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ABSTRACT

Time-to-Degree and the Business Cycle*

When students themselves enjoy large degrees of freedom in determining the duration of their studies, it results in a fairly large degree of interindividual variance in terms of time-to-degree. This paper investigates individual time-to-degree in a model where students determine the optimum time-to-degree whilst weighing up the cost against the consumption benefit accruing from an additional semester of studies. According to this model, the cost level and consumption benefit depend, in turn, on the general economic environment during the study period. An empirical investigation using a data set based on Swiss university graduates from 1981 to 2001 shows that changes in the unemployment rate, real interest rate, wage levels, and economic growth have a significant impact on individual time-to-degree. These results are consistent with the conclusions derived from the theoretical model.

JEL Classification: C81, E32, I2, I23

Keywords: time-to-degree, business cycle, consumption benefit

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1 Background and rationale

In the past, studies on the economics of education have tended to focus on the extent to which economic factors determine whether or not a person opts to take up higher education. In contrast, few if any studies explore whether economic factors may also have an impact on study behavior, notably on time-to-degree. However, this is an obvious question in consideration of the large variance in the number of semesters studied in those subjects and those universities in Switzerland (and other countries as well), where students have a large measure of freedom in determining the length of their studies.

Time-to-degree is also relevant from a macroeconomic point of view, because the prolongation of the period spent by students at university defers the point of transition from full-time university education to labor market entry. This in turn diminishes the labor supply, and entails a loss of fiscal revenue to the State. Leaving aside cases where students increase their time-to-degree involuntarily, e.g. due to failed exams, illness or for other reasons, the longer time-to-degree would logically have to be associated with a benefit to the student, who would otherwise always choose the shortest time-to-degree on rational grounds. The benefit of a longer time-to-degree may arise from higher post-university productivity or from a consumption benefit during the study period. The available data from empirical studies in Switzerland on the wage effect of time-to-degree indicate that the payoff from additional semesters is very small. As such, enhancing individual productivity, and ultimately fetching a higher salary, can not seem to be the main motivation for a longer time-to-degree. Assuming that consumption benefit during the university period is the main motivation for differences in time-to-degree, it would also be logical to assume that this benefit, in turn, is contingent upon economic factors. For instance, it seems obvious that students must have access to financial resources in order to be able to derive a consumption benefit from an additional, i.e. time-to-degree-prolonging, semester in the first place. These financial resources might be procured from parents, a loan, savings, or by engaging in paid work while at university. All these funding options depend on the state of the economy during the period of study. High interest rates make refinancing more expensive. A high unemployment rate makes it more difficult for students to find a sideline job. It is also

important to remember that consumption benefit can explain a longer time-to-degree only if it is greater than the opportunity and direct costs associated with the additional semester. Since these costs in turn depend on the overall economic situation, the latter may impact a decision for or against an additional semester of studies through the channel of study costs.

The role of the consumption benefit in determining individual time-to-degree can only be investigated indirectly, because individual consumption benefit per se is not amenable to direct observation. This essay therefore focuses on the question as to whether it can be proven that the economic situation - which can be expected to influence individual consumption benefit and the costs of studying - has a significant impact on individual time-to-degree. A theoretical model for determination of optimum time-to-degree will be presented. This model will be used to generate hypotheses as to the effects of various economic variables such as interest rates, salaries, economic growth, and unemployment on individual time-to-degree.

The paper's structure is as follows. The starting point is a review of the small economic literature of relevance to the issues of interest here (2). This is followed by a description of the theoretical model and the hypotheses based on it (3). The data section (4) and the empirical analysis (5) are based on a survey of Swiss graduates in the 1981-2001 period. The final section (6) draws conclusions with respect to the relevance of the application of economics of education concepts on time-to-degree in terms of economic theory.

2 Research findings to date

2.1 Partial effects on time-to-degree and expected time-to-degree

This paper breaks new ground in economics of education research by exploring the reasons for individual differences in time-to-degree. A couple of papers look at the impact of selected variables, such as employment while studying (see Amann 2005 and others), or exchange semesters (see Messer and Wolter 2007), on time-to-degree. The aim of these studies was not to explain the individual

time-to-degree per se, but only to investigate whether a specific behavior during the period of study prolongs or does not prolong the time-to-degree.
A somewhat different approach was taken by Brunello and Winter-Ebmer (2003), who used a student survey in 10 European countries to explore whether labor market variables - such as unemployment, wage levels, employee protection, and educational parameters - such as funding of university education - impacted on the likely time-to-degree. In the estimate of the specification of the model, which pools all the countries, it was shown that students with a large number of semesters behind them are likely to expect a longer-than-average time-to-degree. A higher salary bonus for university graduates as compared with non-graduate members of the workforce correlates with an expectation of a shorter time-to-degree. It can thus be seen that, the higher the opportunity costs of a longer time-to-degree, the more inclined students will be to finish their studies quickly. In another specification of the model, Brunello and Winter-Ebmer analyzed the international differences in the expected prolongations of time-to-degree. They concluded that the average prolongation of time-to-degree correlates with a high national unemployment rate among university graduates. Post-university unemployment reduces the opportunity costs, and a large salary difference in favor of university graduates increases the opportunity costs.

2.2 Business cycle and initiation of university studies

Dellas and Koubi (2003) and Dellas and Sakellaris (2003) did not investigate time-to-degree as such, but explored the correlations between economic cycles and the initiation of a university degree program. The authors of these two papers assume that if economic factors impact student behavior, then business cycle-related changes in these variables must also have an impact on student behavior.

For their empirical investigation of the cyclicality of educational decisions, Dellas and Koubi used US data from 1950 - 1990 to investigate high school dropout rates, college enrollment rates, and the percentage of persons (in different age groups) attending a school. Their empirical analysis looks at the impact of the following variables, which are characterized by significant variability over the

business cycle, on the time of the educational decision:

- Level of wages (both absolute and relative across different labor force segments)
- Unemployment rate (within and across different levels of education)
- Expected real interest rate
- Cyclical tightness of credit constraints

The pattern identified by Dellas and Koubi is anticyclical for the most part. In other words, in a recession, people are more likely to opt for a higher level of education, at a time when it is difficult to find work and salaries are fairly low. In addition, education decisions are negatively correlated with changes in real interest rates. Generally speaking, the results seem to support the view that variations in opportunity costs and direct costs, which are associated with the business cycle, play a major role in education decisions.

Dellas and Sakellaris likewise analyze the cyclicality of demand for higher education and again find that people respond to changing business cycles with intertemporal substitution of various activities. Students are more likely to replace work with education when salary levels are fairly low in relation to the expected future salary. As real wage trends tend to be pro-cyclical, students will view a recession as a period usefully spent investing in improving their future earning power by raising their level of education. The empirical results identify a pronounced anticyclical pattern in terms of college enrollment decisions.

The two studies demonstrate - for the USA, at any rate - that the business cycle has a significant impact on the behavior of potential students in terms of college enrollment. The logical assumption is that the same variables will also influence the time-to-degree of students. Assuming that the economy affects enrollment and time-to-degree decisions, it can also be expected to influence the dropout rate.
In this essay, the impact of the state of the economy on the decision to enroll at a university cannot be investigated because the correspondent data are not

available. In addition, the available data provide no sufficient basis for investigating the impact of the economy on the college dropout rate. Solely the impact of business cycles on time-to-degree for individuals, who have completed a university education, will therefore be investigated.

