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Student Performance in the Managerial Accounting Course: An Ordered Probit Model

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Abstract:

An ordered probit model is used to identify factors that influence student performance in managerial accounting. Data derived from 1452 students completing the course over a seven year period indicate that when only letter grade instead of actual numerical points are available that (i) GPA positively impacts letter grades in ACTG252. (ii) Marketing and management majors tend to have lower grades in ACTG252. (iii) Overall letter grade are on the decline for the past 5 years. (iv) Letter grades received in ACTG251 significant impact those in ACTG252.In addition the cumulative and marginal probabilities are calculated in various cases.

Key Words: Managerial Accounting; Performance of Students; Ordered Probit Model.

I. Introduction

Managerial accounting (ACTG252), the second required sophomore-level course for accounting majors and all business administration majors, plays an important role in students' career choices, their ability to succeed in upper division courses and preparation for possible graduate study. A variety of studies have focused on the factors influencing student academic performance in a wide variety of business courses, but relatively few have focused on courses early in the curriculum and the implications for academic advisement and retention. Recent studies on differences of academic performance in undergraduate accounting courses provide us with varied and mixed results while typically using a standard multiple regression model. No current study in the accounting education literature effectively analyzes factors that may influence ordinal final grades nor does any current research consider choice of major across the grading distribution. In this study, we develop and utilize an ordered probit model to test and explain factors influencing academic performance in managerial accounting (ACTG) in a rural Pennsylvania public university.

II. Literature Review

Prior research has looked at various influences on student performance in a variety off accounting courses. Al-Twaijry (2010) considered three sequential courses related to managerial accounting, at both the lower division and upper-division undergraduate level. He found that factors such as math ability, and performance in earlier courses influenced student performance in managerial accounting, and that accounting majors generally succeeded more than other majors in accounting and other courses.

Similar results were observed by Burnett, Friedman, and Yang (2008) regarding student perceptions of accounting having a significant impact on student learning outcomes. The conclusion is that since students with different academic majors typically have different perceptions on accounting courses that student performance will vary across majors. Yunker, Yunker, and Krull (2009) show that mathematical ability, the choice of academic major (accounting majors performed better), and the overall score on the American College Testing (ACT) examination were the only factors important in determining performance in a principles of accounting course. Mathematical ability was predetermined by performance on a mathematical assessment examination and it was even found that this measure had a significantly diminished effect of performance in the accounting course when the cumulative grade point averages of students were included in the analysis. There was not a statistical difference in academic performance across genders for the sample of 535 students. It is worth noting that, in addition to relying on a standard multiple regression model, the study used the percentage of total points scored in principles of accounting as the dependent variable rather than final course grades. There is some question as to changes in score distribution across the sixteen classes in the study whereas final grade distributions typically exhibit small variation over time.

Burnett, Xu, and Kennedy (2010) looked at gender differences and used a multiple regression model on a small sample of 72 students to discover that males and accounting majors score better on a final examination in intermediate accounting. Furthermore, they conclude that students who possess a great deal more self-confidence, as determined from a survey instrument, do significantly better on the examination than students with lower self-confidence concerning the course material. Lynn and Robinson-Backmon (2010) also found that a self-assessment of learning objectives was influential on final grades, but that course load and employment status were not. A study by Eikner and Montondon (2001) of indicators of success in intermediate accounting found that only college GPA, previo0us performance in earlier accounting courses and age were important, while Turner, Holmes and Wiggins (1998) also found that factors associated with prior performance in accounting, as well as students' majors were important. Kirk and Spector report similar results for performance in cost accounting, indicating that GPA, performance in managerial accounting and the first statistics course wer important variables, but that math achievement, age and gender were not.

The results observed over the wide range of studies discussed could have been due to various geographic or demographic factors such as location and income, or other factors such as different pedagogical methodologies. Clearly, one serious shortfall of previous work in this area of analysis is the frequent reliance on multiple regression techniques. Students in any course are most interested in obtaining high final grades and, as a consequence, that presents the most accurate measure of academic performance given that it includes all work accomplished during an entire semester. Final grades, however, are not continuous but ordinal in nature. As a consequence, standard multiple regression analysis is *not* appropriate to use when studying the impact of various factors on final course grades. The primary purpose of this paper is to re-examine the issue of factors affecting performance using an ordered probit model on final grades in managerial accounting. The next section presents the data and the model. Section IV discusses the empirical results and Section V contains a discussion and conclusion.

