Determinants of Students' Success at University*

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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

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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 institutions in the educational sector.

Our study addresses this concern by investigating whether, and if so to what extent the high school leaving grade and other student characteristics such as social background variables can be used for predicting academic success. We measure success by the university grade and by the probabilities of completing studies in the chosen field or at all. Our specific focus is on a differentiated analysis along faculties, where we inquire whether the impacts of previous achievement or background characteristics differ across fields.

For this purpose, we use a comprehensive administrative data set of student careers from Göttingen University in Germany. Compared with representative national data sets, this data set is particularly suited to address our research questions. Our data provide complete information on high school leaving grades, university grades, dropping out of university or changes of field. Since these are sensitive issues, register data are likely to be more reliable than self-reported information. Furthermore, many survey data sets contain this information at best for a small number of observations. Therefore, our data facilitate the analysis of different outcome variables.

Moreover, in our data fields are unequivocally attributed to faculties whereas it would be difficult to aggregate information on study fields from survey responses. Thus, by studying a single university, we can investigate different grading and examination policies of faculties in a controlled environment. At the same time, Göttingen University is typical for many German higher education institutions with respect to size, composition of the student body, and scope of degrees offered.

We find a highly significant and positive effect of the high school leaving grade on academic performance. An improvement of the high school degree by one grade point is associated with an improvement of the university degree by 0.4 grade points and with a 21 percentage points higher probability of graduating at all from university. This result supports the widespread practice of allocating university places on the

basis of merit as measured by high school qualification. The effect of the high school grade on the probability of graduating at a specific faculty is somewhat smaller. This suggests that many students abandon their first degree, but that at least the more able ones have a good chance to succeed later in a different field.

In contrast, variables approximating parents' income or social background only have a small effect or are not statistically significant, and do not noticeably improve the explanatory power of the model. Apparently, the impact of social background on educational achievement, which is particularly strong in Germany (see Schütz et al., 2008), largely occurs before students reach university, and is absorbed in the high school grade. Our results thus underline the importance of policy measures suitable for improving academic achievement of disadvantaged students early on in their schooling career.

When considering individual faculties, we find that the importance of the high school leaving grade differs strongly between fields. In some faculties, for example economic sciences, graduation is less difficult to achieve, but not necessarily associated with a good final grade. However, in other faculties such as humanities, graduation seems to be less likely, but among those students who graduate, the final university grade is on average better and less differentiated. Moreover, at some faculties, notably physics and mathematics, graduation rates are generally low. Especially students with low high school grades can hardly expect to successfully complete studies in these fields. This points towards diverging teaching and examination cultures among faculties. Some of them specialize in preparing a positive selection of students to academia or demanding employment, whereas others provide an education which is accessible for large numbers of high school graduates with average abilities.

These results suggest that policies aiming at raising the number of university graduates may succeed to a different extent in different fields. It appears to be easier to bring about more graduates in economics or humanities than in mathematics or physics. Policy must decide whether investment in tertiary education should primarily be directed towards the first kind of fields where large numbers of students can expect to succeed, or be concentrated in the second group of fields which rather cater to a minority of excellent students.

For the interpretation of these results, it is important to point out the conceptual set-up we have in mind. We consider the high school grade and the performance at university as being two measures of academic ability taken at different points

in time and by different institutions. Both of them are possibly influenced by the same underlying variables such as cognitive, emotional, social, or other skills, or parental, social, or schooling environment. This view is to be distinguished from a perception where the high school grade is a characteristic on its own which is distinct from those variables. Consequently, we do not claim that a good high school grade 'causes' successful university performance. In fact, in our view it would not be sensible to search for a causal effect of the high school grade, since one cannot randomly assign the high school grade without changing the underlying variables. Rather, the empirical analysis shows that the two measurements are highly, but not fully, correlated, and that this link differs by fields.

This result suggests that both measurements are to a large extent driven by the same underlying variables. Our study does not investigate, however, which characteristics are responsible for performance at high school. In particular, we do not imply that the high school grade measures only intellectual abilities. Nor do we attribute any normative meaning to the high school grade in the sense that it is a good, valid, objective, or otherwise desirable measure of true competence. In the same way, we are well aware that one cannot equate university performance with the skills required for success in the labor market or at other endeavors.

