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Heterogene Arbeit: Positive und Normative Aspekte der Qualifikationsstruktur der Arbeit

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Zusammenfassung:

We examine the impact of tuition fees for long term students at the University of Konstanz. Applying duration analysis to examine how tuition fees influence when and how students finish their studies in six different majors, we find significant effects with respect to the hazard rates of the various ways of terminating one's studies. Furthermore, we analyze how the probability of terminating one's studies in a certain period of time changes. Students obtain a degree in a shorter period of time in two majors. In three other majors, however, we observe that the probability of obtaining a degree generally decreased.

JEL Klassifikation : I22, I28
Schlüsselwörter : tuition fees, duration analysis, length of study, dropping out
Download/Reference : http://www.wiwi.uni-konstanz.de/forschergruppewiwi/

A duration analysis of the effects of tuition fees for long term students in Germany*

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January 2006

Abstract

We examine the impact of tuition fees for long term students at the University of Konstanz. Applying duration analysis to examine how tuition fees influence when and how students finish their studies in six different majors, we find significant effects with respect to the hazard rates of the various ways of terminating one's studies. Furthermore, we analyze how the probability of terminating one's studies in a certain period of time changes. Students obtain a degree in a shorter period of time in two majors. In three other majors, however, we observe that the probability of obtaining a degree generally decreased.

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1 Introduction

In Germany, Baden-Württemberg was to first state to introduce tuition fees for long term students. Since the fall semester 1998 students who have not finished their studies within four semesters beyond a standard period of study must pay 511 € per semester. In recent years, several German states have followed this example (see Table 1). Quite similar are 'study accounts' in North Rhine-Westphalia and Rhineland-Palatinate. In these two states, students receive a credit for their study account when they begin their studies. For each semester a certain amount independent of the number of courses attended is automatically deducted from the student's study account. When the student's study account is depleted, he has to pay a fee for each semester he is still enrolled at the university.[1]

State	Tuition fee	Implementation date
Bavaria	500 €	Fall 2005
Baden-Württemberg	511 €	Fall 1998
City of Hamburg	500 €	Spring 2004
Hesse*	500-900 €	Spring 2004
Lower Saxony	500 €	Spring 2003
North Rhine-Westphalia**	650 €	Spring 2004
Rhineland-Palatinate**	650 €	Fall 2004
Saarland	500 €	Fall 2003
Saxony-Anhalt	500 €	Fall 2005
Thuringia	500 €	Fall 2005

Table 1: States with tuition fees for long term students
*: fees depend on the number of semesters beyond the standard period of study
**: when study account is depleted

Immediately after the implementation of tuition fees the number of long term students declined drastically. In the fall semester in 1998, the number of students who were still enrolled at universities in Baden-Württemberg after 13 semesters decreased by 39%. In the following semesters, this number fell even further (Statistisches Landesamt Baden-Württemberg 2003).

[1] In some states students also have to pay when they enroll for a second major or when they are not registered as citizens of the county where the university is located.

According to Baden-Württemberg's department of science, research and arts (Ministerium für Wissenschaft, Forschung und Kunst – MWK) the main reason for implementing tuition fees was to set incentives right: "The primary purpose of tuition fees for long term students is to reduce the average length of study, which is quite high compared to other European countries" (MWK (2003), p. 22). However, whether this goal has actually been achieved cannot be inferred from the fact that the number of long term students has strongly decreased. These students might as well have never intended to finish their studies with a degree, but rather continued to be students to be eligible for student discounts.

To shed more light on the effects of tuition fees for long term students, it is important to analyze the impact on individual behavior. Tuition fees probably will influence students' behavior in a way that the average length of study is reduced, but may also influence their decision to switch their major or to drop out. Since Baden-Württemberg has for some time been the only state where tuition fees had to be paid, some students might also have transferred to universities outside of Baden-Württemberg to avoid these fees.

The main purpose of our paper is to determine these different effects by means of a duration analysis with data from the University of Konstanz. This method has been used in similar settings to analyze the time to obtain a PhD in Great Britain (Booth and Satchell (1995)) and the length of study in the USA (Yamaguchi (1991) und Chizmar (2000)) and Austria (Hackl and Sedlacek (2002a, 2002b) and Sedlacek (2003)). Our analysis, however, differs from these studies in the two ways: In addition to receiving a degree and dropping out we also consider the following possibilities for ending one's studies: switching majors, transferring to another university and not passing one of the mandatory exams (in the following we term this last possibility simply as 'failing'). The main difference, however, is that we analyze the impact of a regulatory measure by which students are affected in different ways depending on when they began their studies.

The remainder of the paper is organized as follows: the next section gives a detailed description of the regulations regarding tuition fees for long term students in Baden-Württemberg. The data set is explained in section 3 and the estimation method in section 4. Our regression results are presented in section 5. In section

6 we demonstrate the effect of tuition fees by comparing the probability of terminating one's studies in a certain way with and without tuition fees. Section 7 provides a brief conclusion.

2 Tuition fees for long term students in Baden-Württemberg

On May 24, 1997, the law to implement tuition fees (Landeshochschulgebührengesetz) was enacted.[2] For each major a standard period of study (SPS) is set. When a student has not ended his studies within four semesters beyond the standard period of study, an amount of 511.30 € (1,000 DM) has to be paid per semester. For each student the SPS is increased whenever one of the following reasons applies:

- the student was on leave (for example because of illness);
- the student was raising a child of age below six;
- the student studied abroad;
- the student was elected into one of the university's committees (at most 2 semesters).

There is a tuition waiver for students who receive student aid (BaföG-Bezieher) or are doing a PhD. There are also exemptions for handicapped students, students with chronic illnesses, economic hardships and victims of crimes.

Tuition fees became first due in the fall semester of 1998. Total revenues in 2003 were about 7.5m € which implies that about 7,300 students had to pay. According to the department of science, research and arts, this amount was mainly spent on improving teaching at universities (MWK (2003), pages 19 and 22).

[2] In the following, we simply use the term 'tuition fees' when we refer to tuition fees for long term students.

	Biology	Chemistry	Economics	Physics	Psychology	Public Adm.
Number of students	1,683	913	1,677	1,157	1,172	2,595
Number of semesters studied	11,367	5,943	9,538	9,206	9,885	25,056
Male	43.6%	71.4%	68.9%	90.7%	28.1%	62.4%
Average age at enrollment	21.4	21.0	21.7	21.1	22.9	21.7
Local students	28.2%	36.3%	39.8%	43.7%	31.9%	35.0%
Tuition fees:						
Students	0.4%	1.3%	1.3%	2.5%	2.2%	3.4%
Semesters	0.1%	0.6%	0.7%	1.0%	0.5%	1.1%
Standard period of study (SPS) in semesters	9	9	8	10	9	9
Average length of study (LOS) when getting a degree	11.6	11.7	11.1	13.3	12.9	13.1
Average LOS when studies are terminated	6.8	6.5	5.7	8.0	8.4	9.7
Number of students with LOS $>$ SPS + 4	4.2%	6.9%	5.5%	8.9%	16.2%	20.8%
Number of semesters with LOS $>$ SPS + 4	1.3%	2.9%	3.2%	4.3%	4.1%	7.5%
Studies terminated by:						
Degree	44.4%	37.8%	27.6%	43.6%	51.1%	60.8%
Transfer to another university	14.6%	14.6%	9.4%	9.0%	9.5%	7.7%
Switching majors	10.2%	15.9%	19.4%	9.6%	4.2%	7.5%
Dropping out	29.3%	31.3%	40.9%	37.4%	34.6%	21.1%
Failing	1.5%	0.5%	2.7%	0.3%	0.6%	2.9%
Still studying	16.9%	6.7%	9.8%	17.6%	25.4%	17.3%

Table 2: Descriptive Statistics

3 Data

The source of our data set are administrative files of the University of Konstanz. These files contain the following information for all students ever enrolled during the time span of fall semester 1985 until spring semester 2003:

- personal characteristics of the student (age, gender, county of residence, nationality);
- data on enrollment (number of semester studied, major, on leave);
- how the studies were terminated (degree, transfer, drop out, failing);
- tuition fees payed.

Additionally we observe whether a student is still enrolled at the university in the fall semester of 2003. No information was available on when the student received his secondary school diploma (Abitur), on his grades and on the university the student transferred to. Also it cannot be ruled out that some of the drop outs later on decided to continue their studies at another university. Our analysis concentrates on the majors (Diplomstudiengänge) Biology, Chemistry, Economics, Physics, Psychology and Public Administration.[3] Furthermore, we focus on German students who began their studies in Konstanz

Descriptive statistics can be found in Table 2 on page 4. Local students are either from the county Konstanz or from one of the adjacent counties Tuttlingen, Bodensee or Ravensburg. Tuition fees had been paid 550 times, which amounts to 281,215 €. Our variable 'number of semesters' is equal to the number of semesters the student was enrolled at the University of Konstanz and therefore includes semesters on leave or semesters studied abroad. It therefore measures how much time a student needs until he terminates his studies.[4]

[3] In addition, the following Diplomstudiengänge are offered at the University of Konstanz: Mathematics, Mathematics and Finance, and Economic Education. These, however, were not suitable for our analysis. In Mathematics, there were not enough observations. The other two majors had not been offered before 1997 and 1999 respectively.

