GENDER, MEASUREMENT CHOICE AND STUDENT ACHIEVEMENT IN INTRODUCTORY ECONOMICS

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ABSTRACT

This paper uses education production functions to examine how gender influences student achievement and learning in both the Principles of Microeconomics and Principles of Macroeconomics courses at Murray State University. This study examines the influence of gender using both grades in the class and score on the Test of Understanding College Economics (TUCE) as dependent variables with the same group of students. This allows us to compare the results from regressions which are identical in every way except for different measures of student achievement and learning. Our results indicate that the choice of measurement of student achievement (standardized test or course grade) as well as the course used in the study (macro vs. micro economics) will influence conclusions concerning a gender gap in the learning of economics.

INTRODUCTION

One of the most widely studied student characteristics in terms of the learning of economics has been gender of the student. Most of the existing evidence has suggested that males generally demonstrate a higher level of economic understanding than females and that this difference first appears during adolescence (high school) or possibly even earlier. The most common explanations offered in the literature for this "gender gap" include the existence of a cultural milieu that discourages women from engaging in analytical or quantitative analysis, the relative advantage of men in spatial and numerical skill, and a classroom climate that is not conducive to female learning (Ferber, Birnbaum, & Green, 1983, p. 29).

This study explores whether conclusions about gender differences in the learning of economics are dependent upon how researchers define learning in college principles (micro and macro) courses. This is performed within the context of education production functions using two different measures of student achievement. First we use the student's grade as the measure of achievement. Given the current emphasis on student retention at most universities, the use of grades is an important consideration. However, the discrete nature of grades as an outcome measure requires the use of ordered probit analysis. Second, we use the same data set and independent variables but we use the student's score on the Third Edition of the Test of

Understanding College Economics (TUCE III) as our measure of economic achievement. This dependent variable allows for the use of the ordinary least squares estimation technique.

In each of these specifications we attempt to address the question whether the level of knowledge and understanding (a stock) at the completion of the college principles course is different for female students than for males. Also, by utilizing both pre-course TUCE scores and post-course TUCE scores, we can address the question of gender differences in the rate of learning (a flow) which occurs in the courses. Thus, by comparing the results of the two estimations, inferences can be made as to whether the answers to the two previous questions depend upon the measure of achievement utilized: grade in the class or score on a standardized test.

BRIEF REVIEW OF RELATED LITERATURE

Over thirty years ago, Siegfried (1979) completed a comprehensive survey of research involving male-female differences in student performances on economics standardized tests. Siegfried makes the useful distinction between those studies that examine differences in the stock of knowledge vs. those that study the rate of learning in a given time period (for example during a course). However, nearly all of the results reviewed by Siegfried are obtained as a by-product of research primarily concerned with other issues in economic education. Upon completing the review, Siegfried concludes that the evidence on learning and understanding economics at the elementary school level indicates few differences between females and males. However, by the high school years, gaps (in favor of males) appear to develop. Thus, he accepts as conclusive the findings of several studies that showed a gender difference in understanding of economics at the time students graduate from high school. Differences in understanding seem to persist through the college years, but there does not necessarily appear to be any widening of the gap. Specifically, Siegfried concludes that about two-thirds of the studies relating to the level of understanding which took gender into account found statistically significant higher levels of understanding for males than for females, and these tended to be studies with larger samples and more sophisticated empirical methods. On the other hand, with regard to the rate of learning in college economics, only about one-third found a statistically significant difference in favor of men.

Most of the subsequent recent research concerning gender differences has addressed whether or not the gender gap exists, and if so when does it first appear, and if it widens in college. It is probably fair to summarize this research by characterizing it as a "mixed bag." Most studies still find the existence of a gap (especially in high school or college), but several do not.

Watts (1987) provides an exception to the conclusions of Siegfried by arguing that males exhibit a higher level of economic understanding as early as grade five. Other studies involving gender differences in student performance on standardized tests of economic knowledge (not all

focus specifically on the issue of gender, but all do explicitly contain at least one independent variable to control for gender) confirm the previous findings that males tend to score higher than females (Soper & Walstad, 1988; Walstad & Soper, 1988 & 1989), especially at the college level (Ferber, Birnbaum, & Green, 1983; Gohmann & Spector, 1989; Lumsden & Scott, 1987; Watts & Lynch, 1989; Fizel with Johnson, 1986). In particular, Heath (1989) concludes that undergraduate males exhibit a higher level of economic knowledge than females, but economic learning appears to occur at the same rate in college men and women. In addition, Heath maintains that in those cases where students take economics as an elective, it is likely that only the most analytical women will choose to take the course due to cultural factors discouraging women from displaying a proclivity for quantitatively oriented courses. She concluded that self-selection does occur in choosing an economics course as an elective and that the result is a downward bias to previous estimates of gender differences in the stock of economic knowledge.