III. Data and Methodology

Data was gathered at Clarion University of Pennsylvania, with an enrollment of approximately 6,000 students, which is part of the Pennsylvania State System of Higher Education, which comprises fourteen public universities (106,000 students in total). The College of Business Administration at Clarion University offers seven academic majors: accounting, management, industrial relations, economics, international business, finance, real estate and marketing and has been accredited by Association to Advance Collegiate Schools of Business (AACSB) since 1998. The data involving student performance in managerial accounting is, therefore, a sample of the student population in the College of Business Administration.

Data Description:

The sample used for this study consists of 1452 students from the fall semester of 2006 to the spring semester of 2011. Data were collected from student transcript records. Both financial accounting (ACTG251) and managerial accounting (ACTG252) are required of all majors per AACSB accreditation guidelines and all students in the sample who successfully passed both accounting courses were included. Data for each student in the sample regarding the cumulative grade point average (GPA), gender (GENDER), major (MAJOR), term (TERM), letter grades in ACTG251 (D_1 , D_2 , D_3) were recorded for the analysis. Since this is a study of academic performance in managerial accounting, the final grade in ACTG252 was also recorded for use as the dependent variable in this analysis.

Empirical Methodology:

Prior analyses have relied primarily on mean standardized scores, analysis of variance or multiple regression models in order to establish a statistical association between student performance in accounting and the above-mentioned suggested explanatory variables. As is well known in statistics, the mean standardized scores method is simple yet efficient: by directly calculating group means and standard errors, one may be able to detect potential differences. Unfortunately, the mean standardized scores method usually ignores the hidden factors that cause the difference between the performance of various students. Analysis of variance models represent a marked improvement in that they can include these factors as additional treatment and, as such, are preferred to the mean standardized score approach. However, dependent variables (average grades in several accounting courses) in analysis of variance models are required to be in interval when estimating the model. This precludes evaluating performance in a single course where grades are ordinal (letter grades are assigned). In addition, analysis of variance models only identify factors that cause differences in a dependent variable (measured academic performance in this case) but do not provide a precise and comparable estimate of how each factor quantitatively influences academic performance. Multiple regression models share the same properties as those of analysis of variance but are more flexible in including explanatory variables that are numerical. When the dependent variable is categorical in nature (such as final letter grades in a course), the least squares regression estimation technique is not appropriate as it can produce spurious probabilities (greater than unity or less than zero) and negative variance estimates (Greene, 2003). As an alternative, a binary logit or probit model will each provide more accurate estimates and explanatory power than a multiple regression model since both are specifically designed to explain 0-1 (pass or fail) outcomes. In the case of more than two outcomes, a multinomial logit or probit model is often used. Unfortunately, such a model suffers from the "independence from irrelevant alternatives" assumption which states that the odds ratio between outcomes i and j must be independent of other ratios for unbiased estimates. As such, this is a rather restrictive condition imposed on the model. To overcome this limitation, we opt for the ordered probit model, which can accommodate multiple outcomes that are ordinal in nature (Zavoina and McElvey, 1975).

Historical grade rubrics in the accounting department at the university are ordinal in nature. Although the accounting department generally attracts better students within the college, the university has recently experienced stiffer competition from schools in adjacent geographical areas. As a result, various curving techniques have been used to make grade distributions more consistent with previous years and to support other programs in the College of Business Administration. With variations in curving methods across semesters, use of numerical examination scores in a problem-solving oriented course as managerial accounting can be problematic. As a consequence, use of an empirical model tailored for the ordinal nature of final grades is most appropriate as long as the grading curve technique preserves the rank order of the final grade distribution. For example, an instructor could add five points to an exam as a simple way to curve (where y = x + 5). Such a practice preserves ranks so that for two scores $x_1 > x_2$ implies $y_1 > y_2$ (x is the original score and y is the curved score). At the extreme, the curving formula $y = 10\sqrt{x}$ clearly favors low achievers: a student who received an original score of 49 would end up getting 70 (a gain of 21 points) while a student with an original score of 95 would obtain a curved score of 97.5, a gain of only 2.5 points. That particular scheme does, however, satisfy the boundary condition (if x = 100 then y = 100) and also preserves ordered ranks as $x_1 > x_2$ translates into $y_1 > y_2$. Other curving techniques, such as y = (x/2) + 50, also possess the rank-preserving property: a letter grade A is better than B, which is better than C and so on. But the difference between letter grades A and B is not the same as that between B and C, hence the variable is ordinal rather than interval. The ordered probit model is designed to provide consistent estimates for this kind of dependent variable.

