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

Malte Hübner*
Universität Mannheim
FB Volkswirtschaftslehre
L7, 3-5
68181 Mannheim

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Abstract

We use the asymmetric introduction of tuition fees in seven out of the sixteen German states in 2007 as a natural experiment to identify the effect of tuition fees on enrollment probabilities. Based on information on enrollment decisions for the entire population of the German high-school graduates between 2002 and 2007 we find that enrollment probabilities amongst residents of the states which introduced tuition fees would have been almost 3% higher had tuition fees not been introduced.

1 Introduction

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 into higher-education. Whether enrollment figures are

*email: huebner@uni-mannheim.de

really sensitive to prices remains however an open question. Consequently, a burgeoning amount of effort has been devoted to settle this question empirically (see (Leslie and Brinkman, 1987) and (Heller, 1997) for a survey).

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 study we 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 (henceforth 'fee states') relative to 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 counterfactual 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.

The difference-in-difference strategy applied in this paper 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 have a strong preference for studying in a state other than the state where they graduated from high-school 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.

The results obtained from this formal analysis also have implications for the interpretation of studies relying on cross-state in tuition costs to measure the price-sensitivity of enrollment rates. Typically, these studies have used U.S. data to identify a relationship between aggregate enrollment rates in a state and some measure of tuition costs in that state. Our analysis highlights however that if college graduates are mobile, tuition costs of neighboring states are likely to have an impact on enrollment probabilities too. Given that in 2006 a quarter of high-school freshmen at 4 year colleges in the U.S. were out-of-state students (Planty, Snyder, Provasnik, Kena, R., Ramani, and Kemp, 2008) not controlling for tuition costs in neighboring states might lead to biased estimates.

Interpretating the results obtained from the difference-in-differences analyisis 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. 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.

2 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 in (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 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.

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; 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

$$P_{kt} = \beta X_{kt} + \gamma_k + \nu_t + \epsilon_{kt} \tag{1}$$

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). We will return to the issue of student mobility below, when we analyze the enrollment decision in a simple discrete choice framework. At this stage simply note that 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.

This paper tries to overcome some of these limitations of earlier studies. First, 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 amongst residents in the other states we are able to single out the effect of tuition

fees on enrollment behavior. Using the non-fee states as a control group we are able to net out any secular changes in enrollment behavior as well as unobserved differences between states.

Second, 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 then sample averages, thus overcoming the small sample problems of earlier studies.

Furthermore, in order 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 the theoretical predictions from this model we will be able to correctly interpret the coefficients of our difference-in-difference estimate.

3 Institutional Background

In Germany, tuition fees were legally banned by federal legislation since the implementation of the Hochschulrahmengesetz 1976. In 2005 the German institutional 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, college 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 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.

Furthermore, tuition fees 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, where 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 7 and 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 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 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 educaion 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 universities until they obtain their first degree was 11.1 terms (approximately 5.5 years) in 2006. At technical colleges (*Fachhochschulen*) 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). Note however, it is generally expected that the average time to degree in Germany will decline as a result of implementing the Bologna Process.

4 Data and Empirical Strategy

4.1 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 collect individual information on all enrolled students. 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. Universities report these data to the Federal Statistical Office of Germany (*Statistisches Bundesamt*), which publishes various summary information taken from these individual data.

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

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 high-school graduates in fee and non-fee states are plotted in Fig. 1. We see that transition probabilities in the group of states that inroduced 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.

Data on tuition levels at German state universities, such as shown in Table 6, and the date when state governments passed legislation which introduced these fees were collected by consulting legal texts.

4.2 Estimation Strategy

The empirical approach used in this paper 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.

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

$$P_i = \beta_0 + \beta_1 D_i After_i + \beta_2 After_i + \beta_3 D_i + \epsilon_i \tag{2}$$

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. Differencing enrollment rates across both group of states and time gives

$$\begin{aligned}&(E[P_i|D_i = 1, After_i = 0] - E[P_i|D_i = 1, After_i = 1]) \\ -&(E[P_i|D_i = 0, After_i = 0] - E[P_i|D_i = 0, After_i = 1]) = \beta_1\end{aligned} \tag{3}$$

The quantity β_1 is also referred to as the 'average treatment effect on the treated' (Imbens and Angrist, 1994). It allows us to infer the counterfactual enrollment rate in the fee states; i.e. what the enrollment rate in these states would have been had tuition fees not been introduced.