However, several studies involving student performance on standardized tests of economic knowledge have not found a gender difference (Rhine, 1989; Buckles & Freeman, 1983; Watts, 1987; Beron, 1990). In addition, when essay questions are used instead of multiple choice, Ferber, Birnbaum, and Green (1983) report that the male-female differential is reduced while Lumsden and Scott (1987) report that the nature of the gap is even reversed. Additionally, in contrast to most other studies, Lumsden and Scott (1987) report that in their study female learning rates were lower than male learning rates. Williams, Waldauer & Duggal (1992, p. 229) used both multiple choice and essay question performance to measure student achievement and "found no evidence to support the hypothesis that significant gender differences exist in college students' performance on economic exams".

Results concerning the gender gap using course grade as the measure of achievement are similarly mixed. Reid (1983) found no significant difference between males' and females' grades in an introductory college economics course as did Brasfield, McCoy, and Milkman (1992) and Brasfield, Harrison and McCoy (1992). However, Myatt and Waddell (1990) found a negative and significant relationship between being female and performance (grade) in a college introductory economics course.

One other study of note involving the issue of gender differences in economic education analyzed the role of gender in terms of enrollment in a second economics course (persistence in the study of economics). Horvath, Beaudin, and Wright (1992) concluded that female students persisted in the study of economics in lower proportions than their male classmates and those females generally required higher grades than males in order to persist in economics.

Most of the early studies described above utilize standardized economics exams (mostly multiple choice) to address issues concerning the gender gap. Ballard and Johnson (2005) in a study of microeconomics principles use grades as the independent variable, no pretest (thus a stock measurement), and find that the independent effect of gender is small and insignificant. However expected grade has a positive and significant effect on class performance and males had a significantly higher expected grade than females. Arias and Walker (2004) use the total

score on four exams given during the term. No pretest is included in their independent variables and they find that while the coefficient for females is negative, again it is not statistically significant.

In this context, this project will provide additional evidence regarding answers to the following questions with respect to possible gender differences upon the completion of college principles (micro and macro) of economics classes:

1. Is there a difference between males and females in the stock of knowledge?
2. Is there a difference between males and females in the flow of learning which takes place in the course?
3. Do the answers to these two previous questions depend upon the measure of achievement utilized (standardized test or course grade)?
4. Do the answers to these two previous questions depend upon whether macro or micro economics is the subject used in the study?

METHODOLOGY AND VARIABLE DESCRIPTIONS

The standard approach to examining the effect of gender on the learning of economics high school economic education is through the use of education production functions (Murname, 1981 and Hanushek, 1979). A total of eight education production functions are estimated, four for performance in microeconomics, and four for performance in macroeconomics. Within each set of four for each course (micro and macro), the dependent variable used in two of the education production functions is the score on the Third Edition of the Test of Understanding College Economics (TUCE III). These two specifications differ only by whether or not each student's pretest score on the TUCE (administered at the beginning of the course) is included as an independent variable. Including the pretest score as an independent variable (Specification 1) allows for inferences concerning the flow of knowledge (learning) while helping with problems of possible omitted variable bias and autocorrelation (Hanushek, 1979). Not including the pretest as an independent variable (Specification II) implies that the posttest measure is a simple measure of the stock of knowledge at the completion of the course and thus it allows for more direct comparisons with much of the previously completed research in this area. We also ran regressions under the specification that the difference between the posttest score and the pretest score on the TUCE is the dependent variable (measure of achievement). The results for both macro and micro are qualitatively identical to those reported in Tables 3 and 4 for Specification I (posttest score as dependent variable with pretest score included as an independent variable).

The technique of ordinary least squares was used to estimate Specifications I and II (standard tests indicated each specification to not be significantly affected by heteroschedasticity). The other two specifications (Specification III and IV) utilized course

grade (A, B, C, D, or F) as the dependent variable and therefore employed the ordered probit estimation technique. Again, specifications III and IV differed only by the inclusion (or not) of the pretest TUCE score. There are two versions of the TUCE: one for microeconomics and the other for macroeconomics. Each student completed the TUCE during the final exam period of their introductory economics course. The score on TUCE determined between five and ten percent of the final course grade. The TUCE pretest was administered during the first two weeks of class to measure prior knowledge. The pretest contains exactly the same questions as the final exam TUCE.

