AN EVALUATION ON ACADEMIC PERFORMANCE IN INTERMEDIATE MICROECONOMICS: A CASE OF PERSISTENCE

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ABSTRACT

This paper uses an ordered-probit model on a sample of 488 students who enrolled in intermediate microeconomics. Analysis on the estimated model and further study into the marginal impact of each explanatory variable shows that a phenomenon of persistence can be used to describe final grades in intermediate microeconomics. A strong academic performance in principles of microeconomics translates to a higher probability of earning a high grade in intermediate microeconomics. We also show that mathematical preparation has a positive effect on the grade in intermediate microeconomics as well as enrollment in a remedial mathematics course for students deficient in mathematical preparation when entering college. Gender and academic major do not have a discernable effect on the grade distribution in intermediate microeconomics.

INTRODUCTION

A principles of microeconomics course provides students with a basic understanding of consumer theory and the theory of the firm without the need of calculus. Intermediate microeconomics, on the other hand, presents a more detailed theoretical extension of the principles course with greater emphasis on mathematical concepts covered in a basic business calculus course. Von Allmen and Brower (1998) showed that academic performance in calculus was an important determinant to student performance in intermediate microeconomics. Unfortunately, they used a relatively small sample size (n=99) and did not consider how academic performance in the principles of microeconomics influenced the final grade in intermediate microeconomic theory. This is an important venture in that it helps underscore the learning process in economics. The concept of persistence in the learning process suggests that the final grades in the principles of microeconomics and the intermediate microeconomics courses should be positively correlated.

Literature studying factors influencing academic performance has been very extensive in recent years beginning with a significant number of articles devoted to the economics discipline and expanding to a large number of other business disciplines. 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. Borg and Shapiro (1996), Becker and Watts (1999), 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), Borg, Mason, and Shapiro (1989), Watts and Bosshardt (1991), Becker and Watts (1996), Raehsler (1999), Vachris (1999), Parks (1999), Oxoby (2001), Becker and Watts (2001a, 2001b), Colander (2003), and Jensen and Owen (2003).

To somewhat of a lesser extent, work has recently been done to determine factors relevant to grades earned by students in upper-level economics courses as well as courses in related business disciplines. Froyen (1996), Salemi (1996), 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) and Becker and Greene (2001) are notable examples of research on student performance in business statistics. Interestingly, several papers in the accounting education field deal with gender-related issues on grade performance in accounting courses and on the Certified Public Accounting examinations. Examples include Lipe (1989), Tyson (1989), Ravenscroft and Buckless (1992), Murphy and Stanga (1994), and Brahmasrene and Whitten (2001). Use of similar model specifications to measure factors influencing student performance in finance courses can be found in Ely and Hittle (1990), Cooley and Heck (1996), Sen, Joyce, Farrell, and Toutant (1997), Chan, Shum, and Lai (1996), and Chan, Shum, and Wright (1997).

Surprisingly, only a few studies are devoted to explaining student performance in intermediate microeconomics courses. Von Allmen and Brower (1998), as discussed above, employed an ordered probit model with only a sample size of 99 students. In addition, they did not provide significance tests on the threshold variables necessary when using the ordered probit model. Yang and Raehsler (2005) apply a similar ordered probit model specification with a slightly larger sample size (n = 195) and conducted the important analysis on the threshold variables. This is important in order to show that the model specification is appropriate for the data employed. Both studies, however, suffer from inadequate sample sizes.

