Are Mathematics, Economics, and Accounting Courses Important Determinants in Financial Management: A Rank Order Approach

Rod D. Raehsler¹, Ken Hung², Chin W. Yang³, and Thomas J. Stuhldreher⁴

Abstract

Using an ordered probit model, we examine the determinants of student performance in an introductory, junior level financial management course at a rural state university in the eastern United States. It is discovered that the cumulative grade point average and academic major of a student are marginally significant predictors of that student’s final letter grade in the course. There is a much more significant positive relationship between grades received in two prerequisite mathematics courses and the grade in the introductory finance course. The letter grade received in the prerequisite microeconomics course reveals the phenomenon of persistence in that the probability of obtaining a good grade in the finance course is greater if the student received an A or B in the microeconomics course. Final grades earned in prerequisite accounting courses also influence final grades in the introductory finance class. It is also determined that students who are required to take remedial mathematics are at a disadvantage when taking the introductory finance course.

JEL Codes: C25, I22

Keywords: ordered probit, financial management.

Introduction

All educators are interested in determining or verifying factors that influence student academic performance. The identification of new factors that positively influence this performance can often signal a need for changes in an academic curriculum whereas the empirical establishment of linkages between an important sequence of courses and disciplines that are historically expected can support claims that are often made to students and the maintenance of existing curricula. A great deal more attention has been paid to the empirical analysis of possible determinants of academic performance since the work of Spector and Mazzeo (1980). In their seminal work, they employed a logit model to examine the performance of students in intermediate macroeconomics. The subsequent literature is extensive, including work on principles of economics courses by Becker (1983), Borg et al (1989), Park (1990), Watts and Bossardt (1991), Becker and Watts (1996, 1999, and 2001). Papers on intermediate economics or econometrics are relatively scarce but include Specter and Mazzeo (1980), Ramonda et al (1990), Becker and Greene (2001), and Yang and Raehsler (2005).

While the literature in accounting is mostly limited to gender-related study (Mutchler et al, 1987; Lipe, 1989; Tyson, 1989; Ravenscroft and Buckless, 1992), other studies do exist that focus on income tax

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courses, CPA exams or other related accounting topics (Murphy and Stanga, 1994; Grave et al, 1993; Brahmasrene and Whitten, 2001). In the literature of finance, Berry and Farragher (1987), among others, were the first to survey introductory financial management courses. Since then there have been papers on introductory finance courses (Ely and Hittle, 1990; Paulsen and Gentry, 1995; Chan et al, 1996; Cooley and Heck, 1996; Sen et al, 1997; Chan et al, 1997; Nofsinger and Petry, 1999; VanNess et al, 1999) but no use of more advanced specifications modeling academic performance in any of the existing educational literature. For example, VanNess et al, (1999) employed ordinary least squares and ordered probit models to discover that part-time instructors typically assigned higher grades, cumulative grade point average was a significant explanatory variable for the final grade, and students majoring in either economics or finance had higher average academic performance in the class. In a similar fashion, Sen et al,(1997) identified grade point average, gender, and performance in prerequisite courses as important indicators of final grades in introductory finance. In their work, females tended to outperform males in the sample while grade point average and prerequisite course grades had a positive influence on performance in the finance course. Interestingly, Didia and Hasnat (1998) discovered that female students did not display a grade disadvantage and transfer students may not fare worse than traditional students. A few studies on higher level or graduate finance courses were completed by Rubash (1994), Mark (1998), and Trine and Schellenger, (1999). Trine and Schellenger, (1995) find identify six factors as significant at either ten percent or two percent levels with a coefficient of determination measure of 0.15 in a stepwise multiple regression analysis. Additional work to identify factors in greater detail and with greater precision has not been accomplished in the financial education literature.

