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Do Tuition Fees Affect the Mobility of University Applicants? Evidence from a Natural Experiment

Nadja Dwenger* Johanna Storck† Katharina Wrohlich‡

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Abstract: Several German states recently introduced tuition fees for university education. We investigate whether these tuition fees influence the mobility of university applicants. Based on administrative data of applicants for medical schools in Germany, we estimate the effect of tuition fees on the probability of applying for a university in the home state. We find a small but significant reaction: The probability of applying for a university in the home state falls by 2 percentage points (baseline: 69%) for high-school graduates who come from a state with tuition fees. Moreover, we find that students with lower high-school grades react more strongly to tuition fees. This might have important effects on the composition of students across states.

Keywords: mobility of high-school graduates, tuition fees, natural experiment
JEL-classification: I22, I28, H75, R23

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1 Introduction

Education at public universities has been free of charge for the past 30 years in Germany. Recently, however, several German states re-introduced tuition fees amounting to 1,000 euro per year. In this paper we want to analyze whether the introduction of tuition fees affected the mobility of university applicants. In particular, we are interested in the question whether applicants from states that introduced tuition fees have a lower probability of applying at a university in their home state.

This question is interesting from a political and from a theoretical point of view. All German high-school alumni are allowed to apply for universities all over Germany. If the introduction of tuition fees by selected states affect the mobility of university applicants in such a way that universities in tuition fee states are avoided, applicants from states that did not introduce fees might have a lower probability to be admitted to a university in their home state. Furthermore, if tuition fees affect groups of university applicants in different ways, the policy might also influence the composition of students across states.

In the theoretical literature on education policy and fiscal federalism many models rely on assumptions concerning the mobility of high-school graduates, or more generally, the mobility of university applicants. For example, one typical question in this context addresses the issue whether centralized or de-centralized financing of universities is optimal (e.g., Schwager, 2007). Another example is the question whether tuition fees improve the quality of higher education (e.g., Kemnitz, 2005; Huebner, 2009). In these models the assumptions concerning mobility of university applicants crucially determine the results. Our analysis goes one step behind and investigates whether the mobility behavior of university applicants is actually affected by policy changes.

Empirical studies on the effect of tuition fees on student mobility are so far mainly based on data from the United States. In the US tuition fees vary widely across states and between universities. Further, all public universities charge out-of-state students with higher tuition fees (non-resident fee) than in-state students. The argument for this is that states are not willing to subsidize the university education of children of non-residents.

Empirical results on the sign of the effect of tuition fees on enrolment are ambiguous: On the one hand, high fees may represent important academic heritage and prestige, offering greater potential future earnings to its graduates.[1] On the other

[1]For instance, Rizzo and Ehrenberg (2003) find that an institution's quality influences the

hand, high tuition raises the cost of attending certain universities (price effect).

Research on student mobility has started with Tuckman (1970), who finds that student out-migration rates vary positively with average tuition fees charged to residents within a particular state. Mixon (1992) updates the data gathered by Tuckman and finds that the effect of tuition fees on out-migration remains significantly positive. Also the study by Morgan (1983), who jointly estimates non-resident tuition rates and the non-resident student's demand for higher education, concludes that students who consider to attend out-of-state universities are significantly deterred by tuition fees. By contrast, employing cross-sectional information on student state-to-state migration flows and controlling for quality and economic conditions, McHugh and Morgan (1984) find an insignificant effect of non-resident tuition fees on enrollment by non-resident high-school graduates. In a study based on university-level data Mixon and Hsing (1994) analyze the determinants of the ratio of resident to non-resident students for a sample of public and private academic institutions. They estimate a positive effect of non-resident tuition fees on enrollment by out-of-state high-school graduates. Their results suggest that tuition acts as a "signal" for university prestige that prevails over the price effect of non-resident tuition fees. In a more recent study Dotterweich and Baryla (2005) employ a data set which contains both information on universities and information on the economic conditions of their regional environments. Similar to the earlier studies they come up with a positive relation between non-resident enrollment and tuition in private institutions, while no significant relationship seems to exist in public institutions.

The mixed empirical evidence from the US does not allow to make clear predictions about how the introduction of tuition fees in some but not all federal states in Germany might affect applicants' mobility. Moreover, the institutional background is very different in Germany, where tuition fees are much lower and private universities play only a very minor role.

Table A1 in the appendix shows that German students are relatively immobile. In 2003 in all German states, except for Brandenburg, the majority of first year students studied in the federal state where they had obtained their high-school leaving degree. In Bavaria, Baden-Württemberg, and Saxony, this share was even larger: In these states, more than 70% of first year students studied at a home university. If individuals decide to take up their studies in another state, they mostly choose their neighboring state. The share of high-school graduates moving beyond the bordering state is below 5% (cf. Figure A1 in the appendix; an exception are students

in-state and out-of-state tuition level.

from Saarland). Moreover, there is neither significant migration from the western states of Germany to eastern states nor vice versa. Only a very small number of students from the eastern states Mecklenburg-Western Pomerania, Saxony-Anhalt, and Thuringia move to western states (although even in this case, these shares are below 10%).

Evidence for the importance of the closeness to home in the choice of the university also comes from surveys among students. Heine et al. (2008) report that 75% of all first semester students state that the closeness to home is one important determinant in the choice of university.[2] All this evidence shows that - although there is some mobility, in particular into neighboring states and city states - the majority of university applicants chooses a university in their home country.

The question that we analyze in our paper is whether there is a mobility reaction to state-specific education policy differences, in particular tuition fees. We exploit the "natural experiment" character of the introduction of tuition fees, that have not been introduced in all states but in only 6 out of 16. Based on data on applicants for medical school by the central clearing house (ZVS) we use a difference-in-difference strategy in order to estimate the effect of the introduction of tuition fees on the probability to study in one's home state. Our findings show that in fact, university applicants from "fee states" have a significantly lower probability of applying at a university in their home state after tuition fees were introduced. The reaction is stronger for men than for women and for applicants with lower high-school grades.

The remainder of the paper is organized as follows: The next section describes the introduction of tuition fees and the corresponding public discussion in Germany. After that, we present our methodological approach and data base in more detail in Section 3. Section 4 shows the results and Section 5 concludes.