To start the analysis let us consider a latent linear regression:

$$y^* = x'\beta + \varepsilon$$

$$= \beta_\circ + \beta_1 GPA_i + \beta_2 MAJOR_i + \beta_3 GENDER_i + \beta_4 TERM_i + \beta_5 D_1 + \beta_6 D_2 + \beta_7 D_3 + \varepsilon_i \quad \text{...} \quad (1)$$

Where y^* = unobserved latent variable of letter grades. Values of y^* can be described as follows:

y = 0 = D if $y^* \leq 0$ ………………………………….……..… (2)

y = 1 = C if $0 < y^* \leq \mu_1$ ……………………………………….. (3)

y = 2 = B if $\mu_1 < y^* \leq \mu_2$ ………………………………………. (4)

y = 3 = A if $y^* \geq \mu_2$ ……………………………………………….. (5)

Where μ_1 and μ_2 are threshold values by which expected letter grades in introductory finance are determined. Variable definitions are:

GPA = grade point average on a 4.0 scale.

MAJOR = '1' for Management or Marketing majors and '0' for Accounting, Economics and Finance majors.

GENDER = ‘0’ for male students and ‘1’ for female students.

TERM = ‘1’ for the Fall Semester 2004 and ‘2’ for the Spring Semester 2005 and so on. It represents a trend in grading if any.

D_1 = ‘1’ denotes a student received a D in ACTG251 (Financial Accounting); $D_1 = 0$ implies he or she received a letter grade of other than a D. It is to be pointed out that the letter grade C is used as the reference group. The coefficient is estimated to compare the performance between students with a D and a C in ACTG251.

D_2 = ‘1’ denotes a student received a B in ACTG251, ‘0’ for other letter grades. Again the coefficient reflects the difference in performance for students with a B and a C.

D_3 = ‘1’ denotes a student received an A in ACTG251, ‘0’ for the other letter grades. The coefficient reflects the difference in performance for students with an A and a C.

ε_i = Normally distributed residual with a mean of ‘0’ and variance of ‘1’.

IV. Empirical Results of the Ordered Probit Model

The estimation procedure is based on TSP version 4.5 (2002) and estimated coefficients for the ordered probit model described in equations (1) through (5) are reported in Table 1.

TABLE 1
Estimates of Ordered Probit Model (Dependent variable = letter grade of Managerial Accounting)

Variable	Coefficient	Standard Error	t ratio	p value
Constant	-0.10339	0.220454	-0.468984	0.639
GPA	0.830214	0.069847	11.8862	0.000*
MAJOR	-0.332400	0.060218	-5.51993	0.000*
GENDER	0.051447	0.060204	0.854543	0.393
TERM	-0.029602	0.00349906	-8.46040	0.000*
D1	-0.478527	0.109519	-4.36936	0.000*
D2	0.293915	0.070356	4.17752	0.000*
D3	0.925369	0.093357	9.91218	0.000*
Math110	0.032844	0.042357	0.775411	0.438
μ_1	1.41833	0.064337	22.0452	0.000*
μ_2	2.54315	0.073630	34.5397	0.000*

Number of Observations = 1452
Likelihood Ratio (Zero Slope) = 614.680 [p value=0.000]
Log Likelihood Function = -1518.19
Scaled R-squared = 0.370955
*=significant at 170

An inspection of Table 1 indicates that the following factors have greatly impacted the performance of ACTG252 at 1% significance level (α=1%):

(1) GPA is shown to have clearly impacted letter grades in ACTG252 with α=1%. Furthermore, the magnitudes can be measured by probabilities shown in Table 3.

(2) When the dummy variable (Major) switches from 0 (Accounting, Economics & Finance) to 1 (Marketing, Management and others), the performance in ACTG becomes worse (negatively related) at the significance level of 1%. See Table 7 in a later section.

(3) As time goes on, the average letter grade of ACTG252 received by students has declined significantly. The magnitude of it is shown in Table 3.

(4) If a student gets a D (D_1 =1) in ACTG251, he or she is expected to have worse grade in ACTG when compared with students receiving a C (reference group) probabilities are listed in Table 4.

(5) If a student gets a B (D_2=1) or an A (D_3=1), he or she is expected to obtain a better letter grade when compared with students receiving a C (reference group). Such probabilities are listed in Tables 5 and 6.

