Can first exam grades and mathematical preparedness predict success in managerial finance?

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ABSTRACT

This study examines whether the first exam grade in a managerial finance course is a significant predictor of a student's final course grade. Mathematical preparedness, measured by grades and number of times required to pass college algebra and business calculus, was also investigated. The data include observations from 214 students from a medium-sized AACSB accredited school of business over the 2016-2017 academic year. Using a measure of pass/fail, the first exam score correctly predicted the course outcome for 87% of the students. Regression analysis confirmed that Exam 1 (administered one month after the start of the semester) was statistically significant as a predictor of final course grade. Performance in prior mathematical courses was also deemed a significant predictor of success.

Keywords: finance, algebra, calculus, academic success
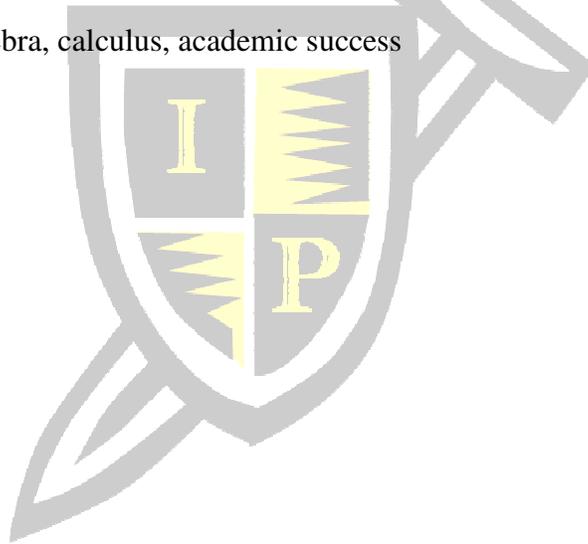
INTRODUCTION

It is a long held belief that a student's grade on the first exam is an excellent predictor of a final course grade. This is especially true in a course where knowledge is cumulative – understanding of the fundamentals covered in the early part of a course is necessary for understanding more complex concepts later. Research from the science and engineering disciplines shows this to be true (Ramanathan and Fernandez, 2017; Jensen and Barrow, 2014). The same is thought to be true in business schools, where finance is a course where a strong foundation is required for further study. Students view finance as a barrier to graduation and often must take the class multiple times. Faculty is disturbed by the high rate of failure in managerial finance, a part of each student's core curriculum. Instructors of finance courses complain of ill-prepared students, unable to even perform simple algebraic tasks. Not surprisingly, statistics show that algebra is the most frequently failed course on college campuses (Berry, 2003; Cortez-Suarez, 2005; Duncan and Dick, 2000; Parker, 2005). If students are struggling with math, they are unlikely to understand the analysis and conceptual framework of finance. Therefore, when it is time for students to provide analysis of such calculated measures (i.e. "to connect the dots"), they cannot, as they are overwhelmed by the arithmetic. Johnson and Kuennen (2006) expound that the "importance of mathematics skills may go beyond merely the ability to do the calculations, and also influence the ability to analyze data, reason quantitatively, and interpret the results of numerical computations."

Therefore, this study aims to address the following: Are first exam grades in a managerial finance course a good predictor of a student's final course grade? Furthermore, what role does a student's grades in college mathematics play in their success in finance? If we can pinpoint the predictors of those that will struggle, early remediation can likely make a difference. Thus, it is posited that a student's final grade in a managerial finance course is forecasted by their first exam grade and/or prior performance in their college math courses.

LITERATURE REVIEW

Many studies have examined various predictors upon college academic success, such as admissions criteria (Roseanu and Drugas , 2011; Mattson, 2007), ACT score (Delong, 1986), high school GPA (Williford, 2009), and ethnicity (Zwick and Sklar, 2005). These factors can be observed before the student sets foot in a college classroom. This study is different: it focuses on predictors that occur after the student arrives on campus, namely early exam performance and a student's mathematical preparedness, to predict the student's final course grade in finance.