2 Institutional Background

In the end of the 1960s tuition fees for students at state universities were abolished in all German states. A few years later, fees were legally banned by federal legislation. From that time on students in Germany only had to pay a small enrollment fee of less than 100 euro per term for admission to a state university. However, in

[2]More indirect evidence on the immobility of German high-school graduates is provided in a study by Spiess and Wrohlich (2009). The authors show that the distance to the nearest university at the time of the high-school leaving exam significantly affects the decision to apply for a university.

May 2003 six federal states[3] with a conservative government filed a constitutional law suite against the nationwide ban of tuition fees. In January 2005 the Federal Constitutional Court of Germany ruled that the law against tuition fees interfered with the rights of the German federal states to determine their education policies. Thus, federal states can decide on the implementation of tuition fees in their federal territory autonomously.

At the time the judgment about tuition fees was made the conservative federal governments of Bavaria, Baden-Württemberg, Hamburg, Lower Saxony, and Saarland announced to implement tuition fees.[4] In federal states with a governing coalition of the conservative (CDU) and social democratic party (SPD), the SPD strongly rejected tuition fees. For that reason the implementation of fees in these states (Saxony-Anhalt, Saxony) was not to be expected. Hence, after the ruling of the court in January 2005 high-school graduates could anticipate that Bavaria, Baden-Württemberg, Hamburg, Lower Saxony, and Saarland would pass legislations to implement tuition fees, while the situation in Hesse was unclear. Until May 2005 the social democratic government in North Rhine-Westphalia still strongly rejected fees, but a government change in May 2005 changed the situation and the new conservative government announced to introduce tuition fees as soon as possible.

Lower Saxony and North Rhine-Westphalia were the first to charge tuition fees in the fall term of 2006. Baden-Württemberg, Bavaria, and Hamburg followed in the spring term of 2007. Saarland completed the process of implementing tuition fees in the fall term of 2007. Hesse also imposed fees in the fall term of 2007, but the fees were again disestablished in the next year. So far the other states[5] have neither started any legal action to introduce fees in their states nor could tuition fees be expected from the public debate in these states.

Despite the fact that states have the undivided power to decide on tuition fees, fees have been rather uniform across the states that introduced fees. Most students have to pay a fee of 500 euro per term, leading to an investment of 1000 euro per academic year. In Bavaria and North Rhine-Westphalia the implementation of tuition fees is decentralized, meaning that universities decide on the fees autonomously.

[3]Baden-Württemberg, Bavaria, Hamburg, Saarland, Saxony, and Saxony-Anhalt.

[4]Thuringia was also governed by the conservative party in 2005. Still, Thuringia's prime minister declared not to raise tuition fees for university students. Hesse's conservative government was in favor of tuition fees, but inferences with the federal constitution constrained the political decision-making on tuition-fees.

[5]Mecklenburg-Western Pomerania, Rhineland-Palatinate, Schleswig-Holstein, Bremen, Brandenburg, Saxony, Saxony-Anhalt, and Thuringia.

Still, most universities in these states charge 500 euro.[6]

The legal and political discussion about tuition fees was highly visible in the media. Nationwide newspapers and magazines as *"UniSpiegel"* and the *"Frankfurter SonntagsZeitung" (FAS)*, among others, continuously published dossiers on the political debate on tuition fees and actively released estimates on where and when fees were going to be imposed. Shortly before the Constitutional Court's ruling, the *"FAS"* published an overview of the federal plans suggesting that Bavaria, Baden-Württemberg, Hamburg, Lower Saxony, North Rhine-Westphalia, Saarland, and Saxony-Anhalt would be raising tuition fees, while Hesse's plans were described as ambiguous. The same situation was predicted in March of the same year by the magazine "*StudiInfo*", that is distributed by the central clearing house.[7] A regularly up-dated dossier in the online edition of *"UniSpiegel"* has summarized all actions and decisions made in the process of the implementation. For an overview of the public debate and the states where tuition fees were actually introduced see Table 1.

University applicants who applied for university in May-July 2005 were the first cohort to know with certainty that they will have to pay tuition fees for their studies in some federal states, while studying will continue to be free of charge in other states. Furthermore, they could distinguish between states charging tuition fees in the near future and states without plans to impose fees.

3 Estimation Strategy and Data

In order to evaluate the effect of the introduction of tuition fees on the mobility of university applicants we exploit the variation in the introduction of tuition fees across states as a "natural experiment". As usual in the evaluation literature, we cannot observe the behavior Y_i of an individual (in our case, the decision to apply for a university in one's home state) under both scenarios, with and without treatment. However, we argue that we can take treatment, i.e., living in a state that introduced tuition fees, as exogenous and can therefore compare the average behavior of individuals living in the two different state groups. Let us denote the behavior of individuals who live in states that introduced tuition fees $Y_i|G = 1$ and

[6] Only two universities that have a medical school charge lower fees of 350 euro and 275 euro (Bielefeld and Münster in North Rhine-Westphalia).

[7] All high-school graduates who wish to apply for medical school in Germany have to apply at a central clearing house called "*Zentralstelle für die Vergabe von Studienplätzen*" *(ZVS)*. See next section.

Table 1: Public debate on tuition fees

	Estimates after the Ruling (26.01.2005)			Actual Development
State	FAS (Jan 2005)	StudiInfo (March 2005)	UniSpiegel (May 2005)	Fees since
Baden-Württemberg	X	X	X	Spring 2007
Bavaria	X	X	X	Spring 2007
Hesse	?	X	?	Fall 2007-Fall 08
Hamburg	X	X	X	Spring 2007
Lower-Saxony	X	X	X	Fall 2006
North Rhine-Westph.	–	–	X	Fall 2006
Saaarland	X	X	X	Fall 2007
Rhineland-Palatinate	–	–	–	–
Saxony-Anhalt	?	X	–	–
Berlin	–	–	–	–
Brandenburg	–	–	–	–
Bremen	?	–	–	–
Mecklenb.-Western P.	–	–	–	–
Saxony	–	–	–	–
Thuringia	–	–	–	–
Schleswig-Holstein	–	–	–	–

Sources: Frankfurter Allgemeine Sonntagszeitung, 23.01.2005, Nr.3; StudiInfo, issue Wintersemester 2005/06, "Wieviel kostet das Bezahlstudium"; UniSpiegel online (http://www.spiegel.de/unispiegel/studium/).
Description: (X/?/–) indicates fees expected/unclear/no fees expected.

