AN ECONOMIC ANALYSIS ON INTERMEDIATE MICROECONOMICS: AN ORDERED PROBIT MODEL

By Chin W. Yang and Rod D. Raehsler[*]

Abstract

An ordered probit model is utilized in this study to determine primary factors leading to academic success among undergraduate students taking intermediate microeconomics. Using a sample of 169 students enrolled in intermediate microeconomics during the 2003-2004 academic year, it is found that individual student cumulative grade point average or total score on the Scholastic Aptitude Test along with choice of academic major influence the expected grade in intermediate microeconomics.

Introduction

A significant body of research has developed in economic education that attempts to determine factors influencing academic performance in a wide variety of courses. The vast majority of work concentrates on student performance in the principles of macroeconomics and the principles of microeconomics courses offered by all universities. The prevalence of studies devoted to the beginning courses in economics is primarily a result of the availability of large data sets due to greater demand for these courses. Spector and Mazzeo (1980) present a study of grades in introductory economics close to the approach of our analysis by utilizing a probit model to determine factors influencing final grades. Anderson, Benjamin, and Fuss (1994), Borg and Shapiro (1996), Becker and Watts (1999), Okpala, Okpala, and Ellis (2000), Ziegert (2000), Marburger (2001), Cohn, Cohn, Balch, and Bradley (2001), Walstad (2001), and Grimes (2002) are a few important examples of studies that discuss evaluation of students and faculty in a principles of economics environment. An equally significant amount of literature has been devoted to teaching methods and techniques in principles of macroeconomics and principles of microeconomics courses. Examples of this growing area of analysis include Sowey (1983), Becker and Watts (1996), Chizmar and Ostrosky (1998), Raehsler (1999), Vachris (1999), Parks (1999), Oxoby (2001), Becker and Watts (2001a, 2001b), Colander (2003), and Jensen and Owen (2003).

To a somewhat lesser extent, work has recently been done to determine factors relevant to grades earned by students in intermediate macroeconomic theory as well as in econometrics. Froyen (1996), Salemi (1996), Smith (1997), Findlay (1999), Gartner (2001), Borg and Stranahan (2002), Walsh (2002), and Weerapana (2003) represent a good cross-section of papers dealing with teaching intermediate macroeconomics and related upper-level economics courses. Becker (1987), Murray (1999), Spinelli (2001), Kennedy (2001), Matthews (2001), and Elder and Kennedy (2001) present a similar body of study for statistics and econometrics courses. In contrast, relatively little attention has been given to studying academic performance in intermediate microeconomic theory. Two articles published by Peter von Allmen (one co-authored with George Brower) are notable exceptions. Von Allmen and Brower (1998) utilized a survey of all economics department chairs to determine how calculus was used in intermediate microeconomics and its importance in course content. It is interesting to note that they were able

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to obtain a relatively high proportion of responses from economics departments across a wide variety of academic environments. Their survey results indicate that the use of calculus in intermediate microeconomics varies widely across universities and is influenced by school enrollment and the general belief as to whether it helps in the understanding of marginal analysis. They also find that there is a substantial mismatch between what students are taught in an undergraduate calculus course and what economists believe students need to know by the time they take intermediate microeconomics. The authors also provide an interesting comparison of theoretical versus applied calculus as it pertains to material taught in microeconomics.

Of greatest relevance to the current analysis is the work by Von Allmen (1996) in which the impact of quantitative prerequisites on student grades in intermediate microeconomics is studied. In his analysis, Von Allmen utilizes an ordered probit model to show that there is a strong link between performance in calculus courses and student performance in intermediate microeconomics. This provocative article has generated some related literature within and outside the economics discipline that merits some attention. Outside the field two articles of note utilize an empirical methodology similar to that presented in the Von Allmen (1996) paper and to that employed in our work. Brahmasrene and Whitten (2001) identify various factors leading to a successful performance on the Certified Public Accountant (CPA) examination. They find that undergraduate grade point average, student age, private accounting experience by the student, and gender are each significant determinants of predicted success on the CPA examination. In a similar fashion, Didia and Haswat (2001) identify significant factors that determine academic performance in an introductory finance course. They find that undergraduate grade point average and prior academic performance in economics, accounting, and mathematics courses represent the most important positive factors that will influence a student's grade in a beginning finance course. It is interesting to note that hours of study were found to have a negative impact on the final grade in introductory finance. This troubling result may be the result of unreliable reporting of study hours by students, multicollinearity between independent variables, or the existence of outliers and is not an issue addressed in the paper.

