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ABSTRACT

The study examines which factors predict academic performance at university and compares the predictive values of subject-related entrance exams and indicators of past school performance. The results show that in the fields of engineering and social sciences entrance exams predict both graduation and the number of study credits better than past performance. In education past school performance is a better predictor of graduation. Changing the admission rule to school grades would affect the average student performance negatively in engineering and social sciences but positively in education. Using only entrance exams would not significantly change the average performance in any field.

JEL Classification: I21

Key words: university admission decisions, entrance exams, academic achievement

1. INTRODUCTION

In most European countries, university education has grown enormously during the past few decades. The enlargement of the secondary education has increased the number of eligible applicants at tertiary level, and as a result, universities have abolished free entry policy and created different kinds of student selection methods. Admission rules should be designed to help in achieving education policy goals and they should be comprehensible, stable, fair, cost-effective and legitimate. Student quality is also of direct economic interest and universities are interested in predicting the academic achievement of the students when deciding which applicants to admit. University admission processes have been formed during a long time and the way they have turned out to be is largely dependent on the whole education system and especially on the structure of the secondary education. In many countries, university admission is based on general aptitude tests, e.g. SAT scores, possibly combined with indicators of past performance at school and interviews or letters of recommendation. Some countries base their university admissions mainly on past performance or even lotteries, while others admit all applicants but only the best performing students may continue their studies after one or two years of study.

In Finland, university admission is currently based on various subject-related entrance exams and grades in the national senior secondary school final exam, matriculation examination. Universities select their students independently and there are no national entrance exams. The problems of the current system are well known. Competition for the slots in higher education is fierce and annual admission quotas apply to all fields of study. In total, less than a third of the applicants are accepted. Competition and quotas force many applicants to apply several times before they are accepted to the desired program. This has lead to a high median starting age in some fields of study. In addition, less selective programs suffer from high dropout rates when students succeed to get into other programs after a few years. The admission decisions are made at the department or faculty level, which makes the admission system very dispersed.[1] The lack of coordination in the admission procedure is problematic from the applicants' point of view because the applicants have to take separate subject-related entrance exams for each university and retake the exam every year they want to apply to the university. The dispersed exam-based system might not be cost-effective for the universities either.

Studies on predicting student performance at higher education abound. However, there are few studies on how alternative admission systems would work and how reforms would change the composition of applicants or students. One of the most important questions for the universities is whether different admission rules lead to altered student populations and change in average student achievement. A subject-related entrance exam may measure motivation and applicant's interest in the field of study and might therefore predict academic success better than a general aptitude test or matriculation examination grades. Entrance exams may also be a second chance for students who have received low grades in school. On the other hand, entrance exams are costly for universities and for the society – especially if students apply several times before they get admitted. It is not self-evident that the current entrance exams measure the right things or give a realistic picture of what the actual studying is like. Also, admission rules that are based on past performance could result in admitting the same individuals than admission based on entrance exams. In this case universities should choose the admission criteria that minimize the costs.

This study examines which factors predict academic performance. In particular it compares the predictive values of subject-related entrance exams and indicators of past school performance which are the instruments that universities can use in the student selection. The

[1] In the 20 Finnish universities, there are a total of 540 units who make the admission decisions.

study also looks at the student and applicant composition and how the student population or average student performance would change if the admission criteria were changed. The study uses three cohorts of students from the University of Jyväskylä and Helsinki University of Technology (HUT). Engineering is the largest field of study and HUT is the oldest, largest and most selective university of technology in Finland, which makes it an ideal university to analyze factors that predict academic achievement in the field of engineering. However, one cannot draw conclusions from looking at one field and therefore, the study also uses data on students in the fields of social sciences, education and sport sciences from the University of Jyväskylä. University of Jyväskylä is a good example of a median Finnish multidisciplinary university.

The rest of this paper is organized as follows. Section 2 summarizes the previous literature on predicting student performance at tertiary education. Section 3 describes the university admission process in Finland. Section 4 introduces the data and variables. Section 5 introduces the methods used in evaluation. Empirical results are presented in Section 6 and Section 7 concludes.

2. PREVIOUS LITERATURE

There is an extensive literature concentrated on predicting student performance. This literature uses mainly correlation analysis and the main conclusion from these studies is that up to 25 percent of an individual's future educational success can be explained with factors that are observable at the time of the admission. The general finding is that grade point averages (GPA) from previous school and aptitude test scores provide the best forecast of success, whether the success is measured as grades or completion of higher education. Betts and Morell (1999) study the determinants of first-year college grades at the University of California, San Diego, and find that personal background (gender, ethnic group, family income) and the socio-economic environment of the school are significantly linked to college GPA. In addition, high school GPA and SAT scores are strongly correlated to success at college, but predictions could be improved by adding background variables. Also Rothstein (2003) finds that much of the aptitude test's predictive power derives from its correlation with high school demographic characteristics.

Krueger and Wu (2000) study the determinants of success of 344 economics graduate students who applied for admission to a "top five" department in the U.S. in 1989. They determine the success by the students' job placement nine years after the beginning of the graduate studies and find that although there is considerable uncertainty in predicting which applicants will be placed in high-ranking jobs, the math graduate record examination, the subjective ratings of the admissions committee, and the prominence of reference letter writers are statistically significant predictors of applicants' subsequent job placements.

Öckert (2001) studies the completion probability and the effects of university studies on labor market performance using data from the admission selection process in Sweden in 1982. His results show that female applicants, applicants with long senior secondary schooling and high GPA from senior secondary school are most likely to graduate from university. Age at entry is negatively related to student performance.

There are also a few studies that have examined the admission procedure in Finland. Most studies find that senior secondary school grades are positively correlated with success in higher education. The correlation of entrance exams and success in studies is somewhat unclear because there are such many types of entrance exams. Lindblom-Ylänne et al. (1992) examine the correlation of an aptitude test and first year university grades for students in medicine and find that the test explains only a very small fraction of the variation in student performance. Gillberg (1987) analyzes students in business and finds that success in the entrance exam is negatively correlated with dropout probability but entrance exams have no connection with times-to-degree. Rantanen (2001) studies non-university tertiary education in Finland and concludes that 60 percent of the applicants would have been admitted to the same program even if entrance exams were abolished and students were admitted on the basis of their past school performance. Rantanen finds that the best indicators for student performance are applicant's school and program preference ranking and the GPA from previous school. Performance in the entrance exam predicted student performance only in the field of engineering. Some studies have found that past performance in school and success in the entrance exam are quite weakly correlated, sometimes even negatively correlated (Silvennoinen et al., 1991; Ahola, 2004).

Most previous studies have looked at student performance at the beginning of the studies and usually for one field of study. This paper includes four fields of study and has access to yearly information on each student's study credits throughout the whole enrollment time, which enables the identification of dropouts and following the students from admission to

graduation. In addition, the data sets used in this study include not only admitted students but all applicants, which makes it possible to calculate how the student population would change if different admission rules were used.

3. FEATURES OF THE FINNISH UNIVERSITY SYSTEM AND ADMISSION PROCESS

The three-year Finnish senior secondary school concludes with a matriculation examination that provides general eligibility for university studies.[2] Matriculation examination is compulsory for all senior secondary school students. It is drawn up nationally, and there is a centralized body to grade the exam according to uniform criteria. The results are also standardized to be comparable across the years. There are four compulsory exams in the matriculation examination: mother tongue, the second national language, one foreign language[3], and either mathematics or science and humanities exam[4]. The grades in each exam range from improbatur (failed) to laudatur (excellent), which are converted to a scale from 0 to 6 in this study. Mathematics exam is compulsory for students who have studied advanced mathematics courses in senior secondary school. Students may also voluntarily take additional exams in other foreign languages or take both the mathematics and the science and humanities exam. The exams are held each spring and autumn during a two-week examination period. From 1996 onwards the students have been able to take the exam over the maximum of three examination periods. Prior to 1996, the full exam had to be taken within the same examination period, usually in the spring term of the senior year. More than 50 percent of the age group completes senior secondary school.

Matriculation exam gives the general eligibility for studies at tertiary level, but universities select their students independently and there is restricted entry to all fields of study. The number of study slots at tertiary level is determined each year in performance negotiations between the Ministry of Education and the universities. Student selection may be based on

[2] Individuals without the matriculation exam are eligible to apply for universities if they have at least three-year vocational qualification after compulsory schooling. However, there are very few applicants without the matriculation exam and these applicants are excluded from the empirical estimations.

[3] For the Finnish-speaking majority, the second national language is Swedish and the compulsory foreign language is usually English.

