Open access • Journal Article • DOI:10.1080/09645292.2017.1305329

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Institutions: University of Göttingen, German Network Agency

Published on: 30 Mar 2017 - Education Economics (Routledge)

Topics: Graduation and Academic achievement

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Working Paper

Determinants of students' success at university

cege Discussion Papers, No. 214

Provided in Cooperation with:
Georg August University of Göttingen, cege - Center for European, Governance and Economic Development Research

Suggested Citation: Danilowicz-Gösele, Kamila; Meya, Johannes; Schwager, Robert; Suntheim, Katharina (2014) : Determinants of students' success at university, cege Discussion Papers, No. 214, University of Göttingen, Center for European, Governance and Economic Development Research (cege), Göttingen

This Version is available at:
http://hdl.handle.net/10419/102397

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Discussion Papers

Number 214 – September 2014

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GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

ISSN: 1439-2305

Determinants of Students' Success at University*

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September 2014

Abstract

This paper studies the determinants of academic success using a unique administrative data set of a German university. We show that high school grades are strongly associated with both graduation probabilities and final grades, whereas variables measuring social origin or income have only a smaller impact. Moreover, the link between high school performance and university success is shown to vary substantially across faculties. In some fields of study, the probability of graduating is rather low, while grades are quite good conditional on high school performance. In others, weaker students have a greater chance of graduating, but grades are more differentiated.

Keywords: university, high school, grade point average, faculties, education
JEL classification: I23, I21

*We gratefully acknowledge financial support by the German Federal Ministry of Education and Research under grant number 01PW11004. We thank Alexander Esseling and Felix Albrecht for very competent assistance in data handling, and Madhinee Valeyatheepillay for carefully proof-reading the text. Responsibility for the content remains with the authors.

1 Introduction

The number of students in higher education worldwide is constantly increasing. Today's students are more heterogeneous than ever before and possess a wide and diverse range of characteristics and abilities. They often differ in educational background, social status, skills, and academic potential, among others. As the diversity of the student population increases, factors predicting students' academic performance become a matter of concern for most institutions in the educational sector (Burton and Dowling, 2005; Simpson, 2006). For example, knowledge about factors affecting academic success is relevant for universities when selecting the most promising students. At an aggregate level, based on such knowledge, policy can decide to what extent investment in tertiary education should be directed towards those fields where large numbers of students can expect to succeed, or be concentrated in fields which rather cater to a minority of excellent students.

Our study addresses this concern by focusing on the question of whether, and if so to what extent student characteristics can be used for predicting academic success. We find a highly significant and positive effect of the high school leaving grade on academic performance. Additionally, we narrow our view towards differences between fields of study, grouped by faculties. We find that the importance of the high school leaving grade differs strongly between fields. In some faculties graduation is less difficult to achieve, but not necessarily associated with a good final grade. However, in other faculties, graduation seems to be less likely, but among those students who graduate, the final university grade is on average better and less differentiated. This points towards diverging teaching and examination cultures among faculties. Some of them specialize in preparing a positive selection of students to science or demanding employment, whereas others provide an education which is accessible for large numbers of high school graduates with average abilities.

The probability of academic success and the reasons for dropping out of university are subject of the continuously expanding research literature in many areas, notably economics of education, psychology and sociology. These studies provide a consistent picture of previous high school performance as the most prominent predictor of university success. Furthermore, various other factors are found to determine students' academic performance. Generally, there is an agreement among the education research field that factors such as gender, age, socio-economic status, and student retention are also relevant (Baron-Boldt, 1989; Clark and Ramsay, 1990; Hong, 1984; Evans, 1999;

McKenzie and Schweitzer, 2001). On the other hand, the validity of some other factors such as field of study, ethnicity or language background remains controversial (Birch and Miller, 2007; Evans, 1999; McKenzie and Schweitzer, 2001).

Although there is a vast amount of literature on factors predicting academic success, our paper differs from previous work in this area in a number of ways. Firstly, to the best of our knowledge, this is the first paper that analyzes a comprehensive administrative data set of student population, that aims to be an encompassing analysis of students' characteristics as predictors for academic success at university in Germany. In contrast to much of the earlier work, we can track students' academic careers from the admission day onward. For instance, we observe changes in fields of study. Secondly, we analyze not only one but three dimensions of academic success: graduation from the university, graduation within a chosen field of study and final grade of the university degree. Thirdly, differentiating between faculties and types of degrees allows us to observe different examination cultures.

The remainder of the paper is structured as follows: In Section 2 we present a brief overview of the related literature. In Section 3 we describe our dataset, explain the variables used, and lay out the empirical setup. We turn our attention to our empirical results in Section 4 and conclude with a discussion of the implications of these results in Section 5.

2 Literature

As the universities' selection process is often based on high school performance, almost all literature dealing with students' academic performance examines in the first place whether the high school Grade Point Average (GPA) is a valid predictor for university success. According to Power, Robertson, and Baker (1987), the correlation between secondary school grades and university GPA is generally about 0.5. Trapmann et al. (2007) find a mean corrected validity between 0.26 and 0.53 for high school grades predicting university success by using a meta-analysis approach including studies from Austria, Czech Republic, Germany, Great Britain and Norway. In this sample, the German high school GPA has the highest validity.

However, the predictive effectiveness of secondary school grades on academic performance seems to be different for diverse groups. For instance, Dobson and Skuja (2005) show that high university entrance scores are indeed a good predictor, but not

for every field of study. They find a strong correlation between the university entrance scores and students' academic performance in agriculture, engineering and science, and almost no correlation in education and health studies. This corresponds to the results of Trapmann et al. (2007) who find a high predictive power for engineering and natural sciences and a comparatively low validity for psychology. Girves and Wemmerus (1988) develop a two-stage model for studying the factors that influence degree progress of graduate students and find that the high school GPA has the best predictive power. Since grading standards are not consistent across study programs, choice of graduate program seems to be an important issue.

The case study of the subsequent performance conducted at the University of Winnipeg by Cyrenne and Chan (2012) provides another evidence for the dependence of academic success on students' high school average. According to their analysis, high school grades are a good predictor of students' academic success in the short run. In the long run, their effect decreases and other factors become more important.

There is also a large number of contributions showing that students with the same entry grades are often found to perform differently in tertiary education, which suggests the importance of other factors when predicting university success. Based on an analysis of about 300 students of Monash University, Australia, Tomazin (2003) shows that an appropriate coaching program can reduce the impact of discrepancy in university entrance scores. Consequently, the entrance scores themselves may not be able to capture all relevant student characteristics.

