# A MODEL FOR EVALUATING PERFORMANCE IN A SOPHOMORE MANAGERIAL ACCOUNTING COURSE

Tony R. Johns, Clarion University of Pennsylvania
Thomas W. Oliver, Clarion University of Pennsylvania
Paul Y. Kim, Clarion University of Pennsylvania

## ABSTRACT

This paper investigates student performance in a sophomore Managerial Accounting course at a state-supported university in Pennsylvania via an ordered probit model. A large sample size (n = 427) coupled with an ordinal dependent variable allows for the use of the ordered probit model, which is an appropriate model for the analysis of multi-category ordinal data.

Our investigation reveals that (i) GPA is a significant predictor of the letter grade obtained in the course, (ii) female students tend to perform significantly better than their male counterparts, (iii) Accounting and Finance majors have a better probability of getting a superior grade than do Management and Marketing majors, and (iv) Financial Accounting, a prerequisite for Managerial Accounting, plays an important role in determining the grade received in Managerial Accounting.

We conclude that GPA and performance in Financial Accounting being significant predictors of performance supports a belief long held by instructors and advisors. Namely that hard work in a course not only pays-off in that course but in future courses as well.

## INTRODUCTION

Efforts to determine and interpret the factors that effect student performance in college courses have received significant attention in the literature. These efforts have included research in areas such as economics (Anderson, Benjamin, and Fuss, 1994; Bosshardt and Watts, 1990; Laband and Piette, 1995; and Borg, Mason, and Shapiro, 1989), accounting (Graves, Nelson, and Deines, 1993), finance (Paulsen and Gentry, 2001) and criminal justice (Leiber, Crew, Wacker, and Nalla, 1993).

In this study, we develop and test a model to explain and predict students' grades in Managerial Accounting (ACTG 252), the second, after Financial Accounting (ACTG251), of a two-course sequence of sophomore level accounting courses. Both of these are required sophomore-level courses for all business administration majors and, as such, play an important role in students' career choices, their ability to succeed in Junior and Senior level courses, and ultimately their preparation for possible graduate study. Despite the obvious importance of these courses, an appropriate performance analysis in terms of course grades has not appeared the literature. An appropriate explanatory and predictive model may be beneficial in several ways, such as providing direction in curriculum development and in identifying student learning difficulties at an early stage. Ultimately, student performance may be improved without compromising academic standards or the quality of learning.

### Data

The sophomore-level accounting courses, both Financial Accounting (ACTG 251) and Managerial Accounting (ACTG 252) serve several purposes in the business curriculum. Primarily they are service courses for business students majoring in other areas such as management, marketing, finance and economics, providing foundation knowledge for core courses and major courses in those fields. They are also foundation courses for students entering the MBA program. An equally important function for these courses, however, is to prepare accounting majors for intermediate financial accounting, cost accounting and other accounting major courses. This dual nature leads to a very wide diversity of both interest and ability within sections. We analyzed data from 14 academic terms, including summers, from the Fall 1999 through Spring 2004 semesters at Clarion University, a medium-sized state university (approximately 5,500 students). In many universities, the practice of "curving" works more in favor of the lower performing student rather than the higher performing student. For example, a professor may use a 10 point scale for determining which students receive an "A's, B's, or C's" but then use a fifteen point scale for those students who receive a grade of "D". Thus, the grades students receive are ordinal rather than interval in nature, and an ordered probit model was chosen for analysis.

**Research Method - An Ordered Probit Model for ACTG 252**

In statistical modeling, analyzing categorical dependent variables entails the use of either logit or probit models. For example, a logit CPA model predicts if students with certain characteristics (explanatory variables) can pass CPA exams. As only two outcomes (pass or fail) are available, a binary logit model is sufficient. An evaluation on course performance involves more than two letter grades; a binary logit is inappropriate and a multinomial logit may be a candidate. However, the multinomial logit or probit model suffers from the notorious "independence of irrelevant alternatives" assumption in that errors in different categories are assumed to be independent of one another. As a consequence, we opt for the ordered probit model, a discrete choice model involving categories that are ordinal in nature. In this model a letter grade of A is better than that of B, which is better than C, which is better than D. However, the difference between A and B does not have to be the same as that between B and C, or C and D.

