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## Do Prerequisites Matter?

# An Analysis of Agribusiness Financial Management and Agribusiness Marketing Management Courses 

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## Synopsis

Success in Agribusiness Financial Management (AEB 4141) and Agribusiness Marketing Management (AEB 4342) classes at the University of Florida in respect to course prerequisites was evaluated. In the case where multiple courses satisfy a prerequisite, the individual course impact on success was evaluated. The primary finding was that one introductory finance course (AEB3144) and one introductory marketing course (AEB3300) was statistically important for Agribusiness Financial Management (AEB 4141) and one introductory marketing (MAR3023) and one introductory finance course (AEB3144) was statistically important for Agribusiness Marketing Management (AEB 4342). Results also indicate that students with higher upper division GPAs received higher course grades.

## Introduction

Prerequisites are standard in college curricula and establish the preconditions for course enrollment. Prerequisites may include specific courses, academic status, and tests of preparedness. Such prerequisites perform two distinct yet related functions. First, they can be used as a filter that prevents program continuation. Second, they serve as a measure of course preparedness. As a filter, prerequisites may improve course performance by eliminating weak students. As a measure of preparedness, valid prerequisites should increase the likelihood for success. As preparation, prerequisites signal the set of entering skills that are required for successful course completion. With the movement toward increased program assessment, the effect of prerequisites on student outcomes becomes increasingly important.

Numerous studies have analyzed the effects of quantitative prerequisites on course performance. A number of papers have explored the characteristics of successful students to introductory economics courses. For example, Anderson, Benjamin, and Fuss (1994) found that a high school calculus course was significant in predicting performance in basic economics. Cohn, Cohn, Hult, Balch, and Bradley (1998) also found math skills important but questioned math as a prerequisite, arguing that evidence from other courses or SAT performance would suffice. Ely and Hittle (1990) found that performance in business finance was improved by completion of accounting courses and was not influenced by mathematical background.

Some of these papers (Siegfried and Strand; B. Greene; Watts and Lynch) have measured success by student performance on standardized exams, while others have used students' final grades in an introductory course (e.g., Borg and Shapiro; Anderson, Benjamin, and Fuss). Most of the remaining studies investigated how a course or individual characteristics affect student success. For example, Henebry (1997) considered the importance of class schedule and found students were more likely to pass a financial management course if it met more than once a week. Hovath, Beaudin, and Wright (1992) investigated gender differences in course persistence and found that female students were less likely to persist in the introductory economics course sequence.

Building upon these works, Buschena and Watts (2001) evaluated success in intermediate economics classes with respect to course prerequisites. Their primary finding was that prerequisites matter two ways: an individual student lacking the prerequisite receives a
lower grade, ceteris paribus, and a student will receive a lower grade in a class in which a high proportion of his or her contemporaries have the prerequisite.

Determining the characteristics of successful agribusiness and agricultural economics students at the senior or "cap-stone" level has received less attention. These senior courses allow evaluation of the benefits to the students of having a prior, often prerequisite, university-level intermediate course. The effect of this prior intermediate course on student performance in senior level courses is important since many agribusiness and agricultural economics departments serve students who have diverse levels of preparedness and have satisfied prerequisites through a mixed variety of courses. This work measured the effect of prerequisites on performance in subsequent senior courses as measured by final grades.

This work models the direct effects of the completion of prerequisite intermediate courses on a student's performance in a senior level course, and then compares the effect between the courses that satisfy a given prerequisite requirement. This second part is particularly important if students are given a choice between courses to satisfy a prerequisite. The concern arises as to similarity of course material, especially those courses provided by different departments.

## Institutional Setting

The University of Florida is a major, public, comprehensive, land grant, research university. The state's oldest, largest and most comprehensive university, Florida is among the nation's most academically diverse public universities. Florida has a long history of established programs in international education, research and service. It is one
of only 17 public, land-grant universities that belong to the Association of American Universities. Enrollment for fall semester 2001 totaled 46,515 students, including 40,499 in-state students representing all Florida counties, with approximately 2,700 international students representing over 100 countries, with the remainder representing all 49 of the other states, the District of Columbia, Puerto Rico, and the Virgin Islands. The ratio of women to men is currently 52:48. Seventy-two percent of enrolled students are undergraduates, 21 percent are graduate students and 7 percent are in professional degree programs (including dentistry, law, medicine, pharmacy and veterinary medicine). Approximately 23 percent of the members of the UF student body are minorities with 7.2percent of the student population consisting of African-American students, 9.6 percent Hispanic students, and 6.8 percent Asian American or Pacific Islander students.

