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WHAT AFFECTS STUDENTS` PERFORMANCE?

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What affects students' performance?

An investigation on the importance of admission characteristics

By

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1. Introduction

For any university or business school it must be of interest to investigate the factors that lead to the final exam results of its students. Yet not many such studies of a quantitative kind have been published for Danish universities. The few to be mentioned here are Albæk (2001) who analyses the passing probabilities for the first year of the economics programme at University of Copenhagen. As one possible explanatory factor Albæk uses high school GPA. The focus of Albæks study is the effects of the admission rules on the economics programme. In another study, Lorentzen (2001), analyses the background factors that leads to a good student performance at the English-language masters programmes at Copenhagen Business School (CBS). Some of his findings are that the entry-level GPA is a good predictor of exit-level GPA, that outside students perform worse than students who have taken their bachelor degree at CBS – a result which he interprets as CBS' lack of ability to attract good students. Finally, Gabrielsen (1996a&b) tries to determine whether there is a "teachers effect" on the grades in statistics at CBS' HD programme. Each of the abovementioned studies have a special focus of their own and this holds true also for the present study that focuses on the performance of the students at the Bachelor of Science in International Business (B.Sc.IB/HA-IB) at CBS making direct comparisons of the results of the abovementioned studies difficult: either dependent variables, explanatory variables or the purpose of the studies are different.

The Bachelor of Science in International Business (B.Sc.IB/HA-IB) at CBS accepts 90 students every year since 1996. The 90 students are admitted through a 20% "kvote-1" and 80% "kvote-2" system. This system was argued back in 1996 to be necessary for securing a 50% Danish - 50% non-Danish student participation – a cornerstone for the Program's international orientation.

Given this 20-80 rule, applicants that apply directly from the high school compete on only 18 places.[1] For the rest of the 72 students a point system that puts more weight on other things than the level of GPA is used: in brief, while a GPA is rewarded by max 12 points, living abroad is rewarded by max 12 points, extra-curricular activities are rewarded by max 16 points, a motivational essay is rewarded by max 20 points, and working experience abroad is rewarded by max 24 points (see Appendix for details). It is important to mention that the HA-IB received in 2004, 440 applications for the "kvote-2" admission group. From them approximately one fifth did not fulfil the minimum requirements in entering the program, leaving thus approximately 350 students to compete for the 72 places. In that sense the program has indeed an opportunity to select among applicants, for which a well-designed point system is important for the program.

Aiming in contributing to the debate about admission processes, the present study seeks to relate student's performance (as that is measured by the grades the students achieve in their studies) and the admission characteristics they have. We thus connect data from CBS's central register system (HSAS) that records all grades our students get during their education with the admission characteristics data the HA-IB office has recorded for 2002 and 2003.[2] A priori, one should not expect a high explanatory validity of the analysis (i.e. a low R^2 is expected); after all, becoming more mature through education, the social and learning environment that students face, etc., affects students' performance. Thus, our hope is to find statistically significant relations, i.e. relations that the data reveal as important in determining the likelihood of having high or low grades, and not finding that admission characteristics explain a large percent of the existent grade's variation (one could also argue that the latter would have been a defeat for the program).

To this end, the following two caveats apply. (i) Arguably, "performance" is not only described by a grade. In particular, we are aware that a grade captures a particular ability in reproducing knowledge. Still, this is the only "fact" that is recorded in the data, and it is a "fact" that is widely used in our education system. Complementing our analysis with other measurements of performance/learning demands extensive research that was beyond this study's aim. (ii) The large number of project-group exams introduces ambiguities as for the interpretation of the grade

[1] These few "kvote-1" places make sure that the average admission GPA has been as high as 10.3 of the Danish scale. The HA-IB program has been toping the list of educations in Denmark for several years now, with a considerable media attention, and thus with considerable positive externalities (for this year, see http://www.infomedia.dk/infomedia/MainPage.aspx?pageid=/infomedia/Artikler/Sogning/VisArtikel.aspx)

[2] Even if the HA-IB program has been running since 1996, a detailed database that records the points an admitted student gets has unfortunately only been collected in a systematic way for the last 3 years, i.e. 2002, 2003 and 2004.

given,[3] and in avoiding these ambiguities we have decided to abstract from group exams and focus on individual written exams.