(6) Gender and the remedial math course (Math 110) do not impact performance of ACTG252 with p-values 39.3% and 43.8% greater than α=1%. Even though gender is not a significant predictive factor, it indicates female students may score slightly better in ACTG252 in general.

(7) The threshold variables μ_1 and μ_2 are found to be significant indicating that letter grades in ACTG significantly separate performance given the data set.

Results in Table 1 show that when all other factors relevant to the final grade in managerial accounting are held constant (these include grade point average, academic major, academic term, and the final grade in the prerequisite accounting course), females in general do slightly better than their male counterparts in the managerial accounting course. With a p-value of 0.393 and a positive coefficient estimate, female students in managerial accounting earned higher final grades (albeit insignificantly) than male students in the course. A further inspection of Table 1 indicates that, as anticipated, cumulative grade point average (GPA) is a significant predictor in determining probabilities of obtaining various letter grades in managerial accounting. The corresponding probability value (p value) approaching zero suggests that a student's cumulative grade point average has a statistically significant effect on the probability of that student earning a higher final grade in managerial accounting. The GPA is a measure of the student's prior performance and can be viewed as representing a combination of student ability and effort. Given the highly quantitative nature of the course, it is encouraging to see that past academic performance and effort appear to translate into academic success in accounting. While this is an expected result, it does not always appear to be statistically significant in some academic disciplines; especially those that are less quantitative.

The choice of academic major also appears to be significantly linked to academic performance in managerial accounting. Students majoring in accounting, economics, or finance (Major=0) had a greater chance of earning a higher grade in managerial accounting than did marketing and management students (Major=1) enrolled in the course. It is generally acknowledged that the fields of accounting, economics, and finance are more quantitative that the marketing and management disciplines. As a consequence, students who possess a greater mathematical ability often self-select into academic fields that are more quantitative thereby causing the difference seen in final grades for this accounting course. Since students majoring in accounting, economics, and finance tend to do better in managerial accounting, it is not surprising that those three academic programs often seek to develop dual programs in an academic environment to accommodate this linkage.

The negative coefficient on TERM, which is used to control for grade inflation or deflation over the sample span, suggests that grades in managerial accounting are declining over time. This may be puzzling, but can be explained by a variety of factors, including a change in faculty complement over time, an increased use of part-time instructors in recent semesters, or, perhaps, a change in the overall academic preparation of students. Since there is a significant faculty union presence on this campus and there is very little administrative control on grade distributions for each course, one might have expected the possibility for grade inflation to exist over time, and this did not occur.

The dummy variable D_1, a control variable, captures the impact of letter grades received in financial accounting (ACTG251) on probabilities of obtaining letter grades in managerial accounting (ACTG252) with the reference group set as those students who received a D in ACTG251. Therefore, negative coefficient of D_1 (-0.478) implies that a typical student who had a D in ACTG251 (D_1 = 1) is expected to perform worse in ACTG252 compared to the student earning a C in ACTG251. The relationship is statistically significant (p value = 0.000). Similarly, the conclusion can be reached for a student who received a B in ACTG251 ($D_2 = 1$) with a p value of 0.000 (significant) and for a typical student who obtained an A in ACTG251 or $D_3 = 1$ (p value of 0.000). It clearly signals that the probability is greater of obtaining a good grade in ACTG252 if a student earned an A or B in ACTG251, an indication that a complete understanding of accounting principles and concepts taught in ACTG251 is indeed necessary for students to succeed in ACTG252.

Finally, the estimated coefficients on the two threshold variables (μ_1 and μ_2 or 4 categories minus 2) used to assign probabilities of obtaining various letter grades are all statistically significant. This result indicates that the use of the four category ordered probit model is appropriate to the data set analyzed. Results on threshold variables, interestingly, are not typically provided in studies using the ordered probit model even though it is an important test that legitimizes the use of the model. Inclusion of estimates and tests of the threshold variables is a unique and transparent aspect of this analysis. The scaled R-squared of 0.371 reflects a moderate fit for this model. In addition, Estrella (1998) points out that the scaled R-squared measure, unlike the McFadden R-squared, is a nonlinear transformation of the likelihood ratio for multinomial logit or probit model. It provides consistent criterion in terms of goodness of fit. However, care must be exercised since a satisfactory measure of fit is lacking in the model of discrete dependent variables. As pointed out by Greene (2003), the maximum linked likelihood estimator is not chosen to maximize a fitting criterion in predicting y. Hence, significance tests on individual coefficients are sufficient for evaluation purposes.

