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Non-technical summary

Almost all academic institutions regularly use graduate surveys in order to assess the determinants of academic success and labour market chances of their graduates. This paper shows how the information drawn from these surveys can be better used than it has been in most studies so far. It analyses the determinants of academic success using individual, socio-economic and group information. It therefore combines a broader spectrum of determinants of academic success than usual. For individual characteristics, gender, age, study length, school education background, migration background, and whether the student had a child before graduation are included. In addition, subjective assessment of different skill dimensions acquired during the study period is used. The socio-economic background is not only depicted by the education level of the parents but also by the way the student financed his or her studies. This contribution also makes clear that it is useful to aggregate individual student characteristics at the academic subject level because these group effects have an additional impact on individual achievement and depict selectivity into subjects. In previous studies, only a limited list of group characteristics has been taken into account. In addition, deviations from subject mean grades should be used instead of absolute grades. This controls for idiosyncratic grading in subjects. It is also important to include final school grades in order to control for innate ability and differences in resources students enjoyed before their academic study. Finally, institutional fixed effects should be controlled for in order to eliminate idiosyncratic grading and differences in scope and selectivity in institutions. This paper implies that individual cognitive and written skills and independent work have a positive impact on academic achievement in contrast to teamwork competences such as co-operation, boundary-spanning or oral skills or foreign languages. Also, broad academic skills such as theoretical knowledge problem solving skills or broad basic knowledge do not lead to better grades. The analysis also shows that gender and the academic background of the parents lose their significance when other determinants of academic achievements are included, and that selectivity effects into academic subjects play an important role for the final grades obtained by students. The paper is based on representative data of more than 4,500 graduates from the German state of Bavaria in the academic year 2003/2004.

Nicht-technische Zusammenfassung

Dieser Beitrag zeigt, wie die in den zahlreichen Absolventenbefragungen üblicherweise enthaltenen Informationen besser als bisher genutzt werden können. Er untersucht die Einflussfaktoren auf akademischen Erfolg auf der individuellen, sozio-ökonomischen und Gruppenebene. Aufgrund des Datensatzes kann hierbei ein breiteres Spektrum von Determinanten als üblich genutzt werden. Bei den individuellen Charakteristiken werden Geschlecht, Alter, Studiendauer, schulischer Hintergrund, Migrationshintergrund und die Information ob der Absolvent oder die Absolventin ein Kind haben genauso berücksichtigt, wie subjektive Einschätzungen zu unterschiedlichen Fähigkeitsdimensionen am Ende des Studiums. Der sozio-ökonomische Hintergrund wird durch das Bildungsniveau der Eltern und durch die hauptsächliche Finanzierungsform des Studiums abgebildet. Der Beitrag zeigt zudem, dass es sinnvoll ist, zunächst alle individuelle Charakteristiken der Studenten zu Durchschnittswerten im Studienfach zu aggregieren, weil eine Reihe dieser Gruppencharakteristiken einen zusätzlichen Einfluss auf den akademischen Erfolg haben und die Selbstselektion der Studenten abbilden. Es sollten zudem Abweichungen von den durchschnittlichen Abschlussnoten im Studienfach genutzt werden anstatt die absoluten Noten, um idiosynkratische Unterschiede in der Notengebung zu kontrollieren. Zudem wird gezeigt, dass es wichtig ist, die schulischen Abschlussnoten einzubeziehen, weil dies inhärente Fähigkeiten und die Ressourcen, die die Absolventen vor ihrem Studium bekommen haben, berücksichtigt. Schließlich werden Institutionen fixe Effekte einbezogen, um eine idiosynkratische Notengebung in den unterschiedlichen Institutionen zu kontrollieren. Der Beitrag zeigt, dass individuelles kognitives Spezialwissen und schriftliche Fähigkeiten im Gegensatz zu Kooperationsfähigkeit, mündliche Ausdrucksweisen, ein breites Basiswissen oder Fremdsprachen die Abschlussnoten positiv beeinflussen. Er zeigt auch, dass das Geschlecht und der Bildungshintergrund der Eltern den Studienerfolg nach Kontrolle aller weiteren Einflussfaktoren nicht mehr beeinflussen. Schließlich sind Selektivitätseffekte in die Fächer, wie die Abiturdurchschnittsnoten und die durchschnittlichen kognitiven Fähigkeiten der Kommilitonen wichtig für Chancen, eine überdurchschnittliche Note in einem Studienfach zu erzielen. Der Beitrag basiert auf repräsentativen Daten von mehr als 4.500 Absolventen bayerischer Hochschulen im akademischen Jahr 2003/2004.

Determinants of Individual Academic Achievement – Group Selectivity Effects Have Many Dimensions

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Abstract

This paper measures determinants of individual academic achievements. In addition to an extensive list of individual characteristics, skills obtained during study and socio-economic background factors, many dimensions of selectivity into academic study subjects are shown to drive individual academic achievement, such as differences between average student grades during tertiary education or cognitive skills. This paper is based on a large and representative graduate survey of graduates in the academic year 2003/2004 in the German state of Bavaria.

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1 Introduction

Many studies have investigated determinants of individual academic success. These are frequently based on large-scale graduate surveys conducted by universities or research institutes. The surveys usually cover graduates from several study subjects or fields of study and they are strongly increasing in number.[1] The literature on drivers of academic success has established a couple of correlations, which have been replicated in many countries, contexts and data sets. We know, for example, that individual characteristics such as previous school achievements, assessments of capabilities or study motivation, are positively correlated with academic success. In addition, socio-economic background, and particularly parental academic achievements, has a measurable positive impact on the academic achievements of students. Finally, student peers and selection into study subjects have also been identified as important drivers of academic success.

This paper replicates many of these correlations. More specifically, it seeks to identify determinants of grades obtained at the end of an academic study. However, it shows that some bivariate correlations disappear when additional factors are controlled for. In addition, this paper concentrates on a novel point. It analyses several indicators of selectivity into academic study subjects by looking at the impact of many average student characteristics on individual grades. It shows that average student characteristics widely differ between study subjects, and that some characteristics have an impact on students' academic achievements in addition to the direct individual effect. Finally, differences in determinants of academic achievement between more and less "academic" grades are shown by differentiating between grades obtained from universities and universities of applied sciences (polytechnic schools/*Fachhochschule*).