Clearly, it is interesting to investigate what fundamentally determines school performance, and whether a university education is relevant for later success. The scope of our study is, however, more limited, in that we analyze the relationship between the measurements provided by the education system, without explaining or questioning them. Given that high school grades are the main criterion in admission decisions, and that graduation rates are important for political choices such as the funding of different fields, this analysis is useful in spite of its modest scope.

The probability of academic success and the reasons for dropping out of university are subject of continuously expanding research literature in many areas, notably economics of education, psychology and sociology. As shown in the meta-analyses by Robbins et al. (2004) and Trapmann et al. (2007), these studies, some of which we survey in section 2, provide a consistent picture of previous high school performance as the most prominent predictor of university success.

From the collections of articles used by Robbins (2004) and Trapmann et al. (2007) one sees that only a small minority of studies in this area of research are based on administrative data. These exceptions include the analyses of individual universities

in the U.S. by Betts and Morell (1999), in Australia by Dobson and Skuja (2005), and in Canada by Cyrenne and Chan (2012). Complementing these articles, to the best of our knowledge, we are the first to have access to a comprehensive administrative data set of student population in Germany. Thus, while our main conclusion is in line with existing research, we add to previous knowledge by providing novel evidence for Germany. The fact that we find highly statistically significant effects in this data set corroborates the perception of the prime importance of high school leaving grades for university success. Furthermore, our research differs from existing studies by its focus on inter-faculty differences. By studying outcomes in different fields in the controlled environment of a single university, we can draw conclusions on differing examination cultures, and derive detailed policy implications.

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 the German university system and 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. In this context, the literature focuses on different measures of success and failure, for example grades and university drop-out. In addition to the high school GPA also the effect of other individual and organizational characteristics as well as the impact of the students' socio-economic background are evaluated.

According to the meta-analysis of Robbins et al. (2004), the correlation between secondary school grades and university GPA is on average about 0.41. 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 sciences, 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. In line with this, Achen and Courant (2009) show that grading policies vary across fields, without however linking university grades to school performance. For Germany, Zwick (2013) underlines the importance of taking differences between fields into account when evaluating the determinants of student performance at university.

Some contributions show that students with the same entry grades perform differently in tertiary education, which suggests that other factors are important when predicting university success. These factors include personal and institutional characteristics. On the personal side, for example, Cohn et al. (2004) show that SAT test scores contribute to explaining college GPA in addition to high school grades. Using data from the University of Western Sydney, Grebennikov and Skaines (2009) find that the odds of dropping out are significantly higher for part-time and mature students. In the same way, Hong (1984) shows that age affects students' achievement. McNabb et al. (2002) investigate gender differences in university performance. Finally, research in psychology emphasizes the importance of self-efficacy, achievement motivation (Robbins et al., 2004; McKenzie and Schweitzer, 2001) and emotional intelligence (Parker et al., 2004) for academic success.

On the institutional side, the type of high school visited influences both the probability of entering a college (Altonji et al, 2005) as well as the probability of obtaining a good degree (Smith and Naylor, 2005). As shown by Levy and Murray (2005), the university can reduce the impact of discrepancy in university entrance scores by offering an appropriate coaching program. Similarly, support for first-year students in adapting to the college environment improved grades at Australian universities (McInnis et al., 2000; Peat et al., 2001).

Besides previous academic performance as well as individual and organizational features, also the impact of socio-economic variables, such as family income and parental education, are taken into account by the literature. In this context, Guimarães and Sampaio (2013) analyze the effect of family background variables on college entrance test scores at a major university in the Northeast of Brazil. The

authors find that parents' education has a positive impact on students' test scores. Furthermore, both father's education and family income are found to be correlated with the probabilities of attending a private school and private tutoring classes, which in turn have a positive effect on students' test scores.

Arias Ortiz and Dehon (2008) use student data collected at the University of Brussels to examine the probability of succeeding the first year at university by accounting for prior schooling and socio-economic background. According to their results, especially the mother's level of education and the father's occupational activity matter for students' academic success. Arulampalam et al. (2005) focus on students at UK universities to evaluate the determinants of dropping out during the first year of university education. In this context, they find significant coefficients for the parents' social class. For Germany, Grave (2011) as well as Zwick (2013) take socio-economic factors such as parental education, number of books and family income into account when analyzing the determinants of student performance at university. They show that after controlling for high school grades such factors only play a minor role, if at all.

