

Do Students with Grades Curved in Mathematics Prerequisites Perform Better or Worse in Business Finance?

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Introduction

Business finance, the first required finance course for business majors, is arguably one of the most difficult courses in a typical business program. Successful performance in this course requires good quantitative and analytical skills developed from a background in mathematics, accounting, and economics, as well as an understanding of financial terminologies. For this reason, students are generally required to complete prerequisites in mathematics, accounting, and economics prior to enrolling in business finance.

Research studies have examined the determinants of student performance in the undergraduate business finance course. Didia and Hasnat (1998) find that aptitude as measured by cumulative grade point average (GPA), background as measured by average grades in accounting prerequisites, economics prerequisites and high school mathematics, maturity as measured by age, and effort as measured by hours of study are significant determinants of student performance in the introductory finance course. Borde, Byrd, and Modani (1998) find that gender, transfer status, cumulative GPA, hours of work, and average grade in prerequisite accounting courses are significant determinants of student performance in introductory corporate finance course. A recent study by Terry (2002) finds that student performance in the introductory corporate finance course is significantly related to gender, major, exam-type, grades in prerequisite classes, cumulative GPA and to whether the course is taken during the summer.

In light of the importance of the mathematics preparation, some studies focus on the relationship between the mathematics background and student performance in business finance. Ely and Hittle (1990) find that performance in business finance is improved by completing accounting courses but is not influenced by mathematical background. Cooley and Heck (1996) find that 80% of the faculty in the survey only cover six concepts in “much detail”: present/future value of single sums and annuities, net present value, internal rate of return, stock valuation and bond valuation. Those six finance concepts require the use of basic mathematical skills. Pritchard, Romeo, and Saccucci (2000) find that student test scores in basic algebra and basic computation skills are positively correlated with student performance in the principles of finance course. Marcal and Roberts (2001) find that students who satisfy the business statistics requirement receive higher grades than those who do not.

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Some studies provide suggestions about how to improve student performance in business finance. Clark and Webster (1995) investigate whether addition in-class time specifically designated to reinforce quantitative work would improve student performance in the introductory finance course. They find that adding instruction time by one credit hour per semester improves performance for students performing at average or below-average levels, but does not materially influence the performance of the above-average and superior students. Pritchard, Romeo, and Saccucci (2000) mention two recommendations from their reviewers. One is to systematically test students the quantitative materials at the beginning of the Principles course. The other is to work more closely with the Mathematics Department to adjust the quantitative course to better prepare business students e.g., devote more time to the review of basic algebra concepts.

This study is a continuation of research to determine ways to improve student performance in business finance. It focuses primarily on student competency in two quantitative courses (college algebra and business statistics) as explanatory variables to examine the student performance in business finance. Since those quantitative courses are difficult and challenging to most of the students, it is likely in many cases that some instructors would “curve” students’ grades. Curving student’s grades in those courses may send an unintended and erroneous message about student mathematical background to business finance instructors. Thus, this study takes a closer look at whether such curving is associated with performance in business finance. Finally, this study also considers some other student demographics variables that have not been examined in the finance education literature.

The remainder of the paper is organized as follows. Section II describes the data, the variables used in the estimation, and the preliminary data analysis. Section III describes the regression models and presents the empirical results. Section IV offers a summary and conclusions.

Data and Preliminary Analysis

This study is conducted at a four-year state university in Appalachian region. The College of Business, recently accredited by the AACSB International, is organized into three departments: the Department of Accounting, Economics, and Finance, the Department of Information Systems, and the Department of Management, Marketing, and Real Estate. Business finance (FIN 360) is an introductory finance course and is a required core course for all business majors. Students are required to complete six homework assignments (20 points each), one project (100 points), eleven quizzes (10 points each), and four examinations (100 points each; three non-cumulative examinations and one comprehensive final examination). The three non-cumulative exams reflect the content in quizzes and homework assignments. The comprehensive final examination reflects the content in the three non-cumulative examinations. Formulas are given in all exams. One exam and three quizzes with the lowest scores are dropped. Students’ final grades are calculated by dividing students’ accumulated scores with total possible score of 600. According to the advised course taking sequence, business students are required to take college algebra (MATH 152)

in the freshman year and business statistics (MATH 354) in the sophomore year. MATH 152 is a prerequisite for FIN 360, but MATH 354 is not.