Our paper concentrates on the effect of mathematics and economics taken as prerequisites upon the performance in the introductory financial management course (FIN 370), a required course for all business majors at Clarion University. In particular, we are interested in examining a well-known phenomenon of mean reversion in academia (the idea that a higher letter grade in principles of microeconomics leads to a lower grade in FIN 370). Or does an empirical analysis identify “persistence” meaning that a high grade in principles of microeconomics results in a high grade in FIN 370? In addition, we explore the impact of a remedial math course on the letter grades in FIN 370. This is important in determining if remedial math contributes positively to the performance in FIN 370. If so, it is an appropriate prerequisite and confirms the importance of a strong mathematics background in learning introductory concepts in finance. If not, then, in this era of tight budgets and fewer faculty, such remedial coursework could be eliminated. It is important to note at this stage that while the linkage between finance, economics, and mathematics seems inherently obvious, this type of linkage is not always confirmed when actual data is analyzed. Raehsler, Johns, Yang, and Hung (2011), for example, showed that student performance in economics and mathematics courses required for operations management did not provide a statistically strong linkage with final grades. Given the highly mathematical nature of operations management one would anticipate that performance in mathematics, in particular, would be an important variable in determining final grades in the course. As such, it is important to empirically test the relationship of grades in economics and mathematics and how those link to grades in managerial finance rather than assume that the relationship is entirely obvious or unworthy of detailed analysis.

The organization of this paper is as follows: Section II introduces an ordered probit model; Section III presents estimated results of the ordered probit model; and Section IV examines marginal probabilities from changes in mathematics scores and the dummy variables. The conclusion is presented in Section V.

Data Description and the Ordered Probit Model

In this study, students enrolled in managerial finance (FIN 370) from the fall semester of 1999 through the summer session of 2011. As discussed above, FIN 370 is a required core course for all business students in the college and prerequisites consist of two principles of economics courses (macroeconomics and microeconomics) along with an introductory mathematics course, two beginning accounting courses, and business statistics. Academic performance in the principles of microeconomics course is considered here as that course is primarily populated by business college students whereas the principles of macroeconomics course exhibits a student population spread across a wide variety of academic majors. The introductory mathematics courses (MATH 131 and MATH 232) expose students to basic concepts in matrix algebra, linear programming, and financial equations (such as net present value) along with slightly more advanced topics of basic business calculus (simple derivatives). The lengthy time period for this analysis provides a substantial sample of 1452 students enrolled in FIN 370. Variation in grading was
minimal throughout this sample as the same instructor taught the course with identical grading methods each term. This and the large sample size helps in providing robust empirical results using the ordered probit model in this study.

It is well known in the econometric literature that when dealing with qualitative measures such as grades or success and failure, the standard ordinary least squares (OLS) regression technique can produce spurious probability estimates (probabilities that are negative or exceed unity) and negative variances (Greene, 2003). To overcome these shortcomings, a binary probit or logit model, which produces consistent probability estimates, provides a better explanation for two outcomes. When more than two outcomes exist, a model of multiple choices such as a multinomial logit or a similar probit model is often used. However, a multinomial logit or probit model suffers from the “independence from irrelevant alternatives” problem. In other words, odds ratios between outcomes i and j are to be independent of all other alternatives; an extremely restrictive condition placed on the model for most types of data analysis. As a result, we opt for the ordered probit model which takes into account the ordinal nature in the dependent variable (Zavoina and McElvey, 1975). The use of the ordered probit model is justified in the multiple-category case (final letter grades in this study), which is considered ordinal in nature. This phenomenon is particularly true in a state-supported university where “curving” the final letter grade and examinations is more common. As a consequence, the distance between various letter grades (the dependent variable Y) is not a fixed interval. In other words, the difference between an A and a B is not the same as that between a B and a C (and so forth). Very often, a greater degree of grading leniency is given to students performing at the lower end of the grading scale and educators find it more difficult to fail students for a wide variety of reasons (budget conditions at academic institutions, student complaints, and even the human nature of instructors). This greater leniency given to low performers compared to high performers in class makes the distribution of different letter grades generally ordinal in nature. Stated more succinctly, a final grade of A is better than a B, which is better than a C, and so on, however, the measured difference between an A and B and a B and C are not necessarily the same. This being the case, consider a latent regression equation in matrix form: (LEFT OFF HERE)

\[ y^* = x'\beta + \varepsilon \]  