First Exam Grades

While professors may verbally encourage students to exert the effort necessary to do well on course exams, very few studies have examined the statistical predictability of the importance of doing well early in a course. Marbouti, Diefes-Sux and Madhavan (2016) use seven different predictive modeling methods to identify at-risk students during week 5 of a first-year engineering course at a large university, concluding that the Naïve Bayes Classifier and Ensemble models produced the most accurate results. Rather than score-based performance data, standards-based grading was used in each of the models.   Jensen and Barrow (2014) research the ability of midterm and first-exam grades to forecast final grades in a multitude of biology

courses, at different levels, in public and private universities. They find, regardless of the data subset, "students' final grades in biology courses are forecasted by both midterm and first-exam grades." Bolstered by this information, "instructors can explain to students, perhaps on the first day of class, that the grades earned early in the course will strongly predict their final grades." Unfortunately, many students "are accustomed to performing well . . . because of their experiences in high school" (Jensen and Moore, 2008b), and "they often overestimate their final grades in college, even despite poor performance" (Jensen and Moore, 2008a). Such students should be encouraged to drop the class before it negatively affects their GPA. Ramanathan and Fernandez (2017) focus on the benefit of the predictability of early assignment scores on final course grade.   At-risk students are identified so "educators and counselors can intervene and help these students to achieve better academic performance, [helping] students graduate on time and to score better grades in each course they undertake." In turn, universities "need to implement new effective and efficient strategies to improve retention, completion, and graduation rates." While Ramanathan and Fernandez found that early assignment grades accurately predicted final course grade, the "early predictor" did not occur until mid-term or later. According to Kuh (2005), "It is too late to wait until midterm exam time to give students an idea of how well they are performing. . . the system simply cannot respond quickly enough to help student salvage a poor semester if they need to wait until well beyond the midpoint of the semester before someone contacts them to formally suggest they need immediate attention to their academic work."

Mathematical Proficiency

Johnson and Kuennen (2006) identify the determinants necessary to achieve academic success in an introductory business statistics class. The most important indicators were "student gender, GPA, ACT science score and the score on a quiz of basic math skills." Ely and Hittle (1990) attempt to document the importance of math skills; surprisingly, the impact of a student's math background was not related to their performance in a basic finance class.

However, antidotal evidence from business school professors tells us most students are unprepared for the mathematical demands of finance courses. While a degree in finance promises a high rate of job placement (with an accompanying healthy compensation package), it is the least popular major in many business schools. A majority of students opt for soft majors in marketing, management or general business. Unfortunately, "students who major in general business and marketing are more likely to be unemployed or underemployed, meaning they hold jobs that don't require a college degree. They also earn less than those in more math-focused business majors, such as finance and accounting" (Selingo, 2017). However, all College of Business majors require fluency in finance, usually acquired in one class (perhaps, 2). Of course, finance majors take multiple courses to increase their depth of knowledge in the discipline. House (2000) found that both a student's academic background and their own "self beliefs" were significant predictors of academic achievement in math. Hunt (2011) investigated various predictors of a student's performance in developmental math. These predictors were divided into 3 categories – those related to the student, the instructor and the classroom. He found the strongest predictor was a pre-test administered before the student entered the course.

STUDY DESIGN

There has been no research examining whether academic achievement on the first exam in a financial management course is a predictor of final course grade. Furthermore, does a student's performance in his college mathematics courses also serve as a predictor of success in financial management?

At a medium-sized regional university (student population 6,500) with an AACSB accredited College of Business, faculty acknowledged the high rate of failure in the financial management course. In order to earn a baccalaureate, students must demonstrate a mastery of this subject – which is evidenced by a "C" or better. Students must have earned at least 54 of non-developmental coursework to be admitted into the class. Also, a "C" or better must have been earned in the following business prerequisites: micro- and macroeconomics, statistics, financial (or managerial) accounting.

The data include observations from 214 students from the university's school of business over the 2016-2017 academic year. Various professors taught the course during the time examined, and the same textbook was utilized covering the same material. Students attended two, 1.5-hour lectures per week for 15 weeks. Power point presentations were used and made available to students; the instructors worked many problems in-class to stress the importance of the topics. Structured homework assignments using the textbook's learning management system were selected to prepare students for the course's first exam. Exam one occurred within one month of the start of each semester (well before the university's drop date), and included the following concepts: financial statement construction/analysis and the time value of money, as well as some basic topics such as business organizational structure and the role of finance in such organizations. Students were allowed to use a financial calculator during the exam, but formula sheets were prohibited. Exam 1 represented approximately 17% of the total points available in the course.

However, in the program examined, there are pre-requisites to the pre-requisites: a "C" or better must be earned in college algebra and business calculus before advancing into business courses. As such, the business school's undergraduate curriculum committee began investigating complaints from instructors of mathematically based courses within the college: students were unprepared, unable to even perform simple mathematical tasks. College algebra and business calculus are part of the student's general education and taught by instructors in another college on campus during a student's freshman experience. Unfortunately, some students must take these classes several times to meet these requirements, prolonging their entry into the business school. If these students can be identified, perhaps early intervention can make a difference and keep them on track to graduation. The committee was considering introduction of a second algebra course and elimination of the business calculus requirement, as Johnson and Kuennen (2006) "find that neither taking calculus nor ACT Math score has a significant effect on [statistics] course performance." However, most peer and aspirant business schools require successful completion of business calculus before proceeding with business courses.

