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Academic Preparation, Gender, and Student Performance in Operations Management

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Abstract

This paper uses an ordered probit model on a sample of 427 students enrolled in operations management; a required course in the curriculum of many business colleges. Analysis on the estimated model and further study into the marginal impact of each explanatory variable displays the expected result that student grade point average and general choice of academic major are both good predictors of academic performance in operations management. Interestingly, when prior grade point average and academic major chosen are controlled, academic performance in prerequisite courses and gender were not found to be significant predictors of student performance in operations management. While lack of sensitivity to differences in gender represents a positive attribute for this course, the inability to link academic performance in prerequisite courses to the final grade in operations management raises some important questions on the business curriculum.

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1 Introduction

A wide variety of research in business education across all disciplines has focused on determining factors important in influencing academic performance. While most analysis has been directed toward studying courses in economics (primarily due to the large sample of available data), a growing interest has evolved in using similar techniques to study courses in accounting and finance. In comparison, very little has been done to mimic this area of analysis in upper-level management courses within business colleges. This is unfortunate in that courses such as operations management represent a vital component in any program of business education. As a consequence, any quantitative and qualitative analysis of factors that influence academic performance in operations management is an important topic relevant to the development of a curriculum designed to enhance the probability of future success of business college graduates.

The primary purpose of this study is to fill this void by identifying the determining factors of student performance in operations management using an empirical model that, while more sophisticated in terms of estimation technique, has proven to be optimal when considering final grades in a course to be the relevant measure of academic performance. Rather than utilizing a standard regression model, this paper uses an ordered probit model that may provide more detailed information on factors affecting final grades by improving on the statistical techniques (such as the student t-tests and analysis of variance procedure) employed by much of the previous literature. Contemporary research has shown that the ordered probit model is the method of choice when analyzing student performance.

In any study attempting to determine important factors influencing student performance it is reasonably assumed that individuals with a significant history of successful past academic performance measured by higher grades will also do well in operations management. While not guaranteed, a positive correlation between student grade point average and the final grade in any course is anticipated. While not expected to be as significant, one would anticipate that the choice of academic major should also influence the final grade in any particular course; especially if the selected major possesses a field of study that emphasizes material important in the course under scrutiny. Specifically, since operations management incorporates a great deal of quantitative material one would expect that students choosing academic majors with greater emphasis on quantitative study would, on average, achieve higher final grades in the course. Regardless of these expectations, both measures (cumulative grade point average and academic major) must be included in the empirical analysis in order to serve as a control and to study any variations in grade performance across groups. Not all students identified and majors in economics, for example, have strong quantitative skills even though that field is acknowledged as relying a great deal on quantitative analysis.

More interesting than determining whether or not grade point average or academic major choice are important factors influencing final grades in operations management is the question as to whether differences in final grades across genders are evident. Gender differences are often witnessed when studying academic performance in science and mathematics as well as in economics and finance for various levels of education. Given the importance of the management field to business education, it would be very important to see if similar differences occur in one of the more challenging courses in the field. Likewise, in developing a useful business curriculum, it is always important to assess how courses are linked in a program and discover whether any changes need to be made. With this in mind, we included measures of academic performance in prerequisite courses to operations management as possible explanatory variables. If these measures are important in determining final grades in operations management then the curriculum can be identified as sound and supporting the academic mission of the college. If these measures are not significant, however, further investigation into the curriculum and teaching methodologies is warranted. Results looking at the link between gender and perquisite course performance are the most interesting in this analysis and provide a unique view of factors determining academic performance in an advanced course in management.

One very positive attribute to conducting this research at this particular academic institution is that the business program at Clarion University requires all students in the college to pass operations management. Many programs only require this course among students majoring in management thereby preventing a thorough analysis of academic performance across students with a wider variety of academic experiences. This is one reason why the sample size is so large for a smaller academic institution. Analysis in this paper will proceed by first providing a general literature review followed by a description of the data and presentation of the ordered probit model. Empirical results will then be presented and discussed providing for a summary conclusion to complete the analysis.