Students in four sections of FIN 360 in the spring and fall semesters of 2005 are the subjects of this empirical study. One hundred and six students were officially enrolled. A survey with questions covering various areas in student characteristics, academic background, and learning experience was given. Ninety students took the survey. Table 1 shows the description of the variables used in this study.

Descriptive statistics of the sample appear in Table 2. As the table indicates, the mean course grade is about 73% or a low "C", but the range is sufficiently wide (from 1% to 99%) to provide a meaningful analysis. The mean age of students is 23 years with the range from 20 to 42 years. The sample is almost evenly split between male and female students, though there are a few more females than males. Seventy-seven percent of the students are in-state students. The sample is classified into accounting and finance (32%), information system (20%), and management, marketing and real estate (48%). The mean grade point average is 3.05 with the range from 2 to 4. The mean ACT (American College Testing) score of students is 21.68. Thirty percent of the students are transferred students, and twenty-seven percent of the students live on the campus. Fifty-six percent of students have a job while taking FIN 360, and their average number of hours worked in a week is almost 14. The mean course grade in MATH 152 is 2.6 or in a "C" range, and thirty-two percent of students indicate that their MATH 152 instructors curve grades. Almost seventy-five percent of students have taken business statistics or take business statistics concurrently with FIN 360. The mean course grade in MATH 354 is 2.7, and thirty-two percent of students indicate that their MATH 354 instructors curve grades.

Table 3 shows the frequency distribution classified by age, gender, major, transfer status, and grades in college algebra and business statistics. The means and the standard deviations of the student performance were calculated. In AGE classification, students who are 21 years old have the best performance in the classes. Students who are 22 years old have the worst performance in the classes. The distribution shows a negative relationship between student age and student performance. In GENDER classification, female students performed better than male students, but the difference in means is not significant in t-test. In MAJOR classification, students with a major in management, marketing, or real estate have the best performance in the class, whereas students with a major in information system have the worst performance in the class. In TRANSFER STATUS classification, transferred students do not perform better than non-transferred students. The difference in means is not significant, however.

The following two panels show the relationship between the performance in college algebra or business statistics and performance in business finance for the sample. In MATH 152 grade classification, students who get an "A" in college algebra have the best performance, whereas students who get an "E" in college algebra have the worst performance. The frequency distribution also shows a positive relationship between performance in college algebra and performance in business finance. In MATH 354 grade classification, students who have taken the business statistics have better performance than

students who have not taken business statistics or are taking concurrently with business finance. The t-statistic for testing the difference in means is -2.69 and is significant at 1% level. Of the students who have taken the business statistics, students who have an “A” in the business statistics have the best performance, whereas students who have a “C” in the business statistics have the worst performance. The relationship between performance in business statistics and performance in business finance is similar to the relationship between college algebra and business finance.

Regression Analysis and Results

Numerous finance education studies examining the factors that affect student performance in introductory finance course use the standard production function approach, where output is the grade received and inputs are factors incorporating student characteristics such as maturity, background, aptitude, and effort. Since the dependent variable (FIN360) in this study is continuous in nature, the ordinary-least-squares regression analysis is employed. The independent variables were described in Table 1. The variable denoting the students with Information system major (IS) is dropped for avoiding the dummy variable trap.

Table 4 reports the regression results. Equations (1) and (2) focus on the relationship between performance in college algebra and performance in business finance. The number of observations in the estimations is 73. The F-statistics to test the null hypothesis that regression coefficients are jointly equal to zero can be rejected at 1% level. The overall fits, as reflected in the R^2 , are good. The variance inflation factors for all independent variables in both equations are less than 10, suggesting that there is no severe multicollinearity.

Turning to individual estimates, the coefficients of M152G are positive and significant at 5% level in Equation (1) and at 10% level in Equation (2), suggesting that students who have higher grades in college algebra perform better in business finance than those who have lower grades in college algebra. The interaction term, $M152G \times M152C$, is employed to measure whether there is any difference in performance between students who have and who do not have their grades curved in college algebra. The coefficient of the interaction term in Equation (2) is positive but insignificant, suggesting that there is no difference in performance between students who have and who do not have their grades curved in college algebra.

The coefficients of GPA are positive and significant at 1% level, suggesting that students with higher GPA prior to the enrollment in FIN 360 have better performance than those with lower GPA. The coefficients of ACT are negative but insignificant, suggesting that students' performance on ACT cannot determine their performance in business finance course.