The Food and Resource Economics Department (FRED) is in the College of Agricultural and Life Sciences (CALS) at the University of Florida. It is home to approximately 42 faculty, 35 support staff, about 200 undergraduate majors and 95 graduate students.

FRED deals with the business and economics of agriculture, natural resources and rural communities.

We evaluated the effect of prerequisites on two senior level "cap-stone" courses. The first, Agribusiness Financial Management (AEB 4141) is an integration of finance and management to solve problems faced by agricultural firms and agribusiness. It is offered once a year during the fall semester and is facilitated through a lecture and case study based format. The second, Agribusiness and Marketing Management (AEB 4342) is
based on the application of management and marketing principles to solve agribusiness and food marketing problems faced by managers. It is offered in the spring semester and is facilitated through the use of lectures, case studies, group projects and student presentations.

Both courses, AEB 4141 and AEB 4342, list as a prerequisite an introductory management course. This requirement could be satisfied by Introduction to Agribusiness Management (AEB 3133) or Introduction to Management (MAN 3025). In addition, AEB 4141 required an introductory finance course satisfied by Introduction to Agricultural Finance (AEB 3144) or Introduction to Business Finance (FIN 3408). Likewise, AEB 4342 also required an introductory marketing course satisfied by Introduction to Agricultural Marketing (AEB 3300) or Introduction to Marketing (MAR 3023). In each prerequisite situation the students had the choice of meeting the requirement with a course offered within the FRE department or through the business department.

This situation gave rise to an additional question, "Did the prerequisite choice at the intermediate level affect the grade achieved at the senior level?" A review of the courses revealed some distinct differences between the two departments. Courses within the FRE department were limited in size (fewer than 90 students) and presented "live" during specific course meeting times. Business department courses averaged 1000-2000 students with flexible delivery times through various media outlets including television, tape, and internet.

## Descriptive Statistics

Academic records and demographic information were acquired through the University of Florida Registrar. Student information was collected from graduated students (earned a minimum of 60 upper-division semester hours) between Fall 1999 and Spring 2001. Grades were collected for the two senior courses as well as all prerequisite courses. In addition, age at time of graduation and upper division GPA (average of grades earned beyond the first 60 hours of college coursework) was determined. Table 1 provides descriptive statistics.

Table 1

|  | $\boldsymbol{N}$ | Mean | StdDev | Min | Max |
| :--- | ---: | :---: | :---: | :---: | :---: |
| AEB 3133 | 124 | 3.22 | 0.82 | 1.00 | 4.00 |
| MAN 3025 | 142 | 2.28 | 0.86 | 0.00 | 4.00 |
| AEB 3300 | 128 | 3.12 | 0.77 | 0.00 | 4.00 |
| MAR 3023 | 146 | 2.47 | 0.96 | 0.00 | 4.00 |
| AEB 3144 | 92 | 3.02 | 1.01 | 1.00 | 4.00 |
| FIN 3408 | 119 | 2.11 | 0.72 | 0.00 | 4.00 |
| AGE | 231 | 23.4 | 3.09 | 20.0 | 49.0 |
| UD GPA | 231 | 2.69 | 0.66 | 1.52 | 4.00 |
| AEB 4141 | 167 | 2.78 | 0.85 | 0.00 | 4.00 |
| AEB 4342 | 208 | 3.32 | 0.70 | 0.00 | 4.00 |

## Model Determination

With the use of course grades as an indicator of performance, multinomial logit or probit models would fail to account for the ordinal nature of the dependent variable. Ordinary regression analysis would err in the opposite direction, however. Linear regression would treat the difference between a 4 and a 3 (an A and a B) the same as that between a 3 and a 2 (a B and a C) whereas in fact they are only rankings. The ordered probit and logit models have come into fairly wide use as a framework for analyzing such responses
(Zavoina and EcElvey, 1975). The model is built around a latent regression in the same manner as the binomial probit model.