Rather than extend the work of Von Allmen (1996) across other courses and fields, our work will concentrate on intermediate microeconomics to see whether there are any similarities and differences. Clarion University and Moravian College (the sample of students used in the Von Allmen study) are similar in that each program requires business students to take intermediate microeconomics. This, of course, ensures a stable and large sample size. The academic environments are different, however, with respect to the total enrollment of students for each school and admission requirements. Moravian College is a private and selective liberal-arts institution while Clarion University is a public institution with more inclusive admission standards. As a consequence, students at the two institutions are likely to be very different from each other. The two campuses primarily enroll students from the state of Pennsylvania and have similar average class sizes. Therefore, students between the two schools do share some geographic characteristics and experience similar classroom environments. Our work represents an important refinement of the Von Allmen study with respect to statistical analysis and sample size. Results appear to be significantly different, and we proceed by doing a statistical analysis on the marginal probabilities, something not done in Von Allmen (1996). In addition to collecting a larger sample size, we also provide results on the threshold variables in our ordered probit model. Therefore, even though the two papers utilize a similar empirical model, our work represents a noticeable improvement in data and statistical presentation.

Data

Data for this study came from Clarion University, a public university in western Pennsylvania. Enrollment at Clarion University is approximately 6,000, and the school is part of the Pennsylvania State System of Higher Education, a collection of 14 universities that collectively make up the largest higher education provider in the state of Pennsylvania (106,000 students across all campuses). The College of Business Administration has a current enrollment of approximately 900 students and offers seven various academic majors leading to a Bachelor of Business Administration degree. These include accounting, management, industrial relations, economics, international business, finance, real estate, and marketing. The college is accredited by the Association to Advance Collegiate Schools of Business (AACSB) and has enjoyed this status since 1998. Intermediate microeconomics is a current requirement of all business majors at Clarion University and helps the college uphold an acceptable level of rigor and analytic ability required of all students per AACSB accreditation guidelines. Regarded by many students as a difficult, abstract, and quantitative-oriented course, intermediate microeconomics tends to be an overwhelming challenge for many students who are not adequately prepared for quantitative study and is uniformly disliked by a stable subset of business majors. Even though this last observation is anecdotal in nature, it is clear that any analysis of factors leading to academic success or failure in this course is an important endeavor.

The sample of 196 students was collected from computerized student transcript records of Clarion University business majors with at least a junior standing as of April 2004. Only those students who received final grades in intermediate microeconomics during the 2003-2004 academic year and had completed the Scholastic Aptitude Test (SAT) were included in the sample. All students in the sample completed both principles of economics courses (macroeconomics and microeconomics) in addition to the business statistics two-course sequence required of all business majors. These prerequisites are similar to those observed by Von Allmen (1996) and are indicative of most business college programs. Data for each student are collected measuring the number of credit hours (HOUR), the cumulative grade point average (GPA), and the combined SAT score (SAT). The final grade in intermediate microeconomics is recorded for each student and is converted for use in the ordered probit model. This conversion is explained in the following section of this paper. Two different instructors taught intermediate microeconomics during the sample period. As each instructor (both are tenured professors) used a different textbook, it is appropriate to include a dummy variable accounting for this difference. A dummy variable is also included to account for the different academic majors of students in the sample. The value of the dummy variable is 1 for students majoring in accounting, economics, or finance and 0 otherwise (primarily marketing and management majors). Given that a significant number of students in the College of Business Administration choose a double major in economics and finance and a smaller group of students elect to double major in accounting and economics, this appears to be a natural grouping to consider. There is also some support in the literature (Didia and Haswat 2001) that suggests a strong grade linkage between accounting, economics, and finance courses. As such, there is some historical and theoretical support for developing the dummy for academic major in this fashion. Gender was included as an explanatory variable in the Von Allmen study and was included in the initial model in the current analysis. Since it was found to be statistically insignificant, it has not been included in the discussion.

