated we would then obtain $DD = \frac{7}{4}DD' = -0.048$. Or, put differently, after accounting for the estimation bias we find that enrollment figures in the fee-states would be 4.8 per-centage points higher, had tuition fees not been introduced. Similarly, we can approximate how enrollment in the non-fee states is affected by the introduction of tuition fees. According to our earlier analysis the size of the spill-over effect amounts to $s = \frac{3}{4}DD' = 0.02055$. In other words, had tuition fees not been introduced in the fee-states would the enrollment rate in the non-fee states be 2.06 per-centage points higher. Given that in 2007 there were roughly 100.000 high-school graduates in the non-fee states of which approximately 38 per cent made an immediate transition this analysis implies that there would have been roughly 2000 more high-school graduates from the non-fee states had tuition fees not been introduced. Together with the effect on the treatment states we thus find that had tuition fees not been introduced there would have been approximately 7000 more new students in the autumn term 2007. Taking into account our earlier analysis this number has to be seen as a lower bound for the true effect.

Standard errors for the coefficients in (3.2) can be obtained by estimating (3.2) with OLS. Table 3.2 shows the results of this estimation. The coefficients are obtained from population means[4]. Standard errors are adjusted for heteroskedasticity because of the

[4] $\beta_0 = E[P_i|D_i = 0, After_i = 0]$, $\beta_2 = E[P_i|D_i = 0, After_i = 1] - E[P_i|D_i = 0, After_i = 0]$, $\beta_3 = E[P_i|D_i = 1, After_i = 0] - E[P_i|D_i = 0, After_i = 0]$

Table 3.1: Difference-in-differences: Share of high-school graduates who enroll into higher education in the year of high-school completion

	2002-2006	2007	Difference
	Male and Females		
Fee States	0.419	0.3976	0.0217
No-Fee States	0.374	0.3796	-0.0058
Difference			0.0274
	Females		
Fee States	0.531	0.483	0.0497
No-Fee States	0.467	0.4386	0.0204
Difference			0.02136

Source: Statistisches Bundesamt (2008a)

binary dependent variable[5].

One potentially confounding factor in the above analysis relates to the military service. In Germany, all male youth have to attend military or civilian service after completing secondary education. Currently, the length of service is 9 month. However, not all youth are actually conscribed. Rather, the number of conscriptions is influenced by military needs and can fluctuate between years. As those youth who are drafted must generally postpone their transition to university by one year conscription policies might have an impact on average enrollment probabilities. Although it is unlikely that these fluctuations have influenced enrollment decision of residents in fee and non-fee states differently we control for this possibility by analysing only the enrollment rates of female youth who are not affected by conscriptions.

Enrollment rates for female youth are shown in rows 4 to 6 of Table 3.1. Standard errors are reported in Table 3.2. Because women are not liable to military service their enrollment probabilities in the year of high-school completion lie above those of male youth. Table 3.1 shows that enrollment rates of female youth have declined in all states after 2006 but this decline has been appreciably stronger in the fee states. The estimate of the average treatment effect on the treated drops slightly to 2.04 percentage points, but the magnitude of the effect is similar to those estimated for the full population.

Throughout our analysis we have maintained the assumption that there are no factors

[5]Note that, given the simple structure of the data, the White standard errors become a function of the aggregate statistics s_{kt} and n_{k1}.

Table 3.2: OLS coefficient estimates

	Male and Female	Female
Intercept	0.374	0.466
	(0.00)	(0.00)
Fees	0.045	0.065
	(0.00)	(0.001)
After	0.006	- 0.028
	(0.002)	(0.002)
Fees*After	-0.0274	-0.0204
	(0.002)	(0.003)

Heteroskedasticity adjusted standard errors in parenthesis

other than the introduction of tuition fees that affected enrollment decisions of high-school graduates in both groups of states differently. Based on the fact that enrollment rates in fee and non-fee states developed remarkedly similar in the years before the policy intervention we have already argued that this assumption is not implausible.

Another way to address this concern is to look explicitly on one factor that is known to have an impact on enrollment decisions. Many studies (Kane 1994, for instance) have shown that enrollment rates are sensitive to the level of unemployment because low unemployment figures increase the opportunity costs of enrolling into higher education.

Figure 3.3 (page 109) compares the development of unemployment rates in the fee and non-fee states. Unemployment in the fee states was lower in the period 2002-2007 but followed a similar pattern as unemployment in the non-fee states. If there are any differences at all, then unemployment fell faster after 2006 in the group of states without fees (i.e unemployment fell from 10.4 in 2006 to 8.6 per cent in 2007 in the fee states and from 16.9 to 14.6 per cent in the non-fee states). We can therefore exclude the possibility that the results are driven by differences in the evolution of unemployment between fee and non-fee states. If at all, the faster decline in unemployment after 2006 should have resulted in declining enrollment rates in the non-fee states.

As a further robustness check, we test whether tuition fees already influenced enrollment decisions before 2007. As Table 3.6 shows, newly enrolled students in Lower Saxony already paid fees in the autumn term 2006. Furthermore, legislation introducing tuition fees had passed parliaments by the end of 2006 in all fee states. Drafts of the new legislation were publicly discussed even earlier. Therefore, students enrolling in 2006 were able to assess the financial implications of enrolling in a fee state with a certain accuracy. Table 3.3 shows the difference-in-difference calculations under the assumption

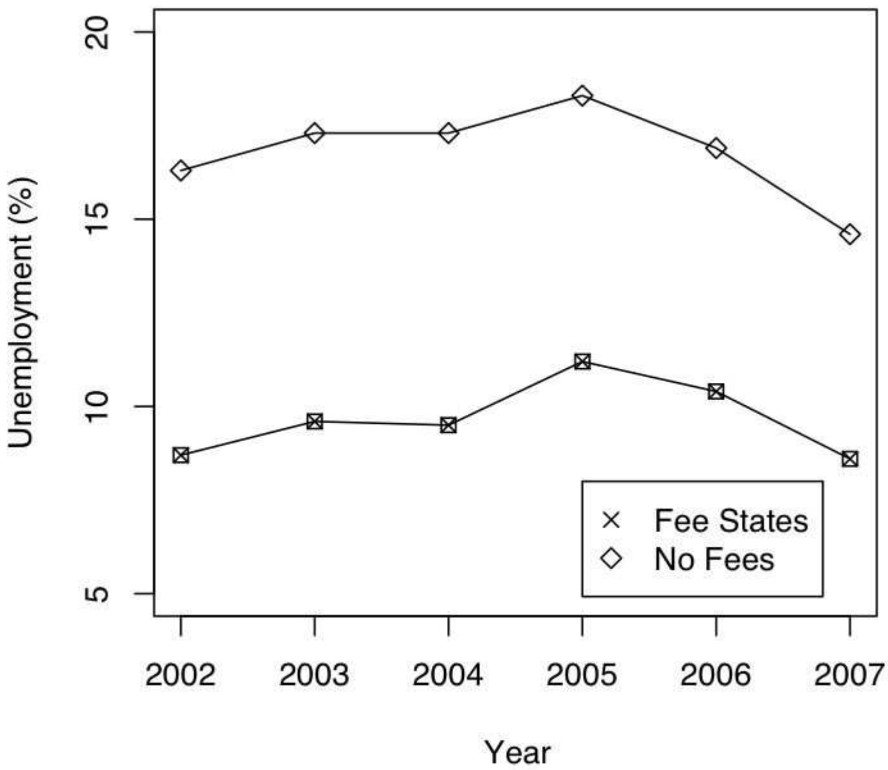

Figure 3.3: Unemployment rates for fee and no fee states between 2002 and 2007

that the treatment already begun in 2006. Standard errors and estimates for the full set of coefficients are in Table 3.4. The results are very similar to our main estimation. As can be seen in Table 3.3 enrollment rates in the fee states declined after 2005 and remained almost constant in the control states. The result of differencing the differences is in the third row of Table 3.3. The average treatment effect on the treated drops slightly to 2.08 percentage points but is of a similar magnitude as before. It therefore seems that high-school graduates took into account the full financial burden of tuition costs over the expected course of their studies and not only the level of tuition fees in the first year after entering higher education.

Overall, the results show that the introduction of tuition fees in a subset of the German states in 2007 had a small, but significant effect on the enrollment rates of German youth in the year in which they completed high-school. Our main estimate indicates that the enrollment rate in the fee states would have been 42.52 per cent instead of 39.76 per

Table 3.3: Treatment already in 2006: Share of high-school graduates who enroll into higher education in the year of high-school completion

	2002-2005	2006-2007	Difference
Fee States	0.4227	0.4019	0.0208
No-Fee States	0.3749	0.3748	-0.0001
Difference			0.0207

Source: Statistisches Bundesamt (2008a)

cent in 2007 had tuition fees not been introduced. Or, put differently, without tuition fees there would have been roughly 5000 more high-school graduates who enrolled at a German university in 2007.

In interpreting the results of this study one should bear in mind that the effect of tuition fees on enrollment is mitigated because students can escape the fee by moving into a non-fee state. It would of course be interesting to know what enrollment probabilities would be if all states introduced tuition fees (and it is hence no longer possible to avoid the paying fees by studying in a non-fee state). Fortunately, it is possible to approximate these counterfactual change in enrollment rates from the observed effect DD'. To this end assume - for the sake of simplicity - that high-school graduates are immobile internationally ($\rho = \overline{\theta}$). The marginal effect of an introduction of a tuition fee in all German states would then be obtained from (3.4) as $-2\overline{\theta}$. Making use of the fact that $\overline{\theta} = -\frac{5}{4}DD'$ we can infer that a nationwide introduction of tuition fees would have reduced enrollment probabilities by $\frac{10}{4}DD'$. Using $DD' = -0.0274$ from our baseline estimation we thus find that $-2\overline{\theta} = -0.0685$. Taken literally, this result suggest that if a tuition fee of 500 Euros per term would be in place in all German states enrollment probabilities would we 6.85 percentage points lower than without a tuition fee. However, this result should be interpreted with care. After all, it depends strongly on the assumption that the unobserved parameters $(\overline{\theta}, v)$ are independently and uniformly distributed. This assumption serves however mainly the objective to increase the analytical tractability of the model rather than to be empirically valid.

3.5 Summary and discussion of results

In the last decade many countries have shifted higher education funding from public to private sources. Often, this trend went along with the introduction of tuition fees at public universities (e.g. in Australia, the United Kingdom and Germany). The introduction of tuition fees has re-ignited the old controversy about the relationship between tuition fees and enrollment rates.

This chapter adds to the empirical literature trying to identify the impact of tuition fees on enrollment behavior by using the introduction of tuition fees in some German states as a natural experiment. This approach allows us to avoid some of the potential pitfalls associated with studies relying on cross-state or across-time variation in tuition levels. While natural experiments have been used to identify the effect of student aid on enrollment behavior (e.g. (e.g. Baumgartner and Steiner 2004, J.Baumgartner and Steiner 2006, Dynarski 2002) to our knowledge the present study is the first one to apply this strategy to estimate the effects of tuition fees.

We find that the introduction of tuition fees at the annual rate of 1000 Euros has reduced the probability of high-school enrollment in the states which introduced fees by 2.74 percentage points. The effect is slightly smaller than the effect of student aid found by (Dynarski 2000) who used the same estimation strategy to evaluate the introduction of the HOPE scholarship in Georgia. Her findings indicate that an increase of $ 1000 in student aid increase enrollment probabilities of 18- to 19-year olds by approximately 7 percentage points. However, unlike the results in (Dynarski 2000) our estimate has to be seen as a lower bound for the true effect.

The effect found in this study is also economically significant. Given the number of students who enrolled at university our estimate implies that there would have been more than 5000 additional students in the fee states had tuition fees not been introduced.

Two further points deserve mention before the results of this study can properly be interpreted.

First, in the present study freshmen can escape a tuition-fee in their home state by enrolling at a university in a state without tuition fees. The option to migrate to a non-fee state mitigates the effect of tuition fees on enrollment probabilities. In a rough calculation we have approximated the effect of tuition fees on enrollment probabilities for the hypothetical situation in which this option is not available (for instance because all states introduce similar fees). In this case the introduction of tuition fees of 1000 Euros per year would reduce enrollment probabilities by roughly 6.5 percentage points. The magnitude of this effect is thus much closer to the one reported by Dynarski for a similar sized change in tuition costs.

A second issue concerns an institutional detail that is specific to the German higher-education system. In Germany, enrollment at a university is associated with a number of side-benefits. For instance, students can typically use public transport at lower fares, subscribe to newspapers at reduced prices and are being offered discounts at public theaters. As enrollment in Germany typically does not require the attendance of lectures or participation in exams youth have an incentive to be enrolled even when they do not actually study.

Table 3.4: OLS coefficient estimates: Treatment period 2006-2007

	Male and Female
Intercept	0.375
	(0.00)
Fees	0.049
	(0.01)
After	0.00
	(0.001)
Fees*After	-0.0208
	(0.002)

Heteroskedasticity adjusted standard errors in parenthesis

Is the reduction of enrollment probabilities inefficient? There is no easy way to answer this question. Of course, the existence of credit constraints as well as possible externalities from the education of students to other parts of the population warrant public subsidies to higher education. Tuition fees must be seen as a reduction of these subsidies. Whether the introduction of tuition fees is inefficient or not therefore depends primarily on whether state subsidies were initially above or below the optimal level.

As a final remark, note that tuition fees are a very recent experience in Germany. Looking at data from the year immediately after the introduction we are not able to predict whether the identified effect persists in the long-run. This is most notably the case as we do not yet know whether tuition fees help to raise the quality of education in the long run. Should this be the case tuition fees might even have a positive long-run effect on enrollment probabilities.