The standard ordered probit model assumes the following form:

$$\mathbf{y = x'\boldsymbol{\beta} + \boldsymbol{\varepsilon}}$$

Where $\mathbf{x}$ and $\boldsymbol{\beta}$ are conventional data and parameter matrices and $\boldsymbol{\varepsilon}$ is a vector matrix of normally distributed error terms. Obviously, the predicted grade (or $\hat{y}$) is unobserved. We do, however, observe the following:

y = 0 (or grade of D) if $\hat{y} \leq 0$ (2)

y = 1 (or grade of C) if $0 < \hat{y} \leq \mu_1$ (3)

y = 2 (or grade of B) if $\mu_1 < \hat{y} \leq \mu_2$ (4)

y = 3 (or grade of A) if $\hat{y} > \mu_2$ (5)

Where $\mu_1$ and $\mu_2$ are threshold variables in the probit model. The threshold variables, used to classify a student into a category, are unknown and jointly estimated via the maximum likelihood estimation procedure for the ordered probit model.

In terms of available data for this study, the first model considered as the latent regression can be formulated as:

$$y_i = \beta_0 + \beta_1 SAT_i + \beta_2\, GENDER_i + \beta_3 MAJOR_i + \beta_4 TERM_i + \beta_5 D_1 + \beta_6 D_2 + \beta_7 D_3 + e_i$$

As expected, an ability variable plays a key role in determining grades of ACTG 252 (y). Being readily available, the SAT score fits the role. The dummy variable GENDER is used to capture any differences in performance between male (GENDER=0) and female (GENDER=1). We set MAJOR = 1 for Accounting, Economics, and Finance (AEF) majors as these majors are generally viewed as more quantitatively oriented, and MAJOR = 0 for Marketing and Management (MM), the less quantitative majors. Again, the potential difference in performance may be attributed to different majors. TERM is used here to control for grading standards from quite a few instructors, some of whom have since retired. It is used as a proxy for trend, TERM = 1 for the winter semester of 1999; 2 for the spring semester of 2000, etc.). Dummy variables $D_1$, $D_2$, and $D_3$ are used here as control variables reflecting grades on ACTG 251, a prerequisite for ACTG 252. $D_1$=1 implies a student received a C while $D_1$=0 indicates the student received other letter grades. In a similar vein, $D_2$=1 and $D_3$=1 indicate a student received a B and an A on ACTG 251 respectively. Along with the estimated regression coefficients, the ordered probit model provides two (four letter grades minus two) threshold variables through which predicted letter grades can be calculated (see Table 1).

A perusal of Table 1 suggests that SAT is a major explanatory variable, albeit not at 5% significance level (probability value = 6%). GENDER (p value = 15.77%) is an important but marginally significant variable. A large negative t statistic of TERM reveals the grades earned on ACTG 252 have been on the decline. One possible contributing factor may be that several tenured but grade-generous professors have retired in the past few years. Alternatively, student performance may have declined for other unknown reasons. The large t statistics on $D_2$ and $D_3$ point to the phenomenon that students who earned a B or an A in ACTG 251 have greater probability to receive higher letter grades in ACTG 252. Interestingly different majors are not significantly related to the letter grades of ACTG 252. The threshold variables are all significant indicating that the 4-category ordered probit model is appropriate for modeling purpose.

The effects of SAT scores may not be as important as GPA, which reflects amount of effort expanded by students. Since most students in ACTG 252 are either second semester sophomores or first semester juniors, GPA is a more recent indicator of student ability than SAT and as such is expected to be a better predictor of performance than SAT score.

For this reason, we present the estimated result when GPA replaces SAT score in Table 2.