[1] For example, a large number of graduate surveys are coordinated by *Kooperationsprojekt Absolventenstudien* (KOAB) in Kassel, Germany or *AG Hochschulforschung* in Konstanz, Germany. Since 2007, the Kooperationsprojekt has surveyed more than 100,000 students from more than 60 higher education institutions in Germany, the *AG Hochschulforschung* surveys between 7,000 and 10,000 German students in a two-year and three-year cycle since 1982 (Grave, 2011). Leitner (2009) provides a good survey of the large number of graduate surveys in Germany. Another large graduate survey data collection is the "Higher Education and Graduate Employment in Europe" (CHEERS) survey with more than 30,000 graduates from 11 European countries, compare Lindberg (2007) or García-Aracil et al. (2007).

The findings on the impact of group characteristics imply that academic success very much depends on with whom you compete in your academic field. Therefore, average student information on several relevant dimensions such as average analytical skills or average grades in tertiary school education should be included when individual determinants of academic success are measured. These additional explanatory factors can be easily implemented in graduate surveys that include students from several academic study fields. Finally, subjective assessments of skills obtained during the study period are included. This shows that written expression skills are more important than oral expression or foreign language skills for academic success. Analytical skills and specific knowledge also have a positive impact on grades in contrast to broad basic and theoretic knowledge or boundary spanning. Independent work skills bring success in contrast to co-operation and communication skills. This contribution is based on a large-scale and representative data set of all graduates from academic institutions in the state of Bavaria in the academic year 2003/2004.

The paper is organised as follows. In the next section, the literature on determinants of academic achievement is surveyed. The third section explains the empirical strategy pursued and what is new in relation to the literature. The fourth section presents the data and some descriptive statistics. The fifth section shows the empirical results on drivers of academic success and their implications. The sixth section concludes.

2 Background

Grades awarded to individuals at the end of an academic study are important indicators of ability and productivity when those individuals look for their first jobs. Consequently, many papers have shown a positive correlation between grades at university and entry wages as well as productivity (Wise, 1975). Therefore, analysis of the determinants of obtained academic grades should allow us to derive implications on how to obtain better academic achievements.

A frequent topic in the literature on determinants of academic achievements is differences between the sexes (Dayioglu and Türüt-Asik, 2007). In descriptive statistics, females are usually more successful in school and at university in Germany (Erdel, 2010) – on average,

females attain a higher school level and obtain better grades. Another individual characteristic related to academic achievement is having been born in a foreign country. Students with a migrant background frequently have a weaker language background, which may make it difficult to obtain good grades in Germany as most academic subjects are more or less completely taught and examined in German.

Many studies show that students with better grades in their final school exams also obtain better grades in their academic studies (Jirjahn, 2007; Erdel, 2010; Dooley et al., 2012). Reasons for this might be that good school grades reveal high intrinsic motivation, individual (otherwise unobservable) capabilities and parental input during the period before the academic study. In addition, school grades determine which academic subjects can be studied (in Germany, several subjects have a so-called *numerus clausus* or in other words only allow students with sufficiently good school grades).[2] In an international comparison including the Czech Republic, Great Britain, Norway, and Austria, Trapmann et al. (2007) demonstrate, using a meta analysis, that German school grades have the highest prediction power for academic achievement. In Bavaria and other German states with central final school examinations, the *Abitur* grade might have an even higher informational value on ability and future academic achievement because the questions in the final school examinations are the same for all graduates in one year and the answers are double-checked by several teachers in order to ensure comparable grading.[3]

An additional degree from apprenticeship training might also influence academic achievement. About 20% of German apprentices hold an entrance licence for an academic study (*Abitur* or comparable), and more than one-fifth of students have a degree obtained from an apprenticeship programme (BMBF, 2012). In contrast to most other countries it is not uncommon in Germany for many students to take on a second professional degree after having obtained a more practical occupational apprenticeship degree. There is evidence that students with a double degree might have obtained knowledge and skills during their apprenticeship they can use for their academic studies. In addition, these students might be

[2] In general, sorting into subjects is mainly determined by school grades.

[3] About 75% of Bavarian students, on average, obtained their university entrance exam in Bavaria, see *Bayerisches Landesamt für Statistik und Datenverarbeitung* (2011).

more determined to obtain a good study certificate because their outside options (financial losses during their studies) are higher and they consciously decided to obtain a higher professional degree after having experienced the alternative labour market options for skilled employees. For example, Pilz (2009) finds that students who have completed apprenticeship training in the financial sector have a stronger career determination than students without an apprenticeship degree.

These are additional hypotheses on the correlation between individual characteristics and academic achievements: Graduates who are younger than their peers given the study length might have better grades because they demonstrated efficiency in studying and career determination (young age is still seen as a positive trait when applying for a job), see Billari and Pellizzari (2012). Analogously, relatively old graduates should have worse grades than their peers of an intermediate age. The study length might be an additional indicator for intrinsic motivation. An especially long study might be negatively correlated with academic achievements (Grave, 2011). Having studied abroad, in contrast, might be an indicator for a positive intrinsic motivation. In addition, students might have learnt more when they have been exposed to only one university system and they might have achieved additional skills in self-organisation. Having had a child before graduation as a student might reduce the possibility of obtaining a good grade. Arguments for the negative impact of having a child during the study period are that only few students have a child and few universities in Bavaria are well equipped to provide child care on campus.

Besides measurable individual characteristics, self-assessed perceived ability in certain relevant dimensions, such as reading and writing skills or social skills gained during the study spell, also might play a role in determining differences between diploma grades (Cassidy, 2011). These differences show which skills are rewarded in academic education and which skills do not have an important role in academic achievements. In addition, self-assessed skills might capture otherwise unobservable differences between students. The data set used in this study has the big advantage of an exceptionally rich list of self-assessed skills categories.