In a study by Grebennikov and Skaines (2009) at the University of Western Sydney, data relating to about 9000 students was analyzed in order to determine a set of variables predicting students' academic performance and retention. They find that the odds of dropping out without applying to other educational institutions are significantly higher for part-time and mature students, who tend to have less time for studying and face stricter financial constraints. Furthermore, the probability of early withdrawal from university is particularly high for students from an English-speaking background and with a low grade point average.

An analysis of academic, psychological, cognitive, and demographic predictors for academic performance can be found in McKenzie and Schweitzer (2001). For this purpose, they examine a group of about 200 first year students and find significant coefficients for the university entry score (accounting for 39% of the variance in GPA), student institution integration (accounting for 3% of the variance in GPA) and self-efficacy (accounting for 8% of the variance in the GPA). When both the measure of

integration and the measure of self-efficacy are included in the model, the prediction of GPA at university is improved by 12%.

Looking at a data set of the population of newly enrolled students at the University of Brussels, Arias Ortiz and Dehon (2008) examine the probability of succeeding the first year at university by accounting for individual characteristics, prior schooling and socio-economic background. According to their results, socio-economic background, especially the mother's level of education and the father's occupational activity, matters for students' academic success. In addition, they observe differences in academic performance between students coming from different high school programs.

Further factors mentioned in the literature that may help identify students at risk of failing include: first year experience at the university (Krause et al., 2005), the ability to adapt to the university environment (McInnis, James and Hartley, 2000; Peat, Dalziel and Grant, 2001) or pre-semester tests (Spencer, 1996). Study skills have also been found to influence academic performance, but they only account for a small amount of variance in the GPA. Further studies emphasize the importance of psychosocial variables such as commitment to university (Tinto, 1975), satisfaction with university (Rickinson and Rutherford, 1996), emotional intelligence (Parker et al., 2004) or financial and social support (Gerdes and Mallinckrodt, 1994; Girves and Wemmerus, 1988).

Altogether it appears to be generally accepted that high school performance is the best predictor for university success. We confirm this result using a new and comprehensive dataset from a German university. Contrary to the mixed results about the link between high school GPA and success in specific fields, we find that such a link is present in all faculties, albeit in different forms. Specifically, by distinguishing between several measures of success, we are able to describe in detail how this relationship varies across fields. Finally, again contrasting with some of the results cited, our data does not support the view that social origin or income have strong additional impact on university success once high school grades are taken into account.

3 Data and Approach

In our analysis we use an extensive administrative dataset from Göttingen University, Germany, which encompasses detailed, anonymized information on more than 12,000 students. One part of the data is collected when students enroll at university and contains information about the student's high school leaving certificate, her parental

address, gender and type of health insurance. The other part includes information about the student's university career, such as the field of study, the reason for her leaving university, whether she obtained a degree and if so, which one.

In addition, we use data on the purchasing power of the German zip-code areas which is provided by *GfK*, a market research firm.[1] The index is based on data provided by the German tax offices as well as other relevant statistics, for instance regarding pensions and unemployment benefits.

Detailed information on data filtering and processing can be found in Appendix I.

3.1 Variable Description and Institutional Background

We use the following three measures of university success: the probability of finishing studies with a degree, the probability of finishing a chosen field of study with a degree and the grade of the final university degree. For the first two measures, it is necessary to distinguish between students who drop out and those who change institution. For this reason, we exclude students who mention that they leave Göttingen University in order to continue studying at another university from the sample.

As one is generally considered to be a successful student if one holds some degree after finishing university, we first examine a binary variable which describes whether the student graduates at all from university. The variable is equal to one for all students who finish their studies with any kind of degree at Göttingen University, and zero otherwise.

However, since in Germany students have to decide on their field of study as soon as they register for university, it is not uncommon that more than one subject is chosen or that the major is changed within the first few years. Therefore, we narrow down the definition of university success by using an additional outcome variable, labeled 'graduation within faculty', measuring success in each program the student enrolled in. This implies that when a student changes her field of study or enrolls in more than one degree program, several observations are generated. Thereby, success or failure are registered individually for every observation dependent on whether the student obtained a degree in this specific field of study or not. For example, for a student who changed her subject of study once during her university career and completed only the second study subject, the dataset will contain two observations. For the first observation,

[1] *GfK* is one of the biggest companies worldwide in the field of market research and collects information on people's lifestyle and consumption behavior.

the variable describing success equals zero, and for the second, it is one. However, as study programs within the same faculty are typically quite similar with respect to their content or required abilities, a change of subject is only seen as a failure if it also implies a change of the faculty.

The third outcome variable is the grade of the university degree. As some students are enrolled in more than one study program or complete two consecutive degree programs, we create individual observations for every final university degree obtained. Furthermore, we transform grades into the U.S. grading scale in order to make results internationally comparable and easier to interpret. In Germany, the grading schedule traditionally ranges from 1.0 to 5.0, with 1.0 being the best grade to achieve and 4.0 the worst grade that is still a pass. This implies that the better the performance, the lower the grade. The outcome variable *university GPA*, which we use in our analysis, is a transformation of the actual grade achieved. It ranges from 1.0 to 4.0 with 4.0 being the best grade to obtain and 1.0 the worst that is still a pass.[2]

The central exogenous variable used in the analysis is the high school GPA, a transformation of the grade of the high school leaving certificate. Similar to the grade of the university degree, it is converted to the U.S. grading scale with 4.0 being the best and 1.0 the worst passing grade.

The students' socio-economic background is captured by two variables: the type of health insurance and the purchasing power of the parents' zip-code area.

Due to a particular institutional feature of the German health insurance system, the type of health insurance can be used as a proxy for the students' educational and socio-economic background. In order to choose a private instead of the generally compulsory public health insurance, one has to earn more than a certain amount of income (2013 : 52,200 Euro gross income per year), be self-employed or work as civil servant. As most students are insured through their parents, the type of health insurance a student holds contains information about whether her parents satisfy at least one of the above criteria. Specifically, a large group of civil servants are teachers, and many self-employed and high earners hold a university degree. Overall, in 2008, 56.7 percent of the people being privately insured held a degree enabling registration at a university or a university of applied science, 38.0 percent had completed university or university of applied science with a degree or a Ph.D. Within the total German population, these shares were much lower, amounting to 24.4 and 13.0 percent respectively (Finkenstädt and Keßler, 2012;

[2]We transformed the grades into the U.S. grading scale by subtracting the final university grade from five. For legal studies the special grade "*vollbefriedigend*" is treated as a 2.5.

