Meta-Analysis of Student Performance in Micro and Macro Economics: Online Vs. Face-To-Face Instruction

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This study presents a meta-analysis of performance differences between online vs. face-to-face undergraduate economics courses in the US. The "effect sizes" represent the strength of the relation between two variables. This strength may be affected by additional factors, referred as "moderators". Statistically significant stronger performances for face-to-face instruction are observed in the analysis, while reports of older/mature online instruction enrollees performing better are documented in individual studies. Additional moderators including gender, prior economics course(s) and mathematics ability need to be examined to determine the impact on student performance, potentially contributing to improved curriculum development and online course design.

INTRODUCTION

The rapidly growing number of offerings in online undergraduate economics education has attracted attention from researchers regarding student performance (Allen & Seaman, 2010; Dawley, 2007). Numerous studies compare online and non-online settings (Horspool & Lange, 2012; Trawick, Lewer & Macy, 2010; Gratton-Lavoie & Stanley, 2009; Bennett, Padgham, McCarty & Carter, 2007; Coates, Humphreys, Kane & Vachris, 2004; Brown & Liedholm, 2002; Navarro, 2000a, b; Shoemaker & Navarro, 2000; Navarro & Shoemaker, 2000; Vachris, 1997). In this article the term "face-to-face" refers to any course using a traditional approach and may include hybrid/blend courses which typically have some actual classroom time, but excluding strictly virtual or online courses that do not require any face-to-face meetings. The comparison group is online courses. These studies on performance of undergraduate level economics education have relatively mixed results.

From looking at individual studies, it is difficult to clearly answer the question, "Do students in online college level economics courses perform as well as the students in face-to-face courses?" These economics courses serve as "rites of passage" for the majority of students in business and economics. They provide foundation knowledge and quantitative capabilities for advanced management science courses, including finance, accounting, marketing, and operations management, among others. Becker (1997) points out that economics courses are considered among the most difficult subjects in a business curriculum; in part, because economists often take information through abstract conceptualization and process it through observation and reflection (Finlay & Deis, 2004). Several studies try to identify major

determinants of student success in learning economics (McCarty, Padgham & Bennett, 2006; Becker & Watts, 2001; Becker, 1997; Bartlett, 1996; Anderson, Benjamin & Fuss, 1994).

This study uses a meta-analysis of existing studies. Meta-analysis is a quantitative approach that systematically combines and integrates results from many comparable empirical studies that examine relations between similar variables (Capon, Farley & Hoenig, 1990). Meta-analysis was first introduced over 70 years ago (Fisher, 1938), and is used today in a wide variety of fields to form a synthesis of previous research. This can provide additional information and power that individual studies do not (Hunter, Schmidt & Jackson, 1982).

Before adopting an institutional policy on online economics course offerings, it appears critical for an educational institution to examine student performance in two different delivery settings: online vs. face-to-face instruction. Statistically combining students' performance data, would allow new course online offerings to become better positioned and targeted for students, and subsequently foster better performance. Thus, the purpose of this study is to determine whether U S. undergraduates in online college level economics courses perform as well as the students in face-to-face courses.

This approach is constrained by the previous research scopes and data availability. The literature review is presented first, followed by this study's methodology and results. Next, the discussion of findings and future research implications are presented.

LITERATURE REVIEW

There has been rapid growth in college level economics online course offerings (Bernard, Lou, Borokhovski, Wade, Wozney, Wallet, Fiset & Huang, 2004; Eastman, Swift, Bocchi, Jordan & McCabe, 2003). Accordingly, there are an increasing number of studies comparing student performance in college economics in online and traditional formats. Some of the research suggests that the student performance between online and classroom instruction is not significantly different when moderators are included for analysis (Horspool & Lange, 2012; Gratton-Lavoie & Stanley, 2009; Bennett et. al., 2007; Vachris, 1997). Other studies suggest that students in face-to-face courses perform better in regard to their test scores when controlling for moderators (Coates et. al., 2004; Terry, Lewer & Macy, 2003; Brown & Liedholm, 2002). Trawick et. al. (2010) used the switching model. In the switching model, members of two different groups can be moved from one group to another and predictions made about how the individuals would function. Maximum likelihood estimation regression is used to determine how a person would function if he or she was moved to the other group. The switching model predicts how a student moved from the face-to-face classroom to the online course would perform and vice-versa. They concluded that "choosing an online course lowers performance by approximately 23%"; that is, if students who chose a traditional classroom course had been placed in an online course, they would have performed worse than a randomly chosen student from the population. Conversely, other research found that, after controlling for moderators, students in an online college economics course outperformed those in a traditional classroom course on final exam (Navarro & Shoemaker, 2000; Navarro, 2000b).