While there are some advantages to using a standardized measure of economic achievement, using grades might be "a more appropriate measure of cognitive achievement than performance on a standardized test because we are explicitly attempting to measure the ability of students to master the specific content of the course as defined by the instructors" (Bonello, Swartz, & Davisson, 1984, p. 205). For those schools emphasizing retention of students, course grade may be the relevant dependent variable, because a major factor influencing the likelihood of a student remaining in school is his or her ability to meet the expectations of instructors.

In Specifications III and IV we assume the existence of an underlying, continuous grade scale of student final grades (call it Y*) for each course, which we assume to be identical across instructors except for a shift factor which is estimated in our regression. The observed dependent variable used here, actual letter grades, thus indicates the need for ordered probit estimation where one estimates the probability of observing the qualitative letter grades.

Table 1: Variable Descriptions

POSTTEST	score on TUCE III administered during final exam
ECOGRA	grade in this course (A=4, B=3, C=2, D=1, F=0)
SEX	male/female dummy variable (1 for female)
PRETEST	score on TUCE III administered during first two weeks of class
STATE	dummy variable (1 for in-state students)
TRANS	dummy variable (1 for transfer students)
COACT	composite ACT score
MA220	completed business math sequence dummy variable (1 if completed
HSECO	dummy variable (1 if the student has had high school economics)
REGHRS	number of credit hours for which student is registered this semester
CRHRS	number of credit hours completed by student prior to this semester
COLGPA	current college GPA
REPECO	dummy variable (1 if the student is repeating this course)
OTHGRA	grade received in the other principles course (A=4, B=3, C=2, D=1, F=0)
WORK	dummy variable (1 for students working on or off campus for pay at time of survey)
ACTIVE	number of extra-curricular activities in which student is involved
HOURS	hours student plans to study in this course per week
PEER	average grade in this class section of student

A brief description of the variables used in the education production functions is presented in Table 1. The measure of student achievement is either the posttest score on the

TUCE (POSTTEST) or grade achieved in the class (ECOGRA). Several of the independent variables measure more than one influence on student achievement. For example, composite ACT scores (COACT), current college GPA (COLGPA), the student preTUCE score (PRETEST), and completed college credit hours (COLHRS) are measures of not only innate ability but also school inputs. Having successfully completed a high school economics class (HSECO), the business math sequence (MA220), or the other Principles of Economics class (OTHGRA) are more logically categorized as strictly school inputs. Regardless, we expect the sign of all of these influences to be positive. Student background and characteristics measures include the student's gender (SEX), involvement in extra-curricular campus activities (ACTIVE), and employment (WORK). These student characteristics have been included in similar previous work with mixed results. Therefore, we assign no expected sign to them. Another student characteristic variable, HOURS, measures the hours per week a student intends to study for the course as reported by the student in the initial weeks of the semester. Recognizing the limitations of this measure, we nonetheless include it with an expected positive sign. Other student characteristic variables include whether or not the student is a transfer student (TRANS), number of hours for which the student is registered (REGHRS), and whether or not the student is repeating the course (REPECO). We include these variables with no a priori expected sign. The PEER variable, defined as the average grade in the class section of the student, is included to pick up peer learning effects, but we recognize that it will pick up instructor grading biases as well. For both of these reasons we expect it to have a positive sign.

DESCRIPTION OF THE DATA

The data used in this study come from four sources. A survey was completed by students in the principles class after the last day to add the class or to drop the class without a "W" (withdrawn--no grade) appearing on the student's transcript, but before the first exam. Students completed this survey during the class period on the date the survey was distributed. The second data source is a student file maintained by the academic records office. This file was used to verify GPA and ACT statistics (for a description of issues surrounding the use of self-reported vs. independently verified data see Maxwell and Lopus (1994)).

The third data source is the final grade reports filled out by the instructors of the two principles classes. These reports contain the data for the students' course grades. Letter grades are used to evaluate student performance at Murray State by instructors and thus we were constrained to working with this discrete dependent variable. Letter grades at our institution are not qualified with pluses and minuses. Therefore, possible letter grades are A, B, C, D, and F. The fourth source is the scoring sheets for each student on both the pretest and posttest TUCE.