In this paper, we significantly expand the sample size and include an additional variable that measures pre-calculus and calculus performance in order to extend the work of Von Allmen and Brower. By including the final grade earned in principles of microeconomics as an explanatory variable, we are able to test whether the learning process in microeconomics follows a pattern of mean reversion or one of persistence. A mean reversion pattern would indicate that a strong academic performance in principles of microeconomics (ECON 212) would lead to a lower grade in intermediate microeconomics (ECON 310). Persistence, which is a grade pattern that educators hope prevails, implies that a higher grade in ECON 212 translates to a higher grade in ECON 310. At first glance it appears relatively straightforward that a pattern of persistence would be most likely when comparing sequence courses in a field. Nevertheless, a case can be made to support the plausibility of a mean reversion pattern in grades between sequenced courses when student composition or course objectives are considered. Yang and Raehsler (2006) show that a mean reversion pattern of grades exists between a first course and a second course in business statistics. We believe this is possibly a result of two factors related to grading: the type of students enrolled in each course and the material presented in each course. A broader spectrum of students enroll in the first business statistics course each semester. While the course is required of all students in the College of Business Administration, a significant number of students with other academic majors take the course to satisfy basic general education requirements. Students outside the College of Business do not typically enroll in the second business statistics course changing the grading pattern between the two courses. Business students typically will do better than students outside the college in the first business statistics course while they compete against each other in the second course. In addition, the first business statistics course concentrates on the theory behind statistics while the second course is more applied. Therefore, the mean reversion pattern might be a result of students being more adept at using computer software than in solving problems related to theory. While we did not test to see which explanation might cause mean reversion in grades between the two courses, we suspect that other sequence courses in mathematics may follow the same type of pattern. Clearly, given that some students taking ECON 212 (non-business students) might not take ECON 310, both grade patterns are plausible. In the current analysis paper we also test to see whether mathematical preparation and the incorporation of a remedial mathematics course in the curriculum is helpful to students in ECON 310.

The remainder of this paper is organized as follows: Section II provides a summary of the data used in this analysis along with a presentation of the ordered probit model estimated, Section III discusses the empirical results, Section IV shows calculations of marginal probabilities for continuous and discrete explanatory variables, and Section V provides concluding remarks.

DATA AND THE ORDERED PROBIT MODEL

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 fourteen 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. A sample of 488 students was utilized in this study and was obtained from computerized student transcript records beginning in the fall semester of 1999 through the spring semester of 2005. Variables collected include student cumulative grade point averages, identification of gender and academic major, assessment scores for MATH 131 (pre-calculus) and MATH 232 (business calculus), the term ECON 310 was taken, a dummy variable to identify whether or not a student took MATH 110 (remedial mathematics), and final grades in both ECON 212 and ECON 310.

We have been able to generate a substantial sample size in a relatively short time frame due to a unique curriculum in the College of Business Administration at Clarion University. All students in the business college at Clarion University are required to pass ECON 310 in addition to the ECON 212 course required by all business programs. As a consequence, we enjoy a much larger and more diverse base of students taking intermediate microeconomics than observed in previous studies. In a sense, we have a large captive audience that makes it easier to generate substantial sample sizes when analyzing student performance in this upper-level economics course.

In this paper we utilize an ordered probit model in favor of a conventional linear model since the latter may produce biased variance and spurious probability estimates (Greene, 2003). Given that the letter grades assigned to ECON 310 are ordinal (the grades are A, B, C, D, and E), an ordered probit model is appropriate for this as a dependent variable. Assuming that sensible grading curves are applied to most courses and given the significant variation in the mathematical background of business students, the difference between an A and a B may well not be equivalent to the difference between a B and a C (and so on).

In what follows, we employ the latent regression model originally developed by Zavoina and McElvey (1975). For a given set of explanatory variables X and y* (unobserved dependent variable), we have

$$y^* = X'B + e \qquad \text{Formula (1)}$$

or, using available data, the matrix equation can be written as

$$\begin{aligned} y^*_i = {} & B_0 + B_1\, GPA_i + B_2 MATH_i + B_3\, MAJOR_i + B_4 GENDER_i \\ & + B_5\, TERM_i + B_6 D_{1i} + B_7\, D_{2i} + B_8\, D_{3i} + B_9 REM_i \\ & + B_{10}\, m_1 + B_{11}\, m_2 + e_i \end{aligned} \qquad \text{Formula (2)}$$

where y* is the unobserved latent variable indicating potential letter grades in ECON 310. Specifically the values are

$y = 0$ (or final grade of D) if $y^* \leq 0$ *Formula (3)*
$y = 1$ (or final grade of C) if $0 < y^* \leq m1$ *Formula (4)*
$y = 2$ (or final grade of B) if $m_1 < y^* \leq m_2$ *Formula (5)*
$y = 3$ (or final grade of A) if $m_2 \leq y^*$ *Formula (6)*