Moderators allow investigators to examine additional variables that contribute to differences in the magnitude of the relation between two variables. In this meta-analysis, moderators indicate sources of differences in student performance between those in online and face-to-face course. Although many of the moderators examined in some of the studies may influence success in online courses across the board, others are more closely related to success in economics. Age, financial aid, GPA, SAT/ACT scores, web facility, to name a few, would affect success in online courses in many disciplines. On the other hand math ability (Bosworth, 2007; Brown & Liedholm, 2002; Coates et. al., 2004; Trawick et. al., 2010) and having taken a previous economics course (E.g., Bennett et. al., 2007) may be more closely aligned with success in economics. Studies that examined gender, show that female students performed significantly higher in the online course, and male students did better in the face-to-face course (Bennett et. al., 2007; Bosworth, 2007; Gratton & Stanley, 2009).

Of concern in comparing online to face-to-face student performance is the fact that students choose which course they prefer. Referred to as "self-selection bias" this means that the samples are not equivalent. Heckman (1979) and Greene (2003) developed techniques to correct for self-selection bias, but others prefer to include as many demographic characteristics as possible as moderators and then concede that there may be unobservable determinants that cannot be controlled for or measured.

To explain the differences in performance, some studies suggest that student performance in the two settings can be explained by gender composition, matching gender effect, average age of the students, years in college, working hours, previous exposure to economics knowledge, complexity of the material, cumulative GPA, and other factors. (See Calafiore & Damianov, 2011; Bennett et. al., 2007; Coates et. al., 2004; Keri, 2003; Brown & Liedholm, 2002; Navarro, 2000a; Ziegert, 2000). This study focuses on the student performance differences in college level principles economics education reported in the studies published from 2000 to 2012.

TABLE 1
HIERARCHY OF CRITERIA FOR SELECTION OF STUDIES

Steps/Procedure:	Studies Considered:	Justification:	Who Evaluated These:
A) All available databases were searched for studies that discussed the difference between teaching entry-level economics in US colleges online or face-to-face.	All articles on pedagogy in economics	Needed articles on the topic from as many sources as possible (Wolf, 1986)	The authors
B) The articles were evaluated based on these criteria: 1) Experimental design 2) Purpose 3) Population 4) Statistics	79 articles found in Step A	The articles used in the meta-analysis had to meet these standards for validity and reliability (Cooper, 2010).	A panel of 3 judges
C) These needed a quantitative measure of student performance in the course. E.g., a final grade, or a final exam score, or a TUCE exam score.	37 articles found in Step B	The measure of student performance had to be explicitly defined.	The authors
D) Finally, the studies needed to be based on independent databases.	12 articles that met criteria in Step C	If two or more studies were from the same database the results of the meta-analysis would be over influenced by these.	The authors
E) These were used in the meta-analysis.	9 articles that met criteria in Step D	These met all criteria.	The authors

METHODOLOGY

For the meta-analysis extensive database searches for articles that are related to a comparison of face-to-face and online student performance in college level economics education resulted in 79 studies. This assured that the retrieved articles covered a sufficiently broad spectrum of databases (Wolf, 1986). Then a panel of three judges evaluated the potential studies with respect to their experimental design, purpose, population, and statistics. Forty-two did not meet one or more of these criteria. Some were not quantitative in nature, did not use samples from undergraduate US institutions of higher education, the variables "online" and "face-to-face" were not clearly defined as well. Some studies provided unusable

statistics such as the F tests with four degrees of freedom found in the analysis in a dissertation (Sylvester, 2004) and were eliminated, because any degree of freedom higher than one cannot guarantee linearity, which impacts the validity of the comparison (Rosenthal, 1991).

Of the remaining thirty-seven, only those with a qualitative measure for overall student performance were included. That is, a final exam score, a final grade, or a Test of Understanding in College Economics (TUCE) at the end of the course was mandatory. Studies that do not have such a measure were dropped. Of the 12 remaining studies, three (two studies by Navarro and Shoemaker, one by Coates et. al.) were based on the same dataset as other studies by the same authors. If two or more studies are based on the same dataset these studies would have too large an impact on the meta-analysis results and would not be independent of each other and were eliminated. This also guaranteed the independence of the samples and of the statistics. Every attempt was made to avoid comparing or aggregating studies of highly dissimilar measuring techniques, variables, and participants. Thus, 9 studies met selection criteria (Table 1) and resulted in a broad range of 3,681 students from a wide variety of undergraduate settings.

