

March 2007

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Oskar R. Harmon
University of Connecticut

James Lambrinos
Union University

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Recommended Citation

Harmon, Oskar R. and Lambrinos, James, "Student Performance in Traditional vs. Online Format: Evidence from an MBA Level Introductory Economics Class" (2007). *Economics Working Papers*. 200703.
https://opencommons.uconn.edu/econ_wpapers/200703



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Department of Economics Working Paper Series

Student Performance in Traditional vs. Online Format: Evidence from an MBA Level Introductory Economics Class

Oskar R. Harmon
University of Connecticut

James Lambrinos
Union University

Working Paper 2007-03

March 2007

341 Mansfield Road, Unit 1063
Storrs, CT 06269-1063
Phone: (860) 486-3022
Fax: (860) 486-4463
<http://www.econ.uconn.edu/>

This working paper is indexed on RePEc, <http://repec.org/>

Abstract

All previous studies comparing online and face-to-face format for instruction of economics compared courses that were either online or face-to-face format and regressed exam scores on selected student characteristics. This approach is subject to the econometric problems of self-selection omitted unobserved variables. Our study uses two methods to deal with these problems. First we eliminate self-selection bias by using students from a course that uses both instruction formats. Second, we use the exam questions as the unit of observation, and eliminate omitted variable bias by using an indicator variable for each student to capture the effect of differences in unobserved student characteristics on learning outcomes. We report the finding that students had a significantly greater chance of answering a question correctly if it came from a chapter covered online.

Journal of Economic Literature Classification: A2, A22

Keywords: online, instruction, economics, face-to-face

Student Performance in Traditional vs. Online Format: Evidence from an MBA Level Introductory Economics Class

Web instruction increases access to university courses because of significant reductions in commuting time, and flexibility in scheduling online learning sessions around work and family responsibilities. It is not surprising that a recent survey (Coates and Humphreys 2003) of economics departments reported that enrollment for “cybereconomics courses....tends to enroll a high proportion of non-traditional students, like working adults and non-degree seeking students.”

Web instruction, however, faces the challenge of developing equivalence between “digital” and “live” communication in student-to-student and student-to-instructor interactions that are fundamental to learning. Factors that contribute to equivalence in communication are students with strong independent learning skills and high levels of self-discipline and motivation. Because these characteristics are typically present in relatively less abundance among traditional than non-traditional undergraduates, Brown and Liedholm (2002) advise that the online format is likely to be far less appropriate than the face-to-face format for the teaching of principles of economics to typical undergraduates.

A factor that might promote equivalence between “digital” and “live” communication is the heretofore less studied format of mixing online lectures with face-to-face lectures in the same course. In a rotating format, the face-to-face lectures could potentially marry the advantages of the online format, which include a self-paced format,

flexibility in scheduling, and convenience in viewing, listening, and printing presentations, with the advantages of the face-to-face format, which include the discipline imposed by attending class at a fixed time, impromptu explanations and examples developed in response to live questions, and greater stimulation than when working alone (Terry, Lewer et al. 2003). An advantage of studying students in the hybrid format is that we eliminate the econometric problem of self-selection bias that arises when students self-select their format of instruction.

All prior studies of the effect of instruction format on learning outcomes have used the approach of regressing a measure of learning outcome on student characteristics. A fundamental disadvantage of this approach is the problem of bias from omitted variables arising because many student characteristics that influence learning outcomes are unobservable and/or difficult to measure. In this study we use a different approach. From a record of exam responses and whether the exam questions were covered in the online format or face-to-face format we estimate a qualitative choice model in which probability of a correct response is correlated with the classroom format. An advantage of this approach is that it solves the omitted variables problem because it uses an indicator variable for each student and in this way captures unobserved student characteristics. In the next section, we review the literature on the effectiveness of online versus traditional in-class teaching. Section II contains a discussion of our data, empirical model and results while the final section contains our conclusions.

1. Online vs. Traditional Teaching

Studies in other disciplines are far more common and the predominant finding of these studies is 'no significant difference'. Moreover, in studies that did find a significant

difference the predominant finding is that the online format is more effective than the face-to-face format in promoting learning outcomes.¹ To our knowledge there are only five studies of economics classes that use direct evidence on test scores to compare learning outcomes in the two different instructional formats. Notwithstanding major differences in the student characteristics of these samples in these studies², the majority of these studies, by the margin of three to two, (60%), conclude that learning outcomes in the online format are inferior to the face-to-face format. This result is contrary to the finding of the apparently comprehensive survey by Russell (2007) that 98% of the reviewed studies report the distance learning format is equal to or superior to the face-to-face format.³..