3 Model

3.1 Net Present Value

When students are at liberty to study for as many semesters s as they like in excess of the minimum number of semesters $s_{\min}$, the optimum number of semesters s^* is determined such that the net present value is maximized at time point $s_0 \in [0, s)$[1]. The net present value is given by

$$\begin{aligned} \mathrm{NPV}(s) &= (W_u - W_g) \int_s^T \mathrm{e}^{-rt}\,\mathrm{d}t + (U(s) - C) \int_{s_0}^s \mathrm{e}^{-rt}\,\mathrm{d}t \\ &\quad -W_g \int_{s_0}^{s_{\min}} \mathrm{e}^{-rt}\,\mathrm{d}t - W_u \int_{s_{\min}}^s \mathrm{e}^{-rt}\,\mathrm{d}t \end{aligned}$$

where W_u denotes the real semiannual salary of a university graduate, W_g the real semiannual salary of a grammar school graduate[2], $U(s)$ the annual consumption benefit per semester, C the direct educational costs per semester and r the individual discount rate of a student.

It is assumed that the time-to-degree has no appreciable impact on a university graduate's starting salary[3]. It is further assumed that all other variables - except the mean consumption benefit - are independent of the total number of semesters.

At the optimum,

$$s^* = \arg\max \ \mathrm{NPV}(s)$$

[1] For the sake of simplicity, the total number of semesters s is treated as a continuous variable.

[2] semiannual salary is chosen because a semester lasts half a year.

[3] See the empirical results of Messer and Wolter (2007). In this data set, the time-to-degree does have a significant impact on the starting salary, but the effect size is so small as to be negligible in the model.

applies, subject to the constraint

$$s^* \quad \geq \quad s_{\min}.$$

The constraint makes sure that the optimum time-to-degree is above the defined minimum time-to-degree. If the net present value for the optimum time-to-degree is negative, i.e. $\text{NPV}(s^*) < 0$, university education does not pay off and the optimum time-to-degree is set at $s^* = 0$. In other words, enrollment will not take place at all.

3.2 Consumption benefit

The mean consumption benefit per semester as a function of the total number of semesters s is given by

$$U : \mathbb{R}_0^+ \to \mathbb{R}, s \mapsto U(s) = -as^2 + bs$$

where $a > 0$ and $b > 0$.

The mean consumption benefit is supposed to be a concave function dependent upon the total number of semesters. The requisite conditions are given by

$$\frac{\mathrm{dU}}{\mathrm{d}s} = -2as + b > 0 \quad \Longleftrightarrow \quad b > 2as \tag{1}$$

$$\frac{\mathrm{d}^2\mathrm{U}}{\mathrm{d}s^2} = -2a < 0 \tag{2}$$

Condition (2) is met for all s, because $a > 0$.

Interpretation of consumption benefit

The mean consumption benefit per semester is higher if a student studies for more semesters overall. With a longer time-to-degree, a student can do more paid work on the side or has more leisure time, which increases the consumption benefit in each semester.
The additional mean consumption benefit per semester declines when the total number of semesters rises, the greater the total number of semesters already spent at university. Marginal benefit per unit of leisure time is thus assumed to decline.

Changes in parameters a and b

An increase in parameter a or a reduction in parameter b leads to a lower mean consumption benefit for each total number of semesters s. Hence, a student with a high parameter a or small parameter b will wish to end his or her studies quickly, that is, the student is impatient (see Appendix). Interindividual differences in the levels of the two parameters for a student may depend, among other things, on the student's social background. For instance, a student from a wealthy family is under less pressure to complete his or her education quickly and can take his or her time, whereas a student from a lower-income family either wants to work on the side or complete his or her degree as quickly as possible. The result is that students with a high parameter a are more likely to be from lower-income families.

3.3 Impact of economic variables

This section explores the impact of a change in business cycle variables on optimum time-to-degree, assuming that all other variables remain constant. All derivations are given in the Appendix. It is assumed that students who decide to enroll have developed particular expectations with regard to the respective business cycle variables and have determined an optimum time-to-degree before they begin their studies. However, as the economic situation changes continuously during the period of study, it is reasonable to assume that the actual time-to-degree is subject to economic, i.e. cyclical effects.

3.3.1 Interest rate

The model assumes a positive linear correlation between the interest rate i and direct costs C. The direct costs can be expressed as

$$C(i) = \mu + \rho i \ ,$$

where $\rho > 0$.

Assuming that the total time-to-degree does not exceed 20 semesters, and that the discount rate is less than 10% [4], the implicit function theorem can be used

[4] Weber und Wolter (2003) estimate the mean discount rate with a representative sample

to show that an increase in the interest rate i shortens the total time-to-degree s, provided that parameter a of the consumption benefit function $U(s)$ exceeds a certain threshold value $\bar{a}$:

$$a > \bar{a} \qquad \Longrightarrow \qquad \frac{\mathrm{d}s}{\mathrm{d}i} < 0$$

This means that the student's impatience surpasses a certain threshold level. As students differ in the level of a (see section 3.2), students will also differ in the intensity of their response to variations in the interest rate. Assuming that students from a low-income family have higher levels of a, they will surpass the threshold value quicker than students from a wealthy family and therefore react more intensely to changes in the interest rates.

The threshold value $\bar{a}$ is

$$\bar{a} = \frac{r^2(2\overline{W}_u - \overline{W}_g + \overline{C})}{2(\mathrm{e}^{r(s^*-s_0)} - 1) + r^2 s^{*2}} > 0$$

Consequences of the model: The longer the chosen time-to-degree, the sooner the threshold value is exceeded. The lower the fixed cost of university education, the sooner the threshold level is exceeded. This means that cost changes have more of an impact when costs at the onset are low. The lower the starting salary of university graduates versus upper secondary school graduates, the sooner the threshold value is exceeded. When the threshold level is exceeded, the cost changes are too large in relation to the return of the degree program with the chosen time-to-degree. At the end of the period of studies, i.e. when the difference $s^* - s_0$ is small, the threshold value will be exceeded less quickly. This means that higher financial costs shortly before graduation are less likely to shorten the time-to-degree and hence are of lesser relevance.

3.3.2 Wages

It is assumed that all wages, both starting wages after graduation from grammar school and starting salaries after university graduation, are subject to the same percent rate of change in the course of the business cycle.

of 1133 students. The mean discount rate ranges from 6 to 7.5% depending on the subject studied and the student's gender.

The prospect of a higher wage for engaging in paid work while still a student corresponds to a higher consumption benefit during the time spent at university. Hence,

$$\begin{aligned} W_g &= kW_u \\ b &= \mu + \nu lkW_u \ , \end{aligned}$$

applies where $0 < k < 1$, $0 \leq l \leq 1$ and $\nu > 0$. The parameter ν may be interpreted as the gain in consumption benefit due to an increase in salary levels during the period of study, and l as a measure of the amount of weekly hours a student is gainfully employed.

Again, the implicit function theorem can be used to show that an increase in the starting salary W_u produces a shorter total time-to-degree s, when parameter a of the consumption benefit function exceeds the threshold value $\bar{a}$ (see section 3.3.1) and the consumption benefit ν stemming from an increase in salary levels is smaller than a certain threshold value $\bar{\nu}$[5]:

$$a > \bar{a} \ , \nu < \bar{\nu} \qquad \Longrightarrow \qquad \left.\frac{\mathrm{d}s}{\mathrm{d}W_u}\right|_{W_g = kW_u} < 0$$

The threshold value $\bar{\nu}$ is

$$\bar{\nu} = \frac{(2-k)r}{lk(\mathrm{e}^{r(s^*-s_0)} + rs^* - 1)}$$

Consequences of the model: The longer the chosen time-to-degree, the smaller the threshold value will be, and the more likely it is that students will replace studies with work in response to increasing wage levels. The smaller the difference between the starting salary after the completion of upper secondary school and the starting salary after university graduation, or the higher the number of weekly hours a student works, the more likely it is that students will prolong their studies in response to a salary increase. Toward the end of a degree course, i.e. when the difference $s^* - s_0$ is small, the threshold value will be larger. Thus, a student will be more likely to study rather than work in response to rising wage levels.