[4] One could also exclude the number of semesters the student was on leave or studied abroad. Then the focus would be on how many semesters a student attended lectures at the university. This

4 Estimation method

4.1 Duration Analysis

Duration analysis is a method to analyze the length of time until a person switches from one state to another and the factors which determine that length of time.[5] For example, in labor economics this method can be used to analyze the effects of continued education on the duration of unemployment. In medical research it is used to determine the survival time of patients with a certain diagnosis and how this survival time is influenced by different therapies. Here we analyze how the length of study of students at the University of Konstanz has been influenced by tuition fees. We distinguish five different possibilities for terminating one's studies: obtaining a degree, transferring to another university, switching majors, dropping out and failing.

Duration analysis is designed to analyze censored data, i.e. data on subjects where only part of the subject's life and only some of the transitions from one state to another are observed by the researcher. With left-censored data it is unknown when the subject began to be in the state in which it is observed initially. In clinical trials, for example, for a particular patient the exact onset of an illness may be unknown; the researcher might only observe that the patient was ill when he entered the study. With right-censored data the subject has not yet transferred from one state to another at the end of the observation period. This is frequently the case in clinical trials where the exact survival time of all patients who are still alive at the end of the study is not observed. Our data are right censored because a number of students have not ended their studies in 2003 which is the last semester we have observations on. However, our data are not left censored because we can observe when a student began his studies.

For our analysis we apply a model in discrete time.[6] Student i, $i = 1, \ldots, n$, begins his studies at time $t = 0$ and ends his studies after $T_i = t \in \{1, 2, 3, \ldots\}$ semesters.

might be the more relevant question from the perspective of the university. We concentrate on the political perspective where the main issue is the time a student needs to obtain a degree.

[5] Duration analysis is also known as 'failure time analysis' or 'survival analysis'.

[6] See Allison (1982), Hamerle and Tutz (1989), Yamaguchi (1991) and Kalbfleisch and Prentice (2002).

j	Termination of studies
1	Degree
2	Transfer
3	Switching majors
4	Dropping out
5	Failing

Table 3: Five ways to leave your studies

T_i therefore is a random variable which measures the number of semesters a student is enrolled at the University of Konstanz before he stops studying his first major. The probability distribution for T_i is

$$f_i(t) = Pr(T_i = t) \quad \text{with} \quad \sum_t f_i(t) = 1. \tag{1}$$

The *hazard rate* or transition probability $h_i(t)$ captures the probability that student i – being still enrolled in the t^{th} semester – ends his studies after t semesters. It is given by:[7]

$$h_i(t) = Pr(T_i = t | T_i \geq t) \quad \text{with} \quad 0 \leq h_i(t) \leq 1. \tag{2}$$

Another important concept is the survival function $G_i(t)$ which measures the probability that student i has not ended his studies within t semesters but is still enrolled in semester $t+1$. The survival function can be derived from the hazard rate in the following way:

$$G_i(t) = Pr(T_i > t) = \prod_{k=1}^{t} (1 - h_i(k)). \tag{3}$$

Note that the following relationship also holds:

$$h_i(t) = \frac{f_i(t)}{G_i(t-1)} = \frac{f_i(t)}{G_i(t)}(1 - h_i(t)). \tag{4}$$

Students can end their studies in different ways J. Table 3 show the five possibilities j. In a duration analysis, m different ways of exiting can be analyzed within

[7] For a continuous-time model the restriction $h_i(t) \leq 1$ does not apply and the hazard rate does not represent a conditional probability.

a *competing risk model*. This model specifies the hazard rates $h_i^j(t)$, $j = 1,\ldots,m$, one for each way j of ending one's studies:

$$h_i^j(t) = Pr(T_i = t, J = j | T_i \geq t). \tag{5}$$

The aggregate hazard rate is the sum of the hazard rates $h_i^j(t)$:

$$h_i(t) = \sum_{j=1}^{m} h_i^j(t). \tag{6}$$

Equation (4) can then be written as

$$h_i^j(t) = \frac{f_i^j(t)}{G_i(t)}(1 - h_i(t)) \tag{7}$$

with $f_i^j(t) = Pr(t_i = t, J = j)$.

For observations which are right censored, i.e. for students who had not terminated their studies in 2003, T_i equals the number of semesters the student is observed. The indicator variable δ_i captures whether T_i is a censoring time or not:

$$\delta_i \equiv \begin{cases} 1 & \text{student } i \text{ ends his studies at } T_i, \\ 0 & T_i \text{ is a censoring time.} \end{cases} \tag{8}$$

In the same way the indicator variables δ_i^j are defined; they capture whether student i has ended his studies in way j:

$$\delta_i^j \equiv \begin{cases} 1 & \text{student } i \text{ ends his studies at } T_i \text{ in way } j, \\ 0 & \text{else.} \end{cases} \tag{9}$$

Note that $\delta_i = \sum_j \delta_i^j$. Like in most other studies we assume independence of the censoring and the survival process. We can now set up the likelihood function

$$\mathcal{L} = \left[\prod_{i=1}^{n}\prod_{j=1}^{m}(f_i^j(t))^{\delta_i^j}\right]\left[\prod_{i=1}^{n}(G_i(t))^{1-\delta_i}\right]. \tag{10}$$

Solving (7) for $f_i^j(t)$ and inserting $G_i(t)$ as specified in (3) yields the log-likelihood function:

$$\begin{aligned} \ln\mathcal{L} &= \sum_{i=1}^{n}\left\{\sum_{j=1}^{m}\left(\delta_i^j \ln\left(\frac{h_i^j(t)}{1-h_i(t)}\right)\right) + \ln G_i(t)\right\} \\ &= \sum_{i=1}^{n}\sum_{j=1}^{m}\delta_i^j \ln\left(\frac{h_i^j(t)}{1-h_i(t)}\right) + \sum_{i=1}^{n}\sum_{k=1}^{t}\ln(1-h_i(k)). \end{aligned} \tag{11}$$

For the hazard rate we assume a logistic functional form:

$$h_i^j(t) = h^j(t|\mathbf{x}_i^j(t)) = \frac{e^{\mathbf{x}_i^j(t)\beta_j}}{1+\sum_{k=1}^m e^{\mathbf{x}_i^k(t)\beta_k}}. \tag{12}$$

$x_i^j(t)$ is the vector of variables for student i for possibility j at t and β_j is the vector of coefficients for possibility j.

Inserting in the log-likelihood function yields:

$$\ln \mathcal{L} = \sum_{i=1}^n \sum_{j=1}^m \delta_i^j \ln\left(\frac{h^j(t|x_i^j(t))}{1-\sum_{j=1}^m h^j(t|x_i^j(t))}\right) + \sum_{i=1}^n \sum_{k=1}^t \ln\left(1-\sum_{j=1}^m h^j(k|x_i^j(k))\right). \tag{13}$$

In contrast to the continuous-time model this log-likelihood function cannot be split up into m different log-likelihood functions, one for each possibility j. Therefore the model has to be estimated simultaneously.[8]

4.2 Explanatory variables

For each possibility of terminating one's studies, the unconditional hazard rates for each semester deviate substantially from the average hazard rate for that possibility. For example, the probability of switching majors is quite high after the first semester, even higher after the second, but then fairly low for subsequent semesters. After the second and fourth semester, the probability of transferring to another university is quite high but relatively low and almost constant for all other semesters. The probability of obtaining a degree is basically zero for the first eight semesters but rises steadily beginning in the ninth semester.

These patterns are difficult to capture by polynomials, so we used dummy variables *sts x* which assume value one when a student is enrolled in semester x. For an observation of a student who is enrolled in his twelfth semester, *sts*12 equals one and all the other dummy variables are equal to zero. We aggregated some of

[8] We take advantage of the fact that this log-likelihood function is equal to the log-likelihood function of a multinomial logit model, as has been shown by Allison (1982). Estimates were performed with the software package Stata.

the dummy variables into one dummy variable. For example, for transferring to another university $sts9, \ldots, sts20$ are aggregated into one dummy variable sts9-20 (with sts9-20 $= \sum_{x=9}^{20} sts\ x$). Since the hazard rates also differed considerably for the different majors, we estimated the model for each major separately.

Tuition fees enter our analysis in two different ways. On the one hand, we estimated the effect of having to pay in the next semester. On the other hand we considered the consequences of knowing that at some point later on tuition fees become due. We therefore employed two different variables:

(i) An indicator for having to pay in the next semester

Tuition fees probably have a direct effect when they become due in the next semester. We therefore created the variable *Ind* which is equal to one when our data indicate that the student has to pay tuition fees in the following semester. To determine the value of Ind_t we only used information up to semester $t-1$. This included all information available which indicated that the student qualified for an exemption like having been on leave, having studied abroad or having raised a child. Since we actually observe whether a student paid in the following semester in most cases, we were able to check the validity of our indicator. Table 4 shows how well our indicator performs. Considering all students who might have to pay in the next semester (i.e. those who have not finished their studies within four semesters beyond the standard period of study), we find that in 99.23% of all cases our indicator predicts correctly.

(ii) Indicators for anticipating that tuition fees can be due later on

Unless students are completely myopic, there is also an indirect effect of tuition fees. In this case not only having to pay for the next semester but also anticipating that tuition fees can become due later on will influence students' behavior. We try to capture this by the dummy variable *A* which depends on whether the student is enrolled at a time when tuition fees had already been implemented. This variable is equal to one when tuition fees had already been implemented or when it was well-known that they will

		Student pays: Yes	Student pays: No
Has to pay according to indicator	Yes	530 (11.63%)	26 (0.57%)
	No	9 (0.20%)	3,992 (87.60%)

Table 4: Relationship between indicator and tuition fees paid

be implemented. Since the law was enacted in May 1997 we assume that students anticipated tuition fees by the fall semester 1997.