Another important dimension for academic achievement is a student's socio-economic background. Typical conceptualisations of the socio-economic background of students are qualification and professional status of peers' parents, home resources, number of books, and internet, communication and information technology at home (Sirin, 2005). This contribution includes parental professional education[4] and home resources measured by the main means used to cover living costs during the study period.[5] However, so-called cultural resources such as complex and abstract language skills or self-confidence, might be more important for academic success and might be more frequently provided than home resources by parents with an academic background.

Finally, the average characteristics of students in the study field might have an important impact on absolute and relative individual academic achievement (Coleman, 1966; Henderson et al., 1978).[6] Students educate both themselves and each other, and the quality of the education any student gets depends in good measure on the abilities of that student's peers (Winston, 1999). The socio-economic status of peers and average grades peers received in school or earlier during their academic study commonly are used as influence indicators (McEwan, 2003; Van Ewiijk and Sleegers, 2007). In this paper, not only are these measures included as indicators of peer quality, but also an extensive list of other aggregated individual characteristics by study subject.

Peers and the characteristics of fellow students are crucial in school and academic education because students can prevent their fellows from learning by disturbing class or otherwise determine the scope of the class and therefore the difficulty of obtaining relatively good grades (Lazear, 2001). For schools, peer effects are an important topic because pupils usually interact more closely in class over a long time and changes in class composition and teachers are rare and can be tracked over time. In addition, institutional rules determine whether

[4] The highest school grade of parents also is available from the data. However, it is very closely correlated with professional education and therefore is not included because the information does not offer any additional insights.

[5] Besides mainly receiving money from parents, working, receiving a grant, public subsidies and having a bank loan are considered.

[6] This impact is termed differently in different disciplines (peer effect, compositional effect, contextual effect), although the underlying principle is the same (Van Ewijk and Sleegers, 2007).

pupils can self-select into certain schools or classes, whether the institution determines who gets into a class or whether class composition is completely independent of ability or previous grades. Therefore, ability grouping (or tracking) for pupils is an interesting topic for educational policy (Hanushek et al., 2003). However, this is not a political issue for academic education because self-selection into academic subjects cannot be avoided and is partly forced by institutional rules such as a *numerus clausus* for subjects with a demand surplus. In addition, the composition of the student body varies across courses in Germany, obligatory study groups are rare and most students therefore study individually or in self-chosen and small study groups of which the composition can change across courses. Peer effects for students' relative performance in a cohort are therefore probably less influenced by direct interaction with other students but by selectivity effects according to subject choice. It is easier to obtain better than average grades when fellow students are less devoted to studying or less able independent of direct interaction effects between students. I therefore argue that interaction effects on academic education can only be measured when we know about personal interaction behaviour such as that of roommates or fraternity members (Hall and Willerman, 1963; Sacerdote, 2001; Zimmerman, 2007). In our data set – as is usually the case with graduate surveys – there is only information on fellow students' characteristics, not on who interacts with whom. Therefore, I prefer to define group interaction effects as 'selectivity effects' here.

Most studies on peer/selectivity effects look at the impact on absolute performance such as standardised tests (PISA, PIRLS, etc.). An empirical issue of measuring peer or selectivity effects is to disentangle self-selection into certain groups and the genuine peer/selectivity effect within a group (Evans et al., 1992) – this is called the endogeneity or simultaneity problem. Remedies proposed for endogeneity are fixed effects regressions, natural experiments, instrumental variables regressions or the use of lagged achievement measures. Hanushek et al. (2003), McEwan (2003) and Sund (2009), for example, show using fixed effects regressions that better peers increase absolute performance of pupils. Kiss (2011) uses a natural experiment with exogeneously changing peers between school grades in order to show that good peers are a positive driver of absolute pupil grades. Evans et al. (1992) use background variables such as metropolitan area unemployment rate, median family income and the regional percentage of adults who completed college as instruments

to explain the peer effects on teenage pregnancy and school drop-out. Hanushek et al. (2003) use lagged achievement measures or predetermined fellow student variables correlated with achievement measures such as the number of books at home or the academic achievements of parents (Ammermüller and Pischke, 2006; McEwan, 2003). This paper includes average final school grades in a subject (usually the university entrance exam) as an indicator of ability and influences before the university study with fellow students.

Some studies ask directly about subjective assessment of peer influence on grades (Santor et al., 2000), most include average grades (and sometimes their variance) of fellow students (Henderson et al., 1978; Kiss, 2011) and some also include selected additional characteristics such as the share of students of migrant background (Sund, 2009) or the share of female students in an academic subject (Dayioglu and Türüt-Asik, 2007). This paper systematically takes all average characteristics of fellow students into account as determinants of academic success, and shows that selectivity effects have more dimensions than those shown in previous studies.

In Germany, selection into different institutions such as a university or university of applied sciences where the same subjects can be studied also plays a role. Although variance within universities or universities of applied sciences might be low with respect to quality of students and quality of education, idiosyncratic influences on grades in certain institutions cannot be excluded. Therefore, institution fixed effects are controlled for in order to account for any endogeneity induced when students choose a specific institution because of the peers they might encounter there or differences in the quality of grades awarded (McEwan, 2003).

Based on these considerations, our empirical model of determinants of deviations from the subject mean of academic grades includes:

- individual characteristics: gender and age
- socio-economic background: father and mother having university degrees
- indicator for subject selectivity, ability and inputs before the study began: final grades in school
- indicator for career determinedness: completed apprenticeship

- inputs during the study: study financing mode, study length, study abroad, subjective ability assessment in 15 different ability dimensions at the end of study, child before end of study
- selectivity effects: average characteristics of students in the same subject in all dimensions mentioned above
- fixed institutional effects: dummies for all universities/universities of applied sciences included in study.

3 Empirical approach

Academic achievement is measured as self-reported cumulative grade point average. In Germany, this is the average of the final grades of all courses relevant for graduation. They are measured between 1.0 = excellent and 4.0 = sufficient (this means the lower the grade, the better) and consist of several written and oral exams and the final student thesis taken with several instructors/professors over a long time period at the end of the study. In order to control for large differences between average subject grades (see Appendix Table A2), it is not the absolute grade which is taken as the dependent variable but the deviation from the average grade per subject (Kiss, 2011). In addition, idiosyncratic differences between subjects and the risk of heterogeneity in variances between subjects are captured using variance clustering at the subject level.