the behavior of those who live in the other group of states as $Y_i|G = 0$. The effect of treatment G on the application behavior could then be calculated by comparing the average behavior across groups, i.e., $(\overline{Y}|G = 1) - (\overline{Y}|G = 0)$. However, if "state effects" are present that are common to the group of states that introduced tuition fees, this difference does not give the causal effect of introducing tuition fees. In order to control for this potential common state effect, we employ a difference-in-difference strategy that eliminates all time-invariant differences. Let us denote the period before treatment as $T = 0$ and the period after treatment as $T = 1$. Then we can calculate the effect of tuition fees Δ as

$$\begin{aligned} \Delta &= \big((\overline{Y}|G = 1, T = 1) - (\overline{Y}|G = 0, T = 1)\big) \\ &\quad - \big((\overline{Y}|G = 1, T = 0) - (\overline{Y}|G = 0, T = 0)\big) . \end{aligned} \tag{1}$$

We argue that all university applicants living in a state that was considered to introduce tuition fees in the latest newspaper article ("*UniSpiegel*") were subject to treatment after the Constitutional Court's decision in January 2005. In spring 2005, it was known that these states would start legal procedures to introduce tuition fees. Since tuition fees have to be paid over the whole time of studying and not only at the beginning, we argue that there is a treatment effect already for those who applied for university in spring 2005. We will later also perform sensitivity checks to see

whether a treatment effect can be found later, when the states had actually started to levy tuition fees, which was fall term 2006 in Northrhine-Westphalia and Lower Saxony and 2007 in the other "tuition states".

Note that one problem with our identification strategy is that up to the extent that university applicants are mobile, also individuals in the control group might be affected by the reform. Applying in (non-home) states that introduced tuition fees likely became less attractive after the reform. As a consequence, the probability of applying at a university in the home state might have also increased for individuals in states of the control group due to the reform. If this is the case, our estimation yields an upper bound of the true effect on the treated individuals. However, we argue that we get a result close to the true effect by taking advantage of the fact that there is only very little migration from east German applicants to western states and vice versa, although there is migration within both group of states (cf. Figure A1 in the appendix). Since no east German state introduced the fees, we can alternatively define the control group consisting only of states in east Germany in order to get a result that is closer to the true effect. We will refer to this point below.

Our difference-in-difference analysis of the effect of tuition fees on applicants' mobility requires a broad data set including all federal states. We have access to a database of the German central clearing house (ZVS) covering applications for the years 2002 to 2008. The following six subjects are centrally administered and part of our data set: medicine, pharmacy, animal health, dentistry, psychology, and biology. For these subjects, the data set is comprehensive, since all individuals who want to study one of these subjects necessarily have to apply with the central clearing house. Applicants between 2002 and 2004 were allowed to apply for two subjects at a time. In that case we only include the first subject choice of the applicant to avoid multiple counting. Multiple applications have not been possible between 2005 and 2008.

Note that one advantage of these data is that they contain information on true preferences of applicants, i.e., the universities they want to go, not actually chosen universities, which might be affected by supply side constraints. To determine the effect of tuition fees on applicants' mobility, we define the variable "home application" if a person applies to a university which is located in the federal state she passed her high-school diploma in. This measure is based on applicants' first preference.[8] This seems justified as the first-ranked university is of great importance in the application

[8]Every applicant may rank up to six universities she applies to. Further, individuals may apply within three procedures applied sequentially. We only consider the first preference in the first procedure (procedure A). If an individual does not apply in procedure A, the first preference in Procedure U is taken.

because the allocation of seats at university follows a priority-based mechanism.[9]

In addition to information about university preferences and home state of the applicants, the data set records individual characteristics such as average grade in the high-school diploma, age, and sex. For our empirical analysis, we only keep applicants for medicine and dentistry. Psychology and biology were affected by the introduction of bachelor studies within the Bologna process and seats for bachelor students are no longer centrally administered. We further exclude animal health because animal health can only be studied in four of the German federal states, i.e., not all applicants have the chance to study this subject at a home university.

Since applicants who have not received their university entrance diploma in Germany can never be "home applicants", we exclude these individuals from our data set. We further exclude applicants from Brandenburg and Bremen because they cannot apply in their home federal state as there are no medical schools located in these two states. By far most of the students start studying in fall;[10] we therefore restrict our analysis to applications for the fall term. This leaves us with a total number of 239,365 individuals over the years 2002 to 2008.

Table 2 shows the distribution of applicants across federal states. The upper panel of Table 2 shows the number of applicants living in states without tuition fees while the lower part gives the corresponding information for federal states charging fees. As we can see from the table, about one-third of the individuals (78,905) live in a state without tuition fees, while about two-third (160,460) live in a federal state charging tuition fees. In the group of those living in a state without tuition fees 44,258 individuals apply for a university within their home state, and another 34,647 apply for a university located outside their home state. In the other group, 107,296 individuals apply within their home state and 53,164 outside their home state.

As pointed out earlier most individuals apply for a university located in their home state. This is also what we find in the present data set. Over all years and states, 63% of applicants in our data set rank a university in their home state as first preference. There are only a few states, namely Hesse, Rhineland-Palatinate,

[9] As is extensively discussed in Braun et al. (2007) the first preference in the first procedure should not be subject to strategic behavior of the applicants. This is because applicants who are admitted in the first procedure are not allowed to take part in the following two procedures even though these applicants generally have very good chances of being admitted to their preferred university in the last procedure (procedure U).

[10] This is because not all universities offer admission in spring and because high-school graduates in Germany are awarded their A-levels in May and June shortly before application deadlines for the fall term in July.

Table 2: Number of applicants across federal states before/after the introduction of tuition fees

Homes state	"Home" applicants		"Non-Home" applicants		
	before (2002-2004)	after (2005-2008)	before (2002-2004)	after (2005-2008)	Total
Berlin	3,796	5,399	648	2,224	12,067
Hesse	3,398	4,760	3,167	5,613	16,938
Mecklenburg-Western Pomeria	1,112	2,003	551	1,166	4,832
Rhineland-Palatinate	1,725	2,227	2,082	3,868	9,902
Saxony	3,619	5,235	1,168	2,902	12,924
Saxony-Anhalt	1,294	2,423	1,055	2,103	6,875
Schleswig-Holstein	1,499	2,155	1,504	2,779	7,937
Thuringia	1,598	2,015	1,265	2,552	7,430
Without tuition fees	**18,041**	**26,217**	**11,440**	**23,207**	**78,905**
Baden-Wuerttemberg	11,149	14,086	3,408	8,903	37,546
Bavaria	11,017	14,310	3,053	7,286	35,666
Free and Hanseatic					6,286
City of Hamburg	1,916	2,434	509	1,427	6,286
Lower Saxony	4,695	6,870	3,887	7,601	23,053
North Rhine-Westphalia	16,211	22,700	4,705	11,262	54,878
Saarland	815	1,093	298	825	3,031
With tuition fees	**45,803**	**61,493**	**15,860**	**37,304**	**160,460**
Total	**63,844**	**87,710**	**27,300**	**60,511**	**239,365**

Source: ZVS data on applicants, waves 2002 to 2008 (fall term).