We begin with:
$y^{*}=\beta^{\prime} x+\varepsilon$
As usual, $y^{*}$ is unobserved. What we do observe is:

$$
\begin{aligned}
y=0 & \text { if } y^{*} \leq 0 \\
=1 & \text { if } 0<y^{*} \leq \mu_{1} \\
=1.5 & \text { if } \mu_{1}<y^{*} \leq \mu_{2} \\
\cdot & \\
=4.0 & \text { if } \mu_{7} \leq y^{*}
\end{aligned}
$$

The $\mu$ 's are unknown parameters to be estimated with $\beta$. We assume that $\varepsilon$ is normally distributed across observations. For the same reasons as in the binomial probit model (which is a special case of $\mathrm{J}=1$ ), we normalize the mean and variance of $\varepsilon$ to 0 and 1 .

With the normal distribution, we have the following probabilities:
$\operatorname{Prob}(y=0 \mid x)=\Phi\left(-\beta^{\prime} x\right)$,
$\operatorname{Prob}(y=1 \mid x)=\Phi\left(\mu_{1}-\beta^{\prime} x\right)-\Phi\left(-\beta^{\prime} x\right)$,
$\operatorname{Pr} o b(y=2 \mid x)=\Phi\left(\mu_{2}-\beta^{\prime} x\right)-\Phi\left(\mu_{1}-\beta^{\prime} x\right)$,
$\operatorname{Pr} o b(y=J \mid x)=1-\Phi\left(\mu_{J-1}-\beta^{\prime} x\right)$.

The marginal effects of the regressors $x$ on the probabilities are not equal to the coefficients. The marginal effects are:
$\frac{\partial \operatorname{Prob}[y=0]}{\partial X}=-\phi\left(\beta^{\prime} X\right) \beta$,
$\frac{\partial \operatorname{Prob}[y=1 \ldots . .7]}{\partial X}=\left[\phi\left(-\beta^{\prime} X\right)-\phi\left(\mu-\beta^{\prime} X\right)\right] \beta$,
$\left.\frac{\partial \operatorname{Prob}[y=8]}{\partial X}=\phi\left(\mu-\beta^{\prime} X\right)\right] \beta$

## Estimation Results

An ordered probit model was estimated for the two courses. Table 2 defines variables used where "Course" $D$ represents a dummy variable, $0=$ not taken, $1=$ taken and "Course"CP represents an interaction variable ("Course"D*Grade in course).

The results are presented in tables 3 and 4.

Table 2

| Variable | Param | Definition |
| :--- | :--- | :--- |
| Constant | $\mathrm{B}_{0}$ |  |
| AEB3300D | $\mathrm{B}_{1}$ | Agricultural Marketing, $0=$ not taken, $1=$ taken |
| AEB3300CP | $\mathrm{B}_{2}$ | Agricultural Marketing, AEB3300D*Grade in course |
| MAR3023D | $\mathrm{B}_{3}$ | Business Marketing, $0=$ not taken, $1=$ taken |
| MAR3023CP | $\mathrm{B}_{4}$ | Business Marketing, MAR3023D*Grade in Course |
| AEB3133D | $\mathrm{B}_{5}$ | Agribusiness Management, 0=not taken, $1=$ taken |
| AEB3133CP | $\mathrm{B}_{6}$ | Agribusiness Management, AEB3133D* Grade in Course |
| MAN3025D | $\mathrm{B}_{7}$ | Business Management, $0=$ not taken, 1=taken |
| MAN3025CP | $\mathrm{B}_{8}$ | Business Management, MAN 3025D* Grade in Course |
| AEB3144D | $\mathrm{B}_{9}$ | Agricultural Finance, $0=$ not taken, $1=$ taken |
| AEB3144CP | $\mathrm{B}_{10}$ | Agricultural Finance, AEB3114D*Grade in Course |
| FIN3408D | $\mathrm{B}_{11}$ | Business Finance, 0=not taken, 1=taken |
| FIN3408CP | $\mathrm{B}_{12}$ | Business Finance, FIN3408D*Grade in course |
| GPA | $\mathrm{B}_{13}$ | Final Grade Point Average |