It is posited that these issues – Exam 1 grades and mathematical preparedness - are somehow related and have an effect on financial management course grades.

MODEL SPECIFICATION AND EMPIRICAL RESULTS

For this study, final course letter grades are converted to the standard 4.0 grading scale. Furthermore, Exam 1 grades are also converted to ordinal numbers instead of using raw scores, where 100-90% = A (4 points), 89-80% = B (3 points), and so on. The initial null hypothesis tested is as follows: first exam grades in a managerial finance course do not accurately predict a student's final course grade. Regression analysis tests Model 1:

$$FMGRADE = B_o + B_1(EXAM1GRADE)$$

where:

FMGRADE =   final course grade in financial management (A=4, B=3, C=2, D=1, F and W=0), and

EXAM1GRADE =   financial management exam 1 grade (A=4, B=3, C=2, D=1, F=0).

The second null hypothesis states that the grade and effort involved (measured via the number of times required to achieve a passing grade) in math prerequisites have no bearing on a student's course grade in financial management. This is Model 2:

$$FMGRADE = B_o + B_2(ALGGRADE) + B_3(CALGRADE)$$

where:

ALGRADE =   grade in college algebra (ACT credit=5, A=4, B=3, C=2) / number of times required to pass with C or better, and

CALGRADE =   grade in business calculus (A=4, B=3, C=2)/number of times required to pass with C or better.

Since both college algebra and business calculus classes require a "C" or better before moving forward in the student's degree plan, we incorporate the number of times the student must take each class in order to meet this threshold, as some students take must college mathematics several times. This is achieved by dividing the point value of their grade by the number of times they enrolled in the course to achieve a passing grade. The higher this ratio, the more mathematically adept the student. Also, the university surveyed grants credit in college algebra to students who score 23 or higher in mathematics on their ACT Exam. Hence, those testing out of college algebra are assigned a numerical grade equal to 5 and the number of times algebra is attempted 1 (since we cannot divide by zero).

Finally, all variables appear in Model 3:

$$FMGRADE = B_o + B_1(EXAM1GRADE) + B_2(ALGGRADE) + B_3(CALGRADE)$$

We expect to see a positive relationship between all of the independent variables and the final course grade.

Table 1 (Appendix) presents some descriptive statistics of the sample. Examination of a binary measure of pass/fail on Exam 1 (where an A, B, or C is regarded as a passing grade) finds the first exam score correctly predicted the course outcome for 87% of the 214 students (an A, B, or C is a passing course grade; a D, F or W is considered a failing grade, as the student must take the course again). Specifically, seventy-six students earned a D or F on Exam 1. Fourteen then withdrew from the course, but 38 remained in the course and failed. However, twenty-four overcame a lackluster performance on Exam 1 to pass the course (i.e., they moved up 1 to 2 letter grades); further investigation revealed that 100% of this subgroup were enrolled in financial management for the first time and close to 50% tested out of college algebra or earned an A during their first attempt. Of the fourteen that took an early withdrawal, four possessed these same characteristics. In other words, close to 30% that threw in the towel early may have had a shot at passing. None of the 38 that eventually failed bore those qualities. In all, Table 2

(Appendix) shows the percentage of students whose grades improved or declined after Exam 1. These changes appear approximately normally distributed; furthermore, a student's exam 1 grade did not change more than two letter grades.

The empirical results used to predict student performance in financial management can be found in Table 3. According to Models 1 and 3, a student's score on Exam 1 is a strong predictor of overall course performance, even when less than 20% of each student's grade was determined ($p<0.01$). Theoretically, even if a student scored 0% on Exam 1, they could rebound and earn a "B" if they earned 100% on all the other assignments in the class. Practically, that is highly unlikely as noted by Jensen and Barron (2014), "students' performances throughout semester quantitatively mirrored their first exam grades. . . .Students earn their eventual grades early in the course and continue to earn similar grades throughout the course." However, performance in prior mathematical courses provides an unexpected indicator. Model 2 indicates success in college algebra is not the predictor of success in financial management as initially believed, but performance in business calculus is statistically significant ($p< 0.01$). Furthermore, the constant term is insignificant, indicating all variation is captured via the independent variables. Model 3 confirms the significance of Exam 1's score and grade/effort in business calculus upon the final course grade. While all regression models are significant according to their F values, the R^2 values for Models 1 and 3 are relatively high – close to 60%.