Statistisches Bundesamt, 2009).

The second socio-economic variable we use is an index of the purchasing power within the zip-code area of the student's home address evaluated in the year 2007. The index, provided by *GfK*, is measured relative to the German average, and normalized to 100. For example, an index value of 110 means that the purchasing power of this area is 10% higher than the German average. Since German zip-code areas are fairly small, with the biggest cities like Hamburg or Berlin encompassing up to 191 different zip-codes, and assuming a certain degree of residential sorting according to income, we are confident that this local measure approximates the students' economic background reasonably well.

As additional covariates we include indicator variables for male students, the sixteen German states and the university's thirteen faculties.

To get a more diversified picture of the determinants of university success, we also divide the data into sub-samples by faculty. At Göttingen University the various fields of study are assigned to thirteen faculties: theology, law, medicine, humanities, mathematics, physics, chemistry, geology/geography, biology, forestry, agriculture, economic sciences, and social sciences. A detailed analysis of individual faculties seems worthwhile since they may differ with regard to scientific approach, organizational structure and general conditions of studying.

3.2 Summary Statistics

The final dataset contains 12,315 students out of which 48% obtained a degree at Göttingen University. The remaining 52% left Göttingen University without completing a degree. Taking into account that students might be enrolled in more than one degree program or change fields of study during their university career increases the number of observations to 16,931. For 49% of these observations the respective field of study is completed with a degree.

When taking a look at those students who graduated, we see that a final grade is registered for 8,204 observations. This implies that around one third of the students who finished their studies obtained more than one university degree. The reason for this could be the introduction of the consecutive study programs which by definition leads to more than one degree for many students.

The mean university GPA is 2.97 and hence, higher than the mean high school GPA of all students in the dataset which is 2.50. Furthermore, the standard deviation of the

Table 1: Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Max
High School GPA	12315	2.50	0.63	1.10	4.00
Graduation (University)	12315	0.48	0.50	0.00	1.00
Graduation (within Faculty)	16931	0.49	0.50	0.00	1.00
Final Grade	8204	2.97	0.59	1.00	4.00
Male	12315	0.47	0.50	0.00	1.00
Private Health Insurance	12315	0.22	0.42	0.00	1.00
Purchasing Power Index	12315	98.50	11.79	64.72	186.99
Theology	16931	0.02	0.13	0.00	1.00
Law	16931	0.07	0.26	0.00	1.00
Medicine	16931	0.09	0.28	0.00	1.00
Humanities	16931	0.20	0.40	0.00	1.00
Mathematics	16931	0.04	0.19	0.00	1.00
Physics	16931	0.03	0.18	0.00	1.00
Chemistry	16931	0.04	0.19	0.00	1.00
Geology/Geography	16931	0.03	0.18	0.00	1.00
Biology	16931	0.08	0.28	0.00	1.00
Forest Sciences	16931	0.04	0.19	0.00	1.00
Agriculture	16931	0.09	0.29	0.00	1.00
Economic Sciences	16931	0.16	0.37	0.00	1.00
Social Sciences	16931	0.11	0.31	0.00	1.00

Grades transformed to 1-4 Scale, with 4 being the best grade and 1 being the worst grade that is still a pass.

final university grade is smaller than the standard deviation of the high school GPA. This indicates that compared to the grade of the high school leaving certificate, the distribution of the final university grade is compressed and shifted to the upper end of the grading scale.

With regard to the other covariates, we see that 47% of the students are male and 22% hold a private health insurance. The mean purchasing power index is 98.50, meaning that the mean purchasing power in our sample is 1.5% lower than the German average.

Taking a look at the distribution of students across faculties, we see that the highest share of students is studying at the faculty of humanities (20%). Theology, on the other hand, is the smallest faculty with a share of 2%.

3.3 Empirical Setup

We start by examining the broadest measure of academic success, namely, whether or not a student graduates from university at all. Afterwards, we narrow our view towards graduation within fields, considering a change of field as a failure in the abandoned subject. Finally, we focus on the final grade of the university degree. This grade is a measure of the relative success within the group of successful students completing their studies.

For each of the three outcome variables we start with the GPA achieved at high school as independent variable only and continue by adding the full set of controls. These also include indicator variables for all 16 German states excluding Lower Saxony, the state where Göttingen is located, so as to reflect potential differences between the states concerning schooling systems and grading standards. Afterwards, we allow for differing effects by faculties. The binary outcome, graduation, is analyzed using probit models. For the continuous outcome variable, university grade, we use simple OLS models. In all the regressions we cluster standard errors by administrative district.

In order to interpret the regression results of the probit models right away, we display marginal effects for a benchmark student.[3] For categorical variables the effects are calculated as discrete changes from the base category. Our benchmark student is characterized by the average high school leaving grade and income, and the mode of categorical variables. Accordingly, the student is female, holds a public health insurance and finished high school in Lower Saxony.

[3]The coefficients of the probit regressions can be found in Tables A.1-A.3.b in Appendix II.

4 Results

There is a strong ex ante expectation that the better the high school leaving grade is, the better the performance at university should be. High income as well as a private health insurance status are expected to have positive effects on academic success. Low family income, proxied by the purchasing power index, might inhibit academic success through channels different from performance in high school. Students from low income families might lack sufficient monetary support and thus have to earn their living expenses outside university, such as working in bars, shops or factories, and thus would have less time to study. They might be less able to buy books that are not (numerous) in the libraries or other auxiliary devices such as software packages. However, payments according to the Federal Training Assistance Act (*BAföG*) should at least partly counteract this effect by providing financial support for students from poorer families.[4] We do not have a clear ex ante expectation about the influence of gender and the different faculties.

4.1 University Level

Table 2 shows the expected highly significant and positive effect of the high school leaving grade on academic success. A marginal improvement of this grade increases the probability of the benchmark student to graduate at all from university by about 21 percentage points per grade, and within fields by about 16 percentage points. An improvement of the high school leaving certificate by one full grade is associated with an improvement of the expected final grade by slightly below 0.4 grades.