The coefficients of FROM are negative and significant at 5% level, suggesting that in-state students do not perform as good as out-of-state students. The coefficients of MMR are positive and significant at 5% level, suggesting that management, marketing, or real estate students perform better in FIN 360 than computer information system students. The coefficients of AF are also positive but insignificant, suggesting that there is no difference in performance between accounting or finance students and information system students.

The coefficients of AGE have negative sign but not significant, suggesting that there is no difference in performance between older and younger students. The coefficients of GENDER are negative but insignificant, suggesting that there is no difference in performance between male and female students. The coefficients of TRANSFER are negative but insignificant, suggesting that there is no difference in performance between transferred students and students starting at the university. The coefficients of CAMPUS are positive but insignificant, suggesting that there is no difference in performance between students who live on campus and students who commute to school from their homes. The coefficients of WORKHR are positive but insignificant, suggesting that there is no difference in performance between students who work and students who do not work.

In Table 4, Equations (3), (4), and (5) focus on the relationship between performance in business statistics and performance in business finance. The number of observations in the estimations is 80 for Equation (3) and 64 for Equation (4) and (5). The F-statistics to test the null hypothesis that regression coefficients are jointly equal to zero can be rejected at 1% level only in Equation (3). The overall fits, as reflected in the R^2 , are good. The variance inflation factors for all independent variables in both equations are less than 10, suggesting that there is no severe multicollinearity.

In Equation (3), the signs and the coefficients for MMR and GPA are quite similar to the results in Table 4. Focusing on M354DUM, the coefficient is positive and significant at 1 percent level, suggesting that students who take business statistics have better performance than those without having business statistics. GPA is the only variable significant in Equation (4) and (5). The coefficients of M354G are positive but insignificant, suggesting that there is no difference in performance between students who have higher grades and students who have lower grades in business statistics. The interaction term, $M354G \times M354C$, is employed to measure whether there is any difference in performance between students who have and who do not have their grades curved in business statistics. The coefficient of the interaction term in Equation (5) is positive but insignificant, suggesting that there is no difference in performance between students who have and who do not have their grades curved in business statistics.

Conclusions

This study employs regression techniques to determine whether there is a relationship between performance in mathematics courses (college algebra and business statistics) and performance in business finance, and whether students have their grades curved in the mathematics courses has any impact on the performance in business finance. The results indicate that students who earn higher grades in college algebra perform significantly better than those who do not. There is no significant difference in performance between students who have their grades curved in college algebra and students who do not. Students who fulfill the business statistics perform significantly better than those who do not. Among students who complete the business statistics, those with higher business statistics grades perform insignificantly better in business finance. There is no significant difference in performance between students who have their grades curved in business statistics and students who do not.

Two implications can be drawn from this study. First, business students are expected to have good command in dealing with numbers. In order to perform better in business finance, it is recommended that students gain more mathematics experience by taking business statistics prior to the enrollment of business finance even though business statistics may not be a prerequisite. Second, the grade received in a course may not necessarily reflect student learning in the course. Conventional wisdom suggests a strong positive relationship between grade received and student learning. In reality, that a student receiving an “A” learns more than a student receiving a “B” sometimes cannot be justified for at least one reason: instructors curve students’ grades. However, if business finance instructors can reinforce and test the same materials to students repeatedly, students’ prior performance in mathematics courses can be irrelevant to their performance in business finance. This implication is supported by the insignificant interaction terms in this study.

References

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Table 1: Variable Description

Variable	Description
FIN 360	Student's course grade recorded as a percentage in business finance
AGE	Student's age in years when enrolled in FIN 360
GENDER	Binary variable: 1 if the student's age is male; 0 otherwise
FROM	Binary variable: 1 if the student is a in-state student; 0 otherwise
AF	Binary variable: 1 if the student is an accounting or finance major; 0 otherwise
IS	Binary variable: 1 if the student is a information system major; 0 otherwise
MMR	Binary variable: 1 if the student is a management, marketing, or real estate major; 0 otherwise
GPA	Student's cumulative grade point average prior to FIN 360 enrollment
ACT	Student's ACT score
TRANSFER	Binary variable: 1 if the student transferred to the university in the study; 0 otherwise
CAMPUS	Binary variable: 1 if the student lives on the campus; 0 otherwise
WORKHR	Number of hours spent working per week on average
M152G	Student's final grade in college algebra; A = 4, B = 3, C = 2, D = 1, E = 0
M152C	Binary variable: 1 if the college algebra instructor curved the students' grades; 0 otherwise
M354DUM	Binary variable: 1 if the student completed business statistics; 0 otherwise
M354G	Student's final grade for business statistics; A = 4, B = 3, C = 2, D = 1, E = 0
M354C	Binary variable: 1 if the business statistics instructor curved the students' grades; 0 otherwise