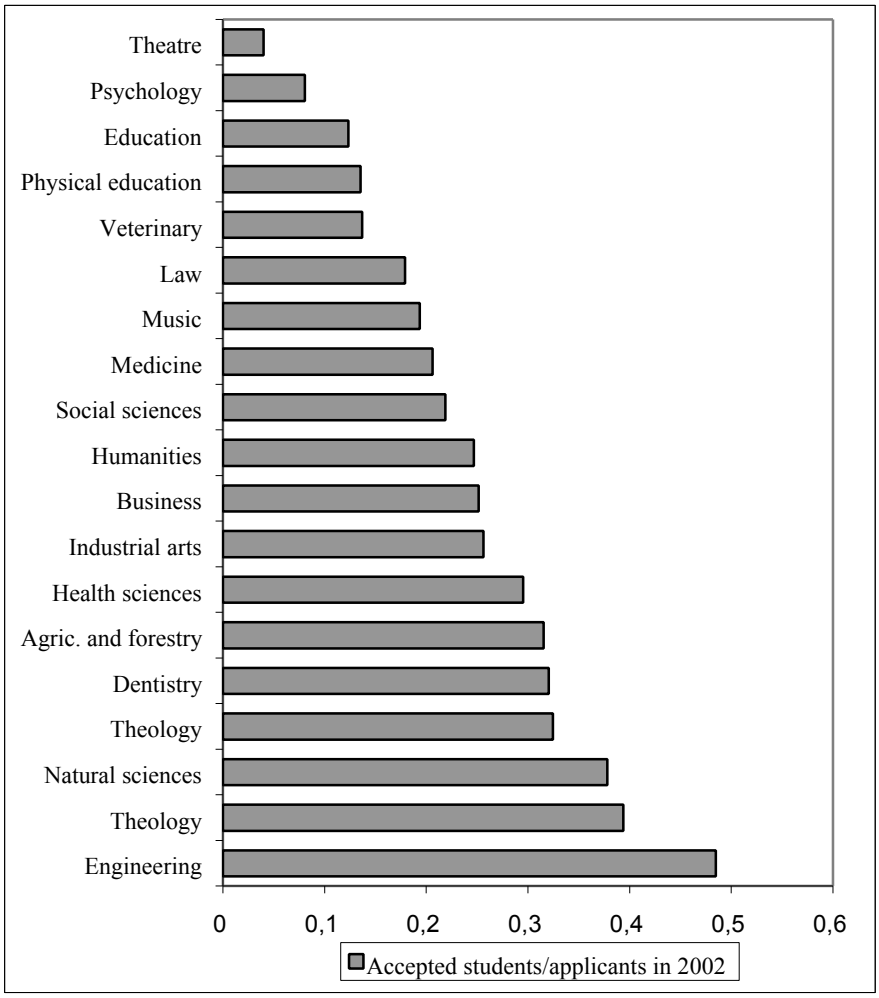
[4] The science and humanities exam includes questions from physics, chemistry, biology, psychology, geography, religion, and history. Students can choose to answer questions from any subject area.

the combination of senior secondary school grades, matriculation exam grades, and the entrance exam, which is the most common procedure; on the entrance exam alone; or on the grades in the matriculation exam and the senior secondary school final grades. In addition, some fields may place additional emphasis on work experience, previous studies or practical training. Entrance exams are designed by the university, faculty or department in question to assess the applicants' motivation, suitability and aptitude in the field concerned. The entrance exams are written subject-related tests with a book or two to read. There may also be interviews or exams based on material that is distributed at the beginning of the test, and students may be required to demonstrate their skills (e.g., at art academies).

Universities co-operate in organizing the student selection to varying degrees. The field of engineering and architecture applies a joint selection system, where each of the universities uses the same selection criteria and the same application form. There is also co-operation between universities in biology, languages, class teacher and kindergarten teacher education, and medicine. However, this co-operation does not constitute an actual joint selection system. For the most fields, there is no coordination of the entrance exams, required literature or dates of the exams. For example, in 2004, there are six universities providing education in sociology. An applicant to sociology could take four entrance exams in four universities and would have to choose between the two universities that have the exam at the same time. Also, the applicant might have to read different material for each of the exams.

In total, less than a third of the applicants are accepted, but there are huge differences in the acceptance rates between the fields and, to some extent, between universities. As shown in Figure 1, the lowest acceptance rates (less than 10 %) are in the fields of theatre and psychology, and the highest acceptance rates are in engineering (48 %), theology (39 %) and natural sciences (38 %).

Figure 1. Share of accepted applicants by study field.



Source: KOTA database of Ministry of Education.

Most students are accepted to programs leading to a Master's degree, which consists of one major and one or more minor subjects. Students usually apply directly to a specific major. The graduation requirement is, depending on the field of study, 160 or 180 credits. One credit corresponds roughly to one week of full-time study. The target duration of studies in most fields is five years, but the actual durations are usually longer. The median time-to-degree is roughly six years. Currently there are no strict limits on the duration of enrollment.

All Finnish universities are state-owned and their activities are mainly financed from the state budget through the Ministry of Education. In 2003, the proportion of state funding was about 65 percent of the operating costs. The rest comes from various sources, mainly as acquired funding for research and services. The state funding system has been gradually

reformed since 1994 towards a system based on university outcomes. The core funding consists of four segments: expenditure on new students and facilities, teaching, research, and societal services. Teaching and research parts comprise 74 percent of the core funding and the funding is allocated on the basis of the number of targeted and completed Master's degrees and doctorates. Thus, there is an incentive for the universities to select successful students who are able to finish their degree in reasonable time. In addition to core funding, universities can receive performance based funding. The performance based funding represents about 2.4 percent of universities' operational expenditure and rewards universities for the quality and effectiveness of their operations. The criteria for the performance based funding include e.g. high quality research, students' progress in studies, and placement of graduates in the labor market. (Ministry of Education, 2004).

3.1. Admission process in the Helsinki University of Technology (HUT)

As mentioned in the previous section, universities of technology have a unique joint application system, which enables students to apply to all universities with one application. The details of the admission rules are summarized in Table 1. In 1986, 1990 and 1995, each applicant had to take two exams, one in mathematics and one in physics, chemistry or social sciences depending on the desired program. Applicants were also given entry credits, which are called initial entry points, on the basis of matriculation exam and senior secondary school grades. In 1986 and 1990, initial entry points were based on the compulsory exams in the matriculation examination, points from questions in physics or chemistry in science and humanities matriculation exam, senior secondary school final grades in mathematics and physics or chemistry, and senior secondary school GPA. In 1995, only senior secondary school final grades in physics or chemistry and compulsory exams in the matriculation exam gave initial entry points. Total admission points are calculated summing up initial points and entrance exam points. Entrance exam constituted 47 percent of the total points in 1986 and 1990, and 65 percent in 1995.

In 1986, the admission of all students was based on total points. In 1990 and 1995, 80 percent of the students were selected on the basis of total points and the remaining 20 percent were selected ranking the applicants according to their entrance exam points. Students are admitted directly into different majors. Due to the higher demand, popular majors have higher entry requirements. Each major makes up a separate admission quota group.

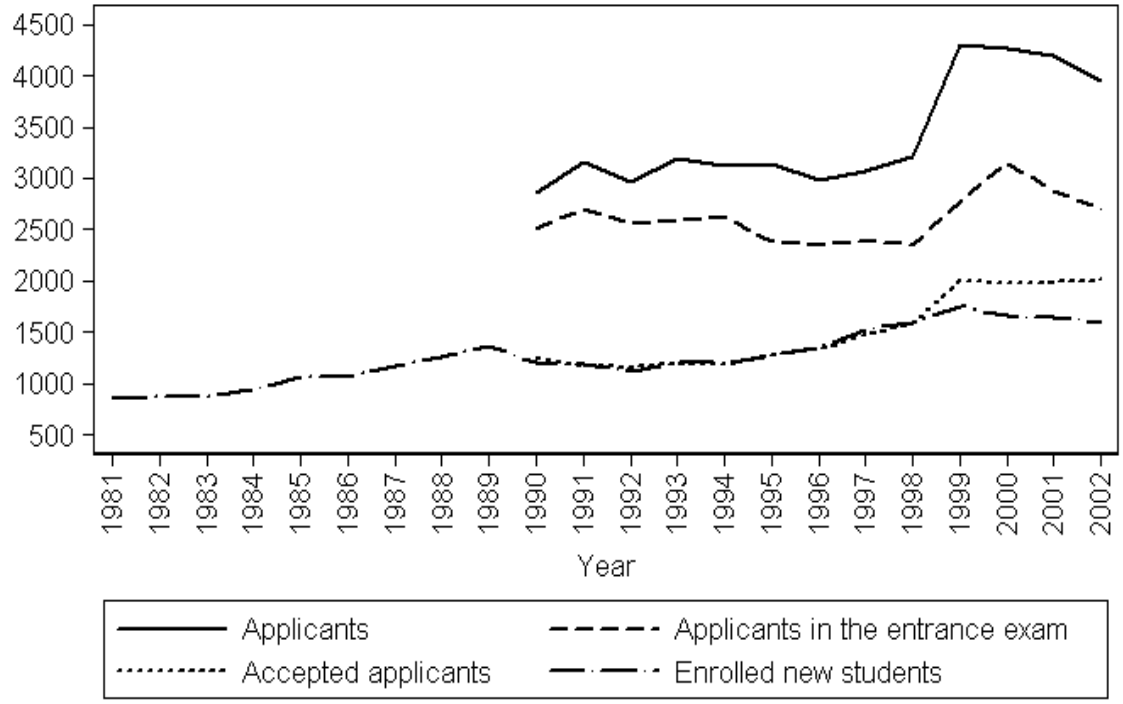
80 percent of the students in engineering are male. Unlike in most other fields, new entrants are on average 19 years old and about 70 percent of the new enrollees at HUT have finished their senior secondary school in the same year. About one thousand new students are admitted each year. The number of accepted students and the fraction of students who decide to enroll have been quite stable in HUT during the time period that is analyzed in this study (figure 2). The number of applications and new students did not grow much until the end of the 1990s. It is also worth noting that nearly all admitted applicants decided to enroll be cause prior to 1999 one could be admitted to and enroll in several universities in the same year.