To control for unobserved heterogeneity, a necessary assumption is that the final school grade $T_{i,0}$ sufficiently captures all previous school, peer, ability and family inputs (Sund, 2009). Vector $X_{i,0}$ is a set of additional individual explanatory variables for achievement growth during the academic study such as study length, perceived skills at the end of study and study financing mode. Selectivity effects are measured by average individual characteristics of students and their socio-economic background per subject $X_{-i,0}$:[7]

$$T_{i,1} = f(T_{i,0}, X_{i,0}, X_{-i,0}).$$

For the regression, the use of institution fixed effects by adding dummy variables for all institutions *c* captures initial sorting into institutions (McEwan, 2003). Demeaning of grades

[7] The subscript *-i* denotes characteristics of all other students in subject *u*.

with respect to subjects is denoted by subscript *u*. Therefore, the final estimation equation is:

$$T_{iu,1} = \alpha_0 + \alpha_1 T_{iu,0} + \alpha_2 X_{iu,0} + \alpha_3 X_{-iu,0} + \alpha_4 c_u + \varepsilon_{iu,1}.$$

This regression is performed for the entire sample, and for university diploma graduates only.

4 Data and sample characteristics

This paper uses the Bavarian Graduate Panel (BAP, *Bayerisches Absolventenpanel*, for details see Falk et al., 2007). All[8] 13,200 graduates in the academic year 2003/2004 in all Bavarian public universities and universities of applied sciences (*Fachhochschule*) were contacted by mail or internet during the period November 2005–March 2006. Only graduates with a diploma or magister were included in the survey (only very few students with the consecutive bachelor or master degrees graduated from German universities in this period). In addition, subjects with (additional) state examinations such as law, medicine or teaching professions were excluded. The reply ratio was about 35% – 4,573 graduates sent back their completed questionnaires (most by mail and about 5% online). The answers are fully representative of all graduates in Bavaria in the subjects included. This was checked by comparing the subject shares in the answers with the number of graduates in the full sample (Falk et al., 2007). The graduates who answered the questionnaire had somewhat better grades and studied a little quicker. Both deviations from the full sample characteristics were not significant, however[9]. In addition, sufficient observations from all academic institutions were obtained in order to include dummy variables for each institution.

[8] Only graduates in those subjects with more than 100 graduates in the academic year 2003/2004 were included.

[9] The sample averages in grades and study length were 10.04 (1.93) and 1.93 (0.52), and the respective full sample averages were 10.75 (2.11) and 2.06 (0.56), standard deviations in brackets.

From the original list of 62 subjects, three subjects[10] were dropped because they had too few graduates. The remaining subjects were combined into 16 subject groups. In more detail, the 21 engineering subjects such as mechanical engineering, construction engineering, electronic engineering, interdisciplinary studies with focus on engineering, and engineering and management were merged into "engineering" after checking that all subjects were homogeneous with respect to observables. In addition, several sub-specialisations in management, mathematics and physics, biology/chemistry and sociology/political science were merged as well as foreign language sciences (mainly English language and literature studies) and interdisciplinary studies with focus on languages. The number of all observations per subject and of all university diploma graduates per subject can be found in Table A1 in the appendix.

Students in the sub-sample of university diploma graduates had somewhat better grades at school than those in the full sample. However, fewer university diploma graduates additionally obtained a dual apprenticeship degree. The share of females and students with children is comparable in the full sample and the sub-sample of university diploma graduates. University diploma graduates obtained the means for their living more frequently from their parents and less frequently from work or a public loan than those in the full sample, see Table 1.

In Germany, there are several ways to obtain admission to universities and universities of applied sciences. The most traditional route is graduation from a grammar school (*Gymnasium*) with the *Abitur*. However, this route has become less common over time. In our data, 70% of university or university of applied science graduates had graduated from a grammar school (96% of university diploma graduates held an *Abitur*). The other graduates were awarded permission to study from another school or did not hold the *Abitur* certification. Some graduates, for example, hold only the so-called *Fachhochschulreife* (this is permission to study only at a university of applied sciences and sometimes only a certain range of subjects) or other evidence that they will be able to keep up with their fellow students.

[10] These were: interdisciplinary studies with focus on law, design and other subjects with together 34 graduates.

Variable	*Mean (all)*	*Mean (university diploma graduates)*	*Variable explanation*
Individual characteristics			
Female	0.45	0.42	Share of female graduates
Father university education	0.27	0.48	Share of fathers with university education
Mother university education	0.16	0.36	Share of mothers with university education
Final grade at school	2.3	2.1	Grade at final higher secondary education exam (from 1.0 = excellent to 4.0 = sufficient)
Age at graduation: young	0.10	0.07	Graduate was less than 24 years old at graduation
Age at graduation: old	0.19	0.16	Graduate was more than 27 years old
Grammar school (*Abitur*)	0.70	0.94	Graduate has school leaving certificate from grammar school instead of more indirect academic study allowance
Dual apprenticeship degree	0.29	0.18	Graduate has degree from dual apprenticeship training
More than 11 semesters studied	0.33	0.48	Study took more than 11 semesters before graduation
Study abroad	0.39	0.13	Graduate undertook part of the study outside Germany
Female	0.45	0.46	Graduate is female
Child	0.07	0.06	Graduate had own child at date of graduation
Living: employment	0.33	0.26	Main source for living is being dependently employed
Living: state loan	0.11	0.09	Main source for living is state loan (*Bafoeg*)
Living: grant	0.03	0.04	Main source for living is grant
Living: parents	0.43	0.54	Main source for living is parental payments
Living: bank credit	0.01	0.01	Main source for living is bank credit
Subjective assessment of knowledge			
Broad basic knowledge	0.21	0.23	Dummy = 1 if graduate chose 1 on scale between 1 (to a high degree) and 5 (to a low degree/not at all)
Specific knowledge in my study field	0.19	0.23	
Theoretical knowledge in my study field	0.19	0.24	
Knowledge in scientific methods	0.15	0.21	
Foreign languages	0.13	0.15	
Independent work	0.47	0.51	
Communication skills	0.25	0.25	
Problem solving skills	0.25	0.29	
Organisation skills	0.31	0.33	
Information and communication technology skills	0.25	0.25	
Written expression skills	0.23	0.24	
Oral expression skills	0.19	0.20	
Co-operation skills	0.20	0.21	
Boundary-spanning thinking	0.21	0.22	
Analytical skills	0.27	0.35	
Number of observations	4271	1985	