3.6 Appendix

Table 3.5: Number of high-school graduates and freshmen by state and year

	2002		2003		2004		2005		2006		2007	
State	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	Fee states											
BW	36705	11620	37579	13160	36913	12896	38949	13769	41564	14046	43433	13690
BY	27573	12925	27338	14901	27941	14497	28932	15580	30764	16308	32909	16915
SL	2426	1239	2518	1364	2579	1329	2713	1457	3050	1592	2891	1626
NI	21568	8736	21962	9673	22829	9289	24335	9677	24925	9156	27471	9986
NW	54811	22699	55730	24749	58956	24463	61159	26297	65448	26351	67450	26714
HH	5353	1898	5410	1843	5503	1658	5712	1969	6108	1928	6488	2417
HE	18674	7846	18754	8854	19445	9118	18605	8545	19975	8594	19959	8410
	Non-Fee states											
BE	12418	4448	12543	4696	12918	4743	13429	4630	13988	4631	13831	5023
BB	11607	3243	11050	3578	12046	3741	11263	3667	11803	3728	12303	3986
HB	2174	950	2252	1082	2193	964	2407	1006	2602	1005	2558	1037
MV	6453	2319	6364	2486	6614	2554	6757	2543	7149	2573	7259	2813
RP	11191	5129	11329	5669	11573	5818	12130	6315	13297	6705	14165	7180
SN	16075	5063	15790	5465	16674	5651	16631	5604	16804	5637	16209	5874
ST	9472	3665	9359	3902	9425	3944	9280	3903	8751	3732	15775	5994
SH	7415	2531	7502	2770	7994	2653	8426	2980	9052	3026	9828	3186
TH	9397	3113	9749	3767	9960	3538	9934	3716	10176	3587	9923	3573

Source: Statistisches Bundesamt (2008a)

(1) Number of high-school graduates (Hochschulzugangsberechtigung und Fachhochschulreife)

(2) High-school graduates amongst (1) who make an immediate transition to university

State	Legislation passed	Average fees in autumn term (EUR)		
		2005	2006	2007
Baden-Württemberg	15.12.2005	0	0	500
Bayern	23.05.2006	0	0	450,2
Berlin	./.	0	0	0
Brandenburg	./.	0	0	0
Bremen	./.	0	0	0
Hamburg	28.06.2006	0	0	500
Hessen	05.10.2006	0	0	500
Mecklenburg-Vorpommern	./.	0	0	0
Niedersachsen	21.11.2006	0	500	500
Nordrhein-Westfalen	16.03.2006	0	450,15	450,15
Rheinland-Pfalz	./.	0	0	0
Saarland	12.07.2006	0	0	500
Sachsen-Anhalt	./.	0	0	0
Sachsen	./.	0	0	0
Schleswig-Holstein	./.	0	0	0
Thüringen	./.	0	0	0

Table 3.6: Tuition fees by state for autumn terms 2005-2007

University	Tuition Fees (EUR) Spring 07	Autumn 07	Total number of students enrolled in Autumn Term 2005
Uni Augsburg	500	500	14330
Uni Bamberg	300	500	8510
Uni Bayreuth	300	500	9099
Uni Eichstätt	500	500	4869
Uni Erlangen	500	500	25125
LMU	300	300	44091
TU München	500	500	20655
Uni Passau	500	500	9036
Uni Regensburg	500	500	17162
Uni Würzburg	500	500	18748
AdBK M	300	300	727
AdBK Nürnberg	300	300	295
HfMT M	300	300	752
HfM Würzburg	500	500	646
HfFF München	300	300	344
FH Amsberg	500	500	1870
FH Ansbach	400	400	1490
FH Aschaffenburg	400	400	1387
FH Augsburg	370	430	4000
FH Coburg	300	400	2942
FH Deggendorf	370	370	2671
FH Hof	500	500	1765
FH Ingolstadt	500	500	2085
FH Kempten	400	400	2981
FH Landshut	400	400	2611
FH München	500	500	13331
FH Neu-Ulm	500	500	1841
FH Nürnberg	500	500	8226
FH Regensburg	500	500	5772
FH Rosenheim	400	400	3673
FH Weihenstephan	500	500	3925
FH Würzburg	400	400	6440
Weighted Average	433,4	450,2	
Total			241399

Table 3.7: Tuition fees at universities in Bavaria

University	Tuition Fees (EUR) Spring 07	Autumn 07	Total number of students enrolled in Autumn Term 2005
RWTH Aachen	500	500	29355
Uni Bielefeld	0	350	18351
Uni Bochum	500	500	31024
Uni Bonn	500	500	30074
Uni Dortmund	500	500	21923
Uni Düsseldorf	500	500	17401
Uni Duisburg	500	500	33693
Uni Köln	500	500	44659
DSH Köln	500	500	4713
Uni Münster 0	275		38389
Uni Paderborn	500	500	14392
Uni Siegen	500	500	12437
Uni Wuppertal	500	500	13403
HfM Detmold	500	500	601
KunstAkad Düsseldorf	0	0	352
R.-Schumann-HS Düsseldorf	500	500	613
Folkwang-HS Essen	500	500	910
HfM Köln	500	500	309
KhM Köln	0	0	1483
KunstAkad Münster	0	400	271
FH Aachen	500	500	8054
FH Bielefeld	500	0	6325
FH Bochum	500	500	4423
FH Bonn	500	500	4453
FH Dortmund	500	500	8347
FH Düsseldorf	0	0	6289
FH Gelsenkirchen	400	400	6375
FH Köln	0	500	16375
FH Lippe	500	500	4838
FH Münster	300	400	9014
FH Niederrhein	500	500	10031
FH Südwestfalen	500	500	5941
Weighted Average	393,3	450,15	
Total			404818

Table 3.8: Tuition fees at universities in North Rhine-Westphalia

	First Round Decisions (October, 13^{th}, 2006)			Second Round Decisions (October, 19^{th}, 2007)		
	Graduate Schools	Excellence Clusters	Flagships	Graduate Schools	Excellence Clusters	Flagships
SH		Kiel		Kiel,Lübeck	Kiel	
HH					Hamburg	
NI	Hannover	Göttingen, Hannover		Göttingen	Hannover	Göttingen
HB	Bremen			Bremen	Bremen	
NRW	Aachen, Bochum, Bonn	Aachen, Bonn (2x)		Bielefeld, Bonn	Aachen, Bielefeld, Köln, Münster	
HE	Gießen	Frankfurt a.M., Gießen		Darmstadt	Darmstadt, Frankfurt a. M.	
RP				Mainz		
BW	Freiburg, Heidelberg,Karlsruhe, Mannheim	Heidelberg, Karlsruhe, Konstanz	Karlsruhe	Heidelberg (2x), Konstanz, Stuttgart, Ulm	Freiburg, Heidelberg, Tübingen, Stuttgart	Freiburg, Heidelberg, Konstanz
BY	Erlangen-Nürnberg, LMU, TU, Würzburg	LMU (3x), TU (2x)	LMU,TU	Bayreuth	Erlangen-Nürnberg	
SL				Saarbrücken	Saarbrücken	
BE	FU,HU			FU (2x), HU (2x)	FU (2x), HU , TU	FU
BB						
MV						
S	TU Dresden	TU Dresden		Leipzig		
ST						
TH				Jena		

Source: Deutsche Forschungsgemeinschaft (DFG)

Table 3.9: Funding decisions of the 'Excellence Initiative' within the three funding lines.

Chapter 4

Welfare Competition in Germany: Decentralization, the Intensity of Competition and some evidence for the factor flow theory

There is by now a large body of literature in public finance which analyzes the strategic interaction amongst local governments. With respect to welfare competition a number of authors have tested empirically whether local governments set their benefit levels interdependently (Figlio, Kolpin, and Reid 1999, Saavedra 2000, Brueckner 2001, Dahlberg and Edmark 2004, Fiva and Rattso 2006). By estimating the best-response function of a representative jurisdiction these researchers have found robust evidence that welfare competition emerges if benefits are provided decentrally.

This chapter makes three contributions to this literature. First, we provide evidence that welfare competition occurred in Germany's highly decentralized welfare system that was in place until the Agenda 2010 reforms that the red-green coalition enacted in 2004. Using data on average per-capita expenditure within the social assistance scheme (*Sozialhilfe*) in the years 2000 and 2004 we find strong evidence for welfare competition in the years prior to the reform. To the best of our knowledge this is the first time that such evidence is provided for a country with a conservative welfare model. So far, existing research is confined to countries with a liberal welfare state (Figlio, Kolpin, and Reid (1999), Saavedra (2000) and Brueckner (2001) for the U.S and Revelli (2006b) for the UK) or with a Scandinavian welfare model (Dahlberg and Edmark (2004) for Sweden and Fiva and Rattso (2006) for Norway) [1].

[1]Here we draw on the influential classification of welfare states of (Esping-Andersen 1990) who distinguishes three clusters of welfare states: The 'liberal' regime, typical for the U.S. and Great Britiain,

Implicit in theoretical accounts of welfare competition (Wildasin 1991) is the prediction that this competition vanishes if welfare benefits were provided by the federal government which internalizes all spill-overs between jurisdictions. More generally, theory suggests that the intensity of competition should be the stronger the larger the influence of local politicians on benefit levels and the larger the share of welfare expenditure that has to be financed locally. While the focus of existing empirical work was mainly on demonstrating that welfare competition emerges if benefits are provided decentrally, the relationship between the degree of decentralization and the intensity of competition has been somewhat neglected.

A second objective of this chapter is therefore to identify this relationship empirically. To achieve this aim we use an institutional change of Germany's major welfare assistance scheme (*Sozialhilfe*) in 2005 which reduced the autonomy of local authorities over their welfare policies. In a simple before-after comparison we compare the intensity of competition to the one estimated with the post-reform data. We find that the intensity of competition is smaller after the reform. This result is consistent with the hypothesis that the move towards a less decentralized administration has reduced the intensity of competition.

While there now exists some evidence that welfare competition does occur it has been harder to identify the exact channel through which this interaction emerges (Revelli 2005). With respect to welfare competition there are two alternative theoretical accounts which can explain an observed strategic interaction between different jurisdictions. The factor flow theory assumes that the migration decisions of mobile welfare recipients depend on welfare levels in a jurisdiction. Under this theory, generous welfare payments attract recipients from neighboring jurisdictions and thus raise marginal welfare costs. In contrast, the yardstick competition hypothesis assumes that local electorates use the policy enacted in neighboring jurisdictions as a yardstick against which they assess the performance of local incumbents. In this theory it is an 'informational externality' which makes the policy of two jurisdictions interdependent. As both theories give rise to the same empirical model estimation of the best-response function is not sufficient to distinguish between the two.

A third objective of this chapter is thus to discriminate empirically between these competing accounts of welfare competition. To this end we employ a rich data set on the welfare benefits administered within Germany's major welfare program Hartz IV. The data set includes monthly data on the average level of housing assistance (*Kosten für Unterkunft und Heizung*) in the 439 German counties (*Kreise and Kreisfreien Städte)* for the time between January 2006 and July 2007. What makes this data set unique is

which is characterized by very modest welfare entitlements; the 'social-democratic' or 'scandinavian' variant in which welfare benefits are an universal right and the 'conservative' or 'corporate' welfare states in which welfare schemes are predominantly designed to preserve status differentials.

that average benefit levels are available by the size of the receiving household.

Our empirical strategy consists of estimating a jurisdiction's best-response function with respect to benefits provided to households of a given size. If yardstick competition is the sole factor driving the strategic interaction then the reaction function should be independent of household size. On the contrary, if factor-flows contribute at least partially to the interdependence of benefit levels then we should find that competition is more intense with respect to small households which are more mobile and also require higher expenditure in per-capita terms.

Since the implementation of the Hartz IV welfare program there has been at least anecdotal evidence (Eberhardt 2007) that the German counties choose the level of housing assistance strategically to induce welfare recipients to move to other jurisdictions. This suggests that the factor flow theory would explain at least a part of an observed welfare competition in Germany.

Our empirical results are indeed consistent with the hypothesis that factor-flows play a causal role in the welfare competition between the German counties. While our overall evidence for welfare competition in the time after the implementation of the reform is mixed, this evidence is confined to small households as one would expect if factor flows are a driving force of the competition.

This result is complementary to that obtained by Revelli (2006a) in his analysis of welfare competition between English local authorities. Revelli shows that welfare competition vanished between two consecutive periods and attributes this finding to the establishment of a nationwide performance rating system which serves as a close substitute for comparisons between geographically connected jurisdictions.

The most likely source of the divergent results between his work and mine are differences in the type of welfare expenditures used for the empirical analysis. The present chapter looks mainly on cash transfers to a mobile population. In contrast, Revelli considers the provision of welfare services (in-kind transfers) that are likely to benefit more immobile individuals, such as the elderly.

Some other papers have tried to discriminate empirically between different theoretical explanations for an observed spatial auto correlation in fiscal policy variables. Besley and Case (1995), Case (1993), Bordignon, Cerniglia, and Revelli (2003) and Sole-Olle (2003) all provide empirical support for the yardstick competition hypothesis by arguing that that the sensitivity of local policy choices to neighboring jurisdictions' policies is dependent on exogenous variations in term-limits or the size of the majority in local parliaments. Evidence for the factor-flow hypothesis comes from Büttner's (2001) analysis of the tax-setting of German municipalities. However, apart from the work of (Revelli 2006b), non of these papers have looked at welfare policies.