We also created variables which depend on how long a student already anticipated tuition fees:

- The variable R measures the share of a student's enrolled semesters in which he knew about tuition fees. For example $R = 0.25$ for a student in his eighth semester, when he was in his seventh semester in fall 1997.
- The variable $Rw = \sqrt{R}$ assumes that the impact of knowing about tuition fees grows at a decreasing rate with each additional semester in which students anticipate tuition fees.

There were only minor differences between using R and Rw. We therefore restrict our analysis to R and A.

Finally, we also included the following variables:

- the age of the student when begins his studies (*age*),
- gender (*male*),
- date of enrollment (*enroll*),

time-independent	time-dependent
male	*sts x*
age	*Ind*
enroll	*A*
local	*R*
class-size	

Table 5: Explanatory variables

- size of class in the first semester (*class-size*),
- county of residence before enrollment (*local*).

The date of enrollment measures the exact date when students were registered at the University of Konstanz. It can serve as a proxy for ability as students with good school grades are frequently given a first choice. Furthermore, students who enroll early may be more motivated. With the variable *local* we analyze whether local students differed in their behavior from other students. Local students had their residence before enrollment either in the county Konstanz or in one of the adjacent counties Tuttlingen, Bodensee (Friedrichshafen) or Ravensburg. Table 5 gives an overview of all explanatory variables and shows which are time-dependent.

4.3 The identification strategy

To analyze the impact of tuition fees on the length of study it would be ideal to observe two different groups who begin their studies at the same time and under the same circumstances and for which the only difference is whether they have to pay tuition fees or not. Unfortunately, this is not feasible with our data set. Therefore, our identification strategy is to compare students who began their studies at different dates. These students differ in their exposure to tuition fees. An obvious setback of this approach is that our variables *A* and *R* may not only measure the impact of tuition fees but also the impact of other unobservable variables which changed at the same time when tuition fees were implemented. However, it is the only feasible approach given the data available. We return to this problem in section 6.2 when we discuss our results.

In the following section we present the estimation results for each of the six majors. It was not always feasible to estimate all coefficients. In some cases, we could not determine the impact of the indicator variable *Ind* because there were not enough observations. For transferring to another university this was not even possible for any of the majors.

5 Regression results

5.1 The effects of tuition fees

j	Hazard rate for	Hypothesis
1	Obtaining a degree	+
2	Transfer	+
3	Switching majors	–
4	Dropping out	+
5	Failing	+

Table 6: Hypotheses on the effects of tuition fees on the hazard rates

Table 6 shows our hypotheses for the effects of tuition fees on the different hazard rates. They apply to the indicators for anticipating that tuition fees might be due later on as well as to the indicator for having to pay in the next semester. In particular, we suppose the following impact on students' behavior:

1. Obtaining a degree

   Tuition fees can be avoided by studying faster. The hazard rate for obtaining a degree should therefore increase.

2. Transfer to another university

   Switching to a university outside of Baden-Württemberg which does not charge tuition fees is a possibility to avoid fees. The hazard rate for transferring to another university can therefore be expected to rise.

3. Switching majors

   If a student switches majors, then the semesters he studied so far are relevant for whether tuition fees have to be paid. The expected costs of switching majors has therefore increased which should lead to a lower hazard rate for switching majors.

4. Dropping out

   Tuition fees have increased the costs of continuing one's studies for those students who expect that they need a long period of time to obtain a degree. The hazard rate for dropping out can therefore be expected to increase. In particular, the hazard rate should be larger if tuition fees have to be paid in the following semester.

5. Failing

   Tuition fees for long term students create the incentive to take exams earlier and less well prepared. The hazard rate for failing can therefore be expected to increase.

Table 7 shows our regression results for the different possibilities of terminating one's studies. We present the results for two regressions. In the first regression, we capture the anticipatory effects of tuition fees by the dummy variable A which is one when tuition fees had already been implemented or when it was known that they will be implemented. The first column of Table 7 shows how the hazard rate changes with A. In the third column, the effect of the indicator of having to pay tuition fees in the following semester is presented for the regression with A. Analogously, the second and fourth column display the results on the various hazard rates when R is used to capture the effects of anticipating tuition fees. This variable measures the share of a student's enrolled semesters in which he knew about tuition fees. The table shows the qualitative effects of the variables measuring the impact of tuition fees and states the significance levels. For the regression with A, the regression coefficients are presented in Appendix A.1. The results with R as the explanatory variable can be obtained from the authors.

	Anticipation		**Indicator fees in** $t+1$	
	A	R	Regression A	Regression R
Obtaining a degree				
Biology	$+^{***}$	$+^{***}$	+	+
Chemistry	+	+	+	+
Economics	+	$+^{*}$	$+^{*}$	$+^{**}$
Physics	+	$+^{**}$	+	+
Psychology	$+^{***}$	$+^{***}$	–	+
Public Adm.	$+^{***}$	$+^{***}$	$+^{***}$	$+^{***}$
Transfer				
Biology	+	+	n.a.	n.a.
Chemistry	+	$+^{**}$	$+^{*}$	$+^{**}$
Economics	$+^{***}$	$+^{***}$	–	+
Physics	$+^{**}$	$+^{**}$	+	+
Psychology	+	+	n.a.	n.a.
Public Adm.	$+^{***}$	$+^{*}$	$+^{***}$	$+^{***}$
Switching majors				
Biology	–	–	n.a.	n.a.
Chemistry	+	+	n.a.	n.a.
Economics	–	–	n.a.	n.a.
Physics	$-^{**}$	$-^{*}$	n.a.	n.a.
Psychology	+	+	n.a.	n.a.
Public Adm.	+	+	n.a.	n.a.
Dropping out				
Biology	+	$+^{*}$	+	$+^{*}$
Chemistry	$+^{***}$	$+^{***}$	–	–
Economics	$+^{**}$	$+^{***}$	+	+
Physics	$+^{*}$	+	$+^{***}$	$+^{***}$
Psychology	–	–	$+^{***}$	$+^{***}$
Public Adm.	$+^{***}$	$+^{***}$	$+^{***}$	$+^{***}$
Failing				
Biology	$+^{**}$	$+^{***}$	n.a.	n.a.
Chemistry	+	+	n.a.	n.a.
Economics	$+^{**}$	$+^{***}$	+	+
Physics	–	+	n.a.	n.a.
Psychology	$+^{***}$	$+^{**}$	+	$+^{***}$
Public Adm.	$+^{***}$	$+^{***}$	+	$+^{***}$

Table 7: Regression results for the effects of tuition fees

+: positive effect; –: negative effect

*: significance level 10%; **: significance level 5%; ***: significance level 1%

n.a.: not available

All significant effects are in line with our hypotheses. With the exception of the hazard rate for switching majors, the hazard rates always change significantly in at least two majors. Particularly strong is the effect of the variables measuring the anticipation of tuition fees. In most majors, there is a significant sign according to our hypotheses. The indicator which measures the impact of having to pay tuition fees in the following semester has a pronounced effect on the hazard rate for dropping out. In four of six majors, there is a significant positive sign.

Table 7 also shows that our results do not depend strongly on whether we use *A* or *R* to measure the anticipatory effects of tuition fees. The signs differ only in three cases.[9] If the coefficient is significant for at least one of the variables, then the signs are always identical.

5.2 Further results

In Table 8 we present the results for additional explanatory variables on the hazard rates. Since the results between the regressions using *A* and *R* hardly differ, we only present the results for the model based on *A* (see Appendix A.1 for the exact values of the coefficients).

Gender: A minus indicates that men have a lower conditional probability to terminate their studies in a particular way. We find that apart from Economics there are no significant differences with respect to obtaining a degree. The hazard rate for transferring to another university or switching majors, however, is significantly lower for men in Chemistry, Physics and Economics. Men therefore seem to be less "mobile" in these majors than women. Furthermore, men have a significantly lower hazard rate for dropping out in Biology and Chemistry.

Age: The hazard rate for obtaining a degree tends to be lower for older students, i.e. students who started their studies at a higher age. Furthermore, the hazard rate for transferring to another university is significantly higher in all majors but Public Administration. Finally, the conditional probability for obtaining a degree is significantly lower in three out of six majors. Older students therefore seem

[9] In Physics the signs of *A* and *R* differ with respect to the hazard rate for failing. The indicator for having to pay tuition fees in the following semester has a different sign for the hazard rate for obtaining a degree in Psychology and for the hazard rate for transferring to another university in Economics.

	Degree	Transfer	Switching m.	Drop. out	Failing
Gender (male)					
Biology	+	–*	–	–**	+
Chemistry	–	–***	–***	–**	–
Economics	–***	–***	–***	–	+
Physics	–	–***	–***	–	n.a.
Psychology	–	+	+	+	+**
Public Adm.	+	–	+	+	+
Age					
Biology	–*	+***	+*	+***	+
Chemistry	–***	+***	+	+	+
Economics	–	+***	+***	+*	–
Physics	–	+***	+*	+	+
Psychology	–***	+**	–	+***	+*
Public Adm.	–	+	+	+***	+***
Date of enrollment					
Biology	–	+	+	+***	+
Chemistry	–	+*	+	+***	+
Economics	–**	+	–	+***	+
Physics	–	+	–	+***	+
Psychology	–	–	–	+**	+*
Public Adm.	–***	+	–	+***	+*
Local students					
Biology	+**	+	+	–	–
Chemistry	–	+*	+	–*	–
Economics	–	+	+	–***	+
Physics	–	+	–	–	+**
Psychology	+	+	–	–***	–
Public Adm.	–***	+***	+***	+**	+
Size of class					
Biology	–	+***	+	+***	+**
Chemistry	+*	+	–	+**	–
Economics	–**	+*	–**	+***	–
Physics	+	+***	–**	+**	–
Psychology	–	+	–	+	–
Public Adm.	–	+***	+*	+**	+

Table 8: Further regression results

to be less successful. One explanation for this phenomenon is that older students may have a larger time gap between the end of secondary schooling and the take-up of their university studies. A reason may also be that older students already needed more time for secondary schooling which could indicate lower ability.