Table 2 contains basic information on the Principles of Microeconomics and Principles of Macroeconomics classes used in this study. The classes used in this study include principles classes offered at Murray State University for seven semesters. Though students are free to take

either the microeconomics or macroeconomics class first, most students enroll in macroeconomics before microeconomics. One likely reason for this is that the course number for macroeconomics (ECO 230) is lower than the course number for microeconomics (ECO 231).

Table 2: Descriptive Statistics for Macro Principles (based on 469 observations)

Variable	Total Mean (Std.Dev.)	Mean for Males (Std.Dev.)	Mean for Females (Std.Dev.)	Mean for Difference (t-stat.)
POSTTEST	13.307	13.531	13.070	.461
	(4.312)	(4.401)	(4.212)	(1.158)
ECOGRA	2.252	2.232	2.272	- .040
	(1.121)	(1.383)	(1.105)	(- .381)
SEX	.486	---	---	---
	(.500)			
PRETEST	9.612	9.988	9.215	.773**
	(2.886)	(3.019)	(2.688)	(2.926)
STATE	.669	.660	.680	- .020
	(.471)	(.475)	(.468)	(- .461)
TRANS	.115	.137	.092	.045
	(.320)	(.344)	(.290)	(1.524)
COACT	22.528	22.477	22.561	- .084
	(3.751)	(3.742)	(3.768)	(- .778)
MA220	.345	.303	.390	- .087*
	(.476)	(.460)	(.489)	(-1.993)
HSECO	.243	.295	.189	.106**
	(.429)	(.457)	(.392)	(2.696)
REGHRS	15.456	15.382	15.535	- .153
	(2.305)	(1.995)	(2.522)	(-.728)
CRHRS	48.699	49.299	48.066	1.233
	(24.904)	(25.475)	(24.326)	(.536)
COLGPA	2.762	2.649	2.881	- .232**
	(.645)	(.641)	(.630)	(-3.942)
REPECO	.100	.112	.087	.024
	(.301)	(.316)	(.284)	(.876)
OTHGRA	.200	.191	.210	- .020
	(.718)	(.699)	(.739)	(- .296)
WORK	.420	.357	.487	- .130**
	(.494)	(.480)	(.501)	(-2.868)
ACTIVE	1.019	1.029	1.099	.020
	(1.009)	(.946)	(1.074)	(.216)
HOURS	2.876	2.797	2.960	- .164
	(2.207)	(2.157)	(2.259)	(-.803)
PEER	2.112	1.943	1.973	- .029
	(.399)	(.458)	(.448)	(- .695)

*Indicates significance at the .05 level.

**Indicates significance at the .01 level.

Table 2: Descriptive Statistics for Micro Principles (Continued--) (based on 345 observations)				
Variable	Total Mean	Mean for Males	Mean for Females	Mean for Difference
	(Std.Dev.)	(Std.Dev.)	(Std.Dev.)	(t-stat.)
POSTTEST	13.864	14.783	13.060	1.723**
	(4.694)	(4.838)	(4.423)	(3.455)
ECOGRA	2.441	2.466	2.419	.047
	(1.071)	(1.037)	(1.103)	(.409)
SEX	.533	---	---	---
	(.500)			
PRETEST	10.423	10.484	10.370	.114
	(3.300)	(3.504)	(3.113)	(.320)
STATE	.655	.683	.630	.053
	(.476)	(.467)	(.484)	(1.028)
TRANS	.136	.174	.103	.071
	(.344)	(.380)	(.305)	(1.913)
COACT	22.235	22.590	21.924	.666
	(3.642)	(3.573)	(3.684)	(1.699)
MA220	.478	.466	.489	- .023
	(.500)	(.500)	(.501)	(- .431)
HSECO	.267	.329	.212	.117**
	(.443)	(.471)	(.410)	(2.471)
REGHRS	15.458	15.416	15.495	- .079
	(2.465)	(2.360)	(2.559)	(- .297)
CRHRS	63.089	61.217	64.726	-3.509
	(25.680)	(27.281)	(24.149)	(-1.267)
COLGPA	2.778	2.690	2.854	- .164**
	(.627)	(.686)	(.562)	(-2.441)
REPECO	.087	.099	.076	.023
	(.282)	(.300)	(.266)	(.764)
OTHGRA	1.745	1.665	1.815	- .151
	(1.364)	(1.410)	(1.322)	(-1.024)
WORK	.568	.615	.527	.088
	(.496)	(.488)	(.500)	(1.643)
ACTIVE	1.284	1.547	1.054	.492**
	(1.248)	(1.304)	(1.153)	(3.722)
HOURS	5.477	5.251	5.674	- .422
	(2.990)	(2.794)	(3.145)	(-1.31)
PEER	2.127	2.174	2.085	.088
	(.430)	(.457)	(.402)	(1.903)
*Indicates significance at the .05 level.				
**Indicates significance at the .01 level.				