2 Literature Review

Spector and Mazzeo [41] were first to employ a logit model to examine student performance in introductory macroeconomics. Performance in principles of economics courses has also been examined by Kim [22], Becker [4], Borg, Mason, and Shapiro [7], Park [31], Watts and Bosshardt [46]. Work related to intermediate economics or econometrics however has not been as plentiful: Raimondo, Esposito, and Gershenberg [34], and Yang and Raehsler [47]. Most work looking at courses in economics show a strong linkage between student grades, student performance on college entrance examinations (especially in mathematics), and student performance in the class studied. The choice of academic major does make a difference in the upper-level economics courses but gender does not typically matter. Prerequisite course performance does make a difference in academic performance in economics courses as outlined in Von

Allmen and Brower [45].

In the accounting field, similar analysis has provided slightly different results. As a recent example, Johns, Oliver, and Yang [20] examined predictors of student performance in a sophomore accounting course and find that student grade point average and the selection of an academic major in either accounting or finance positively influence academic performance. Interestingly, they find that female students tended to perform better in the sophomore accounting course than their male counterparts. In addition, academic performance in the prerequisite course for managerial accounting (financial accounting) was very important in predicting academic performance. The analysis utilized an ordered-probit model similar to the one used in this study. Many other accounting studies have been gender-related [14, 25, 29, 35, 36, 44] with most finding that male students tended to perform better in accounting courses. Only a few studies focusing on income tax courses, CPA exams or other related accounting topics are found in the literature [17, 28].

In the finance related literature, Berry and Farragher [5] were among the first to survey introductory courses. Subsequently there have been papers on introductory finance courses [8-10, 13, 15, 24, 30, 32, 38, 40] and a few on higher level or graduate finance courses [28,37,42]. Most studies found student grade point average to be an important predictor of student performance. In addition, when gender was included the studies found that male students tended to do better in finance courses.

In the field of operations management, a common concern for educators has been the real or perceived decline in quantitative ability and the increase in mathematics anxiety [12, 27, 33]. According to Desai and Inman [12], only one or two of forty students would have taken operations management under their own initiative. To address this crisis, Desai and Inman [12] proposed the implementation of internships or guest speakers from industry. Griffin [19] indicates that an integrative approach of connecting disparate areas of OM is more effective in that students may realize they have become problem solvers and designers. In addition, Peters, Kethley, and Bullington [33] examined the impact of homework on student performance in an introductory operations management course. Via t tests and Pearson correlation technique, they found that homework did not improve student performance on the introductory operations management course. Surprisingly, they found that student performance deteriorated with homework. Kanet and Barut [21] implemented a problem-based learning technique in an attempt to address ill-structured real-world problems. Using regression analysis, they showed that using that approach, modeled after the medical school learning model [1], can lead to greater learning of knowledge in operations management and improves problem-solving abilities.

Attention to differences in learning among men and women in business disciplines along with specific performance analysis in operations management has been significant over a long period of time. Analysis directed primarily at studying gender differences first was concentrated in economics based on the work by Siegfried [39] showing that attitudinal variations between men and women were important in explaining why females scored, on average, lower on standardized economics examinations than their male counterparts. Interestingly, Lawson [23] showed that the differences in test scores between genders became statistically insignificant when the sample controlled for racial differences in the student sample. A more recent study by Davies, Mangan, and Teljah [11] uses university and secondary school data to show that males typically outperform females on examinations testing economic knowledge and ability due to personality differences between the two genders. Specifically, they find that males tend to be more bold, reckless, and adaptable in learning styles and that these traits lead to a more thorough understanding of economic concepts.