The remainder of this chapter is organized as follows. Section 4.1 summarizes the factor-flow and yardstick-competition theories and shows that both give rise to the same empirical specification. Section 4.2 provides some background on the German welfare system and its reform in 2005 and Section 4.3 discusses our identification strategy and some econometric issues. Section 4.4 then presents estimation results before Section 4.5 considers the robustness of the results. Section 4.6 concludes.

4.1 Two theories of welfare competition

The theoretical fiscal federalism literature has advanced a number of theories on why local governments might not set their fiscal policies independently of each other. Revelli (2006b) provides a review of these theories. With respect to welfare competition there are basically two theories that are able to explain an observed spatial interdependence of benefit levels. This section briefly summarizes both competing theories. The exposition follows that of Revelli (2006b) but it is adapted to the area of welfare competition.

The first theory assumes the presence of a mobile factor that local governments either wish to attract or the inflow of which they like to prevent by an appropriately chosen policy. Accordingly, this theory is also referred to as 'factor-flow theory' or the 'constraints interaction hypothesis' (Revelli 2006b).

Within the context of welfare competition this mobile resource is constituted by welfare recipients which are assumed to be mobile across jurisdictions or need at least considered to be mobile by local politicians. In this case the number of welfare recipients in a jurisdiction i, r_i, depends on the average benefit level in that region z_i as well as on benefit levels in the neighboring jurisdiction z_j and some region specific characteristics $x_i \in \mathbb{R}^m$. Hence, we can write that

$$r_i = r(z_i, z_j, x_i) \tag{4.1}$$

A natural assumption is that increasing benefit levels attracts recipients from other jurisdictions: $\partial r_i/\partial z_i > 0$ and $\partial r_i/\partial z_j < 0$.

Furthermore, it is maintained that utility of a representative agent or median voter in jurisdiction i depends on own consumption as well as on the level of welfare benefits in that region. Consumption is in turn linked to welfare expenditures through the budget constraint; i.e. $c = c(r_i z_i)$. Utility can hence be expressed as

$$u_i = u(c(r_i z_i), z_i, x_i') \tag{4.2}$$

where $x_i' \in \mathbb{R}^n$ is again a vector of socio-economic characteristics of jurisdiction i. Wildasin (1991) for instance assumes that the non-mobile residents in a jurisdiction are partially altruistic towards the poor, implying that $\partial u/\partial z_i > 0$.

If politicians in jurisdiction i choose benefit levels to maximize (4.2), taking the policy in the neighboring jurisdictions as given, the first-order condition

$$\left(\frac{\partial r_i}{\partial z_i} z_i + r_i\right) c'(r_i z_i) \frac{\partial u}{\partial c} + \frac{\partial u}{\partial z_i} = 0 \tag{4.3}$$

describes a reaction-function

$$z_i = z_i(z_j, \tilde{x}_i) \tag{4.4}$$

where $\tilde{x}_i = (x_i, x_i') \in \mathbb{R}^{m+n}$. The first-order condition (4.3) shows that under decentralization the choice of z_i is distorted as politicians anticipate that higher benefit levels attract recipients from other regions. This is captured by the term $(\partial r_i/\partial z_i)z_i$ in (4.3). Under standard assumptions benefit levels of neighboring jurisdictions are strategic complements; i.e. $\partial z_i/\partial z_j > 0$, implying that equilibrium benefits are lower than under centralization. This nicely represents the concern that the mobility of households can give rise to a 'race to the bottom' in welfare payments.

Another theory which helps explain why welfare levels of neighboring jurisdictions might be interdependent is the so called 'yardstick competition' hypothesis (Besley and Case 1995). This theory does not require welfare recipients to be mobile but assumes that an imperfectly informed local electorate uses the policies enacted in neighboring jurisdictions as a yardstick to obtain a signal about the quality of their local incumbent.

More formally, the yardstick competition theory assumes that the benefit level which recipients in a jurisdiction i are entitled to receive can be written as the sum of a non-stochastic component $\overline{z}$ and a cost shock ϵ_i; i.e. $z_i = \overline{z} + \epsilon_i$. In the context of this chapter the cost shock might for instance arise from the fact that housing prices are higher in some counties which induces higher welfare expenditure.

Politicians in a region finance welfare expenditures $E_i(z_i) = r_i z_i$ through lump sum taxes. Hence, if there are N tax-payers in a jurisdiction the budget balancing tax-rate is $t_i = E_i/N$. Incumbent politicians can claim that the region experienced a larger cost-shock, such that the actual benefit level is $\tilde{z}_i > z_i$. In this case revenue $E(\tilde{z}_i)$ exceeds actual expenditure $E(z_i)$ and office holders appropriate some rents $w_i(\tilde{z}_i) = E(\tilde{z}_i) - E_i(z_i) = r_i(\tilde{z}_i - z_i)$.

Voters cannot observe the cost shock but are able to obtain a signal on whether politicians divert rents by comparing the local policy $\tilde{z}_i$ to that in the neighboring jurisdiction $\tilde{z}_j$. All that is required for this inference is that cost shocks are correlated between jurisdictions; i.e. $Cov(\epsilon_i, \epsilon_j) > 0$. Under these assumptions, the re-election probability p_i of an incumbent in jurisdiction i depends on relative transfer levels $p_i = p_i(\tilde{z}_i, \tilde{z}_j, x_i)$, where $\partial p_i/\partial \tilde{z}_i < 0$ and $\partial p_i/\partial \tilde{z}_j > 0$.

To see how expenditure levels of neighboring jurisdictions become interdependent it is sufficient to assume that incumbents can stay in office for at least one more period. Office holders choose benefit levels for the present and subsequent period (z_i^0, z_i^1) to maximize their discounted utility

$$u_i = v(w_i(z_i^0)) + p_i(\tilde{z}_i^1, \tilde{z}_j^1, X_i)v(w_i(\tilde{z}_i^1))$$

where $v'(\cdot) > 0$ and $v''(\cdot) < 0$. Upon solving this maximization problem one again finds that benefit levels in jurisdiction i depend on benefit levels in neighboring jurisdictions as in (4.4).

Having laid out both theoretical accounts of welfare competition we are able to identify two necessary conditions that have to be met in order for strategic interaction in the setting of benefit levels to emerge under either of the two theories: i) local governments must be able to manipulate welfare levels and ii) governments need to have incentives to do so, either because benefit levels affect utility of the median voter in a jurisdiction or because they feed back on the re-election probability of local incumbents. In addition, a prerequisite that applies only to the factor-flow theory is the existence of a mobile resource.

If these conditions are met one can test for the presence of strategic interaction. This is usually done by estimating a reduced-form of the reaction function (4.4). It is standard to assume this reduced-form to be linear, leading to the following empirical specification:

$$z_{it} = \rho \sum_j w_{ij} z_{jt} + \theta X_{it} + \epsilon_i \tag{4.5}$$

where w_{ij} represent a set of weights that aggregate the level of housing assistance of competitors of jurisdiction i into a weighted average. The vector X_{it} captures socio-economic characteristics of jurisdiction i that might influence the benefit level in that jurisdiction.

The key parameter of interest in equation (4.5) is the slope parameter ρ. If local governments set their welfare policies interdependently we expect this parameter to be non-zero. From our earlier theoretical analysis we would expect ρ to be positive if local governments are engaged in welfare competition.

Note that both theories of welfare competition lead to the same reduced form empirical specification of the reaction function. Without further modeling a resource equation such as (4.1) or exploiting special features of the available data, estimation of (4.5) is not sufficient to discriminate between the two theories.

It is intuitive that under both theories, the intensity of competition, measured as the slope of the best-response function, is positively correlated with the degree of decentralization. As a federal government internalizes all fiscal externalities between different jurisdictions only local governments have an incentive to engage in welfare competition under the factor-flow theory. The same holds for the yardstick competition hypothesis where only the performance of local politicians can be assessed by using the policy in other jurisdictions as a yardstick. Accordingly, welfare competition should be intense if welfare benefits are provided decentrally.To see this, consider the extreme cases of perfect centralization and decentralization. In the former case,policies implemented in different jurisdictions are independent of each other. This means that the first-term in (4.3) vanishes. Hence, the best-response function of a jurisdiction would be horizontal. At the other extreme, the best-response function are positively sloped, indicating that welfare policies are interdependent. In intermediate degrees of decentralization, the first-term in (4.3) becomes more important as the degree of decentralization increases, thus raising the slope of the best-response function.

The subsequent empirical analysis tries to identify this relationship between the degree of decentralization and the intensity of competition by making use of a reform of Germany's welfare system that became effective in 2005. The reform was associated with a move from a completely decentralized administration of a major assistance scheme (*Sozialhilfe*) to a more centralized provision in which welfare payments are jointly administered by the German counties and the federal government[2].

A second objective of the empirical analysis is to identify the exact channel trough which welfare competition between the German counties emerges. This question will be addressed by estimating the best-response function (4.5) for specific groups of welfare recipients that differ in their degree of mobility. If we find that the intensity of competition is sensitive to the mobility of welfare recipients then we can conclude that factor-flows drive at least a part of the strategic interaction. On the contrary, if we find that the strength of the strategic interaction is independent of the recipient's degree of mobility this evidence would be only consistent with the yardstick competition theory.

Before we take a closer look at the available data and the concrete identification strategy the next section first describes some important features of Germany's welfare system and the reform that became effective in 2005.

4.2 Institutional Background

In this section we summarize the main features of Germany's welfare system. We begin with a short introduction to the system that was in place until the end of 2004 and then turn to a brief description of the current situation. The aim of this section is to show that the German welfare system exhibits a significant degree of decentralization to make it an ideal testing ground for the various implications of the welfare competition theories that we have identified above.

[2]For most recipients the former Sozialhilfe was replaced by the *Grundsicherung für Arbeitssuchende* when the 'Hartz IV' reforms were implemented

4.2.1 Germany's welfare system until 2004

Until 2004 the main welfare programme in Germany was the so called 'social assistance' (*Sozialhilfe*) which, together with the unemployment assistance for the long-term unemployment (*Arbeitslosenhilfe*), constituted the building block of Germany's welfare state. In 2003, two years before the new system became effective, both programmes together covered around 5 million welfare recipients.

In the empirical part of this paper we use data from the social assistance which covered the needs of those who were not entitled to receive benefits from other programs such as the federal unemployment insurance. Typically, individuals who received social assistance had either not contributed long enough to the unemployment insurance or they were classified as being permanently out of the labor force.

The administration of the social assistance lay in the hands of the German counties, the third level of Germany's multi-tiered federal structure, who were also solely responsible for financing the benefits.

In 2004 expenditure for social assistance in Germany amounted to approximately 25,59 billion Euros or roughly 1% of GPD(Statistisches Bundesamt 2004). The bulk of these expenditures took the form of the so called 'living assistance' (*Hilfe zum Lebensunterhalt*) and comprised regular benefits (*laufende Leistungen*) and non-regular benefits. The level of the former was oriented at some standard rates which were determined by state parliaments each year[3]. Table 4.8 shows these rates for household heads for the years 1999/2000 and 2004/2005. A measure of the standard rates in a given year can then be obtained by calculating the average rate over the first and second half of a year.

Non-regular benefits mainly comprised housing assistance, such as the rent and costs for heating (*Kosten für Unterkunft und Heizung*). We use the German abbreviation (KUH) to refer to this expenditure category.

Total expenditure of a jurisdiction i on social assistance in the time prior to the reform can be written as the sum of regular benefits (REG), non-regular benefits and other expenditure (OTHER). As non-regular benefits comprise mainly housing expenses we obtain

$$\text{TOTEXP}_i = \text{REG}_i + \text{KUH}_i + \text{OTHER}_i$$

where other expenditure comprises mainly health care and expenditure for the integration of disabled people into the labor market (Fichtner 2003).

Of importance for the ensuing analysis is the fact that the counties, through their local administrative units, had a substantial degree of discretion in determining actual benefit levels.

[3]The new rates became effective on July, 1^{st} each year

For example, the level of housing assistance specified in the law left room to some interpretation as the law code only ascertained that the level of housing assistance must be "appropriate". [4]

Moreover, while regular benefits were largely defined by the standard rates a local administration could deviate from this rates in exceptional cases when it assessed the needs of a recipient differently.

For the time prior to 2005 we therefore expect strategic interaction in welfare expenditure to occur through the non-regular benefits which constitute the largest expenditure block (Statistisches Bundesamt 2004) and are also most easily manipulated by local administrations due to the fact that the exact level of entitlement is not precisely defined by the law.

4.2.2 The Agenda 2010 Reform

With the Agenda 2010 reform, which became effective in 2005, this system has undergone some changes.

A first prominent change concerns the unification of the benefit schemes for the long term unemployed (*Arbeitslosenhilfe*) with the social assistance program (*Sozialhilfe*). Since the reform all unemployed individuals whose unemployment spell lasts longer than 12 to 18 month and their household members receive transfers through a common 'basic assistance' programme (*Grundsicherung für Arbeitslose*). This system is reminiscent to the former social assistance and also comprises almost all of its former members. The second part of the empirical analysis, where we try to discriminate between alternative explanations for an observed welfare competition will be based on expenditure data from the new basic assistance program.