[5]The conclusion from $a < \bar{a}$ and $\nu > \bar{\nu}$ would be that an increase in the starting salary W_u produces a lower total study duration s. However, only the case where $a > \bar{a}$ holds is of interest to us.

3.3.3 Unemployment rate

Various channels of influence are assumed with respect to the impact of the unemployment rate. An increase in the unemployment rate u results in lower than expected starting salaries W_g and W_u and a lower consumption benefit $U(s)$ during the time of studies. It is assumed that the expected starting salary W_g after graduation from upper secondary school fluctuates more widely in response to changes in the unemployment rate than the expected starting salary W_u after university graduation, because it is harder for a person with lower qualifications to find work. Hence,

$$\begin{aligned} W_u &= \delta - \alpha u \\ W_g &= \varepsilon - \beta u \\ b &= \eta - \gamma u \end{aligned}$$

applies, where $0 < \alpha < \beta$ and $\gamma > 0$. γ can be interpreted as loss of consumption benefit due to unemployment during the period of studies, while α and β represent the likely loss of salary through unemployment.

Once again, the implicit function theorem can be used to show that an increase in the unemployment rate u results in a lower total time-to-degree s, provided parameter a of the consumption benefit function exceeds the threshold value $\bar{a}$ (see section 3.3.1) and the consumption benefit loss γ due to unemployment is large enough in relation to the likely salary loss $2\alpha - \beta$[6]:

$$a > \bar{a} \ , \ \gamma k_{r,s^*,s_0} > 2\alpha - \beta \qquad \Longrightarrow \qquad \frac{\mathrm{d}s}{\mathrm{d}u} < 0$$

where $k_{r,s^*,s_0} > s^*$ and $\mathrm{d}k_{r,s^*,s_0}/\mathrm{d}s_0 < 0$. This means that in this case, if unemployment increases, work will be replaced by academic activity and the total time-to-degree will be shorter as a result. The longer the chosen time-to-degree is, the higher is the constant k_{r,s^*,s_0}. Hence, if the chosen time-to-degree is long, the consumption benefit loss γ through unemployment can be small compared to the likely salary loss, with the result that work is replaced by

[6]The conclusion from $a < \bar{a}$ and $\gamma k_{r,s^*,s_0} < 2\alpha - \beta$ would be that an increase in the unemployment rate u produces a lower total time-to-degree s. However, only the case where $a > \bar{a}$ holds is of interest to us.

academic activity. Toward the end of the university period, i.e. when s_0 is large, the factor k_{r,s^*,s_0} will be small. Thus, an increase in the unemployment rate is more likely to make the student prolong his or her studies.

4 Data

4.1 Graduate survey

The data used in this paper are from 11 waves of survey (1981, 1983, ... , 2001) of Swiss university graduates. The survey is covering all graduates and is conducted by the Swiss Federal Statistical Office every two years since 1981. The surveys have remained basically unchanged since 1981, but key questions were added to the questionnaires in later rounds of the survey[7]. Although the 2003 and 2005 surveys have been conducted and the results presented to the public, the datasets were not accessible to the authors during the preparation of this paper.

About one year after finishing their studies, information is elicited in writing from graduates with regard to labor force entry and their first job or to post-graduate studies. Information is also elicited on study behavior which at least enabled the partial reconstruction of their university biography.

4.2 Dataset

The pooled dataset of all 11 waves was used for this paper, in order to have access to the largest possible number of observations for the estimates. The final dataset contains 12,028 observations. As a result of adjustment of the dataset for the purposes of this essay, only approximately 20% of the dataset was used for the empirical analysis. The main reasons for reduction of the original dataset are presented below.

Various important aspects of the organization of studies at Swiss universities were taken into account in the processing and analysis of the database:

[7]For example, graduates were asked about their parents' level of education for the first time in 1999, and questions about exchange semesters were first incorporated in the 1991 questionnaire.

Many courses of study have a fairly rigid, school-like structure, leaving students with little to no latitude in terms of study planning. Deviations from the standard time-to-degree are observed only for students who failed exams and had to repeat a year or more for that reason. In consequence, variations in time-to-degree in these subjects are due rather to performance than to individual study planning on the part of students. Economic variables such as unemployment rate and wage levels are therefore unlikely to have an impact on time-to-degree in these courses of study. Therefore, degree programs with this kind of rigid structure were excluded from the sample. Furthermore, a number of degree programs, particularly at universities in French-speaking Switzerland, have a minimum time-to-degree of only three years. This time span may be viewed as being too short to allow economic changes to impact on student decisions. As a result, these degree programs were also excluded from the dataset. Students completing their studies in fewer than 8 or more than 20 semesters were removed from the database because it can be assumed that such extreme values are for reasons other than voluntary prolongation or curtailment of time-to-degree. Degree programs with a very small level of variation in time-to-degree, and those with a very low number of students, were excluded from the dataset for the same reason. The analysis only took comparable degree programs into account. The discipline law is another special case, because the bulk of the law graduates embark upon a low-paid internship after graduating. This means that prospective lawyers have different expectations of their salary in the immediate post-university period than students of other disciplines (Wolter and Zbinden (2001), Weber and Wolter (2003)). For that reason, law was excluded from the database.

Students who began their studies before 1977 or after 1992 were not included in the analysis. As the first graduates were surveyed in 1981, any graduates who started studying before 1977 will be those with a longer than average time-to-degree. The opposite applies to graduates initiating their studies after 1992. This group will only contain graduates with a shorter than average time-to-degree, since the last data was collected in 2001. The business cycle data is matched to the individual observations according to the year of initia-

tion; therefore, a consistent level of variability of individual times-to-degree is desirable for all years of study initiation. This lead to a substantial reduction in the number of observations.

Furthermore, this paper only considers graduates who initiated their studies between the ages of 17 and 35. Any observations with inconsistent replies, as identified by comparing the number of studied semesters and the number of semesters during which the student engaged in paid work, were excluded from the analysis. The original data collection included also graduates who had completed a PhD. To limit the analysis to graduates in a similar situation concerning the time-to-degree decision, only graduates with a primary degree (who may be thinking of doing a second degree) were taken into consideration. PhD students were therefore excluded from the dataset.

To sum up: The final database contains Swiss university graduates from the 1980 to 2000 period who initiated their studies between 1977 and 1992, studied no fewer than 8 semesters and no more than 20 semesters, were largely free to determine their study planning, and had a primary degree at the time of the survey.

4.3 Variables used

The requisite economic data, i.e. unemployment rate, real wage index, consumer price index (CPI), short-term nominal interest rate and gross domestic product, were made available by the Swiss Federal Statistical Office (SFSO), Swiss National Bank (SNB) and the State Secretariat for Economic Affairs (SECO). The following economic variables were used from this data:

Unemployment rate Arithmetic mean of monthly figures for a given year (SECO)

Real 3-month interest rate Difference in the annual mean of the nominal 3-month interest rate (SNB) and inflation rate for the given year[8]

[8] Euromarket CHF 3-month interest rate at month's end.

Inflation rate Calculated from the rate of change of the mean consumer price index (SFSO) in a given year versus the previous year

Wage change Change in real wage index (SFSO) in a given year versus the previous year

GDP growth Change in mean real gross domestic in a given year versus the previous year

The individual observations were matched with the value of these variables for both the third and fourth year of studies. The reason for this procedure is the assumption that the state of the economy during the first two years of study, i.e. the basic study period, has no impact on time-to-degree. Furthermore, the shortest time-to-degree in the final dataset is 8 semesters. This means that the impact of an economic variable on time-to-degree can only be analyzed in the third or fourth year of study.