The controls are of lesser importance: All else being equal, coming from a family that provides a student with private health insurance increases the estimated probability of the benchmark student of graduating at all or within a faculty by 5 or 4 percentage points respectively. This effect is highly significant but relatively small: Being privately insured raises the graduation probability by as much as having a 0.25 better grade at high school. Conditional on graduating, there is no significant effect of the health insurance on the final grade.

The income variable does not show significant effects in any of the regressions pre-

[4]These payments are based on the income of the parents and the student. They can amount to up to 670 Euro per month (2010) of which only 50% are to be repaid, capped at a maximum amount due of 10,000 Euro. In winter term 2009/2010 almost 20% of all students in Göttingen received payments according to this act.

Table 2: University Level

	Graduation -All Faculties- Probit		Graduation -Within Faculty- Probit		Final Grade OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
High School GPA	0.210***	0.210***	0.165***	0.161***	0.371***	0.386***
	(28.121)	(28.444)	(21.810)	(26.022)	(0.010)	(0.010)
Male		-0.006		-0.009		-0.019
		(-0.548)		(-1.077)		(0.014)
Private Health Insurance		0.053***		0.036***		0.014
		(4.825)		(3.826)		(0.015)
Purchasing Power Index		0.001		0.000		0.001
		(0.748)		(0.423)		(0.001)
Constant					1.986***	1.902***
					(0.027)	(0.070)
States included	No	Yes	No	Yes	No	Yes
Observations	12315	12315	16931	16931	8204	8204
Pseudo-R^2	0.048	0.051	0.031	0.033		
Log Likelihood	-8120	-8093	-11368	-11338		
R^2					0.155	0.169

Columns: marginal effects for benchmark student, z-statistic in parentheses; columns 5-6: coefficients, standard errors in parentheses; clustered by counties; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

sented in Table 2. This might indicate that financial aid, provided according to the Federal Training Assistance Act, is performing well. It could also mean that income alone is not very important for academic success if aspects such as the educational family background, as captured by the health insurance status, are accounted for. Another explanation could be that those who are negatively affected by their low family income have never even started university education in the first place.

Finally, the higher importance of the high school leaving GPA with respect to overall graduation compared to graduation within a field might indicate that being a good (high school) student does not help to find the most preferred field of study right away. Obviously, re-orientation at an early stage of the studies towards a field that fits the student's own preferences or abilities better should not be seen as severe as an overall failure to graduate. This is especially true with respect to international comparisons. For instance in the U.S. a major might be chosen only after trying several fields whereas in Germany students select their field prior to entering university.

4.2 Faculties

Some students change their field of study while being enrolled. This might reflect some change in their preferences or time needed to search for the perfect match. At the same time it might also reflect differences in the (perceived) degree of difficulty to graduate or to get a good grade. Every now and then a discussion arises in Germany about whether or not some faculties give good grades too easily. The faculties in question will usually defend themselves by pointing out the high ability of their student body (see for instance Krass and Scherf, 2012). In order to address this issue, we allow for differing effects by faculties. Firstly, we add indicator variables for the 13 faculties excluding the base category/faculty, humanities. Afterwards we present separate regressions for each of the faculties.

Column (1) of Table 3 shows marginal effects for a probit regression, estimating the probability of graduation, for the benchmark student. Column (2) presents corresponding OLS results for the final university grade given graduation.

Many indicator variables of faculties show effects that are significant at the 0.1 percent level. For the benchmark student the predicted probability of graduating, given she started studying at the faculty of humanities, is about 39%; given successful graduation, her expected final grade is 3.1. A male student is almost 2 percentage points less likely to graduate within the given faculty compared to the benchmark. Ceteris

Table 3: Faculties

	Graduation Probit (1)	Final Grade OLS (2)
High School GPA	0.190***	0.373***
	(25.212)	(0.011)
Male	-0.016*	0.049***
	(-2.000)	(0.012)
Private Health Insurance	0.047***	0.023*
	(5.040)	(0.011)
Purchasing Power Index	0.000	0.001*
	(0.638)	(0.001)
Theology	-0.073**	-0.648***
	(-2.580)	(0.086)
Law	-0.004	-1.164***
	(-0.233)	(0.024)
Medicine	0.075**	-0.267***
	(2.989)	(0.024)
Mathematics	-0.060***	-0.123***
	(-3.504)	(0.030)
Physics	-0.059**	0.020
	(-2.820)	(0.029)
Chemistry	-0.020	0.042
	(-0.946)	(0.033)
Geology/Geography	0.103***	0.073*
	(4.959)	(0.032)
Biology	0.119***	0.063***
	(7.784)	(0.019)
Forest Sciences	0.283***	-0.327***
	(13.612)	(0.027)
Agriculture	0.259***	-0.204***
	(15.286)	(0.021)
Economic Sciences	0.185***	-0.414***
	(12.445)	(0.018)
Social Sciences	0.066***	0.001
	(4.541)	(0.019)
Constant		2.056***
		(0.065)
States included	Yes	Yes
Observations	16931	8204
Pseudo R^2	0.062	
Log Likelihood	-11005	
R^2		0.423

Column 1: marginal effects for benchmark student, z-statistics in parentheses; column 2: coefficients, standard errors in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

paribus, if he does, he receives slightly better grades. The private health insurance status is associated with both better grades and a higher probability of graduating.

All else being equal, the predicted probability of graduating at the faculty of economic sciences is about 19 percentage points higher than at the faculty of humanities; at the faculty of mathematics it is 6 percentage points lower than at the base faculty. Given graduation, the faculty of economic sciences awards, ceteris paribus, a final grade that is more than 0.4 grades worse than the respective grade at the faculty of humanities. This difference is greater than the expected change in the degree associated with an improvement of the high school leaving certificate by one full grade. The worst grades are awarded by the faculty of law.[5]

Doing the same regressions separately by faculties, the picture gets more differentiated. Tables 4.a and 4.b reveal strong differences with respect to how important the high school GPA is for the probability of graduating at the different faculties of Göttingen University. The effect is not significantly different from zero at the faculty of geology and geography, and it is strongest at the medical school and the faculty of chemistry. For the benchmark student at these two faculties, a marginal increase in the GPA earned in high school is associated with an increase in the graduation probability by almost 29 percentage points per grade. At the faculty of social sciences, the effect is only about one third of that size.

Private health insurance status, which proxies a high socio-economic background, is significant and has a positive sign for about half of the faculties, while being insignificant for the other faculties. Purchasing power is also of little importance for the probability of graduating at the faculty level. It is significant only at the faculty of social sciences.