Or in linear form:

\[ Y = \beta_0 + \beta_1 \text{GPA}_i + \beta_2 \text{MATH}_i + \beta_3 \text{MAJOR}_i + \beta_4 \text{GENDER}_i + \beta_5 \text{TERM}_i + \beta_6 D_1 + \beta_7 D_2 + \beta_8 D_3 + \beta_9 D_4 + \beta_{10} D_5 + \beta_{11} D_6 + \beta_{12} \text{REM}_i + \varepsilon_i \]  

Where \( y^* \) = unobserved latent variable of letter grades

\[ y = 0 = \text{D if } y^* \leq \mu_1 \]  

\[ y = 1 = \text{C if } 0 < y^* \leq \mu_2 \]  

\[ y = 2 = \text{B if } \mu_1 < y^* \leq \mu_2 \]  

\[ y = 3 = \text{A if } y^* \geq \mu_2 \]  

and where \( \mu_1 \) and \( \mu_2 \) are threshold values by which expected letter grades in FIN 370 are determined. Individual variable definitions are as follows:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPA</td>
<td>grade point average on a 4.0 scale.</td>
</tr>
<tr>
<td>MATH</td>
<td>average score on two pre-requisite mathematics courses pre-calculus and calculus.</td>
</tr>
<tr>
<td>MAJOR</td>
<td>‘1’ for Management or Marketing majors and ‘0’ for Accounting, Economics and Finance majors.</td>
</tr>
<tr>
<td>GENDER</td>
<td>‘1’ for male students and ‘0’ for female students.</td>
</tr>
</tbody>
</table>
TERM  = ‘1’ for the Fall Semester 1999 and 2 for the Spring Semester 2000 and so on. It captures a trend in grading if any.

\[ D_1 = \text{‘1’ denotes a student received a D or E in Principles of Microeconomics; } D_1 = 0 \text{ implies he or she received a letter grade of other than a D. It is to be pointed out that the letter grade C is used as the reference group.} \]

\[ D_2 = \text{‘1’ denotes a student received a B in Principle of Microeconomics, ‘0’ for other letter grades.} \]

\[ D_3 = \text{‘1’ denotes a student received an A in Principle of Microeconomics, ‘0’ for other letter grades.} \]

REM  = ‘1’ denotes a student was not required to take the remedial math course: ‘0’ if the student was required to take remedial math.

\[ D_4 = \text{‘1’ denotes a student received a D or E in Financial Accounting or ACTG 251, ‘0’ for other letter grades.} \]

\[ D_5 = \text{‘1’ denotes a student received a B in Financial Accounting or ACTG 251, ‘0’ for other letter grades.} \]

\[ D_6 = \text{‘1’ denotes a student received an A in Financial Accounting or ACTG 251, ‘0’ for other letter grades.} \]

\( \epsilon_i = \) Normally distributed residual with a mean of ‘0’ and variance of ‘1’.

**Empirical Results**

Via the use of TSP version 4.5 (2002), we obtain the estimates of the ordered probit model as shown in Table 1.