Schleswig-Holstein, and Thuringia, in which more individuals apply to non-home universities. Interestingly, applicants in federal states charging tuition fees seem to be particularly immobile; among these federal states, there is none whose students by majority apply in another federal state. Similar to the overall picture of mobility, applicants for medical school migrate within eastern and within western Germany but there is nearly no exchange between these two parts (cf. Figure A2 in the appendix).

In addition to the total number of applicants, we are also interested in differences in personal characteristics of applicants to control for changes in the composition of applicants over time and to analyze the effect of tuition fees on the behavior of sub-groups of applicants. Table 3 contrasts the characteristics of those individuals living in a state without tuition fees and those living in a state with tuition fees. It further distinguishes the time period before and after the introduction of tuition fees in some federal states. From Table 3 we can see that there are no important differences between the group of controls and the treated. The average applicant is about 21 years old. Further, average grades for the treatment and the control group are virtually identical. The average applicant has a grade of 2.3.[11]

[11]In Germany grades are measured on a 1 to 6 scale with 1.0 being the top grade. The lowest passing grade is 4.0. The last column of the table displays the share of applicants in the different

Table 3: Descriptive statistics

Personal characteristics	Control group (without tuition fees)		Treatment group (with tuition fees)		
	before (2002-2004)	after (2005-2008)	before (2002-2004)	after (2005-2008)	Total share
Age (years)	21.113	21.236	21.368	21.406	-
	(2.785)	(2.883)	(2.847)	(2.788)	
Male	0.370	0.360	0.424	0.403	39.53%
	(0.483)	(0.480)	(0.494)	(0.490)	
Grade	2.320	2.218	2.394	2.286	-
	(0.629))	(0.6250)	(0.633)	(0.625)	
Grade group 1: 1.0 - 1.5	1.229	1.233	1.227	1.221	9.77%
	(0.142)	(0.142)	(0.144)	(0.147)	
Grade group 2: 1.6 - 2.0	1.718	1.724	1.718	1.727	20.31%
	(0.139)	(0.140)	(0.140)	(0.142)	
Grade group 3: 2.1 - 2.5	2.205	2.194	2.209	2.196	28.40%
	(0.140)	(0.141)	(0.138)	(0.139)	
Grade group 4: 2.5 - 3.0	2.688	2.679	2.691	2.686	24.47%
	(0.140)	(0.140)	(0.141)	(0.140)	
Grade group 5: 3.0 - 4.0	3.232	3.221	3.247	3.245	17.05%
	(0.191)	(0.191)	(0.203)	(0.203)	
Total	29,481	49,424	61,663	98,797	239,365

Source: ZVS data on applicants, waves 2002 to 2008 (fall term). Standard deviation in parentheses.

4 Results

To identify the effect of tuition fees on the mobility of applicants who graduated from high school in a state where fees were implemented, we estimate the probability that a person applies for a university in his or her home state using probit models. Let y_i^* denote a latent variable such as the propensity to apply for a university in own's home state (see equation 2). According to the difference-in-difference strategy explained in Section 3, the explanatory variables include a dummy variable indicating the period after the introduction of the tuition fees ("after"), a dummy variable indicating the group of states that introduced fees ("fee state") as well as an interaction term of the two. The coefficient of this interaction term, β_3, gives the causal effect of tuition fees on the probability to apply in one's home state. Furthermore, we control for sex, age, grade of the high-school diploma as well as for an overall time trend, summarized in X_i. The vector of control variables moreover includes the variable "top university". This is a dummy variable indicating if an individual comes from Bavaria, Baden-Württemberg or Berlin. We restrict "top universities" to these three states, since the medical schools ranked best are located in these states.[12] Therefore, applicants from these states might have a higher probability to stay in

grade groups.

[12]CHE UniversityRanking for medical school, year 2006.

their home state, since it offers one of the best or most popular medical schools. ε_i is an error term following a normal distribution.

$$y_i^* = \beta_1 * after_i + \beta_2 * feestate_i + \beta_3 * after \times feestate_i + \gamma' X_i + \varepsilon_i, \qquad (2)$$

Table 4 summarizes the main estimation results (marginal effects). First of all, we find that applicants from "fee states" have generally a higher probability to apply for a university at home, as has already been suggested by the descriptive statistics in Section 3. Second, there seems to be a general time trend in that mobility in all states is higher in the years after tuition fees have been announced in some states. The interaction term of the two variables is strongly significant and indicates that on top of that trend, applicants from fee states have a significantly lower probability to apply for a university in their home state.[13] This probability is reduced by roughly 3 percentage points (baseline 63%).

This result is robust to different definitions of the treatment group. Table 4 also shows estimation results when we change the treatment period from 2005-2008 (basic model) to 2006-2008 (columns 3 and 4) and 2007-2008 (columns 5 and 6), respectively. We estimate these specifications to check whether the actual introduction of the tuition fees has an additional effect on top of the "announcement effect". We do not find support for this hypothesis, since the interaction term is roughly of the same magnitude as in the first specification. Also the effect of the control variables such as sex and grade of the high-school diploma is constant across the three different specifications. We find that applicants with very good grades (grade category 1) have a lower probability to apply in their home state than applicants with lower grades. As expected, applicants living in a state with at least one top-ranked medical school have a higher probability to apply at home.