Note that we obtain the coefficient β_1 by using population means in (3). For instance, using the notation introduced earlier, we calculate the last term in (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 two identifying assumptions: 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. Fig. 1 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.

Second, interpreting β_1 as the full effect on the treated requires 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 mobiliy of high-school graduates both groups are sufficiently differently affected by the introduction of tuition fees, such that the difference-in-difference strategy can be successfully applied. It is this analysis that we now turn to.

4.3 A model of university enrollment

To analyze the demand for higher education in a federation we draw on a model of Huebner (2009). The model considers a federation consisting of two jurisdictions A and B. Within the context of this paper a natural interpretation is to think of these jurisdictions as the fee and non-fee states. For simplicity, I will refer to jurisdiction as 'states'. 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 is larger than the fraction of youth who study abroad. For $\rho = \overline{\theta}$ all youth are completely immobile and enroll in their home state, regardless of the differences in tuition fees between states.

In addition to being able to choose between enrolling into higher education individuals can also decide 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 that a youth in state k enrolls into higher-education is equal to $p^k(f_k, f_j) = s_{kk}(f_k, f_j) + s_{kj}(f_k, f_j)$.

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.

Differentiating the functions for s_{kk} and s_{kj} in (Hübner, 2009) by f_k and evaluating at $f_k = f_j$ we find that if a state k introduces a tuition fee the expected enrollment probability of a youth in that state declines by

$$\frac{\partial p^k}{\partial f_k} = -(\overline{\theta} + \rho)$$

If, on the contrary, tuition fees are introduced in state $j \neq k$, the enrollment probability of a youth in state k reduces by

$$\frac{\partial p^k}{\partial f_j} = -(\overline{\theta} - \rho)$$

This analysis highlights an important point: As long as there is a home bias in student's migration decisions; i.e. $\rho > 0$ the introduction of a tuition fee in a given state reduces the enrollment rate of its own residents more than the enrollment probabilities in the other state. 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 Fig. 3 shows the optimal choice of high-school graduates in a region $k \in \{A, B\}$ 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 $y = w^H - f_k$ the net present value of lifetime income of an in-state student and by $y^* = w^H - f_j$ the net present value of lifetime income of a state k resident who is an out-of-state student in state j.

The left part of Fig. 3 shows a 'status quo' in which neither state levies a tuition fee. Net present value of life-time income of a student is thus independent of where he attends university ($y = y^* = w^H$). Given these income levels individuals with negative migration costs migrate to state j. Amongst the movers individuals with low costs of

attending university become students (s_{kj}) and the remaining movers decide to work (l_{kj}). Similarly, individuals who stay at home also sort into students (s_{kk}) and laborers (l_{kk}) depending on their costs of attending university. The enrollment probability of a state i resident drawn at random from the population corresponds to the area $s_{kk} + s_{kj}$. Furthermore, note that the number of migrating students (area s_{kj}) gets smaller as the home bias ρ increases.

How does the introduction of a tuition fee f in state j change enrollment behavior in state k? To see what happens in this case look at Fig. 3 (middle): We see that only those individuals with a high preference for moving to state j 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 j rather to study abroad, causing the enrollment probability of state k residents to decline by Δp^*.

A similar response is observed when state k instead of j introduces a tuition fee f. Now, individuals with high migration costs are affected by the policy intervention as income y of the students staying at home declines. Consequently, more individuals choose to work at home and the enrollment probability of a state k resident shrinks by 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. This insight lies at the heart of our claim that when one wants to study the demand for higher education it is not only the level of tuition costs in a given state that matter but also differences in tuition fees between states.

Fig. 3 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 (Fig. 3, 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 only 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). In case high-school graduates are completely immobile; i.e. $\rho = \overline{\theta}$, 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 (2) we will then only be able to obtain a lower bound for the effect of tuition fees. Note however that, given the analysis above, the estimated coefficient will be the closer to the full effect the stronger the home

bias of high-school graduates.

In Germany, students are mobile between states, but the home bias in student's migration decisions is sizeable. 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.

5 Estimation Results

Table 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 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 attendence 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 Sec. 4.3 this estimate has to be seen as a lower bound for the true effect.

Table 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

Table 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

Standard errors for the coefficients in (2) can be obtained by estimating (2) with OLS. Table 2 shows the results of this estimation. The coefficients are obtained from population means[1]. Because of the binary dependent variable standard errors are adjusted for heteroskedasticity[2].