Spiess and Wrohlich (2010) as well as Steiner and Wrohlich (2012) evaluate the determinants that influence the decision to enroll at university. With regard to socio-economic variables, Spiess and Wrohlich (2010) find positive and statistically significant effects of the mother's and father's education on accessing university. Other socio-economic control variables including parents' income and family status are, however, insignificant. These results are partly confirmed by Steiner and Wrohlich (2012) who find statistically significant effects only for the mother's education and parental income, but not for the father's education. They explain these results by suggesting that parental education indeed influences the students' choice of education but especially on the secondary and upper secondary level. On the tertiary level the effect of parental education appears to be no longer important, especially when controlling for parental income.

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, although some work finds stronger effects of background variables than we do, our results are broadly in line with earlier research which shows that social origin or income do not have a large 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.[1]

In addition, we use data on the purchasing power of the German zip-code areas which is provided by *GfK*, a market research firm.[2] 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.

Compared to representative datasets such as the German Socio Economic Panel (SOEP), the German National Educational Panel Study (NEPS) or the German DZHW graduate panel, our dataset has the advantage of comprehensively covering an entire university. Moreover, it does not rely on self-reported information but uses administrative data. This may be especially important with regard to information on university drop-out and change of the field of study. Furthermore, the SOEP and NEPS data would not allow for the analysis and results presented in this paper. Firstly, they do not provide information on the high school leaving grade and the final university grade or, if they do, for a much lower number of observations. Secondly, our dataset includes more detailed information on the individual's university career which allows us to evaluate several measures of university success and, in particular, to take a closer look at the different fields of study.

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

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

3.1 Göttingen University and the German University System

In Germany, there are mainly two types of institutions of higher education: universities and universities of applied sciences. Universities have the right to award doctoral degrees, prepare young researchers for an academic career, and engage substantially in research. Universities of applied sciences are often specialized with regard to fields of study and offer more application-oriented teaching.

Also the student body at these types of institutions differs with regard to the students' upper secondary educational background. In 2010, most students who started studying at a university held a general higher education entrance qualification (*allgemeine Hochschulreife*) which is normally obtained after finishing a secondary school (*Gymnasium*), a specialized secondary school (*Fachgymnasium*) or a comprehensive school (*Gesamtschule*) (Autorengruppe Bildungsberichterstattung, 2012). It certifies that students achieved an in-depth general education. Although specialization is possible to some extent, all students who obtained such a high school leaving certificate have a very similar, and hence comparable, secondary school education.

At universities of applied sciences, in 2010, only around half of the new students held a general higher education entrance qualification. The other half obtained a subject-related entrance qualification (*fachgebundene Hochschulreife*) or a vocational diploma (*Fachhochschulreife*) that are awarded by vocational schools that offer courses at upper secondary level. A small share of students achieved access to higher education through different tracks (Autorengruppe Bildungsberichterstattung, 2012).

The differences of the student body with regard to the higher education entry qualification between universities and universities of applied sciences underlines as well the importance of early tracking for the selection of university students. Although changing to a different secondary school is possible, the main decision on which school of secondary education to visit, and hence which higher education entrance qualification can be obtained, is made at age ten to twelve.

When deciding to enroll at university, students have to select a specific subject of study, e.g. mathematics, law, history, business economics, already when filling out the application form. This means that the major is chosen prior to university entrance. Similarly, education in the chosen subject of study starts from the first semester and courses from other fields can only be taken to a very limited extent, if at all. This is

different to other countries, e.g. the U.S., where students may try different subjects before selecting their major.

Moreover, there are different types of admission procedures that depend on the subject of study. For a few subjects, such as medicine, dentistry, veterinary medicine and pharmacy, admission is restricted nationwide. In this case, students have to apply at a central institution which allocates study places using various criteria, first and foremost the grade of the high school leaving certificate. Also other subjects of study may be restricted depending on the demand. However, this means that admission may vary between universities and years. In the case of restricted admission to undergraduate studies, the main criteria in the selection process is the grade of the high school leaving certificate. In addition, further information such as grades in selected courses may be used.