The data used are described in the next section, while the model used to perform the analysis is described in section 3. The results are described in section 4, while some concluding remarks are to be found in section 5.

2. The data

As mentioned above, the data have been collected for students that started at HA-IB in 2002 and 2003, as these are the years where admission characteristics data have been systematically registered. CBS's central student register (HSAS) provided the data on grades from individual written exams with latest entry being August 2004. Based on this, we collected data on grades from the following 11 courses:[4]

111:	The company in an international setting
112:	Microeconomics
114E:	International business environment
122E:	Macroeconomics
123:	Intercultural communication
131:	International economics
132E:	Principles of marketing
212E:	Management information systems (MIS)
222:	Corporate finance
234:	Statistics for business
241:	International business law

For 1st year courses the number of observations (grades per course) ranges from 72 to 146, indicating that while in some courses students get pre-approval from having studied similar courses previously, in other courses extra students attend first-year exams (open university, exchange students, second year students that want to improve their grades, etc.). For 2nd year

[3] "Has the student earn the grade as a result, or in spite, of the abilities of the other group members?"
[4] The first number in the code indicates the year the course is taught, while the "E" code denotes written exam, indicating that the course has other forms of evaluations too, e.g. a project.

courses the number of observations ranges from 32 to 51, indicating in turn that many students have postponed taking the exam. Note that, due to HA-IB's intense quarter-teaching periods, it is very customary to hand-in a totally blank answer, just in order to get the permission to sit-in in a re-take exam (as the rules and regulations require). However, given that a blank answer was awarded the grade "0" (and not "blank", as it is now), we have abstracted from observations with grade "0", as we do not believe that a "0" implies that the student has performed "unacceptably".

From all the admission characteristics that we have, we have in order to keep the model simple chosen here to focus on the following: (i) whether a student is "kvote-1" or "kvote-2", (ii) the age of the student upon admission, (iii) if "kvote-2" student, whether the student is from Scandinavia or not, (iv) if "kvote-2" student, the level of the student's GPA in the admission process, and (v) if "kvote-2" student, the quality of the motivational essay (as that is represented by the points two program managers award independently). Variable (i) is obvious and central to the whole issue that we raise here. Variable (ii) enters since it can be argued that delaying studies has an ambiguous effect on performance. Variable (iii) enters since there can be an effect of knowing the country, the education system, or having similar high school education as Danish students have. Variable (iv) represents some "hard" facts, while variable (v) represents some "soft" facts on the admission process. The reason for not including more variables from the point giving activities of a kvote-2 student is that we believe that the effects of such additional variables would be captured by the motivational essay variable as well. A small additional analysis including these variables can be found in section 4.2 and can be regarded as a sensitivity analysis.

Some data averages can be interesting here. As we mentioned, 20% of the students are admitted as kvote-1 students. Of the remaining 80%, roughly 50% come from a Scandinavian country. In total, the HA-IB office makes sure that approx. 50% are Danes while 50% are non-Danes. Some discretion may also enter in the admission process as, other things equal, country diversity matters, i.e. the office attempts to put together a diversified, international class. The average age of a kvote-1 student is 20.38, while the average age of the kvote-2 student is 23.78. Finally, we notice that the average GPA of the kvote-1 students is 10.2, while the average for the kvote-2 Scandinavian student is 8.87 and for the kvote-2 non-Scandinavian student is 8.46.

3. The estimated equation

We shall now describe the equation that we estimate. Our dependent variable is the grades in each 1st and 2nd year course that has a written examination. The independent variables are the following:

a dummy variable for whether the students have gained access by kvote-1 or kvote-2 (if kvote-2, then the dummy variable is 1, otherwise it is 0) and a variable for the age of the students when admitted to the program. For kvote-2 students the GPA from high school, the motivational average and an indicator (dummy) for whether or not the student comes from a Scandinavian country (the dummy is 1 if the student comes from a Scandinavian country and 0 otherwise) are also used as explanatory variables.