**Table 1: Estimates of Ordered Probit Model**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t ratio</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-1.324</td>
<td>0.228</td>
<td>-5.817*</td>
<td>0.000</td>
</tr>
<tr>
<td>GPA</td>
<td>0.636</td>
<td>0.075</td>
<td>8.462*</td>
<td>0.000</td>
</tr>
<tr>
<td>MATH</td>
<td>0.470</td>
<td>0.052</td>
<td>8.998*</td>
<td>0.000</td>
</tr>
<tr>
<td>MAJOR</td>
<td>-0.143</td>
<td>0.060</td>
<td>-2.400**</td>
<td>0.016</td>
</tr>
<tr>
<td>GENDER</td>
<td>0.146</td>
<td>0.060</td>
<td>2.431**</td>
<td>0.015</td>
</tr>
<tr>
<td>TERM</td>
<td>-0.010</td>
<td>0.004</td>
<td>-2.924*</td>
<td>0.003</td>
</tr>
<tr>
<td>D_1</td>
<td>-0.152</td>
<td>0.107</td>
<td>-1.412</td>
<td>0.158</td>
</tr>
<tr>
<td>D_2</td>
<td>0.414</td>
<td>0.071</td>
<td>5.860*</td>
<td>0.000</td>
</tr>
<tr>
<td>D_3</td>
<td>0.893</td>
<td>0.111</td>
<td>8.075*</td>
<td>0.000</td>
</tr>
<tr>
<td>D_4</td>
<td>-0.143</td>
<td>0.110</td>
<td>-1.296</td>
<td>0.195</td>
</tr>
<tr>
<td>D_5</td>
<td>0.110</td>
<td>0.071</td>
<td>1.546</td>
<td>0.122</td>
</tr>
<tr>
<td>D_6</td>
<td>0.453</td>
<td>0.095</td>
<td>4.782*</td>
<td>0.000</td>
</tr>
<tr>
<td>REM</td>
<td>0.083</td>
<td>0.043</td>
<td>1.931***</td>
<td>0.053</td>
</tr>
<tr>
<td>( \mu_1 )</td>
<td>1.490</td>
<td>0.058</td>
<td>25.669*</td>
<td>0.000</td>
</tr>
<tr>
<td>( \mu_2 )</td>
<td>2.871</td>
<td>0.074</td>
<td>38.663*</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Dependent variable = letter grade for introductory finance
Number of observations = 1452
Likelihood ratio = 752.364 (p value = 0.000)
Log likelihood function = -1486.48
Scaled R-squared = 0.439
* = significant at 1%
** = significant at 5%
*** = significant at 10%
An examination of Table 1 indicates that the cumulative GPA is significant in explaining the probability of getting a specific letter grade in FIN 370 (a p-value of 0.00). This is not surprising since a mastery of FIN 370 requires a decent grasp of the material presented in the previously completed pre-requisite coursework and a strong academic background. Therefore, it is not surprising that the GPA as a measure of effort plays an important role in the determination of grades in FIN 370. In addition, the average score in the two pre-requisite mathematics courses plays a key role in grade determination (a p-value of 0.00). It appears that topics such as time value of money, risk management and securities valuation which are covered in FIN 370 are much easier to comprehend when the student has the appropriate preparation in algebra and elementary calculus.

It is interesting to note that students majoring in accounting, economics or finance have greater likelihood of obtaining better grades in FIN 370 with a significantly positive relationship (a p-value of 0.016). This may be attributed to the belief that marketing and management disciplines are not as quantitatively oriented as accounting, economics, and finance and, therefore, students majoring in the marketing or management disciplines might not perform as well in FIN 370 because they are self-selected into majors with less emphasis on quantitative methods. Male students (dummy variable GENDER = 1) tend to score better in FIN 370, and the relationship is statistically significant (a p-value of 0.015). This may confirm the conjecture that male students are better equipped with mathematic skills required for FIN 370 or it may display a general difference in interest in finance between genders. The trend variable TERM is included to account for potential grade inflation or deflation over the long sample period and indicates that student average grades in FIN370 has been declining in the sample period (a p-value of 0.003).

The dummy variable D1 (which indicates that the student received a grade of ‘D’ or ‘E’ in principles of microeconomics) is negatively related to the probability of obtaining a better letter grade (in FIN 370) as compared to the reference group of students who received a C in principles of microeconomics. Interestingly, this relationship was not found to be statistically significant (a p-value of 0.158). In contrast, a student was more likely to obtain a better letter grade in FIN 370 if he or she received a B in principles of microeconomics (D2 = 1) and such a relationship was statistically significant (a p-value of 0.000). The same conclusion can be drawn for D3 (D3 = 1 indicates a student obtaining an A in principles of microeconomics) where the p-value was also 0.000. These findings suggest the attribute of persistence in principles of microeconomics and FIN 370 where persistence identifies that a typical student who does well in ECON 212 will have higher probability of doing well in FIN 370 and doing poorly in ECON 212 indicates a greater probability of doing poorly in FIN 370. This means that, if a student has received an A or B in ECON 212, that grade will not cause the student to reduce the effort needed to do well in FIN 370. Instead, the student is expected to get a good grade in FIN 370 as well. In contrast, even though the statistical relationship is not significant, the student who earned a D in ECON 212 was less likely to do well in FIN 370.