Methodology

Prior studies have largely utilized multiple regression, probit, or logit models to analyze statistical relations between grades and other explanatory variables. Because of the discrete nature of the dependent variable in this study, ordinary least squares regression would be an inappropriate model. As a consequence, most recent studies of student grades choose a model for discrete choice; typically a logit or probit analysis. A simple binary logit or probit specification (y = 1 for the letter grade A, y = 0 for a grade of B or C) as utilized in Spector and Mazzeo (1980) gives only two discrete outcomes, thereby arbitrarily aggregating grade outcomes into two groups. Lumping grades arbitrarily together implies that grades of B and C or C and D are equivalent measures of student performance; a proposal likely to be rejected by most instructors and students alike. With this in mind, a multinomial model for discrete choice of ordered data is more applicable to grade data. While the multinomial outcomes logit model is a significant improvement, it does suffer from the well-known independence of irrelevant alternatives assumptions as outlined in Greene (1991). As an example, Greene shows that the odds ratio between car and bus passenger numbers changes if one further differentiates cars into domestic and foreign makes and models. Therefore, as in Von Allmen (1996), we opt for the ordered probit model in which letter grades A, B, C, D, and E correspond to censoring values 4, 3, 2, 1, and 0, respectively (Clarion University assigns E as the failing grade rather than F).

Historical grade rubrics in the economics department at Clarion University are intrinsically ordinal in nature. A curving formula $\hat{y} = \sqrt{y} * 10$ where $\hat{y}$ is a curved score and y is the original score is a simple example that can be used to outline this procedure. Average scores on examinations based on test banks very often fall below the standard 75 percent target when using a standard grading scale (90 percent for an A, 80 percent for a B, and so on). Using this specific curving technique clearly benefits low achievers (y = 49 leads to a curved score of 70) more than it benefits high achievers (y = 90 leads to a curved score of 94.9). Nevertheless, this curving technique does preserve the rank of examination scores ($y_1 > y_2 \Rightarrow \hat{y}_1 > \hat{y}_2$) as well as the grade boundary conditions ($\sqrt{0} * 10 = 0$ and $\sqrt{100} * 100 = 100$). In addition, we have observed that some majors register more complaints on the course than do other majors. Given that grade issues exist for both instructors and students in intermediate microeconomics, it is of great interest and importance to analyze the model with the most recent data set collected.

Given that five letter grades (A through E) are ordinal in nature, an ordered probit model is applied to 169 intermediate microeconomics students taking the course during the 2003-2004 academic year. It is important to use a model of this kind because the difference between A and B may not be the same as that between B and C (and so on) due to a variety of curving methods and grading rubrics. The standard ordered probit model is widely used to analyze discrete data of this variety and is built around a latent regression of the following form:

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

where **x** and **β** are standard variable and parameter matrices, and ε is a vector matrix of normally distributed error terms. Obviously predicted grades ($\hat{y}$) are unobserved. We do, however, observe the following:

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

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

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

$$y = 3 \text{ (or grade of B) if } \mu_2 < \hat{y} \leq \mu_3 \quad (5)$$

$$y = 4 \text{ (or grade of A) if } \mu_3 \leq \hat{y} \quad (6)$$

where μ_1 , μ_2, and μ_3 are threshold variables in the probit model. The threshold variables are unknown and determined in the maximum likelihood estimation procedure for the ordered probit.

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

$$y_i = \beta_0 + \beta_1 \text{ HOUR}_i + \beta_2\text{GPA}_i + \beta_3 \text{ MAJOR}_i + \beta_4 \text{ INSTRUCT}_i + e_i \quad (7)$$

where y_i is the final grade for intermediate microeconomics, HOUR is the number of credit hours, and GPA is the cumulative GPA. MAJOR and INSTRUCT denote the academic major and instructor dummy variables described in the previous section. It is assumed that e_i is normally distributed across observations and is normalized with the mean and variance of zero and one. Note that three (five categories minus two) threshold values are to be estimated jointly with the regression coefficients. From the three values (μ_i), we could readily estimate the probability of an individual student's achieving each particular final grade (A, B, C, D, or E) given values of the explanatory variables. Greene (1991) outlines this methodology. The threshold variables are estimated jointly with the model.