The synopsis of each study included (Table 2) confirms that each tests the delivery of beginning college economics courses in a comparison between online and face-to-face classes. After selecting the studies, the statistics for analysis were calculated. In meta-analysis, many statistics can be used to define relations between two variables. The statistical results of studies are referred to as "effect sizes," meaning the strength of the relation between two variables. As defined by Cohen (1988, p.9-10), "effect size" is "the degree to which the phenomenon is present in the population, or the degree to which the null hypothesis is false." Effect size is a broad term and can be operationalized and reported using a number of statistics such as correlation r, d, z scores, etc. The statistic "d" is defined as the "standard mean difference." That is, it "expresses the distance between the two group means in terms of their common standard deviation. (Cooper, 2010, p.170)" For the purposes of this meta-analysis, the statistic representing effect size in each article could be converted to "r." Correlation r is used as a measure of the strength of the association between two interval-scaled or ratio-scaled variables and is frequently referred to as Pearson's r or as the Pearson product-moment correlation coefficient. It ranges from -1 to +1, where the extremes indicate perfect correlation (Romal, 2008; Rosenthal, 1991). The "r's" for each study were combined and a confidence interval computed.

TABLE 2
SUMMARY OF ARTICLES FOR META-ANALYSIS OF STUDENT PERFORMANCE COMPARISON IN COLLEGE ECONOMICS EDUCATION BETWEEN ONLINE VS. FACE-TO-FACE CLASSROOM INSTRUCTION*

Author(s)	Research Design	Conclusion
Bennett et al (2007)	Final course grade as a percentage for 406 traditional and 92 internet students in macro courses at Jacksonville State University. Tested 6 undergrad variables using ordinary least squares.	Students performed better in traditional classroom than in online courses significant at p=.06. (Using all data from microeconomics and macroeconomics courses.)
Bosworth (2007)	The average of four exam scores of 589 students in traditional and 86 students in online principles macroeconomics courses at Utah State University. Used a treatment model and Heckman technique to recognize selection bias. Probit, maximum likelihood estimation, ordinary least squares. Tested 9 variables.	Online students generally outperformed their traditional counterparts after controlling for selection bias significant at p = .05.
Brown & Liedholm (2002)	Scores of 37 questions from exams that could be subdivided into three groups – definitions, application, and complex application of a concept. Students in Live	Students in virtual classes performed significantly (p=.01) worse on the examinations than the live students. The difference was most pronounced when

	(363), Hybrid (258), and Virtual (89) in principles of microeconomics courses at Michigan State University. Ordinary least squares and a Chow test. Tested 5 variables.	the questions required more sophisticated application of concepts and definitions.
Coates et al (2004)	Test of Understanding in College Economics (TUCE) scores, 92 students in virtual and 84 students in face-to-face courses in college level economics (both micro and macro) courses in three different colleges and universities (UMBC, SUNY Oswego, C. Newport U.), OLS, switching model, sparse Laplacian shrinkage. Tested 21 variables.	Students in online classes score 3-6 statistically significant ($p<.1$) fewer correct answers (out of 33 TUCE questions), and controlling for selection bias in the sparse Laplacian shrinkage model resulted in an 18% reduction nearly significant at $p=.102$. The endogenous switching model finds that students who select online classes perform better than they would, ceteris paribus, in a traditional face-to-face class.
Finlay & Deis (2004)	Final letter grades for 478 online and 1,288 students in campus classes were provided for Fall 1998 to Summer 2002 for Principles of Macroeconomics and Microeconomics at Clayton College & State University. Raw data from which a t-test of means was developed.	Students in campus classes performed better and the withdrawal rate was significantly higher for online students (30.3% to 21.4%). However, the main thrust was the introduction of Mimio Broadcast that improved student performance in both online and classroom instructions.
Gratton-Lavoie &Stanley (2009)	Final exam scores of 98 students in hybrid and 58 students in online introductory microeconomics classes at California State University. Tested 7 variables. Maximum likelihood estimation and t-test of means.	The online teaching mode has no significant effect compared to face-to-face instruction, after adjusting for course selection bias.
Horspool & Lange (2012)	Percentage grades as a measure of success. 88 out of 119 online students and 64 out of 71 face-to-face students replied to a survey. Principles of microeconomics courses taught by the same instructor using the same format at California State Polytechnic University. T-test of means.	No significant difference was found between success of online and face-to-face classes. Self-selection bias was not addressed, but the authors did examine why students choose the online course. Distance, scheduling and workload were significant factors.
Navarro (2000)	Final exam scores on a 15 short essay question test. Of 200 undergraduate students, 151 selected hybrid, 49 virtual in macroeconomics courses at the University of CA, Irvine. No moderators or selection bias. T-test of means.	A simple t-test shows significantly better performance by cyber-learners ($p=.014$) without controlling for selection bias.
Trawick et al (2010)	Four exams of thirty multiple choice questions from the text test bank were selected by someone other than the instructor, who taught the online and classroom courses. 78 students in the face-to-face class and 31 students in the online version at Western Kentucky University took the exams on campus. Ordinary least squares and sparse Laplacian shrinkage. 10 variables tested.	Students in online classes perform significantly worse ($p = .05$) than they would in a face-to-face course, after controlling for self-selection bias. Results show no selection bias for student choice and, using a switching model, choosing an online course lowers performance of a student by 23% evaluated at the mean from the entire sample.