As mentioned earlier, up to the extent that university applicants in the control group have been mobile and applied in a different state (now charging tuition fees) than their home state before the reform, we are overestimating the true effect on the treated individuals. However, we argue that, since there is very little east-west or west-east migration, we can confine our control group to eastern states and get an estimate that should be close to the true effect. As Figure A2 in the appendix shows, the migration flows of medical school applicants are not different from those of all first year students. Most migration is observed between neighboring states

[13] Following Ai and Norton (2003) we calculate the marginal effect of the interaction term as $\Phi(\widehat{\beta}_{feestate} + \widehat{\beta}_{after} + \widehat{\beta}_{after \times feestate} + \widehat{\gamma}'\overline{X}) - \Phi(\widehat{\beta}_{feestate} + \widehat{\gamma}'\overline{X}) - \Phi(\widehat{\beta}_{after} + \widehat{\gamma}'\overline{X}) + \Phi(\widehat{\gamma}'\overline{X})$ where Φ is the cdf of the normal distribution. The corresponding standard errors are calculated using the Delta method.

Table 4: Estimation results (marginal effects)

Treatment period	Basic Model 2005-2008		Sensitivity check 1 2006-2008		Sensitivity check 2 2007-2008	
Variable	Marg. Eff.	Std. Err.	Marg. Eff.	Std. Err.	Marg. Eff.	Std. Err.
Fee State	0.1218***	0.0037	0.120***	0.0038	0.1157***	0.0038
After	-0.1528***	0.0054	-0.165***	0.0058	-0.1623***	0.0062
After * Fee State	-0.031***	0.0042	-0.0220***	0.0045	-0.0273***	0.0005
Male	-0.0074***	0.0021	-0.0060***	0.0023	-0.0066***	0.0025
Age	0.0003	0.0004	0.0003	0.0005	-0.0003	0.0005
Top Universtity	0.0381***	0.0024	0.0414***	0.0027	0.0475***	0.0029
Grade[1]						
1.0-1.5	-0.0108**	0.0042	-0.0114**	0.0046	-0.0182***	0.0051
1.6-2.0	-0.0019	0.0035	-0.0046	0.0038	-0.0078	0.0042
2.1-2.5	-0.0462***	0.0032	-0.0462***	0.0035	-0.0425***	0.0039
2.5-3.0	-0.0295***	0.0032	-0.0265***	0.0035	-0.0244***	0.0039
Year Dummies						
fall 2003	-0.0142***	0.0043	-0.0142***	0.0043	-0.0142***	0.0043
fall 2004	-0.0135***	0.0042	-0.0134***	0.0042	-0.0134***	0.0041
fall 2005	0.0508***	0.0034	–	–	–	–
fall 2006	0.0238***	0.0036	0.0217***	0.0037	–	–
fall 2007	0.0058*	0.0036	0.0038	0.0037	0.0043	0.0037
Procedure A[2]	0.0548***	0.0039	0.0623***	0.0044	0.0594***	0.0046
Number of Observations	239,365		199,459		163,861	

Source: Estimations based on ZVS data on applicants, waves 2002 to 2008 (fall term).
(***/**/*/): indicates significance at the 1%- / 5%- / 10%-level. Control group in all three specifications: years 2002 to 2004.

[1] Grades in high-school diploma. Declining from 1 to 4. Grade group 5 with grades 3.0 to 4.0 serves as base category.

[2] As noted earlier we only consider the first preference of applicants. This first preference stems from procedure A where applicants with excellent grades have a very good chance of being admitted to their preferred university or from procedure U which allows universities to admit students according to their own preferences (for details on these procedures cf. Braun et al., 2007). Since there may be differences across procedures, we control for the procedure preferences have been stated for.

and there is very few east-west or west-east migration.

Thus, in Table 5, we show estimation results where the three western states without tuition fees, i.e., Hesse, Rhineland-Palatinate, and Schleswig-Holstein, are excluded. Indeed, compared to the previous results, the marginal effect of the interaction term capturing treatment is smaller in this case, indicating that including the western states in the control group leads to an upward bias of the true effect. The interaction term, however, is still strongly significant and shows that the introduction of tuition fees reduces the probability of an applicant from a tuition fee state to apply at home by 2 percentage points (baseline 69%).[14] We argue that this estimate comes close to the true effect, since there has been relatively little migration from eastern to western states before the reform.

In the next step, we further exploit information on individual characteristics available in our data set and check for heterogenous effects for applicants with different grades. We estimate a model in which we additionally interact the interaction term of "fee-state" and "after" with dummy variables indicating different grade groups. As can be seen from the results summarized in Table 6, we find that applicants with very good grades (average grades 1.0 - 1.5) have an even higher probability of applying in their home state than they would have had in a scenario without tuition fees. On the other hand, applicants whose grades are worse have a higher probability of applying in another state. This implies that applicants with very good grades are more willing to pay the tuition fee and/or are less willing to leave their home state, despite the fee. The reason might be that they are more confident in their ability to complete university and find a high-income job. Another explanation could be that good students believe that the introduction of tuition fees will increase the quality of universities in tuition states and therefore choose those universities. Several universities waive students with stipends and with the best grades in the first university exams from fees; since grades in the high-school diploma are probably correlated with grades in university exams and with the probability of obtaining a stipend, it is also possible that excellent applicants hope for being exempted and hence more weakly react to the introduction of fees. Grades in the high-school diploma might also be correlated with parental income, which

[14] Another sensitivity check we performed is an estimation where Sachsen-Anhalt is left out of the control group, since in the year 2007, the number of high-school graduates doubled due to a schooling reform. In this case, the point estimate is a bit lower, however not statistically significantly different from the one reported above. Moreover, we performed a so-called "placebo-treatment" exercise where we randomly assigned states from the control group into a placebo treatment group (see Table A4 in the Appendix). We do not find significant effects of the placebo reform.

Table 5: Estimation results with eastern states as control group (marginal effects)

Variable	Marg. Eff.	Std. Err.
Fee State	0.0196***	0.0045
After	-0.1756***	0.0061
After * Fee State	-0.0207***	0.0049
Male	-0.0028	0.0022
Age	0.0004	0.0004
Top Universtity	0.0370***	0.0024
Grade[1]		
1.0-1.5	-0.0027	0.0045
1.6-2.0	-0.0062*	0.0037
2.1-2.5	-0.0589***	0.0034
2.5-3.0	-0.0353***	0.0035
Year Dummies		
fall 2003	0.0221***	0.0047
fall 2004	0.0223***	0.0045
fall 2005	0.0456***	0.0036
fall 2006	0.0242***	0.0038
fall 2007	0.0072*	0.0038
procedure A[2]	0.0540***	0.0041
Number of Observations	204,588	

Source: Estimations based on ZVS adiministrative data, waves 2002 to 2008 (fall term).