While the business disciplines of economics, accounting, and finance have been particularly looked at with regard to identifying differences in learning between male and female students, very little similar work has been done in the management field. One exception to this relative lack of attention is the work done by Arbaugh and Stelzer [2] who studied differences in learning in an introductory management course. They found that regardless of whether an introductory management course is taught online or in a traditional format, gender is an important predictor of the final grade in the course. Interestingly, they show that in the student sample studied women received significantly higher grades than men. This is a similar conclusion found in a number of similar studies in accounting courses described earlier in this section. Barboza, Yang, and Johns [3] showed that in a higher level management course (operations management), there is no significant difference in overall academic performance between men and women. There is, however, a higher likelihood that a female student will complete an extra credit project provided in operations management. Not surprisingly, students with higher overall grade point averages are also more likely to complete the same project in their study. Trine and Bandy [42] present work that is most closely linked to the analysis in this paper. Using simple linear correlation and a stepwise multiple regression model they show that grades in mathematics and statistics, the overall grade point average, and scores on college entrance examinations all have a positive impact on grades in operations management. This paper improves on the work of Trine and Bandy by utilizing a more advanced and accurate empirical model and including measures identifying gender and performance in prerequisite courses in economics as a control feature of the analysis.

3 Main Results

3.1 Data description and Variable Definitions

The data for this study were obtained from a public university in western Pennsylvania. Enrollment at this university (Clarion University) is approximately 7,000, 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 at this university has a current enrollment of approximately 900 students and offers seven various academic majors administered by five academic departments 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. Operations management is a current requirement for all business majors and helps the college uphold the acceptable level of rigor and analytic ability required of all students per AACSB accreditation guidelines. Regarded by many students as a quantitatively oriented course, operations management tends to be a challenge for many students who are not adequately prepared for mathematical modeling or analytical reasoning.

The data for this study consists of 427 student transcript records of business majors. Each student record was complete with no missing data. Using the ordered probit model, we included the following explanatory variables: GPA (an overall performance variable that may explain any performance differences), gender (dummy variable), term (to control for any trend in grading over time), major (dummy variable), and two composite indices Comp1 and Comp2 (control variables) of student performance in prerequisite courses. One composite index consisted of courses that were analytical in nature but considered to be less-quantitative while the second index consisted of courses that are considered to be analytical and quantitative in nature.

In the analysis we include an aggregate indicator of academic major to identify students choosing academic disciplines with greater quantitative emphasis and those that do not depend as much on quantitative skills. The academic majors of students in the sample included accounting, business economics, finance, management, and marketing. In performing the initial analysis we found that using four dummy variables to identify five academic majors provided similar results to identifying one composite variable. As a consequence, we collected data on each student's academic major in the sample and assigned them to either a major that emphasizes quantitative analysis (accounting, business economics, and finance) or one that does not tend to emphasize as much quantitative analysis (management and marketing). While this division might not be universal across academic institutions, it was deemed appropriate based on our discussions with department chairpersons in the business college. Generally, it is recognized that accounting, business economics, and finance rely on a wider variety of quantitative techniques than the fields of management and marketing at the undergraduate level. Use of this type of dummy variable rather than a separate measure for each major improves accuracy of the empirical model.

The term that the operations management course was offered was also identified in this analysis with the fall term in 2004 being the first observation (given a value of 1) and the spring term of 2009 as the last term (given a value of 18). A summary of variables used in the ordered probit model analysis is provided below:

y_i = letter grade for operations management.

GPA_i = grade point average on a 4.0 scale

$Gender_i$ is a dummy variable. It equals 0 for female and 1 for male.

$Term_i$ = a proxy for any trend in grades over time (defined above)

$Major_i$ is a dummy variable. It equals 0 for marketing and management majors and 1 for accounting, economics and finance majors.

$Comp1_i$ is a composite score calculated by averaging each student's grades in principles of management, financial accounting and managerial accounting.

$Comp2_i$ is a composite score calculated by averaging each student's grades in principles of microeconomics, principles of macroeconomics, business statistics, pre-calculus and business calculus.