Brown and Liedholm (2002) surveyed students in a match pair of online and face-to-face principles of economics course taught by the same instructor. The students in their sample were traditional aged undergraduates at a large residential university.⁴ They reported that exam scores, after controlling for differences in student characteristics, are approximately 6% percent higher for the face-to-face format than for the online format. It was further reported that for questions of concept identification

¹ Studies in other disciplines of the issue of whether instructional format effects learning outcomes are far more common and the predominate finding is of “no significant difference”. The website by T.Russell (<http://nosignificantdifference.wcet.info>), compiles dozens of studies on distance education (Coates et. al. 2004) shows as of 2/22//2007 shows that 131 (73%) studies report “no significant” difference” in outcomes between materials delivered as distance-education or face-to-face, 45 (25%) studies report outcomes improved when delivered as distance-education, 7 report mixed results, and 3 (2%) improved outcomes when delivered face-to-face.

² Two studies are of undergraduate students, and the remaining three are of MBA students.

³ Though, it is puzzling that the five studies of economics classes we next review are not included in the Russell (2007) survey

⁴ The face-to-face course was taught in two large sections averaging 180 students each and did not use online instructional materials. The online course was taught in two small sections averaging 45 students each and used an array of online instructional materials that included access to video of the face-to-face class lectures, PowerPoint lecture slides, and interactive online practice materials. A principal component of the practice materials was the online Excel exercises *Principles of Microeconomics* (<http://www.msu.edu/course/ec/201/brown/pim>)

there was no significant difference, but for questions of higher level learning (concept application) the mean was significantly lower for the online classes. They attribute the relatively better performance in the face-to-face classes to the benefit of in-person instructor-student interactions, and attribute the relatively poorer performance of the students in the online class to the lack of self-discipline necessary for successful independent learning in the online environment.

Coates et al. (2004) surveyed three matched pairs of face-to-face and online principles of economics courses taught at three different institutions. The students in the online courses were older, had longer commute times and more job responsibilities than the students selecting the face-to-face courses.⁵ The students score on the Test of Understanding College Level Economics (TUCE) administered at the end of the semester is used as the measure of learning outcomes. After controlling for selection bias and differences in student characteristics, they report that the average TUCE scores are about 15% higher for the face-to-face format than for the online format.⁶

Anstine and Skidmore (2005) surveyed two matched pairs of face-to-face and online courses, one in statistics, and the other in managerial economics.⁷ The students in their sample were in a program that offers an MBA degree in a face-to-face classes or

⁵ In the traditional format sample 50% of the students work, and of those working the average weekly hours are 18, 40% live on campus and 90% are in the age range 17-22. In the online sample 73% of the students have jobs, of those the average work week is 33 hours, 20% live on campus, and 63% are in the age range 17-22. Sample has 126 observations, 67 in the traditional format class, and 59 in the online format. Two of the matched pairs were principles of macroeconomics and the other principles of microeconomics. The live and online classes were of similar size ranging from 24 to 37 students each and the response rates range from 85% to 96%. The exams were multiple choice, the exams for the online class were not proctored.

⁶ Other findings were that freshman and sophomores taking the online format scored lower than upperclassman, and that students who self select the online format did better than a randomly selected student of similar characteristics, a difference they attribute to an unobserved positive interaction of learning styles and instruction format.

⁷ The instructor, class materials and exams, which were take-home, are identical for the face-to-face and the online sections statistics and managerial economic courses, respectively.

entirely online. Because students can self-select the online option, they use a 2SLS with correction for sample selection bias.⁸ For the second stage they report that after controlling for student characteristics and selection bias, students in the online format of the statistics class had exam scores 14.1 percentage points less than in the traditional format, whereas, for the managerial economics class the test scores between the two formats were not significantly different⁹.

Navarro and Shoemaker (1999) surveyed a matched pair of face-to-face and online sections of an MBA class in principles of macroeconomics. The students self-selected the instruction format, each section was approximately 30 students, and there was no difference in the demographic composition of each section. They used a simple comparison of means on test scores and reported no-significant difference in learning outcomes between the two formats.

Terry, Lewer and Macy (2003)⁹ surveyed 240 MBA students in a program offering courses in the three formats of online, face-to-face, and hybrid. Approximately seventy students were enrolled in each sequence. Using a standard regression model with final exam score as the dependent variable and student characteristics as independent variables, they report that predicted exam scores for students in the online courses were significantly less than for students in the face-to-face and the hybrid formats. However, for the comparison of exam scores between students in the hybrid compared to the face-to-face classes they report 'no significant difference'.

⁸ In their selection model of choice of learning environment the dependent variable is class format (online = 1) and the independent variables are travel time, reported weekly hours devoted to work and children in the home. Results are not presented but they report that the indicator variable for children in the family was positive and significant.