The most important feature for the subsequent analysis is however the move from a very decentralized administration of welfare benefits to a more centralized system:

In contrast to the old system, where expenditure for social assistance was entirely administered by the counties alone, expenditure for the basic assistance is now administered by newly created local employment agencies (*Arbeitsgenturen*) which are jointly operated by the Federal Employment Agency and the local county. In general, there is one such

[4] At the time this paper is written the original text of the law reads as follows and does not differ from the respective passage in the time prior to the reform:

> Leistungen für Unterkunft und Heizung werden in Höhe der tatsächlichen Aufwendungen erbracht, soweit diese angemessen sind. Erhöhen sich nach einem nicht erforderlichen Umzug die angemessenen Aufwendungen für Unterkunft und Heizung, werden die Leistungen weiterhin nur in Höhe der bis dahin zu tragenden Aufwendungen erbracht.[5]

agency in each of the 439 German counties. A few exemptions exist where two counties jointly operate a single employment agency or where there are two employment agencies in one county.

There are a few exemptions to the joined administration of the basic assistance programme. To enable experimentation with different institutional settings there are 69 counties (the so called *Optionskommunen*) which administer their welfare payments independently of the Federal Employment agency. On the costs sharing side there are however no differences to the local employment agencies in counties with a mixed administration.

Non-withstanding the existence of the still relatively independent Optionskommunen, the introduction of the joined administration in the vast majority of the German counties has reduced the degree of decentralization of the German welfare system.

In the ensuing empirical analysis we will use this institutional change to identify a relationship between the degree of decentralization and the intensity of welfare competition.

The expenditure administered by the employment agencies falls into two categories: regular benefits (*Regelleistung*) to cover living expenses and housing assistance (*Leistungen für Unterkunft und Heizung*). Both expenditure categories are roughly equivalent to regular and non-regular benefits under the old system.

Total expenditure for basic assistance in a county i can therefore be expressed as the sum of regular benefits and housing assistance (KUH)

$$\text{TOTEXP}_i = \text{REG}_i + \text{KUH}_i$$

The respective section of the law defining the level of housing assistance has remained the same. In particular, the law still only requires that housing assistance must be 'appropriate', leaving it to the county administration to decide on the actual benefit level.

Apart from the newly introduced joined administration differences to the old system lie mainly on the financing side. In contrast to the time prior to the reform, expenses for basic assistance are now jointly born by the federal government and the 439 German counties. While at the federal level the Federal Employment Agency accounts for expenses associated with the regular benefits (REG_i), each county has to cover the expenses for housing assistance (KUH_i).

As a minor point, note that the federal government participates in the expenditure for non-regular benefits through transfers. However, unlike in a classical matching-grant scheme, these transfers are determined ex-post and are negotiated between the federal government and state governments (Kaltenborn and Schiwarov 2006). Hence, these transfers should not influence actual benefit levels in a county or the intensity of the strategic interaction between counties.

Concerning our empirical analysis of welfare competition we expect strategic interaction in the new system to occur through the level of non-regular benefits; i.e. housing assistance, as under the old social assistance system. In particular this expenditure category satisfies the two necessary conditions for the emergence of welfare competition: Firstly, local administration have some degree of discretion over the "appropriate" level of housing assistance and secondly, there are still substantial incentives to use the level of housing assistance as a strategic instrument: On the one hand, local governments can expect to induce an outflow of recipients by a restrictive interpretation of the law. On the other hand, given the fact that expenditure for non-regular benefits constitutes a large expenditure block, local politicians might try to undercut the expenditure of neighboring counties in an attempt to signal voters that they do not waste taxpayer's money.

There is indeed some anecdotal evidence that some counties lowered the level of housing assistance in order to induce an outflow of recipients. In 2006 the local employment agency in Mannheim reported a drastic increase in the number of newly regisered welfare recipients who migrated to Mannheim from the neighboring Rhein-Neckar county. The local administration in Mannheim publicly accused the employment agency in Rhein-Neckar to have deliberately cut housing-assistance in an attempt to induce recipients to move to Mannheim. The discussion has attracted some attention in the press (Eberhardt 2007). While this evidence clearly speaks in favor of factor-flows as the mechanism driving the welfare interaction it requires a systematic analysis of the available data before reliable conclusions can be drawn.

The German welfare system described in this section will now serve us as a testing ground for two predictions entailed in the welfare competition theories.

Our first hypothesis concerns the intensity of the strategic interaction. Using the change in the degree of decentralization accompanying the reform we are able to identify the effect of the degree of decentralization on the intensity of competition. This will be achieved by comparing the estimated reaction functions from the time prior to the reform to those after the reform. We expect that the intensity of competition has declined due to change towards a less decentralized system, resulting in a smaller slope of the reaction function.

A second question aims at the nature of the strategic interaction. Using data on average expenditure for housing assistance within the basic assistance program we are able to investigate whether the intensity of competition is also sensitive to household size. This analysis allows us to identify the source of welfare competition. If we find that welfare competition is more intense for smaller, more mobile households then we can conclude that the factor-flow hypothesis needs to be at least part of the explanation. If the intensity of competition is however insensitive to household size, and hence household mobility, we can exclude the factor-flow hypothesis from the set of explanations for an observed spatial interdependence of welfare expenditure, leaving yardstick competition as the sole source of the interaction.

Before we turn to the estimation results the next section describes the data used in this analysis in more detail and also highlights some key issues of the empirical strategy.

4.3 Data and Empirical Strategy

To estimate the best response function (4.5) for the time before the Agenda 2010 reforms were in place we use annual data on total expenditure for social assistance in the 439 German counties (*Kreise und Kreisfreie Städte*). These data were obtained from the state branches of the Federal Statistical Office.

We use a cross-section of the 439 counties for the year 2000. By comparing the strategic interaction in the time immediately before the reform to that after the reform was in place we are able to identify the effect of changes in the institutional setup on the intensity of the strategic interaction. In a robustness check we also use a cross section for the year 2004.

In our first estimates, where we focus on the time before the reform was in place, we use total annual expenditure in a county normalized by the number of recipients for that year as the dependent variable. That is, we base our analysis on actual welfare benefits which has become quite standard in the empirical literature on welfare competition. A similar approach is for instance followed by Fiva and Rattso (2006) and Dahlberg and Edmark (2008). Note that we will refer to the dependent variable as per-capita expenditure although we actually mean expenditure per recipient.

As socioeconomic control variables we include the unemployment rate and the number of insolvencies per-capita as a proxy for local business activity. To control for the tightness of the local budget constraint we include the level of transfers received form upper level governments, measured in Euros per-capita, and the level of public debt, measured in 100 Euros per-capita. Note that these transfers are mainly intended to equalize differences in tax-revenue between jurisdictions and are thus independent of welfare expenditure. Also, we control for the per-capita income in a region and the vote share that parties from the left spectrum of the German political system received in the Federal Elections[6]. Controls for the share of left and right parties are sometimes included in empirical studies of welfare competition to account for the possibility that welfare benefits are higher in

[6]We defined as 'left' parties the Social Democrats (SPD), the PDS/Linke, and the Greens (Bündnis 90/Die Grünen)

counties with a left-wing majority. Figlio, Kolpin, and Reid (1999) for instance control for the vote shares of Republicans but find no significant influence on expenditure levels within the AFDC program.

Data for all co-variates were taken from various issues of the regional database *Statistic Regional* which is published annually by the Federal Statistical Office.

Furthermore, to control for the influence of the standard rate for the regular benefits we collected the level of these rates by consulting the respective state laws. Table 4.8 shows standard rates for household heads by state for the years 1999/2000 and 2004/2005 from which we can calculate an average standard rate for the years 2000 and 2004.

Summary statistics of the dependent variable as well as for the controls are shown in Table 4.1.

Our estimation results for the time after the implementation of the Agenda 2010 reform are based on monthly data on the average level of housing assistance in the 439 German counties for the time between January 2006 and July 2007. In particular, this information is available by household size. These data can be accessed over the website of the Federal Employment-Agency[7].

Concerning the inclusion of socioeconomic controls we face the problem that some of the relevant data is not published on a monthly basis. Other information that one would ideally want to control for is only released with a substantial lag of several years - as for instance information about county budgets - and therefore not available at the time of writing this chapter. However, it can be assumed that most socioeconomic controls are proxies for variables that are constant over a relatively short time period. We therefore estimate (4.5) in first-differences. That is, we test how changes in the average level of housing expenditure in one county depend on changes in the level of housing assistance in neighboring counties

$$\Delta z_{it} = \rho \sum_{j} w_{ij} \Delta z_{jt} + \theta \Delta X_{it} + \epsilon_i \tag{4.6}$$

In this approach individual county specific effects, such as the level of transfers received from higher levels of government, that are time invariant in the short run and for which we are not able to control are netted out.

To carry out the first-difference estimation we construct two panel data sets from the available data. Each panel consists of two cross-section samples. We use two panels that each range over a 12 month interval (January 2006-January 2007 and July 2006-July 2007) to avoid a confounding influence of seasonal changes of the unemployment rate.

For each panel we estimate the reaction function using the change in average monthly level of housing assistance to a n-person household, where $n \in \{1, \ldots, 4, > 4\}$, as the

[7] www.arbeitsagentur.de

Table 4.1: Summary statistics 2000 and 2004

Variable	Unit	2000			2004		
		N	Mean	Std. Dev.	N	Mean	Std. Dev
Debt	100 EUR per-capita	435	107.2	43.78	323	102.76	37.03
Insolvency	per 1×10^6 residents	435	50.54	19.62	323	129.8	45.95
Transfers	EUR per-capita	435	295.37	147.55	323	404.87	53.42
Unemployment	per cent	435	10.86	5.57	323	10.6	5.74
Rate	EUR	435	269.93	6.2	323	304.2	35.29
Left	share	435	0.51	0.097	323	0.48	0.12
Total Exp.	100 Euro per-capita per month	435	3.76	1.61	323	4.07	1.94
Income	1000 EUR per-capita	435	15.52	2	323	16.82	2.2

Counties with at least one missing observation are removed from the data.

dependent variable.

Table 4.2 shows summary statistics of average expenditure for each month in the panel. Note that the average level of housing assistance has increased between January 2006 and February 2007. This increase was strongest for one person households who have on average received 24 Euros more housing assistance in January 2007 than in January 2006. A plausible explanation for this increase is an overall rise in energy prices in the time between January 2006 and January 2007. Over this period the price for gas increased by roughly ten per cent. Electricity prices have also soared by roughly three percent during the same period and continued to rise by more then five per cent between June 2006 and June 2007. Overall the rise in energy prices led to an increase of the consumer price index for Gas, Water and fossil fuels by 2.7% between January 2006 and July 2007 (Statistisches Bundesamt 2008c). In the ensuing empirical analysis we need to make sure that we do not spuriously attribute the spatial correlation of benefit levels caused by this country-wide increase in energy prices to the presence of welfare competition. We return to this issue in Section 4.5.

Also, as can be seen from Table 4.2, larger households require less expenditure in per-capita terms than smaller households. Under the factor flow hypothesis this creates greater incentives for local governments to induce an out-migration of smaller households. This fact reinforces our hypothesis that -under the factor flow hypothesis- we should observe that the intensity of welfare competition depends on the size of the household at which expenditure is directed[8].

Available socioeconomic control variables are the change in the unemployment rate over the respective twelve-month period as well as the change of the rent level between 2006 and 2007. It is to be expected that an increase in the average rent level is associated with higher expenditure on housing assistance. For the change in the unemployment rate we expect that rising unemployment tightens a county's budget constraint and leads to lower benefit levels. However, previous studies on welfare competition have sometimes found a positive relationship between unemployment and benefit levels (Shroder 1995, Brett and Pinske 2000).

Ideally, one would like to use more detailed proxies for a change in the tightness of a counties budget constraint such as the level of transfers from higher level governments or the debt level of a county. Unfortunately, these data is not yet available for the respective time period and will not be released on a monthly basis. However, it is plausible that local governments are only able to obtain full information about the exact state of their budget at the end of a year. One might thus consider the budget of a county as constant

[8]One could also argue that, for a given amount of effort, inducing the outflow of a larger household provides a stronger relief for the local budget. In this case incentives would be reversed. However, due to various legal regulations, mobility costs of large hoseholds are very high so that this is a rather unlikely possibility.

Table 4.2: Average monthly level of household assistance by household size in Euro

		Household Size				
		1 person	2 persons	3 persons	4 persons	>4 persons
January 2006	Mean	193.8	275.2	321.7	383.1	458.2
	Std. Dev.	35.2	44.75	50.76	57.86	68.53
July 2006	Mean	200.8	279.2	326.5	389.00	466. 8
	Std. Dev.	35.24	44.65	50.1	56.14	68.6
January 2007	Mean	218.5	286.1	333.8	397.3	479.7
	Std. Dev.	35.37	45.98	53.5	60.00	73.73
July 2007	Mean	221.6	288.7	335.2	398.1	482.2
	Std. Dev.	35.8	46.56	54.68	60.27	73.67

Source: Bundesarbeitsagentur

over a twelve month period in which case it constitutes a county fixed effect which is accounted for by the first-difference strategy.

Data on monthly unemployment rates were taken from the Federal Employment Agency. Information about rent-prices were kindly provided to us by the *Bundesamt für Bauwesen und Raumordnung.* These data are based on advertisements in regional newspapers and report an average annual rent level for each county.

On July, 1^{st} in 2007 the state Sachsen-Anhalt re-organized the boundaries of its counties and reduced their number. Because this reform made it impossible to calculate the change in welfare expenditure for these counties they were excluded from the July panel. In case where these counties had neighbors in other states they were also removed from the neighbor list of these counties.

4.3.1 Econometric Issues

There are some econometric issues that need to be addressed before we can estimate equations (4.5) and (4.6). In particular, we need to specify the weight matrix that defines the competitors of a given county. In addition, we need to make sure that spatial auto-correlation in the data can indeed be attributed to strategic interaction.