3.2 Empirical Model and Methodology

Use of regression analysis cannot be readily applied in the analysis of student performance when the dependent variable is ordinal in nature (either pass and fail or though the assignment of student grades) as opposed to a continuous variable such as grade point average or examination score. A complete model for evaluating student performance cannot be constructed satisfactorily unless it can address student performance being categorized into letter grades of A, B, C, D, and F. The binary logit or probit model in which Y = 1 for pass and Y = 0 for failure, as was done by Spector and Mazzeo (1980), is too rudimentary for properly evaluating student performance. The multinational logit or probit model, which allows for more than two categories, suffers from the well-known "independence of irrelevant alternatives" assumption (Greene, 2003), as errors are assumed to be independent for each category. To circumvent this problem, the ordered probit model allows the dependent variable (letter grades in operations management) to assume values which are ordinal in nature. Thus, in this study we used Y = 4 if the student received an A, and 3, 2, 1 or 0 if the student received a B, C, D, or F, respectively. A model that can address ordinal data is needed because grade assignments may not be interval in nature. For example while an A my be assigned to students with a final average between 90 and 100, a B may be assigned to students whose final average is 78 to 90 with similar variations occurring for those students who received a C, D, or F.

The explanatory variables defined in the previous section are used to predict the probabilities of receiving different letter grades as shown below.

$$y_i^* = \beta_0 + \beta_1 GPA_i + \beta_2 Gender_i + \beta_3 Term_i + \beta_4 Major_i + \beta_5 Comp1_i + \beta_6 Comp2_i + e_i \quad (1)$$

where

y_i^* = unobserved Operations Management grade

y_i = letter grade for Operations Management.

$y_i = 0$ if $y^* \leq 0$, indicating the student received a letter grade D

$y_i = 1$ if $0 \leq y^* < \mu_1$, indicating the student received a letter grade C

$y_i = 2$ if $\mu_1 \leq y^* < \mu_2$, indicating the student received a letter grade B

$y_i = 3$ if $\mu_2 \leq y^*$, indicating the student received a letter grade A

where

μ_1 and μ_2 are jointly estimated threshold values which determine the letter grade a student is expected to receive, and

e_i = error term which are normally distributed with a mean of zero and standard deviation of one.

Note that a student who fails the course has to repeat it and thus is not included in the sample. As a consequence, y_i cannot take a value of 0 (or failure in the course). Since one of the authors was the only instructor of the course for the data used in the sample, the need to control for student performance due to different instructors is not needed. Other variables in the model were defined in an earlier section, however, equation (1) can be presented in matrix format as $\boldsymbol{\beta}'\mathbf{x}$. In this case, the cumulative function in the ordered probit that needs to be estimated can be written as:

$$F(\boldsymbol{\beta}'\mathbf{x}) = \int_{-\infty}^{\boldsymbol{\beta}'\mathbf{x}} \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt \quad (2)$$

This specification combining equations (1) and (2) requires that a maximum likelihood estimation technique is needed to derive empirical estimates addressed in the following section. The TSP version 4.5 (2002) statistical package used for this study readily performs this estimation with the data we have collected.

One distinct advantage of using the ordered probit model specification involves calculating the probabilities of receiving the four letter grades by including the use of the estimated threshold values. Given the cumulative normal function $\boldsymbol{\varphi}(\boldsymbol{\beta}'\mathbf{x})$, the probabilities can be shown as below:

Prob [y = 0 or D] $= \boldsymbol{\varphi}(-\boldsymbol{\beta}'\mathbf{x})$ (3)

Prob [y = 1 or C] $= \boldsymbol{\varphi}[\mu_1 - \boldsymbol{\beta}'\mathbf{x}] - \boldsymbol{\varphi}(-\boldsymbol{\beta}'\mathbf{x})$ (4)

Prob [y = 2 or B] $= \boldsymbol{\varphi}[\mu_2 - \boldsymbol{\beta}'\mathbf{x}] - \boldsymbol{\varphi}(\mu_1 - \boldsymbol{\beta}'\mathbf{x})$ (5)

Prob [y = 3 or A] = $1-\boldsymbol{\varphi}(\mu_2-\boldsymbol{\beta}'\mathbf{x})$ (6)