5 Empirical analysis

5.1 Statistical model

In a first approach, a linear regression model (OLS) is used in estimating the correlation between time-to-degree and various economic variables. Time-to-degree is taken as the dependent variable y. The explanatory variables used are the economic variables $\boldsymbol{x} = (x_1, x_2, x_3)$, consisting of unemployment rate, real interest rate, and changes in wage index or GDP growth, and faculty dummies $\boldsymbol{z} = (z_1, \ldots, z_{J-1})$ for the J various faculties, and additional descriptive variables such as dummies for universities, dummies for years, age at study initiation, gender, nationality, completion of vocational training before studying, and university teacher education programs, reproduced by the vector $\boldsymbol{v}$. Due to the strong correlation between the economic variables of wage change and GDP growth, the effects of these variables on time-to-degree are estimated in separate models due to multicollinearity.

This yields the model equation

$$y = \mu + \boldsymbol{x}\boldsymbol{\beta} + \boldsymbol{z}\boldsymbol{\gamma} + \boldsymbol{v}\boldsymbol{\delta} + \varepsilon \tag{3}$$

where $\boldsymbol{\beta}, \boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ represent the column vectors with the coefficients to be estimated.

With the linear regression model, the impact of the economic variables in the third and fourth year of study on time-to-degree is investigated. However, because the students display different times-to-degree ranging from 8 to 20 semesters, the analysis falls midway during their studies for some and at the end of their studies for others. There is also the fact that the economic variables vary over time. Hence, it is not measured the same for all students. In view of this circumstance, it makes sense to analyze the short-term effects of changes in economic variables at a particular time on time-to-degree to test the robustness of the findings in the OLS model. Short-term in this context means a period of 1-2 years.

For this purpose, in a second approach the dependent variable y was converted to a binary variable $\tilde{y}$, where the newly introduced variable takes the value of 1 if a graduate has a time-to-degree of more than 9 semesters - which is another way of saying a graduate needed more than four whole years until graduation - and zero otherwise.

$$\tilde{y} = \begin{cases} 1 & \text{if } y \geq 10 \\ 0 & \text{otherwise} \end{cases}$$

A probit model with $\tilde{y}$ as dependent variable enables an estimation of the effect of economic variables in the third and fourth year of study on the probability of studying for more than 9 semesters. The model equation is as follows:

$$\Pr(\tilde{y} = 1 | \boldsymbol{x}, \boldsymbol{z}, \boldsymbol{v}) = \Phi(\mu + \boldsymbol{x}\boldsymbol{\beta} + \boldsymbol{z}\boldsymbol{\gamma} + \boldsymbol{v}\boldsymbol{\delta}) \ , \tag{4}$$

where $\Phi(\cdot)$ denotes the standard normal distribution function.

5.2 Estimation

5.2.1 Linear regression model

In a first approach, model equation (3) is estimated using linear regression. The results are given in tables 1 and 2.

Unemployment rate

The first question addressed is the effect of a rising unemployment rate in the third or fourth year of study on a graduate's time-to-degree. Both estimations lead to the result that an increase in the unemployment rate has the same significant negative impact on time-to-degree, both in the third and in the fourth year of study. A one percentage point increase in the unemployment rate, ceteris paribus, shortens the time-to-degree by approximately 12% in both cases. Given the median time-to-degree of 12 semesters, a one percentage point increase in the unemployment rate in the third or fourth semester shortens the time-to-degree by 1.5 semesters to 10.5 semesters. Since a rising unemployment rate is associated with a lower probability of being engaged in paid work, the logical conclusion for a student is to substitute engaging in employment on the labor market by studying[9]. This applies in particular if the student expects the increase in unemployment to be of short duration and expects to be able to find a job soon after the earlier graduation. This effect is likely to have a different impact in countries with a persistently high rate of graduate unemployment.
The available data indicate that the overall effect of a change in the unemployment rate on time-to-degree is negative. As such, this outcome is consistent with the outcomes of the investigations by Dellas and Koubi (2003) and Dellas and Sakellaris (2003). Both studies conclude that individuals replace work with education in periods when it is more difficult to find work, particularly during recession. In contrast, the findings presented by Brunello and Winter-Ebmer (2003), according to which a higher unemployment rate is associated with a higher average excess of time-to-degree, are not directly comparable to the results presented in this paper, because those results are based on a cross-sectional analysis comparing students in countries with a structurally high unemployment with those from countries with a low unemployment rate.

[9]The impact measured in this study is probably that large because a relatively high number of students in the disciplines covered by the dataset is engaged in side employment. In the humanities and social sciences for example, 85 % of the students reported side employment in 2005 (see BFS 2007).

Table 1: OLS estimation with wage change

Dependent variable: Number of semesters (logarithmized)

Independent variables	**Coeff.**	**(St. Err.)**	**Coeff.**	**(St. Err.)**
Unemployment rate (3)	-0.115**	(0.002)		
Unemployment rate (4)			-0.119**	(0.002)
3-month interest rate (3)	-0.015**	(0.001)		
3-month interest rate (4)			-0.007**	(0.001)
Wage change (3)	-0.143	(0.127)		
Wage change (4)			-0.449**	(0.134)
Theology	-0.052**	(0.007)	-0.059**	(0.007)
Cultural sciences and history	0.002	(0.005)	0.003	(0.005)
Social sciences	-0.078**	(0.005)	-0.077**	(0.005)
Economic sciences	-0.181**	(0.005)	-0.180**	(0.005)
Formal sciences	-0.100**	(0.007)	-0.099**	(0.007)
Natural sciences	-0.148**	(0.005)	-0.148**	(0.005)
Age at study initiation	-0.024**	(0.006)	-0.022**	(0.005)
Age at study initiation (squared)	0.000**	(0.000)	0.000**	(0.000)
Woman	-0.002	(0.003)	-0.004	(0.003)
Swiss nationality	-0.006	(0.005)	-0.006	(0.005)
Teacher education program	0.022**	(0.007)	0.016*	(0.007)
Apprenticeship	0.014**	(0.005)	0.010*	(0.005)
Intercept	2.776**	(0.071)	2.723**	(0.070)
Number of observations	12028		12028	
R^2	0.558		0.564	
$F_{(30,11997)}$	503.946		517.441	

Significance levels : † : 10% * : 5% ** : 1%

Outcomes were controlled for year of survey and university, language and literature studies are taken as the reference group.

Real interest rate

As already seen for the unemployment rate, the outcome is again the same for both estimates: both in the third and in the fourth year of study, an increase

in the real interest rate produces approximately the same significant negative impact on time-to-degree. A one percentage point increase in the real interest rate shortens the time-to-degree by up to 2%. Since higher interest rates are accompanied by a higher interest burden on loans, the outcome indicates that variations in the financing cost are of relevance to students. Even if students, or their parents, do not rely on loans for funding, higher interest rates increase the cost of a university education because the students or their parents would otherwise be able to invest this money profitably at higher interest rates instead of using it to fund a university education. Dellas and Koubi (2003) and Dellas and Sakellaris (2003) likewise underline the importance of financing costs on the education decisions of individuals. According to their findings, an increase in the real interest rate correlates with a reduction in enrollment rates. This outcome, in turn, agrees with the results presented here.

Change in real wages

With respect to the effects of real wage growth on time-to-degree, it can be seen that higher wages at an early stage in the period of study have no significant effect. Although higher wages increase the opportunity costs of a university education, they also mean better earning opportunities while at university. At a time when study completion is not yet an option, these two effects cancel each other out. When a student approaches the potential end of his or her studies, the opportunity costs predominate, which explains why high wage growth during the fourth year of study tends to shorten the time-to-degree. This result is consistent with the conclusions from the model (see 3.3.2). However, the effect size is fairly small compared with the effect of the unemployment rate.