One possible difficulty in interpreting the results of parameters estimated for equation (7) involves the use of GPA as an explanatory variable. Nevertheless, we find that GPA is an important variable to focus on when conducting marginal analysis on our model. From a practical standpoint, the primary rationale for placing the cumulative grade point average in the model is that students with a proven track record of successful academic achievement or ability will likely do better in the intermediate microeconomics course. Therefore, we would expect that β_2 would be positive and significant. One problem is that the distribution of grades is not uniform across the various academic disciplines. Some fields provide significantly higher grades than others, making GPA less a measure of academic preparedness and more dependent on the major chosen by the student. The economics department at Clarion University routinely assigns lower grades to students and often meets to discuss grade issues in order to minimize any grade inflation from entering the major. This variability in GPA across majors might actually mask the impact of academic major on the final grade in intermediate microeconomics, an important result sought in this paper. The aggregate SAT score, however, would be a measure that transcends academic major and reflects a level of quantitative and verbal preparedness independent of GPA variability (not independent of GPA). Therefore, the second latent regression model used to develop the ordered probit analysis considered in this paper is given as:

$$y_i = \beta_0 + \beta_1 \text{ HOUR}_i + \beta_2\text{SAT}_i + \beta_3 \text{ MAJOR}_i + \beta_4 \text{ INSTRUCT}_i + e_i \quad (8)$$

Results for each model will be presented in the next section along with an explanation. From the slope parameter and threshold estimates, it is relatively straightforward to calculate probabilities of receiving the five letter grades assigned in intermediate microeconomics. Given the cumulative normal function $\boldsymbol{\varphi}\ (\boldsymbol{\beta}'\ \mathbf{x})$, the probabilities can be shown as below:

$$\text{Prob } [y=0 \text{ or E}] = \boldsymbol{\varphi}\ (-\boldsymbol{\beta}'\ \mathbf{x}) \quad (9)$$
$$\text{Prob } [y=1 \text{ or D}] = \boldsymbol{\varphi}\ [\mu_1 - \boldsymbol{\beta}'\ \mathbf{x}] - \boldsymbol{\varphi}\ (-\boldsymbol{\beta}'\ \mathbf{x}) \quad (10)$$
$$\text{Prob } [y=2 \text{ or C}] = \boldsymbol{\varphi}\ [\mu_2 - \boldsymbol{\beta}'\ \mathbf{x}] - \boldsymbol{\varphi}\ (\mu_1 - \boldsymbol{\beta}'\ \mathbf{x}) \quad (11)$$
$$\text{Prob } [y=3 \text{ or B}] = \boldsymbol{\varphi}\ (\mu_3 - \boldsymbol{\beta}'\ \mathbf{x}) - \boldsymbol{\varphi}(\mu_2 - \boldsymbol{\beta}'\ \mathbf{x}) \quad (12)$$
$$\text{Prob } [y=4 \text{ or A}] = 1 - \boldsymbol{\varphi}\ (\mu_3 - \boldsymbol{\beta}'\ \mathbf{x}) \quad (13)$$

where $\boldsymbol{\beta}'\ \mathbf{x}$ is a set of specific values of x for the estimated coefficients (β) and the threshold values (μ's).

Results and Discussion

Equation (7) was initially estimated including the instructor dummy variable. After discovering that this dummy variable was statistically insignificant, the model was re-estimated excluding INSTRUCT from the model. Unlike students in the Von Allmen (1996) study where no student received a failing grade in a sample of 99 (a result we will hide from our students), we were able to consider three threshold variables since all five grades were observed in our sample of 196 students. The empirical results are represented in Table 1.

The two instructors who taught the course using different textbooks are first included in the model to control for potential differences in grades attributable to instructors. However, because the instructors are of comparable academic background and used the textbooks of similar level, we expect the results are close as shown in Table 1. Alternatively, the SAT scores can be a useful predictor. Table 2 reports the estimated result when GPA is replaced by SAT score.