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

With a moderate amount of calculation, the coefficients in the ordered probit model can be interpreted readily. Evident from equations (3), (4), (5), and (6), the marginal effects of the explanatory variable GPA on the probability of getting a letter grade for an average student are

$$\partial \Pr ob[Y=D]/\partial GPA = -\phi(\boldsymbol{\beta}'\mathbf{x})*(\hat{\beta}_2) \quad (7)$$

$$\partial \Pr ob[Y=C]/\partial GPA = [\phi(-\boldsymbol{\beta}'\mathbf{x})-\phi(\mu_1-\boldsymbol{\beta}'\mathbf{x})]*(\hat{\beta}_2) \quad (8)$$

$$\partial \Pr ob[Y=B]/\partial GPA = [\phi(\mu_1-\boldsymbol{\beta}'\mathbf{x})-\phi(\mu_2-\boldsymbol{\beta}'\mathbf{x})]*(\hat{\beta}_2) \quad (9)$$

$$\partial \Pr ob[Y=A]/\partial GPA = \phi(\mu_2-\boldsymbol{\beta}'\mathbf{x})]*(\widehat{\beta}_2) \quad (10)$$

where ϕ is the normal density function. By definition, the sum of the marginal effect equals zero. Empirical values calculated for equations (3) through (10) are presented in the next section.

3.3 Empirical Results

Results for the ordered probit model are reported below:

Table 1: Estimates of the Ordered Probit Model

Variable	Estimated Coefficient	Standard Error	t-statistic	p-value
Constant	-4.027	0.541	-7.448	0.000
GPA	1.889	0.274	6.899	0.000
Major	0.429	0.115	3.734	0.000
Term	-0.001	0.012	-0.059	0.953
Gender	0.028	0.117	0.242	0.809
Comp 1	0.098	0.135	0.727	0.407
Comp 2	-0.156	0.187	-0.836	0.403
μ_1	1.293	0.108	11.997	0.000
μ_2	2.541	0.129	19.632	0.000

n = 427
Likelihood Ratio (zero slope) = 190.124 (p-value = 0.000)
Log likelihood value = 449.019, Scaled R^2 = 0.397

An examination of Table 1 indicates that grade point average (GPA) is the dominant explanatory variable with the t statistic of 6.899 (probability value of 0.00) indicating that a higher GPA leads to greater probability of getting a better letter grade in operations management (indicated by a greater value in y). Note that the estimated coefficient has no direct interpretation but can be used to calculate probabilities of getting different letter grades and their corresponding marginal probabilities. We will present these calculations in the next section.

Another important explanatory variable is the dummy variable Major. When Major = 0, the student is a Management-Marketing (MM) major; when it is equals 1, the student is an Accounting-Economics-Finance (AEF) major. Given the large t statistic (3.734) and small probability value (0.0), it implies that the probability for an AEF major, all other factors held constant, to receive a better grade in operations management is significantly greater. The insignificant t value for Term implies that final grades in operations management have remained relatively stable over time. The estimated threshold variables (μ_1 and μ_2) are very significant indicating the ordered probit model with 4 different letter grades is highly appropriate. The next step is to evaluate the probabilities for students with a specific set of characteristics: on GPA, Major and other predictors.

Scaled R-squared, a nonlinear transformation of the constrained and unconstrained maximum likelihood values, is a good measure of fit. It is bounded within zero and one like ordinary R-squared in classical regression analysis (Estrella, 1998). A value of a 0.397 is considered satisfactory for a large cross-section data set of 427 students. The probability value of 0.000 for the likelihood ratio indicates that the explanatory variables used in the probit model are appropriate.

For a typical student in our college who took the course, average values of GPA, Major, Gender, Term, Comp1, and Comp2 are 3.028, 0.567, 0.414, 7.244, 3.076, and 2.813. This translates into $\boldsymbol{\beta}'\mathbf{x} = 1.863$ (or a typical business student in the college). From a normal cumulative probability table and equations (2), (3), (4), and (5), the expected probabilities of obtaining letter grades A, B, C, and D can be readily calculated as follows:

$P(\hat{y} = A) = 0.2843$, $P(\hat{y} = B) = 0.4314$, $P(\hat{y} = C) = 0.2529$, and $P(\hat{y} = D) = 0.0314$,

respectively. This grade distribution is typical of an upper-level business course where students who make an E are required to retake the course and students are also allowed to retake the course in an attempt to improve their grade should they wish to do so. Thus there are essentially no E's in the data and also very few D's given that students who make a D often retake the course.