Table 1. Summary of admission rules.

	Helsinki University of Technology			University of Jyväskylä		
	Engineering			Social sciences	Sport sciences	Education
Year	86	90	95	92, 95, 97	92, 95, 97	92, 95, 97
Total points						
1. Initial points						
i. Matriculation exam						
a. Mother tonguea	X	X	X	X	X	X
b. 2nd national languagea	X	X	X		X	X
c. Foreign languagea	X	X	X	X	X	X
d. Mathematics/Sciencea	X	X	X	X	X	X
e. Other foreign language					X	X
f. Science/Mathematics	Xb	Xb			Xe	Xg
ii. Senior secondary school grades						
a. Average (GPA)	X	X	X	X	X	X
b. Subjects	Math Phys/Chem	Math Phys/Chem	Phys/Chem		Sports	
iii. Other merits						
a. Work experience					In field	
b. Previous studies					In field	Tertiary
c. Other					Gender	
2. Entrance exam points						
i. Written exam	Math Phys/Chem/ Soc c	Math Phys/Chem/ Soc c	Math Phys/Chem/ Soc c	Subject related	Subject related	Subject related
ii. Aptitude test				Xd	X	
Exam's weight in total points	47 %	47 %	65 %	50 %	55 %f	55 %
Admission rule						
i. Total points	100 %	80 %	80 %	80 %	100 %f	50 %
ii. Entrance exam points		20 %	20 %	20 %		50 %

Notes: a=compulsory exam, b=questions in physics/chemistry, c=depends on applied major, d=Psychology applicants, e=higher weight on compulsory exams, f=weights for entrance exam points differ between majors, the applicants with highest initial points are invited to the entrace exams, g=four best exams.

Figure 2. Number of applicants, accepted applicants and enrolled new students in Helsinki University of Technology.



Source: KOTA database of Ministry of Education.
Note: From 1999 onwards a student can enroll as a new student in only one university program in a given year. This explains the larger difference between the accepted applicants and enrolled new students after 1998.

3.2. Admission process in the University of Jyväskylä

The details of the admission rules in the University of Jyväskylä are summarized in Table 1. The admission rules were about the same in all of the years analyzed (1992, 1995 and 1997) but differed between the fields of study. Half of the students in education were selected using only subject-related entrance exam, the other half of the students were selected on the basis of total points. Total points were calculated summing up entrance exam points and initial entry points, which were based on four best grades in the matriculation exam, senior secondary school GPA, and extra points from previous tertiary level studies. Entrance exam made up 55 percent of the total points. Each year, roughly 45 students are admitted to education. 94 percent of the students in education are female and students are on average 22 years old when they enter the program.

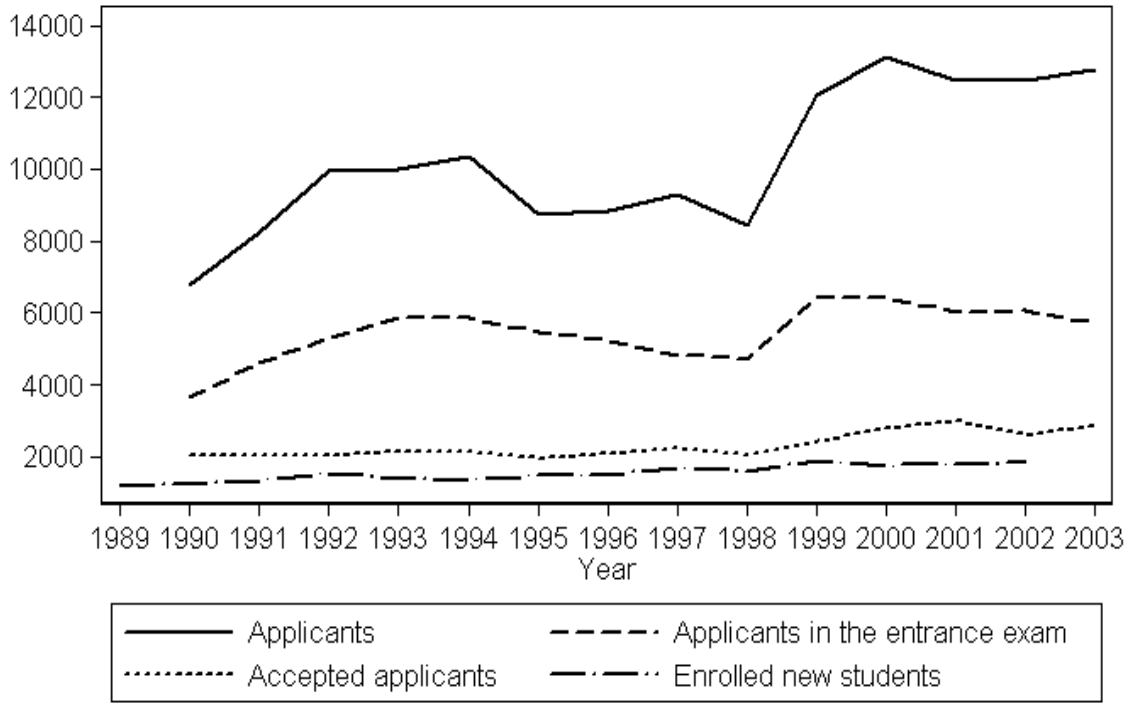
In the years analyzed in this study, 80 percent of the students in social sciences[5] were selected on the basis of total points and the remaining 20 percent were selected ranking the remaining applicants according to their entrance exam points. Entrance exam constituted 50 percent of the total points. Initial entry points were based on senior secondary school GPA, matriculation exam grades in mother tongue, foreign language, and mathematics or science and humanities exam. In addition, the applicants to psychology had to take a special aptitude test. Each year, roughly 230 students are admitted to social sciences. About 60 percent of the admitted applicants are female and only 18 percent are senior secondary school graduates of the same year. The average age at entry is 21.9 years.

Students in sport sciences were selected in two phases. First, applicants were ranked based on their matriculation examination grades, senior secondary school GPA and grade in physical education, work experience as a gym teacher or studies in the field. About 300 best male and 300 best female applicants were then invited to take the written entrance exam and the aptitude test measuring athletics and teaching skills. Students were ranked according to the sum of exam points and initial entry points, giving a different weight to the initial points in different majors. Entrance exam constituted about 55 percent of the total points. About 80 students are admitted each year and each major forms its own admission quota. 55 percent of the new entrants are female and the proportion of recent senior secondary school graduates is about 12 percent.

The number of accepted students and the fraction of students who decide to enroll have been very stable in the University of Jyväskylä between the years 1992, 1995 and 1997 (figure 3). For the fields studied in this paper, roughly 15 percent of the admitted applicants decide not to enroll.

[5] Social sciences include philosophy, political science, psychology, social policy, social work, sociology, statistics, economics, business, and information systems science. Students are admitted directly into majors.

Figure 3. Number of applicants, accepted applicants and enrolled new students in University of Jyväskylä.



Source: KOTA database of Ministry of Education.
Note: From 1999 onwards a student can enroll as a new student in only one university program in a given year. This explains the larger difference between the accepted applicants and enrolled new students after 1998.

4. DATA

This study uses data from two universities, the Helsinki University of Technology (HUT) and the University of Jyväskylä. The data from HUT is based on the joint application register to Master's programs[6] in technology in 1986, 1990 and 1995. Students in architecture and landscape architecture are excluded from the sample because of the different admission procedure. The data from the University of Jyväskylä includes individuals who applied to Master's programs in education, social sciences, or sport sciences in 1992, 1995 and 1997. The data sets include both admitted and rejected applicants. Information is collected on each applicant's age, gender, mother tongue, senior secondary school graduation year, grades in the senior secondary school final exam (matriculation examination) converted to a scale from 0 to 6, senior secondary school grade point average (GPA), scores in the entrance exam, initial entry points based on past performance, preference ranking of the majors, and acceptance information (university, rank of the student in the quota, accepted

[6] Master's degree is the first degree in Finland.

applicant's major). Unfortunately there was no acceptance information for the students in sport sciences and for the 1995 and 1997 starting cohorts of students in education. Therefore, we can observe the accepted applicants who enrolled into these programs, but we cannot distinguish an admitted applicant who did not enroll from a rejected applicant. However, this does not cause any problems when we are looking at the achievement of the enrolled students.

