

The Gender Gap in Undergraduate Economics Course Persistence and Degree Selection

Job Market Paper

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Abstract

The gender gap in degree attainment among undergraduate economics students has been well documented. Prior research finds that women are less likely to persist in economics courses and major in economics. Gender disparities may also exist in the type of economics degree students select. This study uses a series of logistic regressions to examine male and female economics course persistence at a large, state university via a combination of student, instructor, and structural characteristics. The study also assesses gender differences in a student's choice of an economics degree from among a Bachelor of Science, a Bachelor of Arts, or an economics minor. Findings indicate that grades in economics courses are a significant determinant of course persistence and degree selection. Women's choices are correlated with the grades they receive in their economics classes relative to the grades they earn in other departments' courses, while men's decisions are affected by both their absolute and relative economics grades. Additionally, women who choose an economics major by the time they complete their second economics course have a higher likelihood than their male counterparts of advancing to a subsequent economics course. Results also indicate that women's math and verbal abilities are significantly correlated with their choice of economics degree, but men's degree selection process is primarily influenced by their math aptitude. This study suggests that offering multiple types of economics degrees may encourage women with strong language skills to choose an economics major; however, women may never consider an economics degree if they perceive low relative grades in their economics courses as a signal that they will not be successful.

1 Introduction

Women represent approximately 58% of all undergraduates, suggesting that colleges and universities are ripe with potential female recruits into economics (Ball, 2012; Ceci et al., 2014; Goldin, Katz, & Kuziemko, 2006). Yet nationwide women comprise approximately one-third of all economics bachelor's degree-earners in the United States, a proportion that has remained relatively stagnant for over twenty years (Ball, 2012; Ceci, Ginther, Kahn, & Williams, 2014; Goldin, 2013; Kim, Markham, & Cangelosi, 2002; McElroy, 2014; National Center for Education Statistics, 2015; Rask & Tiefenthaler, 2008; Siegfried, 2016). The percentage of women earning an economics degree has also declined slightly since the early-2000s, despite increases in the overall number of economics majors (Bayer & Rouse, 2016; Siegfried, 2016). The reason for the gender gap does not appear to be that women are necessarily uninterested in business-related or math-intensive careers. Women represent approximately half of all graduates in business and STEM (Science, Technology, Mathematics, and Engineering) fields, and the gender gaps in degree attainment in many of these majors have decreased in the last two decades (Ball, 2012; Ceci et al., 2014; Kim et al., 2002; Malgwi, Howe, & Burnaby, 2005). In fact, women who earn higher math SAT scores are more likely to major in engineering or the physical sciences than in economics (Ceci et al., 2014; Turner & Bowen, 1999). Many women may never even consider majoring in economics (Calkins & Welki, 2006). They are also significantly less likely than men to take an introductory economics course and have a lower likelihood of economics course persistence (Dynan & Rouse, 1997; Emerson, McGoldrick, & Mumford, 2012; Fournier & Sass, 2000; Horvath, Beaudin, & Wright, 1992; Rask & Tiefenthaler, 2008).

Studies have analyzed the determinants of the gender gap through a variety of factors, including interest in economics, math ability, economics course grades (both absolute and relative), pedagogical methods, class size, and the influence of same-sex role models and peers (Chizmar, 2000; Dynan & Rouse, 1997; Emerson et al., 2012; Goldin, 2015; Horvath et al., 1992; Jensen & Owen, 2001; Rask & Tiefenthaler, 2008; Robb & Robb, 1999). Most of this prior research has emphasized student selection between an economics major and a non-economics one, rather than the choice among different types of

economics degrees, such as a Bachelor of Science (B.S.), a Bachelor of Arts (B.A.), or an economics minor. Prior studies have also assessed students' decisions to take a first college economics course as well as their economics course persistence (Emerson et al., 2012; Fournier & Sass, 2000; Horvath et al., 1992; Rask & Tiefenthaler, 2008). However, that research has not incorporated data from students who received economics course equivalency prior to entering an institution by earning a passing grade on an Advanced Placement (AP) economics exam, nor have many of the studies included instructor effects.

I build upon prior research by analyzing gender differences in economics course persistence and degree selection among undergraduate students at a land grant and comprehensive public university. Using a series of binary logit models, I consider how student, instructor, and structural characteristics differentially affect the likelihood of taking additional courses beyond introductory microeconomics. The data includes students who take all economics courses through the university as well as those who pass an Advanced Placement (AP) economics exam. Additionally, I use multinomial logit models to assess how student characteristics and college coursework influence the type of economics degree students select.