Date of enrollment: Date of enrollment measures the exact date within the registration period when students registered at the University of Konstanz. We found that students who registered late had a significantly higher hazard rate for dropping out in *all* majors. Furthermore, the hazard rate for transferring to another university (Chemistry) and failing (Psychology, Public Administration) is significantly higher. For Economics and Public Administration we find a significantly lower hazard rate for obtaining a degree. These results are in accordance with a study by Hackl and Sedlacek (2002a). They performed a duration analysis for students at the Vienna University of Economics and Business Administration. Students who enrolled at a later date were less successful in the sense that they had a significantly longer duration of their studies. How can this finding be explained? On the one hand, the practice that students with good school grades are given a first choice seems to be responsible for the importance of the date of enrollment. This is the case in Biology, Psychology and Public Administration which employed a *Numerus Clausus* throughout the observation period. On the other hand, motivated students will usually tend to enroll early even if there are no grade restrictions. In contrast, students who are not sure about which major to choose will enroll rather late. These students are probably less determined in their studies.

Local students: Students who come from Konstanz or nearby show a significantly higher hazard rate for transferring to another university. It seems that these students are interested in getting to know something different after all. Otherwise, the results depend highly on the chosen major. In Public Administration, students have a significantly higher hazard rate for dropping out. One reason may be that this major is chosen as a way to stay in the Konstanz area. For other majors, this effect does not hold.

Size of class: A larger class size significantly raises the hazard rate for transferring to another university or to drop out. The decline in the studying conditions due to more fellow students is probably responsible for this result.

6 Progress of studies with and without tuition fees

6.1 Cumulative incidence functions

The regression results presented in the previous section illuminate only partially how tuition fees change the behavior of students. In particular, it is not a priori clear whether more or less students obtain a degree or drop out as tuition fees tend to increase both hazard rates. Even if one considers the coefficients, it cannot be seen which effect is dominant.[10] Furthermore, the quantitative impact of tuition fees remains unclear.

For this reason, we calculate *cumulative incidence functions* for the different ways of terminating one's studies.[11] For given values of the explanatory variables these functions state for each possibility j of terminating one's studies the probability that a student has finished his studies within semester t. The functions are calculated in the following way. First, the probability of terminated one's studies in a certain way j in period t is given by the product of the survival function $G(t|\mathbf{x}_i(t))$ and the respective hazard rate $h^j(t|\mathbf{x}_i^j(t))$. Summing up these probabilities until semester t yields the cumulative incidence function:

$$I^j(t) = I^j(t|\mathbf{x}_i(t)) = \sum_{k=1}^{t} G(k|\mathbf{x}_i(t))h^j(k|\mathbf{x}_i^j(t)). \tag{14}$$

Based on our regressions which use the variable A to capture the anticipatory effects of tuition fees, we calculate the cumulative incidence functions for two sample students $i = 0, 1$. For these students, all explanatory variables are equal to the average values for each major with the exception of the variables A and Ind which capture the impact of tuition fees:

[10] This problem is well-known in the context of a multinomial logit model which is formally identical to our competing risk model. Even if a variable has a positive coefficient with respect to one event, the probability for this event can decline if the probability for other events increases by more.

[11] See Kalbfleisch and Prentice (2002), p. 252.

	student 0	student 1	difference
Biology	11.81	11.36	–0.45
Chemistry	11.73	11.50	–0.23
Economics	11.08	10.69	–0.39
Physics	13.18	12.87	–0.31
Psychology	13.64	12.44	–1.20
Public Adm.	12.97	12.27	–0.70

Table 9: Average length of studies for obtaining a degree

- For student 0, both *A* und *Ind* are equal to zero, i.e. this student is not affected by tuition fees.
- For student 1, we set *A* and *Ind* equal to one. This student always knows about tuition fees and must pay the fees if he studies too long.

Table 9 shows the estimated average length of study to obtain a degree for the six majors. In all majors it is lower for student 1.[12] According to this figure, which is in the center of the public debate, the introduction of tuition fees is a success story. However, the cumulative incidence functions we present in the following show that the reasons why student 1 seems to study faster are quite different for the six majors.

As an illustration, Figure 1(a) displays the cumulative incidence functions for obtaining a degree in Psychology. It shows that students start obtaining their degree after semester 8. The probability to graduate within 12 semesters is 17.7% for student 0 and 30.2% for student 1. Until semester 17, the cumulative incidence function has a larger value for student 1. Then, student 0 has a higher probability of obtaining a degree than student 1. The probability to graduate within 20 semester is 56.6% and 55.5% respectively.

[12]The average length of study is calculated conditional on the first 20 semesters. For student 1, the remaining semesters should hardly increase the average length of study as his probability of studying more than 20 semester is only 1%. For student 0, however, we may somewhat underestimate of average length of study because the probability of studying more than 20 semester may reach up to 6.6%. This implies that the reduction in the average length of study between student 0 and student 1 is probably even larger.

To analyze how tuition fees affect the probability of terminating one's studies within a certain period of time, we calculate the difference between the cumulative incidence functions of student 1 and student 0:

$$D^j(t) = I_1^j(t) - I_0^j(t). \tag{15}$$

Using the Delta-method (see Greene (2003, p. 70)), we determine pointwise confidence intervals. Based on these confidence intervals, we can say whether tuition fees have significantly changed the probability of terminating one's studies within semester t for each possibility j.

Figure 1(b) shows the difference between the two functions presented in Figure 1(a) and the corresponding 95% confidence interval. From semesters 8 to 13 the lower bound of the confidence interval is above zero. This implies that tuition fees have increased the probability of successfully finishing one's studies in these semesters at the 5% significance level. In the long run, there are no significant changes.

In the following, we present graphs of the functions $D^j(t)$ for each possibility of terminating one's studies. Appendix A.2 contains the numerical values and states whether the functions $D^j(t)$ are significantly different from zero.

Obtaining a degree:

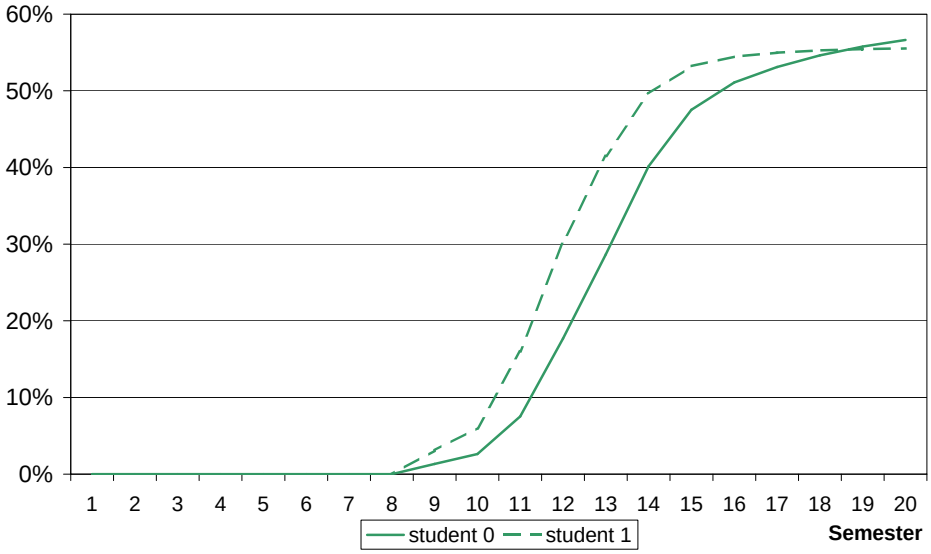
Figure 2 shows the difference between the cumulative incidence functions for obtaining a degree. For earlier semester we observe the following results:

- An increase in the probability of obtaining a degree

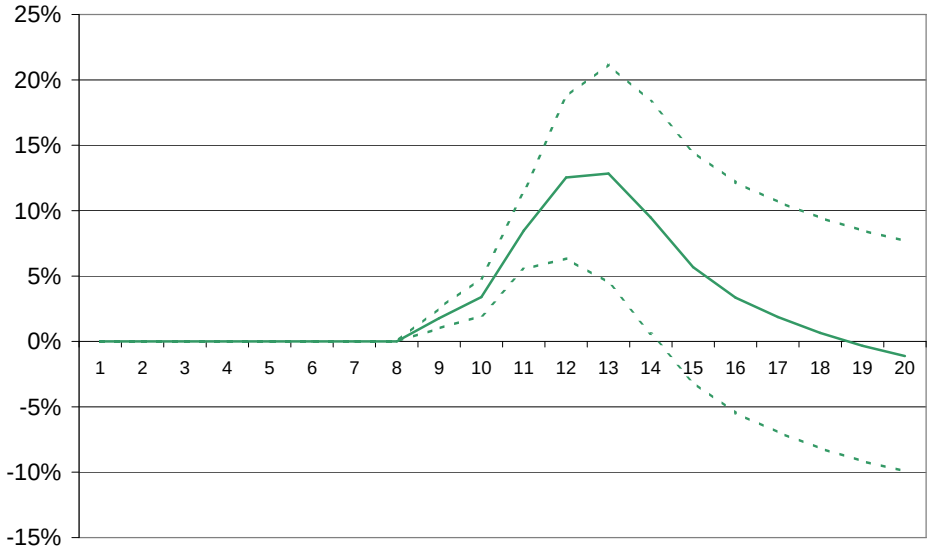
  In Biology, Psychology and Public Administration the probability of obtaining a degree increases. This change is significant in Biology (semesters 8 to 10), Psychology (semesters 8 to 14) and Public Administration (semester 12).