Weighting Schemes

In theoretical models of welfare competition the policy of one region potentially exerts an influence on all other regions. In practice however, each region only interacts with a subset of all other regions. Estimation of equations (4.5) and (4.6) therefore requires that we specify a weights matrix W defining which counties interact with each other.

In this study we use a row-normalized binary contingency weight matrix which has become standard in the literature. Under this matrix two jurisdictions are assumed to interact with one another if and only if they share a common border. An entry in this matrix thus takes the form

$$w_{ij}^{nc} = \frac{w_{ij}^{bc}}{\sum_k w_{ik}^{bc}}$$

where $w_{ij}^{bc} = 1$ if i shares a common border with j and $w_{ij}^{bc} = 0$ otherwise. We denote this matrix as W^{nc}.

Case, Rosen, and Hines (1993) argue that it might well be possible that a jurisdictions benefit levels are influenced by jurisdictions other than its direct geographical neighbors. If the strategic interaction is driven by factor flows then this might for instance be the case if welfare recipients are mobile between economically similar regions but not so much between geographical neighbors. One could for example imagine that some individuals prefer to live in urban areas while others have a preference for living in rural areas. In this case we would expect migration flows between rural areas to be higher than flows from rural to urban areas and vice versa. To account for this possibility we also make use of a weighting scheme that is based on economical distance, rather than geographical distance. We follow Shroder (1995) who proxies for economic distance by using migration flows between counties. To this end let m_{ij} denote the number of individuals that moved from region i to region j in the year 2004. Our measure of economic closeness is then

$$w_{ij}^M = \frac{m_{ji}}{\sum_k w_{ik}^M}$$

Under this weighting scheme the impact of region j's benefit level on the benefit level in region i is assumed to rise with the number of individuals that moved from j to i in the year 2004[9]. The weight matrix for this set of weights will be denoted by W^m.

Note that using migration data from 2004 ensures that the weights are exogenous in the estimation of (4.5).

Sources of spatial auto-correlation

There are a number of well known empirical problems associated with the estimation of (4.5). A first econometric challenge is constituted by the fact that the spatial lag term $\sum_j w_{ij} z_{jt}$ is correlated with the error terms in (4.5). Intuitively this is due to the fact that observed benefit levels are determined simultaneously in a Nash-equilibrium. This simultaneity means that the spatial lag on the right-hand side of (4.5) is endogenous, leading an OLS estimation to yield inconsistent results (Anselin 1988a). To see this write (4.5) in matrix form

$$z = \rho W z + \theta X + \epsilon \tag{4.7}$$

A reduced form of (4.7) is then given by

$$z = (I - \rho W)^{-1} X\theta + (I - \rho W)^{-1}\epsilon \tag{4.8}$$

From the last term of equation (4.8) we see that the benefit level in jurisdiction j depends on the errors of all regions through the vector ϵ. The econometric literature has advanced a number of strategies to deal with this simultaneity. One way is to estimate (4.8) by Maximum Likelihood methods (Anselin 1988a). This method was for instance used by Saavedra (2000) and Brueckner and Saavedra (2001). Another frequently used method is to instrument for Wz by using an instrument matrix that contains own and neighbor's co-variates. This approach goes back to Kelejian and Prucha (1998) and has for instance been applied by Figlio, Kolpin, and Reid (1999) and Fiva and Rattso (2006).

[9] Data on migration flows between the German counties in the year 2004 were provided to us by the Federal Statistical Office

In this study our standard approach will be to estimate the reduced-form of the reaction function by the Maximum-Likelihood methods proposed by Anselin (1988a).

Estimation of (4.8) by Maximum-Likelihood techniques depends on the assumption that the errors are spatially independent. If errors are instead spatially correlated, as might for instance be the case in the presence of regional shocks, then an observed spatial auto-correlation need not be due to strategic interaction between counties.

Suppose, for instance, that the errors are spatially dependent and satisfy the relationship

$$\epsilon = \lambda W \epsilon + \nu \tag{4.9}$$

where ν is a well behaved error vector. Then estimation of (4.8) would give a false impression of spatial lag dependence ($\rho \neq 0$) when $\rho = 0$ holds in the true model. Consequently, it is important to investigate whether spatial lag or spatial error dependence is the most likely source of spatial auto-correlation (Brueckner and Saavedra 2001). Several approaches exist for dealing with this problem. A standard test for the significance of the spatial lag parameter ρ is Anselin's (Anselin 1988b) test based on the Lagrange multiplier principle which estimates the hypothesis $H_0 : \rho = 0$. There is a similar test for the presence of spatial error dependence with the Null $H_0 : \lambda = 0$. These tests are henceforth denoted by 'LMlag' and 'LMerr' respectively. However, the power of the former test is not good when the errors are spatially correlated, while the latter test requires that $\rho = 0$.

A better solution is therefore to apply the robust LM tests proposed by Anselin, Bera, Florax, and Yoon (1996) which test for spatial lag and spatial error dependence and are robust to the presence of the other. In what follows we denote these tests by 'RLMlag' and 'RLMerr'.

Identification strategy

With a description of the data and the empirical strategy in place we are now able to state our identification strategy more precisely.

To identify the effect of the degree of decentralization on the intensity of welfare competition we start by estimating the slope parameter ρ at hand of the pre-reform data from the year 2000. This estimate will then be compared to the slope parameter obtained from the post-reform data. As the Agenda 2010 reform was associated with a partial centralization of the welfare administration we expect the estimate of ρ to be smaller after the reform, independently of household size. This would imply that in the time after the implementation of the reform local administrative units responded less intensivly to changes of expenditure levels in neighboring counties than they did under the more decentralized system that was previously in place.

To disentangle different theories of welfare competition we are going to use the estimates of ρ for households of different size obtained by estimating (4.6) based on the data from 2006 and 2007. If factor flows are driving the strategic interaction then we expect competition to be more intense for smaller, more mobile households which are also associated with higher per-capita expenditures. In other words, if factor-flows matter, we expect to find a stronger spatial auto-correlation in the data if we look at smaller households. If, on the contrary, yardstick competition is the sole mechanism driving the strategic interaction then the estimates of the slope parameter should not depend on household size.

4.4 Estimation Results

This section first presents estimation results for the cross-section for the time prior to the reform. Thereafter follows a description of the results for the post-reform period.

4.4.1 Estimation Results for 2000

Table 4.3 shows the results obtained from estimating the model (4.5) with the Maximum-Likelihood approach of Anselin (1988a) using the two weighting schemes discussed in the previous section and the cross-section for 2000. Probability values are shown in parenthesis. For each weighting scheme we estimate three different specifications of (4.5).

In our baseline model we include per-capita debt, the number of insolvencies per-capita, the level of transfers from higher levels of government and the vote share of the left parties as well as the standard rate in the vector of socio-economic controls. The coefficient estimates for this specification are in columns 1 and 4 of Table 4.3.

In a second specification we added the local unemployment rate to the socioeconomic controls. The unemployment rate is an important proxy for the state of the local economy as well as for the tightness of a county's budget constraint. The reason why this variable is omitted from the baseline-specification is that the unemployment rate is potentially endogenous to the level of welfare expenditure per-capita. The results for this augmented specification are shown in columns 2 and 5 of Table 4.3.

In Germany, local elections are held simultaneously in each state but there might be differences in the timing of elections across states. To account for the fact that the timing of elections might have an influence on per-capita expenditure we add an election dummy in a further specification of the model which equals one if there was an election of the local parliament (*Kreistag*) in the year 2000. This applies to all counties in Schleswig-Holstein and North-Rhine Westphalia. Estimation results for this specification are in columns 3 and 6 of Table 4.3.

The key results in Table 4.3 are the estimates of the slope parameter ρ. This parameter is positive and significantly different from zero under all specifications and both weighting schemes. These results are consistent with the occurrence of welfare competition between the German counties in the year 2000. As expected, the reaction functions generated by this strategic interaction are positively sloped. The estimated slope parameters lie in the range between 0,7 and 0,85, implying that a reduction of average per-capita expenditure by 1 Euro in one county triggers its neighbors to reduce per-capita expenditure by 0,7 to 0,85 Euros. As can be seen in Table 4.3, the estimated slope parameter is robust to the inclusion of the unemployment-rate and the election dummy.

Amongst the socio-economic control variables only per-capita income, the vote-share of parties from the left and the standard rate have a significant impact on the average per-capita expenditure for social assistance. With one exception all coefficients have the expected sign. An increase in the per-capita income of a county by 1000 Euros is associated with a decrease in annual per-capita expenditure on social assistance of approximately 6,6 Euros. Similarly, counties with a higher vote share of the parties from the left spend more on welfare. If the vote share of the left parties increases by one percentage point this leads to a rise in per-capita expenditure of 192 Euro per year.

Note that this effect is only marginally significant under the migration weights where the effect is also smaller. However, for the present analysis it s only important that this covariate does not influence the intensity of the strategic interaction. We have therefore excluded the variable from the estimation which left the spatial lag parameter virtually unchanged.

Surprisingly, the standard rate has a significantly negative impact on per-capita expenditure. The magnitude of this impact is however very small. The interpretation of this coefficient estimate is the following: If a state increases the standard rate by 1 Euro (which corresponds to 12 Euros per year) the counties in that state decrease per-capita expenditure on social assistance by roughly 0,4 Cents per year. In theory, one would expect this coefficient to equal one because an increase in the standard rate should force local administrations to increase regular benefits by a similar amount. In practice however, a county can offset higher benefits in one expenditure category by cuts in another category. This highlights the importance of using actual benefit levels instead of welfare norms as the dependent variable as pointed out by Fiva and Rattso (2006).

Note that the baseline results reported in columns (1) and (4) of Table 4.3 remain virtually unchanged after the inclusion of additional control variables.

As noted above, the slope parameter ρ might be found to be significantly different from zero, although $\rho = 0$ holds in the true model, giving false evidence for the presence of strategic interaction. This situation occurs if the error terms in (4.5) are spatially

Table 4.3: Maximum-Likelihood coefficient estimates for the 2000 cross-section

	2000 Total Expenditure					
	W^n			W^m		
	(1)	(2)	(3)	(4)	(5)	(6)
ρ	0.725***	0.722***	0.722***	0.85***	0.85***	0.85***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Debt	-0.001	0.00	0.00	0.00	0.00	0.00
	(0.21)	(0.26)	(0.30)	(0.48)	(0.50)	(0.52)
Insolvencies	-0.001	0.00	0.00	0.00	0.00	0.00
	(0.62)	(0.86)	(0.81)	(0.45)	(0.50)	(0.49)
Transfers	0.00	0.00	0.00	0.00	0.00	0.00
	(0.53)	(0.42)	(0.40)	(0.56)	(0.54)	(0.54)
Income	0.066**	0.04	0.05	0.04	0.04	0.04
	(0.023)	(0.23)	(0.21)	(0.14)	(0.29)	(0.29)
Rate	-0.03***	-0.03***	-0.03***	-0.03***	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Left	1.92***	2.25***	2.32***	1.04*	1.11	1.12
	(0.01)	(0.01)	(0.00)	(0.09)	(0.102)	(0.10)
Unempl.		-0.02	-0.02		0.00	-0.03
		(0.25)	(0.25)		(0.83)	(0.83)
Election			-0.06			-0.019
			(0.67)			(0.89)
Tests of Error Spec.						
LM Breusch Pagan	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LM Test Spat. Error	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LM Test Spat. Lag	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Robust Tests						
RLM Test Spat. Error	(0.16)	(0.03)	(0.02)	(0.88)	(0.09)	(0.16)
RLM Test Spat. Lag	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	435	435	435	435	435	435

p-values in parenthesis

*** denotes significance at the 1% level, ** denotes significance at the 5% level and * denotes significance at the 10% level dependent.

To determine whether spatial error dependence has been improperly ignored let us first look at Anselin's (Anselin 1988b) tests for the significance of the spacial lag parameter. As can be seen in Table 4.3, both tests (LMerr and LMlag) reject their respective null hypothesis, indicating that both spatial lag or error dependence might be the reason for the observed spatial auto-correlation.

To be able to conclude that the positive estimate of the slope parameter can indeed be attributed to the presence of welfare competition we therefore need to consult the test for the significance of spatial lag parameter ρ which is robust to the presence of error dependence (RLMlag). Table 4.3 shows that this test rejects the null-hypothesis of no spatial lag dependence under all specifications, indicating that the positively sloped reaction function can indeed be interpreted as evidence for the presence of welfare competition.

A potential problem is the result of the Breusch-Pagan test, which rejects the hypothesis of constant error variance under all specifications. To address this issue we repeated the estimations using the instrumental variables approach of Kelejian and Prucha (1998) for which it is possible to obtain heteroskedasticity-robust standard errors in the Software package R that was used for this analysis. The results obtained with this estimation procedure are qualitatively similar to those in Table 4.3. In particular, the slope-parameter is positive and highly significant. The results of these estimates for the standard weights are in Table 4.4.

The slope parameters in Table 4.4 are slightly higher than the one obtained from the Maximum-Likelihood strategies. This effect is not uncommon and has been observed in related studies. Fiva and Rattso (2006) for instance also find smaller estimates for the ML than for the IV estimates. They explain this pattern by the fact that the IV approach of Kelejian and Prucha (1998) is robust to omitted spatial error correlation while the ML approach is not.

To avoid having to rely on data from only one cross-section we conducted a similar analysis for the year 2004. The results are shown in Table 4.5. The coefficient estimates are very similar to those obtained for the 2000 cross-section. In particular, the estimate of the slope parameter is of the same magnitude as before and also significantly different from zero at the 1% level for all specifications of (4.5).