Table 1: Descriptive sample statistics

In universities of applied sciences, students attend most courses together, graduate (more or less) together and have little choice in their schedule. The traditional diploma and magister structure at universities (and to a lesser extent the new bachelor and master structure) requires more individual choice from a curriculum comprising mainly theoretical subjects and self-organisation skills. To get on-the-job experience, internship semesters are a mandatory part of study at a *Fachhochschule*. Therefore, it is likely that students at universities of applied sciences are better trained in transferring learned knowledge and skills into practice, whereas students at universities are better trained in method development and self-organisation. University diploma graduates are more confident about their skills at the end of their studies – the largest differences in perceived skills are in analytical skills, scientific methods and theoretical knowledge in their field of study, see Table 1.

Please note that average absolute grades at the end of the academic study are better than average grades at the end of schooling (compare the first two rows in Table A2). This is in contrast, for example, to Canada where university students at least during their first years get, on average, poorer grades than when in school (Wintre et al., 2011). This again shows idiosyncratic traditions in grading in different schooling institutions.

5 Empirical results

First, a couple of important bivariate correlations between variables are discussed. The individual correlation between school and university grades is 0.42 (the significance of the correlation is less than 1% – see Table 2). Also, achievement at higher secondary school is one of the main predictors of academic achievement in the multivariate regressions below (see also Jirjahn, 2004). This shows that ability and skills obtained in school must be included in order to avoid an overestimation of factors acquired during the study period. Please note that the correlation is clearly lower between final school grades and the deviation from university subject grades (0.35) than between school grades and absolute university grades. This is a consequence of less academically able pupils self-selecting into subjects with a higher share of other pupils with lower school grades, see the discussion on differences between subjects and self-selection below.

In descriptive statistics, it is frequently found that female students obtain better grades than male students (Erdel, 2010). This is also the case in our data set – on average, female graduates obtain a grade of 1.88 (SD: 0.51), which is significantly better than the average grade of male graduates (1.97, SD: 0.53).[11] This difference is also found in the bivariate correlation between grades and gender (see last line in Table 2).

Variable	*School grade*	*University grade*
Final school grade		0.42*** (absolute grade)
Final school grade		0.35*** (deviation from mean)
Father university education	-0.15***	-0.10***
Mother university education	-0.15***	-0.08***
Gender	-0.12***	-0.17***

Table 2: Bivariate correlations between school/university grades and the individual/socio-economic characteristics of graduates. Grades are measured as deviation from subject mean besides in first line. Number of observations: 4282. Significance levels: ***<0.01.

There is also a strong positive bivariate correlation between parental academic education and school grades. In addition, the correlation between grades and academic achievement of the mother is stronger than the corresponding correlation of the father, see Table 2. Finally, Table 2 also shows that a stronger parental academic background leads to a higher self-perception of own relevant skills.[12]

Next, differences between academic subjects with respect to average grades and student characteristics are discussed. Average school grades and academic grades are, of course, also positively correlated between subjects (bivariate correlation is: 0.76***, significance level<0.01). Graduates in subjects with a better than average final grade are more likely to have mothers (the correlation is 0.55***) and fathers (0.56***) with an academic degree and are more frequently female (0.34***). We analyse deviations from subject means in multivariate regressions and therefore the level effect between better average final grade and a higher share of parents with academic background cancels out later.

[11] The difference between males and females is even larger in the final school examination grades (females 2.21 (SD: 0.57), males 2.34 (SD: 0.61)).

[12] Most bivariate correlations between parental academic education and students' subjective assessments of skills are significantly positive. The highest correlations of fathers' and mothers' university education are for foreign languages, communication, problem solving and analytic skills. Insignificant are broad basic knowledge and ICT. There are no significant differences between father's and mother's academic achievements.

In multivariate regressions (see the first three columns in Table 3) that explain the deviation from subject mean final grade, the impact of the final grades in school is smaller than in the bivariate case but this is still one of the main drivers of academic success (see Dooley et al., 2012). The multivariate correlation between school grade and academic achievement is somewhat lower than that reported in a recent meta analysis by Trapmann et al. (2007) for Germany[13]. An important reason for the smaller correlation might be that the present study includes a large number of additional covariates, and that the studies included in the meta analysis included mainly bivariate correlations.

The bivariate difference in academic achievements between male and female pupils and students found in Table 2 vanishes in the multivariate approach. This finding is familiar from other studies (see, for example, Jirjahn, 2004 or Cassidy, 2011). The differences between male and female students are caused by differences in the choice of "male" and "female" subjects (García-Aracil et al., 2007). Females more often choose subjects where students get relatively good final grades on average (such as psychology or social work, see Table A2 in the appendix). The gender differences in grades therefore vanish when we take into account differences in average subject grades and other explanatory variables.

Interestingly, a certificate from a grammar school (*Abitur*) instead of more indirect routes to higher education does not have an impact on grades. When a student was especially young (younger than 24 years) at the date of graduation, the grades were significantly better, but when an applicant was especially old (older than 27 years), the grades were significantly worse. In addition, those graduates who took more than 11 semesters to graduate had significantly worse grades. Age at graduation and study length might be indicators for intrinsic study motivation or ability. An additional apprenticeship degree improves the academic achievement significantly – this indeed might be a sign of a higher career determination (double degree). Study abroad (which also might be a signal for higher motivation) has a significantly positive impact on grades.

[13] In a comparable meta-analysis of 20 studies, Peers and Johnston (1994) found an overall correlation of 0.28 between A-level grades and final degree performance in Great Britain.