Göttingen University is one of the larger German universities with regard to its student population. In the winter term 2009, around 23,300 students were enrolled at Göttingen University while the mean of all universities[3] was around 15,400. At the median university, around 14,000 students were enrolled in the given year. With regard to the share of female students, Göttingen University does not differ substantially from the other universities. In the winter term 2009, the share of female students at Göttingen University was 52 percent compared to a mean of 51 percent and a median of 54 percent within all universities in Germany. In our sample, 53 percent of the students are female.[4]

Among the German universities, there is a group of institutions that is characterized by offering studies within a broad variety of fields, namely humanities, mathematics, law, medicine, natural sciences, economic sciences and social sciences. In addition, these university are often quite old and rich in tradition. Göttingen University belongs to this group of institutions, which also includes Heidelberg, Jena, Marburg and Tübingen. Furthermore, Göttingen is very similar, and hence comparable to these cities with regard to population size and share of students. All in all, we are confident that although only looking at one single university, our results are typical for this type of traditional research university.

[3]Private universities, distance universities, art and movie colleges, conservatories as well as special colleges of education and theology are not taken into account.

[4]Source: Statistisches Bundesamt, 2010, own calculations.

3.2 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, 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.[5]

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.

The type of health insurance can be used as a proxy for the students' socio-economic background since students normally are insured through their parents during university education. There exist two types of health insurance: public and private health insurance. 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. If both parents are privately insured, the child also holds a private health insurance. The same is true if one parent is privately insured and he or she has a higher income than the parent who is publicly insured. Therefore, the type of health insurance a student holds contains information about whether a student's 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 sciences, 38.0 percent had completed university or university of applied sciences with a degree or a Ph.D (Finkenstädt and Keßler, 2012). Within the total German population, these shares were much lower, amounting to 24.4 and 13.0 percent respectively (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 percent higher than the German average. Since German zip-code areas are

[5]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.

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. This view is further supported by the fact that there are more than 3000 different zip-codes in our sample.

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.

3.3 Summary Statistics

The final dataset contains 12,315 students out of which 48 percent obtained a degree at Göttingen University. The remaining 52 percent 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 percent of these observations the respective field of study is completed with a degree (Table 1).

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 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.

Table 1: Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Max
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
High school GPA	12315	2.50	0.63	1.10	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.

With regard to the other covariates, we see that 47 percent of the students are male and 22 percent 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 percent lower than the German average. A possible reason for the comparatively low purchasing power index is that Lower Saxony and in particular the region around Göttingen, from where the university draws the majority of students, has an average disposable income per capita that is below the German mean (Statistische Ämter der Länder, 2014).

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 percent). Theology, on the other hand, is the smallest faculty with a share of 2 percent.

Table 2.a: Summary Statistics Humanities

Variable	N	Mean	Std. Dev.	Min	Max
Graduation	3343	0.41	0.49	0.00	1.00
Final grade	1365	3.20	0.47	1.30	4.00
High school GPA	3343	2.52	0.63	1.20	4.00
Male	3343	0.33	0.47	0.00	1.00
Private health insurance	3343	0.23	0.42	0.00	1.00
Purchasing power index	3343	98.11	11.07	69.10	186.99

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

Table 2.b: Summary Statistics Biology

Variable	N	Mean	Std. Dev.	Min	Max
Graduation	1410	0.56	0.50	0.00	1.00
Final grade	784	3.29	0.45	2.00	4.00
High school GPA	1410	2.72	0.61	1.20	4.00
Male	1410	0.30	0.46	0.00	1.00
Private health insurance	1410	0.20	0.40	0.00	1.00
Purchasing power index	1410	98.13	11.98	70.16	186.99

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

Table 2.c: Summary Statistics Mathematics

Variable	N	Mean	Std. Dev.	Min	Max
Graduation	660	0.38	0.49	0.00	1.00
Final grade	253	3.24	0.54	1.80	4.00
High school GPA	660	2.72	0.69	1.20	4.00
Male	660	0.70	0.46	0.00	1.00
Private health insurance	660	0.21	0.41	0.00	1.00
Purchasing power index	660	97.03	10.12	70.16	149.09