*The terminology used in this table is that of the authors of each study.

RESULTS

Table 3 summarizes the main result of this study and is explained from left to right. Reporting only "r" (Cooper, 2010, p. 161), which is then used to convert to Fisher's z-scores, a 95% confidence interval can be calculated. The mean of the z-scores based on r is not in this interval and therefore the null hypothesis that there is no relation between the type of delivery and student performance can be rejected. Also, a sign test indicates that there is better performance in the face-to-face classes.

TABLE 3
TESTING DIFFERENCE IN STUDENT PERFORMANCE OF COLLEGE LEVEL ECONOMICS COURSES

Article:	N	Pearson's r [a]	Fisher's z_r = (½) ln((1+r)/(1-r))	N-3	(n-3)*(z_i)	z.=
Bennett et al (2002)	498	0.003469	0.003469	495	1.716963	
Bosworth (2007)	675	-0.13134	-0.1321	672	-88.7726	
Brown et al (2002)	452	0.104126	0.104505	449	46.92255	
Coates et al (2004)	128	0.144957	0.145985	125	18.24815	
Finlay & Deis (2004)	1,311	0.200741	0.203505	1,308	266.1843	
Gratton-Lavoie& Stanley (2009)	156	-0.19597	-0.19854	153	-30.3762	
Horspool & Lange (2012)	152	0.059122	0.059191	149	8.819449	
Navarro (2000)	200	-0.2543	-0.26001	197	-51.2216	
Trawick et al (2010)	109	0.190739	0.193104	106	20.46902	
Total/means	3,681	$r_=$ = .01 [b]	z_r = 0.013235	3,654	191.9901	z.= 0.052542 [c]

a. Conversions available from the authors.
b. Mean of the Pearson's r for each study. From Kanji,1999, p167
c. The confidence interval = z. +/- 1.96/√(3,654) = (0.020118, 0.084967). Since z_r = o is not in this interval, the null hypotheses that there is no relation between the type of delivery and student performance in face-to-face and online courses can be rejected.

Moderators were then examined for possible contributors to the differences in the method of instruction. The studies in this analysis included variables such as age, previous economics course, first generation college student, financial aid, GPA, SAT/ACT scores and others. Rosenthal (1991, p.81) emphasizes that moderators "should not be interpreted as giving strong evidence for any causal relation." He recommends statistics for moderators be calculated only when there are at least four studies. Age was statistically significant as a moderating variable in 5 studies. Thus, the moderating variable "age" could be combined and was significant, demonstrating that older students outperformed younger ones. Other moderators were not considered in a sufficient number of studies to make further analysis possible. These other, possible, moderators can, however, provide ideas for further research.

DISCUSSION

While this meta-analysis shows that students perform better in a face-to-face class, it is important to remember that education employs numerous activities that include technological contents (Sousa & Mirmirani, 2005; Sosin, Blecha, Agarwal, Bartlett & Daniel, 2004). Most frequently, students have access to online contents of class materials and correspond via email with instructors. Class notes, reading materials or problems sets are often posted online, and, instructors routinely use PowerPoint slides in

class lectures as well as online-workbooks provided by publishers of textbooks. It is extremely likely that all face-to-face classes use online delivery to some extent.