For illustration and further comparison of faculties, Table 5 provides predicted probabilities of graduation based on the estimation results underlying Tables 4.a and 4.b. The predictions for the benchmark student are presented in the middle column (mean high school GPA). The remaining predictions deviate from the usual benchmark by the high school GPA used. We define low and high high school GPA as the mean GPA minus two standard deviations and mean GPA plus two standard deviations respectively.

Although we do not want to put too much emphasis on these predictions, they serve to illustrate the rather large differences between faculties. The predicted probability of graduation for the benchmark student is between roughly 20 and 60 percent. Based on these predictions, a student with a low high school GPA can hardly expect to graduate

[5]The faculty of law is traditionally known to only rarely award very good grades. Accordingly, not too much attention should be given to this fact.

Table 4.a: Graduation by Faculties

	Graduation by Faculties						
	Theology	Law	Medicine	Humanities	Mathematics	Physics	Chemistry
High School GPA	0.180***	0.256***	0.285***	0.187***	0.279***	0.209***	0.285***
	(4.558)	(11.171)	(9.357)	(12.378)	(6.412)	(7.185)	(9.016)
Male	0.112	0.007	0.019	-0.114***	0.060	0.110*	0.043
	(1.789)	(0.231)	(0.685)	(-6.688)	(1.677)	(2.257)	(1.004)
Private Health Insurance	0.184*	0.019	0.080**	0.068***	0.131*	-0.013	0.011
	(2.507)	(0.611)	(2.923)	(3.541)	(2.464)	(-0.310)	(0.253)
Purchasing Power Index	0.002	-0.000	-0.001	0.002	-0.001	-0.000	0.001
	(0.633)	(-0.031)	(-0.729)	(1.522)	(-0.575)	(-0.246)	(0.349)
States included	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	284	1246	1481	3342	660	567	644
Pseudo R^2	0.109	0.076	0.125	0.059	0.164	0.111	0.137
Log Likelihood	-167	-774	-896	-2128	-367	-345	-378

Marginal effects for benchmark student, z-statistics in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 4.b: Graduation by Faculties

	Graduation by Faculties					
	Geology/Geography	Biology	Forest Sciences	Agriculture	Economic Sciences	Social Sciences
High School GPA	0.069	0.176***	0.152***	0.132***	0.159***	0.086***
	(1.875)	(8.304)	(3.971)	(5.451)	(8.061)	(4.521)
Male	-0.127*	-0.016	0.031	0.049	-0.022	-0.027
	(-2.151)	(-0.587)	(0.651)	(1.471)	(-1.071)	(-1.225)
Private Health Insurance	0.061	0.037	0.040	-0.038	0.064**	0.011
	(1.070)	(1.113)	(1.056)	(-1.071)	(3.110)	(0.388)
Purchasing Power Index	0.004	-0.002	-0.000	-0.002	0.001	0.004***
	(1.436)	(-1.826)	(-0.029)	(-1.390)	(0.553)	(3.340)
States included	Yes	Yes	Yes	Yes	Yes	Yes
Observations	542	1410	666	1546	2740	1778
Pseudo R^2	0.039	0.047	0.043	0.024	0.032	0.019
Log Likelihood	-360	-923	-425	-1004	-1819	-1198

Marginal effects for benchmark student, z-statistics in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 5: Predicted Probabilities of Graduation by Faculties

	High School GPA		
	Low	Mean	High
Theology	0.10	0.27	0.53
Law	0.14	0.40	0.72
Medicine	0.19	0.52	0.83
Humanities	0.21	0.42	0.66
Mathematics	0.04	0.24	0.67
Physics	0.05	0.21	0.54
Chemistry	0.06	0.30	0.69
Geology/Geography	0.41	0.50	0.59
Biology	0.30	0.51	0.72
Forest Sciences	0.38	0.57	0.75
Agriculture	0.45	0.62	0.77
Economic Sciences	0.39	0.59	0.77
Social Sciences	0.34	0.45	0.56

Predicted probability of graduating at a faculty for female students who are publicly insured, come from a zip code area with average purchasing power, and finished high school in Lower Saxony. Low and high high school GPA are defined as the mean GPA minus two standard deviations and mean GPA plus two standard deviations, respectively.

at some of the faculties, such as mathematics and physics. At other faculties chances to graduate are still relatively high; the predicted probabilities for such a student are 45 and 39 percent at the faculties of agriculture and economic sciences respectively. For an otherwise identical student with a high high school GPA the predictions vary between about 50 and 80 percent.

Tables 6.a and 6.b show corresponding regression results for final grades at graduation. There is a highly significant positive effect of the high school GPA at every faculty. However, the importance of this GPA differs strongly. It is highest at the faculty of mathematics, where the expected grade at graduation is more than half a grade better for every full grade of the high school leaving certificate. At the faculty of chemistry, where the coefficient of high school GPA is the smallest, the effect is only about half that size. Given graduation, male students can expect slightly better grades than their female fellow students in about half of the faculties. The effects of health insurance status and purchasing power are indistinguishable from zero at most faculties.[6]

[6]There is a surprisingly large, highly significant, positive effect of the private health insurance status

Table 6.a: Grades by Faculties

	Final Grade by Faculties						
	Theology	Law	Medicine	Humanities	Mathematics	Physics	Chemistry
High School GPA	0.434**	0.428***	0.279***	0.393***	0.503***	0.291***	0.270***
	(0.157)	(0.030)	(0.044)	(0.019)	(0.043)	(0.051)	(0.052)
Male	-0.078	0.090*	-0.066	0.080**	0.150*	0.166*	0.099
	(0.208)	(0.038)	(0.050)	(0.024)	(0.068)	(0.067)	(0.065)
Private Health Insurance	0.536***	0.016	0.053	0.036	0.081	0.018	-0.052
	(0.146)	(0.052)	(0.049)	(0.023)	(0.062)	(0.059)	(0.059)
Purchasing Power Index	-0.019*	0.001	0.005**	0.002	0.004	-0.002	-0.004
	(0.008)	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)	(0.003)
Constant	3.125***	0.743**	1.739***	1.971***	1.177**	2.551***	2.957***
	(0.797)	(0.278)	(0.210)	(0.128)	(0.371)	(0.287)	(0.312)
States included	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86	502	776	1365	253	249	270
R^2	0.324	0.234	0.097	0.277	0.421	0.184	0.171

Coefficients, standard errors in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