CONCLUSION

This study examines whether the first exam grade in a managerial finance course is a significant predictor of a student's final course grade. We also investigated whether achievement in college math (algebra and business calculus) translated into success in financial management. Two hundred fourteen students at a medium-sized regional university with an AACSB accredited College of Business were examined. Regression analysis confirmed that Exam 1 administered one month after the start of the semester was statistically significant as a predictor of final course grade. Performance in prior mathematical courses was also significant. However, performance in business calculus was a stronger predictor than performance in algebra. This is surprising as the college's undergraduate curriculum committee considered eliminating the calculus requirement. Therefore, the recommendation made to strengthen performance in financial management is to retain the business calculus course, as business calculus may act as a proxy for critical thinking and problem solving. Of course, college algebra is retained, as well. Furthermore, instructors of financial management must emphasize from day 1 how exam 1 performance is a harbinger of performance in the course. These predictors of success help improve placement of students, or at least identify those that need help to succeed. Remediation/intervention is suggested after one or both of the following: (1) before/during business calculus, (2) after financial management exam 1, but before exam 2. Knowing these predictive qualities can help identify at-risk students. Such measures will likely improve the student's probability of success in the financial management course and keep them on track to graduation.

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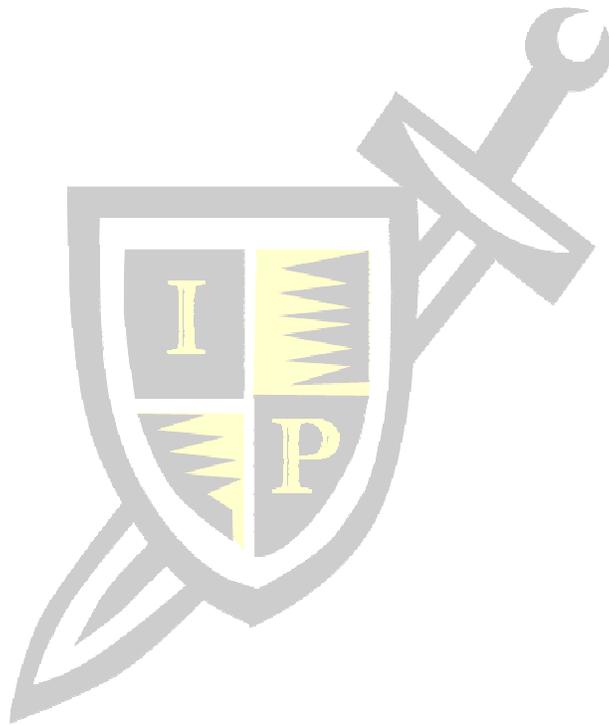
APPENDIX

Table 1: Descriptive Statistics of Sample, N = 214

Statistic	Financial management exam 1 grade (raw score)	Financial management exam 1 grade (EXAM1GRADE)	Financial management final course grade (FMGRADE)
Mean	74.444	2.229	2.257
Standard Deviation	19.586	1.485	1.385
Median	80.000	3.000	2.000
Mode	90.000	4.000	2.000
Maximum	100.00	4.000	4.000
Minimum	15.000	0.000	0.000

Statistic	College algebra final course grade	Number of times required to pass college algebra
Mean	3.650	0.743
Standard Deviation	1.272	0.759
Median	3.500	1.000
Mode	5.000	1.000
Maximum	5.000	3.000
Minimum	2.000	0.000

Statistic	Business calculus final course grade	Number of times required to pass business calculus
Mean	2.771	1.308
Standard Deviation	0.756	0.656
Median	3.000	1.000
Mode	2.000	1.000
Maximum	4.000	5.000
Minimum	2.000	1.000

Table 2: Change in grades between Exam 1 and final course grade

Change	Percent
Up 2 letter grades	9%
Up 1 letter grade	13%
Unchanged	53%
Down 1 letter grade	19%
Down 2 letter grades	6%

Table 3: Regression Results – FMGRADE as dependent variable (t-statistics in parentheses)

Variable	Model 1	Model 2	Model 3
Constant	0.664 (5.959)***	0.378 (1.456)	0.080 (0.423)
EXAM1GRADE	0.706 (16.966)***		0.639 (14.550)***
ALGGRADE		0.179 (3.018)***	0.061 (1.408)
CALGRADE		0.510 (5.678)***	0.213 (3.174)***
R^2	57.01	21.67	59.46
F	287.84***	29.46***	103.66***
N	214	214	214

NOTE: t-statistics are in parentheses, *** denotes significance at 1%.