An examination of Table 2 suggests immediately that GPA is a better predictor with a probability value of 0.00. The dummy variables of GENDER, (p value = 4.7%) MAJOR (p value = 2.4%), $D_3$ (p value = 0.7%) are all significant at 5% level. TERM and threshold variables ($\mu_1$ and $\mu_2$) are all highly significant. The scaled R-squared[1] (27.9%) is noticeably greater than that when SAT is used (20.1%). The scaled r squared is a better measure of fit than the McFadden R-squared, for its consistency in interpretation (Estrella, 1998). This being the case, we opt for the second model in the ensuing sections. The significant relationships between grades on ACTG 252 and explanatory variables (GPA, GENDER, MAJOR, TERM, and $D_3$) have the following meaning. First, GPA is an indication of a student's performance in a wide variety of courses. It may be a good indicator of several things, including student ability, student motivation and diligence. Logically this would be an important predictor as this accounting course takes a lot of effort in working out problems. Second, female students have an advantage in ACTG 252 as they may be more meticulous and patient in problem solving. Third, AEF majors tend to attract students who are more diligent and more quantitatively oriented; hence a positive relationship is expected. Fourth, the retirement of several more lenient professors contributes in regard to trend. Fifth, the significant t statistic on D3 speaks to the fact that a student has much greater chance to get a better letter grade if he or she earned an A in ACTG 251. Last, the significant threshold variable again testifies that the four-category (A through D) ordered probit model fits the data satisfactorily. Note that there not being an E in the data set does not convey that every student passed the course. Rather, those who failed the course would have to repeat or drop out of the sample.

**Probability Assessment of Performance**

We can now readily calculate the probabilities to obtain a letter grade for a given student (see Greene, 1991). Given the cumulative normal function $\boldsymbol{\varphi}(\boldsymbol{\beta}'\mathbf{x})$, the probabilities can be shown as below:

Prob [y=0 or D] = $\boldsymbol{\varphi}(-\boldsymbol{\beta}'\mathbf{x})$ (6)

Prob [y=1 or C] = $\boldsymbol{\varphi}\,[\mu_1 - \boldsymbol{\beta}'\mathbf{x}] - \varphi(-\boldsymbol{\beta}'\mathbf{x})$ (7)

Prob [y=2 or B] = $\boldsymbol{\varphi}\,[\mu_2 - \boldsymbol{\beta}'\mathbf{x}] - \varphi(\mu_1 - \boldsymbol{\beta}'\mathbf{x})$ (8)

Prob [y=3 or A] = $1 - \boldsymbol{\varphi}(\mu_2 - \boldsymbol{\beta}'\mathbf{x})$ (9)

Where $\boldsymbol{\beta}'\mathbf{x}$ is a set of specific values of $\mathbf{x}$ for the estimated coefficients $(\boldsymbol{\beta})$ and the threshold values ($\mu$'s). For a typical business student, the average values of GPA, GENDER, MAJOR, TERM, D1, D2, and D3 in our sample are 3.028, 0.4145, 0.5667, 7.2434, 0.344, 0.391, 0.225 respectively. Thus, for a typical business student, $\boldsymbol{\beta}'\mathbf{x}$ can be calculated as 2.2423. Along with $\mu_1$=1.587 and $\mu_2$=2.632, the probabilities for the typical student to obtain letter grades D, C, B, and A can be calculated based on equations (6) through (9) to be 1.25%, 22.97%, 40.957, and 34.83% respectively. Clearly, the modal grade is B reflecting that ACTG 252 is relatively accessible for students to learn after passing ACTG 251. Several explanations may hold. Although both ACTG 251 and ACTG 252 are quantitative, the Managerial Accounting (ACTG 252) course is more user oriented and the Financial Accounting (ACTG 251) course is more preparer oriented. As a result, ACTG 252 may be less technical (i.e. less emphasis on debits and credits), and therefore, generally an easier course than ACTG 251. In addition, students who progress to ACTG 252 have acclimated somewhat to college-level business courses, and therefore improve their performance in the second accounting course they take.