Initial entry points are points that admission units calculate from the matriculation examination grades, senior secondary school grades and possibly some other indicators of past performance. Initial entry points are calculated differently for each field as described in the previous section. To be able to compare entrance exam scores and initial entry points, percentile ranks within the admission quota (major) are used instead of actual scores. To be able to make comparisons across the fields, different components of the initial points as well as an alternative measure for initial points, which is calculated similarly for all fields, are used in the estimations.

The applicant registers are matched with the student registers of the corresponding universities. The student registers contain yearly information on student's enrollment, academic achievement (number of credits and courses taken) and time of the graduation. Students are followed from the entry year to the fall of 2003. A student is defined as a dropout in the year after which no study credits are achieved. Student register information is naturally only available for admitted applicants who have decided to enroll. There is no information on study success for the rejected applicants or admitted applicants who did not start their studies. Further, the data do not include information on whether these applicants were admitted later or to other programs in other universities[7]. This creates a selection problem that is discussed in the next section. The data include 3,278 students in engineering, 687 students in social sciences, 249 students in sport sciences and 133 students in education. Descriptive statistics of the applicants and enrolled students are presented in the Appendix in Table A1.

[7] Except for engineering, where acceptance (but not enrollment) information was available for all universities of technology for the years 1986, 1990 and 1995.

5. METHODS

It is not self-evident how "academic achievement" should be defined when trying to analyze which factors predict achievement. The university might be interested in admitting students that receive high grades, but clearly that is not the only measure of success. Since the times-to-degree in Finland are very long and the government funding is partly based on the received degrees, one interesting issue is how to select students who will graduate in the targeted time. In addition, universities might be interested in predicting the dropout rates of different types of applicants. Furthermore, graduate placement in the job market is also an interesting issue. How graduates succeed in the labor market after graduation is an indicator of school quality which affects the pool of applicants. Graduate placement is also a factor in the government funding formula. Unfortunately, the data in their current form do not include any labor market information on students or their job placements after graduation. Thus, this study concentrates on predicting the number of credits received during the first four study years and the probability to graduate within seven years.

The university's problem is to identify a subset of the applicant pool most likely to be academically successful. Following Rothstein (2003), the university's assessment of student i is given by

$$E[y_i \mid S_i, X_i] = \alpha + S_i\beta + X_i\gamma \,, \qquad (1)$$

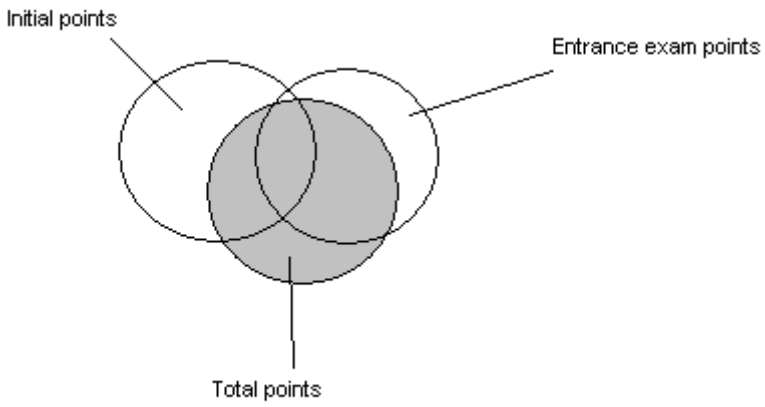
where y_i is a measure of the student's success at university (e.g. grades, number of credits), S_i is the student's entrance exam score, and X_i is a vector of other admissions variables (e.g. matriculation exam grades). The conditional expectation is assumed to be linear and additive.[8]

The population for whom outcomes are to be predicted is the group of potential applicants, while success in university can only be observed for enrolled students. Since one cannot observe how well rejected students would have performed had they been admitted to the university, the sample is selective. However, the data include all information that is used when selecting the students from the pool of applicants. Under the selection-on-observables assumption the OLS estimates for admitted applicants reflect the predictive power of entrance exams and other admission criteria for all applicants. However, since there are no

observations on the admitted applicants who did not enroll and the enrollment decision might not be random, the estimates might still be biased. The probable explanation why admitted students do not enroll is that they get accepted to other programs. Unfortunately this is not observed in the data. Since the number of admitted applicants who do not enroll is quite small, this should not be a major problem.

The basic analysis is based on an OLS regression model where the number of credits after four study years is used as the dependent variable. Only a small fraction of students graduates in less than four years. However, 10–15 percent of the students drop out. The OLS models are estimated both including the dropouts and conditional on studying in the fourth year. In addition, linear graduation probability models are estimated for the student population. The empirical models are estimated separately for each field but pooling the data for the three entry cohorts and adding cohort dummies to the models. The results do not change much if models are estimated separately for each cohort.

Figure 4. Illustration of the intersections of the admission rules.



Second part of the empirical analysis considers the effects of changes in the admission rules on achievement of the student population. Changing admission rules could lead to a different student composition. Figure 4 illustrates three admission rules, initial entry points, entrance exam and total points, which is the sum of initial points and entrance exam points. How much these admission rules overlap is a question that can be answered empirically. Taking the two extreme admission rules as an example, 74 percent of the admitted students in engineering would be admitted regardless of the admission being based solely on past

[8] A variety of tests and model specifications including higher terms do not offer any evidence against the linearity assumption.

performance or on the entrance exam alone (Table 2). The student composition would change more in social sciences, sport sciences and education. 36 percent of the admitted students in social sciences, 28 percent in sport sciences and 46 percent in education would be admitted regardless of the admission being based on initial entry points or entrance exam.

Since the different admission rules are likely to select more or less the same students in the upper end of the distribution, the mean academic achievement whether measured as graduation or study credits could be the same regardless of the selection criteria. Therefore, it is more interesting to compare applicants who would change their admission status when the admission criteria are changed. The first column of Table 3 presents the age and gender distributions of the applicants in the sample who would be admitted using entrance exams but rejected if admission was based on initial points only. The second column presents the distributions for applicants who would be admitted if initial points were used but rejected if entrance exams were the only selection criteria. Entrance exams select more male students and older students than initial points. A smaller fraction of new senior secondary school graduates would be admitted if only entrance exams were used. This might be due to the learning effect, i.e. older applicants might be applying to the university for the second or third time and have more information on how one should prepare for the entrance exams. Female applicants have higher matriculation exam grades which explains why females would benefit if students were selected on the basis of past performance.

Table 2. Number of students whose admission is dependent on the admission criteria.

	Engineering	Social sciences	Sport sciences	Education
Total number of applicants	7,758	5,552	1,286	575
Number of admitted applicants	3,430	952	227	139
Would be admitted using either entrance exam or initial points	2,526	344	63	64
Would be admitted using entrance exam but not using initial points	904	608	164	75
Would be admitted using initial points but not using entrance exam	904	608	164	75
Would not be admitted using either criteria	3,424	3,992	895	361

Table includes three cohorts of applicants. Results are very similar for each cohort.

Table 3. Age and gender distributions of applicants who would change admission status when admission criteria are altered.

	(1) Admitted using entrance exam, but not using initial points	(2) Admitted using initial points, but not using entrance exam	(3) Difference (1) – (2) (std error)
Engineering	(904 obs)	(904 obs)	(1,808 obs)
Fraction of female applicants	0.102	0.287	-0.185** (0.018)
Mean age at entry	20.37	19.96	0.408** (0.100)
Fraction of new senior secondary school graduates	0.428	0.378	0.050* (0.023)
Social Sciences	(608 obs)	(608 obs)	(1,216)
Fraction of female applicants	0.516	0.696	-0.179** (0.028)
Mean age at entry	22.61	20.70	1.903** (0.184)
Fraction of new senior secondary school graduates	0.081	0.421	-0.339** (0.023)
Sport Sciences	(164 obs)	(164 obs)	(328 obs)
Fraction of female applicants	0.470	0.720	-0.250** (0.053)
Mean age at entry	21.63	20.70	0.933** (0.271)
Fraction of new senior secondary school graduates	0.158	0.390	-0.232** (0.048)
Education	(75 obs)	(75 obs)	(150 obs)
Fraction of female applicants	0.920	0.933	-0.013 (0.043)
Mean age at entry	23.31	21.44	1.867* (0.726)
Fraction of new senior secondary school graduates	0.028	0.333	-0.305** (0.058)

The sample used includes only students who are admitted using one admission criteria, either entrance exam or initial points, but not with both admission criteria (rows 4 and 5 in Table 2) . Standard errors in the parenthesis are from a robust regression. * significant at 5 percent level; ** significant at 1 percent level. The results in column 3 are unchanged if controls for the applied major and starting cohort are included.

We can see how the student population would change if the admission criteria were altered, but there are no observations on the achievement of the rejected applicants who would have been admitted using other criteria. Since the admission is based on observables, the success in studies can be predicted for the applicants that were not accepted or did not enroll using the results on the enrolled students. Predicting the performance of the admitted but non-enrolled applicants is not problematic since they are very similar in their observable characteristics to enrolled students. Predicting the performance at university for the rejected applicants has to be done by running out of sample predictions, since there is very little overlap in the entrance exam results between the admitted and rejected applicants. Since the admission weighs the entrance exam more than the past school performance, there is some overlap in the matriculation exam and senior secondary school grades between the admitted and rejected applicants. Out of sample predictions rely heavily on functional form assumptions. Within the sample (enrolled students), the relationship between entrance exams and

study credits after four years is linear and it is assumed in this study that the relationship is linear also for the lower tail of the entrance exam distribution. Using higher moments of explanatory variables in the performance prediction does not affect the qualitative results.