The impact of a continuous explanatory variable on probabilities of getting different letter grades can be evaluated from taking the partial derivative of equations (3), (4), (5) and (6) utilizing techniques outlined in Greene (2003). With a moderate amount of calculation, the coefficients in the ordered probit model can be interpreted readily. Evident from equations (7), (8), (9), and (10), the marginal effects of the explanatory variable grade point average (GPA) on the probability of getting a letter grade for an average student are presented in Table 2. In the equations used to calculate the marginal probabilities, φ is the normal density function implying that marginal effects need to observe changes in the cumulative normal density function. It is worth noting that the sum of the marginal effect equals zero indicating that probability is simply being reapportioned with the change in grade point average. Table 2 reports the marginal effects that an increase of one unit of the continuous explanatory variable (GPA) has on letter grades of operations management.

Table 2: Estimates of Direct and Marginal Probabilities of Final Grades in Operations Management: Effect of Grade Point Average on Final Grade Probability

Final Grade	Direct Probability	Marginal Probability
A	0.284	0.598
B	0.431	0.043
C	0.253	-0.507
D	0.031	-0.133

Note: Direct probabilities represent estimates of equations (3) – (6). Marginal probabilities reflect the change in final grade probabilities when GPA increases by one unit.

Specifically, Table 2 indicates that if grade point average increases by one unit (or cumulative letter grade), the probability of obtaining one of the better final grades (an A or a B) in the operations management course goes up by 59.8% and 4.25% respectively, while the chances of receiving one of the poorer grades (a C or a D) goes down by 50.7% and 13.3% respectively. This shows the strength of the relationship between GPA and the grade received in the course, illustrating clearly that students with better GPA's coming into the course have a superior chance of obtaining an A or B in the course when compared to students who have lower GPA's.

The impact of different majors, MM (major = 0) versus AEF (major = 1), on the probabilities of receiving different letter grades cannot be evaluated by equations (6), (7), (8), and (9) as major is a dummy (discrete) variable. However, we can calculate these changes in probabilities by setting Major = 0 and 1 respectively and substitute them into equation (2) through (5) separately. Final results along with intermediate steps are presented in Table 3.

Table 3: Impacts of Academic Major on Probabilities of Receiving Different Final Grades in Operations Management

Final Grade	Major = 0 (MM Major)	Major = 1 (AEF Major)	Difference
A	0.1788	0.3121	0.1333
B	0.4505	0.4543	0.0038
C	0.3181	0.2134	-0.1047
D	0.0526	0.0202	-0.0324

An examination of Table 3 indicates that a student with an AEF major (Major = 1) when compared to an MM major (Major = 0) has a better chance (13.33%) of receiving an A. That is, a typical MM major has 17.88% to receive an A while a typical AEF major has 31.21% to receive an A. The difference is quite noticeable and can possibly be explained in the context of AEF majors being more quantitatively oriented than MM majors. However, difference in major has relatively weak effect on getting a B (0.4%). Since the grade received is a zero-sum game, if a student's chance of receiving a particular grade or grades increases, then that student's chance of receiving another grade or grades must decrease to off-set this increase. Thus for the typical AEF major the increased probability of receiving an A or B is offset by a decreased probability of receiving a C or D (13.33% + .4% - 10.47% - 3.247% = 0.0).

While the results linking student grade point average and the choice of academic major based on quantitative content is important, they are empirical results most business educators expect. Using data to verify a commonly accepted relationship in education is valuable, however, it is often the case that more interesting information can be garnered from expected linkages that do not exist. Using Table 1 presented earlier it was found that the coefficient on Gender (a dummy variable with a value of 0 for female students and 1 for male students) was insignificant with a t-statistic of 0.242. Unlike many other studies in the field, gender in this sample did not significantly influence the final grade in operations management.