Note that m_1 and m_2 denote threshold variables on which letter grades are determined. The remaining variables in equation (2) are defined as follows:

GPA	*= the cumulative grade point average on a 4.0 scale.*
GENDER	*= 1 for male students and 0 for female students*
MAJOR	*= 1 for students majoring in Accounting, Economics, or Finance (AEF), and zero for students majoring in Management and Marketing (MM).*
TERM	*= is a proxy to control for grade inflation and different instructors over the sample period.*
REM	*=1 for students who were required to take a remedial mathematics course (MATH 110 or intermediate algebra) based on university entrance examinations.*
D_1	*= 1 indicates that a student received a final grade of D in ECON 212 (principles of microeconomics), zero otherwise.*
D_2	*= 1 indicates that a student received a B in ECON 212 and zero otherwise.*
D_3	*= 1 indicates that a student received an A in ECON 212 and zero if he or she received a letter grade other than an A.*
MATH	*= the average score on MATH 131 (pre-calculus) and MATH 232 (business calculus) assessment.*

where e_i is a normally distributed error term with a mean of zero and a constant variance. Note that D_1, D_2, and D_3 are included in the model to examine the relationship between the two statistics courses. The m_1 and m_2 terms represent threshold variables (four letter grades less two). Note that only four letter grades are available from the data set as failing grades are not considered. This is because a student is required to repeat ECON 310 if he or she receives a failing grade in the course. A simple linear probability model is ruled out in order to avoid the generation of negative probability variables and negative variances; both of which are unfeasible.

EMPIRICAL RESULTS

The ordered probit model based on equation (2) is estimated using the statistical package (TSP version 4.5, 2002) and the results are reported in Table 1.

Table 1: Estimates of the Ordered Probit Model (Equation 2)				
Variables, Measures	Parameter Estimate	Standard Error	t-statistics	P-value
Constant	-0.688	0.425	-1.620	0.105
GPA	0.150	0.118	1.269	0.205
MATH	0.545	0.092	5.955	0.000
MAJOR	-0.010	0.104	-0.101	0.919
GENDER	0.076	0.106	0.713	0.476
TERM	0.007	0.013	0.573	0.507
D_1	-0.200	0.228	-0.874	0.382
D_2	0.642	0.119	5.390	0.000
D_3	1.642	0.178	9.246	0.000
REM	-0.016	0.113	-0.145	0.885
m_1	1.556	0.090	17.252	0.000
m_2	2.682	0.118	22.626	0.000
Sample Size	488			
Scaled R-square	0.371			
Likelihood Ratio	206.999			0.000
Log-Likelihood Function	-522.249			

In Table 1, student cumulative grade point average (GPA) is only marginally significant and, therefore, is not as important a predictor of the final grade in ECON 310 (p-value = 0.205) as we anticipated. Grade point averages, unlike SAT scores (a good predictor for freshman academic performance), may represent how much effort a student places in a course more than inherent academic ability. We estimated equation (2) replacing GPA with the student SAT score and found that SAT scores were not important in determining the final grade in ECON 310. This is consistent with the notion that as students progress forward of their freshman year, SAT scores and grades are not as closely linked. The ECON 310 course is typically taken by first-semester juniors.

Not surprisingly, mathematical preparation (MATH) plays a significant role in determining academic performance in ECON 310 with a coefficient value of 0.545 (p-value of 0.000). Students with a more proficient mathematics background have a greater probability of earning a higher grade in ECON 310 than those who are less mathematically prepared. As in the Von Allmen and Brower (1998) study, mathematical knowledge plays a crucial role in student performance in intermediate microeconomics. It is important that this portion of our analysis supports their work with a much larger sample size. Related to this, the coefficient on REM was found to be insignificant (p-value = 0.885). As a consequence, no difference in grade pattern is ECON 310 could be attributed as to whether a student was required to take a remedial mathematics course. One would expect that students required to take remedial mathematics (MATH 110) would not do as well in ECON 310 and that the coefficient on REM should be negative. The statistical insignificance of the REM coefficient, therefore, suggests that the MATH 110 course has removed the disadvantage these students had with regard to mathematical ability relevant to ECON 310. This analysis is unique compared to previous work in the economic education literature and lends support to the use of remedial courses to better prepare students for upper-level courses.