The range of the entrance exams and indicators of past performance is restricted in the sense that those who have performed poorly in school and who are likely to perform poorly in the entrance exam do not apply to university. Therefore, if the regressions were run for the whole population, the university admission criteria would probably explain a much higher proportion of the variation in achievement at university. Nevertheless, the predictions for the population are not very interesting for the university's decision making.

Altered admission rules could affect the pool of applicants because people adapt to regulatory frameworks. However, there is no straightforward way to analyze what the effects would be for the pool of applicants. A survey on senior secondary school graduates finds that applicants with high grades prefer admission that is based on school grades or subject-related tests whereas applicants who did not excel in school prefer general aptitude tests (Garam and Ahola, 2001). Admission rules based on past performance could increase retaking passed matriculation exams and senior secondary school courses. Grade inflation, retaking passed courses or choosing easier courses at senior secondary school to get better grades has become a problem in Sweden, where university admission is largely based on past performance (SOU 2004). Using entrance exams as the sole admission rule could encourage individuals with lower school grades to apply to university but also discriminate new senior secondary school graduates who have less time to prepare for the entrance exams than older applicants.

6. RESULTS

OLS regression results on the number of study credits after four years are presented in Table 4. The sample used includes all admitted and enrolled students, regardless of their student status in the fourth year. Some of the students have graduated, dropped out or changed field of study, but the cumulative number of study credits can still be calculated for all individuals who enrolled at least in the first year. Since each major within the field of study forms an admission quota, all models include controls for the major subjects. The possible cohort effects are controlled with dummy variables for the

admission year. In addition to the controls for student's major and cohort, the first column for each field includes percentile ranks of entrance exam score and field specific initial entry points. The results show that students with high rank in the entrance exam have more study credits after four years. The magnitude of the effect varies between the fields of study and it is statistically significant at 5 % level for all fields except for education. The coefficient of the initial points percentile rank is positive but much smaller and statistically significant only for sport sciences.

Table 4. OLS estimates of cumulative number of credits after four years.

	Social sciences		Sport sciences		Education		Engineering	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rank of entrance exam	90.775***	82.353***	35.445**	30.991*	37.236*	37.469*	54.430***	59.875***
	(18.960)	(18.738)	(16.650)	(16.700)	(20.031)	(19.532)	(5.545)	(5.515)
Rank of initial points	11.683	7.239	29.274**	20.937	37.088	39.934*	5.313	5.225
	(7.611)	(8.568)	(11.293)	(12.712)	(22.529)	(20.432)	(4.178)	(4.244)
Female		19.972***		4.040		-57.486***		20.436***
		(4.855)		(7.009)		(17.286)		(2.646)
Age at entry: 21-23		10.407**		-3.704		-14.364		15.229***
		(4.347)		(6.908)		(8.722)		(3.035)
24-		6.425		-22.187**		-17.313		3.992
		(6.534)		(10.536)		(15.797)		(7.060)
Observations	687	687	244	244	133	133	3,278	3,278
R-squared	0.12	0.14	0.06	0.09	0.07	0.14	0.08	0.11
F statistic	7.65	8.09	2.43	2.55	2.24	4.41	17.19	19.30
(Prob>F)	(0.0000)	(0.0000)	(0.0201)	(0.0061)	(0.0679)	(0.0002)	(0.0000)	(0.0000)

Robust standard errors in parentheses. * significant at 10 %; ** significant at 5 %; *** significant at 1 % level. All models include controls for student's major and entry cohort. The excluded entry age group is 18-20-year-olds.

Background variables in student performance prediction are not particularly informative about admissions policy, but they are still interesting. It is plausible that entrance exam score and school grades are correlated with socio-economic background of the student that predicts the student performance. The data include information on student's gender and age. These are added as controls in the second column for each field in Table 4. The coefficient of the entrance exam rank is more or less unchanged. The effect of the rank of initial points is diminished for social sciences, engineering and sport sciences. For the field of education, the effect of the rank of initial points increases slightly and it is significant at 10 % level. Female students have more study credits after four years in all fields except in education. The deviating gender effect for education is probably due to the very small number of male students in the field. Female students have on average higher grades in the matriculation

examination and therefore higher initial points. When gender is not controlled for, the percentile rank of initial points partly captures the gender effects. There are no statistically significant age effects for the field of education. Students who are 21-23-years old when they enter the university perform better than 18-20-year-olds in the fields of engineering and social sciences. Students who are older than 23 when they enter the university perform worse in sport sciences.

Since initial points are calculated differently in each field, it is difficult to make comparisons between fields. Therefore, Table 5 uses an alternative measure of initial points that are calculated similarly for all fields. Initial points in Table 5 include four compulsory exams in matriculation exam and senior secondary school GPA. The results do not change much for social sciences, because this measure of initial points is very similar to the way the real initial points are calculated. For the other fields, the coefficient of the rank of initial points is diminished.

It is also possible to look at how the different components of initial points predict cumulative number of study credits. Table 6 includes entrance exam ranks, senior secondary school GPA and matriculation exam grades in the compulsory exams. The sample size in these regressions is smaller because all matriculation grades were not available for some students. Senior secondary school GPA is a good predictor of study credits at university in all fields but matriculation exam grades are mostly insignificant and even negative. The variation in the matriculation exam grades is not very large among the admitted students; the maximum grade in the matriculation exam is 6 and the mean grade in the student population is about 5. Therefore, it is not so surprising that the explanatory power of matriculation exams is so poor. Results do not change even if rank of entrance exam is excluded from the regressions. None of the coefficients in the field of education are statistically significant because of the small sample size.

Table 5. OLS estimates of cumulative number of credits after four years using same initial points for all fields.

	Social sciences		Sport sciences		Education		Engineering	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rank of entrance exam	88.540***	82.303***	32.455*	28.999*	30.440	33.706*	54.730***	60.010***
	(18.976)	(18.800)	(17.371)	(17.493)	(21.348)	(19.631)	(5.548)	(5.513)
Rank of initial points[a]	15.204**	8.182	5.455	-6.243	7.532	17.565	3.421	-0.014
	(7.284)	(7.601)	(10.805)	(10.894)	(17.530)	(16.467)	(3.631)	(3.651)
Female		20.047***		8.947		-54.907***		20.858***
		(4.876)		(6.729)		(16.193)		(2.657)
Age at entry: 21-23		8.496**		-4.099		-20.605**		14.521***
		(4.216)		(6.931)		(8.681)		(2.988)
24-		4.625		-25.007**		-22.342		3.029
		(6.081)		(10.671)		(15.933)		(7.031)
Observations	687	687	244	244	133	133	3,278	3,278
R-squared	0.12	0.15	0.04	0.08	0.04	0.12	0.08	0.11
F statistic	7.67	8.10	1.30	2.21	1.38	3.70	17.13	19.31
(Prob>F)	(0.0000)	(0.0000)	(0.2519)	(0.0180)	(0.0370)	(0.0011)	(0.0000)	(0.0000)

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1% level. a initial points are calculated similarly for all fields including four compulsory matriculation exams and senior secondary school GPA (max. 34 points). All models include controls for student's major and entry cohort. The excluded entry age group is 18-20-year-olds.

Table 6. OLS estimates of cumulative number of credits after four years. Matriculati on exam results.

	Social sciences	Sport sciences	Education	Engineering
	(1)	(2)	(3)	(4)
Rank of entrance exam	83.731***	19.042	38.884	54.256**
	(21.405)	(18.553)	(24.325)	(5.575)
Senior secondary school GPA	12.824***	19.472***	22.021	14.936***
	(4.797)	(6.817)	(13.281)	(2.135)
ME grade mother tongue	-5.452*	1.649	8.511	-3.658***
	(3.075)	(4.482)	(6.101)	(1.206)
ME grade mathematics/science	0.071	1.598	-3.986	-0.947
	(1.889)	(2.668)	(3.726)	(1.423)
ME grade foreign language	-6.705**	-5.510	-3.918	-4.329***
	(2.773)	(3.344)	(6.252)	(1.076)
ME grade the other national language	4.424	0.205	-4.570	0.649
	(3.377)	(3.832)	(9.063)	(1.156)
Observations	520	214	110	3,267
R-squared	0.16	0.12	0.09	0.10
F statistic	6.58	2.71	2.37	17.78
(Prob>F)	(0.0000)	(0.0028)	(0.0220)	(0.0000)

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1% level. All models include controls for student's major and entry cohort.

Table 7. OLS of cumulative number of credits after four years if students who drop out within four years are excluded from the sample.