Differences in the total mean values of many of the variables between macro and micro are attributed to the fact that most students take ECO 230 (macro) prior to ECO 231 (micro). The OTHGRA values in Table 2 are consistent with this typical ordering. Since the majority of students take macro first, micro students typically have completed one more semester than macro students. This extra semester of college experience for the typical micro student is evidenced by the 14.4 difference in the mean values of "COLHRS" of the two groups. It is interesting to note

that the mean values of the sex variable are higher in ECO 231 (micro) than they are in macro (230). That is, the majority (51.4%) of students in macro (typically the first class taken) are males while the majority of students (53.3%) in micro (typically the second class taken) are females. Unlike the results of Horvath, Beaudine, and Wright (1992), these data provide a less than rigorous (since not all students take macro first and some students transfer in credit for one of the courses) indication that at Murray State University females may be better "persisters" than males in principles of economics.

The difference between mean posttest and pretest scores is slightly larger in macro than it is in micro. This is probably because most students enroll in macro before micro. Mean pretest scores are higher for students in microeconomics since they have presumably learned some economics in the macroeconomics class. Also the mean value of ECOGRA (as well as PEER) is higher for the microeconomics class. This may be due to a filtering process. Those students who do not do well in the macroeconomics class may decide not to enroll in the microeconomics class.

Also included in Table 2 for both courses are means and standard deviations for each of our variables broken down by male and female samples. The final column lists differences in these means (male mean minus female mean) and the difference in means t-statistic. While not necessarily surprising, some of the significant differences are nonetheless interesting.

Males score significantly higher than females on both the pretest TUCE and the posttest TUCE in macro. Thus, males appear to begin the macro course, typically the first course taken (only 8% of the macro students in our sample had already passed micro) with a higher stock of knowledge (as measured by the TUCE) as well as end the course with a higher stock of knowledge. This is consistent with the higher proportion of males (29.5% vs. 18.9% for females) who have completed a high school economics course. However, while on average males score higher on the pretest in micro, the difference is not statistically significant. Thus, when students start micro (70% of whom have already passed macro), the gender gap as measured by the TUCE is narrowed or nonexistent. This could occur due to a relative increase in the stock of economic knowledge by females between macro and micro or a decrease in the relative stock of knowledge on the part of males. Another explanation is that the thirty percent of the students in micro who have not taken macro are responsible for this result. It is also possible that females approach the pretest in a more serious fashion than males. Regardless, at the completion of the micro course males score significantly higher than females on the TUCE for that course. Thus, the gender gap seems to reappear. Regardless, these data are consistent with regression results to be reported in the next section.

Other interesting and possibly related results become evident upon perusal of female/male differences with respect to the Composite ACT score (COACT), repeating the course (REPECO), and the grade in the other economics course (OTHGRA). While no significant difference exists between female and male ACT scores in the macro course, males in the micro course have significantly higher ACT scores. Thus some filtering may be occurring

based upon gender specific characteristics embodied in the ACT. Possibly related is the fact that the macro grades of females in micro are higher (but not significantly) than those of males. Females are also more likely to have completed the business math sequence (MA220) before enrolling in macro. (This is even more remarkable since the mean number of credit hours earned at time of enrollment in macro is greater for females than for males.) In addition, females are less likely to be repeating the micro course and possess higher college GPA's (COLGPA) than males in both courses. These results are consistent with the previously reported conclusion that "females require more concrete symbols of success (higher grades) than males in order to continue in the introductory economics sequence" (Horvath, Beaudin, & Wright, 1992, p. 107). It also seems to indicate that on average our females are "better students" with respect to course work (at least in terms of grades) than our male students. There is more to come on this later.

EMPIRICAL RESULTS

Table 3 contains the estimated education production functions for the macroeconomics class and Table 4 contains the estimates for the microeconomics class. The first column of each table presents estimates for the OLS regression using the TUCE posttest as the dependent variable and including the pretest as an independent variable (Specification I). The specification estimated in the second column (Specification II) is identical to the first except the pretest is not included as an independent variable. The third column presents estimates for the ordered probit regression with course grade as the independent variable (Specification III) with pretest included, while the specification estimated in the fourth column (Specification IV) is identical to the third except the pretest is not included as an independent variable.