Table 3, AEB4141

| Variable | Parameter | Estimate | Std Error | t-stat | P-value |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Constant | $\mathrm{B}_{0}$ | .340327 | 1.43421 | .237292 | .812 |
| AEB3300D | $\mathrm{B}_{1}$ | -1.1753 | .520669 | -2.25729 | .024 |
| AEB3300CP | $\mathrm{B}_{2}$ | .271873 | .149405 | $\mathbf{1 . 8 1 9 7 0}$ | .069 |
| MAR3023D | $\mathrm{B}_{3}$ | -.588589 | .435777 | -1.35066 | .177 |
| MAR3023CP | $\mathrm{B}_{4}$ | .178205 | .162287 | 1.09809 | .272 |
| AEB3133D | $\mathrm{B}_{5}$ | -1.17723 | .602877 | -1.95269 | .051 |
| AEB3133CP | $\mathrm{B}_{6}$ | .289859 | .191314 | 1.51510 | .130 |
| MAN3025D | $\mathrm{B}_{7}$ | -.348926 | .382027 | -.913354 | .361 |
| MAN3025CP | $\mathrm{B}_{8}$ | .137921 | .147241 | .936698 | .349 |
| AEB3144D | $\mathrm{B}_{9}$ | -.253437 | .680254 | -.372563 | .709 |
| AEB3144CP | $\mathrm{B}_{10}$ | .248831 | .152646 | $\mathbf{1 . 6 3 0 1 2}$ | .103 |
| FIN3408D | $\mathrm{B}_{11}$ | -.117828 | .574766 | -.205002 | .838 |
| FIN3408CP | $\mathrm{B}_{12}$ | .154448 | .179693 | .859514 | .390 |
| GPA | $\mathrm{B}_{13}$ | .936213 | .430622 | $\mathbf{2 . 1 7 4 1 0}$ | .030 |

Marginal Effects, AEB4141
$\mathrm{B}_{2}$ (AEB330CP)

|  | PROB2* | PR1B2 | PR15B2 | PR2B2 | PR25B2 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Value | -0.0023068 | -0.0054436 | -0.0042442 | -0.056807 | -0.029168 |
|  | PR3B2 | PR35B2 | PR4B2 |  |  |
|  | -0.0032232 | 0.043063 | 0.058130 |  |  |

*The probability decrease (or increase) of receiving a " 0 " or failing AEB4141 if
AEB3300 is taken.
$\mathrm{B}_{10}$ (AEB3144CP)

|  | PROB10 | PR1B10 | PR15B10 | PR2B10 | PR25B10 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Value | -0.002111 | -0.004982 | -0.0038845 | -0.051992 | -0.026696 |
|  | PR3B10 | PR35B10 | PR4B10 |  |  |
|  | -0.00295 | 0.039413 | 0.053203 |  |  |

$\mathrm{B}_{13}$ (GPA)

|  | PROB13 | PR1B13 | PR15B13 | PR2B13 | PR25B13 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Value | -0.0079437 | -0.018746 | -0.014615 | -0.19562 | -0.10044 |
|  | PR3B13 | PR35B13 | PR4B13 |  |  |
|  | -0.011099 | 0.14829 | 0.20017 |  |  |