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

Table 2.d: Summary Statistics Economic Sciences

Variable	N	Mean	Std. Dev.	Min	Max
Graduation	2740	0.56	0.50	0.00	1.00
Final grade	1534	2.73	0.48	1.50	3.92
High school GPA	2740	2.42	0.59	1.20	4.00
Male	2740	0.60	0.49	0.00	1.00
Private health insurance	2740	0.17	0.37	0.00	1.00
Purchasing power index	2740	98.84	11.54	68.60	179.39

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

Tables 2.a to 2.d present summary statistics for four selected faculties – humanities, biology, mathematics and economic sciences – on which we also focus in the discussion of the results. The descriptive statistics show differences between these faculties with regard to the outcome as well as the independent variables. In particular, the graduation rate, the final university grade, the mean high school GPA and the share of male students varies. Consequently, the summary statistics already suggest that it is worthwhile to take a closer look at the different faculties in the context of student performance.

3.4 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 the only independent variable 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 regressions we cluster standard errors by administrative districts (*Landkreise*). These districts play an important role with regard to local services of general interest in the German system. Occasionally, in smaller administrative districts there is only one school which can award entrance to higher education and hence, all high school students graduating in such districts went to the same school. Therefore, standard errors might potentially be correlated within these administrative districts, suggesting a cluster-robust estimation approach.

In order to interpret the regression results of the probit models right away, we display marginal effects for a benchmark student.[6] 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.

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.[7] We do not have a clear ex ante expectation about the influence of

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

[7] 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 percent are to be repaid, capped at a maximum amount due of 10,000 Euro. In winter term 2009/2010 almost 20 percent of all students in Göttingen received payments according to this act.

Table 3: 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
Pseudo-R^2	0.048	0.051	0.031	0.033		
Log Likelihood	-8120	-8093	-11368	-11338		
R^2					0.155	0.169
Observations	12315	12315	16931	16931	8204	8204

Columns 1-4: marginal effects for benchmark student, z-statistic in parentheses; columns 5-6: coefficients, standard errors in parentheses; clustered by counties; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

gender and the different faculties.

4.1 University Level

Table 3 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.[8]

[8]Since in the regressions for graduation within faculty and grades we have more than one observation for several students, we re-estimated these equations with standard errors clustered at the student level. This leads only to minor changes in the standard errors and significance levels.

Furthermore, 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.

The other 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 presented in Table 3.

In general, our analyses show either insignificant or comparatively small effects of the socio-economic variables. This is in line with the existing literature on Germany which finds a small impact of the student's socio-economic background on performance at university, if at all (see for example Grave, 2011 and Zwick, 2013). The minor importance of family income and parental education may have several reasons. Firstly, it might indicate that financial aid, provided according to the Federal Training Assistance Act, is performing well. Secondly, those who start at university may be a comparatively homogeneous group with regard to their socio-economic background. In fact, descriptive statistics show that in 2012, 60 percent of the students at a German university or university of applied sciences had at least one parent holding a high school leaving certificate that enables access to tertiary education (Middendorf et al., 2013). This may indicate that those who are negatively affected by their low socio-economic background have never even started university education in the first place.

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 4 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.

When including dummy variables for the thirteen faculties, the impact of the high school leaving grade stays significant at the 0.1 percent level and similar in magnitude both for the probability of graduating and the grade of the final university degree. Furthermore, the R^2 increases substantially, which underlines the importance of controlling for differences between fields of study in the context of academic performance.

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 percent; given successful graduation, her expected final grade is 3.1.

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.[9]

[9]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: 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
Pseudo R^2	0.062	
Log Likelihood	-11005	
R^2		0.423
Observations	16931	8204

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

Table 5.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
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
Observations	284	1246	1481	3342	660	567	644

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

Table 5.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
Pseudo R^2	0.039	0.047	0.043	0.024	0.032	0.019
Log Likelihood	-360	-923	-425	-1004	-1819	-1198
Observations	542	1410	666	1546	2740	1778

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

Doing the same regressions separately by faculties, the picture gets more differentiated. Tables 5.a and 5.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.

For illustration and further comparison of faculties, Table 6 provides predicted probabilities of graduation based on the estimation results underlying Tables 5.a and 5.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 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 7.a and 7.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.

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.