- A decline in the probability of obtaining a degree

  In Chemistry, Economics and Physics the probability of obtaining a degree falls. This is significant in Chemistry (starting semester 10) and Economics (starting semester 9).



(a) Cumulative incidence functions



(b) Difference of cumulative incidence functions with 95 % confidence interval

Figure 1: Obtaining a degree in Psychology

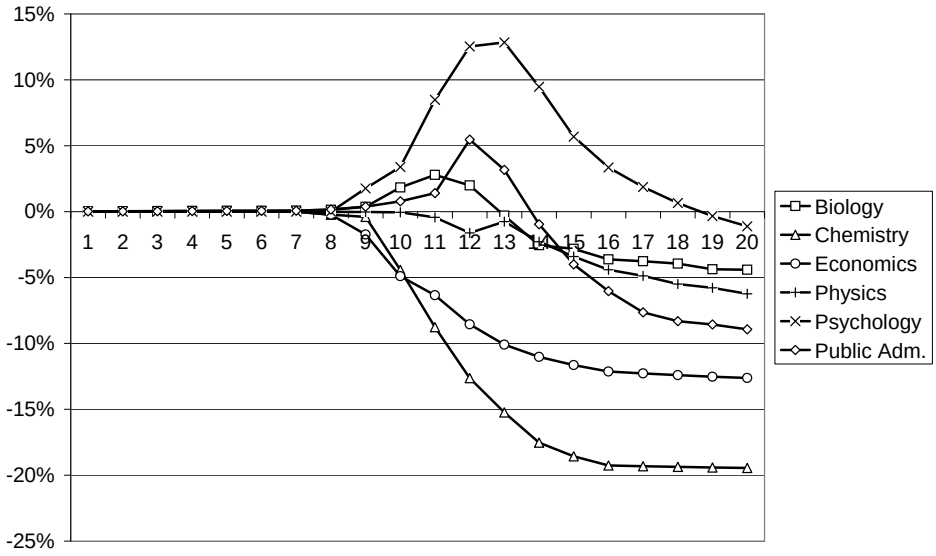


Figure 2: Obtaining a degree – difference between cumulative incidence functions

In the long run the probability of obtaining a degree falls in all majors. However, this decline is significant only in Chemistry, Economics and Public Administration.

Overall, we can distinguish four groups of majors:

1. *Earlier degrees:* In Biology und Psychology we observe a significant short run increase in the probability of obtaining a degree without a significant long run change. In these majors, students therefore seem to study more determined and obtain their degree earlier.

2. *Fewer degrees:* In Chemistry and Economics we find a significant decline in the probability of obtaining a degree for most semesters.

3. *Mixed evolution:* In Public Administration the probability of obtaining a degree increases significantly in the short run but declines significantly in the long run.

4. *No significant effects:* For Physics we observe no significant effects.

Transfer to another university:

Figure 3 demonstrates that tuition fees increase the probability to transfer to another university in all majors. These changes are significant in Physics, Economics and Public Administration. Students therefore seem to evade tuition fees in some majors by switching to another university.

Switching majors:

Figure 4 shows the result for the changes in the probability to switch majors. In almost all majors, tuition fees decrease this probability. Only in Psychology we find a non-significant increase. The decline is significant in Economics and Physics. This is in line with the hypothesis that students tend to switch their major less frequently because the expected costs have increased due to tuition fees.

Dropping out:

As Figure 5 illustrates, the probability of dropping out increases for all majors. Only in Psychology a temporary decline until semester 11 can be observed which is not significant. The increase is significant in Chemistry, Physics, Economics and Public Adminstration. This result is probably due to the fact that tuition fees raise the costs of continuing one's studies.

Failing:

Figure 6 shows that the probability of failing one's studies increases in all majors but Physics where no change is observable. A significant increase can be found for Biology and Public Administration. A possible explanation is that students tend to take their exams earlier and less well prepared to avoid tuition fees.