Results on the composite prerequisite course dummy variables are very interesting and somewhat surprising. Prior performance in prerequisite courses that are less quantitative in nature (Comp 1) and in more quantitative prerequisite courses (Comp 2) has no significant impact on academic performance in operations management. As a consequence, the prerequisite courses in economics, accounting, business statistics and (surprisingly) introductory management do not appear to assist students in earning higher grades in this upper-level management course. This creates some serious concern as to the efficacy of the business curriculum. Marginal probability impacts of gender and the prerequisite courses on final grades could have been calculated using the ordered probit specification, however, they would not have been significantly different from zero. As a consequence, these values were not reported.

4 Conclusion

By applying an ordered probit model to a sample of 427 students, we have found that the indicator of student previous performance, grade point average, is a significant predictor of student performance in operations management. Needless to say, operations management involves a large portion of analytical thinking and problem solving and, as such, an industrious student as reflected by a higher grade point average ought to perform well in the course. It was also found that a typical students majoring in accounting, economics, or finance was more likely to obtain a better grade in operations management than a student majoring in management or marketing. This can partially be attributed to the belief that students selecting a major in accounting, economics, or finance are typically more skilled in quantitative techniques and will do better in the most quantitative course in the management core courses. Of course, this might be unique to the academic institution; an avenue of inquiry that will be addressed in future work in this discipline.

The ordered probit model also sheds light on the magnitudes of impacts from grade point average and the choice of academic major. It indicates that an increase of one unit in grade point average is expected to increase the probabilities of receiving an A or B by 59.8 % and 4.25 % while decreasing the probabilities of obtaining a C or a D by 50.7 % and 13.3 %. In a similar vein, a typical student majoring in accounting, economics, or finance is expected to have a 13.33 % and 0.4 % larger chance to receive an A or B when compared to a typical student majoring in management or marketing. He or she is also expected to have 10.47 % and 3.24 % less chance to receive a C or a D. While results do not appear to be unexpected, it is important to derive empirical verification that links cumulative grades and choice of academic major to performance in any course. It is of particular interest that students choosing a field in management did not, on average, do better in this management course when compared to academic majors with greater quantitative evidence. This supports the notion that operations management is indeed a highly quantitative course in a business college.

More important to the primary focus of this paper are the results showing that gender and course prerequisites do not have a statistically significant impact on the final grades in operations management. Given conflicting results concerning academic performance and gender in business disciplines, this is a relatively unique result. It directly counters the work of Arbaugh and Stelzer (2003) who showed a difference among genders regarding academic performance in a management course. It is encouraging to see that an upper-level management course with a significant reliance on quantitative analysis does not show that there is an achievement gap between male and female students considering that business education and the business environment in general have been viewed by many as being male dominated.

The results showing that overall academic performance in the prerequisite courses to operations management do not significantly influence final grades in the course are interesting; especially in light of the differences already observed among students with different academic majors. Grades students earned in the prerequisite courses in economics, accounting, management, and business statistics did not affect the grade distribution in operations management. Collectively, this may imply that even though students choosing academic majors with greater quantitative content achieve higher grades in operations management, this same linkage does not exist among the prerequisite courses. That is a conjecture, however, that remains to be tested. Clearly, the results on prerequisite courses imply that changes need to be considered for the business curriculum as to how it serves the operations management course important for all business majors or how material is presented in the existing prerequisite courses. It may be the case that some courses among the prerequisites are more important than others and instructor variation might play a part in statistically diminishing the importance of these variables. This will be the subject of future research.

In summary, we conclude that the best way to enhance student performance in operations management is twofold. First, it is clear that quantitative methods must be emphasized in earlier courses; especially courses in introductory management. Second, serious consideration must be directed toward looking at an optimal business curriculum that gives students the best chance to succeed. Operations management is an important upper-level course taken by all business students at the university program studied and it should be the case that mastery of material taught in prerequisite courses translates to success in key capstone courses. Future research will focus on exploring this relationship further and looking into teaching techniques that might be considered in the operations management course.

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