(*/**/***): indicates significance at the 1%- / 5%- / 10%-level.

[1] Grades in high-school diploma. Declining from 1 to 4. Grade group 5 with grades 3.0 to 4.0 serves as base category.

[2] As noted earlier we only consider the first preference of applicants. This first preference stems from procedure A where applicants with excellent grades have a very good chance of being admitted to their preferred university or from procedure U which allows universities to admit students according to their own preferences (for details on these procedures cf. Braun et al., 2007). Since there may be differences across procedures, we control for the procedure preferences have been stated for.

Table 6: Estimation results with eastern states as control group (marginal effects): by grade

Variable	Marginal Effect[1]	Standard Error
Grade1 * After * Fee State	0.0850***	0.0082
Grade2 * After * Fee State	0.0011	0.0064
Grade3 * After * Fee State	-0.0596***	0.0061
Grade4 * After * Fee State	-0.0458***	0.0063
Grade5 * After * Fee State	-0.0093	0.0069

Source: Estimations based on ZVS data on applicants, waves 2002 to 2008 (fall term).
(***/**/*): indicates significance at the 1%- / 5%- / 10%-level.
[1] Calculation based on the results presented in Table A3 in the appendix.

possibly also prevents very good, i.e., richer applicants from a reaction on the introduction of tuition fees.

While we can only speculate about the reason for the heterogenous effects, tuition fees in some but not all states certainly have consequences for the composition of students in universities across Germany. If the "high ability" students stay in the tuition states, universities in states without fees are left with the "less able" students or, more exactly, are only able to attract "less able" students. This could in turn amplify the process of implementing "Elite-Universities". Besides, we find that men are more responsive to the introduction of tuition fees than women are.[15]

5 Conclusion

This paper contributes to the small empirical literature on changes in applicants' mobility if tuition fees are introduced. Knowing the size of applicants' reaction is important from both a political and an academic point of view. Politically, it is of great interest since all German high-school graduates are allowed to nationwide apply for universities. If the mobility of university applicants is affected in such a way that universities in tuition fee states are avoided, this may entail higher costs for those states who did not introduce tuition fees. Since applicants may react differently depending on their personal characteristics, tuition fees might also affect the composition of applicants.

We estimate the size of applicants' reaction by exploiting a "natural experiment". In particular, we take advantage of the fact that recently, several but not all federal states in Germany introduced tuition fees. Arguing that the treatment, i.e., living in a state that introduced tuition fees, is exogenous we use a difference-in-difference

[15] More detailed results on this finding can be obtained from the authors upon request.

approach to obtain the causal effect of fees on the probability to apply for a university in one's home state. In so far as, before the reform, individuals from non-fee states had applied in states nowadays charging fees and have been deterred from doing so after the reform, we overestimate the true effect. However, we argue that we get a result close to the true effect by taking advantage of the fact that there is only very little migration from east German applicants to western states and vice versa. We thus define the control group consisting only of states in east Germany in order to get a result that is close to the true effect. We find that applicants from fee states have a significantly lower probability of applying for a university in their home state once tuition fees have been introduced. The probability of applying at home is reduced by roughly 2 percentage points (baseline probability 69%).

As our results show, this average effect in fact hides important differences between individuals. For example, we find that applicants with lower high-school grades react more strongly to the introduction of fees and are more likely to apply in a non-home state. In contrast, applicants with excellent high-school grades even have a higher probability to stay in their home state after tuition fees have been introduced. These heterogenous behavioral effects lead to differences in the composition of students across states. In particular, this implies that the advantage of "fee states" is twofold. First, they increase their budget by collecting fees, and second, they attract applicants with better grades.

Against this background, the political discussion on centralized versus de-centralized finance of higher education is likely to continue. It might be that other federal states will follow and introduce general tuition fees. Another possibility is that the idea of non-fee states to introduce fees for non-resident applicants (so-called "Landeskinderregelung") might regain importance. Such a regulation has shortly been in place in Hamburg. The criteria, however, whether fees had to be paid were not conditioned on the state of the high-school exam but rather the residential state of the applicant ("Hauptwohnsitz"). By moving to Hamburg, thus, every applicant could avoid the fees. In the United States, all public research institutions charge out-of-state students higher tuition fees than in-state students, presumably because state taxpayers do not want to subsidize higher education of non-taxpayers from other states. Several states in the US have combined this price discrimination between in-state and out-of-state residents with reciprocity agreements between neighboring states that allow non-resident students from a neighboring state to attend the public institution at less than the normal out-of-state (see Rizzo and Ehrenberg, 2003). In the German context, such agreements might be interesting for small states who

cannot afford to offer university education in all subjects and might also encourage universities to achieve cost efficiencies by specialization. Another possibility to compensate non-fee states for additional non-resident students' enrollment might be a reform of the financial equalization scheme that takes university education into account.