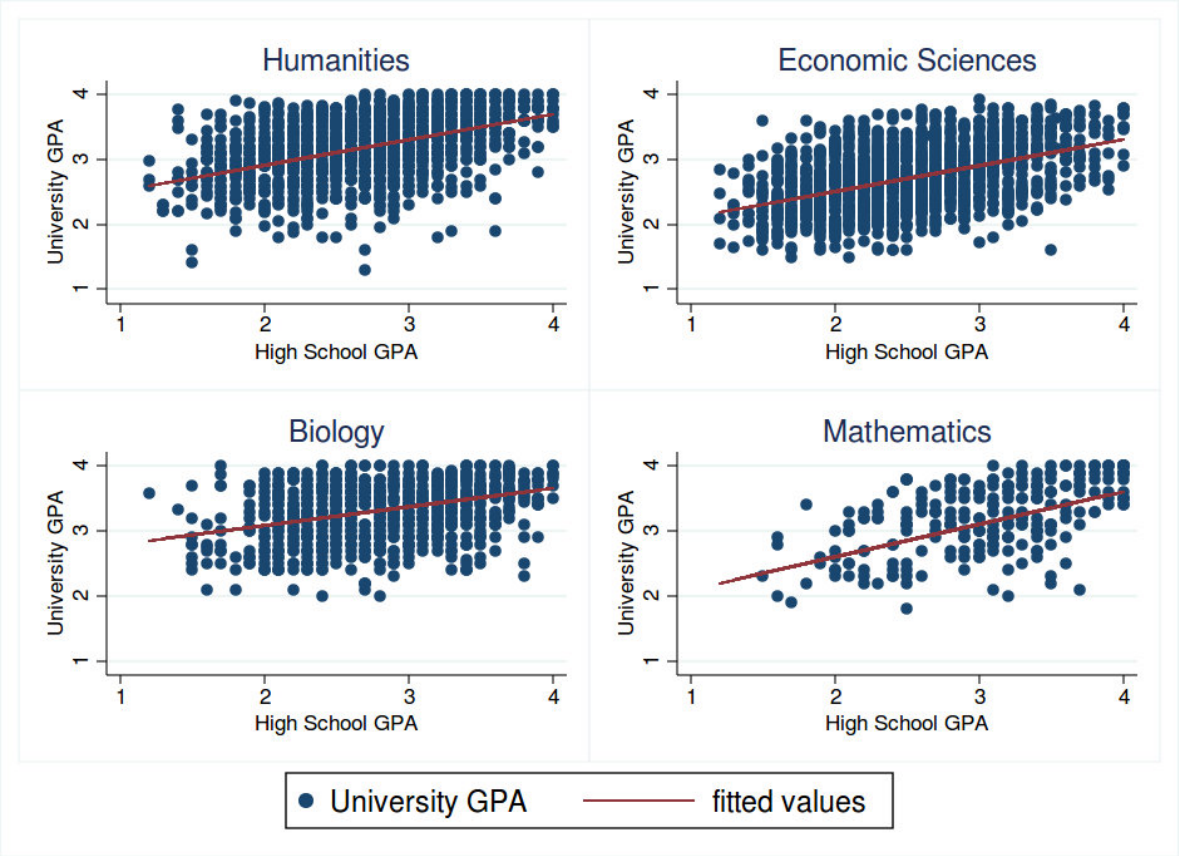
Table 6.b: Grades by Faculties

	Final Grade by Faculties					
	Geology/Geography	Biology	Forest Sciences	Agriculture	Economic Sciences	Social Sciences
High School GPA	0.293***	0.288***	0.352***	0.386***	0.398***	0.398***
	(0.057)	(0.029)	(0.041)	(0.024)	(0.019)	(0.026)
Male	-0.064	0.113***	0.116**	0.018	0.017	0.054
	(0.051)	(0.033)	(0.043)	(0.029)	(0.022)	(0.027)
Private Health Insurance	0.011	0.013	0.041	-0.087*	0.014	0.050
	(0.053)	(0.030)	(0.053)	(0.037)	(0.035)	(0.035)
Purchasing Power Index	-0.003	0.002	0.003	-0.000	0.001	0.000
	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Constant	2.807***	2.339***	1.573***	2.030***	1.575***	2.110***
	(0.335)	(0.159)	(0.250)	(0.171)	(0.129)	(0.171)
States included	Yes	Yes	Yes	Yes	Yes	Yes
Observations	250	784	408	953	1534	774
R^2	0.212	0.158	0.184	0.232	0.247	0.250

Coefficients, standard errors in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Figure 1 visualizes the relationship between the GPA earned at university and at high school across selected faculties. The red lines represent fitted values for female students who are publicly insured, come from a zip code area with average purchasing power and finished high school in Lower Saxony. We can notice from the upper two panels of this figure that grades in humanities are generally better than in economic sciences. The lower two panels show that the relationship between high school GPA and university grade is much steeper in mathematics than in biology.

Figure 1: Grades at Selected Faculties



Dots represent one or several observations. Fitted values are the predicted university GPA for female students who are publicly insured, come from a zip code area with average purchasing power, and finished high school in Lower Saxony.

Comparing the faculties with the highest number of students, humanities and eco-

on the final grade at university at the faculty of Theology. Taking this coefficient at face value, a reason for this strong effect could be that children of pastors in Germany are privately insured. However, due to the small sample size of the underlying regression, we refrain from emphasizing this finding.

nomic sciences, it seems to be easier to graduate in economic sciences whereas the expected grade conditional on graduation is worse. This pattern can also be found for a couple of other faculties and might suggest differences in grading and examination culture between the faculties. It seems that at some faculties it is more difficult to obtain a degree while the grades given differentiate less strongly between students. However, at others achieving a degree is more likely while the grades obtained vary more within the grading scale.

There are a number of possible mechanisms which might contribute to these faculty-specific results. Firstly, students may self-select into faculties on unobservable characteristics related to the outcome variables. For example, some students may be more motivated to obtain good grades at university than they were in high school. If such students disproportionately choose humanities rather than mathematics or economics, we will find better grades in the former faculty conditional on high school GPA. While we cannot exclude such self-selection with the data at hand, in our view it is not very plausible that students of various faculties should differ precisely in this respect.