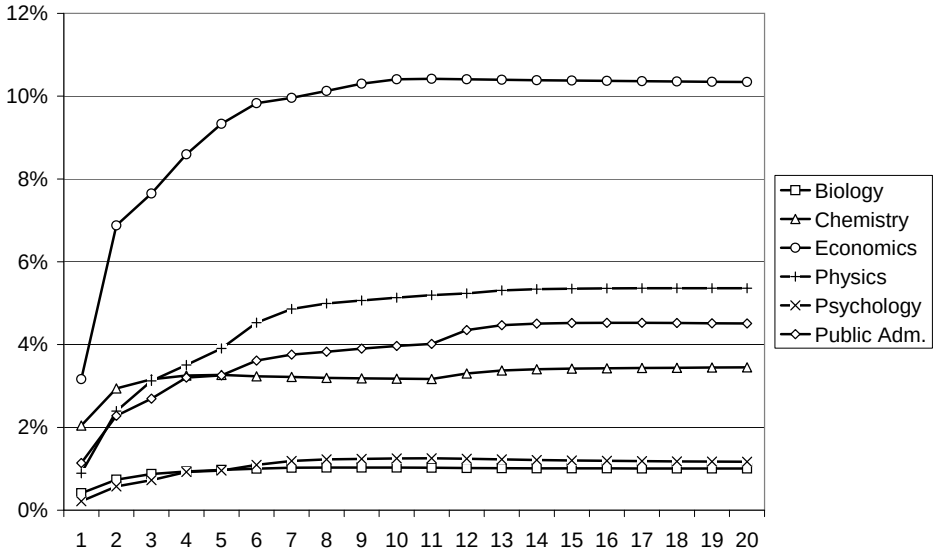


Figure 3: Transfer – difference between cumulative incidence functions

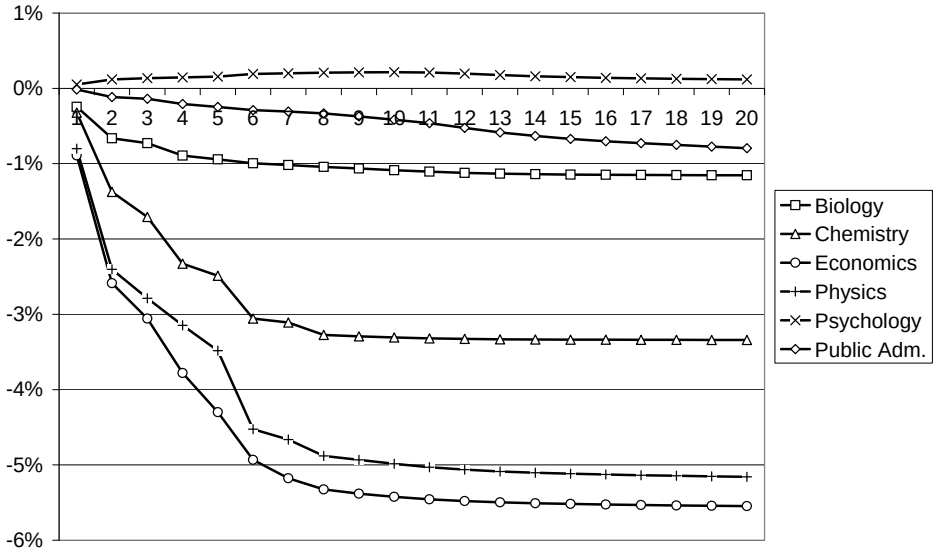


Figure 4: Switching majors – difference between cumulative incidence functions

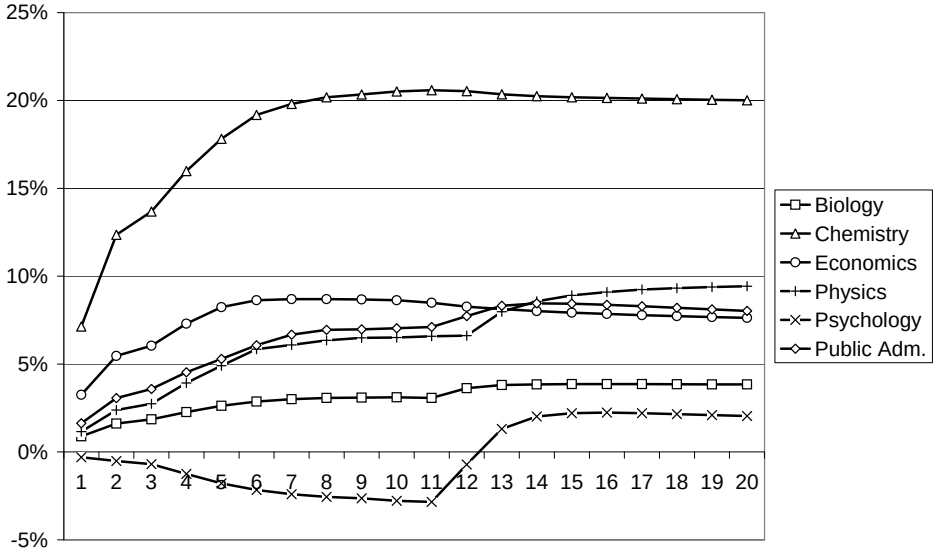


Figure 5: Dropping out – difference between cumulative incidence functions

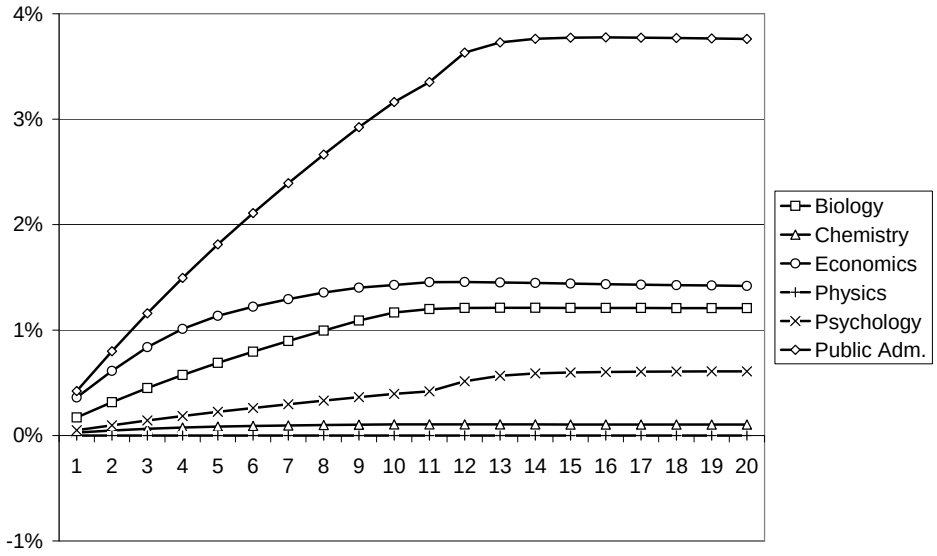


Figure 6: Failing – difference between cumulative incidence functions

	Degree	Transfer	Switching m.	Dropping out	Failing
Biology	F –	+	–	+	$+^{*}$
Chemistry	$-^{***}$	+	–	$+^{***}$	+
Economics	$-^{**}$	$+^{***}$	$-^{**}$	$+^{**}$	+
Physics	–	$+^{**}$	$-^{**}$	$+^{**}$	0
Psychology	F –	+	+	+	+
Public Adm.	$-^{***}$	$+^{**}$	–	$+^{***}$	$+^{***}$

Table 10: Effects of tuition fees after 20 semesters

6.2 Discussion

Table 10 summarizes the results of our analysis based on the cumulative incidence functions. The sign of the difference between student 0 and 1 after 20 semesters is shown. An F indicates that students study faster, i.e. there is a significant short run increase in the probability of obtaining a degree but there are no significant long run effects with respect to this probability.

Based on the significant changes after 20 semester, we can state the following results:

- The significant decline in the probability of obtaining a degree in Chemistry, Public Administration und Economics is due to an increase in the probability of
  - a transfer to another university (Economics, Public Adminstration),
  - dropping out (all three),
  - failing one's studies (Public Administration).
- In Physics there are no significant long run effects with respect to the probability of obtaining a degree. A significant increase in transfers to other universities is compensated by a significant decline in the switch of majors.
- In Biology und Psychology, virtually no long run effects of tuition fees can be observed.

It is interesting to compare these results with our regression analysis for the hazard rates in Table 7. The sign of the variables capturing the effect of tuition fees is frequently significantly positive and never significantly negative for the hazard rate for obtaining a degree. In contrast, the probability of obtaining a degree is significantly lower in three cases and never increases. In particular, in Public Administration the signs are opposite and significant. This apparent contradiction can be explained if one considers the relationship between the probability of obtaining a degree and the respective hazard rate. The probability of obtaining a degree in a certain semester is given by the product of the probability of still being a student in this semester and the hazard rate for obtaining a degree (see equation (14)). In Public Administration, there is a positive effect of tuition fees on switching majors, dropping out and failing (see Table 7). As a consequence, the probability that students are still studying is lower with tuition fees. This explains why the probability of obtaining a degree falls even though the hazard rate for obtaining a degree increases.

As pointed out in the introduction, the main purpose for implementing tuition fees is to encourage students to study faster. Our results show that students of Biology, Psychology and, to some extent, Public Administration indeed seem to obtain their degree after a shorter duration of their studies. However, other majors show a different picture. In Chemistry, Public Administration and Economics, the probability of obtaining a degree is significantly lower after the introduction of tuition fees. An interesting question is why the results differ between the majors. One possibility is that the majors vary in the flexibility students have in accelerating their studies. In some majors, students may be able to avoid tuition fees by intensifying their studies and by passing the necessary exams earlier. In other majors, this may not be possible and students drop out if they are not able or willing to pay tuition fees. Another explanation is that the majors attract distinct types of students who react differently to the introduction of tuition fees.

It is also interesting to contrast our results with the changes in the average length of studies which we presented in Table 9 on page 20. Based on this table, the introduction of tuition fees for long term students seems to be a complete success. In all majors, students appear to study faster. However, this interpretation ignores

that this figure is conditional on students obtaining a degree. In particular, it can decline for two reasons:

(i) students obtain their degree in a shorter period of time.

(ii) less long term students obtain a degree.

As our analysis shows the first reason applies to Biology, Psychology and Public Administration. In Chemistry, Economics and Physics, in contrast, the lower average length of study is entirely due to less students obtaining a degree. In particular, the probability of dropping out has increased in these majors. This can hardly be called a success. We therefore do not think that the average length of study is a good measure to capture the effects of tuition fees. Unfortunately, this statistic is usually regarded as the most important policy target.

Finally, we return to our identification strategy. We compared students who are differently affected by tuition fees because they took up their studies at different dates. We chose this approach because no control group is available who studied at the same time but was not affected by tuition fees. Clearly, a limitation of this strategy is that we may measure the impact of other factors which changed over time apart from the introduction of tuition fees. In particular, reforms of the major programmes can be responsible for changes in the hazard rates. We therefore sent a questionnaire to the administrators of the different majors and found that the requirements for the majors Chemistry and Public Administration were reformed in 1999, one year after the introduction of tuition fees for long term students. We suspect that the reform in Chemistry may partially explain the quantitatively strong effects which we observe in this major (see Figure 2). We can also not rule out that the introduction of an 'orientation examination' after two semesters had an influence on student behavior. Under this scheme, which was introduced in all majors but Economics in the fall term 2000, students are required to pass a certain number of exams within two semesters.[13] Finally, there was some insecurity about the exact future of the Economics programme in 1997. This may have contributed to the large increase in the probability of transferring to other universities (see Figure 3).

[13] In Economics, such a requirement was already implemented in 1993.

We also considered whether changes in the entry requirements for the different majors could be responsible for some of the effects we observe after the introduction of tuition fees. In particular, it may be important whether the majors had a *Numerus Clausus* (NC), i.e. were only open to students with a minimum grade average in high school. This, however, does not seem to be an important factor. In Biology, Psychology and Public Administration there was a NC throughout the observation period, while in Economics there were no entry restrictions. Chemistry and Physics had a NC for a short period of time (Chemistry for 4 years in the mid-90s, Physics for some time in the 80s). The abolition of the NC in Chemistry may have contributed somewhat to the decline in the probability of obtaining a degree after the introduction of tuition fees.

7 Conclusion

This study examined the impact of tuition fees for long term students at the University of Konstanz. In a duration analysis we examined how tuition fees change when and how students finish their studies in the majors Biology, Chemistry, Economics, Physics, Public Administration and Psychology. The effect of tuition fees was measured by an indicator for having to pay tuition fees in the following semester as well as by variables which capture whether students knew that tuition fees are due if they study too long.

In most majors we found evidence that the introduction of tuition fees influenced students' behavior. With respect to the hazard rate, i.e. the conditional probability of terminating one's studies in a particular way, we observed the following significant effects:

1. The indicator for having to pay tuition fees in the following semester often raises the hazard rate for dropping out. In some majors, there is also evidence that the hazard rate for obtaining a degree and for transferring to another university has increased.

2. Knowing that tuition fees have to be paid frequently increases the hazard rate for obtaining a degree, for transferring to another university, for dropping out and for failing.

Based on our regression results we furthermore examined how the probability of terminating one's studies within a certain period of time changes. In two majors we found that students obtain a degree in a shorter period of time. In three other majors, however, we observed that the probability of obtaining a degree generally decreased. In addition, the probability of transferring to another university, of dropping out and of failing significantly increased in the long run. The probability of switching majors fell significantly in two majors.

In the political debate, the average length of study to obtain a degree plays a prominent role. Considering only this measure, tuition fees for long term students appear to be successful. In all majors, this measure fell with the introduction of tuition fees. However, if one considers the different possibilities of terminating one's studies, things look differently. In three of the six majors examined, the length of study to obtain a degree is reduced only because less long term students finish with a degree. In particular, the number of drop outs increased. Nevertheless, in two majors we found that the average length of study to obtain a degree decreased because students were actually studying faster. Our study therefore does not allow us to draw a clear-cut conclusion. In future research, it would therefore be desirable to analyze data from other universities. Of particular interest would be a comparison with universities in states which have not introduced tuition fees for long term students.