Academic achievement of fathers and mothers no longer has any impact using the multivariate approach. One reason might be that socio-economic background also has an impact on the choice of the academic field of study (Hansen, 1997) – see the large differences in average shares of parents' academic education by subject in Table A2. The way students earn their living has the expected impact on grades. Students who have to work during the semester and mainly finance their living by working have significantly worse grades. Students who obtained a grant (which frequently is based on good school grades or a positive assessment test of academic skills) have significantly better grades.

It is also interesting to note that (the subjective assessment of) high specific knowledge in the study field yields significantly better grades in contrast to broad basic knowledge and theoretical knowledge in the study field and knowledge of scientific methods. Clearly, mainly subject-specific knowledge is tested in contrast to basic knowledge in academic exams. Written expression, independent work and analytical skills are drivers of good grades in contrast to oral and communicative skills such as co-operation, boundary-spanning, oral expression, foreign languages or communication skills. This may be a consequence of the fact that most exams are written individually and few grades can be obtained by oral tests or teamwork. In line with the discussion by Cassidy (2011), proficiency in computer use does not lead to better grades – this might reflect the fact that computers do not play a large role in academic education.

	(1)	(2)	(3)	(4)
Individual characteristics				
Final school grade	0.255***	0.242***	0.268***	0.280***
	(0.016)	(0.015)	(0.019)	(0.021)
Father university degree	-0.019	-0.012	-0.016	-0.010
	(0.014)	(0.015)	(0.015)	(0.018)
Mother university degree	0.026	0.026	0.022	-0.040*
	(0.026)	(0.028)	(0.027)	(0.022)
Woman	0.005	0.007	0.002	0.014
	(0.028)	(0.028)	(0.017)	(0.032)
Foreigner	0.072**	0.063	0.070**	0.003
	(0.035)	(0.038)	(0.034)	(0.051)
Age at graduation: young	-0.045*	-0.050*	-0.045*	-0.006
	(0.024)	(0.025)	(0.026)	(0.025)
Age at graduation: old	0.106***	0.102***	0.104***	0.103***
	(0.022)	(0.022)	(0.023)	(0.037)
Long study duration	0.152***	0.160***	0.151***	0.101***
	(0.024)	(0.023)	(0.029)	(0.020)
Child	0.070	0.072	0.077*	0.159**
	(0.044)	(0.043)	(0.044)	(0.059)
Dual apprenticeship degree	-0.085***	-0.093***	-0.092**	-0.070*
	(0.023)	(0.022)	(0.025)	(0.041)
Study abroad	-0.071***	-0.091***	-0.101***	-0.124***
	(0.019)	(0.018)	(0.016)	(0.031)
Grammar school degree	-0.017	-0.009	-0.019	-0.132***
	(0.020)	(0.020)	(0.031)	(0.039)
Living: employment	0.066***	0.069***	0.072***	0.065***
	(0.015)	(0.015)	(0.015)	(0.020)
Living: public subsidy	0.034	0.039	0.033	0.022
	(0.025)	(0.025)	(0.023)	(0.048)
Living: study grant	-0.056	-0.052	-0.053	-0.029
	(0.034)	(0.036)	(0.036)	(0.042)
Living: parents	0.022	0.025	0.023	0.029
	(0.018)	(0.019)	(0.022)	(0.020)
Living: bank credit	0.093*	0.095**	0.084*	0.076
	(0.047)	(0.043)	(0.043)	(0.095)

Subjective knowledge assessment				
Broad basic knowledge	0.009	0.009	0.008	0.014
	(0.016)	(0.016)	(0.016)	(0.033)
Specific knowledge in my study field	-0.068***	-0.069***	-0.073**	-0.069**
	(0.020)	(0.021)	(0.021)	(0.029)
Theoretical knowledge in my study field	-0.010	-0.009	-0.009	-0.028
	(0.014)	(0.014)	(0.016)	(0.021)
Knowledge in scientific methods	0.021	0.013	0.012	0.011
	(0.022)	(0.021)	(0.020)	(0.016)
Foreign languages	0.064**	0.057***	0.042	0.040
	(0.026)	(0.020)	(0.026)	(0.024)
Independent work	-0.059***	-0.048***	-0.051***	-0.046***
	(0.015)	(0.013)	(0.012)	(0.016)
Communication skills	0.014	0.019	0.019	0.040*
	(0.017)	(0.019)	(0.018)	(0.021)
Problem solving skills	-0.018	-0.024	-0.022	-0.015
	(0.017)	(0.016)	(0.016)	(0.022)
Organisation skills	0.020	0.026	0.024	0.046**
	(0.018)	(0.018)	(0.017)	(0.018)
Information and communication technology skills	0.007	0.011	0.004	-0.014
	(0.015)	(0.018)	(0.017)	(0.024)
Written expression skills	-0.091***	-0.088***	-0.087***	-0.084***
	(0.016)	(0.015)	(0.015)	(0.022)
Oral expression skills	0.015	0.015	0.015	0.009
	(0.025)	(0.023)	(0.023)	(0.027)
Co-operation skills	0.004	0.011	0.011	0.009
	(0.016)	(0.017)	(0.017)	(0.027)
Boundary-spanning thinking	0.025	0.022	0.022	0.047*
	(0.019)	(0.019)	(0.020)	(0.026)
Analytical skills	-0.048***	-0.050***	-0.048***	-0.051**
	(0.017)	(0.013)	(0.014)	(0.023)

Average student characteristics (selected selectivity effects)				
Fathers with university education			0.510	-0.111
			(0.438)	(1.324)
Mothers with university education			0.113	0.301
			(1.038)	(1.684)
Average number of semesters			-0.091	-0.048
			(0.083)	(0.077)
Average final school grade			-0.284**	-0.283**
			(0.123)	(0.123)
Average share high problem solving skills			0.198	0.281
			(0.452)	(0.643)
Average share boundary-spanning skills			-0.133	-0.107
			(0.120)	(0.225)
Average share high analytical skills			0.363***	0.354*
			(0.138)	(0.230)
Share students with study grant			0.806	0.529
			(2.333)	(3.940)
Share students with bank credit			-2.931	-0.263
			(6.112)	(1.816)
Constant	-0.583***	-0.536***	0.530	0.588
	(0.050)	(0.050)	(0.387)	(1.453)
10 university dummies	Yes	Yes	Yes	Yes
16 university of applied sciences dummies	Yes	Yes	Yes	No
R-squared	18.28%	20.04%	21.31%	25.28%
Observations	4,250	4,250	4,250	1,930