**Calculation of Continuous Marginal Probabilities**

It is of interest to evaluate the change in probabilities in response to a change of a continuous explanatory variable. Since GPA represents such a variable with statistical significance and is of great interest in the performance analysis, we obtain the following derivatives from taking the partial derivative of (6), (7), (8), and (9) with respect to GPA. The marginal effects of the explanatory variable GPA on the probability of getting a letter grade for an average student are calculated as follows:

$\partial$ Prob [Y=0 or D]/ $\partial$GPA

$= -\varphi\,(-\boldsymbol{\beta}'\mathbf{x}) * (\beta_2)$ (10)

$= -\varphi\,(-2.24) * (1.095)$

$= -0.0325 * 1.095$

$= -0.0356$

$\partial$ Prob [Y=1 or C]/ $\partial$GPA

$= [\varphi(-\boldsymbol{\beta}'\mathbf{x}) - \varphi\,(\mu_1 - \boldsymbol{\beta}'\mathbf{x})] * (\beta_2)$ (11)

$= [\varphi(-2.24) - \varphi\,(1.578 - 2.24)] * 1.095$

$= -0.3183$

$\partial$ Prob [Y=2 or B]/ $\partial$GPA

$= [\varphi(\mu_1 - \boldsymbol{\beta}'\mathbf{x}) - \varphi\,(\mu_2 - \boldsymbol{\beta}'\mathbf{x})] * (\beta_2)$ (12)

$= [\varphi\,(1.578 - 2.24) - \varphi\,(2.632 - 2.24) * 1.095$

$= -0.051$

$$\partial \text{ Prob } [Y=3 \text{ or } A] / \partial GPA$$
$$= \varphi(\mu_2 - \mathbf{\beta'x}) * (\beta_2) \quad (13)$$
$$= \varphi(2.632 - 2.24) * 1.095 = 0.4048$$

where φ is the normal density function. Notice that the sum of the marginal effects equals zero. The results indicate that if GPA increases by one unit, probabilities to obtain A, B, C, and D is expected to increase by 40.48%, to decrease by 5.1%, 31.83%, and 3.56% (See Table 3). This implies a significant increase in GPA (by one point), would very likely (40.48%) to render a typical student to get an A in ACTG 252, while reducing the probability of such a student to receiving a B, C, and D. Note that 3.56% + 31.83% + 5.1% ≈ 40.48%.

**Assessment of Impact of Dummy Variables**

The effect of change in GPA can be readily calculated from taking partial derivatives of equations (6), (7), (8), and (9). If, however, the variable is discrete, such as MAJOR, taking the partial derivative is not appropriate. One must reevaluate equations (6), (7), (8), and (9), with MAJOR = 0 and MAJOR = 1, and calculate the difference of the two resulting probabilities. Since the procedures are perhaps least clear among discrete models, we produce intermediate steps in Table 4 in which change in MAJOR is made. Evident from Table 4, an AEF major has 10.16% more chance to receive an A, but 1.26%, 7.99%, and 0.94% less chances to obtain B, C, and D. As before, the net change must be zero.

The advantage of being a female student in terms of scoring a higher grade in ACTG 252 is evaluated by setting GENDER = 1 (female) and GENDER = 0 (male). An examination of Table 5 suggests that an average female student has 28.59% greater chance of receiving an A for the course which results in 20.84%, 7.01%, 0.74%, less chance of obtaining B, C, and D respectively.

ACTG 252 depends critically on the performance in ACTG 251 because the former is essential for understanding the latter. Furthermore, a good grade in ACTG 251 serves as a confidence builder for other accounting courses. The dummy variable $D_3$=1 implies the student obtained an A in ACTG 251 and $D_3$=0 otherwise. As the coefficient on $D_3$ is significant, we evaluate changes in probabilities in the similar way. Results are reported in Table 6.

An inspection of Table 6 reveals readily that if a student gets an A in ACTG 251, the probability of getting an A in ACTG 252 increases by 16.68%, but that of getting B, C, and D are reduced by 13.74%, 2.94%, and 0.09% respectively. This result highlights the importance of ACTG 251: a stepping stone course that may well lead the student to a career in Accounting.

## CONCLUSIONS

Developing an appropriate explanatory and predictive model for success in accounting courses may be beneficial in several ways. Certain factors affecting performance may not be controllable by faculty, but others may. First, GPA is a multidimensional variable that may reflect not only a student's ability, but also his or her work habits and motivation. While it is not surprising to find that a student who does well in many other courses also does well in accounting, this allows the advisor or mentor to stress the interrelationship of success across disciplines and the difficulty of achieving at a satisfactory level without cultivating good study habits. Second, the specific need to succeed in the financial accounting course in order to ensure success in later accounting courses can be emphasized by advisors and mentors as well. Accounting instructors often preach this to accounting majors, and our results support this assertion. Finally, students can be encouraged to continue their efforts when they can be shown that their hard work will pay off in future courses as well. Ultimately in curriculum development, accounting faculty can strive for ways to improve student learning without compromising academic standards or the quality of learning.