	Social sciences		Sport sciences		Education		Engineering	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rank of entrance exam	88.230***	79.576***	26.851*	26.321*	32.023*	30.878*	34.573***	42.142***
	(18.725)	(18.047)	(14.011)	(14.187)	(17.580)	(16.481)	(4.607)	(4.467)
Rank of initial points	15.337**	8.791	28.166***	26.690**	49.469**	53.174***	21.269***	24.599***
	(6.898)	(7.667)	(9.515)	(10.976)	(21.613)	(19.295)	(3.577)	(3.521)
Female		21.599***		1.250		-38.110**		26.380***
		(4.102)		(6.279)		(17.863)		(1.969)
Age at entry: 21-23		8.621**		0.442		-14.554**		24.075***
		(3.765)		(5.898)		(6.554)		(2.448)
24-		5.548		-3.344		-5.445		23.260***
		(5.654)		(10.731)		(15.233)		(6.758)
Observations	609	609	219	219	114	114	2,772	2,772
R-squared	0.11	0.15	0.10	0.10	0.18	0.27	0.12	0.21
F statistic	6.07	7.14	3.64	2.65	6.52	5.18	23.31	37.40
(Prob>F)	(0.0000)	(0.0000)	(0.0010)	(0.0046)	(0.0001)	(0.0000)	(0.0000)	(0.0000)

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1% level. All models include controls for student's major and entry cohort. The excluded entry age group is 18-20-year-olds.

Table 7 presents the same regressions as Table 4 conditional on staying on the first four years of study, i.e. excluding dropouts. This reduces sample sizes by about 15 percent. The results are about the same for other coefficients, but the coefficient for the rank of initial points is increased in size and significance. Given that the student has not dropped out during the first years of study, high rank in initial points is positively associated with student performance. Controlling for the success in the entrance exam, the students with good grades in matriculation exam are more likely to dropout. One possible explanation for this is that students with higher grades have better academic outside options since they are more likely to get into other programs in other universities.

Table 8 presents the probability to graduate within seven years using a linear probability model. The results are in line with Table 4. Students with a high rank in the entrance exam have higher probability to graduate. The coefficient is statistically significant for social sciences, sport sciences and engineering. The rank of initial points is positive for all fields but statistically significant only for education. Female students have higher graduation probability in social sciences and engineering but lower in education. Older students have higher graduation probability in engineering but lower graduation probability in other fields.

Table 8. Linear probability to graduate in 7 years.

	Social sciences		Sport sciences		Education		Engineering	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rank of en-	0.480***	0.510***	0.416***	0.381**	0.124	0.136	0.304***	0.346***
trance exam	(0.161)	(0.163)	(0.158)	(0.158)	(0.220)	(0.218)	(0.047)	(0.046)
Rank of	0.113	0.029	0.120	0.072	0.529***	0.539***	0.039	0.041
initial points	(0.069)	(0.078)	(0.114)	(0.122)	(0.165)	(0.159)	(0.036)	(0.036)
Female		0.118***		-0.089		-0.459***		0.151***
		(0.046)		(0.071)		(0.153)		(0.022)
Age at entry:		-0.090**		-0.232***		-0.071		0.104***
21-23		(0.044)		(0.074)		(0.098)		(0.024)
24-		-0.030		-0.349***		-0.231*		0.089
		(0.057)		(0.090)		(0.135)		(0.050)
Observations	687	687	244	244	133	133	3,278	3,278
R-squared	0.11	0.13	0.11	0.16	0.07	0.11	0.06	0.08
F statistic	7.72	7.58	7.13	6.08	2.76	4.96	12.40	14.75
(Prob>F)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0306)	(0.0000)	(0.0000)	(0.0000)

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1% level. All models include controls for student's major and entry cohort. The excluded entry age group is 18-20-year-olds.

6.1. Predicted effects of a change in the admission rules

The results in the previous tables show that subject-related entrance exams are better predictors of achievement in engineering, social sciences and sport sciences whether the achievement is measured as study credits after four years or as graduation. Initial points predict graduation better in the field of education. In addition, results show that senior secondary school GPA is a good predictor of success at university. However, it is hard to compare different admission systems based on these results because a large number of students would be admitted regardless of the admission rules used. Therefore, it is interesting to look at students who would be admitted using one rule but rejected using the other. Success in studies can only be observed for the students who were admitted in the current system and alternative selection rules might admit different students. However, since the admission is based on observables, the performance of the non-enrolled students can be predicted using results in Table 4. Controls are added for entrance exam and initial point ranks, gender, three age groups, major, and entry cohort. Including higher terms of regressors does not change the qualitative results.

The first column in Table 9 presents the success of students who would have been admitted using entrance exam but rejected using initial points and the second column presents the success of students who would have been accepted using initial points but rejected using entrance exam. The difference between the first group (entrance exam) and the second group

(initial points) – presented in the third column – can be seen as the difference in the average performance of the "marginal" individuals. In engineering, the difference in mean number of study credits after four years between the two groups is about 19 credits, the difference in median credits is slightly lower (15 credits). Further, a significantly higher proportion of students graduate within seven years in the first group than in the second group. For social sciences, the mean (median) number of study credits after four years is about 22 (27) credits more for the first group, and almost 51 percent of the students in the first group graduate in seven years compared to the 37 percent in the second group. In education and sport sciences, the only significant difference between the groups is the fraction of students who graduate in seven years. Students selected using entrance exams do better in sport sciences but worse in education.

The results using the "marginal" students who would only be selected using one admission rule suggest that at least in engineering and social sciences it would be better to select students with entrance exam. The interesting question for the university is how the total performance of students would change if the current system using mainly total points would be replaced by a system using either entrance exams or initial points. The performance of the non-enrolled students is predicted as above. The effect of the change in the admission rules on mean performance is estimated by regressing the number of study credits after four years on a full set of dummy variables for different combinations of admission status in the three admission systems (see figure 4) and calculating the change as a linear combination of the dummy variables. The first column in Table 10 shows the change in the mean study credits of the whole student population if the selection system is changed from total points to entrance exams. There are no statistically significant changes in the mean number of study credits for any fields.

Table 9. Success of students who will change admission status depending on which admission criteria are used.

	(1) Admitted using entrance exam, but not using initial points	(2) Admitted using initial points, but not using entrance exam	(3) Difference (1) – (2) (std error)
Engineering	(904 obs)	(904 obs)	(1,808 obs)
Number of study credits after four years			
Mean	86.4	67.7	18.694** (1.836)
Median	82.4	67.1	15.415** (1.388)
Fraction of students who graduate within 7 years	0.207	0.116	0.091** (0.014)
Social sciences	(608 obs)	(608 obs)	(1,216 obs)
Number of study credits after four years			
Mean	142.1	120.0	22.095** (1.841)
Median	146.0	119.5	26.523** (1.771)
Fraction of students who graduate within 7 years	0.508	0.366	0.142** (0.018)
Sport sciences	(164 obs)	(164 obs)	(328 obs)
Number of study credits after four years			
Mean	120.1	124.9	-4.296 (3.052)
Median	123.1	124.4	-1.793 (1.202)
Fraction of students who graduate within 7 years	0.580	0.502	0.078* (0.037)
Education	(75 obs)	(75 obs)	(150 obs)
Number of study credits after four years			
Mean	144.9	146.2	-1.273 (6.961)
Median	152.9	151.5	1.356 (5.268)
Fraction of students who graduate within 7 years	0.309	0.593	-0.133* (0.063)

The sample used includes only students who are admitted using one admission criteria, either entrance exam or initial points, but not with both admission criteria. Performance of the students who were not admitted or did not enroll is predicted using results from table 4 (including controls for gender, three age groups, starting cohort and students' major). Standard errors in the parenthesis are from a robust regression. * significant at 5 % level; ** significant at 1 % level.

The second column shows the same figures for the change from total points to initial points system. In social sciences and engineering the mean number of credits after four years would diminish if the total points system was replaced by a system based on initial points. In education the mean performance of the student population would be better if initial points were used instead of total points.

Table 10. Change in the mean number of credits after four years of the student population if admission rules were changed.