Table 3: Dependent variable: Deviation from subject mean[14].
Standard errors in parentheses, adjusted by clusters by subject (*** p<0.01, ** p<0.05, * p<0.1), columns (1)-(3) full sample, column (4) only university diploma

One of the main topics in this paper is the inclusion of many different dimensions of selectivity effects. Selectivity effects can be controlled for in graduate studies with graduates from different subjects by aggregating individual graduate characteristics to the academic subject level. The aggregation of student characteristics to the subject level is an intermediate approach that takes into account that students do compete with their fellow students in the same subject and their interaction is much weaker than the interaction between pupils or fixed study groups or roommates in student dormitories. The competition from (and interaction with) students of other subjects is low, however, and therefore the

[14] Note that the lower the average grade in Germany, the better the grade (the grade range is between 1 = excellent and 4 = sufficient).

impact of the inclusion of cohort effects that might capture changes in characteristics of the entire student body over time should be small.

To date, papers on academic achievements have included few selected average peer characteristics per subject. This paper systematically includes all average characteristics in order to test which characteristics have an impact on individual academic achievement and how average characteristics interact with other determinants. We distinguish between 16 subjects (clusters) and therefore cannot include too many variables at the subject aggregation level without risking multicollinearity. This problem can affect most studies on the basis of graduate survey data (that usually include a limited number of subjects). Therefore, first only a sub-sample of peer dimensions as usually found in the literature is included: the share of students whose fathers and mothers have academic degrees and the average final grades of students in school. We find that it is harder to excel in subjects with many students who were successful in school, see column (1) in Table A3 in the Appendix. Share of fathers and mothers with university degrees does not have an impact on individual academic achievement, however. Interestingly, when additional average individual and socio-economic characteristics are added, school grades lose only a little of their explanatory power. In addition, average study length in the subject has a positive correlation with the chance of being better than the average student. All other peer characteristics are not significant, see column (2) in Table A3.

In separate regressions, the impact of average means of living and subjective assessment of knowledge per subject also are tested. Again, most of the individual influence factors that have a positive impact on individual academic achievement have a negative group effect – a high share of more able peers selecting themselves into a subject makes it harder for individual students to excel. Some significant factors lose their significance, however, some change their signs and a few gain significance. A high share of students with a perceived good knowledge in boundary spanning in a subject improves the academic achievements, a high share of students with high analytical skills and problem solving skills makes it harder to excel, see column (3) in Table A3. A high share of students with a study grant has a negative impact on academic achievement of their fellow students. A high share of students with a

bank loan has a negative impact on individual grades – this means a positive impact on achievements because a higher grade is worse – see column (4) Table A3.

Next, the significant influences of all three lists of potential group effects (individual/socio-economic characteristics; means of living; subjective knowledge assessment) are combined in our preferred estimation model, which also includes all individual, socio-economic characteristics as well as institutional fixed effects, see column (3) in Table 3. Average school grades and a high share of students with high analytical skills remain significant peer dimensions, all other group dimensions are no longer significant. This indicates that group effects at the academic subject level are highly correlated. The direct correlations with individual characteristics and academic achievement are little affected by including group characteristics, compare columns (2) and (3) in Table 3. This means that individual and group characteristics are more or less orthogonal and both dimensions have separate explanatory power.

Some of the university and university of applied sciences dummies are significant (not shown here).[15] This means that some institutions, on average, award better or worse grades than others even when observed individual, socio-economic and group factors are controlled for.

As a robustness check, the sample is reduced to graduates with a university diploma (Table 3, column (4)). The determinants for academic success are remarkably stable. The correlation between final school grade and university achievement is stronger. This is also found by Peers and Johnston (1994) for Great Britain. In addition, not having obtained a grammar school exam (*Abitur*) is now negatively correlated with academic grades, an additional indicator that grammar school prepares students better for the more theoretical study required for a university diploma than does alternative education routes. In the same direction points the significantly positive impact of having a mother with university degree. Clearly, academic achievement of the mother plays a larger role than academic achievement of the father (McEwan, 2003; Jirjahn, 2007). Subjective skill assessments and the way of making a living have more or less the same impact on academic achievements for the

[15] Examples are significantly better grades awarded at Regensburg University or University of Applied Science in Landshut (having controlled for the other characteristics listed in Table 3).

smaller university diploma sample as for the full sample of graduates. Also the group effects are remarkably stable in both samples (this applies at least for the significant coefficients).

6 Discussion

This paper shows that academic achievement can be explained by individual, socio-economic and group characteristics. It proposes that besides the usual explanatory variables, such as gender, grades in tertiary education or study length, also perceived acquired skills and the means of making a living during the study period have a role in final academic grades. The paper also argues that it is important to control for differences between the grading traditions in academic subjects by demeaning grades by subject, and to control for institutional fixed effects. It uses final school grades as a measure of innate ability and inputs before studying. Finally, differences in the determinants for a good university diploma and other academic grades are analysed. The main contribution of this paper, however, is to show that group selectivity effects have different dimensions. It is not sufficient to control for single average student characteristics by subject such as average school grades or average shares of parents with academic degrees, as has mainly been done before. By systematically aggregating all individual characteristics of students to subject averages, it can be also shown that selectivity into subjects indicated, for example, by average study length and average subjective assessments of skills, has an important impact on individual academic achievements.

The analysis implies that mainly individual cognitive skills such as analytical skills, specific knowledge in the study field and independent work abilities positively affect academic success. Broad knowledge and theoretical knowledge do not lead to better grades. Also, teamworking skills such as co-operation skills, oral skills or foreign languages do not positively influence academic achievements in Germany. In addition, we also find a strong impact of selectivity on academic grades. The better the analytical skills of students in a subject on average and the better their grades in tertiary education, the smaller are the individual chances to excel in these subjects. Finally, correlations between gender, academic background of parents and individual academic achievements found in other studies may be spurious because they vanish when other determinants of grades at the end of an academic study are included.