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**Dr. Tony R. Johns** earned his Ph.D. at The Florida State University in 1992. Currently he is an Associate Professor in the Administrative Sciences Department at Clarion University of Pennsylvania. Previously he has published articles in various academic journals including *Decision Sciences*, *European Journal of Operations Research*, and *Computers and Industrial Engineering*.

**Dr. Thomas W. Oliver** earned his Ph.D. at The University of Massachusetts in 1983 and is currently Professor and Chairperson of the Department of Accountancy at Clarion University of Pennsylvania. His research has been published in journals including *The Accounting Review, Advances in Financial Planning and Forecasting,* and *Advances in Accounting*.

**Dr. Paul Y Kim** earned his Ph.D. at The University of Minnesota in 1973 and is currently a Professor in the Marketing Department at Clarion University of Pennsylvania. He has previously published in journals that include the *Pennsylvania Journal of Business and Economics*, *American Business Review*, and *Journal of Economic Education*.

Table 1

Estimation of the Ordered Probit Model Using SAT Score

| Variable | Coefficient | Standard Error | t statistic | p value |
|---|---|---|---|---|
| CONSTANT | 0.813 | 0.558 | 1.456 | 0.145 |
| SAT | 0.0013 | 0.00049 | 2.776* | 0.06 |
| GENDER | 0.170 | 0.12 | 1.416 | 0.157 |
| MAJOR | 0.079 | 0.116 | 0.682 | 0.495 |
| TERM | -0.066 | 0.0133 | -5.01** | 0.00 |
| $D_1$ | 0.497 | 0.280 | 1.771* | 0.076 |
| $D_2$ | 0.829 | 0.281 | 2.953** | 0.03 |
| $D_3$ | 1.544 | 0.307 | 5.023** | 0.00 |
| $\mu_1$ | 1.522 | 0.19 | 8.01** | 0.00 |
| $\mu_2$ | 2.501 | 0.197 | 12.702** | 0.00 |

* = significant at 10%, ** = significant at 5%, Number of Observations = 427, Scaled R-squared = 0.201
Likelihood Ratio (zero slope) = 90.6952 [p value = 0.00], Log likelihood Function = -405.595

Table 2

Estimation of the Ordered Probit Model Using GPA

| Variable | Coefficient | Standard Error | t statistic | p value |
|---|---|---|---|---|
| CONSTANT | -0.881 | 0.554 | -1.59 | 0.112 |
| GPA | 1.095 | 0.164 | 6.676** | 0.00 |
| GENDER | 0.242 | 0.1217 | 1.99** | 0.047 |
| MAJOR | 0.276 | 0.1219 | 2.261** | 0.024 |
| TERM | -0.062 | 0.0135 | -4.562** | 0.00 |
| $D_1$ | 0.357 | 0.282 | 1.269 | 0.204 |
| $D_2$ | 0.41 | 0.288 | 1.421 | 0.155 |
| $D_3$ | 0.879 | 0.327 | 2.689** | 0.007 |
| $\mu_1$ | 1.587 | 0.195 | 8.133** | 0.00 |
| $\mu_2$ | 2.632 | 0.203 | 12.963** | 0.00 |

** = significant at 5%, Number of Observations = 427, Likelihood Ratio (zero slope) = 129.219 [P value = 0.000]
Log likelihood Function = -386.333, Scaled R-squared = 0.279

Table 3

Marginal Effects of GPA on Letter Grades in Accounting 252

| Letter Grade | $\frac{\partial \text{ Letter Grade}}{\partial \text{ GPA}}$ |
|---|---|
| A | 40.48% |
| B | -5.1% |
| C | -31.83% |
| D | -3.56% |