A comparison of Table 1 and Table 2 suggests that either GPA or SAT explains a significant portion on the probability of getting a letter grade. On the contrary, number of credit hours plays a cameo role, and choice of instructor is indeed insignificant. The dummy variable of majors is significant (p value = 0.049 or 0.045) when SAT is used and appears to be marginally significant (p value = 0.146 or 0.135) when GPA replaces SAT.

As is well known in the literature, SAT is a good predictor for freshmen, and its explanatory power wears off as students become sophomores and so on. The intermediate microeconomics course is a junior level course required for all business majors in the college. As such, we opt for the probit model with the GPA variable. This is further echoed by the much greater scaled R^2 (0.55 vs. 0.09). 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. 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 (1991), the maximum linked likelihood estimator is not chosen to maximize a fitting criterion in predicting y. It is important to point out at this stage that the result using SAT scores circumvents different grading standards across majors. As such, it is not surprising that academic major is a significant predictor of student grades in intermediate microeconomics when the SAT score is used in its place. The dummy variable for instructors is insignificant, indicating consistent grading across the two faculty members assigned to teach intermediate microeconomics. This could well be a result of efforts by the department of economics at Clarion University to instill a consistent grading pattern for each course across all faculty members in economics. We have been consistently used as a model for responsible grading practices on our campus.

Using equations (9) through (13), one is able to calculate the probabilities of receiving five letter grades. It entails the use of the estimated threshold values given the cumulative normal function $\boldsymbol{\varphi}(\boldsymbol{\beta}' \mathbf{x})$. For a typical student in our college who took the intermediate microeconomics course, given average values of GPA, credit hours, major, and instructor, are 2.979, 103.124, 0.479, and 0.503. This translates into $\boldsymbol{\beta}' \mathbf{x} = 2.622$, and from a normal cumulative probability table, the expected probability of obtaining letter grades A, B, C, D, and E can be readily calculated as 4.55 percent, 34.04 percent, 53.657 percent, 7.34 percent, and 0.44 percent, respectively. The microeconomics course is one of the more rigorous courses a business student is required to take. The fact that more students get a letter grade of C is not unexpected and actually is in fair agreement with the result of the probit model.

Table 1: Estimates of the Ordered Probit Model I (Equation 7).

	With Instructor Dummy			Without Instructor Dummy		
Variables, Measures	Estimate	t ratio	P value	Estimate	t ratio	P value
Constant	-4.84	-5.278	0.00	-4.805	-5.254	0.00
Hour	0.006121	0.999	0.317	0.0063	1.031	0.303
GPA	2.236	9.617	0.00	2.233	9.609	0.00
Major	0.255	1.454	0.146	0.261	1.495	0.135
Instructor	0.096	0.554	0.58			
μ_1	1.158	5.366	0.00	1.156	5.373	0.00
μ_2	2.908	11.2326	0.00	2.909	11.251	0.00
μ_3	4.315	13.725	0.00	4.312	13.745	0.00
Sample Size	169			169		
Scaled R^2	0.555			0.555		

Table 2: Estimates of the Ordered Probit Model II (Equation 8).

	With Instructor Dummy			Without Instructor Dummy		
Variable	Estimate	t Ratio	P value	Estimate	t Ratio	P value
Constant	-0.624	-0.689	0.49	-0.601	-0.666	0.506
Hour	0.0045	0.774	0.439	0.00462	0.793	0.428
SAT	0.002	2.959	0.03	0.00199	2.951	0.03
Major	0.333	1.971	0.049	0.338	2.004	0.045
Instructor	0.061	0.37	0.711			
μ_1	0.946	5.144	0.00	0.945	5.148	0.00
μ_2	2.178	10.556	0.00	2.178	10.569	0.00
μ_3	3.085	13.621	0.00	3.085	13.634	0.00
Sample Size	169			169		
Scaled R^2	0.0930			0.0924		