This is mainly an exploratory study that uses already existing data. The data set is comparable to many other graduate surveys all over the world. It is interesting to explain deviations from final grade averages in an academic subject because students can successfully signal higher ability to the labour market when they have better academic grades from an academic institution (controlling for university type and location) than their competitors who are mainly students graduating from the same subject and institution.

One drawback of the data set is that it can only analyse achievements of graduates. We therefore cannot control for differences in selectivity of drop-outs during the study period that also might differ between subjects. The validity of the results hinges on the assumption that school grades depict ability and inputs obtained before the study period. Grades obtained in central examinations such as in the German states Bavaria, Baden-Württemberg, Hesse, Saxonia or Thuringia[16] might indicate academic ability better than grades from decentral exams obtained from single schools. Unfortunately, we do not know which students obtained their university entrance qualifications from a Bavarian gymnasium. For future research, it therefore would help to reduce the sample to students with a comparable *Abitur* obtained in a state with central examinations.

This study lies between typical economists' studies on academic achievement that mainly focus on precise estimation of peer and selectivity effects, and social science studies that include a wide array of explanatory factors (Van Ewijk and Sleegers, 2007). The economic studies are typically more rigorous but they frequently include only a small set of explanatory and potentially informative covariates or they are confined to rather specific evaluation situations that allow the identification of causal effects. The social science studies include more explanatory variables and frequently have more representative data, and therefore might be more relevant for policy advice. However, as they frequently do not control (fully) for selection bias or simultaneity bias, they have a higher risk of reporting biased results. The coefficients of group effects on academic achievement are similar in studies from different disciplines. One reason might be that explicitly controlling for

[16] Other German states have introduced central examinations recently; however, most for selected subjects only.

endogeneity and including additional mechanisms such as financial resources, subjective motivation or ability measures (coincidentally) both lead to a comparable reduction of estimation biases (Van Ewijk and Sleegers, 2007).

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Appendix

Subject	*Number of all graduates*	*Number of university diploma graduates*
History	51	-
Geography	78	-
Management	1328	677
Economics	104	97
Social work	315	-
Mathematics	67	65
Physics	85	85
Psychology	160	160
Sociology/Political Science	144	73
Engineering	950	184
Biology/Chemistry	258	258
Computer science	268	138
Education science	149	94
Foreign languages	128	89
German philology	127	14
Architecture	137	51
Total	***4271***	***1985***

Table A1: Number of observations by subject (all and university diploma)

Subject	*Average grade higher secondary school education*	*Average study grade*	*Share of fathers with university grade*	*Share of mothers with university grade*	*Share female students*
History	2.1	1.6	0.33	0.22	0.41
Management	2.3	2.1	0.25	0.15	0.51
Economics	2.0	1.9	0.41	0.26	0.35
Social work	2.4	1.8	0.14	0.10	0.81
Mathematics	1.8	1.5	0.43	0.27	0.37
Physics	1.7	1.4	0.44	0.33	0.11
Psychology	1.9	1.5	0.36	0.18	0.86
Sociology/Political Science	2.3	2.0	0.31	0.19	0.51
Engineering	2.5	2.1	0.19	0.10	0.10
Biology/Chemistry	2.1	1.5	0.33	0.17	0.52
Computer science	2.2	1.9	0.28	0.18	0.18
Education science	2.6	1.9	0.31	0.14	0.79
Foreign languages	1.8	1.8	0.45	0.28	0.86
German philology	2.2	1.9	0.39	0.22	0.82
Architecture	2.3	2.2	0.32	0.15	0.49
Total	***2.3***	***1.9***	**0.27**	**0.16**	**0.45**

Table A2: Subject characteristics

	(1)	(2)	(3)	(4)
Average student characteristics				
Fathers with university education	-0.418	-0.094		
	(0.510)	(0.499)		
Mothers with university education	0.774	0.235		
	(0.885)	(1.081)		
Average grade in higher secondary education	-0.245**	-0.228**		
	(0.103)	(0.093)		
Average number of semesters		-0.099***		
		(0.028)		
Share female students		0.034		
		(0.107)		
Share students with apprenticeship training		0.276		
		(0.445)		
Share students with foreign study		0.100		
		(0.087)		
Share old students		-0.710		
		(0.903)		
Share young students		0.263		
		(1.092)		
Share students with children		0.487		
		(1.336)		
Average knowledge assessment				
Broad basic knowledge			0.172	
			(1.526)	
Specific knowledge in my study field			-0.221	
			(0.440)	
Theoretical knowledge in my study field			0.398	
			(0.874)	
Knowledge in scientific methods			0.532	
			(2.846)	
Foreign languages			0.133	
			(0.367)	
Independent work			0.296	
			(1.464)	
Communication skills			-0.341	
			(1.573)	
Problem solving skills			0.575**	
			(0.210)	
Organisation skills			-0.693	
			(1.250)	
Information and communication technology skills			-0.111	
			(0.684)	
Written expression skills			0.697	
			(1.418)	
Oral expression skills			-1.474	
			(6.395)	
Co-operation skills			0.906	
			(3.516)	
Boundary-spanning thinking			-0.901***	
			(0.332)	

Analytical skills			0.518**	
			(0.246)	
Average study finance				
Share students with employment				-0.227
				(0.345)
Share students with public subsidy				-0.232
				(0.693)
Share students with grant				1.287*
				(0.652)
Share students finance by parents				0.270
				(0.446)
Share students with bank credit				-1.065***
				0.399
Nine individual characteristics	Yes	Yes	Yes	Yes
Five study financing characteristics	Yes	Yes	Yes	Yes
15 subjective knowledge assessments	Yes	Yes	Yes	Yes
10 university dummies	Yes	Yes	Yes	Yes
16 university of applied sciences dummies	Yes	Yes	Yes	Yes
R-squared	20.08%	21.39%	21.56%	20.96%
Observations	4,250	4,250	4,250	4,250

Table A3: Dependent variable: Deviation from subject mean.
Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1), all columns full sample