GDP growth

A change in real GDP growth during the third year of university studies has a significant positive impact on time-to-degree, while a change in economic growth in the fourth year of study has a significant negative effect on the time-to-degree. The hypothesis that GDP growth has a similar effect on time-to-degree as wage changes seems to be validated for the fourth year of study, for the same reasons as in the case of wage changes.

Table 2: OLS estimation with GDP growth

Dependent variable: Number of semesters (logarithmized)

Independent variables	**Coeff.**	**(St. Err.)**	**Coeff.**	**(St. Err.)**
Unemployment rate (3)	-0.113**	(0.002)		
Unemployment rate (4)			-0.120**	(0.002)
3-month interest rate (3)	-0.020**	(0.001)		
3-month interest rate (4)			-0.005**	(0.001)
GDP growth (3)	0.010**	(0.001)		
GDP growth (4)			-0.005**	(0.001)
Theology	-0.052**	(0.007)	-0.058**	(0.007)
Cultural sciences and history	0.003	(0.005)	0.004	(0.005)
Social sciences	-0.078**	(0.005)	-0.077**	(0.005)
Economic sciences	-0.180**	(0.005)	-0.179**	(0.005)
Formal sciences	-0.099**	(0.007)	-0.098**	(0.007)
Natural sciences	-0.147**	(0.005)	-0.148**	(0.005)
Age at study initiation	-0.024**	(0.006)	-0.022**	(0.005)
Age at study initiation (squared)	0.000**	(0.000)	0.000**	(0.000)
Woman	-0.002	(0.003)	-0.004	(0.003)
Swiss nationality	-0.006	(0.005)	-0.006	(0.005)
Teacher education program	0.021**	(0.007)	0.017*	(0.007)
Apprenticeship	0.014**	(0.005)	0.011*	(0.005)
Intercept	2.742**	(0.071)	2.732**	(0.070)
Number of observations	12028		12028	
R^2	0.561		0.564	
$F_{(30,11997)}$	511.402		518.093	

Significance levels : † : 10% * : 5% ** : 1%

Outcomes were controlled for year of survey and university, language and literature studies are taken as the reference group.

The positive effect of GDP growth in the third year of study on time-to-degree, which was not observed in connection with real wage growth, can once again be explained by the fact that in the third year of study, students cannot obtain

their degree quick enough and it is more profitable to engage in a sideline job than to spend more time on their studies. This result is consistent with the consequences derived from the model (see 3.3.2).

Other variables

Age at study initiation has a significant positive impact on time-to-degree. The older a person is at study initiation, the more likely this person is to complete the studies quickly. This effect is easy to understand given that advancing age correlates with rising opportunity costs, with the result that the student is under pressure to complete his or her studies as soon as possible.
The fact that the teacher education program at university level significantly lengthens the time-to-degree is also readily understandable on an intuitive basis. The teacher education program at university is an additional qualification which students are required to complete in addition to their chosen basic course of studies. In contrast, the observation that a completed vocational apprenticeship before initiation of studies has a significantly positive effect on time-to-degree is not easily explained. Possibly, it is easier for students with a vocational qualification to find a job while studying, and they are unwilling to forgo the employment experience and a paycheck after their years of vocational training, which ultimately results in a longer time-to-degree.

5.2.2 Probit model

As an alternative specification, the probit model equation (4) is estimated. The results are given in Tables 3 and 4.
In qualitative terms, the results are the same as with the linear regression model. Therefore, the following discussion is limited to a brief description of the results for the economic variables. Possible reasons are presented in the previous subsection 5.2.1. In addition, all observations from survey years 1999 and 2001 are omitted in the probit estimation, because graduates with a time-to-degree below 10 semesters are not included in the final dataset: Students who commenced their studies after 1992 were excluded (see section 4.2).

Table 3: Probit estimation with wage change
Dependent variable: Studying for more than 9 semesters (marginal effects)

Independent variables	**Coeff.**	**(St. Err.)**	**Coeff.**	**(St. Err.)**
Unemployment rate (3)	-0.209**	(0.008)		
Unemployment rate (4)			-0.201**	(0.006)
3-month interest rate (3)	-0.014**	(0.003)		
3-month interest rate (4)			-0.001	(0.003)
Wage change (3)	0.380	(0.254)		
Wage change (4)			-0.753**	(0.258)
Theology	-0.009	(0.018)	-0.019	(0.018)
Cultural sciences and history	-0.010	(0.013)	-0.011	(0.012)
Social sciences	-0.179**	(0.019)	-0.165**	(0.018)
Economic sciences	-0.252**	(0.020)	-0.254 **	(0.020)
Formal sciences	-0.129**	(0.024)	-0.132**	(0.024)
Natural sciences	-0.257**	(0.020)	-0.258**	(0.020)
Age at study initiation	-0.039**	(0.011)	-0.035**	(0.012)
Age at study initiation (squared)	0.001**	(0.000)	0.001**	(0.000)
Woman	0.000	(0.006)	-0.004	(0.006)
Swiss nationality	0.012	(0.011)	0.010	(0.010)
Teacher education program	0.043 **	(0.012)	0.037**	(0.011)
Apprenticeship	0.024*	(0.009)	0.020 *	(0.009)

Number of observations	10460	10460
Log-likelihood	-3803.481	-3759.204
$\chi^2_{(28)}$	3098.196	3186.75
Observed probability	0.792	0.792
Estimated probability	0.904	0.911
Pseudo R^2	0.290	0.298

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Outcomes were controlled for year of survey and university, language and literature studies are taken as the reference group.

Table 4: Probit estimation with GDP growth
Dependent variable: Studying for more than 9 semesters (marginal effects)

Independent variables	**Coeff.**	**(St. Err.)**	**Coeff.**	**(St. Err.)**
Unemployment rate (3)	-0.202**	(0.007)		
Unemployment rate (4)			-0.203**	(0.006)
3-month interest rate (3)	-0.022**	(0.003)		
3-month interest rate (4)			0.001	(0.003)
GDP growth (3)	0.016**	(0.002)		
GDP growth (4)			-.007**	(0.002)
Theology	-0.007	(0.017)	-0.018	(0.018)
Cultural sciences and history	-0.008	(0.012)	-0.009	(0.012)
Social sciences	-0.179**	(0.019)	-0.162**	(0.018)
Economic sciences	-0.252**	(0.020)	-0.249**	(0.020)
Formal sciences	-0.131**	(0.025)	-0.128**	(0.024)
Natural sciences	-0.256**	(0.020)	-0.253**	(0.020)
Age at study initiation	-0.039**	(0.011)	-0.036 **	(0.010)
Age at study initiation (squared)	0.001**	(0.000)	0.001**	(0.000)
Woman	0.000	(0.006)	-0.004	(0.006)
Swiss nationality	0.011	(0.011)	0.009	(0.010)
Teacher education program	0.042**	(0.012)	0.037 **	(0.011)
Apprenticeship	0.025*	(0.009)	0.020*	(0.008)
Number of observations	10460		10460	
Log-likelihood	-3778.240		-3759.170	
$\chi^2_{(28)}$	3148.677		3186.818	
Observed probability	0.792		0.792	
Estimated probability	0.904		0.913	
Pseudo R^2	0.294		0.298	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%
Outcomes were controlled for year of survey and university, language and literature studies are taken as the reference group.

All probit estimations produce the same result with regard to the marginal effect

of the unemployment rate. A change in the unemployment rate in the third or fourth year of study is negatively correlated with the probability of studying for more than 9 semesters.