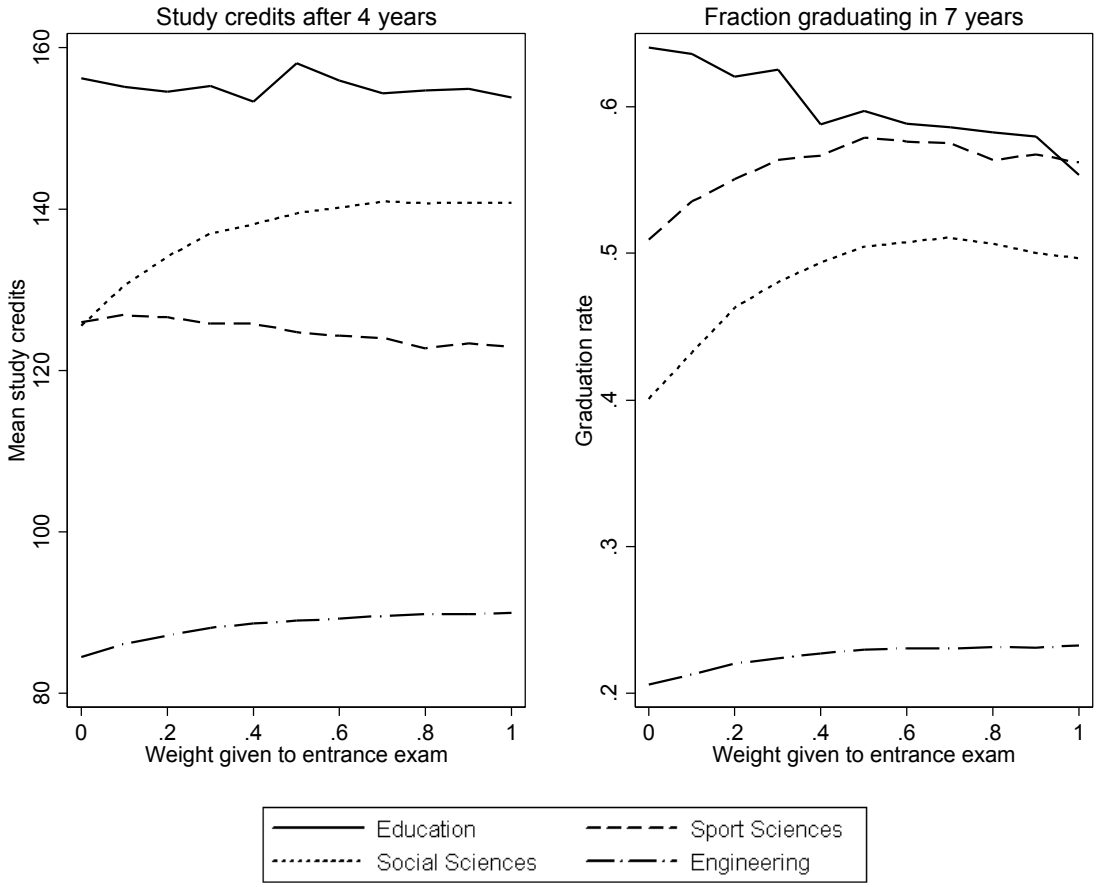
	Change from total points to entrance exam	Change from total points to initial points
Engineering		
Change in mean study credits after four years	-5.019 (9.194)	-38.784** (8.910)
Social Sciences		
Change in mean study credits after four years	10.118 (6.398)	-22.365** (5.672)
Sport Sciences		
Change in mean study credits after four years	-3.712 (12.005)	11.345 (9.996)
Education		
Change in mean study credits after four years	15.490 (14.542)	24.089** (9.074)

* significant at 5 % level; ** significant at 1 % level. Standard errors in parenthesis. The performance of the students who were not admitted or did not enroll is predicted using regression in table 3 (including controls for gender, three age groups, cohort and student's major).

The optimal admission selection rules might not be either entrance exam or initial points, but some combination of the both. However, the optimal rule does not have to weigh the both parts equally. Figure 5 plots measures of success for different student populations selected weighting the entrance exam points from zero to one. In social sciences and engineering, the mean sum of study credits after four years increases the more weight is given to entrance exams. On the other hand, in sport sciences more weight should be given to initial points and in education both parts should be weighted equally. Graduation rates are highest if entrance exams are weighed more heavily in all fields except in education.

One might be concerned that students with high matriculation exam grades have lower incentives to do as well in the entrance exams. In fact, matriculation exam grades and initial points are negatively correlated with entrance exam points in education and sport sciences (Table A2 in the Appendix). This might indicate lower incentives, but a more probable explanation is that entrance exams measure different things than school grades (e.g. physical aptitude tests in sport sciences). Most fields apply a threshold condition which requires that a student has to get a certain amount of points in the entrance exam to be admitted. In practice, these threshold points are not sufficient for admission.

Figure 5. Performance of students when admission decision is made giving different weights to the entrance exam.



Other concern is that percentile ranks of entrance exams might predict success better because the distribution of the entrance exams is different from the distribution of the initial points and there might be more variation in the entrance exam points. Figure A1 in the Appendix shows histograms of initial points and entrance exam points in each field. There are clear differences in the distributions but both initial points and entrance exam points have variation. Further, since 80 percent of the students in social sciences and engineering are admitted using total points and the remaining 20 percent are selected using only entrance exam, this last 20 percent has by definition lower initial points than the first 80 percent of the students. This might affect the coefficients of the percentile ranks. As a robustness check, the regressions are run excluding the students who were admitted on the basis of the entrance exam only. The results do not change qualitatively.

7. CONCLUSION

At best, factors which can be used as admission criteria and which are observable to the admission committee at the time of the admission decision explain about 15 percent of the variation in the student achievement. The results show that initial entry points based on past performance in school are good predictors of graduation from university in the field of education. For the fields of social sciences, sport sciences and engineering, percentile ranks in entrance exams provide a better prediction for student achievement. A large fraction of students would be admitted whether the admission was based on entrance exams, initial entry points or total points, which is the sum of entrance exam and initial points. This is especially true for the field of engineering. Admitting students on the basis of their past school performance instead of total points would decrease the mean performance of the student population in engineering and social sciences but increase the mean performance in education. Using only entrance exams would not affect the mean performance in any of the fields studied. However, changing the admission rules could lead to changes in the pool of applicants and unfortunately it is not possible to estimate the effects of the change in the pool of applicants. In addition, the performance predictions of the rejected applicants are based on strong assumptions on the functional form, and the results on the effect of a change in the admission criteria should be read with that in mind.

University admission process has some important welfare effects. Direct costs of the admission systems might not be very large but the quality of the students significantly influences the financial situation of the universities through the government funding criteria. Students who have to apply to universities for several times before they get admitted have high costs in the form of foregone earnings. Also, it is estimated that if Finnish students would enter universities at younger age and finish their education one year faster than what they do today, the amount of highly educated workers would increase by 15,000 (Ministry of Education 2003). This would be a significant increase in the educated labor force. Thus, the efficiency of the university admission system should be intensified.

The data in the current form include no family background variables or labor market information for the students. The future extension of this study is to match the data with registers that include information on student's family background, earnings and months of work during and after the enrollment. This will enable e.g. to study how much pre-university skills affect earnings after graduation or the effect of different admission criteria on the success in the labor market.

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APPENDIX

Table A1. Descriptive statistics.

	Engineering					
	Admitted applicants			Non-admitted applicants		
Variable	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Female	3,391	0.196	0.397	4,366	0.185	0.388
Age at entry: 18-20	3,391	0.850	0.357	4,366	0.661	0.473
21-23	3,391	0.124	0.330	4,366	0.244	0.430
23-	3,391	0.026	0.159	4,366	0.095	0.293
Number of study credits after four years	3,391	89.1	52.9			
Rank in entrance exam	3,391	0.757	0.166	4,366	0.309	0.194
Rank in initial points	3,391	0.709	0.213	4,366	0.344	0.233
ME grade mother tongue	3,391	5.254	0.877	4,362	4.548	1.080
ME grade the other national language	3,385	5.088	1.067	4,356	4.168	1.307
ME grade foreign language	3,389	5.176	1.040	4,359	4.375	1.287
ME grade mathematics	3,387	5.581	0.693	4,290	4.546	1.181
ME grade science and humanities	1,109	5.605	0.809	1,763	4.481	1.341
Senior secondary school GPA	3,389	8.832	0.616	4,362	8.106	0.693
Cohort 1986	3,391	0.337	0.473	4,366	0.285	0.451
Cohort 1990	3,391	0.334	0.472	4,366	0.305	0.461
Cohort 1995	3,391	0.329	0.470	4,366	0.410	0.492

	Social Sciences					
	Admitted applicants			Non-admitted applicants		
Variable	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Female	881	0.620	0.486	4,671	0.601	0.490
Age at entry: 18-20	881	0.413	0.493	4,671	0.468	0.499
21-23	881	0.390	0.488	4,671	0.344	0.475
23-	881	0.196	0.397	4,671	0.188	0.391
Number of study credits after four years	881	101.6	74.8			
Rank in entrance exam	881	0.871	0.137	4,671	0.456	0.253
Rank in initial points	881	0.711	0.260	4,671	0.471	0.279
ME grade mother tongue	853	5.298	0.811	4,445	4.823	0.966
ME grade the other national language	765	4.918	1.080	4,181	4.246	1.185
ME grade foreign language	853	5.014	1.072	4,443	4.304	1.214
ME grade mathematics	720	4.601	1.256	3,421	3.986	1.403
ME grade science and humanities	809	5.190	1.024	4,265	4.611	1.190
Senior secondary school GPA	710	8.537	0.691	3,612	8.118	0.704
Cohort 1992	881	0.296	0.457	4,671	0.300	0.458
Cohort 1995	881	0.356	0.479	4,671	0.305	0.461
Cohort 1997	881	0.347	0.476	4,671	0.395	0.489

