PREDICTORS OF BUSINESS MATHEMATICS GRADES

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Abstract: This study attempt to investigate the determinants of the grades in mathematics courses taken by the students who graduated from College of Commerce and Economics (CCE), Sultan Qaboos University, Oman. Five years data on grades in mathematics courses, gender and percentage marks in high school along with stream (arts or science) for all the students were obtained from admissions and registration department of the university. Ordinal regression analysis was performed to investigate the effect of gender, high school marks and prerequisite mathematics courses on the probabilities of obtaining the grades. This analysis reveals that high school marks have significant effect on the probabilities of obtaining a grade in business mathematics courses. Although it has been the general perception that females had higher probabilities of obtaining higher grades but it was not true when high school marks were taken into consideration.

Keywords: Business Mathematics, Grades, Ordinal Regression, Predictors

I. INTRODUCTION

When his majesty Sultan Qaboos bin Said decided to improve the quality of education in Oman, he announced in 1980 to construct the sultan Qaboos University. Construction started in 1982 and the first batch of students was enrolled in 1986. The university initially started with five colleges (medicine, engineering, education, agriculture and science) and the college of arts started in 1987, while the college of commerce and economics was opened in 1993.The college of law joined the university in 2006 and finally in 2008 the college of nursing was established. In August 1993, 122 new students were admitted to the college of commerce and economics, and started classes in September 1993. College of Commerce and Economics Student enrollments have increased from 122 in September 1993 to 1,556 in May 2007. The college of Commerce and Economics, as an integral part of Sultan Qaboos University, interacts with other colleges and utilizes the different facilities and resources available to the university. This college has six departments which are "Accounting", "Economics and Finance", "Information Systems", "Management", "Marketing", and " Operations Management and Business Statistics" in which student can major.

The Deanship of Admissions and Registration controls the admission to the university, based on the university council's recommendations. Admission to the College of Commerce and Economics will be open to students coming from General Secondary (Science and Arts streams) and Commercial Secondary Schools. Limited seats are available for technical college graduates and transfer students from recognized international institutions. The admission is based on percentage that student obtained in higher secondary school.

The students of commerce and economics (both art and science) must take at least two mathematics courses and two courses of statistics from department of mathematics and statistics in college of science. The students who are science stream study two courses which are Business Math I (Math1101) and Business Math II (Math1102). The art stream students study three courses which are Mathematics for College of Commerce and Economics I (Math1061), Mathematics for College of Commerce and Economics II (Math1062) and Mathematics for College of Commerce and Economics III (Math1063). And both (art and science) students study two courses of statistics which are Business Stat I and Business Stat II. All courses are graded as: (A, A-, B+, B, B-, C+, C, C-, D+, D and F). Since each course is of three credit hours therefore the grade points for each grade are (A=12, A-=11.1, B+=9.9, B=9, B-=8.1, C+=6.9, C=6, C-=5.1, D+=3.3, D=3). The grade points are used for the analysis of data in this study. The art stream students study the first course to provide them with mathematics necessary to bring them up to a level comparable with that of students with science background. Therefore this course is not considered here for comparison. The second course is to introduce them to logarithmic and exponential functions, progressions, differentiation and derivatives, while the third course covers optimization techniques for functions of one and several variables, basic techniques of integration and the applications of the definite integral to problems

from economics and social sciences. Whereas the science stream students take the first course directly in which they learn more about algebra and differential calculus and their applications to the fields of business and economics and after that they take the second course to improve their skills in deferential calculus, optimization techniques for functions of one and two variables, basic techniques of integration, and applications of differentiation and integration to various real life problems from economics and the social sciences. And then both students study the first statistics course to have knowledge about descriptive statistics and the methods for analyzing data from business and economics, and then they study business stat II to learn about inferential statistics such as contingency tables, regression and correlation and residual analysis of variance.

In the present study we aim to determine the probabilities of obtaining the grades in Business Mathematics courses and to investigate the effect of gender and high school percent marks on these probabilities. For this purpose, we have taken the grades in each mathematics course by gender along with their percentage marks in high school for all the students who graduated from 2003 to 2008. These records were taken from the department of admission and registration files [1]. This comprises a sample of 1239 student records in which there are 624 males and 615 female students. More over there are only 120 records from the arts stream and the rest are from science stream.