Finally, we want to comment on the implications of our results for the debate on the introduction of general tuition fees which have to be paid for each semester studied. These fees are likely to have stronger effects than the current fees for long term students. In particular, they will also influence students who expect to finish within four semesters beyond the standard period of study. According to our analysis, general tuition fees should have a considerable impact on how fast students study and whether they obtain a degree. However, an important aspect will be whether fees are accompanied by a student loan scheme. This is not the case for the current tuition fees for long term students.

A. Appendix

A.1 Regression results

	Biology	Chemistry	Economics	Physics	Psychology	Public Adm.
Degree						
sts8	1.974967***	20.2287***	4.260039***	19.45348***	n.a.	2.920238***
sts9	3.397996***	19.86454***	6.218726***	19.45348***	20.44832***	3.814612***
sts10	5.662304***	23.24294***	7.184894***	19.45348***	20.44832***	4.71912***
sts11	7.378845***	23.60037***	7.601967***	22.42413***	21.87805***	5.922132***
sts12	7.44879***	23.91013***	7.644835***	23.62787***	22.82276***	6.477966***
sts13	7.597168***	23.88942***	7.389974***	23.93926***	23.21273***	7.321886***
sts14	7.930193***	24.3195***	7.071717***	24.13418***	23.71829***	7.160747***
sts15	5.861437***	23.98152***	6.869842***	23.50445***	23.73998***	6.839535***
sts16	7.35232***	24.0679***	6.837578***	23.35253***	23.37639***	6.512411***
sts17	5.692042***	21.58534***	5.718039***	22.56984***	23.07087***	6.405023***
sts18	6.054108***	21.58534***	5.718039***	22.89418***	23.07087***	5.605654***
sts19	7.549235***	21.58534***	5.718039***	22.17571***	23.07087***	4.644008***
sts20	5.064344***	21.58534***	5.718039***	22.71232***	23.07087***	5.101521***
male	0.1164097	-0.2172269	-0.3737093***	-0.2914152	-0.0039631	0.0375017
age	-0.6435049*	-2.022609***	-0.1685597	-0.7726283	-0.4874159***	-0.1318994
enroll	-0.0082655	-0.0129179	-0.0137154**	-0.0012705	-0.0051815	-0.0145248***
local	0.2437513**	-0.2182385	-0.0372965	-0.1363979	0.0210963	-0.1887497***
class-size	-0.0022371	0.0055694*	-0.0036107**	0.0002042	-0.0049904	-0.0003815
A	0.343907***	0.162498	0.1465043	0.0718659	0.8572541***	0.3594634***
Ind	0.1848649	0.0634963	0.5877511*	0.408061	-0.1534556	0.4849847***
const	-6.303439***	-20.48888	-7.273345***	-22.64185	-22.91521	-7.659718***
Transfer						
sts2	0.0611056	-0.1781256	0.4735028**	0.6542962**	0.56272*	0.139246
sts3	-0.6485812***	-1.313005***	-0.9934174***	-0.0116743	-0.2588272	-0.8213257***
sts4	-1.253751***	-1.565894***	-0.5634423*	-0.5298933	0.0681669	-0.5084243*
sts5	-1.499817***	-2.311762***	-0.5434851	-0.3732931	-1.657214**	-2.728362***
sts6	-1.560806***	-1.108872***	-0.6364782	0.2443782	-0.2133594	-0.6988106**
sts7	-1.582918***	-2.548449***	-1.870737***	-0.320059	-0.551057	-1.551012***
sts8	-3.503091***	-2.51121***	-1.479822**	-1.197199	-1.450943*	-2.234751***
sts9-20	-3.67331***	-3.57254***	-1.210622***	-1.745857***	-2.282797***	-2.068758***
male	-0.2641158*	-0.7249841***	-0.697343***	-0.9368295***	0.0951684	-0.1462606
age	1.513525***	1.547521***	1.758308***	2.518581***	0.5301219**	0.5455654
enroll	0.0063263	0.0196962*	0.0113911	0.0120502	-0.0085142	0.0131276
local	0.13792	0.3271722*	0.2115051	0.2316609	0.1190214	0.6970058***
class-size	0.0223436***	0.0001706	0.0047906*	0.0120946***	0.0190861	0.004051***
A	0.1184073	0.4445865	1.223186***	0.6986277**	0.1741252	0.6964993***
Ind	n.a.	2.208698*	-0.1728365	0.787424	n.a.	1.509301***
const	-8.379917***	-5.365878***	-7.867756***	-9.923418***	-7.046656***	-6.230482***

	Biology	Chemistry	Economics	Physics	Psychology	Public Adm.
Switching majors						
sts2	0.5794609***	0.6715915***	0.5320003***	0.7819458***	0.3395517	0.7688363***
sts3	-1.313513***	-0.5695386*	-0.7765511***	-0.6241763*	-0.9537078	-0.9937873***
sts4	-0.3539095	-0.0717464	-0.3639707*	-0.6241763*	-1.507402**	-0.1493226
sts5	-1.552763***	-1.523288***	-0.6948294***	-0.6241763*	-1.507402**	-0.8820427**
sts6	-1.48928***	-0.3078543	-0.4598338*	0.6065015*	-0.1654198	-0.9612757**
sts7	-2.302278***	-2.732351***	-1.393332***	-1.393406*	-1.657781	-1.887952***
sts8	-2.265815***	-1.575297***	-1.879352***	-0.8931372	-1.631124	-1.570922***
sts9-20	-2.485305***	-3.734553***	-2.714367***	-2.308758***	-1.817148***	-1.216996***
male	-0.1027515	-0.6544738***	-0.4164134***	-1.305817***	0.4637762	0.1448964
age	0.8585485*	0.310408	1.166683***	1.287214*	-0.1159352	0.3059622
enroll	0.00213	0.0000255	-0.0006809	-0.0035324	-0.0079007	-0.0045018
local	0.0221473	0.1076915	0.0082337	-0.2519128	-0.0275291	0.6096544***
class-size	0.0009991	-0.0009691	-0.0034395**	-0.0079171**	-0.0117013	0.0026074*
A	-0.0936973	0.0124755	-0.1404207	-0.7096649**	0.06867	0.0197209
Ind	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
const	-5.474606***	-3.364237**	-4.805014***	-4.983414***	-4.023478**	-6.004521***
Dropping out						
sts2	0.0275029	0.0903734	0.0874903	0.2274827	-0.2560648	0.0229043
sts3	-0.9369486***	-1.140102***	-1.082016***	-0.936578***	-0.4539695	-0.9287206***
sts4	-0.2469692	-0.3294629	0.0859385	0.4603892**	0.7889643***	-0.2086328
sts5	-0.2285155	-0.3220855	0.4210878***	0.4792717**	0.8743837***	-0.3479509*
sts6	-0.4700747**	-0.3093046	0.5104502***	0.6741985***	0.6298195***	-0.2112073
sts7	-0.9175168***	-0.9277298***	-0.3905777*	-0.5987*	0.2247153	-0.3923557*
sts8	-1.50017***	-1.271706***	-1.393037***	-0.3674402	-0.1787363	-1.103335***
sts9	-2.655011***	-2.030767***	-1.499522***	-0.9228817**	-0.9492164**	-3.152148***
sts10	-1.807645***	-1.532291***	-1.334647***	-3.133373***	-0.6234914	-2.427758***
sts11	-1.831407***	-1.628181***	-0.7148301*	-1.396396***	-1.778823**	-1.82287***
sts12	-1.232548**	-2.277854**	-0.3481676	-1.396396***	-0.7667034	-1.459584***
sts13-20	-1.138159*	-0.5835983	-0.6326656*	-1.396396***	-0.0889769	-0.2992622
male	-0.2453875**	-0.3007809**	-0.0307982	-0.2346281	0.0028107	0.0307512
age	0.9873081***	0.5776969	0.5092352*	0.6684465	0.4621017***	0.5986893***
enroll	0.0256908***	0.023144***	0.0164711***	0.017397***	0.0118794**	0.0199791***
local	-0.0460841	-0.2600392*	-0.4127154***	-0.1318082	-0.3689604***	0.2544592**
class-size	0.012736***	0.0060457**	0.0049849***	0.0037631**	0.0074347	0.0020393**
A	0.1651401	0.8883495***	0.4721371***	0.2664241*	-0.1111032	0.5432201***
Ind	1.544195	-0.7177593	0.1287419	2.05273***	1.97766***	1.141365***
const	-5.682223***	-3.593123***	-3.825025***	-4.290384***	-4.843065***	-5.171585***
Failing						
male	0.6058492	-0.3277562	0.0291644	n.a.	2.410151**	0.3753721
age	1.620225	1.060357	-0.7020984	2.200965	1.546876*	1.336394***
enroll	0.0144437	0.0809847	0.001702	0.0045826	0.0544989*	0.0259608*
local	-0.2837911	-0.6658845	0.3399538	21.04945**	-1.664271	0.0698376
class-size	0.042646**	-0.0283409	-0.0046668	-0.0332951	-0.0682431	0.0014566
A	1.135638**	0.765601	0.8324706**	-0.154604	22.42727***	1.438029***
Ind	n.a.	n.a.	0.5165393	n.a.	1.773447	0.7164247
const	-14.51838***	-6.513882	-3.734778	-30.72349	-28.62266	-9.644116***
Number of semesters	11,367	5,943	9,538	9,206	9,885	25,056
Log-Likelihood	-4,491.30	-2,785.67	-5,182.13	-3,265.69	-2,956.45	-7,526.73