Table 4, AEB4342

| Variable | Parameter | Estimate | Std Error | $\boldsymbol{t}$-stat | P-value |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Constant | $\mathrm{B}_{0}$ | -1.75282 | 1.37039 | -1.27907 | .201 |
| AEB3300D | $\mathrm{B}_{1}$ | -6.88616 | .579914 | -1.18744 | .235 |
| AEB3300CP | $\mathrm{B}_{2}$ | .204043 | .166495 | 1.22552 | .220 |
| MAR3023D | $\mathrm{B}_{3}$ | -.182460 | .451249 | -.404346 | .686 |
| MAR3023CP | $\mathrm{B}_{4}$ | .250314 | .168481 | $\mathbf{2 . 1 5 9 6 5}$ | .031 |
| AEB3133D | $\mathrm{B}_{5}$ | -.647540 | .527568 | -1.22741 | .220 |
| AEB3133CP | $\mathrm{B}_{6}$ | .214652 | .152064 | 1.41160 | .158 |
| MAN3025D | $\mathrm{B}_{7}$ | .137568 | .370443 | .371360 | .710 |
| MAN3025CP | $\mathrm{B}_{8}$ | -.058686 | .133282 | -.440310 | .660 |
| AEB3144D | $\mathrm{B}_{9}$ | -1.07908 | .588090 | -1.83488 | .067 |
| AEB3144CP | $\mathrm{B}_{10}$ | .467544 | .174421 | $\mathbf{2 . 6 8 0 5 5}$ | .007 |
| FIN3408D | $\mathrm{B}_{11}$ | .599259 | .478901 | 1.25132 | .211 |
| FIN3408CP | $\mathrm{B}_{12}$ | -.212454 | .183954 | -1.15493 | .248 |
| GPA | $\mathrm{B}_{13}$ | 1.45414 | .475841 | $\mathbf{3 . 0 5 5 9 3}$ | .002 |

Marginal Effects, AEB4342
$\mathrm{B}_{4}$ (MAR3023CP)

|  | PROB4 | PR1B4 | PR15B4 | PR2B4 | PR25B4 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Value | -0.00307 | -0.0007 | -0.0016 | -0.0111 | -0.016 |
|  | PR3B4 | PR35B4 | PR4B4 |  |  |
|  | -0.062849 | 0.00073 | 0.09464 |  |  |

$\mathrm{B}_{10}$ (AEB3144CP)

|  | PROB10 | PR1B10 | PR15B10 | PR2B10 | PR25B10 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Value | -0.00573 | -0.001347 | -0.002999 | -0.020778 | -0.029889 |
|  | PR3B10 | PR35B10 | PR4B10 |  |  |
|  | -0.11739 | 0.0013662 | 0.17678 |  |  |
|  |  |  |  |  |  |
| B13 (GPA) |  |  |  |  |  |
|  | PROB13 | PR1B13 | PR15B13 | PR2B13 | PR25B13 |
| Value | -0.017845 | -0.0041916 | -0.009329 | -0.064623 | -0.092959 |
|  | PR3B13 | PR35B13 | PR4B13 |  |  |
|  | -0.36511 | 0.004249 | 0.54981 |  |  |

## Conditional Probabilities

For each of the probabilities, there are two effects for taking a particular course. The first is the effect of simply having taken the course, regardless of the grade earned. Since it is a dummy variable, this effect is calculated by evaluating the probability of each grade conditionally upon having taken the course. Then a probability is also calculated for the case where the course was not taken. The difference in the two probabilities is then the effect of having taken the course.

As an example, the probability of receiving an "A" in AEB4141conditional upon completing AEB3144 versus not taking the course was evaluated using TSP in the following manner:

1) Probability $[\mathrm{y}=4 \mid \mathrm{AEB} 3114 \mathrm{D}=1]=1-\mathrm{CNORM}\left(\mathrm{A} 6-\mathrm{MXB}+\mathrm{B}_{9}{ }^{*}(\right.$ Mean of AEB3144D $)$
$+\mathrm{B}_{10} *\left(\right.$ Mean of AEB3144CP) $-\mathrm{B}_{9}-\mathrm{B}_{10} *($ Mean grade of students who took the course $)$ )
2) Probability $[y=4 \mid A E B 3114 D=0]=1-C N O R M\left(A 6-M X B+B_{9} *(\right.$ Mean of AEB3144D $)$
$+\mathrm{B}_{10} *($ Mean of AEB3144CP))

Results are reported in tables 4 and 5 along with the differences in probabilities for grade attainment.