Table 3: Macro Regression Results

Specification:	I: OLS Post as Dep. Variable	II: OLS Post as Dep. Variable	III: Ordered Probit Grade as Dep. Variable	IV. Ordered Probit Grade as Dep. Variable
CONSTANT	3.052	5.707**	-4.935	-4.410
	(1.759)	(3.320)	(-9.228)	(-8.688)
SEX	-0.495	-.751*	-0.239*	-0.281*
	(-1.413)	(-2.096)	(-2.078)	(-2.446)
PRETEST	.336**	---	0.059**	---
	(5.495)	---	(3.269)	---
TRANS	1.159	1.197*	-0.066	-0.057
	(2.079)	(2.080)	(- .379)	(- .322)
COACT	.339**	.401**	0.087**	0.096**
	(6.321)	(7.430)	(-5.908)	(-6.550)
MA220	-0.335	-0.44	.268*	0.248*
	(- .920)	(-1.172)	(2.275)	(2.110)
HSECO	-0.734	-0.795	-0.117	-0.125
	(-1.850)	(-1.942)	(- .925)	(- 1.002)
REGHRS	-0.132	-0.146	-0.002	-0.004
	(-1.692)	(-1.815)	(-.064)	(-.144)

Table 3: Macro Regression Results				
Specification:	I: OLS Post as Dep. Variable	II: OLS Post as Dep. Variable	III: Ordered Probit Grade as Dep. Variable	IV. Ordered Probit Grade as Dep. Variable
CRHRS	0.004	0.005	0.0003	0.001
	(0.483)	(0.659)	(0.131)	(-0.266)
COLGPA	1.019**	1.045**	1.082**	1.070**
	(-3.093)	(3.075)	(11.999)	(-12.742)
REPECO	-0.982	-1.133	-0.014	-0.042
	(-1.628)	(-1.822)	(-.079)	(-.248)
OTHGRA	0.093	0.231	0.045	0.068
	(0.379)	(0.923)	(0.529)	(-0.783)
WORK	0.01	-0.08	-0.143	-0.154
	(-0.027)	(-.222)	(-1.247)	(-1.342)
ACTIVE	-0.234	-0.296	-0.069	-0.079
	(-1.292)	(-1.590)	(-1.180)	(-1.345)
HOURS	.311**	.313**	.254**	0.252**
	(3.931)	(3.842)	(14.929)	(15.269)
PEER	-.886*	-1.149**	.665**	0.612**
	(-2.293)	(-2.903)	(5.594)	(-5.114)
MU(1)			1.29	1.279
			(10.231)	(-10.285)
MU(2)			2.694	2.663
			(18.654)	(-19.017)
MU(3)			4.201	4.148
			(23.84)	(-24.568)
R^2	0.323	0.277		
F	14.42**	12.49**		
Log-Likelihood			-500.84	-505.59
Restricted Log-L			-702.91	-702.91
Chi-Squared			404.15	394.63
Significance Level			0	0
NOTES: T-Statistics are in parenthesis.				
*indicates significance at the .05 level.				
**indicates significance at the .01 level.				

Table 4: Micro Regression Results				
Specification:	I: OLS Post as Dependent	II: OLS Post as Dependent	III: Ordered Probit Grade as Dep. Variable	IV. Ordered Probit Grade as Dep. Variable
CONSTANT	2.07	2.588	-3.524	-3.524
	-0.948	(1.152)	(-5.786)	(-5.836)
SEX	-1.998**	-1.945**	-0.178	-0.178
	(-4.512)	(-4.265)	(-1.373)	(-1.374)
PRETEST	.328**	---	.00001	---
	(4.601)	---	(.001)	---
TRANS	0.094	0.513	0.052	0.052
	(0.146)	(0.781)	(0.284)	(0.295)
COACT	.371**	.492**	.053*	0.053**
	(5.285)	(7.342)	(2.530)	(3.007)