In contrast with the linear regression model, a variation in the real interest rate has only in the third year of study a significant negative effect on the probability of graduating after 10 semesters at the earliest, which, by all means, might be the consequence of the specification of the dependent variable. In any case, and again consistent with the conclusion derived from the theoretical model, the non-significance of the interest rate variable in the fourth year of study can be explained by the fact, that higher financial costs shortly before graduation are less likely to shorten the time-to-degree.

As with the OLS estimation, an increase in real wages has a significant negative impact on the probability of studying for longer than 9 semesters only in the fourth year of study.

The marginal effect of GDP growth indicates a positive effect of a change in GDP growth in the third year of study on the probability of graduating after no less than 10 semesters, and suggests a negative effect of GDP growth in the fourth year of study. Again, this result is consistent with the OLS estimation.

5.2.3 Omitted variable bias

All estimations in this section were additionally performed using a smaller sample consisting of the surveys (1989, 1991, ... , 2001) which contained more information on variables that also have an impact on time-to-degree. This was used to test whether the results presented for the years from 1981 to 2001 are subject to a bias arising from the fact that certain independent variables could not be taken into account throughout the entire period. As expected, the results showed that engaging in paid work and studying at the same time has a significant impact on individual time-to-degree. A sideline job unrelated to the subject being studied was identified in particular as tending to increase the time-to-degree (see Messer and Wolter (2005)). The estimation of the model including paid work with the smaller sample produces no quantitative or qualitative differences in any of the other estimated coefficients of the model. In other words, it can be assumed that the omission of variables measuring student side-

line employment does not produce any omitted variable bias in the estimations. The same result is obtained if the model including the information, whether a student spent one semester or more at another university during the course of his or her studies, is estimated.

6 Summary and conclusions

Time-to-degree - apart from a given minimum number of semesters - is not rigidly set forth at many faculties and universities, and thus depends to a very great extent on the students themselves. This paper presents a model which allows optimum individual time-to-degree to be determined as a tradeoff between the cost and the consumption benefit of additional semesters of study. This paper also sets up hypotheses as to the effects of economic factors - such as the unemployment rate, interest rates, changes in wages and economic growth - on the optimum time-to-degree. Similar to empirical studies demonstrating a cyclical effect on the probability of commencing a university education, empirical review of our model shows that the business cycle also helps to determine the individual time-to-degree. To be more precise, a high unemployment rate and high real interest rate shorten the time-to-degree by directly increasing the cost of a university education. Vigorous changes in real wages and economic growth, in turn, are indicators of rising opportunity costs, and have the same effect of shortening the individual time-to-degree. In a business cycle, however, rapidly rising wages and high economic growth are typically associated with low interest rates and a low unemployment rate. This prompts the question whether these effects cancel each other out during the business cycle or whether a cyclical pattern prevails nevertheless. Judging by the individual effect sizes, changes in the unemployment rate have by far the strongest effect on the individual time-to-degree. A possible explanation might be that most students rely on jobbing on the side to finance their studies and their consumption needs. The possibility of financing one's studies by working on the side depends heavily on the overall labor market situation. Hence, a low unemployment rate makes it more probable that students will engage in paid work instead of concentrating on their studies, which in turn lengthens their time-to-degree. If the effect of unemployment is

predominant despite the mutually counteractive effects of unemployment, interest rates, wage growth and economic growth, the time-to-degree can be assumed to follow a pro-cyclical pattern, i.e. individual times-to-degree will tend to be longer if the economy is strong, and vice versa. Hence, the cyclical patterns of time-to-degree and the probability of embarking on a university education are directly opposed. On account of lower opportunity costs, recessions increase the probability of initiating a university education, and at the same time are likely to be associated with shorter individual times-to-degree, because students find it less easy to engage in paid work instead of concentrating on their studies during their time at university.

Overall, the effect of the economic environment on aggregate mean time-to-degree increases the more students are able to influence their time-to-degree on an individual basis, and the more students must rely on paid sideline work to put themselves through university.

The paper has made both a methodological and a substantive contribution. On the methodological side, it is - to our knowledge - the first time that time-to-degree is modelled in a human capital framework. On the substantive side, this paper adds to the literature that shows, that students are subject to economic influences not only in their decision to take up a study but also in their study behavior. The latter is further evidence, that labor market conditions and the general economic situation can influence the educational sector as much as educational institutions and regulations.

References

[1] **Amann, R.A. (2005)**. The Effects of Employment on Time-to-Degree in Higher Education: Does the Type of Employment matter?, Working Paper der Forschergruppe "Heterogene Arbeit: Positive und normative Aspekte der Qualifikationsstruktur", Universität Konstanz und Zentrum für Europäische Wirtschaftsforschung, Mannheim.

[2] **Brunello, G. and Winter-Ebmer, R. (2003)**. Why Do Students Expect to Stay Longer in College? Evidence from Europe, in: *Economics Letters*, 80 (2), 247-253.

[3] **Bundesamt für Statistik (BfS) (2007)**. Studien- und Lebensbedingungen an den Schweizer Hochschulen. Hauptbericht der Studie zur sozialen Lage der Studierenden 2005, Neuchâtel.

[4] **Dellas, H. and Koubi, V. (2003)**. Business Cycles and Schooling, in: *European Journal of Political Economy* 19 (4), 843-859.

[5] **Dellas, H. and Sakellaris, P. (2003)**. On the Cyclicality of Schooling: Theory and Evidence, in: *Oxford Economic Papers*, 55 (1), 148-172.

[6] **Messer, D. and Wolter, S.C. (2007)**. Are Student Exchange Programs Worth It?, Higher Education, forthcoming.

[7] **Weber, B. und Wolter, S.C. (2003)**. Welche Löhne und Bildungsrenditen erwarten Studierende an Schweizer Hochschulen?, in: U.Backes-Gellner/C. Schmidtke (Hrsg.), Hochschulökonomie - Analysen interner Steuerungsprobleme und gesamtwirtschaftlicher Effekte, Duncker & Humblot, Berlin.

[8] **Wolter, S.C. and Zbinden, A. (2002)**. Labour Market Expectations of Swiss Students. International Journal of Manpower, 23 (5), 458-470.

A Derivations

All variables used to derive the model are described in section 3.1.

A.1 Net present value

Net present value is given by

$$\begin{aligned} \mathrm{NPV}(s, \boldsymbol{x}) &= (W_u - W_g) \int_s^T \mathrm{e}^{-rt}\,\mathrm{d}t + (U(s) - C) \int_{s_0}^{s} \mathrm{e}^{-rt}\,\mathrm{d}t \\ &\quad -W_g \int_{s_0}^{s_{\min}} \mathrm{e}^{-rt}\,\mathrm{d}t - W_u \int_{s_{\min}}^{s} \mathrm{e}^{-rt}\,\mathrm{d}t \ , \end{aligned}$$

where $\boldsymbol{x} = (W_u, W_g, C)$ designates the vector of the business-cycle variables. The net present value is to be maximized with respect to the time-to-degree s. For this purpose, function $f(s, \boldsymbol{x})$ is defined as

$$f(s, \boldsymbol{x}) = \frac{\mathrm{dNPV}(s, \boldsymbol{x})}{\mathrm{d}s} \ .$$

In the optimum, the first-order condition

$$\begin{aligned} f(s^*, \boldsymbol{x}) &= -(2W_u - W_g + C + a{s^*}^2 - bs^*)\mathrm{e}^{-rs^*} \\ &\quad -\frac{(b - 2as^*)(\mathrm{e}^{-rs^*} - \mathrm{e}^{-rs_0})}{r} \\ &= 0 \end{aligned}$$

holds, where s^* designates the optimum choice of time-to-degree.