⁹ Similar to the (Coates 2004) study they report that of the many variables for student characteristics tested, few were statistically significant. For the statistics class only age was significant, and for the managerial class only GMAT, study time, and foreign student status were statistically significant.

The two studies of undergraduate students (Brown and Liedholm 2002; Coates, Humphreys et al. 2004) reported lower test scores for students in the online class compared to the face-to-face class. In contrast the three studies of MBA students report the opposite result. Two of the three studies of MBA students reported ‘no significant difference’ for courses in economics (Navarro and Shoemaker 1999; Anstine and Mark 2005) , and only the third study (Terry, Lewer et al. 2003) reported lower exam scores for the online class compared to the face-to-face class. These results suggest that unobserved differences among students might have a significant role in explaining the differing outcomes between studies of MBS students and studies of undergraduates.

To correct for bias from self-selection and omitted unobserved variables, previous researchers have used the Heckman Correction econometric procedure. These researchers have had, arguably, limited success in eliminating the bias. These researchers report that of the many observable variables (such as GPA, gender, age, and SAT scores) they use (as proxies for unobservable attributes, such as of self-discipline, motivation, and independent learning skills) to estimate the Heckman Correction, few have statistically significant explanatory power.¹⁰ Our finding – that unobserved differences in attributes such as independent learning skills between MBA students and undergraduate students might account for why studies of these students have opposite conclusions—is consistent with the observation that prior researchers might not have been entirely successful in eliminating this bias.

¹⁰ For example both Anstine and Skidmore (2005) and Coates (2002) report that they are unable find more than a few student characteristics with statistically significant explanatory power.

II. Data, Empirical Model and Results

To eliminate bias in the estimation, we use one class that was exposed to both teaching formats instead of multiple classes, and we employ an approach previously introduced by Marburger (2001; Marburger 2006) to estimate the effect of absenteeism on student performance. In this approach the exam questions are the units of observation. An indicator variable, which is used for each student in the sample, captures the effect of differences in unobservable student characteristics, and in this way eliminates bias from omitted variables. We use a logit model to estimate the effect of instruction format on the probability of a correct response to the exam questions.

The data for our study come from a principle of economics class taught in an MBA program for students who could not waive the course. Two undergraduate courses in economics with grades of B- or better were required to waive this course. The course covered both microeconomics and macroeconomics. All eighteen chapters in the textbook were covered in this course and these consisted of two introductory chapters, eight micro chapters and eight macro chapters. In addition to eight MBA students, there were also five students from an Engineering Management program in the class.

Five of the 8 microeconomics chapters and six of the 8 macroeconomics chapters were taught in a traditional lecture format using power point slides. For the remaining chapters, the lecture was recorded in a PowerPoint presentation and made available electronically. Homework problems were assigned for each chapter. For the face-to-face lectures the answers to the homework problems were reviewed in class time permitting; for the online chapters, the solutions to the homework problems were made available electronically.

There was a midterm covering the two introductory chapters and the eight micro chapters and a final exam covering the eight macro chapters. The exams consisted of two parts – Part I were multiple choice questions and Part II were problems. The multiple choice questions were mostly conceptual in nature although some were numerical problems. They were all obtained from the test bank provided with the textbook and the degree of difficulty of the question on a 1 to 5 scale was provided in the test bank. The student's answers to the multiple choice questions were used to determine if their performance was different in the online portion of the course compared to their performance using a traditional lecture.

The empirical model takes the following form:

$$(1) \quad C_{ij} = B_0 + B_1 O_i + B_2 E_i + B_3 D_i + B_4 MBA_j + B_5 GPA_U_j + B_6 GPA_G_j \\ + B_7 G_j + U_{ij}$$

Where C_{ij} – correct; 1 if student j has the correct answer for question i ; 0 otherwise

Question-Specific Independent Variables:

O_j – online; 1 if the chapter that question i was taken from was covered online; 0 otherwise

E_j – exam; 1 if question i was from the final; 0 for the midterm

D_j - difficulty level of question i ; 1 easiest to 5 hardest

Student-Specific Independent Variables:

MBA_j – 1 if student j is an MBA student; 0 if engineering management

GPA_U_j – undergraduate GPA of student j

GPA_G_j – graduate GPA of student j

G_j – gender; 1 if student j is female; 0 if male

U_{ij} – random error term for student j and question i

Since the dependent variable is an indicator variable, a logistic regression was estimated. A difficulty with the approach of identifying student characteristics is that we have many omitted variables such as motivation, hour spent studying etc. An alternative approach is to assign an indicator variable each student. In this way we control for all the ways in which each student is different.