For a typical student in our college with mean values of 2.9623 (GPA), 0.5110 (GENDER), 0.5165 (MAJOR), 17.096 (TERM), 0.0937 (D_1), 0.3574 (D_2), 0.2032 (D_3), and 0.2891 (MATH110) probabilities of receiving various letter grades can be calculated as follows:

Prob [y = 0 or D] = $\phi(-\beta' x)$ ………………………………………. (6)

Prob [y = 1 or C] = $\phi[\mu_1 - \beta' x] - \phi(-\beta' x)$ ……………………………. (7)

Prob [y = 2 or B] = $\phi[\mu_2 - \beta' x] - \phi(\mu_1 - \beta' x)$ …………………….... (8)

Prob [y = 3 or A] = 1 - $\phi(\mu_2 - \beta' x)$ …………………………………… (9)

Where x is a set of mean values for a typical student and β is a set of estimated coefficients of the ordered probit model. Note that ϕ (•) is cumulative normal function μ_1 and μ_2 are the threshold variables. The calculated probabilities from equations (6) through (9) for a typical student are found to be 2.33%, 26.1%, 42.45% and 29.12% respectively as presented in Table 2.

TABLE 2

Probabilities of Getting Letter Grades in ACTG252

Probability / Letter Grade	p(y)
y = D	2.3 %
y = C	26.1 %
y = B	42.5 %
y = A	29.1 %

A typical student at Clarion University (COBA) has 2.3%, 26.1%, 42.5% and 29.1% to receive D, C, B or A. respectively. The impact of GPA and Term on ACTG252 Performance since GPA are also significant in our model.

We calculate the marginal probability (Greene 2003) as shown below:

$$\partial \Pr ob[Y = 0 \ or \ D] / \partial GPA = -\phi(-\beta' x) * (\hat{\beta}_1) \ldots\ldots\ldots\ldots \quad (10)$$

$$\partial \Pr ob[Y = 1 \ or \ C] / \partial GPA = [\phi(-\beta' x) - \phi(\mu_1 - \beta' x)] * (\hat{\beta}_1) \ldots\ldots\ldots \quad (11)$$

$$\partial \Pr ob[Y = 2 \; or \; B]/\partial GPA = [\phi(\mu_1 - \beta' x) - \phi(\mu_2 - \beta' x)] * (\hat{\beta}_1) \ldots\ldots\ldots\ldots \quad (12)$$

$$\partial \Pr ob[Y = 3 \; or \; A]/\partial Math = \phi(\mu_2 - \beta' x)] * (\beta_1) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

Where $\hat{\beta}_1$ is the estimate coefficient on GPA and ϕ is normal density function. The results are reported in Table 3. If GPA increases by one point, the probabilities to get an A, B, C and D increase by 28.47%, and decreases by 0.32%, 23.57% and 4.57% respectively (See Table 3). Note the sum of these probabilities equals zero.

TABLE 3

Probabilities of Getting Letter Grades in ACTG252 Relative to GPA and Term

Probability / Letter Grade	∂ p(y)/∂GPA	∂ p(y)/∂Term
y = D	-4.57%	0.16%
y = C	-23.57%	0.84%
y = B	-.32%	0.011%
y = A	28.47%	-1.015%

Similarly, as time goes on (term), the probability of getting an A actually decreases by 1.015%, and probability of a B, C, and D increases by 0.011%, 0.84% and 0.16% respectively: the sum again equaling zero.

Discussion of the Probabilities of Letter Grades in ACTG252

By using cumulative normal density functions, we can detect the impact of letter grades on ACTG251 on performance of ACTG252. A perusal of Table 4 indicates a student who receives a D in ACTG251 has 3.94% and 13.73% more chance to receive a D and C in ACTG252 respectively when compared to those who receive C in ACTG251. At the same time, that student has 3.28% and 14.39% less chance to receive B and A in ACTG252. Similarly, receiving a B in ACTG251 enhances the probability of receiving an A by 10.11%, but reduces chance to get B, C and D by 0.55%, 8.01% and 1.55% respectively when compared to those who receive C in ACTG251 These results are summarized in Table 5. If a student received an A in ACTG, he or she has 34.18% more chance to repeat an A in ACTG252, while she or he has a 8.66%, 22.26% and 3.26% lower chance to get a B, C, and D respectively in ACTG252, when compared to those who earned C in ACTG252. Table 6 has a summary of these results.