The academic major (MAJOR) of a student and the semester ECON 310 is taken by the student (TERM) do not appear to influence the final letter grade in intermediate microeconomics. The insignificance of MAJOR (p-value of 0.919) counters any belief that a particular group of academic majors typically known for more extensive quantitative preparation (accounting, economics, and finance) do not have an advantage over other students (marketing and management majors) with regard to ECON 310 grades. The insignificant coefficient on TERM (p-value of 0.567) is not surprising given that faculty members in the Department of Economics at Clarion University are required to submit their course grade distributions in an attempt to curb any grade inflation or deviations in grades across instructors.

The estimated coefficient on GENDER is positive indicating a male student may have an advantage in obtaining a better letter grade than a female counterpart in this particular course. However, the relationship is not found to be statistically significant (a p-value of 0.476) thereby indicating that gender does not play an important role in predicting final grades in the intermediate microeconomics course. This result contradicts a common belief in education that males outperform females in more quantitatively demanding business and economics courses.

The coefficient of D_1 (the dummy variable of those students receiving a D in ECON 212 relative to those earning a C) is negative but statistically insignificant (p-value of 0.382). While a negative coefficient would imply that students receiving a D in ECON 212 have a lower probability of earning a good grade in ECON 310, the lack of statistical significance implies that the effect is negligible. The coefficients on D_2 and D_3 (D_2 =1 and D_3 = 1 denote students that receive a B or an A in ECON 212 are both significant (p-values of 0.000 for each) and positive. This indicates that students with a better foundation in principles of microeconomics have greater probabilities in obtaining a good letter grade in intermediate microeconomics. The phenomenon of mean reversion (a poor letter grade in principles of microeconomics translating into a better letter grade in intermediate microeconomics and vice versa) does not show up when analyzing our data. Rather, we witness the phenomenon of persistence: those who attain good grades in principles of microeconomics have a greater probability of continued academic success in intermediate microeconomic theory. This result is as puzzling as it is interesting. The persistence phenomenon in academia, unlike that in regression toward the mean, presents problems in economic education: it is more difficult to practice the pedagogical principle of teaching to the mean. It is possible that this result may not be consistent across different types of academic institutions that employ varying admission standards. In addition, this result might change if we knew the number of times students repeated either ECON 212 or ECON 310. Currently, university privacy policy prohibits us from obtaining this type of data.

Finally, significant coefficients on the threshold variables m_1 and m_2 suggest that the use of the four-category ordered probit model is indeed justified. The goodness of fit measure, the scaled R-squared, is preferred for its consistency and marginal measurement (Estrella, 1998). Its value (0.371) is relatively satisfactory in terms of the number of significant coefficients and the likelihood ratio test (p-value of 0.000) confirms that we have a well-specified empirical model.

SENSITIVITY ANALYSIS AND MODEL APPLICATION

The ordered probit model specification allows us to measure how changes in important explanatory variables influence the marginal probability of a student receiving various grades in intermediate microeconomics. For a specific set of values of **X**, we can calculate the initial probabilities to obtain a letter grade in intermediate microeconomics. Letting the cumulative normal function be N(B'X), the probabilities for each grade in ECON 310 can be calculated as below:

Prob [y=0 or D] = N(-B'X) *Formula (7)*
Prob [y=1 or C] = N [m_1 – B'X] - N (-B'X) *Formula (8)*
Prob [y=2 or B] = N [m_2 – B'X] - N (m_1 – B'X) *Formula (9)*
Prob [y=3 or A] = 1 - N (m_2- B'X) *Formula (10)*

where B'X is a set of specific values of X for the estimated coefficients (B) and the threshold values ($m_1$and m_2). For a typical business student, the average values of GPA, MATH, GENDER, MAJOR, TERM, D_1, D_2, D_3, and REM in our sample are 3.046, 2.904, 0.398, 0.457, 6.745, 0.057, 40.4, 15.9, and 0.592 respectively. Substituting these values into Equations (7), (8), (9), and (10), we find the probabilities of obtaining letter grades A, B, C, and D to be 8.44 percent, 48.70 percent, 33.27 percent, and 9.59 percent (this is summarized in Table 2). It is to be noted that those who repeated the course would eventually receive an official letter grade in order to remain in the business program. The actual proportion of students receiving a letter grade of A or B in intermediate microeconomics is approximately 57 percent while the remaining 43 percent received either a C or a D in the course. From experience, this grade distribution would have been different without a substantial grading curve needed to slightly inflate final grades.