Comparing the faculties with the highest numbers of students, humanities and economic 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

Table 6: 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. The middle column gives the predicted probability for a student whose high school GPA equals the sample mean. Low and high high school GPA are defined as the mean GPA minus two standard deviations and mean GPA plus two standard deviations, respectively.

more within the grading scale.

There are a number of possible mechanisms which might contribute to these faculty-specific results. Firstly, as emphasized by Zwick (2013), students may self-select into faculties on unobservable characteristics which are not or only partially reflected in the high school grade but 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, or motivation may generally be more important at university than in secondary education. If motivated students then disproportionately, say, choose biology rather than mathematics, we will find better grades and a higher graduation probability in the former faculty than in the latter. In fact, concerning these two faculties, the results from Table 4 are consistent with such an explanation since in both columns, the dummy for biology is substantially larger than the dummy for

Table 7.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
R^2	0.324	0.234	0.097	0.277	0.421	0.184	0.171
Observations	86	502	776	1365	253	249	270

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

Table 7.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
R^2	0.212	0.158	0.184	0.232	0.247	0.250
Observations	250	784	408	953	1534	774

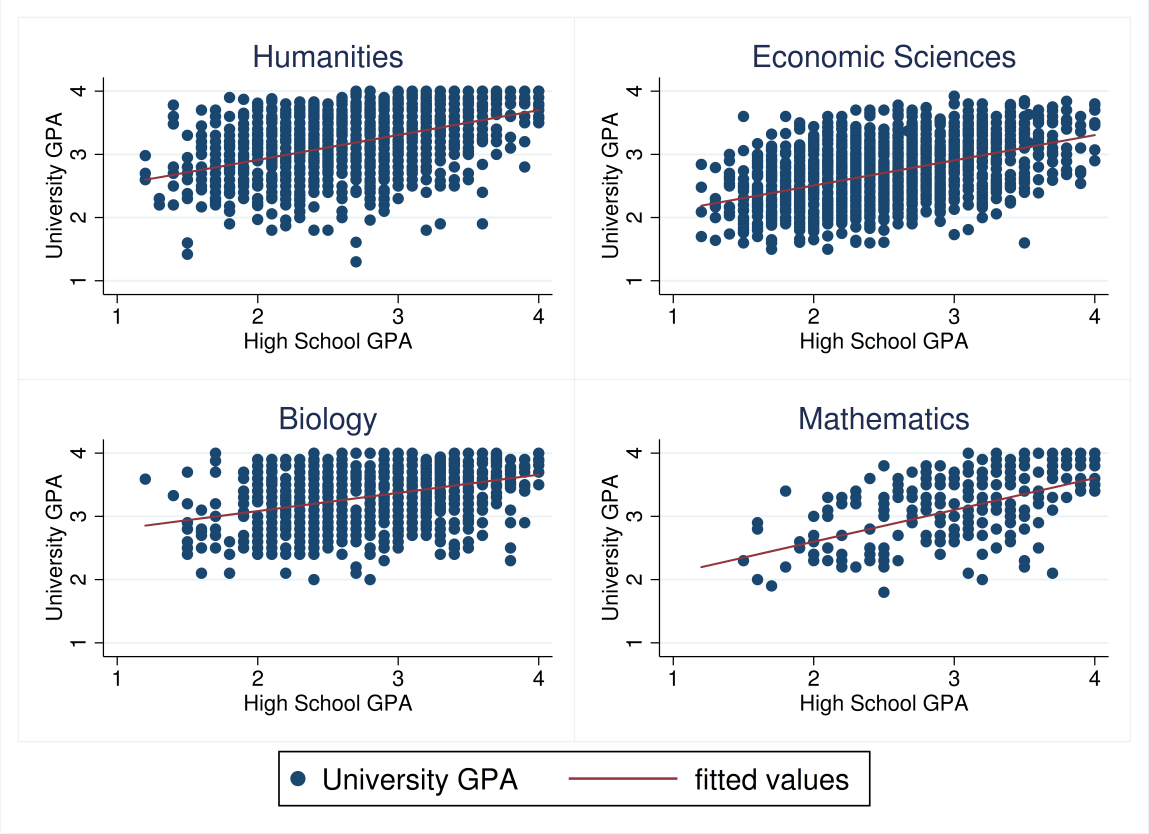
Coefficients, standard errors in parentheses; clustered by county; $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

mathematics.