Taken together, the results presented in this section clearly suggest that the German counties were engaged in welfare competition in the years before the implementation of the Agenda 2010 reform. The estimated slope of the reaction function lies in the range between 0,5 and 0,85 implying that when a county decreased its per-capita expenditure by 1 Euro its neighbors reacted by reducing their expenditure by 0,5 to 0,85 Euros.

The intensity of this competition is comparable to related studies that tested for welfare competition in other countries. Our estimates are however at the upper end of the results

Table 4.4: Instrumental Variables Estimation: Standard Weights

	Dependent Variable: Total Expenditure per recipient 2000		
ρ	0.875***	0.91***	0.939***
	(0.00)	(0.00)	(0.00)
Debt	0.00	0.00	0.00
	(0.60)	(0.74)	(0.73)
Insovencies	0.00	0.00	0.00
	(0.49)	(0.71)	(0.59)
Transfers	0.00	0.00	0.00
	(0.39)	(0.52)	(0.63)
Income	0.07 ***	0.054**	0.05
	(0.00)	(0.03)	(0.15)
Rate	-0.016*	-0.017*	-0.02**
	(0.08)	(0.09)	(0.04)
Left	0.71	0.62	1.096
	(0.29)	(0.40)	(0.19)
Unempl.		.01	-0.01
		(0.61)	(0.58)
Election			-0.106
			(0.46)
N	435	435	435

p-values in parenthesis

*** denotes significance at the 1% level, ** denotes significance at the 5% level and * denotes significance at the 10% level

Table 4.5: Maximum-Likelihood coefficient estimates for the 2004 cross-section

	2004 Total Expenditure					
	W^n			W^m		
ρ	0.70***	0.698***	0.698***	0.85***	0.848***	0.85***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Debt	-0.003	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.19)	(0.30)	(0.33)	(0.18)	(0.27)	(0.32)
Insolvencies	0.00	0.00	0.00	0.00	0.00	0.00
	(0.90)	(0.87)	(0.872)	(0.94)	(0.97)	(0.97)
Transfers	-0.004***	-0.003***	-0.004**	-0.003*	-0.002*	-0.003*
	(0.01)	(0.02)	(0.018)	(0.05)	(0.09)	(0.07)
Income	-0.03	-0.076	-0.075	-0.04	-0.007	-0.07
	(0.38)	(0.13)	(0.14)	(0.27)	(0.10)	(0.11)
Rate	0.004*	0.004*	0.003	0.004*	0.003	0.003
	(0.06)	(0.10)	(0.14)	(0.08)	(0.12)	(0.19)
Left	2.81***	3.41***	3.42***	1.45*	1.96**	1.97**
	(0.00)	(0.00)	(0.00)	(0.05)	(0.02)	(0.02)
Unempl.		-0.029	-0.026		-0.025	-0.02
		(0.19)	(0.27)		(0.21)	(0.35)
Election			-0.08			-0.134
			(0.74)			(0.55)
Tests of Error Spec.						
LM Breusch Pagan	(0.32)	(0.03)	(0.0)	(0.11)	(0.01)	(0.00)
LM Test Spat. Error	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LM Test Spat. Lag	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Robust Tests						
RLM Test Spat. Error	(0.02)	(0.06)	(0.07)	(0.02)	(0.08)	(0.09)
RLM Test Spat. Lag	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	323	323	323	323	323	323

p-values in parenthesis

*** denotes significance at the 1% level, ** denotes significance at the 5% level
and * denotes significance at the 10% level

obtained in other studies. For instance Fiva and Rattso (2006), looking at welfare competition in Norway, estimate the slope of the reaction function as 0,81 which is comparable to the results reported here. Brueckner and Saavedra (2001) and Dahlberg and Edmark (2008) obtain estimates of around 0,3 for the slope of the reaction function. In the light of these findings, welfare competition between German counties in the time prior to the Agenda 2010 was intense, relative to welfare competition in other countries.

4.4.2 Estimation Results for 2006 and 2007

Having found robust evidence for the occurrence of welfare competition between the German counties in the years before the Agenda 2010 reform we now turn to the the results for the years 2006 and 2007, the time after the implementation of the reform. Recalling from our description of the institutional background that the reform was associated with a move towards a more centralized administration of welfare benefits we expect to find less auto-correlation in the data, indicating a decline in the intensity of competition. Concerning the relationship between the intensity of competition and household size the expected results depend on the mechanism driving the strategic interaction: If factor-flows are at least part of the explanation for an observed strategic interaction we should find that this competition is more intense for smaller households. If the intensity of competition is however independent of household size this would leave the yardstick competition hypothesis as the sole source for the strategic interaction.

January Panel

The results of estimating equation (4.6) with the January panel are in Table 4.6 in which probability values are shown in parenthesis. Again, we have estimated the model with a dummy indicating that a local election took place in the respective county either in 2006 or 2007. This dummy is set to one for all counties in Lower Saxony (which held elections in September 2006) and Sachsen-Anhalt (where elections were held in April 2007). The reason for the inclusion of Sachsen-Anhalt is the assumption that the election campaign started already at the end of 2007 and is thus likely to have affected the strategic interaction in the respective counties between 2006 and 2007. However, the results are virtually unchanged if the dummy is excluded.

Looking at Table 4.6 we see that the key parameter of interest, the slope parameter ρ, is positive and significantly different from zero under both weighting schemes and for one-, two- ,four- and five-person households. For three person households the estimated slope parameter does not differ significantly from zero, indicating the absence of strategic interaction in the setting of average benefit levels for three-person households.

As expected, all slope parameters are significantly smaller compared to the time before the reform for all weighting schemes and household sizes. This finding is consistent with the hypothesis that the intensity of welfare competition has declined due to the introduction of the joined administration of the welfare benefits.

The socio-economic control variables fail to have a significant influence on average benefit levels for all estimations of (4.6).

So far we do not know whether the spatial auto-correlation of the benefits provided to one-, two-, four- and five-person households are an indication of welfare competition or merely reflect the presence of the spatial error correlation. The simple tests for the presence of spatial lag and spatial error correlation LMlag and LMerr indicate that both explanations might be the source of the observed spatial auto-correlation. We therefore need to take a look at the robust Lagrage-Multiplier tests. Turning first to four- and five-person households the robust test for the presence of spatial lag dependence fails to reject the null hypothesis of the absence of this dependence under both weighting schemes. Accordingly, there is no evidence that local governments set benefits levels to four- and five- person households strategically.

For smaller one- and two-person households a different result is obtained. The robust test for spatial error dependence, RLMerr, indicates the absence of spatial error correlation while the robust test for spatial lag dependence, RLMlag, rejects the hypothesis of the absence of spatial lag dependence. Under the migration weights this null hypothesis is however only marginally rejected at the 10% level.

The results obtained from the robust tests for spatial lag dependence therefore indicate that the German counties set benefit levels to one- and two-person households strategically between January 2006 and January 2007. Concerning three-person and larger households, there is no evidence that the observed spatial autocorrelation is caused by welfare competition.

The results reported so far are consistent with the hypothesis that the intensity of welfare competition between the German counties has declined, or even completely ceased in the case of three- and more person households, due to the partial centralization associated with the welfare reform.

Moreover, the fact that we find evidence for welfare competition only when we look at average expenditure to small households is consistent with the hypothesis that local politicians take the mobility of welfare recipients into account when setting benefit levels. If yardstick competition was the sole channel driving the strategic interaction then the intensity of the observed competition should have been independent of household size.

Assuming that one-person households are more mobile than two-person households the intensity of competition should be larger for the former in order for the results to be fully consistent with the factor-flow theory. A further look at Table 4.6 shows that this is indeed the case.

Table 4.6: January Panel: Maximum Likelihood Coefficient Estimates by household size

	$n=1$		$n=2$		$n=3$		$n=4$		$n>4$	
	W^{nc}	W^{m}	W^{nc}	W^{m}	W^{nc}	W^{m}	W^{nc}	W^{m}		
ρ	0.183***	0.308***	0.09	0.174*	0.003	-0.00	0.14**	0.199**	0.14**	0.19
	(0.00)	(0.00)	(0.16)	(0.06)	(0.96)	(0.99)	(0.04)	(0.04)	(0.04)	(0.03)
Constant	19.97***	16.86***	8.4***	7.27***	11.76***	11.79***	13.05***	11.6***	13.05***	11.52***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ΔUnemployment	0.362	0.25	-0.14	-0.17	0.78	0.78	1.22	1.13	1.22	1.13
	(0.33)	(0.49)	(0.77)	(0.72)	(0.28)	(0.29)	(0.19)	(0.22)	(0.19)	(0.22)
Δ Rent	1.34	1.38	3.27	3.27	-3.24	-3.27	0.01	-0.32	0.01	-0.32
	(0.69)	(0.67)	(0.45)	(0.45)	(0.62)	(0.62)	(0.99)	(0.97)	(0.99)	(0.97)
Election	0.23	0.73	-0.93	-0.68	0.08	0.08	0.07	0.30	0.07	0.29
	(0.80)	(0.43)	(0.44)	(0.57)	(0.96)	(0.97)	(0.97)	0.97	(0.97)	(0.90)
Breusch-Pagan	(0.54)	(0.44)	(0.13)	(0.15)	(0.98)	(0.98)	(0.75)	(0.78)	(0.55)	(0.78)
LMErr	(0.01)	(0.00)	(0.03)	(0.04)	(0.90)	(0.95)	(0.03)	(0.04)	(0.03)	(0.04)
LMLag	(0.00)	(0.00)	(0.13)	(0.04)	(0.96)	(0.99)	(0.03)	(0.04)	(0.03)	(0.04)
RLMErr	(0.75)	(0.15)	(0.01)	(0.09)	(0.73)	(0.23)	(0.88)	(0.58)	(0.87)	(0.61)
RLMLag	(0.04)	(0.107)	(0.04)	(0.11)	(0.72)	(0.23)	(0.79)	(0.50)	(0.55)	(0.78)
N	343	343	343	343	343	343	343	343	343	

p-values in parenthesis

*** denotes significance at the 1% level, ** denotes significance at the 5% level

and * denotes significance at the 10% level

In sum, the results from the January panel are therefore consistent with the hypothesis that the strength of welfare competition has declined after the implementation of the Agenda 2010 reform and that this decline is stronger for larger, less mobile households.

July Panel

Turning to the estimates of (4.6) for the July panel we fail to find evidence that the German counties set welfare levels interdependently. The ML coefficient estimates are in Table 4.7. It can be seen that the slope parameter ρ is only significantly different from zero for single-households. This provides a clear indication for the absence of a strategic setting of welfare benefits to larger households.

Looking more closely at the results for one person-households we see that spatial lag as well as spatial error dependence both qualify as the source of the observed auto-correlation. It is therefore crucial to consider the results of the robust LM tests. The RLMlag test however fails to reject the null hypothesis of the absence of spatial lag dependence. Accordingly, there is no evidence that the observed spatial auto-correlation of benefit levels for one-person households can be attributed to the presence of welfare competition.

In total, for the July panel, we fail to find any evidence for the hypothesis that the German counties engage in welfare competition. A possible explanation for the difference in results between the two panels is indicated by the election dummy. In contrast to the January panel, this coefficient is positive and significantly different from zero at least for single households. Apparently, counties in which a local election took place have been more generous in their setting of benefit levels. It might thus be that in those counties short-run attempts to maximize reelection probabilities in upcoming elections have temporarily dominated the strategic objectives of local governments, making it impossible to identify any strategic competition that took place between July 2006 and July 2007.

However, the lack of evidence for welfare competition in the time between July 2006 and July 2007 is again consistent with the hypothesis that the intensity of welfare competition has declined due to the partial centralization of the welfare administration.

In sum, evidence for the presence of welfare competition in the time after the Agenda 2010 reforms is at best mixed. To some extend, this outcome was to be expected given that the introduction of the joined administration has reduced the autonomy of local authorities over welfare policies. Insofar, this result is consistent with the hypothesis that the intensity of competition depends positively on the degree of decentralization.

What might come as a surprise is the extent to which competition is reduced. After all, the counties still maintain a significant influence on the benefit levels and also share

Table 4.7: July Panel: Maximum-Likelihood Coefficient Estimates by household size

	$n=1$		$n=2$		$n=3$		$n=4$		$n>4$	
	W^{nc}	W^{m}	W^{nc}	W^{m}	W^{nc}	W^{m}	W^{nc}	W^{m}		
ρ	0.177***	0.34***	-0.01	0.08	-0.05	-0.02	0.003	0.02	0.03	0.02
	(0.00)	(0.00)	(0.89)	(0.40)	(0.49)	(0.82)	(0.64)	(0.82)	(0.64)	(0.82)
Constant	16.12***	12.78***	8.4***	7.51***	8.97***	8.85***	5.63***	5.59***	5.63***	5.59***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
ΔUnemployment	0.41	0.33	0.44	0.38	1.23*	1.22*	-0.50	-0.52	-0.5	-0.52
	(0.33)	(0.42)	(0.36)	(0.42)	(0.09)	(0.09)	(0.61)	(0.60)	(0.61)	(0.60)
Δ Rent	0.36	0.08	-5.99	-5.9	-5.04	-4.63	-10.62	-10.75	-10.6	-10.75
	(0.92)	(0.98)	(0.14)	(0.14)	(0.40)	(0.44)	(0.19)	(0.19)	(0.20)	(0.19)
Election	2.33**	2.33**	-0.11	-0.08	1.46	1.39	3.50	3.59	3.49	3.59
	(0.04)	(0.04)	(0.89)	(0.95)	(0.45)	(0.47)	(0.19)	(0.18)	(0.19)	(0.18)
Breusch-Pagan	(0.81)	(0.91)	(0.02)	(0.02)	(0.00)	(0.00)	(0.32)	(0.33)	(0.32)	(0.33)
LMErr	(0.00)	(0.00)	(0.91)	(0.43)	(0.45)	(0.70)	(0.68)	(0.84)	(0.68)	(0.84)
LMLag	(0.00)	(0.00)	(0.89)	(0.40)	(0.47)	(0.81)	(0.63)	(0.82)	(0.63)	(0.82)
RLMErr	(0.36)	(0.93)	(0.31)	(0.38)	(0.83)	(0.02)	(0.64)	(0.78)	(0.64)	(0.78)
RMLLag	(0.29)	(0.72)	(0.31)	(0.35)	(0.92)	(0.02)	(0.60)	(0.76)	(0.60)	(0.76)
N	330	330	330	330	330	330	330	330		

p-values in parenthesis

*** denotes significance at the 1% level, ** denotes significance at the 5% level

and * denotes significance at the 10% level

a large part of the financial burden. However, as argued above, the failure to detect evidence for welfare competition in the time between July 2006 and July 2007 might has to be attributed to the fact that local elections were held in some states during that period.