Table 2: Student Performance in Intermediate Microeconomics and Marginal Probabilities with Changes in MATH

Grade	Probability of Grade (Equations 7-10)	Marginal Effect for Unit Increase in MATH
A	8.44%	+9.28%
B	48.70%	+12.11%
C	33.27%	-12.94%
D	9.59%	-8.45%

Average values are selected for other explanatory variables. MATH is the average score of MATH 131 (pre-calculus) and MATH 232 (calculus) required of all business majors.

Now that the average grade distribution in ECON 310 has been derived from the model specification, we now proceed with a sensitivity analysis that evaluates changes in grade probabilities in response to changes in continuous explanatory variables. Since mathematical preparation (MATH) is such an important predictor of performance in ECON 310, this is the first such variable we consider. By taking derivatives of equations (7), (8), (9), and (10) with respect to MATH we obtain the following:

$d\{Prob\ [\ Y=0\ or\ D]\}/\ d\{MATH\} =\ - N(B'X)\ (B^*_2)$ *Formula (11)*
$d\{Prob\ [\ Y=1\ or\ C]\}/\ d\{MATH\ \}= [N(-B'X)- N(\mu_1 - B'X)]\ (B^*_2)$ *Formula (12)*
$d\{Prob\ [\ Y=2\ or\ B]\}/\ d\{MATH\} = [N(\mu_1 - B'X) - N(\mu_2 - B'X)]\ (B^*_2)$ *Formula (13)*
$d\{Prob\ [Y=3\ or\ A]\}/\ d\{MATH\} = N(\mu_2 - B'X)\ (B^*_2)$ *Formula (14)*

where N is the normal density function and B^*_2 is the estimated coefficient on MATH in equation (2). Equations (11), (12), (13), and (14) measure the marginal effects of changes in MATH on the probability of obtaining the identified letter grade for the average student in ECON 310. This directly follows work presented in Greene (2003). Note that the sum of the marginal effects must equal zero for consistency. The results indicate that if MATH increases by one unit, probabilities to obtain an A and B are expected to increase by 9.28 percent and 12.11 percent respectively and probabilities to receive a C and D are expected to decrease by 12.94 percent and 8.45 percent respectively (see Table 2). Even though the estimated coefficient on MATH in the ordered probit model is highly statistically significant (the p-value is 0.000), the marginal effects of MATH on grade probabilities appear to be relatively moderate. While this is a measure made under the assumption that all other explanatory variables are fixed, it illustrates one reason why evaluating marginal probabilities is an important addition to significance tests on estimated coefficients when using the ordered probit model.

If, however, a variable is discrete such as dummy variables D_2 and D_3, we must reevaluate equations (7), (8), (9), and (10) with the dummy variables (D's) equal to zero and one before calculating the difference in the two probabilities. In other words, substituting 0 and 1 into the estimated equations and comparing numerical values obtained serves as sensitivity analysis for discrete variables. The results are reported in Table 3.

Table 3: Impacts of Letter Grades in Principles of Microeconomics on Letter Grades in Intermediate Microeconomics

Equation	$D_2 = 0$	$D_2 = 1$	Change	$D_3 = 0$	$D_3 = 1$	Change
Equation (7) P[y=0 or D]	0.1216	0.0394	-0.0822	0.1285	0.0030	-0.1255
Equation (8) P[y=1 or C]	0.5484	0.5406	-0.0078	0.5427	0.1121	-0.4306
Equation (9) P[y=2 or B]	0.2645	0.2278	-0.0367	0.2639	0.3411	0.0772
Equation (10) P[y=3 or A]	0.0655	0.1922	0.1267	0.0649	0.5438	0.4789
D_2 =1 indicates a student receives a letter grade of B in principles of microeconomics.						
D_3 =1 indicates a student receives a letter grade of A in principles of microeconomics.						