II. ORDINAL REGRESSION ANALYSIS

Ordinal regression is a statistical technique that is used to predict behavior of dependent variables with a set of independent variable when the dependent variable is the ordered response category variable and the independent variables may be categorical, interval or a ratio scale variable. The first category is considered as the lowest category and the last category is considered as the highest category [2],[3],[4]. A link function is used to predict the dependent variable category. In ordinal regression there is one regression equation for each category except the last category which can be predicted by subtraction from one.

The link function is a transformation of the cumulative probabilities of the dependent ordered variable that allows for estimation of the model. Minitab [7] provides three link functions, logit (the default), normit (also called probit), and gompit (also called complementary log-log) allowing you to fit a broad class of ordinal response models. In this study we used logit which is the inverse of the standard cumulative logistic distribution function. This class of models is defined by:

$$g(\chi_k) = \theta_k + \mathbf{x}'\boldsymbol{\beta}, \; k = 1, ..., K-1 \; , \; \text{where:}$$

K = the number of distinct categories of the response

χ_k = the cumulative probability up to and including category k,

$g(\chi_k)$ = the link function (described below)

θ_k = the constant associated with the k^{it} distinct response category.

$\boldsymbol{\beta}$ = a vector of coefficients associated with the predictors

$\mathbf{X}$ = a vector of predictor variables

III. ESTIMATION OF THE MODEL

The above model was estimated using MINITAB statistical software which uses maximum likelihood method of estimation of parameters [7]. The table(1) shows the estimated coefficients for all math courses that are taken by science stream students according to their predictor variables and the table(2) shows the estimated coefficients for math courses that are taken by art stream students according to their predictor variables. These estimated coefficients were used to find the probability of getting a certain grade in each math course by using the logit function to apply ordinal method. The chi square goodness of fit test shows that these models were adequately fitted and all the slops were significant at 1% level of significance indicating that the gender, percentage marks in high school and grades in prerequisite courses play an important role for determining the grades in Business Mathematics courses. The calculation of probabilities of getting a grade using these models reveals that although it has been the general perception that females had higher probabilities of obtaining higher grades but it was not true when high school marks were taken into consideration.

TABLE I: ESTIMATED COEFFICIENTS OF THE PARAMETERS OF ORDINAL REGRESSION MODEL FOR SCIENCE STREAM STUDENTS.

	Math1101		Math1102	
	Estimated coefficients	S.E.	Estimated coefficients	S.E.
D	13.391	1.908	4.675	1.918
D+	14.298	1.900	5.725	1.917
C-	14.956	1.911	6.573	1.919
C	15.843	1.917	7.407	1.921
C+	16.499	1.921	8.061	1.923
B-	16.945	1.925	8.642	1.925
B	17.493	1.928	9.542	1.928
B+	18.068	1.931	10.283	1.931
A-	18.966	1.936	11.354	1.936
Percent	-0.185	0.0220	-0.044	0.022
Gender	0.414	0.1429	-0.025	0.142
Math1101			-0.546	0.026

TABLE II: ESTIMATED COEFFICIENTS OF THE PARAMETERS OF ORDINAL REGRESSION MODEL FOR ARTS STREAM STUDENTS

	Math1062		Math1063	
	Estimated coefficients	S.E.	Estimated coefficients	S.E.
D	5.768	5.141	8.572	5.206
D+	6.625	5.136	9.183	5.210
C-	7.457	5.140	10.004	5.219
C	8.052	5.145	10.756	5.229
C+	8.798	5.154	11.745	5.245
B-	9.148	5.159	12.185	5.252
B	9.671	5.166	12.882	5.265
B+	10.75	5.182	14.123	5.286
A-	11.75	5.195	15.289	5.308
Percent	0.079	0.057	0.077	0.058
Gender	0.253	0.335	0.498	0.33
Math1061	-0.271	0.063	0.094	0.065
Math1062			-0.471	0.078

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