In a similar vein, a student who received an ‘A’ in ACTG 251 has a greater probability of earning a better letter grade than those who received a ‘C’ (a p-value of 0.000). The difference for students who earned a B or C is not significant (a p-value of 0.122) as is that between D and C (a p value of 0.195). It appears that the knowledge students obtain in ACTG 251, such as balance sheet and income statement is important in FIN 370 as this relates closely to information presented in capital budgeting. It does not appear that this relation is as significant as the one described in principles of microeconomics throughout the entire grade range.

REM is a dummy variable which indicates whether or not a student is required to take a remedial mathematics course. Remedial mathematics (or MATH 110) is a basic algebra course required of students who come in as freshman and test poorly in mathematics or do not take the mathematics placement test. Since some beginning freshman and transfer students do not take this placement examination despite having reasonable training in mathematics, it is important to include this indicator variable. Using a value of 1 if a student was not required to take remedial mathematics and of 0 if the student was required to , the estimated coefficient for REM is marginally significant (a p-value of 0.053). This reveals that students who are not required to take the remedial math course (REM = 1) have a better chance to do well in FIN 370 as is expected, however, not with the level of significance observed for economics and accounting course grades. Freshman business majors who score unsatisfactorily on the mathematics placement test are required to take the remedial course. Even if students who are required to take remedial math do well in that course, this reveals that those students generally still lack the mathematical competence to master the
quantitative topics in FIN 370. This implies that either these students cannot learn higher level mathematics concepts or that the content of MATH 110 needs to be revamped in such a way that the students can actually apply the material they learn in MATH 110 to FIN 370 and other upper level courses which require mathematical sophistication.

Finally, the estimated coefficients of the two threshold variables ($\mu_1$ and $\mu_2$ or 4 categories minus 2) are all statistically significant indicating that the use of the four category ordered probit model is warranted. This type of empirical result is lacking in most papers utilizing the ordered probit specification but of extreme importance in defending resulting estimates from criticism of the model. The scaled r-squared (0.439) is a better measure of goodness of fit than the McFadden r-squared statistic for its consistency in interpretation (Estella, 1998). The value 0.439 is reasonably satisfactory for models of discrete choice which have an unsettled criterion of fit.

**Applications of the Ordered Probit Model**

For a representative student, average values of GPA, MATH, MAJOR, GENDER, TERM, D_1, D_2, D_3, D_4, D_5, D_6, REM are found to be 2.962, 1.909, 0.517, 0.511, 17.1, 0.092, 0.324, 0.144, 0.094, 0.357, 0.203, 1.093. Substituting these values into Equation (2) yields the expected value of $y = 1.741 = \beta' x$. Coupled with estimated threshold values $\mu_1 = 1.490$ and $\mu_2 = 2.871$, the value of probabilities for an average student to receive a particular letter grade in FIN 370 are shown below:

$$
\text{Prob } [y = 0 \text{ or } D] = \Phi(-\beta' x) \quad \text{........................................... (7)}
$$

$$
\text{Prob } [y = 1 \text{ or } C] = \Phi(\mu_1 - \beta' x) - \Phi(-\beta' x) \quad \text{........................................... (8)}
$$

$$
\text{Prob } [y = 2 \text{ or } B] = \Phi(\mu_2 - \beta' x) - \Phi(\mu_1 - \beta' x) \quad \text{........................................... (9)}
$$

$$
\text{Prob } [y = 3 \text{ or } A] = 1 - \Phi(\mu_2 - \beta' x) \quad \text{........................................... (10)}
$$