Table 4
Impacts of MAJOR on the Probability in Getting Grades in Accounting 252

| | Major = 0 | Major = 1 | Change |
|---|---|---|---|
| **-β'x** | -2.086 | -2.362 | |
| **$\mu_1$-β'x** | 1.587-2.086 = -0.449 | 1.587–2.362 = -0.775 | |
| **$\mu_2$-β'x** | 2.632-2.086 = 0.546 | 2.632-2.362 = 0.27 | |
| Equation (9)<br>P[y=0 or D] | **φ** (-2.086)= 0.0185 | **φ** (2.362)= 0.0091 | -0.0094 |
| Equation (10)<br>P[y=1 or C] | **φ** (-0.499)**-φ**(-2.086)<br>= 0.29 | **φ** (-0.775)**-φ** (-2.362)<br>= 0.2101 | -0.0799 |
| Equation (11)<br>P[y=2 or B] | **φ** (0.546)**-φ** (-0.499)<br>= 0.3995 | **φ** (0.27)**-φ** (-0.775)<br>= 0.3869 | -0.0126 |
| Equation (12)<br>P[y=3 or A] | 1- **φ** (0.546)<br>= 0.292 | 1- **φ** (0.27)<br>= 0.3936 | 0.1016 |

*rounding errors to the third decimal place occurred since we used the cumulative normal table which contains z-values with 2 decimal places.

Table 5
Impacts of GENDER on Probabilities in Getting Letter Grades in Accounting 252

| | GENDER = 0 | GENDER = 1 | Change |
|---|---|---|---|
| **-β'x** | -2.142 | -2.384 | |
| **$\mu_1$-β'x** | 1.587-2.142 = -0.555 | 1.587–2.384 = -0.797 | |
| **$\mu_2$-β'x** | 2.632-2.142 = 0.49 | 2.632-2.384 = 0.248 | |
| Equation (2)<br>P[y=0 or D] | **φ** (-2.142)= 0.016 | **φ** (-2.384)= 0.0086 | -0.0074 |
| Equation (3)<br>P[y=1 or C] | **φ** (-0.555)**-φ**(-2.142)<br>= 0.2735 | **φ** (-0.797)**-φ** (-2.384)<br>= 0.2034 | -0.0701 |
| Equation (4)<br>P[y=2 or B] | **φ** (0.49)**-φ** (-0.555)<br>= 0.3984 | **φ** (0.248)**-φ** (-0.797)<br>= 0.19 | -0.2084 |
| Equation (5)<br>P[y=3 or A] | 1**-** **φ** (0.49)<br>= 0.3121 | 1**-** **φ** (0.248)<br>= 0.598 | 0.2859 |

*rounding errors to the third decimal place occurred since we used the cumulative normal table which contains z-values with 2 decimal places.

Table 6
Impacts of $D_3$ on the Probabilities in Getting Letter Grades in Accounting 252

| | $D_3 = 0$ | $D_3 = 1$ | Change |
|---|---|---|---|
| **-β'x** | -3.427 | -4.306 | |
| **$\mu_1$-β'x** | 1.587-3.427 = -1.84 | 1.587–4.306 = -2.719 | |
| **$\mu_2$-β'x** | 2.632-3.427 = -0.795 | 2.632-4.306 = -1.674 | |
| Equation (2)<br>P[y=0 or D] | **φ** (-3.427)= 0.0001 | **φ** (-4.306)= 0.00001 | -0.0009 |
| Equation (3)<br>P[y=1 or C] | **φ** (-1.84)**-φ**(-3.427)<br>= 0.0239-0.0001<br>= 0.0328 | **φ** (-2.719)**-φ** (-4.306)<br>= 0.0034-0.00001<br>= 0.00339 | -0.02941 |
| Equation (4)<br>P[y=2 or B] | **φ** (-0.795)**-φ** (-1.84)<br>= 0.2138-0.0328<br>= 0.181 | **φ** (-1.674)-φ (-2.719)<br>= 0.047-0.0039<br>= 0.04361 | -0.13739 |
| Equation (5)<br>P[y=3 or A] | 1**- φ** (0.195)<br>= 0.7862 | 1**- φ** (-1.674)<br>= 0.953 | 0.1668 |

*rounding errors to the third decimal place occurred since we used the cumulative normal table which contains z-values with 2 decimal places.