The dropout rate in online courses and the size of similar face-to-face classes are of concern. If the usual class size is 35 students and 22 are in an online class and 35 in the face-to-face, but professors are paid the same, the online class may be economical for the students, all other things being equal, but may not be cost beneficial for the institution (Coates et. al., 2004). Many fewer students selected online courses or fewer were available, but from the sizes of the classes, it appears that seats were available in the online courses, should students prefer that type of course (899 online to 2,782 face-to-face). Only Finlay and Deis (2004) provided data on withdrawal rates. Although 1,311 students remained to complete the courses, 30.3% had dropped the online version and 21.4 % the face-to-face classes. This confirms anecdotal reports and is significant ($t = 9.47$, $p = .05$). Navarro (2000a) questioned those who dropped before the drop date and suggests that they were course "shopping". However, it is possible students drop online courses because they put off working on them until it is too late to succeed or find the course material does not appeal to them. This issue needs further investigation and possible course redesign (Horspool & Lange, 2012).

Another feature of online courses that could not be easily controlled for is the changes in technology available for online courses. While this analysis still found significant differences between groups receiving face-to-face classes and those receiving online instructions only, online instruction involves a rapidly developing technology. For example, an online microeconomic course offered ten to fifteen years ago would not be the same microeconomics online course being offered today.

Similar logic can be applied to other variables in study design. Student ability and skills of earlier online or face-to-face courses may not be the same as those of 2012. Brown and Liedholm (2002) found performance differences were most pronounced when exam questions required sophisticated application of basic concepts rather than memorizing definitions or recognizing important concepts of economics. In their study, the students in the face-to-face course performed better than the online group on the questions that required sophisticated application of basic concepts (Ibid.). The meta-analysis could not pursue this difference because this information was not explicitly addressed in any of the other studies.

CONCLUSION

From this meta-analysis, several conclusions can be drawn. At the present time there is some reason to believe that face-to-face course delivery is superior to online; however, identifying the factors that contribute to that difference may alter elements of course design and management. More research into moderators to consider in course design and curriculum development is necessary. Knowledge of self-selection bias between online and face-to-face student performance would be valuable. Caution is needed *in moving* to online courses, because there may be drawbacks related to student depth of understanding, retention, and success, as well as convenience for students and costs to the institution.

Performance differences in online vs. face-to-face instruction certainly require more attention and should be addressed in designing new online economics courses. Contents requiring factual demonstration and simple information delivery might be more appropriate and effective for online college level economics courses, while other contents requiring more complex and sophisticated application may be delivered more effectively in a face-to-face environment; however, online instruction may also be more clearly designed to foster development of applied and abstract application of concepts.

FUTURE RESEARCH

Inquiry into moderators may lead to changes in focus in the courses and in curriculum development. As more studies become available and a greater number of possible moderating factors are controlled for, the results should expand understanding of this comparison issue. There are also practical considerations in monitoring online instruction such as the venue for testing and the nature of student responses required in testing. It is important to emphasize the judicious use of technology in instructional delivery methods

in principles of economics education. For course redesign, a more interactive and improved delivery, geared to identify moderators may reduce the dropout rate in online courses (Navarro, 2000a).

Several studies on moderators for this subject have shown less than conclusive/inconclusive results regarding 1) the performance differences and 2) relevant factors affecting the performance differences in online versus face-to-face instructions. One study showed that undergraduate students took online principles of microeconomics courses had higher ACT scores, more college experience, longer work schedules, and fewer reported study hours, compared to the students who took traditional courses (Brown & Liedholm, 2002). This study also showed that the students who took traditional courses received higher overall scores compared to their counterparts in the online courses, while highlighting the fact that the traditional students did significantly better on the more complex subject matter. Another study showed that students in the online introduction to macroeconomics courses were less likely to have taken previous economics courses, but have attained higher GPAs than the students in traditional macroeconomics courses (Shoemaker & Navarro, 2000). Yet another study suggested that those online economics students tended to be older in age, compared to the students in equivalent non-online, traditional in-classroom courses (Keri, 2003). Given the data sets with heterogeneous moderators' definitions and measures, it would not be meaningful to distinguish the moderators for discernment for the major impact(s) on the student performance in undergraduate principles of economics courses at this point. A randomized study that controlled for all moderators with the students randomly assigned to either an online or face-to-face section of larger scaled principles of economics classes in which the sole and only distinguishing factor between the two modes was the delivery of the lectures would be best. For the completeness of the study, the attrition rate should also be carefully examined and studied.

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