Table 2: Descriptive Statistics

Variable	# of Obs.	Mean	Std. Dev.	Min	Max
FIN 360	106	0.728	0.193	0.008	0.991
AGE	90	22.9	4.195	20	42
GENDER	106	0.481	0.502	0	1
FROM	106	0.774	0.420	0	1
AF	106	0.321	0.469	0	1
IS	106	0.198	0.400	0	1
MMR	106	0.481	0.502	0	1
GPA	87	3.054	0.477	2	4
ACT	82	21.683	3.197	15	30
TRANSFER	90	0.3	0.461	0	1
CAMPUS	90	0.267	0.445	0	1
WORKHR	90	13.322	13.504	0	40
M152G	80	2.638	1.009	0	4
M152C	81	0.321	0.470	0	1
M354DUM	90	0.744	0.439	0	1
M354G	67	2.657	1.067	0	4
M354C	73	0.315	0.468	0	1

Table 3: Frequency Distribution Classified by Age, Gender, Major, Transfer Status, and Grades in College Algebra (MATH 152) and Business Statistics (MATH 354)

		FIN 360		
AGE		Freq.	Mean	Std. Dev.
	20	17	0.801	0.137
	21	30	0.808	0.085
	22	14	0.708	0.142
	23	11	0.731	0.164
	>=24	18	0.725	0.208
GENDER				
	Female	55	0.737	0.207
	Male	51	0.718	0.178
MAJOR				
	ACC & FIN	34	0.707	0.225
	IS	21	0.643	0.234
	MGT, MKT & RST	51	0.777	0.131
TRANSFER STATUS				
	Non-transfer	63	0.780	0.132
	Transfer	27	0.732	0.178
MATH 152				
	A	18	0.858	0.102
	B	27	0.739	0.146
	C	24	0.716	0.149
	D	10	0.750	0.105
	E	1	0.311	0
MATH 354				
	Not completed	39	0.623	0.236
	Completed	67	0.789	0.130
	A	17	0.889	0.070
	B	22	0.769	0.135
	C	17	0.716	0.141
	D	10	0.794	0.086
	E	1	0.730	0

Table 4: Regression Results on the Relationship between Business Finance and College Algebra and Business Statistics

	Equation (1)		Equation (2)		Equation (3)		Equation (4)		Equation (5)	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Intercept	0.513	4.157***	0.508	3.985***	0.462	3.908***	0.601	4.746***	0.613	4.870***
AGE	-0.002	-0.728	-0.002	-0.773	-0.001	-0.436	-0.005	-1.615	-0.005	-1.539
GENDER	-0.043	-1.497	-0.048	-1.563	-0.022	-0.857	-0.018	-0.691	-0.021	-0.792
FROM	-0.060	-1.989**	-0.057	-1.759*	-0.047	-1.599	-0.043	-1.498	-0.043	-1.466
AF	0.024	0.543	0.026	0.573	0.003	0.064	-0.008	-0.200	-0.001	-0.021
MMR	0.085	2.392**	0.082	2.271**	0.064	1.680*	0.043	1.290	0.042	1.297
GPA	0.136	4.048***	0.140	4.135***	0.130	4.030***	0.115	2.732***	0.109	2.557***
ACT	-0.010	-1.547	-0.009	-1.565	-0.006	-1.308	-0.002	-0.436	-0.002	-0.439
TRANSFER	-0.001	-0.019	0.000	0.011	-0.020	-0.633	-0.015	-0.447	-0.015	-0.438
CAMPUS	-0.007	-0.255	-0.007	-0.226	0.008	0.287	-0.016	-0.600	-0.021	-0.767
WORKHR	0.000	0.459	0.000	0.400	0.000	0.382	-0.000	-0.601	-0.001	-0.734
M152G	0.038	2.141**	0.035	1.808*						
M152C × M152G			0.006	0.591						
M354DUM					0.104	2.670***				
M354G							0.012	0.653	0.011	0.621
M354C × M354G									0.009	1.254
# of obs.	73		73		80		64		64	
F-statistic	4.96***		4.60***		5.12***		3.73***		3.77	
Adjusted R ²	46.08%		46.36%		44.99%		37.79%		38.77%	

***Significant at the 1% level

**Significant at the 5% level

*Significant at the 10% level