In each formula $\Phi$ is the cumulative normal density function. For instance, the probability for a typical student to receive a D or C can be calculated as

$$
p(y = 0, D \text{ or } E) = \Phi (-1.741) \approx 0.0409
$$

and

$$
p(y = 1 \text{ or } C) = \Phi(1.490 - 1.741) - \Phi(-1.741) = 0.3604
$$

The same procedure could be applied to the probability of getting an A or B based on equations (9) and (10). For clarity, we report four such probabilities in Table 2. Since the average score in the two mathematics courses plays a significant role in predicting letter grades in FIN 370, we calculate the marginal probabilities (Greene 2003) as shown below:

$$
\frac{\partial \text{Pr } ob[Y = 0 \text{ or } D]}{\partial \text{Math}} = -\phi(-\beta' x) \ast (\hat{\beta}_2) \quad \text{........................................... (11)}
$$

$$
= -\phi(-1.741) \ast (0.47)
= -0.0878 \ast 0.47
= -0.04123
$$

$$
\frac{\partial \text{Pr } ob[Y = 1 \text{ or } C]}{\partial \text{Math}} = [\phi(-\beta' x) - \phi(\mu_1 - \beta' x)] \ast (\hat{\beta}_2) \quad \text{........................................... (12)}
$$

$$
= (0.0878 - 0.3867) \ast 0.47
= -0.14035
$$

$$
\frac{\partial \text{Pr } ob[Y = 2 \text{ or } B]}{\partial \text{Math}} = [\phi(\mu_1 - \beta' x) - \phi(\mu_2 - \beta' x)] \ast (\hat{\beta}_2) \quad \text{........................................... (13)}
$$

$$
= (0.3867 - 0.2107) \ast 0.47
$$
These probabilities show that students with higher grades in mathematics reduce their probability of receiving a D (-4.123%) or a C (-14.035%) and increase their probability of receiving a B (+8.264%) or an A (+9.8938%). Note that the sum of the marginal probabilities equals zero (see Table 2) and \( \phi \) denotes the normal probability density function, which is required to calculate marginal probabilities (Greene, 2002).

Table 2: Probability and Marginal Probability of Getting Specific Letter Grades in FIN 370 for Typical Student

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Probability</th>
<th>( \frac{\partial}{\partial MATH} p(y) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = D )</td>
<td>4.090%</td>
<td>-4.123%</td>
</tr>
<tr>
<td>( y = C )</td>
<td>36.040%</td>
<td>-14.035%</td>
</tr>
<tr>
<td>( y = B )</td>
<td>46.950%</td>
<td>8.264%</td>
</tr>
<tr>
<td>( y = A )</td>
<td>15.200%</td>
<td>9.894%</td>
</tr>
</tbody>
</table>

As is evident from Table 2, a great majority of students in FIN 370 received a B (46.95%) or C (36.04%). Students who failed the class would have to repeat the course and pass it or drop out of the program and, therefore, do not show up in this sample. It is interesting to note that some students repeated FIN 370 to get a better grade even if they had passed the course the first time with a C or D. The importance of the average score in the two prerequisite mathematics courses cannot be overstated for these grades distinctly show how students improve their chances of getting an A or B while simultaneously reducing their chances of receiving a C or D in FIN 370. The partial derivatives of the cumulative normal density function are valid for a continuous variable (for example, MATH or GPA in this analysis). In evaluating impacts from a dummy variable, however, we need to substitute the value of the dummy variable (zero and one) into (7), (8), (9), and (10) and calculate the probabilities. Since the procedure is one of the least understood of the econometric models involving discrete variables, we report the results for the dummy variable D3 (those who earned an A in ECON 212 versus those who received a C) and REM (those who took the remedial mathematics course against those who did not). The results are reported in Tables 3 and 4 below.