Alternatively, and arguably more convincingly, the results may be driven by features of the teaching and grading system in the respective faculties. A first explanation along this line is based on the similarity between curricula in high school and in university. The high school grade is a composite of a comprehensive variety of subjects whereas university studies are more specialized. Since students likely choose subjects which fit their specific abilities, one may expect that in highly specialized fields, university grades are better and less closely associated with high school GPA than in broader subjects. Given that the impact of high school GPA on university grades is largest in mathematics, which is a more specialized field than social science or economics, this explanation, however, does not find much support in the data.

Instead, the differences in grades are likely to reflect different grading cultures. Some faculties may simply be willing to award good grades to most students without differentiating strongly among good and mediocre performance. More subtly, an upward drift of average grades may be built in the structure of some degree programs. When a program grants ample choice among electives, students can avoid difficult or unpleasant courses while still obtaining the degree. Moreover, if students can freely choose courses, teachers might have an incentive to attract students by grading leniently. As a result, grades from such a program will be compressed at the upper end of the scale compared to programs with a more rigid structure of compulsory courses.

Although we have some sympathy for the last explanation, our data do not permit

to conclusively distinguish between these mechanisms. Instead, we confine ourselves to pointing out the main result of this paper: The relationship between high school grades and university success varies in a statistically discernible manner among faculties, which hints at some differences in grading, teaching, and examination cultures.

5 Discussion and Policy Implications

In this paper, the determinants of studying successfully are analyzed using data from more than 12,000 students from Göttingen University. Two main results are shown. Firstly, the high school leaving grade is by far the best predictor of both the probability of graduating and the final grade obtained at university. Other factors, notably gender or social origin, play only a minor role. Secondly, differences emerge among the various faculties regarding grading and graduation policies. In some faculties, like humanities or social sciences, the rate of graduation is low but those who graduate can expect to obtain quite good grades even when they start from a weaker academic base as measured by the high school GPA. In other faculties, such as economic sciences or forest sciences, the chance of obtaining a degree is relatively high whereas grades are moderate, and strongly linked to high school GPA. Finally, in some faculties such as mathematics and physics, graduation appears to be very difficult and good grades are hard to obtain, especially for weaker students.

These findings carry a number of implications both for the university and for the students individually as well as for education policy in general. Most obviously, our results support the current process of admission to German universities, which is based primarily on high school GPA. Clearly, this practice contributes to improving the academic success of those admitted. We do not find any evidence that adding other information can improve the selection. Specifically, variables capturing income or social background have a comparatively low explanatory power. This suggests that granting privileged access to minorities or providing universities with financial incentives to admit more students from poor districts, rather than focusing exclusively on ability, may raise the number of unsuccessful students. Most of the impact of social origin on university achievement is already absorbed in the high school leaving grade. Consequently, policy should address social imbalances in educational outcomes at earlier stages of the academic career.

For prospective students, the faculty specific results, summarized in Table 5, may

give useful hints about what subject to choose. A student with mean high school GPA has a higher chance of graduating if she chooses agriculture or economic sciences rather than humanities or social sciences. If obtaining some degree irrespective of the field is very important for her, such a student should enroll in the former rather than in the latter faculties. Considering mathematics, physics, or chemistry, the recommendation is even clearer: The average student will graduate in these faculties with a probability of 30% or less. For weaker students with high school GPA substantially below the mean this probability falls below 10%. This suggests that these three fields are almost unfeasible for students in the bottom half of the ability distribution and that such students are well advised to opt for other fields.

Extending the principle of selection on academic merit to the aggregate level obviously raises a consistency issue: Not every university or field can be restricted to the best students, since the weaker ones also will have to be placed somewhere, or else must be told not to study. This points out a basic choice which education policy must make: Should universities provide an excellent education for the most able individuals at a level defined by the current state of knowledge, or should tertiary education be targeted to large numbers of students and settle for an academic level accessible for these? Related to this, there are competing views on the main purpose of university studies. On one hand, in Humboldt's tradition, one may see academic studies mainly as a tool of personal intellectual enhancement, where knowledge, understanding and academic debate are rewards in themselves. On the other hand, studies may be seen as an investment in productivity, whose main reward comes in the form of a higher wage. In the former view, graduation and examination grades are of lesser importance. In the latter case, the signaling value of a degree is likely to be essential for employers. As a consequence, the labor market will honor only completed degrees, and a wage premium will be paid for good grades as long as these are rare enough so as to convey credible information.

The results presented in this paper suggest that faculties take different sides in this debate. In humanities, graduation rates are relatively low and individual grades are less differentiated than in other fields. This corresponds to the idea that one does not study for the sake of the examination or for a higher wage, but for intrinsic motivation. Quite possibly these fields specifically attract students with such expectations. In this view, a low completion rate in such subjects should not be seen as a sign of failure. These fields offer students an education tailored to their abilities and preferences and students use this offer to the extent which is individually optimal. On the other end

of the scale, examinations in mathematics, physics and chemistry are highly selective. Thereby, these fields cannot cater to large numbers of students, but they prepare those who make it for demanding sections of the labor market. Similarly, economic sciences serve the labor market by awarding differentiated grades while still being accessible for large numbers of weaker students.

These considerations shed some light on the recommendation, repeatedly voiced by the OECD (see for instance OECD, 2013, p. 151), that Germany should produce more university graduates and the corresponding complaint by employers' organizations that German industry faces a shortage of graduates from mathematics, natural sciences, and engineering (see Anger et al., 2013). It is certainly conceivable that reforms in secondary schooling can raise the number of students entering university. It appears far-fetched, however, that a large fraction of those additional students will display academic abilities superior to those of the average current student. Our results show that average or below average students will typically be unable to successfully complete a degree in mathematics, physics or chemistry. Therefore it seems highly unlikely that an increase in university enrollment will produce substantial numbers of additional graduates in the subjects required by industry, at least as long as the concerned faculties are unwilling to lower their academic standards. If this does not occur, any increase in university enrollment will lead to larger numbers of graduates in those fields which cater to the preferences and abilities of the majority of students but not in those fields which firms demand.

Appendix I: Data Processing

We exclude students for whom not all information is available as well as students for whom we observe pure data errors, such as when the grade of the high school leaving certificate is not within the possible interval. Ph.D. students are also dropped from the dataset. The reason for this is that they form a highly selective group and their success may be influenced by other factors than regular students' performance. Furthermore, we only take into account students who either finished university with a degree or dropped out of their study program. Since students are asked to give the reason for dropping out when they leave university, we can distinguish between real drop outs and students who intend to continue their studies at another university. We exclude these students from the sample in order not to register a drop out for the latter group.