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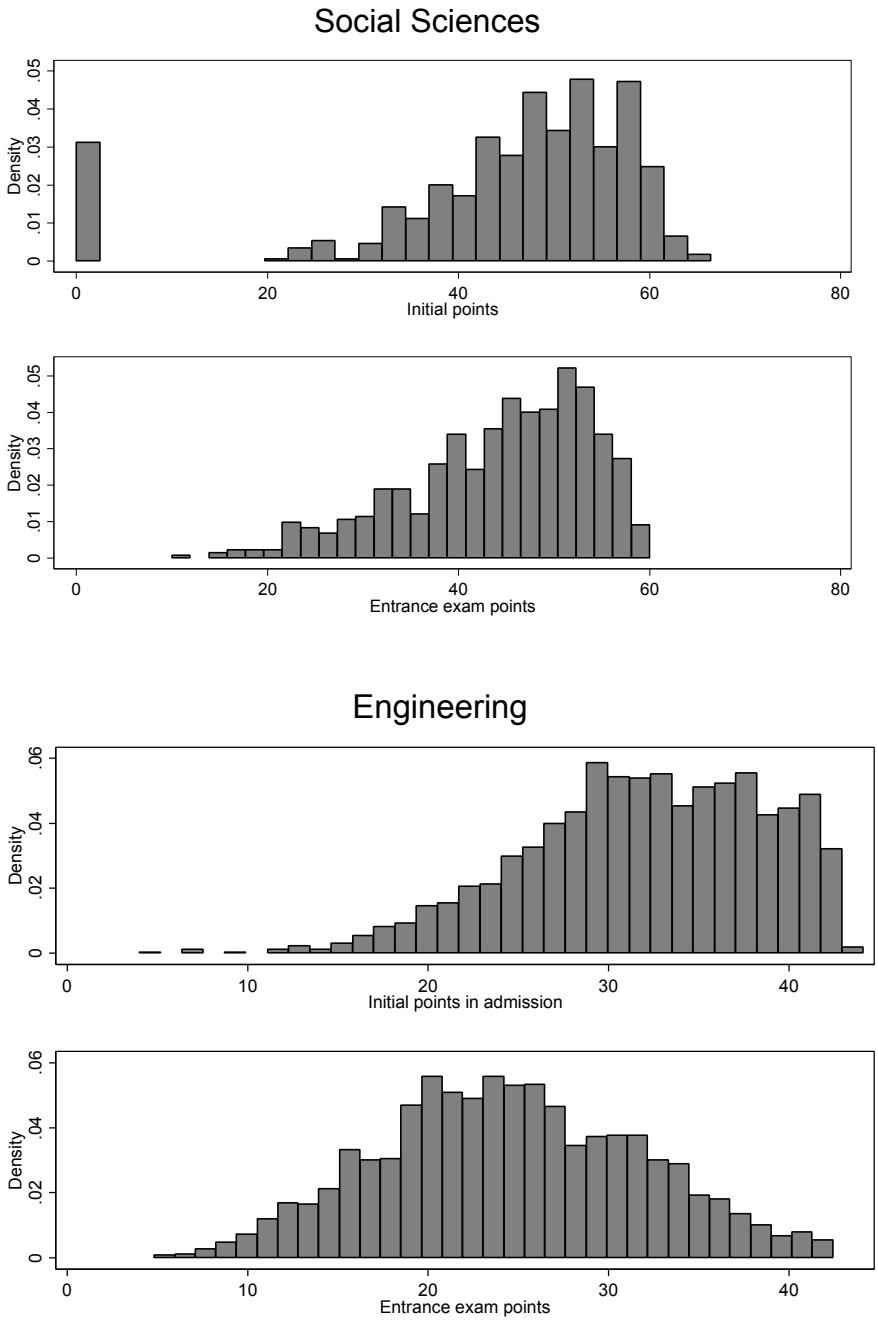
	Sport Sciences					
	Admitted applicants			Non-admitted applicants		
Variable	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Female	249	0.546	0.499	1,067	0.455	0.498
Age at entry: 18-20	249	0.367	0.484	1,067	0.608	0.488
21-23	249	0.438	0.497	1,067	0.276	0.447
23-	249	0.192	0.394	1,067	0.116	0.321
Number of study credits after four years	249	118.5	47.3			
Rank in entrance exam	249	0.768	0.221	1,067	0.419	0.263
Rank in initial points	249	0.607	0.285	1,067	0.480	0.281
ME grade mother tongue	239	4.954	0.846	1,007	4.906	0.811
ME grade the other national language	235	4.762	1.079	942	4.562	0.969
ME grade foreign language	239	4.506	1.045	1,006	4.326	1.066
ME grade mathematics	216	4.366	1.254	927	4.297	1.204
ME grade science and humanities	230	4.700	1.164	972	4.623	1.078
Senior secondary school GPA	219	8.537	0.609	859	8.444	0.535
Cohort 1992	249	0.341	0.475	1,067	0.407	0.491
Cohort 1995	249	0.309	0.463	1,067	0.303	0.460
Cohort 1997	249	0.349	0.477	1,067	0.291	0.454

	Education					
	Admitted applicants			Non-admitted applicants		
Variable	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Female	137	0.934	0.249	438	0.863	0.344
Age at entry: 18-20	137	0.431	0.497	438	0.400	0.490
21-23	137	0.394	0.490	438	0.349	0.477
23-	137	0.175	0.382	438	0.251	0.434
Number of study credits after four years	137	141.6	57.3			
Rank in entrance exam	137	0.816	0.158	438	0.409	0.250
Rank in initial points	137	0.719	0.233	438	0.439	0.273
ME grade mother tongue	134	5.142	0.833	423	4.574	0.943
ME grade the other national language	125	4.704	0.976	419	3.924	1.138
ME grade foreign language	134	4.328	1.024	423	3.652	1.202
ME grade mathematics	107	4.243	1.373	296	3.541	1.491
ME grade science and humanities	129	5.116	0.898	407	4.199	1.121
Senior secondary school GPA	115	8.501	0.566	381	7.947	0.639
Cohort 1992	137	0.365	0.483	438	0.477	0.500
Cohort 1995	137	0.299	0.460	438	0.281	0.450
Cohort 1997	137	0.336	0.474	438	0.242	0.429

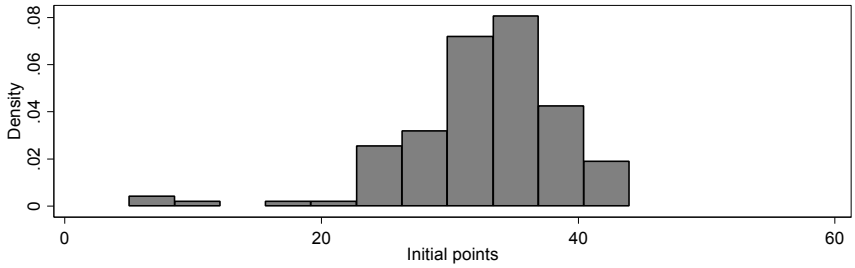
Table A2. Rank correlations of variables.

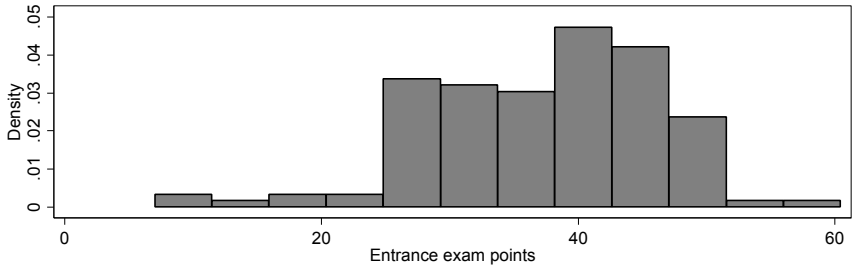
Spearman's rank correlation	ME mean grade	Mother tongue ME grade	Other national language ME grade	Foreign language ME grade	Mathe-matics ME grade	Senior secondary school GPA	Initial points	En-trance exam points
Engineering:								
Initial points	0.43	0.42	0.43	0.38	0.30	0.53		
Entrance exam points	0.29	0.16	0.15	0.17	0.37	0.24	-0.03	
Number of study credits after 4 years	0.06	0.01	0.07	-0.01	0.07	0.17	0.03	0.24
Social Sciences:								
Initial points	0.79	0.71	0.70	0.67	0.37	0.75		
Entrance exam points	0.06	0.05	0.08	-0.02	-0.06	0.03	0.08	
Number of study credits after 4 years	0.04	-0.03	0.12	-0.05	0.02	0.17	0.05	0.11
Sport Sciences:								
Initial points	0.58	0.36	0.45	0.38	0.36	0.51		
Entrance exam points	-0.09	-0.17	-0.08	-0.14	-0.01	-0.11	-0.09	
Number of study credits after 4 years	0.09	0.09	0.02	-0.09	0.08	0.22	0.19	0.11
Education:								
Initial points	0.75	0.47	0.67	0.59	0.45	0.86		
Entrance exam points	-0.33	-0.15	-0.21	-0.16	-0.001	-0.31	-0.09	
Number of study credits after 4 years	0.01	0.15	-0.03	0.02	0.06	0.14	0.14	0.17

Figure A1. Distribution of initial points and entrance exam points of admitted students by field of study.



Education





Sport Sciences