As can be inferred from results displayed in Table 3, an average student who received a letter grade of A in principles of microeconomics had a 25.19% greater chance of earning an A in the introductory finance course and a 4.41% greater probability of earning a B in FIN 370. Likewise, a student earning an A in principles of microeconomics would be 24.84% less likely to earn a C and 4.76% less likely to receive a D in FIN 370. Notice that the sum of the marginal probabilities equals zero so that the sum of probabilities of getting specific letter grades in FIN 370 is one. Similarly, an average student who need not take the remedial math course, MATH 110, has 1.8% and 1.32% more chance of getting an A or B respectively while reducing his or her chance to get a C or D by 2.35% and 0.77% respectively in FIN 370. These are small percentages indicating the remedial mathematics course is not as important (albeit with a p-value of 5.3%) as obtaining high grades in principles of microeconomics. The magnitudes are relatively small, but the effects do exist.
### TABLE 3: Impacts of D3 on the Probability of Getting Specific Grades in FIN 370

<table>
<thead>
<tr>
<th>Value</th>
<th>D3 = 0</th>
<th>D3 = 1</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>- $\beta' x$</td>
<td>-1.612</td>
<td>-2.505</td>
<td></td>
</tr>
<tr>
<td>$\mu_1 - \beta' x$</td>
<td>-0.122</td>
<td>-1.015</td>
<td></td>
</tr>
<tr>
<td>$\mu_2 - \beta' x$</td>
<td>1.259</td>
<td>0.366</td>
<td></td>
</tr>
<tr>
<td>Equation (7)</td>
<td>$\Phi(-1.612) = 0.058$</td>
<td>$\Phi(-2.505) = 0.006$</td>
<td>-4.76%</td>
</tr>
<tr>
<td>Equation (8)</td>
<td>$\Phi(-0.122) - \Phi(-1.612)$</td>
<td>$\Phi(-1.015) - \Phi(-2.505)$</td>
<td>-24.84%</td>
</tr>
<tr>
<td>Equation (9)</td>
<td>$\Phi(1.259) - \Phi(-0.122)$</td>
<td>$\Phi(-0.366) - \Phi(1.015)$</td>
<td>4.41%</td>
</tr>
<tr>
<td>Equation (10)</td>
<td>1 - $\Phi(1.259) = 0.104$</td>
<td>1 - $\Phi(-0.366) = 0.356$</td>
<td>25.19%</td>
</tr>
</tbody>
</table>

D3 = 1 means received an A in principles of microeconomics. Rounding errors to the third decimal place occurred since we used the cumulative normal table which contains z-values with two decimal places.

### Table 4: Impacts of Remedial Math on the Probability of Getting Specific Grades in FIN 370

<table>
<thead>
<tr>
<th>Value</th>
<th>Remedial = 0</th>
<th>Remedial = 1</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>- $\beta' x$</td>
<td>-1.650</td>
<td>-1.733</td>
<td></td>
</tr>
<tr>
<td>$\mu_1 - \beta' x$</td>
<td>-0.160</td>
<td>-0.243</td>
<td></td>
</tr>
<tr>
<td>$\mu_2 - \beta' x$</td>
<td>1.221</td>
<td>1.138</td>
<td></td>
</tr>
<tr>
<td>Equation (7)</td>
<td>0.050</td>
<td>0.042</td>
<td>-0.77%</td>
</tr>
<tr>
<td>Equation (8)</td>
<td>0.387</td>
<td>0.363</td>
<td>-2.35%</td>
</tr>
<tr>
<td>Equation (9)</td>
<td>0.452</td>
<td>0.466</td>
<td>1.32%</td>
</tr>
<tr>
<td>Equation (10)</td>
<td>0.111</td>
<td>0.129</td>
<td>1.80%</td>
</tr>
</tbody>
</table>

Remedial = 1 means student was not required to enroll in remedial mathematics. Rounding errors to the third decimal place occurred since we used the cumulative normal table which contains z-values with two decimal places.
Performance in the introductory accounting course (ACTG 251) plays an important role on letter grades of FIN370 as well. Knowledge of balance sheets and income statements is necessary to understand capital budgeting and other financial ratios. Receiving an A in ACTG 251 (or $D_6=1$) has a noticeable effect in the regression ($p$-value $= 0.00$). Again, we calculate the relative impacts of a student who received an A in ACTG 251 on letter grades he or she will receive in FIN370. These results are reported in Table 5 and a more detailed examination indicates that a student with “A” in ACTG 251 has 10.94% or 6.01% greater chance of earning an A or B respectively in FIN370 while the same student has a 13.79% and 3.16% smaller chance of receiving a C or D in the finance course.