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 1. Standard errors are reported in Table 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 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

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

[2] 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}.

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 beore the policy intervention we have already argued that this assumption is not unplausible.

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 (for instance (Kane, 1994)) 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. Fig. 1 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 6 shows, newly enrolled studens 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 shows the difference-in-difference calculations under the assumption that the treatment already begun in 2006. Standard errors and estimates for the full set of coefficients are in Table 4. The results are very similar to our main estimation. As can be seen in Table 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. The average treatment effect on the treated drops slightly to 2.08 percentage points but is of a similar magnitude. 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 cent in 2007. Or, put differently, in the fee states there would have been roughly 5000 more high-school graduates who enrolled at universities in 2007 had tuition fees not been introduced.

Table 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

6 Summary and Conclusion

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 paper adds to the empirical literature trying to identify the impact of tuition fees on enrollment behavior by using the asymmetric 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. (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.

The results should however be interpreted with care. On the one hand, we do not know with certainty whether the reduction in enrollment rates mean that students decided permanently against enrolling into higher education or whether they simply postponed their transition to university. However, it seems difficult to rationalize that tuition

fees lead youth to postpone their entry to university. After all, this would raise opportunity costs of higher education in the form of foregone earnings and thus even reinforce the price-effect of tuition fees.

On the other hand, 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 effects persists in the long-run.

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Table 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

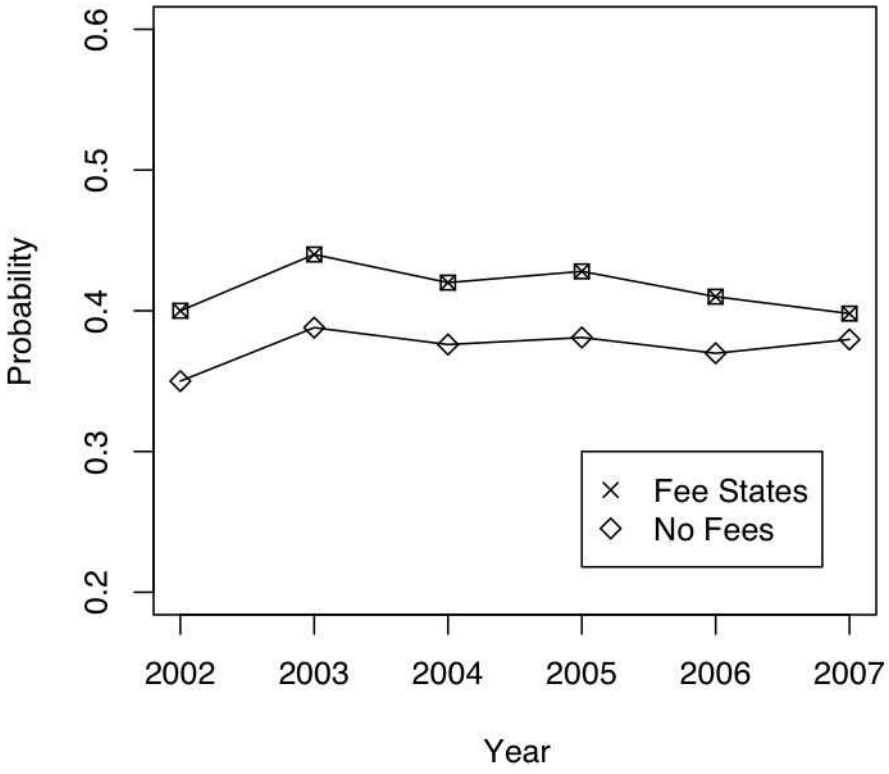

Figure 1: Enrollment probabilities for fee and no fee states between 2002 and 2007

Table 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
NDS	21568	8736	21962	9673	22829	9289	24335	9677	24925	9156	27471	9986
NRW	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											
B	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
MP	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
S	16075	5063	15790	5465	16674	5651	16631	5604	16804	5637	16209	5874
SA	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