As is indicated in Table 7, a typical marketing or management major (Major=1) has 1.82%, 9.31% and 0.49% to get a D, C, and B respectively in ACTG252; at the same time, he or she has 11.62% lower chance to receive an A in ACTG252.

TABLE 4

Impact of D_1 on the Probability of Getting Specific Grades in ATCG252

	D_1 = 0 (receiving other than a D in ACTG251)	D_1 = 1 (receiving a D in ACTG251)	Change
$-\beta' x$	-2.0334	-1.55487	
$\mu_1 - \beta' x$	-0.61507	-0.13654	
$\mu_2 - \beta' x$	0.509751	0.988278	
Equation (6) P[y=0 or D]	φ (-2.03) = 0.0212	φ (-1.5548) = 0.0606	3.94%

Equation (7) P[y=1 or C]	**φ** (-0.61507)- **φ** (-2.03) = 0.2464	**φ** (-0.1365)- **φ** (-1.5548) = 0.3837	13.73%
Equation (8) P[y=2 or B]	**φ** (0.509751)- **φ** (-0.61507) = 0.4274	**φ** (-0.1365)- **φ** (0.988278) = 0.3946	-3.28%
Equation (9) P[y=3 or A]	1 - **φ** (0.5097) = 0.305	1 - **φ** (0.988278) = 0.1611	-14.39%

TABLE 5

Impact of D_2 on the Probability of Getting Specific Grades in ATCG252

	D_2 = 0 (receiving other than a B in ACTG251)	D_2 = 1 (receiving a B in ACTG251)	Change
$-\beta'$ x	-1.883	-2.17744	
$\mu_1 - \beta' x$	-0.46519	-0.75911	
$\mu_2 - \beta' x$	0.659629	0.365714	
Equation (6) P[y=0 or D]	**φ** (-1.883) = 0.0301	**φ** (-2.17744) = 0.0146	-1.55%
Equation (7) P[y=1 or C]	**φ** (-0.46519)- **φ** (-1.883) = 0.2891	**φ** (-0.75911)- **φ** (-2.17744) = 0.209	-8.01%
Equation (8) P[y=2 or B]	**φ** (0.659629)- **φ** (-0.46519) = 0.4262	**φ** (0.365714)- **φ** (-0.75911) = 0.4207	-0.55%

Equation (9) P[y=3 or A]	1 - φ(0.659629) = 0.2546	1 - φ(0.365714) = 0.3557	10.11%

TABLE 6

Impact of D_3 on the Probability of Getting Specific Grades in ATCG252

	D_3 = 0(receiving other than an A in ACTG251)	D_3 = 1 (receiving an A in ACTG251)	Change
$-\beta' x$	-1.80057	-2.72594	
$\mu_1 - \beta' x$	-0.38224	-1.30761	
$\mu_2 - \beta' x$	0.742579	-0.18279	
Equation (6) P[y=0 or D]	φ (-1.8) = 0.0359	φ (-2.725) = 0.0033	-3.26%
Equation (7) P[y=1 or C]	φ (-0.38)- φ (-1.8) = 0.3161	φ (-1.307)- φ (-2.725) = 0.0935	-22.26%
Equation (8) P[y=2 or B]	φ (0.742)- φ (-0.382) = 0.4184	φ (0.182)- φ (-1.307) = 0.3318	-8.66%
Equation (9) P[y=3 or A]	1 - φ (0.742) = 0.2296	1 - φ (0.182) = 0.5714	34.18%

TABLE 7

Impact of Major on the Probability of Getting Specific Grades in ATCG252

	Major = 0 (Accounting, Economics and Finance)	Major = 1 (Marketing and Management)	Change
- $\beta' x$	-2.16027	-1.82787	
$\mu_1 - \beta' x$	-0.74194	-0.40954	
$\mu_2 - \beta' x$	0.382877	0.715277	
Equation (6) P[y=0 or D]	**φ** (-2.16) = 0.0154	**φ** (-1.83) = 0.0336	1.82%
Equation (7) P[y=1 or C]	**φ** (-0.742)- **φ** (-2.16) = 0.2142	**φ** (-0.409)- **φ** (-1.83) = 0.3073	9.31%
Equation (8) P[y=2 or B]	**φ** (0.383)- **φ** (-0.742) = 0.4184	**φ** (0.715)- **φ** (-0.409) = 0.4233	0.49%
Equation (9) P[y=3 or A]	1 - **φ** (0.383) = 0.352	1 - **φ** (0.715) = 0.2358	-11.62%

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