Table 5: Impacts of Financial Accounting or $D_6$ on the Probability of Getting Specific Grades in FIN 370

<table>
<thead>
<tr>
<th>Value</th>
<th>$D_6 = 0$</th>
<th>$D_6 = 1$</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>$- \beta' x$</td>
<td>-1.649</td>
<td>-2.102</td>
<td></td>
</tr>
<tr>
<td>$\mu_1 - \beta' x$</td>
<td>-0.158</td>
<td>-0.612</td>
<td></td>
</tr>
<tr>
<td>$\mu_2 - \beta' x$</td>
<td>1.222</td>
<td>0.769</td>
<td></td>
</tr>
<tr>
<td>Equation (7) $P[y=0 or D]$</td>
<td>0.050</td>
<td>0.018</td>
<td>-3.16%</td>
</tr>
<tr>
<td>Equation (8) $P[y=1 or C]$</td>
<td>0.391</td>
<td>0.253</td>
<td>-13.79%</td>
</tr>
<tr>
<td>Equation (9) $P[y=2 or B]$</td>
<td>0.448</td>
<td>0.509</td>
<td>6.01%</td>
</tr>
<tr>
<td>Equation (10) $P[y=3 or A]$</td>
<td>0.111</td>
<td>0.221</td>
<td>10.94%</td>
</tr>
</tbody>
</table>

$D_6 = 1$ signifies that student received an A in ACTG 251.

Conclusion

This paper focuses on the impact of mathematics, economics and accounting preparation on the grades earned in junior level introductory finance by the typical business student at a rural state university in the eastern United States. The ordered probit model of a large sample ($n=1452$) indicates that the average score in the two mathematics prerequisite courses is a significant predictor of performance in FIN 370. Grade point average, an effort variable, is found to be significant as is the student’s academic major; an accounting, economics or finance major has a better chance to perform better than, on average, students with other majors in the college of business. Gender is found to be an important explanatory variable as male students are found to outperform female students in FIN 370, however, overall average performance in introductory finance has deteriorated over time.

An important finding central to this analysis is that a student with an A or B in principles of microeconomics has greater probability of getting a better grade in FIN 370 and this relationship is statistically significant. The implication is that there appears to be a phenomenon of “persistence” in student performance: those who performed well in prerequisite principles courses will continue to do well in FIN 370. In addition, students who took the remedial mathematics course did not perform as well in FIN
compared to those who did not take the course, however, the magnitudes of this relationship are relatively small when compared to the prerequisite courses for FIN 370. This may suggest a need for more coordination regarding topical coverage between the mathematics and finance departments or it could mean that remedial mathematics students lack the ability to grasp the necessary mathematical concepts. Alternatively, it may mean that at least some of these students are less motivated to work hard in math courses. Determining which of these is the case will make for interesting future research. Finally, a student with an ‘A’ in ACTG 251 has much better chance to earn an ‘A’ or ‘B’ and less likely to receive a ‘C’ or ‘D’ in FIN370.

The importance of mathematics, economics, and accounting to the expected final grade for students in managerial finance verifies the strong theoretical and quantitative linkage between these disciplines. This overall result has direct implications as to how academic achievement in finance can be improved by promoting a strong business curriculum that encourages a strong foundation in quantitative prerequisites. Future work will focus on differences among genders with regard to academic achievement in introductory finance in addition to the relative decline in academic performance observed over the time period of this study. Gender differences in performance might be linked to variable abilities in mathematics while declining achievement over time could reflect a change in overall academic preparedness among incoming students.

References