Table 4: Micro Regression Results				
Specification:	I: OLS Post as Dependent	II: OLS Post as Dependent	III: Ordered Probit Grade as Dep. Variable	IV. Ordered Probit Grade as Dep. Variable
MA220	-0.798	-0.772	0.049	0.049
	(-1.859)	(-1.747)	(0.378)	(.378)
HSECO	-0.607	-.550	.032	-0.032
	(-1.266)	(-1.113)	(- .221)	(-.222)
REGHRS	-0.112	-0.12	.008	0.008
	(-1.260)	(-1.304)	(0.301)	(.302)
CRHRS	.019*	.024**	0.002	0.002
	(-2.246)	(2.786)	(0.791)	(0.818)
COLGPA	1.507**	1.460**	1.038**	1.038**
	(3.75)	(3.527)	(10.572)	(10.692)
REPECO	0.086	0.251	.500*	0.501*
	(0.112)	(.316)	(2.017)	(2.017)
OTHGRA	0.138	0.214	0.127**	0.127**
	(0.821)	(1.249)	(2.772)	(2.857)
WORK	-0.187	-0.378	-0.088	-0.088
	(- .436)	(- .859)	(- .665)	(- .690)
ACTIVE	-.393*	-.436*	-0.061	-0.061
	(-2.149)	(-2.317)	(-1.050)	(-1.050)
HOURS	-0.106	-0.138	-0.032	-0.032
	(-1.488)	(-1.893)	(-1.388)	(-1.395)
PEER	0.464	-0.366	0.717**	0.717**
	(- .941)	(- .721)	(4.824)	(4.865)
MU(1)			0.974	0.974
			(7.214)	(7.241)
MU(2)			2.121	2.121
			(14.067)	(14.126)
MU(3)			3.577	3.577
			(19.317)	(19.335)
R^2	0.373	0.332		
F	13.06**	11.77**		
Log-Likelihood			-405.26	405.26
Restricted Log-L			-500.02	500.02
Chi-Squared			189.51	189.51
Significance Level			0	0
NOTES: T-Statistics are in parenthesis.				
* indicates signifcance at the .05 level.				
** indicates significance at the .01 level.				

Our results lend support to the hypothesis that the existence of a gender gap in economics depend upon the specification of the model, and in our case, even the course under study (macro vs. micro). Inferences concerning the possible existence of a gender gap in favor of males appear to be linked to the various characteristics and issues embodied in the eight different regression estimates. These characteristics and issues include whether results concerning macro or micro are analyzed, what measure of achievement is utilized (TUCE vs. course grade), and whether the interest is in stock or flow of learning.

In the macro regressions (Table 3), the estimate of the gender variable (where male = 0 and female = 1) is negative but insignificant in our "value added" or flow specification (I). However, in our simple stock specification (II) the estimate of the gender variable is negative and significant. These results, in conjunction with those of Table 2, seem to indicate that females begin (using the pretest TUCE) and end the macro course (typically their first college course) with a lower stock of knowledge than males, regardless of whether we use the TUCE or course grade as our dependent variable. But given that Specification I for macro leads to no significant difference in the gender variable, when other factors are accounted for, the gap does not necessarily get larger during the macro course. This is consistent with much of the previous research. However, the results for the gender variable in the microeconomics regressions present a different picture. While similar to macro, the coefficient for sex is negative and significant when using the TUCE as our measure of achievement (for micro in both Specifications I and II), but unlike macro, the coefficient is negative but insignificant in Specifications III and IV when grades are used as the dependent variable. This result for micro using grades is consistent with the findings of Ballard and Johnson (2005). Thus, using TUCE as our measure of knowledge, females not only finish microeconomics with a lower stock of knowledge but they do so at least in part because they learn less during the course. However, they do not necessarily receive lower grades. We also estimated "gender specific" education production functions separately for males and females in our sample as a quick test for gender differences in our estimates. No remarkable qualitative differences were found. Within these "gender specific" regressions we also included a teacher-gender variable, but found no significance for this variable for males or females. It appears that the choice of dependent variable, or measurement of achievement (TUCE vs. course grade), will influence our conclusions regarding the existence of a gender gap in microeconomics (generally the last course taken here) but not in earlier macroeconomics! Table 5 summarizes the results regarding the possible existence of a gender gap in both courses.