A.2 Differences of the cumulative incidence functions

Semester	Biology	Chemistry	Economics	Physics	Psychology	Public Adm.
Degree						
1	0.02%	0.00%	0.00%	0.00%	0.00%*	0.01%*
2	0.03%	0.00%	0.00%	0.00%	0.00%*	0.03%*
3	0.04%	0.00%	0.00%	0.00%	0.00%*	0.04%*
4	0.05%	0.00%	0.00%	0.00%	0.00%*	0.04%*
5	0.06%	0.00%	0.00%	0.00%	0.00%*	0.05%*
6	0.07%	0.00%	-0.01%	0.00%	0.00%*	0.06%*
7	0.08%	0.00%	-0.01%	0.00%	0.00%*	0.06%*
8	0.14%*	-0.23%	-0.23%	-0.02%	0.00%*	0.16%*
9	0.36%*	-0.40%	-1.74%**	-0.03%	1.77%***	0.37%
10	1.84%*	-4.42%**	-4.90%***	-0.05%	3.39%***	0.78%
11	2.79%	-8.77%**	-6.34%***	-0.43%	8.48%***	1.40%
12	1.99%	-12.63%***	-8.55%***	-1.61%	12.53%***	5.46%**
13	-0.30%	-15.24%***	-10.09%***	-0.75%	12.84%***	3.17%
14	-2.55%	-17.53%***	-11.02%***	-2.28%	9.47%**	-0.95%
15	-2.82%	-18.57%***	-11.64%***	-3.41%	5.68%	-4.01%
16	-3.62%	-19.26%***	-12.13%***	-4.41%	3.35%	-6.03%**
17	-3.76%	-19.32%***	-12.28%***	-4.88%	1.87%	-7.64%**
18	-3.94%	-19.37%***	-12.41%***	-5.49%	0.65%	-8.31%***
19	-4.37%	-19.41%***	-12.52%***	-5.78%	-0.34%	-8.56%***
20	-4.41%	-19.46%***	-12.62%***	-6.24%	-1.11%	-8.94%***
Transfer						
1	0.41%	2.04%	3.16%***	0.89%*	0.22%	1.14%**
2	0.74%	2.94%	6.88%***	2.39%**	0.57%	2.28%**
3	0.87%	3.16%	7.65%***	3.12%**	0.72%	2.69%**
4	0.94%	3.25%	8.60%***	3.51%**	0.92%	3.20%**
5	0.97%	3.27%	9.33%***	3.90%**	0.96%	3.25%**
6	1.00%	3.23%	9.83%***	4.53%**	1.09%	3.61%**
7	1.03%	3.22%	9.96%***	4.86%**	1.19%	3.76%**
8	1.03%	3.19%	10.13%***	4.99%**	1.23%	3.83%**
9	1.03%	3.19%	10.30%***	5.06%**	1.24%	3.90%**
10	1.03%	3.18%	10.41%***	5.13%**	1.25%	3.97%**
11	1.03%	3.17%	10.42%***	5.20%**	1.25%	4.02%**
12	1.02%	3.30%	10.41%***	5.24%**	1.24%	4.35%**
13	1.02%	3.37%	10.40%***	5.31%**	1.23%	4.47%**
14	1.01%	3.40%	10.39%***	5.34%**	1.21%	4.51%**
15	1.01%	3.42%	10.38%***	5.35%**	1.20%	4.52%**
16	1.01%	3.43%	10.37%***	5.36%**	1.19%	4.53%**
17	1.01%	3.43%	10.36%***	5.36%**	1.19%	4.52%**
18	1.01%	3.44%	10.35%***	5.36%**	1.18%	4.52%**
19	1.01%	3.45%	10.35%***	5.36%**	1.18%	4.52%**
20	1.01%	3.45%	10.34%***	5.36%**	1.17%	4.51%**
Switching majors						
1	-0.24%	-0.32%	-0.89%	-0.80%**	0.05%	-0.01%
2	-0.66%	-1.37%	-2.59%*	-2.40%***	0.12%	-0.12%
3	-0.73%	-1.71%	-3.06%*	-2.79%***	0.14%	-0.14%
4	-0.89%	-2.33%	-3.78%**	-3.15%***	0.15%	-0.21%
5	-0.94%	-2.49%	-4.30%**	-3.48%***	0.16%	-0.25%
6	-1.00%	-3.06%	-4.93%**	-4.52%***	0.19%	-0.29%
7	-1.02%	-3.11%	-5.18%**	-4.66%***	0.20%	-0.31%
8	-1.04%	-3.27%	-5.32%**	-4.88%***	0.21%	-0.33%
9	-1.06%	-3.29%	-5.38%**	-4.93%***	0.21%	-0.37%
10	-1.09%	-3.31%	-5.42%**	-4.98%***	0.22%	-0.42%

Semester	Biology	Chemistry	Economics	Physics	Psychology	Public Adm.
Switching majors (cont.)						
11	-1.11%	-3.32%	-5.46%**	-5.03%***	0.21%	-0.46%
12	-1.12%	-3.33%	-5.48%**	-5.06%***	0.20%	-0.53%
13	-1.13%	-3.33%	-5.50%**	-5.09%***	0.18%	-0.58%
14	-1.14%	-3.33%	-5.51%**	-5.10%***	0.16%	-0.63%
15	-1.14%	-3.34%	-5.52%**	-5.12%***	0.15%	-0.67%
16	-1.15%	-3.34%	-5.53%**	-5.13%***	0.14%	-0.70%
17	-1.15%	-3.34%	-5.53%**	-5.14%***	0.13%	-0.73%
18	-1.15%	-3.34%	-5.54%**	-5.14%***	0.13%	-0.75%
19	-1.15%	-3.34%	-5.54%**	-5.15%***	0.12%	-0.77%
20	-1.15%	-3.34%	-5.55%**	-5.16%***	0.12%	-0.79%
Dropping out						
1	0.89%	7.14%***	3.25%***	1.16%	-0.30%	1.64%***
2	1.61%	12.36%***	5.47%***	2.39%*	-0.52%	3.07%***
3	1.86%	13.68%***	6.05%***	2.74%*	-0.70%	3.58%***
4	2.27%	15.99%***	7.30%***	3.93%*	-1.25%	4.53%***
5	2.63%	17.82%***	8.24%***	4.91%*	-1.78%	5.29%***
6	2.87%	19.18%***	8.63%***	5.85%*	-2.16%	6.08%***
7	3.01%	19.81%***	8.70%**	6.09%*	-2.40%	6.67%***
8	3.08%	20.19%***	8.70%**	6.36%*	-2.55%	6.95%***
9	3.10%	20.35%***	8.68%**	6.50%*	-2.64%	6.98%***
10	3.11%	20.51%***	8.64%**	6.51%*	-2.78%	7.04%***
11	3.08%	20.58%***	8.49%**	6.58%*	-2.84%	7.12%***
12	3.63%	20.53%***	8.27%**	6.62%*	-0.71%	7.73%***
13	3.81%	20.35%***	8.13%**	7.98%**	1.31%	8.32%***
14	3.85%	20.25%***	8.02%**	8.58%**	2.02%	8.46%***
15	3.86%	20.18%***	7.92%**	8.91%**	2.21%	8.44%***
16	3.86%	20.14%***	7.85%**	9.10%**	2.24%	8.38%***
17	3.86%	20.11%***	7.79%**	9.24%**	2.21%	8.29%***
18	3.85%	20.07%***	7.73%**	9.33%**	2.16%	8.21%***
19	3.85%	20.04%***	7.68%**	9.39%**	2.10%	8.12%***
20	3.84%	20.01%***	7.63%**	9.43%**	2.05%	8.02%***
Failing						
1	0.17%*	0.03%	0.36%	0.00%	0.05%	0.42%***
2	0.32%*	0.05%	0.61%	0.00%	0.10%	0.80%***
3	0.45%*	0.06%	0.84%	0.00%	0.14%	1.16%***
4	0.57%*	0.08%	1.01%	0.00%	0.18%	1.49%***
5	0.69%*	0.08%	1.14%	0.00%	0.22%	1.81%***
6	0.79%*	0.09%	1.22%	0.00%	0.26%	2.11%***
7	0.90%*	0.10%	1.29%	0.00%	0.30%	2.39%***
8	0.99%*	0.10%	1.36%	0.00%	0.33%	2.66%***
9	1.09%*	0.10%	1.40%	0.00%	0.36%	2.92%***
10	1.17%*	0.11%	1.43%	0.00%	0.39%	3.16%***
11	1.20%*	0.11%	1.45%	0.00%	0.42%	3.35%***
12	1.21%*	0.11%	1.46%	0.00%	0.51%	3.63%***
13	1.21%*	0.11%	1.45%	0.00%	0.57%	3.73%***
14	1.21%*	0.11%	1.45%	0.00%	0.59%	3.76%***
15	1.21%*	0.10%	1.44%	0.00%	0.60%	3.77%***
16	1.21%*	0.10%	1.44%	0.00%	0.60%	3.78%***
17	1.21%*	0.10%	1.43%	0.00%	0.61%	3.77%***
18	1.21%*	0.10%	1.43%	0.00%	0.61%	3.77%***
19	1.21%*	0.10%	1.42%	0.00%	0.61%	3.77%***
20	1.21%*	0.10%	1.42%	0.00%	0.61%	3.76%***

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