With a fair amount of calculation, the coefficients in the ordered probit model can be interpreted readily. Evident from equations (9), (10), (11), (12), and (13), the marginal effects of the explanatory variable GPA on the probability of getting a letter grade for an average student are calculated as follows:

$$\begin{aligned}\partial \text{ Prob [Y=0 or E]}/\partial \text{GPA} &= -\varphi\,(\boldsymbol{\beta}'\mathbf{x}) * (\hat{\beta}_2) \\ &= -\varphi\,(2.62) * 2.236 \\ &= -0.0129 * 2.236 = -0.029\end{aligned} \tag{14}$$

$$\begin{aligned}\partial \text{ Prob [Y=1 or D]}/\partial \text{GPA} &= [\varphi(-\boldsymbol{\beta}'\ \mathbf{x}) - \varphi(\mu_1 - \boldsymbol{\beta}'\ \mathbf{x}) * (\hat{\beta}_2) \\ &= [\varphi\,(-2.62) - \varphi\,(1.158 - 2.62)\,] * 2.236 \\ &= -0.278\end{aligned} \tag{15}$$

$$\begin{aligned}\partial \text{ Prob [Y=2 or C]}/\partial \text{GPA} &= [\ \varphi\,(\mu_1 - \boldsymbol{\beta}'\ \mathbf{x}) - \varphi\,(\mu_2 - \boldsymbol{\beta}'\ \mathbf{x})] * (\hat{\beta}_2) \\ &= [\ \varphi\,(1.158-2.62) - \varphi\,(2.408 - 2.62)] * 2.236 \\ &= -0.548\end{aligned} \tag{16}$$

$$\partial \text{ Prob [Y=3 or B]} / \partial \text{GPA} = [\varphi(\mu_2 - \boldsymbol{\beta}' \mathbf{x}) - \varphi(\mu_3 - \boldsymbol{\beta}' \mathbf{x})] * (\hat{\beta}_2) \quad (17)$$
$$= [\varphi(2.908\text{-}2.62) - \varphi(4.315\text{-} 2.62)] * 2.236$$
$$= .641$$

$$\partial \text{ Prob [Y=4 or A]} / \partial \text{GPA} = \varphi(\mu_3 - \boldsymbol{\beta}' \mathbf{x}) \quad (18)$$
$$= \varphi(4.315 - 2.62) * 2.236 = 0.214$$

where φ is the normal density function. Notice that the sum of the marginal effect equals zero. Table 3 reports the two marginal effects that each continuous explanatory variable has on letter grades.

Table 3: Marginal Effects of the Explanatory Variables on Letter Grades

Variable/ Grade	Hour	GPA
A	0.0586%	21.4%
B	0.1755%	64.1%
C	-0.15%	-54.8%
D	-0.076%	-27.8%
E	-0.0079%	-2.9%

An examination of Table 3 indicates that as GPA is up by one point, probabilities of obtaining A and B are expected to increase by 21.4 percent and 64.1 percent. On the contrary, probabilities of receiving C, D, and E are expected to decrease by 54.8 percent, 27.8 percent, and 2.9 percent, respectively, for an average business major in our college. By the same token, we can calculate the marginal effects emanating from numbers of credit hours taken. Since it is not statistically significant, the effects are trivial as shown in Table 3.

The derivative used in measuring marginal effects does not apply to dummy variables that assume values of zero or one. Different majors do not seem to exert noticeable influence on probabilities of receiving letter grades (p value of 0.146 in Table 1) when divided this way. Similarly, different instructors play only a trivial role (p value of 0.58). We first calculate the explanatory variables ($-\boldsymbol{\beta}' \mathbf{x}$) at mean values with major equal to 0 (marketing and management) and with major equal to 1 (economics, finance, and accounting). The two categories of academic majors were chosen due to the small number of students majoring in economics and finance. Implications of this will be addressed in the conclusion of this paper. We then substitute these values along with the estimated μ's into (2) through (6). Since the procedures are the least obvious of all the models (Greene, 1991, p. 705), we report the intermediate steps and results in Table 4. A complete set of calculations of these values is available on request. The change between the two values of the dummy variable is only relevant for the five probability figures. It is important to note that in Table 4 rounding errors to the third decimal place occurred since we used the cumulative normal table, which contains z-values with only two decimal places.