TABLE 5

Specification:	I. TUCE with pretest	II. TUCE no pretest	III. Grade with pretest	IV. Grade no pretest
Macro Results for Student Gender	Negative but NOT Significant	Negative and Significant*	Negative and Significant*	Negative and Significant*
Micro Results for Student Gender	Negative and Significant*	Negative and Significant*	Negative but NOT Significant	Negative but NOT Significant

Tables 3 and 4 also illustrate the importance of other independent variables in predicting student achievement in both classes. Not surprisingly, students' pretest scores are significant predictors of their posttest scores in both regressions. The macro pretest score is also a significant predictor of a student's grade in macro. College grade point average (COLGPA) is a significant predictor of achievement for all specifications in both macroeconomics and microeconomics. This finding is consistent with previous pedagogical research both in and out of economics (for example see Clauretie & Johnson, 1975) and simply confirms the hypothesis

that previous achievement is a good predictor of future achievement. Similarly, coefficients for students' Composite ACT scores (COACT) are positive and significant in all specifications for both macro and micro.

The PEER variable is also significant and positive in Specification III for both courses. Simply interpreted, the better the grades of an entire section, the better an individual student is likely to do in either macroeconomics or microeconomics. This could be due to instructor grading biases (some instructors giving generally higher grades than others) or due to "true" peer learning effects. We also tried one other specification of the PEER variable: Using the mean COLGPA for each class section as our PEER variable. This alternative peer variable was not statistically significant in any of the regressions. We also tried adding instructor dummy variables. The instructor dummy variables did not change the impact of the PEER variable or the alternative specification of the PEER variable when grade was used as the dependent variable, however both the PEER variable and the alternative specification of the peer variable were insignificant when the instructor dummy variables were included. These results highlight the difficulty of separating out the peer learning effects from instructor grading biases and other section specific effects.

The math sequence variable MA220, is positive and significant in the macroeconomics regression but not the microeconomics regression. One possible explanation for this result is that principles of macroeconomics typically incorporates more algebra, especially in national income determination models, than does microeconomics. Or, possibly students learn the necessary mathematical tools in macro (typically the first course) and therefore don't need to have completed the math sequence before micro. Finally, students with poor math skills may not "persist" to micro and therefore are not present in the micro sample to make a significant difference. Oddly, the intended study hours variable is positive and significant in all specifications for macro but negative (however insignificant) in the micro regressions. Finally, one variable of interest found not to be significant in Specification III or IV of either course is number of completed college credit hours (CRHRS). This result runs counter to previous research (for example see Clauretie & Johnson, 1975), who found the same variable to be positively related and significant with course grade.

CONCLUSIONS

Our results indicate that conclusions concerning the existence of a gender gap may depend upon how the achievement variable is specified and which principles of economics course is under study. In our sample, and using the TUCE as our measure of knowledge, females appear to begin and end the college principles of economics course with a lower stock of knowledge. Results concerning a gender gap in the flow of learning however are mixed. Again, using TUCE scores as our measure of economic knowledge, the gap between males and females does not widen in our macro courses but it does widen in our micro courses. Results are also

mixed when grades are used as the measure of achievement but, with respect to macro and micro, in an opposite fashion. Specifically, females do not receive significantly lower grades in micro (when several other factors are accounted for) but they do in macro, where they begin with less knowledge perhaps due to a lack of interest or exposure to economics in high school.

Regardless of whether the perception of course grades is that they measure a stock (the more common) or a flow of knowledge, it is quite clear that the choice of measurement of achievement, or the dependent variable (TUCE score vs. course grade), as well as whether macro or micro principles of economics is the course under study, can dramatically influence conclusions concerning the gender gap (and possibly other issues as well) when estimating education production functions. If stock of knowledge is the issue, in our sample, using TUCE scores would lead to the conclusion that a gender gap exists in both macro and micro while if course grades are used, the gap only appears in macro. If flow of knowledge is the issue, using our sample's TUCE scores would lead to the conclusion that the gap exists in micro but not macro, while using grades would indicate it exists in macro but not in micro. Clearly the choice of dependent variable in estimating economic education production functions as well as the specific economics course under study (principles of macro vs. micro) is critical when addressing the role of gender in learning economics.

Unfortunately, these results lead to more questions (all of which are related) than definitive answers. Just what does constitute "knowledge" in introductory college economics? What are appropriate and accurate measures of this knowledge? Are gender differences in learning really different in macro vs. micro economics? Are measured gender differences a result of biases in the measurements themselves, or a result of different learning styles of males and females thus requiring concrete actions to improve the classroom climate for females (as suggested by Ferber 1984 and 1990)? While our estimates of simple gender specific education production functions could not provide any evidence of obvious learning style differences, we are far from convinced that this issue has been fully explored. Therefore, this area we believe to be a fruitful avenue for future research.

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