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

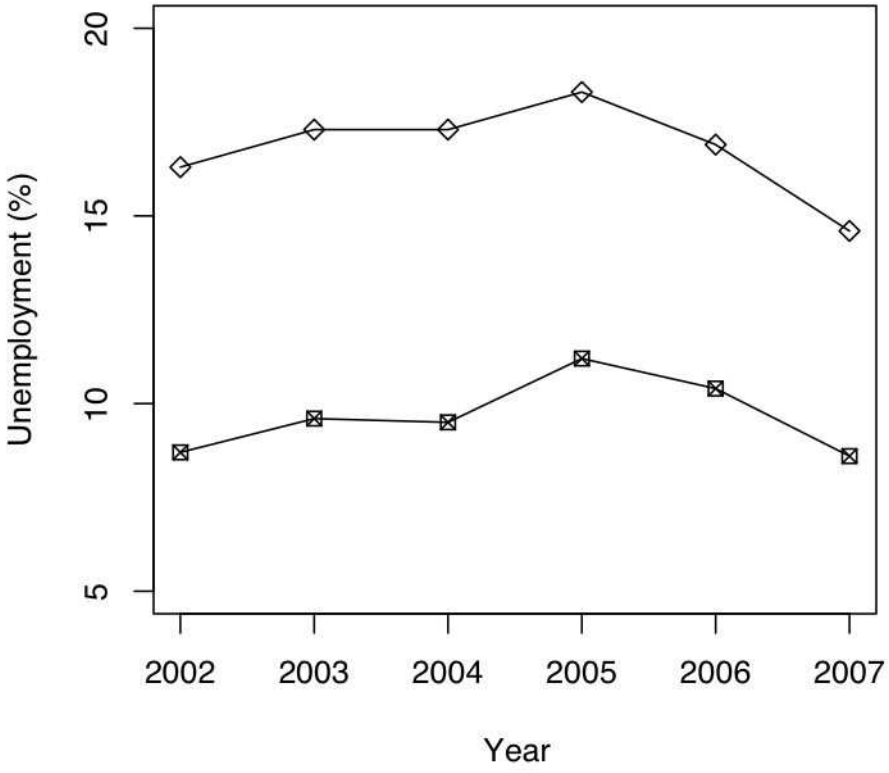

Figure 2: Unemployment rates for fee and no fee states between 2002 and 2007

State	Legislation passed	Average fees in autumn term (€)		
		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	0
Mecklenburg-Vorpommern	./.	0	0	0
Niedersachsen	21.11.2006	0	500	500
Nordrhein-Westfalen	16.03.2006	0	0	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 6: Tuition fees by state for autumn terms 2005-2007

	Tuition Fees (€)		Total number of students enrolled in Autumn Term 2005
University	Spring 07	Autumn 07	
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 7: Tuition fees at universities in Bavaria

	Tuition Fees (€)		Total number of students enrolled in Autumn Term 2005
University	Spring 07	Autumn 07	
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 8: Tuition fees at universities in North Rhine-Westphalia

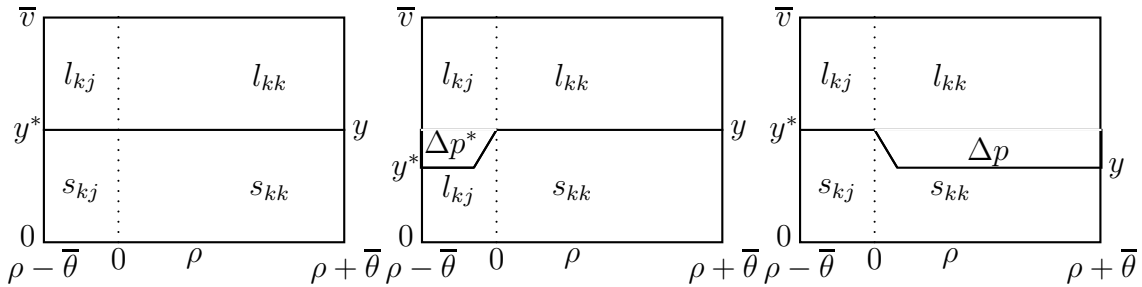

Figure 3: Choices of youth in state k in case no state levies a tuition fee (left). In this case net present value of income of university graduates is $y = y^* = w^H$, regardless whether individuals study in k or j. If state j introduces a tuition fee f, income of university graduates declines to $y^* = w^H - f$. As a consequence, the number of students in state k who enroll into higher education shrinks by Δp^* (middle). If tuition fees are introduced in state i instead, income of graduates in state k drops to $y = w^H - f$ (right). The number of students falls by Δp. The decline is stronger than in the case where tution fees are introduced in state j.