This explanation is questioned, however, by the fact that we observe several faculties where the results for both outcome measures point in different directions. In economic sciences, for example, graduation is more likely than in humanities, whereas the grade obtained is substantially lower (see Table 4). To rationalize such a finding by self-selection would require that economics students are self-selected according to an unobserved characteristic which makes graduation more likely but lowers grades.

Self-selection might also affect the estimated coefficients of the high school grade. A first explanation along this line is based on the similarity between curricula in high school and at university. The high school grade is a composite of a comprehensive variety of subjects whereas university studies are more specialized. Since students

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.

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. The results for physics and chemistry, two highly specialized fields, are in line with this view. In contrast, mathematics, which is equally specialized, displays quite low grades and the largest impact of high school GPA on university grades. Therefore, this explanation finds at best weak support in the data.

More generally, there may be unobservable individual characteristics which enhance the impact of the high school GPA on university performance; that is, there may be an interaction effect of these characteristics with the high school GPA. If students self-select into fields according to such a variable, the faculty-specific coeffi-

cients of the high school GPA would pick up the interaction effect. For example, one could rationalize the high coefficients of high school GPA displayed for the faculty of mathematics in Tables 5.a and 7.a by arguing that students with such a characteristic are more likely to enter mathematics than other fields. While this explanation is logically possible, it does however not seem particularly appealing, not least because it is difficult to imagine what characteristic could enhance the impact of the high school GPA. In general, while we cannot exclude self-selection with the data at hand, in our view it is not very plausible that students of various faculties should differ precisely in the ways discussed in the previous paragraphs.

Alternatively, and arguably more convincingly, the results may be driven by features of the teaching and grading system in the respective faculties. Some observers might argue that certain 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. Three 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, high school performance is more strongly linked to whether a student graduates at all from university than to

his or her success in a specific faculty. Thirdly, 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, 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 are relevant for the current process of admission to German universities, which is primarily based on high school GPA. Instead of this, universities could, and are sometimes encouraged to, use other criteria such as interviews or field specific tests. Since we have no such alternative admission procedures in the data, we cannot explicitly test their predictive validity against that of the high school grade. Nevertheless, given the very high statistical significance of the coefficient we estimate, we expect that it is very difficult to devise a test for student selection which dominates the high school GPA. Therefore, our results strongly suggest that the current practice of admitting students based on high school grades contributes to improving the academic success of those admitted, and that adding other information will not improve the selection substantially.

Specifically, variables capturing income or social background have a comparatively low explanatory power. This suggests that students from disadvantaged social backgrounds do not, on average, have abilities relevant for success at university which are undocumented by high school grades. Consequently, granting privileged access to minorities or providing universities with financial incentives to admit more students from poor districts can be a useful policy to raise equity in higher education, but will not enhance the overall quality of the students. It appears that most of the impact of social origin on university achievement is already absorbed in the high school leaving grade. Consequently, policy should start addressing social imbalances in educational outcomes at earlier stages of the academic career.

In addition to admission, our results can also serve for universities to identify students in need of special support or additional training. Also in this respect, high

school grades apparently are a good indicator, which may only marginally be improved by considering social origin or income.

Our second finding may be due to the fact that many students, including some of those who are academically well prepared, first try out a field and later switch to a better match where they succeed. This argues against considering a termination of the first field of study as a failure of students or as a sign of inadequate teaching by the university. Rather, early dropping out of the first field may well reflect the end of a search phase which students need to find their way in the highly specialized curricula of a German university.

For prospective students, the faculty specific results, summarized in Table 6, 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 percent or less. For weaker students with high school GPA substantially below the mean this probability falls below 10 percent. 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 3

	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
Pseudo-R^2	0.048	0.051	0.031	0.033
Log Likelihood	-8120	-8093	-11368	-11338
Observations	12315	12315	16931	16931

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

Table A.2: Faculties - Coefficients of Table 4

	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
Pseudo R^2	0.062
Log Likelihood	-11005
Observations	16931

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 5.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
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
Observations	284	1246	1481	3342	660	567	644

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 5.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
Pseudo R^2	0.039	0.047	0.043	0.024	0.032	0.019
Log Likelihood	-360	-923	-425	-1004	-1819	-1198
Observations	542	1410	666	1546	2740	1778

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

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