For each course, we run regressions of the following type:

$$GRADE_i = \beta_0 + \beta_1 DQ_i + \beta_2 GPA_i * DQ_i + \beta_3 MOTAVR_i * DQ_i + \beta_4 DSCAND_i * DQ_i + \beta_5 AGEADMIT_i + error_i$$

where GRADE is the grade for student 'i' who has participated in the exam under study; DQ is the dummy for admission-kvote. DQ = 1, if the student is admitted via kvote-2, DQ = 0 if the student is admitted via kvote-1; GPA is the high school grade-point average for a kvote-2 applicant (this is why it is multiplied by DQ in the model equation); MOTAVR is the figure for motivational average given to the essay-text of the student (multiplied by DQ2 for same reasons as above); DSCAND is a dummy for home country of the student (DSCAND=1 if the student comes from a Scandinavian country and 0 otherwise). Also this background variable is considered of interest for kvote-2 applicants only and this is why it has been multiplied by DQ2 in the model equation; AGEADMIT is the students age when admitted. The 'error' is a stochastic error term assumed to follow a normal distribution with mean zero and a constant variance.

The interpretation of the model is as follows:

- The expected grade of a student who has been admitted via kvote-1 is $\beta_0 + \beta_5$*ageadmit, i.e. the intercept of the model plus the coefficient of "ageadmit" times the age of the student at the time of the admission. If this age is 20.3 years, we have:

  $\beta_0 + \beta_5$*20.3.

- Similarly, the expected grade of a non-Scandinavian kvote-2 student is:

  $\beta_0 + \beta_1 + \beta_2$*GPA + β_3*MOTAVR + β_5*ageadmit

  For example, if the student has GPA=8.46 (the average), has MOTAVR=12.80 (the average) and is 23.78 years old when admitted, we have: $\beta_0 + \beta_1 + \beta_2$*8.46 + β_3*12.80 + β_5*23.78.

- The expected grade of a Scandinavian kvote-2 student is:

  $\beta_0 + \beta_1 + \beta_2$*GPA + β_3*MOTAVR + $\beta_4 + \beta_5$*ageadmit

  For example, if the student has GPA=8.87 (the average), has MOTAVR=12.80 and is 23.7 years old when admitted, we have: $\beta_0 + \beta_1 + \beta_2$*8.87 + β_3*12.8 + $\beta_4 + \beta_5$*23.7

4. The results

4.1 Results from the main model.

The results are presented in the following two tables; table 1 for the first year courses and table 2 for the second year courses. Note, that the tables present only the variables that turn out to be significant, reporting a "-" for the cases where the variables where not statistically significant (therefore all reported estimates have asterisks, indicating statistical significance). Naturally, we have tested whether the removal of these insignificant variables affect the model specification and we have found that it does not. (The results are found in the row of the table called 'overidentifying restrictions F).

Tabel 1: Results of the estimation, 1st year courses.

Variable	Course 111	Course 112	Course 114E	Course 122E	Course 123	Course 131	Course 132E
Intercept term	10.61***	8.81***	8.17***	9.2***	9.17***	9.0***	9.8***
DQ	-	-1.83***	-2.84***	-3.57***	-	-3.47***	-
GPA*DQ	-	0.11**	-	0.18***	-	0.09**	-
MOTAVR*DQ	-	-	0.18***	-	-	0.15**	-
DSCAND*DQ	-	-	-	-	-	-	-
AGEADMIT	-0.06***	-	-	-	-	-	-0.07***
Number of observations	145	120	146	76	-	114	116
R^2	0.06***	0.09***	0.12***	0.26***	-	0.17***	0.06***
Whites hetero	0.21	3.73	1.74	3.14	-	12.91	0.10
p-value	0.90	0.29	0.63	0.37	-	0.04	0.95
JB	3.21	0.87	0.56	0.78	-	3.45	2.98
p-value	0.20	0.65	0.75	0.68	-	0.18	0.23
Overidentifying Restrictions F	1.74	0.24	0.86	0.26	-	2.03	0.25
p-value	0.15	0.87	0.46	0.85	-	0.14	0.91

Tabel 2: Results of the estimation, 2nd year courses

Variable	Course 212E	Course 222	Course 234	Course 241
Intercept term	8.00***	10.13***	8.50***	8.66***
DQ	-1.31**	-2.59***	-3.60***	-
GPA*DQ	0.15***	0.18**	0.15**	-
MOTAVR*DQ	-	-	-	-
DSCAND*DQ	-	-	2.00***	-
AGEADMIT	-	-	-	-
Number of observations	51	31	46	-
R^2	0.17**	0.30***	0.39***	-
Whites test	2.06	2.50	4.53	-
p-value	0.56	0.48	0.48	-
JB test	1.85	1.09	7.69	-
p-value	0.40	0.58	0.02**	-
Overidentifying Restrictions F	1.68	1.20	0.85	
p-value	0.18	0.33	0.44	

'*' means significant at the 10% level.
'**' means significant at the 5% level.
'***' means significant at the 1% level.