The pattern of strategic-interaction that we do observe after 2006 is clearly consistent with the hypothesis that welfare competition is at least partially caused by factor-flows between the German counties. If a yardstick competition process was the sole factor determining the interaction of local authorities, evidence as well as the intensity of competition in the time between January 2006 and 2007 should have been independent of household size.

The latter result matches anecdotal accounts of welfare competition (Eberhardt 2007), which suggested that factor-flows play a decisive role in this process.

Our results are therefore in part complementary to those of Revelli (2006b) in his analysis of welfare competition between English local authorities. Revelli shows that welfare competition vanished between two consecutive time periods and attributes this finding to the establishment of a nationwide performance rating system which would serve as a close substitute for comparisons between geographically concentrated jurisdictions. From this observation he concludes that yardstick competition must play a causal role in the strategic interaction between local governments as otherwise his empirical findings should not have been affected by the widening of the voters information set.

The most likely source for the divergence in the results between his study and the work in this chapter are differences in the type of welfare expenditures considered in the empirical analysis. In the present chapter we have looked at monetary transfers to a mobile population. In contrast, the expenditure in (Revelli 2006b) is directed at the provision of welfare services that are likely to benefit mainly immobile individuals, such as the old.

4.5 Robustness and discussion of results

The results reported in the previous section are consistent with the hypothesis that i) a higher degree of centralization reduces the intensity of welfare competition and that ii) factor flows play a crucial role in the setting of benefit levels by the German counties. There are however still some issues that warrant a brief discussion before definite conclusions can be drawn. The first point concerns the evidence for strategic interaction in the post-reform period. Here, one might be concerned that the results are driven by an overall rise in energy prices over the observation period, rather than being caused by strategic interaction between the German counties. A second issue relates to the identification of the effect of the degree of decentralization on the intensity of competition. Our argument rests on the assumption that the move towards a more centralized administration has been the only change that could potentially influence the intensity of welfare competition. This section addresses both issues in turn.

4.5.1 The role of energy prices

In our discussion of the summary statistics in Section 4.3 we have pointed out that energy prices have been rising between January 2006 and July 2007. As these prices are likely to influence housing costs we need to make sure that we do not spuriously attribute a nation-wide increase in energy prices to the presence of strategic interaction.

There are two reasons why we think we can rule out that rising energy prices are driving the results. Firstly, this price increase should have influenced welfare payments to all households over the entire period between January 2006 ad July 2007. However, we have only detected a spatial auto-correlation of welfare payments to small households and only in one of the two panels. This pattern makes it unlikely that the spatial auto-correlation found for small households was caused by rising energy prices.

To further test whether energy prices are driving the results we have estimated equation (4.6) using a random permutation of the weight matrix W^{nc}. More precisely, we have repeated the estimation of (4.6), using the change in average benefits for one- and two-person households between January 2006 and January 2007 as dependent variable. Before each estimation the weight matrix was randomly permutated. In other words, we have altered the neighborhood relationship by assigning each county a random set of neighbors. This procedure is equivalent to randomly assigning each county a new location on a map of Germany. If rising energy prices, which affect all counties equally, have been the source for the spatial auto-correlation in the January panel then we should find that this correlation persists, even for a permutated weight matrix. If the auto-correlation was however caused by strategic interaction of neighboring counties we should cease to detect this correlation for the random weighting schemes.

The results clearly suggest that rising energy prices are an unlikely source of the spatial auto-correlation detected in the data. Under the randomized weighting schemes we only estimated a positive slope parameter in 450 out of 1000 runs in case of one-person households. When we looked at two person households the slope parameter was only positive in 459 out of 1000 cases. Only in 65 out of the 450 cases did the t-value, indicating the significance of the slope-parameter for one-person households, exceeded 1,5 which is a very generous interpretation of significance. Similarly, for two-person households, the t-value was greater than 1,5 only in 16 out of the 459 cases. Under a randomly permutated neighborhood relationship we thus fail to find any evidence for a spatial auto-correlation of benefit levels.

4.5.2 Identification of the centralization effect

We have argued above that the decline in the intensity of competition that we observed after the implementation of the reform was caused by the move towards a less decentralized administration of welfare benefits. However, implicit in this argument was the assumption that the alteration of the degree of decentralization was the only change that might have affected the intensity of competition. There are however two other institutional variations that potentially violate this assumption.

Firstly, one might worry that the merger of the assistance provided to long-term unemployed (*Arbeitslosenhilfe*) with the welfare assistance (*Sozialhilfe*) into the so called basic assistance has indirectly affected the intensity of competition. This point is rather subtle as it requires us to look more closely at the assignment of eligible individuals to either the federal unemployment insurance or the social assistance. Prior to the reform, for some individuals the affiliation to either of the two schemes was not unambiguously defined. A county therefore had a strong incentive to 'mis-classify' individuals who were actually 'permanently out of the labor force' as 'long-term unemployed'. In this case an individual became eligible in the federal unemployment insurance and was thus shifted from the local budget to the budget of the federal government. In the time prior to the reform local governments could therefore pursue two strategies to remove welfare recipients from the local budget: They could set low benefit levels to induce an outflow of recipients to neighboring counties or they could try to move recipients onto the federal budget. After the reform only the first alternative was still available to the counties. If both strategies are complementary to each other then the observed decline in the intensity of competition could merely be caused by the abolition of the possibility to mis-classify individuals and not by the gradual centralization of the welfare administration. However, in the appendix we develop a simple model which demonstrates that both strategies are in fact substitutes: The model shows that if counties are able to shift some recipients into the federal program they have less incentives to engage in welfare competition. Accordingly, the unification of both assistance schemes should, if at all, have led to a more intensive competition.

Secondly, the reform was associated with a standardization of benefit levels which reduced the possibility of local administrations to assess the needs of recipients individually. Accordingly, the reform went along with a loss of discretion over the actual level of local welfare expenditures. However, this loss in discretion affected mainly the regular benefits and not the housing-assistance on which the present analysis has focused. As we have pointed out in Section 4.2, the passage in the law which defines the 'appropriate' level of housing assistance was unaffected by the reform. Because these costs constitute the largest expenditure block within the non-regular benefits it seems fair to assume that our results are largely unaffected by the standardization of the regular benefits.

The attentive reader might of course suggest that one could also single out the effect of changes in the degree of decentralization on the intensity of competition by following a difference-in-difference strategy, using the Optionskommunen as the control group. In this approach, one would compare the change in the slope of the reaction function of the Optionskommunen over time to the reaction functions of the counties with a joined administration. An estimation procedure that allows to estimate different slope parameters for two groups of jurisdictions is in principle available (Allers and Elhorst 2005). However, due to a lack of sufficient data on benefit levels in the Optionskommunen - a point to which we will return below - it is infeasible to pursue this approach.

4.5.3 Missing Data

In the two panels for the post-reform time there are a number of missing observations. The January panel contains observations for 323 out of the 439 counties. In the July panel there are only slightly more observations; i.e. in 343 out of 439 cases. In general, this missing data results from the failure of the Optionskommunen to report the required information. In the July panel, we only have data for 55,8% of the Optionskommunen, but for 92% of the counties with a joined administration. For the January panel there is no data for the Optionskommunen but for 93% of the other counties. One explanation for this pattern is that all data are collected with the software platform A2LL which only a few of the Optionskommunen had implemented by July 2007. It is this lack of data on the Optionskommunen that prevents us from using more elaborate identification strategies, discussed in Section 4.2.2.

In cases where no data was available for a county we had to exclude this jurisdiction from the neighbor set of other counties. Under the normalized weighting schemes employed in the preceding analysis, more weight is thus assigned to the remaining neighbors of a county. For spatial regressions it is hard to judge whether deletion of neighbors affects the estimation results. Figures 4.1 and 4.2 therefore show a map of the counties with missing observations in the January and July panel. We see, that the missings cluster in a few regions of Germany. This clustering minimizes the number of counties of which we had to alter the set of neighbors. While this does not warrant the conclusion that missing observations do not affect the results we obtain at least some indication that this issue could be more serious.

4.6 Summary and concluding remarks

In this chapter we hve looked empirically on the strategic interaction of the 439 German counties with respect to the determination of welfare benefit levels.

Our first contribution was to show that the intensity of welfare competition - here measured as the slope of a jurisdiction's reaction function - has declined after a reform of Germany's major welfare scheme, which reduced the autonomy of the counties over welfare policies. Of course, it is difficult to exclude other forces that might be causal for this result. However, the evidence is at least consistent with the prediction that the intensity of the interaction should be the stronger, the higher the autonomy of local authorities over their welfare policies.

The results of this study have some direct policy implications. In December 2007 the German constitutional court decided that the current administration of the basic assistance scheme violates the autonomy of the counties and reminded politicians to reorganize the welfare administration until the end of 2010 (Bundesverfassungsgericht 2007). In general, it is expected that this reorganization will either encompass a move towards a complete centralization or decentralization of the administration. In the light of the findings presented in this study it is to be expected that - without a reorganization of the financing side - a decentralization will lead to a strengthening of welfare competition between the German counties.

A second objective of the paper was to identify the exact source of the interaction. Using a rich data set which allows us to discriminate between households of different sizes we saw that competition in the time after the reform was confined to mobile households. This evidence is inconsistent with the yardstick competition as the sole driving force for the observed strategic interaction.

Our results are complementary to those of (Revelli 2006a) who looks at social service provision in the UK and identifies an "informational externality" as the most likely source of interaction. The difference in results are best understood by recalling that the expenditure in the study of Revelli benefits mostly immobile households, such as the elderly while the housing-assistance considered in this paper is also targeted at the mobile population.

4.7 Appendix

4.7.1 A small model of welfare competition

In Section 4.5 we have argued that in the time prior to the reform counties were able to manipulate the number of recipients within their borders by trying to move them into the federal unemployment insurance. This was possible because in some instances it was not unambiguously defined whether a recipient had to be classified as a long-term unemployed person or as being permanently out of the labor force (in which case he received welfare assistance). After the reform, the affiliation to the unemployment insurance or the basic assistance scheme was more precisely defined. Accordingly, a strategic reduction of benefit levels remained the only way for local administrations to reduce their case-load.

Potentially, the abolition of the possibility to reduce the number of recipients on a county's budget by moving them into the federal unemployment insurance might confound the identification of the effect of centralizing the welfare administration on the intensity of welfare competition. This would be the case if the strategy to shift recipients into the federal unemployment insurance is complementary to inducing an outflow of recipients by lowering benefit levels.

However, with the help of a simple model, we show that both strategies are in fact substitutes. Accordingly, not being able to move some recipients out of the welfare assistance program should lead to a more intense competition. Hence, if at all, our identification strategy tends to underestimate the effect of a more centralized administration on the intensity of competition.

Note that the model developed in this section belongs to the class of factor-flow models, as this has been identified as the most likely source of the observed strategic interaction.

A simple factor flow model of welfare competition

We consider the competition between two identical jurisdictions A and B. Let us assume that amongst the residents of each jurisdiction lives a continuum of welfare recipients with mass one.

Welfare recipients are partially mobile between jurisdictions but differ in their migration costs μ which are uniformly and independently distributed over the support $[-\overline{\mu}, \overline{\mu}]$.

A recipient μ in jurisdiction $i \in \{A, B\}$ migrates to jurisdiction $j \neq i$ if the gain in expected welfare benefits exceeds his migration costs. Letting $\tilde{z}_i$ denote average benefits in jurisdiction i this is the case if

$$\mu < \tilde{z}_j - \tilde{z}_i$$

If n_{ii} denotes the number of welfare recipients in jurisdiction i who do not migrate and $n_{ij} = 1 - n_{ii}$ denotes the number of movers then we can show that the total number of recipients in jurisdiction i, $n_i = n_{ii} + n_{ji}$ equals

$$n_i(\tilde{z}_i, \tilde{z}_j) = 1 - \frac{\tilde{z}_i - \tilde{z}_j}{2\overline{\mu}}$$

The policy of each jurisdiction consists of choosing the benefit level z_i and the probability p_i with which someone who is entitled to receive welfare benefits actually does so. Here, the underlying assumption is that the fraction $1 - p_i$ of entitled individuals have been successfully misclassified by local administrations and receive benefits $\overline{z}$ from the federal unemployment insurance.