An examination of Table 3 indicates that in a principles of microeconomics course, if a typical student received a B ($D_2 = 1$) he or she is expected to have a 12.67 percent greater chance of obtaining an A in intermediate microeconomics. This same student will expect to see his or her probability of obtaining a B, C, or D in ECON 310 diminish by 3.67 percent, 0.78 percent, and 8.22 percent respectively. This clearly suggests that academic performance in principles of microeconomics (a letter grade of B) is at least as important as the average score in the two mathematics courses (MATH) when results are compared. For a student who obtained an A in microeconomic principles ($D_3 = 1$), he or she is expected to perform satisfactorily in intermediate microeconomics as well. Specifically, for a student receiving an A in principles of microeconomics the probabilities of getting an A or B in intermediate microeconomics increase by 47.89 and 7.72 percent respectively while the probabilities of getting a C or D are expected to decrease by 43.06 percent and 12.55 percent respectively. It signals an important message: an A student in principles of microeconomics can expect a higher grade (most likely an A) in intermediate microeconomic theory. This supports the notion of persistence of the grade distribution rather than mean reversion when calculating the marginal probabilities as well as when analyzing coefficients in the ordered probit model.

CONCLUSION

Literature abounds in evaluating the performance in economics courses. The purpose of this paper, however, concentrates on the determinants of performance in intermediate microeconomics, a required course for business majors at Clarion University. A sample of 488 students was used to estimate the ordered probit model: a model appropriate for ordinally scaled data. The results indicate that (i) cumulative grade point average is marginally significant, (ii) average scores of the two math courses is a significant predictor on performance in intermediate microeconomics, (iii) a student who received a D in principles of microeconomics has a tendency to perform poorly in intermediate microeconomics (albeit the relationship is not statistically significant with a p-value of 0.382), (iv) a student who received an A or B in principles of microeconomics is expected to also perform well in intermediate microeconomics (with a p-value of 0.000), (v) taking the remedial math course has little impact on academic performance in intermediate microeconomics, and (vi) coefficients on the threshold variables are highly significant indicating the appropriateness in using the ordered probit model.

The sensitivity analysis conducted suggests that better performance in preparatory mathematics helps students perform better in ECON 310 even at the margin. In addition, prior grades in principles of microeconomics play a critical role in determining final grades in intermediate microeconomics. Given that this relationship remains equally strong when conducting marginal analysis as with analysis of the dummy variable coefficients in the ordered probit model, the persistence hypothesis of grades in principles of microeconomics and intermediate microeconomics holds.

We also found that the remedial mathematics course (intermediate algebra) helps to diminish any handicap these students may have regarding an exceptional lack of initial mathematical preparation needed for intermediate microeconomics. This implies that intermediate algebra is indeed necessary for students placed into lower percentiles in freshmen-level mathematics placement examinations and that the course successfully prepares students for material used in intermediate microeconomics.

All of these results are very encouraging from a pedagogical standpoint in that it tells us that earlier foundation material does matter in looking at student performance in the related upper-level course. There is often a perception that courses in a business college curriculum are disjoint without an established linkage. The strong linkage established here between mathematics, principles of microeconomics, and intermediate microeconomics is an important counter to this perception. Possible extensions of this research include performing a similar type of analysis at other universities with different admission and retention policies and trying to obtain data to incorporate any course repeats students have for the two microeconomics courses.

While results in this study provide insight into the basic learning pattern in microeconomics, it is important to outline some limitations in this analysis. Clearly, selecting all students taking a sequence of courses during a significant period of time provides for a sample size much larger than in related studies. It is equally clear, however, that this does not constitute a true random sample. As a consequence, empirical results should be viewed as biased in a sense that statistical tests utilized assume a sense of randomness in the data collection scheme. Replicating this study at other universities would allow us to provide a random sample and would represent a unique contribution in this area of research. Additionally, the current analysis did not account for differences in the teaching experience among instructors of courses studied. One would anticipate that grade distributions will vary across instructors with different degrees of teaching experience and that this could confound our explanation concerning the grade patterns between courses. While we believe the enforcement of a departmental grade distribution minimizes the possibility of grade variations across instructors, it would be interesting to explore this possibility in future studies.

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