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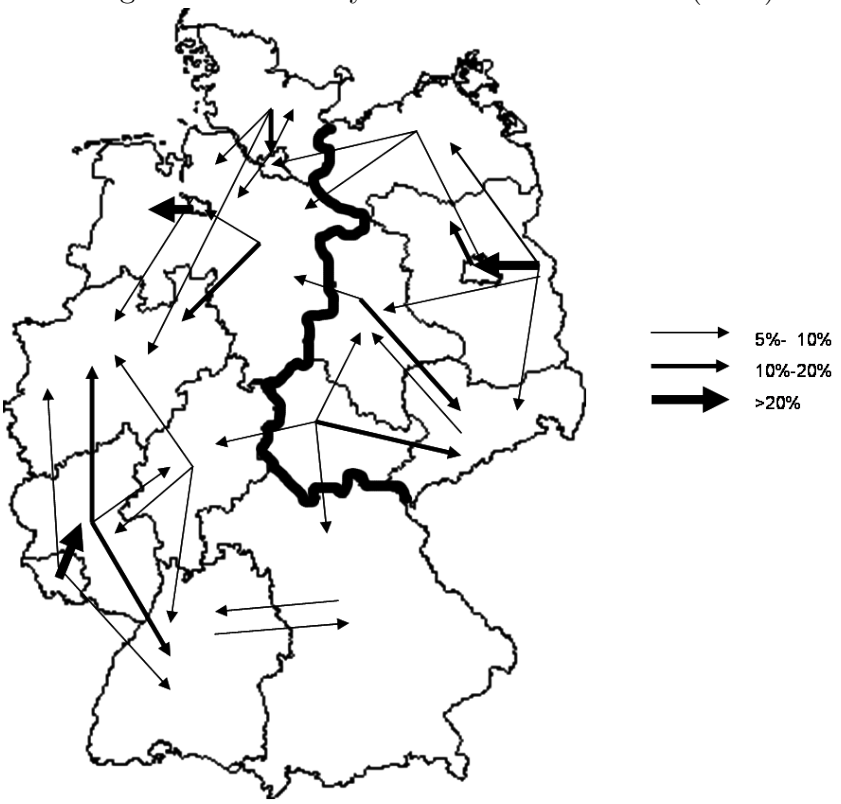
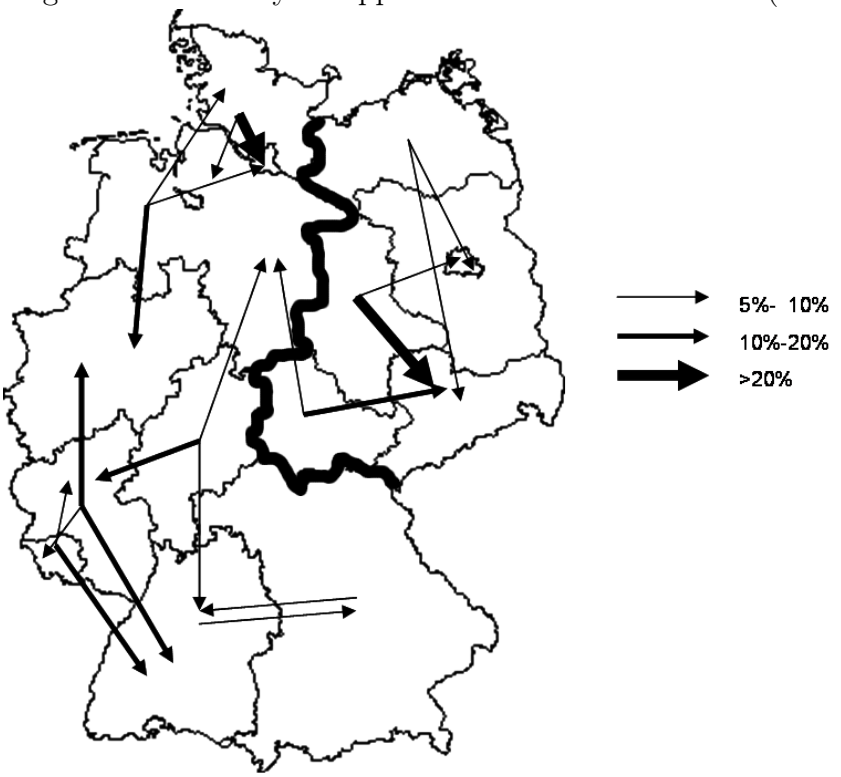
6 Appendix

Figure A1: Mobility of First Year Students (2003)



Source: Own depiction. Figure based on Table A1.

Figure A2: Mobility of Applicants for Medical Schools (2003)



Source: Own depiction. Figure based on Table A2.

Table A1: Mobility of First Year Students in 2003: Distribution of students over states (in percent)

	Home State															
	East Germany						*West Germany*									
State of study	B	BB	MV	SN	SA	TH	HB	HE	RP	SH	BW	BV	HH	NS	NRW	SL
East Germany																
Berlin (B)	62.80	22.87	7.56	1.71	3.50	1.77	2.26	0.98	0.81	1.59	1.48	0.89	1.81	1.42	1.02	0.52
Brandenburg (BB)	15.36	33.10	2.33	1.83	1.74	0.64	0.27	0.35	0.23	0.53	0.33	0.21	0.51	0.51	0.26	0.16
Mecklenb.-Western Pomeria (MV)	2.93	6.09	57.07	0.82	1.40	0.78	0.74	0.23	0.26	3.21	0.22	0.15	1.27	1.06	0.28	0.08
Saxony (SN)	2.81	12.67	4.64	71.79	13.11	13.64	0.94	0.87	0.75	1.28	1.21	1.20	0.72	1.24	0.71	0.38
Saxony-Anhalt (SA)	2.58	5.63	2.04	6.23	56.24	5.27	0.61	0.47	0.44	0.79	0.45	0.45	0.69	1.93	0.43	0.41
Thuringia (TH)	1.05	2.12	1.17	4.17	4.94	53.33	0.37	0.81	0.57	0.67	0.48	0.74	0.40	0.62	0.33	0.25
West Germany																
City of Bremen (HB)	0.41	0.57	1.06	0.23	0.42	0.25	60.82	0.29	0.23	2.09	0.23	0.18	1.71	6.88	0.45	0.16
Hesse (HE)	1.91	2.09	1.51	2.05	2.33	5.24	1.85	69.64	9.43	2.75	3.12	2.25	1.50	3.85	3.26	2.57
Rhineland-Palatinate (RP)	0.52	0.60	0.67	0.57	0.47	0.84	0.54	7.26	53.20	0.98	2.23	0.74	0.37	0.97	1.58	25.25
Schleswig-Holstein (SH)	0.62	1.03	4.88	0.31	0.55	0.52	2.73	0.38	0.32	50.95	0.25	0.20	7.06	2.84	0.49	0.08
Baden-Württemberg (BW)	1.61	2.16	1.72	1.81	1.90	2.60	2.90	5.81	14.29	3.45	76.80	5.14	1.88	2.69	1.98	5.49
Bavaria (BV)	1.70	2.55	1.40	4.51	2.02	6.79	1.45	3.68	2.67	2.56	8.12	84.29	1.78	2.32	1.71	1.94
City of Hamburg (HH)	0.86	1.71	5.13	0.54	1.23	1.05	2.70	0.58	0.67	14.99	0.53	0.42	68.31	3.55	0.66	0.44
Lower Saxony (NS)	1.61	3.43	5.62	1.25	7.04	3.88	15.48	2.94	1.35	8.72	0.89	0.67	7.94	59.77	3.80	0.55
North Rhine-Westphalia (NRW)	3.13	3.18	3.13	2.06	2.96	3.28	6.10	5.48	11.80	5.32	3.27	2.36	3.96	10.19	82.80	5.06
Saarland (SL)	0.11	0.20	0.10	0.13	0.14	0.12	0.24	0.22	2.95	0.14	0.37	0.11	0.11	0.13	0.26	56.65
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Notes: Figures refer to all first year students in Germany (all subjects).
Source: Own calculations based on Statistisches Bundesamt (2004).