Table 5, AEB4141

|  | Value | $\mathbf{Y}=4$ "A" | $\boldsymbol{Y}=3$ " $\boldsymbol{B} "$ | $\boldsymbol{Y}=2$ "C" |
| :--- | :--- | :--- | :--- | :--- |
| AEB3144D | 1 (taken) | 0.2516 | .77175 | 0.99162 |
|  | 0 (not taken) | 0.093188 | 0.59739 | 0.97089 |
| Difference |  | 0.11197 | 0.17436 | 0.020733 |

Table 6, AEB4342

|  | Value | $\boldsymbol{Y}=\mathbf{4}$ <br> "A" | $\mathbf{Y}=3$ " $\mathbf{B "}$ | $\mathbf{Y}=\mathbf{2}$ " $\mathbf{C}$ " |
| :--- | :--- | :--- | :--- | :--- |
| MAR3023D | 1 (taken) | 0.43991 | 0.95296 | 0.99523 |
|  | 0 (not taken) | 0.27860 | 0.89222 | 0.98446 |
| Difference |  | 0.16131 | 0.060737 | 0.010764 |

## Discussion

In the case of AEB4141, Agribusiness Financial Management, introductory finance and management courses are required prerequisites. Analysis showed that the completion of AEB3144, the FRE department's finance course, had a significant impact on the grade achieved in the senior level course, while the Business course did not. Looking at the marginal effects, a one-unit increase in the AEB3144 grade achieved would decrease the probability of receiving a $\mathrm{F}, \mathrm{D}, \mathrm{D}+, \mathrm{C}, \mathrm{C}+$, or B , while increasing the probability of receiving a $\mathrm{B}+$ or A in AEB 4141 . The conditional probabilities, directly comparing the probability of grade attainment based upon completion of the course versus not, revealed a clear increase in the probability differences as you move from a projected grade of "C" to an "A" in favor of completing the course. These results provide a strong justification for choosing AEB3144 over FIN3408 and validating its requirement as a prerequisite. The introductory marketing course AEB3300 was also significant although not a prerequisite, while neither management course was significant. In light of this, there would appear to be justification in reviewing the management requirement and its importance to later material as well as the marketing course to determine existing synergies.

With AEB4342, Agribusiness Marketing Management, introductory marketing and management courses are required prerequisites. Analysis showed that the completion of MAR3023, the Business department's course, had a significant impact on the grade achieved in the senior level course, while the FRE department course did not. Looking at the marginal effects, a one-unit increase in the MAR3023 grade achieved would decrease
the probability of receiving a $\mathrm{F}, \mathrm{D}, \mathrm{D}+, \mathrm{C}, \mathrm{C}+$, or B , while increasing the probability of receiving a $\mathrm{B}+$ or A in AEB4342. The conditional probabilities revealed a clear increase in the probability differences as you move from a projected grade of "C" to an "A" in favor of completing the course. This information provides rational for the FRE department to review AEB3300 and the role it must play in order to justify it as a valid prerequisite. The introductory finance course AEB3144 was also significant although not a prerequisite, while neither management course was significant once again.

In both cases, the upper-division GPA was significant with a positive effect on grade achievement. The marginal effects showed that a one-unit increase in GPA would decrease the probability of receiving a $\mathrm{F}, \mathrm{D}, \mathrm{D}+, \mathrm{C}, \mathrm{C}+$, or B , while increasing the probability of receiving a $\mathrm{B}+$ or A in AEB4141 and AEB4342. In this case, upperdivision GPA was used as an explanatory variable as a proxy of overall individual student effort.

## Conclusion

Today, there is an increasing public demand for institutions to provide effective and efficient levels of education. Institutions are challenged to increase the quality of education and the quantity of graduates in light of unprecedented budget restrictions. One area of potential efficiency gains is the evaluation of prerequisite courses. Today's administrators are focusing on ways to reduce course material duplication (i.e. multiple courses providing the same material) and standardized levels of preparedness for students entering programs or courses (I.e. structure and strength of prerequisite work).

This analysis illustrated the importance of prerequisite intermediate courses in the determination of grades in both a senior-level marketing and finance course. It provided the information necessary to answer two questions. First, does the completion of a specific prerequisite course significantly impact future grade attainment and second, if so, what is the measure of that impact?

Additional research would focus on the continual update of the student database and evaluation of prerequisite course significance in grade determination. Also this work could evolve into a cost-benefit evaluation viewed from the academic as well as student perception.

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