Two misspecification tests are performed: the Whites general test for heteroscedasticity and the Jarque-Bera (JB) test for normality of the error term. In both cases a p-value smaller than 0.05 would indicate that the model was misspecified. As it is seen, all models seem to be quite well specified. With cross sectional data it does not make much sense to use the DW test for autocorrelation.

As seen, the models used have some explanatory value for all courses but two, viz. Intercultural Communication (123) and International Business Law (241), where none of the variables that we have looked at have an effect on grades. In these two courses, the expected average grade is 9.17 and 8.66 respectively. For all other courses the regressions have an explanatory value between 6% (The company in an international setting) and 39% (Business Statistics), which, as mentioned previously, is what we expected. What these numbers indicate is that the admission characteristics used in this study can at maximum 39% of the grades variation in the HA-IB courses – the rest of the variation is explained by other factors that affect performance and learning in general.

Focusing on which variables turn out to be significant it is seen that whether a student has been admitted through kvote-1 or kvote-2 affects quite a lot the grade in courses like

Microeconomics, International Business Environment, Macroeconomics, International Economics, MIS, Corporate Finance and Business Statistics. Moreover, the effect is negative, i.e. a kvote-2 student performs comparatively (with kvote-1 students) less good in these courses. The age variable turns out to be significant only in two courses (The company in an international setting and Principles of Marketing) and in both of these courses it enters with a negative effect on grades, i.e. older students perform worse than younger students.

Looking now at what is important for the performance of the kvote-2 students, we notice that both a good GPA upon admission and a good motivational essay improve the students' performance considerably. Whether the student is of Scandinavian origin or not, does not matter at all for all courses but in Statistics for Business, where non-Scandinavians perform considerably worse.

Based on the above estimates, and using the formulas described in the interpretation of the model, we can calculate the expected grades in the different courses. The results are described in table 3.

Table 3: Expected grades for HA-IB students

Course	**Kvote-1 student**	**Kvote-2/Scand.**	**Kvote-2/Non-Scand.**
1. YEAR			
The company in an international setting (111)	9.39	9.18	9.18
Microeconomics (112)	8.81	7.64	7.64
International business environment (144E)	8.17	7.62	7.62
Macroeconomics (122E)	9.20	6.80	6.80
Intercultural Communication (123)	9.17	9.17	9.17
International Economics (131)	9.00	8.01	8.01
Principles of Marketing (132E)	8.37	8.19	8.19
2. YEAR			
MIS (212E)	8.00	7.62	7.62
Corporate finance (222)	10.13	8.64	8.64
Statistics for business (234)	8.50	7.80	5.80
International business law (241)	8.66	8.66	8.66

Note: For explanatory variables the evaluation is done based on the average value for each of the categories for the students that took the exams in the specific courses.

Consistent with the previous presentation of the results, a kvote-1 vs. kvote-2 admission most evidently affects the performance in Microeconomics, International Business Environment, Macroeconomics, International Economics, MIS, Corporate Finance and Business Statistics. For two of the courses, Intercultural Communications and International Business Law, we

find no significant differences what so ever. Notice that for some courses (111, 132E) the difference in performance stems exclusively from the average age differences that can be observed amongst kvote-1 (20.3 years of age) and kvote-2 students (23.78 years of age). The Scandinavian vs. Non-Scandinavian characteristic seems to affect only (and significantly) the expected average grade in Statistics for Business.

4.2 Sensitivity analysis

In order to determine the robustness of our conclusions and to see if we can raise the explanatory power of our final models we decided to extend our work in two directions. First we try to extend our initial 'big' models with data for additional point giving activities of a kvote-2 student to see if we were right in leaving out these variables in the first place. Our additional variables are:

Eduhome: Time spend on additional education at home.
Eduout: Time spend on additional education abroad.
Workhome: Time spend on work at home.
Workout: Time spend on work abroad.
Livabr: Time spend living abroad.