The effect of a variable x_i on time-to-degree s can be derived using the implicit function theorem (IFT). Let us assume $\bar{\boldsymbol{x}} = (\overline{W}_u, \overline{W}_g, \overline{C})$ is a vector with the given values of the business-cycle variables. Provided that $f(s, \boldsymbol{x})$ is continuously differentiable and $\frac{\partial f}{\partial s}(s^*, \bar{\boldsymbol{x}}) \neq 0$,

$$\frac{\mathrm{d}s}{\mathrm{d}x_i}(\bar{\boldsymbol{x}}) = -\frac{\frac{\partial f}{\partial x_i}(s^*, \bar{\boldsymbol{x}})}{\frac{\partial f}{\partial s}(s^*, \bar{\boldsymbol{x}})} \ .$$

hence holds in an environment of $\bar{\boldsymbol{x}}$.

A.2 Interest rate

In the function $f(s, \boldsymbol{x})$, C is replaced by $\mu + \rho i$ with $\rho > 0$. The aim is to investigate when $\mathrm{d}s/\mathrm{d}i < 0$ holds. Using the IFT,

$$\frac{\mathrm{d}s}{\mathrm{d}i}(\bar{\boldsymbol{x}}) = \frac{\rho r}{r^2(2\overline{W}_u - \overline{W}_g + \overline{C} - s^*(b - as^*)) + 2r(b - 2as^*) + 2a(1 - \mathrm{e}^{r(s^* - s_0)})} \tag{5}$$

is obtained.

Since $\rho > 0$ and $r \in (0, 1)$, the numerator is $\rho r > 0$. Thus, the question arises, when the denominator does become negative. The partial derivative of the denominator with respect to the parameter a is negative in the range of interest, where $s \in [8, 20]$ and $r \in (0, 1)$. This means that the denominator declines in this range as parameter a rises. As soon as parameter a crosses a certain lower threshold value $\bar{a}$, the denominator becomes negative. To identify this threshold value, the denominator is set to zero and solved with respect to parameter a. The threshold value as a function of parameter b is

$$\bar{a}(b) = \frac{2\overline{W}_u - \overline{W}_g + \overline{C} + b(2/r - s^*)}{2(\mathrm{e}^{r(s^* - s_0)} - 1)/r^2 + s^*(4/r - s^*)}$$

Assuming that the discount rate r is not more than 10% and the time-to-degree is in the range of 8 to 20 semesters, condition (1) yields

$$a > \bar{a}(b) > \bar{a}(2as^*)$$

Solved with respect to parameter a, this inequality represents the condition for a negative denominator in the range of interest:

$$a > \bar{a} = \frac{r^2(2\overline{W}_u - \overline{W}_g + \overline{C})}{2(\mathrm{e}^{r(s^* - s_0)} - 1) + r^2 s^{*2}} \tag{6}$$

From $W_u > W_g$ and $\mathrm{e}^{r(s^* - s_0)} > 1$ follows that $\bar{a} > 0$. Hence, if parameter a is greater than the threshold value $\bar{a}$, the denominator in (5) is negative and therefore $\mathrm{d}s/\mathrm{d}i$ is negative.

A.3 Wages

In the function $f(s, \boldsymbol{x})$, W_g is replaced by kW_u and b is replaced by $\mu + \nu lkW_u$ with $0 < k < 1$, $0 \leq l \leq 1$ and $\nu > 0$. The intention is to investigate when

$\mathrm{d}s/\mathrm{d}W_u < 0$ holds. Applying the IFT yields

$$\frac{\mathrm{d}s}{\mathrm{d}W_u}(\bar{\boldsymbol{x}}) = \frac{(2-k)r + \nu lk(1 - \mathrm{e}^{r(s^*-s_0)} - rs^*)}{r^2(2\overline{W}_u - \overline{W}_g + \overline{C} - s^*(b - as^*)) + 2r(b - 2as^*) + 2a(1 - \mathrm{e}^{r(s^*-s_0)})} \tag{7}$$

The denominator is the same as in (5). If, therefore, inequality (6) is met, the denominator will be negative. Thus, the question arises, when the numerator becomes positive. Since $\mathrm{e}^{r(s^*-s_0)} > 1$, $0 < k < 1$ and $l \geq 0$ hold, the numerator declines as parameter ν increases. Hence, as long as parameter ν does not exceed a certain upper threshold value, the numerator remains positive. To obtain this threshold value $\bar{\nu}$, the numerator is set to zero and solved with respect to parameter ν. The threshold value is

$$\bar{\nu} = \frac{(2-k)r}{lk(\mathrm{e}^{r(s^*-s_0)} + rs^* - 1)}$$

From $\mathrm{e}^{r(s^*-s_0)} > 1$ and $0 < k < 1$ follows that $\bar{\nu} > 0$. If, therefore, $a > \bar{a}$ ($a < \bar{a}$) holds, the denominator in (7) is negative (positive) and the numerator is positive (negative) and therefore $\mathrm{d}s/\mathrm{d}W_u$ is negative.

A.4 Unemployment rate

In the function $f(s, \boldsymbol{x})$, W_u is replaced by $\delta - \alpha u$ and W_g is replaced by $\varepsilon - \beta u$, where $\beta > \alpha > 0$. In addition, b is replaced by $\eta - \gamma u$ with $\gamma > 0$. The intention is to investigate when $\mathrm{d}s/\mathrm{d}u < 0$ holds. Applying the IFT yields

$$\frac{\mathrm{d}s}{\mathrm{d}u}(\bar{\boldsymbol{x}}) = \frac{r(\beta - 2\alpha) + \gamma(\mathrm{e}^{r(s^*-s_0)} + rs^* - 1)}{r^2(2\overline{W}_u - \overline{W}_g + \overline{C} - s^*(b - as^*)) + 2r(b - 2as^*) + 2a(1 - \mathrm{e}^{r(s^*-s_0)})} \tag{8}$$

The denominator is the same as in (5). If, therefore, inequality (6) is met, the denominator will be negative. This leads to the question when the numerator will be positive. The condition for a positive numerator is

$$\gamma k_{r,s^*,s_0} > 2\alpha - \beta \tag{9}$$

where $k_{r,s^*,s_0} = s^* + (\mathrm{e}^{r(s^*-s_0)} - 1)/r$. From $s^* - s_0 > 0$ and $r > 0$ follows that $k_{r,s^*,s_0} > s^*$. If, therefore, $a > \bar{a}$ ($a < \bar{a}$) and inequality (9) is met (not met), then the denominator in (8) will be negative (positive) and the numerator will be positive (negative) and therefore, $\mathrm{d}s/\mathrm{d}u$ is negative.

A.5 Parameters of the consumption benefit function

The consumption benefit function of the form

$$U(s) = -as^2 + bs$$

with $a > 0$ and $b > 0$ can be written as

$$U(s) = -a\left(s - \frac{b}{2a}\right)^2 + \frac{b^2}{4a} = -a(s+m)^2 + n$$

with $m < 0$ and $n > 0$.

The parameter a gives a measure of how fast the parabola rises or falls. The larger the absolute value of a, the smaller is the parabola opening, which is downward for the consumption benefit function.
The parameter m and n shift the normal parabola $y = x^2$ along the x- and y-axis respectively. If $m < 0$, the normal parabola shifts in positive x-direction and if $n > 0$, it shifts in positive y-direction.

Therefore, the larger the value of a is, the smaller is the downward parabola opening, and the smaller are the values of m and n. Hence, the parabola shifts in (-x)- and (-y)-direction. The larger the value of b is, the bigger the value for m and n will be, and the parabola will shift in x- and y-direction.