As German and foreign high school leaving grades may not be comparable and university success of students with a foreign educational background may be influenced by additional factors such as language skills, we only take into account students who hold a German high school leaving certificate. In addition, we exclude students with a high school leaving grade of 4.0, the worst grade still allowing a student to pass. This is done as in our dataset a high school leaving grade of 4.0 was often found for students, in particular for foreign students, who enrolled in fields of study without admission restriction. This strongly suggests that the grade is sometimes used as a place holder when the real grade seemed not to be important for the admission procedure. However, we are confident that we have only deleted a very small number of students who actually have a high school leaving grade of 4.0 by imposing this restriction.

In addition, students have to provide information about their home address, usually their parents' address, and their semester address, usually the place students live by themselves. Since most students move to Göttingen when starting university, home and semester address should differ. Nonetheless, for some students in our dataset the two zip-codes are identical. As we make use of the parents' address in our analysis it is important that the correct zip-code is used. To deal with this problem, we look at all students for whom the zip-code of their home and semester address are the same. If both zip-codes belong to a place outside of Göttingen, it is very likely that this student is still living with her parents. If the zip-codes are identical and from Göttingen, it might be that the student did not provide any information about her parents' home address. Therefore, we take a look at the administrative district the student went to school in. If she graduated from a high school in Göttingen, we have no reason to doubt that her parents also live there. On the other hand, if she went to school outside of Göttingen, it is not entirely clear that the information about the home address really corresponds to the parental address. Consequently, we exclude these students from the sample.

Appendix II: Coefficients

Table A.1: University Level - Coefficients of Table 2

	Graduation -All Faculties- Probit		Graduation -Within Faculty- Probit	
	(1)	(2)	(3)	(4)
High School GPA	0.528***	0.527***	0.414***	0.405***
	(0.019)	(0.018)	(0.019)	(0.016)
Male		-0.014		-0.022
		(0.025)		(0.021)
Private Health Insurance		0.134***		0.091***
		(0.028)		(0.024)
Purchasing Power Index		0.002		0.001
		(0.002)		(0.002)
Constant	-1.359***	-1.513***	-1.076***	-1.142***
	(0.048)	(0.271)	(0.079)	(0.240)
States included	No	Yes	No	Yes
Observations	12315	12315	16931	16931
Pseudo-R^2	0.048	0.051	0.031	0.033
Log Likelihood	-8120	-8093	-11368	-11338

Coefficients, standard errors in parentheses; clustered by counties; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A.2: Faculties - Coefficients of Table 3

	Graduation Probit (1)
High School GPA	0.493***
	(0.016)
Male	-0.040*
	(0.020)
Private Health Insurance	0.119***
	(0.023)
Purchasing Power Index	0.001
	(0.002)
Theology	-0.196*
	(0.080)
Law	-0.009
	(0.039)
Medicine	0.191**
	(0.065)
Humanities	base
Mathematics	-0.160***
	(0.047)
Physics	-0.157**
	(0.057)
Chemistry	-0.052
	(0.055)
Geology/Geography	0.261***
	(0.052)
Biology	0.302***
	(0.039)
Forest Sciences	0.730***
	(0.058)
Agriculture	0.663***
	(0.046)
Economic Sciences	0.467***
	(0.038)
Social Sciences	0.167***
	(0.037)
Constant	-1.587***
	(0.216)
States included	Yes
Observations	16931
Pseudo R^2	0.062
Log Likelihood	-11005

Coefficients, standard errors in parentheses; clustered by county; $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A.3.a: Graduation by Faculties - Coefficients of Table 4.a

	Graduation by Faculties						
	Theology	Law	Medicine	Humanities	Mathematics	Physics	Chemistry
High School GPA	0.539***	0.663***	0.714***	0.479***	0.889***	0.717***	0.820***
	(0.115)	(0.057)	(0.076)	(0.038)	(0.083)	(0.088)	(0.089)
Male	0.310	0.019	0.048	-0.304***	0.181	0.336*	0.121
	(0.167)	(0.084)	(0.070)	(0.047)	(0.112)	(0.150)	(0.120)
Private Health Insurance	0.496**	0.048	0.204**	0.173***	0.373**	-0.044	0.032
	(0.188)	(0.078)	(0.071)	(0.048)	(0.139)	(0.145)	(0.125)
Purchasing Power Index	0.006	-0.000	-0.003	0.005	-0.003	-0.001	0.002
	(0.009)	(0.004)	(0.003)	(0.003)	(0.006)	(0.006)	(0.005)
Constant	-2.518**	-1.900***	-1.496***	-1.848***	-2.571***	-2.438***	-2.742***
	(0.953)	(0.419)	(0.406)	(0.364)	(0.623)	(0.666)	(0.551)
States included	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	284	1246	1481	3342	660	567	644
Pseudo R^2	0.109	0.076	0.125	0.059	0.164	0.111	0.137
Log Likelihood	-167	-774	-896	-2128	-367	-345	-378

Coefficients, standard errors in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table A.3.b: Graduation by Faculties - Coefficients of Table 4.b

	Graduation by Faculties					
	Geology/Geography	Biology	Forest Sciences	Agriculture	Economic Sciences	Social Sciences
High School GPA	0.172	0.441***	0.388***	0.346***	0.410***	0.218***
	(0.092)	(0.053)	(0.104)	(0.068)	(0.049)	(0.048)
Male	-0.325*	-0.040	0.081	0.132	-0.057	-0.069
	(0.151)	(0.069)	(0.123)	(0.090)	(0.053)	(0.056)
Private Health Insurance	0.154	0.093	0.102	-0.098	0.168**	0.028
	(0.145)	(0.083)	(0.097)	(0.092)	(0.055)	(0.072)
Purchasing Power Index	0.010	-0.006	-0.000	-0.005	0.002	0.009***
	(0.007)	(0.003)	(0.005)	(0.004)	(0.003)	(0.003)
Constant	-1.375	-0.472	-0.772	-0.031	-0.971**	-1.589***
	(0.715)	(0.369)	(0.546)	(0.423)	(0.374)	(0.308)
States included	Yes	Yes	Yes	Yes	Yes	Yes
Observations	542	1410	666	1546	2740	1778
Pseudo R^2	0.039	0.047	0.043	0.024	0.032	0.019
Log Likelihood	-360	-923	-425	-1004	-1819	-1198

Coefficients, standard errors in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

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