As all of these variables are relevant for kvote-2 students only they enter the regression equation multiplied by DQ (the kvote-dummy) just like the GPA variable, the motivational average and the DSCAND dummy. The results of this exercise can be found in table 4 below. The general conclusion from this exercise is that not much is changed. Though for some of the models competing equations with one or two of these variables arise. It is, however, still possible to accept our original simplified equations in most cases.

Table 4: Results of testing down to the models of table 1 & 2 from the extended models.

Course	F-stat for overidentifying restriction towards the models found in table 1 or 2	p-value of F-test	Competing model – if any
111	0.94	0.50	
112	0.79	0.61	
114E	1.10	0.37	
122E	0.51	0.84	
123	1.09	0.37	
131	2.38	0.03	Extended by eduhome
132E	0.64	0.72	DQ2, GPA*DQ2 Livabr*DQ2
212E	0.77	0.63	
222	0.76	0.64	
234	0.44	0.87	
241	0.79	0.64	

An additional exercise to check robustness is done along the following lines: As it seems that most of the potential explanatory power comes from admission data for kvote-2 students it may be regarded as an unnecessary complication to include kvote-1 students in the data sets at all (or as an artificial way of obtaining explanatory power as the number of observations increases by doing so hence decreasing standard errors of the estimators which would increase the likelihood of rejecting insignificance of a parameter). Again most of our conclusions seem robust in the sense that the expected grade for a kvote-2 student with no additional contribution from the explanatory variables is very close to the level obtained by adding the value of the intercept and the coefficient of DQ in the models of tables 1 and 2. Also the partial slope coefficients are very similar to their counterparts from tables 1 and 2. Even though some of the models have decreased a little in overall explanatory power all of the models are significant at a 5% level.

5. Concluding remarks

The study has by and large confirmed our prior expectations concerning the importance of the GPA variable for performance of the kvote-2 students at the HA-IB programme at CBS. Also the prior

belief that the admission group of the student was important has generally been confirmed. The size of the effects vary from course to course but the direction is the same: A kvote-2 student is generally doing worse than a kvote-1 student and if you are a kvote-2 student you will perform better the higher your entry-GPA. Only for a very limited number of courses do we find no explanatory power for any of our explanatory variables.

For some of the models the explanatory power – although significant – is very low and to reinforce the results of the study it will therefore be desirable to obtain more observations to decrease the standard errors and possibly increase the significance of the explanatory variables. At the moment, however, this is not possible.

With the above caveat in mind we still believe that we are quite safe in suggesting that the weight of the entry-GPA of kvote-2 students at the HA-IB programme should be increased.

6. References

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Appendix

For details of the admission requirements, see
(http://web.cbs.dk/stud_pro/adgang/adgdegree_ukbachuk.shtml#1adm)

"Kvote-2" applicants are assessed according to the following Point System:

Grade Point Average	8.1-8.4 3 points 8.5-8.9 6 points 9.0-9.4 9 points 9.5-over 12 points
Other education and post-secondary courses (min. 3 months - max 1 academic year per category)	Point per month or course: In home country: 0.5 Abroad: 0.5
Work experience (min. 3 months - max 24 months per category)	Point per month: In home country: 0.5 Abroad: 1
Living abroad (min. 3 months - max 24 months)	0.5 point per month
Extra-curricular activities (max. one page)	2-3 points per personal qualification 3-5 points per professional qualification (max. 16 points)
Motivational essay (max. two pages)	Possible points: 0-20

Work experience, time spent abroad, and post-secondary courses can only be included in the assessment if the activity:

- took place after the applicant turned 15 years old
- occurred within 5 years prior to 1 July in the year of application
- is included in detail on the application form
- is documented

Post-secondary courses Has to be full-time study to count as months, otherwise it will count as courses. Courses must be successfully passed.
Work experience: Only work experience with more than 15 hours per week will be recognised. Part-time work will be recalculated to full-time work (30 hours per week).
Extra-curricular activities: Any activities you have participated in that you feel gave you particular qualifications. Such as student organisations, volunteer work in political parties, grass root's organisations, etc. The special qualifications that were needed or gained should be stated, e.g. independence, leadership, maturity, cooperation, the practical use of a foreign language, first-hand knowledge gained of another culture.
Motivational essay: These pages should allow CBS to get to know the person in a different way from objective data. The essay should tell us more about who you are and what you value.