B Data

B.1 Excluded data

Rigid courses of study:
All courses of study at the Swiss Federal Institutes of Technology at Zurich and Lausanne and at the University of St.Gallen were excluded, as were the disciplines of medicine, pharmacy, law and engineering.

Degree courses with a minimum study duration of three years:
At the University of Fribourg, the disciplines of chemistry, geography and earth sciences were excluded. Excluded disciplines at the University of Geneva are sociology, political science, chemistry and economic sciences. At the University of Lausanne, the disciplines special education, sociology, political science, economic sciences and formal sciences were excluded. Excluded disciplines at the University of Neuchâtel are special education, political science, economic sciences and formal sciences. Other excluded subjects are teacher training for elementary and grammar school, interpreting and translation.

Degree courses with a small variance in time-to-degree or with a small number of students:
All degree courses at the University of Lugano, the subjects of linguistics, iberian language and literature, raetoromanic language and literature, christian catholic theology, philosophy at the University of Lucerne, information systems at the University of Bern, and all interdisciplinary degree courses.

Degree courses that are not comparable with other courses:
Social work was excluded because it is only on offer in this form at the University of Fribourg and is not directly comparable with the educational science discipline hosted at all other universities. Interdisciplinary degree courses such as ecology and sports were removed from the dataset, since they cannot be assigned to a specific discipline group.

B.2 Descriptive statistics

B.2.1 Number of semesters

Graduates spent 8 to 20 semesters obtaining a university degree, whereas half of the students required 12 semesters or less. Approximately 20% required less than 10 semesters and about 35% required more than 12 semesters. An even number of semesters is more common than an odd number of semesters. This observed phenomenon suggests that students prefer to complete their degree after a full academic year.

Table 5: Distribution of time-to-degree

Number of semesters	**Frequency**	**Frequency (%)**	**Cumulative frequency**
8	1'319	10.97	10.97
9	860	7.15	18.12
10	2'218	18.44	36.56
11	1'295	10.77	47.32
12	2'062	17.14	64.47
13	945	7.86	72.32
14	1'161	9.65	81.98
15	535	4.45	86.42
16	784	6.52	92.94
17	255	2.12	95.06
18	336	2.79	97.86
19	92	0.76	98.62
20	166	1.38	100.00
Total	12'028	100.00	

Table 5 shows the distribution of time-to-degree. The table strongly suggests that the distribution of study duration is positively skewed, which is illustrated in a histogram of time-to-degree (see Figure 1). For that reason, the logarithm of the variable 'Number of semesters' was used as the dependent variable.

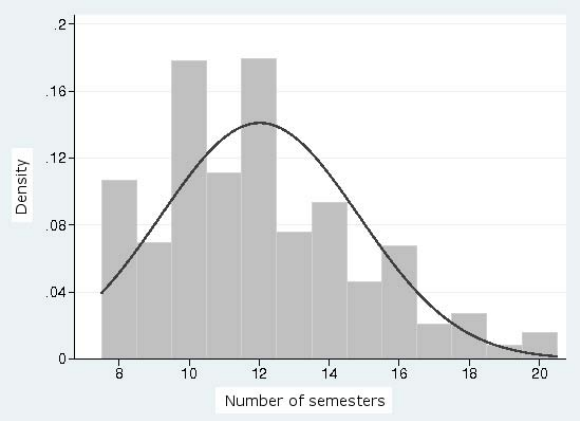

Figure 1: Histogram of time-to-degree

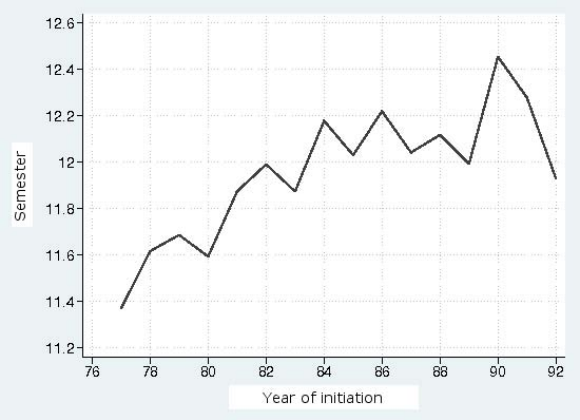

Figure 2: Mean time-to-degree by year of initiation

Figure 2 shows the trends in mean time-to-degree as a function of time, as calculated for each year for graduates who commenced their studies in that year. The curve indicates a long-term trend toward a higher mean time-to-degree with increasing time. It is also clearly apparent that the mean number of semesters studied fluctuates around the trend in the short-term, i.e. in a comparison of the time-to-degree of two or more groups of graduates, who commenced their studies in successive years[10].

[10] During data processing, it was attempted to ensure the same possible values for time-to-degree for all years of initiation. However, with respect to graduates who commenced their studies in 1991 or 1992, this group only contains graduates with less than 18 or 16 semesters

B.2.2 Economic variables

Table 6: Economic variables (in %)

Year	Unemployment rate	Interest rate (real)	Δ Index of wages (real)	Δ GDP
1980	0.209	1.749	1.600	4.575
1981	0.190	2.786	-1.181	1.470
1982	0.428	-0.775	0.797	-1.330
1983	0.905	1.092	2.372	0.531
1984	1.138	1.407	-0.386	3.129
1985	0.982	1.440	0.388	3.513
1986	0.832	3.411	3.089	1.708
1987	0.798	2.284	0.375	1.255
1988	0.720	1.263	1.866	3.279
1989	0.564	4.011	0.366	4.551
1990	0.501	3.382	-0.730	3.798
1991	1.083	2.224	1.838	-0.829
1992	2.549	3.703	1.083	0.027
1993	4.504	1.489	-0.714	-0.229
1994	4.723	3.205	0.719	1.066
1995	4.233	1.049	-0.357	0.379
1996	4.656	1.079	0.358	0.522
Mean	1.707	2.047	0.675	1.613
St. Dev.	1.697	1.246	1.184	1.866

of study, since the most recent graduates surveyed completed their degree in 2000.

B.2.3 Other variables

Table 7: Distribution of years of initiation

Year of initiation	Frequency	Frequency (%)	Cumulative frequency
1977	613	5.10	5.10
1978	670	5.57	10.67
1979	601	5.00	15.66
1980	728	6.05	21.72
1981	666	5.54	27.25
1982	743	6.18	33.43
1983	711	5.91	39.34
1984	728	6.05	45.39
1985	741	6.16	51.55
1986	752	6.25	57.81
1987	736	6.12	63.93
1988	798	6.63	70.56
1989	794	6.60	77.16
1990	919	7.64	84.80
1991	913	7.59	92.39
1992	915	7.61	100.00
Total	12'028	100.00	

Table 8: Quantitative variables (12'028 observations)

Variable	Mean	St. Dev.	Min.	Max.
Number of semesters	11.974	2.819	8	20
Age at study initiation	23.115	3.132	17	35

Table 9: Dummy variables (12'028 observations)

Variable	Mean
Theology	0.061
Languages and literature	0.193
Cultural sciences and history	0.161
Social sciences	0.170
Economic sciences	0.187
Formal sciences	0.055
Natural sciences	0.174
University of Basel	0.135
University of Bern	0.151
University of Fribourg	0.102
University of Geneva	0.102
University of Lausanne	0.076
University of Lucerne	0.008
University of Neuchâtel	0.032
University of Zurich	0.394
Survey in 1983	0.045
Survey in 1985	0.090
Survey in 1987	0.111
Survey in 1989	0.108
Survey in 1991	0.121
Survey in 1993	0.125
Survey in 1995	0.122
Survey in 1997	0.148
Survey in 1999	0.096
Survey in 2001	0.035
Woman	0.435
Swiss nationality	0.923
Teacher education program	0.047
Apprenticeship	0.094