$$(2) \quad (2) C_{ij} = B_0 + B_1 O_i + B_2 E_i + B_3 D_i + B_4 MBA_j + B_5 GPA_U_j + B_6 GPA_G_j + B_7 G_j + B_8 S_j + U_{ij}$$

where S_j – student; 1 for student j ; 0 otherwise

Table 1 Descriptive Statistics

Variable	N	Mean	Standard Deviation
C	611	0.7332	
Percentage Correct Online	195	0.7538	0.4318
Percentage Correct Traditional	416	0.7235	0.4477
Question-Specific Variables:			
O	611	0.3191	
E	611	0.4893	
D	611	3.0851	1.0287
Student-Specific Variables:			
MBA	13	0.6154	
GPA_U	13	3.2415	0.3647
GPA_G	13	3.6131	0.2366
G	13	0.3846	

As can be seen from table 1, the students answered 73.3% of the questions correctly. Of the questions covered online, 75.4% were correct while only 72.4% were

correct that covered in the traditional format. However, without holding constant the effect of the other variables, it is difficult to make any conclusions about the difference in effectiveness in teaching formats just on the basis of the difference in means. The average difficulty level was 3.1 (on a scale of 1 to 5) and 49% of the questions were on the final exam. From the student specific variables, we see that 62% of the students were in the MBA program, the students had an average undergraduate GPA of 3.24, a graduate GPA of 3.61 at the time they were taking this class and that 38% of the students were female.

Model 1 reports the results without the student indicator variables while model 2 repeats the same model with a series of indicator variables for each student. The

Table 2 Exam Performance and Class Format

Variable	MODEL1		MODEL 2		MODEL 3	
	Coefficient	Pr > ChiSq	Coefficient	Pr > ChiSq	Coefficient	Pr > ChiSq
Intercept	-0.44	0.78	4.47	0.46	1.66	0.00
O	0.40	0.07	0.41	0.06	0.41	0.06
E	-0.40	0.03	-0.41	0.03	-0.41	0.03
D	-0.23	0.02	-0.23	0.02	-0.23	0.02
MBA	-0.17	0.52	-0.12	0.80		
GPA_U	0.03	0.94	-0.86	0.39		
GPA_G	0.66	0.27	0.06	0.96		
G	-0.33	0.18	1.21	0.27		
S			*	*	*	*
N	611		611		611	
Likelihood Ratio	16.68	0.02	27.02	0.09	27.02	0.03

*The estimation results for the 12 student indicator variables are not reported here.

results show that the covered online variable (C) is positive and statistically significant indicating that the students did better on the questions which came from the chapters covered online. The coefficient of 0.40 from model 1 for the covered online variable (C)

indicates that the students had a 40% higher chance of answering the question correctly if it was from a chapter covered online. In model 2 with an indicator for each student, the coefficient for the covered online variable (C) is similar at 0.41. Model 3 just shows the results for the three significant variables in the model with no change in any of the coefficients.

The responses to questions on the final exam were less likely to be correct compared to the midterm and the higher the difficulty level of the question, the less likely was the response the question to be correct. None of the student specific variables were significant in the model. The student's GPA, either undergraduate or graduate, degree program or gender did not successfully increase or decrease the likelihood of getting a question correct. Adding the student indicators to the model did not appreciably change the results. The significant variables remain significant and with almost the identical set of coefficients with the student indicators as without. This suggests that having the same set of students exposed to both teaching formats may have already eliminated the bias that the student indicators are designed to eliminate.

III. Conclusions

The issue of "no significant difference" between online and face-to-face instruction formats is important for non-traditional undergraduates and MBA students because web instruction significantly expands their higher education opportunities. The promise of these opportunities would be less appealing if the mode of instruction inherently handicaps learning outcomes.

Previous studies compared courses that were either online or face-to-face format and regressed exam scores on selected student characteristics. The approach is subject to the econometric problems of self-selection bias and bias from omitting unobserved characteristics such as motivation, maturity, and independent learning skills, which have important effects on learning outcomes. Our study uses exam questions as the unit of observation with the same set of students being exposed to both formats.. We use an indicator variable for each student to capture the effect of differences in unobserved student characteristics on learning outcomes, and in this way eliminate the bias of omitted unobserved variables.

Our finding is that the online format does not handicap learning outcomes relative to the face-to-face format when used in an MBA program in the hybrid format of an alternating schedule of face-to-face and online lectures. Informally, students reported that in the online format they were able to listen to the power point slides at a time that was conducive to good learning and they were able to listen to the slides repeatedly, which they were not able to do with the face-to-face format. The disadvantage of the online format they reported was not being able to ask questions immediately upon having difficulty understanding a particular concept covered on the power point slide. The exam results for our sample suggest that in the hybrid format the advantages of online lectures offset its disadvantages.

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