We assume that marginal costs of public funds are constant and equal one. Hence, local policy makers seek to minimize welfare expenditure in their jurisdiction $E_i = p_i z_i n_i$.

Furthermore, let us assume that the benefit level defined in the law is $\overline{z}$. However, each jurisdiction can deviate from this level in which case it faces the probability of being subjected to a costly law-suit. We summarize the costs of deviating from $\overline{z}$ (monetary or in terms of bad press) as $c(z_i) = 0.5\alpha(\overline{z} - z_i)^2$. Similarly, a local government can try to shift some recipients into the federal program in order to reduce local expenditure. Again, there are some constraints to this strategy which are summarized by the cost function $k(p_i) = 0.5\beta(1 - p_i)^2$. We require that $\beta > \frac{\overline{z}}{2\overline{\mu}}$. Later we will interpret the abolition of the possibility to move recipients into the federal program as an increase in β. The objective of the government is therefore to minimize local welfare costs

$$E_i(\tilde{z}_i, \tilde{z}_j) + 0.5\beta(1 - p_i)^2 + 0.5\alpha(\overline{z} - z_i)^2$$

Note that, given our assumptions, the expected welfare level in jurisdiction i is

$$\tilde{z}_i = p_i(z_i - \overline{z}) + \overline{z}$$

Both regions choose their policy (p_i, z_i) simultaneously, taking the policy of the other jurisdiction as given. Then, the first-order conditions describing the best-response function of jurisdiction i are

$$\begin{aligned} \Omega_{p_i} &\equiv \frac{z_i p_i}{2\overline{\mu}} + n_i z_i - \beta(1 - p_i) = 0 \\ \Omega_{z_i} &\equiv \frac{p_i^2}{2\overline{\mu}} + n_i p_i - \alpha(\overline{z} - z_i) = 0 \end{aligned}$$

If we assume that the second-order condition $\Omega_{p_i p_i}\Omega_{z_i z_i} - \Omega_{z_i p_i}\Omega_{p_i z_i} > 0$ holds at all solutions of the first-order conditions then, by Cramer's rule, we obtain that welfare levels are strategic complements; i.e.

$$\begin{aligned} \frac{\partial z_i}{\partial z_j} &= \frac{\begin{vmatrix} \Omega_{p_i p_i} & -\Omega_{p_i z_j} \\ \Omega_{z_i p_i} & -\Omega_{z_i p_j} \end{vmatrix}}{\Omega_{p_i p_i}\Omega_{z_i z_i} - \Omega_{z_i p_i}\Omega_{p_i z_i}} \\ &= \frac{p_i(\frac{z_i - \overline{z}}{2\overline{\mu}}(1 - z_i) + \beta) + z_i(\frac{p_i}{\overline{\mu}} + n_i + \frac{z_i - \overline{z}}{2\overline{\mu}} p_i)}{\Omega_{p_i p_i}\Omega_{z_i z_i} - \Omega_{z_i p_i}\Omega_{p_i z_i}} \\ &= \frac{\frac{p_i(z_i - \overline{z})}{2\overline{\mu}} + \beta p_i + \frac{p_i z_i}{\overline{\mu}} + n_i z_i}{\Omega_{p_i p_i}\Omega_{z_i z_i} - \Omega_{z_i p_i}\Omega_{p_i z_i}} > 0 \end{aligned}$$

where the latter inequality follows simply from our assumption that $\beta > \frac{\overline{z}}{2\overline{\mu}}$ and from the fact that we assumed the second-order condition to hold.

Also, we see directly that competition gets more intense when β rises; i.e. when it becomes harder to move recipients from the locally to the centrally funded benefit scheme. In our context, this corresponds to a steeper slope of the best response function. We see immediately that this is the case by calculating

$$\frac{\partial(\partial z_i/\partial z_j)}{\partial\beta} = \frac{p_i}{\Omega_{p_i p_i}\Omega_{z_i z_i} - \Omega_{z_i p_i}\Omega_{p_i z_i}} > 0$$

The analysis of this section therefore highlights two points: i) per-capita benefit levels are strategic complements, independently of whether local governments are able to manipulate the number of welfare recipients by classifying some of them as non-eligible and ii) if it becomes harder for local governments to do so, for instance because it is no longer possible to shift some recipients into the federal assistance scheme, then we expect competition to become more intense.

The main insight gained from this formal analysis concerns the intensity of strategic interaction. We have seen that this intensity increases as it becomes harder for local governments to manipulate it's welfare caseload directly. Hence, the decline in the intensity of competition that we observed after the reform cannot be attributed to the more clearly defined affiliation of a recipient to either the basic assistance scheme or the federal unemployment insurance.

4.7.2 Tables and Figures

Table 4.8: Standard Rates by state and year

	Standard Rate at July, 1^{st} in EUR			
State	1999	2000	2003	2004
Hamburg	279,68	281,21	345	345
Bremen	279,68	286,84	345	345
Mecklenburg-Vorpommern	263,32	263,32	331	331
Baden-Württemberg	269,45	269,45	345	345
Bavaria	260,76	272,52	272,52	341
Brandenburg	255,65	255,65	283	283
Hesse	276,10	276,10	345	345
Lower Saxony	279,68	281,21	281,21	281,21
North Rhine-Westphalia	279,68	281,21	296	345
Rhineland Palatine	268,9	268,9	268,9	345
Saarland	268,9	268,9	268,9	345
Saxony	266,90	268,43	268,43	345
Sachsen-Anhalt	265,36	265,36	331	331
Schleswig-Holstein	268,94	268,94	268,94	345
Thüringen	256,67	256,67	256,67	331
Berlin	281,21	281,21	281,21	281,21

Rates for the year 1999 and 2000 are converted in Euros.

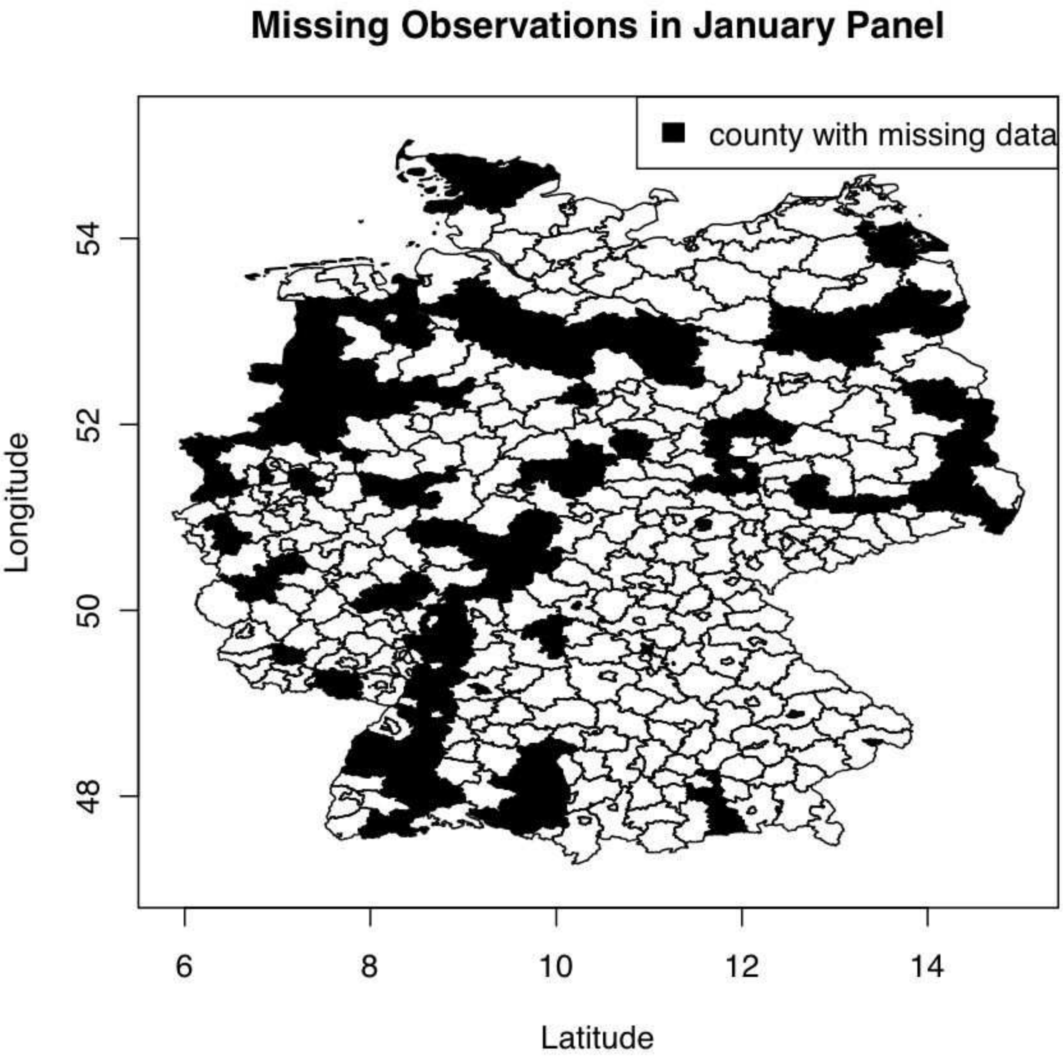

Figure 4.1: Missing data between July 2006 and July 2007

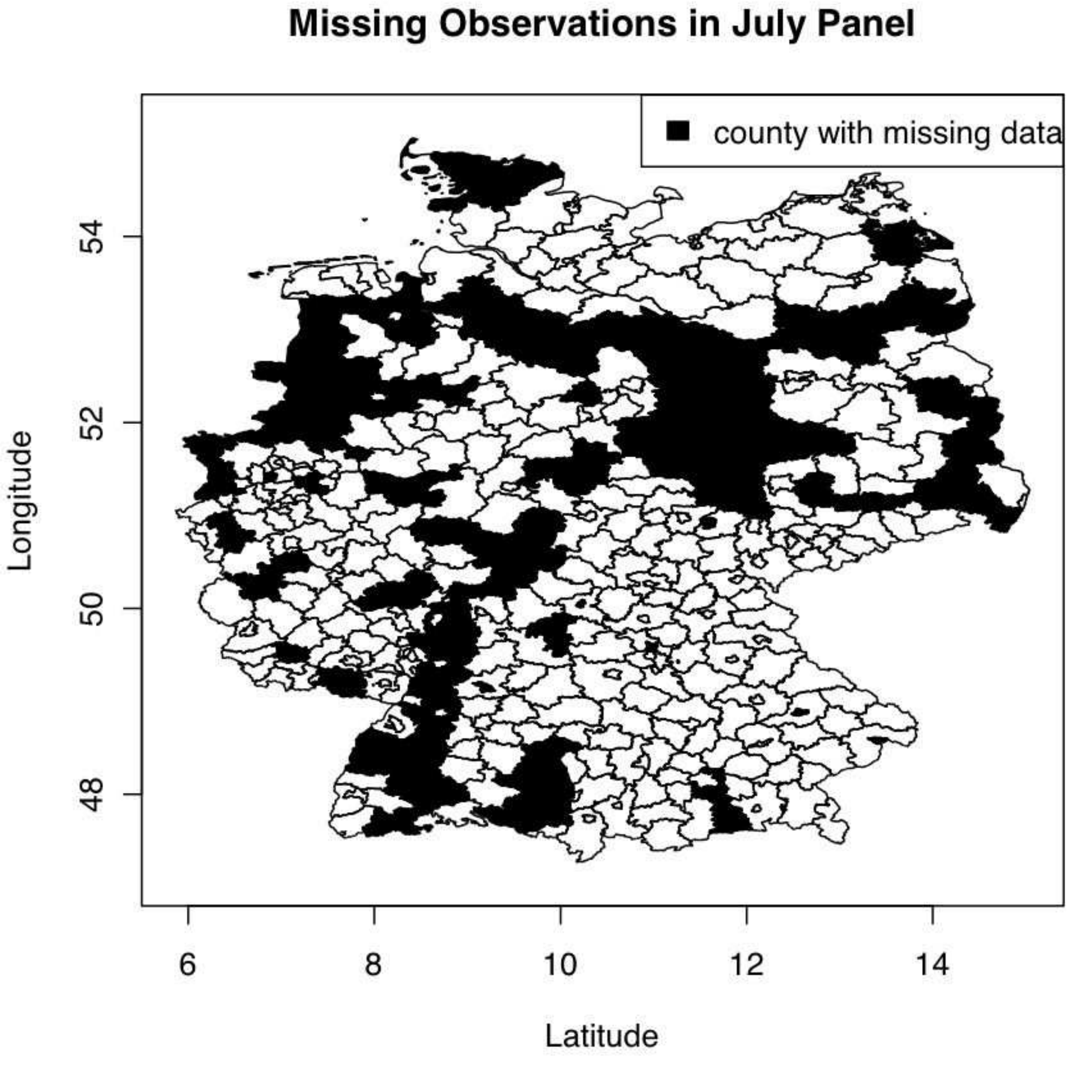

Figure 4.2: Missing data between January 2006 and January 2007

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Eidesstattliche Erklärung

Hiermit erkläre ich, dass ich die Dissertation selbstandig angefertigt und mich anderer als der in ihr angegebenen Hilfsmittel nicht bedient habe, insbesondere, dass aus anderen Schriften Entlehnungen, soweit sie in der Dissertation nicht ausdrücklich als solche gekennzeichnet und mit Quellenangaben versehen sind, nicht stattgefunden haben.

Mannheim, den 30.06.2009

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