Table A2: Mobility of Applicants for Medical School in 2003: Distribution of applicants over states (in percent)

	Home State													
	East Germany					*West Germany*								
Application in	B	MV	SN	SA	TH	HE	RP	SH	BW	BV	HH	NS	NRW	SL
East Germany														
Berlin (B)	84.02	8.73	3.92	5.14	3.93	3.00	1.81	4.51	3.43	2.69	1.85	4.44	2.31	1.60
Mecklenb.-Western Pomeria (MV)	4.95	68.84	2.66	2.39	2.58	1.36	1.26	4.91	2.08	1.47	3.08	4.33	2.32	0.53
Saxony (SN)	1.87	5.31	74.88	20.10	14.77	1.91	1.42	1.40	1.60	1.71	1.48	2.01	1.53	0.80
Saxony-Anhalt (SA)	1.80	1.37	3.92	56.22	3.51	0.45	0.79	1.00	0.99	0.55	0.12	1.62	0.89	0.00
Thuringia (TH)	0.40	0.68	4.92	4.31	56.40	0.73	0.39	0.40	0.27	0.47	0.12	0.32	0.14	0.27
West Germany														
Hesse (HE)	1.00	0.51	0.80	0.60	1.76	53.34	3.86	1.30	1.75	1.36	0.74	2.46	3.32	0.53
Rhineland-Palatinate (RP)	0.13	0.00	0.13	0.24	0.83	12.78	45.58	0.30	0.84	0.43	0.37	0.42	0.49	5.08
Schleswig-Holstein (SH)	0.47	4.97	0.20	0.60	0.41	0.68	0.39	48.14	0.72	0.49	4.67	5.74	2.03	0.27
Baden-Württemberg (BW)	1.34	1.37	2.86	2.15	2.79	9.32	16.56	4.41	75.57	8.89	4.31	3.87	3.19	10.96
Bavaria (BV)	0.74	0.86	3.06	1.44	4.03	3.59	2.76	1.60	7.36	78.46	1.11	2.01	1.40	1.87
City of Hamburg (HH)	0.47	4.11	0.60	1.08	0.21	1.50	0.39	21.97	1.32	0.90	77.86	8.24	1.44	0.53
Lower Saxony (NS)	1.54	1.54	1.00	4.19	7.13	7.50	1.97	6.52	1.38	1.43	2.46	54.33	4.14	0.80
North Rhine-Westpfahlia (NRW)	0.94	1.71	1.06	1.08	1.55	3.73	16.09	3.41	2.26	1.04	1.85	10.00	76.63	2.94
Saarland (SL)	0.33	0.00	0.00	0.48	0.10	0.09	6.70	0.10	0.43	0.11	0.00	0.21	0.17	73.80
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Notes: Figures refer to the sample used in our analysis (medical subjects only), i.e., Brandenburg and City of Bremen excluded.
Source: Own calculations based on ZVS data on applicants, wave 2003 (fall term).

Table A3: Estimation results with eastern states as control group: by grade

Variable	Marginal Effect	Standard Error
Grade1 * After * Fee State	0.2513***	0.0234
Grade2 * After * Fee State	0.0279	0.0192
Grade4 * After * Fee State	-0.1253***	0.0179
Grade5 * After * Fee State	-0.0923***	0.0185
Fee State	0.0477***	0.0122
After	-0.4981***	0.0183
After * Fee State	-0.0363	0.0197
Male	-0.0074	0.0060
Age	0.0014	0.0011
Top University	0.1005***	0.0066
Grade[1]		
1.0-1.5	-0.1276***	0.0165
1.6-2.0	-0.0311**	0.0138
2.1-2.5	-0.0956***	0.0128
2.6-3.0	-0.0501***	0.0130
Year Dummies		
fall 2003	-0.0616***	0.0126
fall 2004	-0.0631***	0.0121
fall 2005	0.1335***	0.0103
fall 2006	0.0711***	0.0107
fall 2007	0.0225**	0.0106
procedure A[2]	0.1435***	0.0113
Constant	0.6310***	0.0291
Number of Observations	204,588	

Source: Estimations based on ZVS data on applicants, waves 2002 to 2008 (fall term).

(***/**/*): indicates significance at the 1%- / 5%- / 10%-level.

[1] Grades in high-school diploma. Declining from 1 to 4.

[2] As noted earlier we only consider the first preference of applicants. This first preference stems from procedure A where applicants with excellent grades have a very good chance of being admitted to their preferred university or from procedure U which allows universities to admit students according to their own preferences (for details on these procedures cf. Braun et al., 2007). Since there may be differences across procedures, we control for the procedure preferences have been stated for.

Table A4: Estimation results: Placebo treatment (Mecklenburg-Western Pomerania and Saxony as treatment group; Saxony-Anhalt and Thuringia as control group)

Variable	Marg. Eff.	Std. Err.
Placebo Fee State	0.1851***	0.0092
After	-0.1284***	0.0146
After * Placebo Fee State	-0.0160	0.0112
Male	0.0197***	0.0060
Age	-0.0069***	0.0012
Grade[1]		
1.0-1.5	-0.0249*	0.0131
1.6-2.0	0.0128	0.0119
2.1-2.5	-0.0085*	0.0116
2.5-3.0	0.0101***	0.0120
Year Dummies	***	
fall 2003	0.0103	0.0121
fall 2004	0.0105	0.0116
fall 2005	0.0691***	0.0095
fall 2006	0.0153***	0.0101
fall 2007	0.0102	0.0100
procedure A[2]	0.0568	0.0111
Number of Observations	32,061	

Source: Estimations based on ZVS data on applicants, waves 2002-2008 (fall term) .
(*/**/***): indicates significance at the 1%- / 5%- / 10%-level.

[1] Grades in high-school diploma. Declining from 1 to 4.

[2] As noted earlier we only consider the first preference of applicants. This first preference stems from procedure A where applicants with excellent grades have a very good chance of being admitted to their preferred university or from procedure U which allows universities to admit students according to their own preferences (for details on these procedures cf. Braun et al., 2007). Since there may be differences across procedures, we control for the procedure preferences have been stated for.