Table 4: Impacts of Major on Grades in Microeconomics Theory

	Major = 0	Major =1	Change
$-\boldsymbol{\beta}'\mathbf{x}$	-2.500	-2.755	
$\mu_1-\boldsymbol{\beta}'\mathbf{x}$	-1.342	-1.597	
$\mu_2-\boldsymbol{\beta}'\mathbf{x}$	0.410	0.153	
$\mu_3-\boldsymbol{\beta}'\mathbf{x}$	1.815	1.56	
Equation (9) P[y=0 or E]	0.0062	0.003	-0.0032
Equation (10) P[y=1 or D]	0.0839	0.052	-0.0319
Equation (11) P[y=2 or C]	0.5653	0.5047	-0.0606
Equation (12) P[y=3 or B]	0.3062	0.3798	0.0736
Equation (13) P[y=4 or A]	0.0347	0.0594	0.0247

The results of Table 4 reveals that, for a typical student with an accounting or economics or finance (AEF) major versus the marketing or management major (MM), the probability of receiving (i) B or A is expected to increase by 7.36 percent or 2.47 percent and (ii) C, D, or E is expected to decrease by 6.06 percent, 3.19 percent, or 0.32 percent, respectively. The results are not really unexpected; the AEF majors of this college are geared more toward analytical and quantitative training. However, usual caveats apply: the effect is statistically significant since the coefficient of the dummy variable only has a p value of 14.6 percent.

Conclusions

Past literature focuses primarily on economic education in principles of macroeconomics and microeconomics or even econometrics. Little result is known on the teaching of intermediate microeconomics courses. In many universities and colleges, intermediate microeconomics is an elective course. Therefore, large samples in a short time span may not be feasible. From the academic year 2003-2004, a sample of 169 students was employed to estimate the ordered probit model. It is found that GPA is the most significant explanatory variable in predicting probabilities of receiving letter grades for the course. The ordered probit model represents an improvement in methodology over the binary probit model or logit model by Spector and Mazzeo (1980) and others. The ordinal nature of grading rubrics in our college makes the ordered probit a desired choice. The majority (53.65 percent) of students taking the course receive a letter grade C, possibly indicating that faculty in the department of economics at Clarion University practice very stringent grading standards. On the other hand, this relatively high number of C's for a junior-level course might be indicative of inadequate training in quantitative and abstract thinking for a typical business major in this sample. However, 38.59 percent of students are expected to receive B or A. It speaks to the fact that a diligence variable (GPA) is the largest determining factor. Surprisingly enough, different majors play a noticeable role in the model: accounting, economics, and finance (AEF) majors appear to have an edge in grades over that of management and marketing (MM) majors. Note that an increase of GPA by one unit, ceteris paribus, is expected to (i) increase the probability of receiving A or B by 21.4 percent and 64.1 percent and (ii) decrease the probabilities of obtaining C, D, or E by 54.8 percent, 27.8 percent, and 2.9 percent, respectively. As for impacts of the dummy variable for a typical AEF major, probabilities of getting A or B are expected to go up by 2.47 percent and 7.36 percent. On the other hand, it is expected to decrease by 6.06 percent, 3.19 percent, and 0.32 percent in receiving letter grades C, D, or E. In sum, while intermediate microeconomics is viewed as one of the more rigorous courses in terms of logical and abstract training, it provides ample opportunities for diligent students to receive a satisfactory grade. Unlike work presented in Von Allmen (1996), the dummy variable for instructor is not significant in our sample. One explanation for this relates to a long-standing policy practiced by the department of economics at Clarion University of discussing grading practices across instructors each semester. While the primary purpose of that practice is to limit grade inflation, it has resulted in a very consistent grading pattern across instructors.

In addition to some of the important results described above, this paper also studies the marginal effects of GPA and credit hours on expected grades using the probit model specification. This is an exercise that is missing from previous work and represents a useful means of determining the full impact of explanatory variables on grades. We also provide readers with results on our three threshold estimates, necessary in an ordered probit model. This allows other researchers at other academic institutions to replicate our work and completely compare results. Our analysis of grades in this course and other courses in economics will continue in order to obtain a larger sample size and identify additional factors influencing student success. Our current analysis enjoys a larger sample size compared to previous research (by virtue of requiring intermediate microeconomics in the curriculum); however, more information is always beneficial. Future work will also concentrate on factors leading to grade improvement (from principles of microeconomics) rather than grade attainment and incorporate performance in quantitative courses as outlined by Von Allmen (1996).

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