Findings are consistent with prior research that female students overall are less likely to persist in economics courses beyond those required by their major and are less likely to earn an economics degree. Students' grades in their economics courses are a significant predictor of course persistence for both men and women. Women's course persistence is significantly correlated with their relative economics course grades in comparison to their grades received in other departments' courses. Men's persistence is strongly affected by both their absolute and relative economics course grades. Female students who declare an economics major by the time they take their second course have a higher likelihood than their male counterparts of both economics course persistence and graduating with an economics degree. Finally, men's choice of economics degree is significantly correlated with only their math abilities, while women's degree selection is affected by both their math and verbal aptitudes. In particular, women with a higher math SAT score are more likely to choose a quantitative B.S. degree in economics, while women with a higher verbal SAT are more likely to select a B.A. degree in economics.

2 Prior Literature

Although there is a small body of literature examining the gender disparities in economics course persistence and degree attainment among undergraduate students, prior studies all conclude that a significant gender gap exists. Yet research has not been able to reach any definitive explanations for this gender gap. Some studies have assessed student characteristics related to ability and aptitude, such as math and verbal standardized test scores, college economics course performance, and high school coursework and GPAs (Ashworth & Evans, 2001; Chizmar, 2000; Dynan & Rouse, 1997; Emerson et al., 2012; Goldin, 2015; Horvath et al., 1992; Rask & Tiefenthaler, 2008; Turner & Bowen, 1999). Other research has analyzed gender differences in students' interest in and opinions about economics (Ashworth & Evans, 2001; Ballard & Johnson, 2005; Bansak & Starr, 2010; Calkins & Welki, 2006; Jensen & Owen, 2001). Additional studies have examined the effects of instructor gender and environmental characteristics, including class size and peer ability (Ashworth & Evans, 2001; Bettinger & Long, 2005; Emerson et al., 2012; Fournier & Sass, 2000; Jensen & Owen, 2001; Rask & Bailey, 2002; Robb & Robb, 1999).

Gender differences in math preparation and ability may be one reason for the gender gap in economics course persistence and degree selection, but research findings are mixed. Some evidence suggests that women with higher math SAT scores may be more likely to take economics courses and major in economics (Dynan & Rouse, 1997; Rask & Tiefenthaler, 2008). However, findings also indicate that math performance on standardized exams may only explain a small part of the gender gap in economics course persistence and the decision to major in economics (Dynan & Rouse, 1997; Emerson et al., 2012; Horvath et al., 1992; Jensen & Owen, 2001; Rask & Tiefenthaler, 2008). For instance, using a decomposition analysis Turner and Bowen (1999) found that less than 1% of the gender gap among economics majors could be explained by differences in men and women's math SAT scores. Additionally, some evidence indicates that women with higher math SAT scores may be less likely to persist in enrolling in additional economics courses beyond the first one (Horvath et al., 1992; Rask & Tiefenthaler, 2008).

Students also make academic decisions based on their relative math and English abilities. Both male and female students who have a comparative advantage in math over English are more likely to take subsequent economics courses and to major in economics. For example, Rask and Tiefenthaler (2008) found that students' math SAT scores positively affect economics course persistence, while verbal SAT scores are negatively correlated with persistence in economics courses. Ashworth and Evans (2001) found that students with higher scores on a standardized math exam relative to their scores on an English exam are more likely to choose an economics degree than an arts or humanities degree. Women tend to have a comparative advantage in English over math (Davison, Jew, & Davenport, 2014; Turner & Bowen, 1999). As a result, they may be less likely to take economics courses and choose economics as a major.

Other proxies of students' ability, such as their high school coursework and achievement, may also affect students' selection of an economics major. Students who take a high school economics course are more likely to major in economics than business (Ashworth & Evans, 2001; Bansak & Starr, 2010; Lopus, 1997). Research also shows that students may have a strong propensity to pursue majors in which they take Advanced Placement (AP) exams (Mattern, Shaw, & Ewing, 2011; Morgan & Klaric, 2007). In fact, students who pass an AP Microeconomics or Macroeconomics exam with a score of a 4 or 5 are more inclined to major in economics (Avery, Gurantz, Hurwitz, & Smith, 2016; Morgan & Klaric, 2007). Since many states do not require students to take a high school economics course (Council for Economic Education, 2016), it is possible that students who do, especially those who take an AP course, may have a stronger interest in economics than students who do not take an economics course in high school. Evidence also indicates that students who take a high school economics course may earn higher grades in their introductory economics courses in college, which may represent a mediating factor in students' academic decisions (Brasfield, Harrison, & McCoy, 1993; Melican, Debebe, & Morgan, 1997).

Course grades may provide a signal of success in a field of study, and a considerable amount of research suggests that students' grades in their college courses are a significant determinant of their major choice (Ashworth & Evans, 2001; Butcher, McEwan, & Weerapana, 2014; Emerson et al., 2012; Rask & Bailey, 2002; Riegle-Crumb, King, & Moore, 2016). The grades students earn in courses within their

selected major are positively correlated with persistence in that major (Chizmar, 2000; Griffith, 2010; Ohland, Zhang, Thorndyke, & Anderson, 2004; Ost, 2010; Riegle-Crumb et al., 2016). Moreover, when students' non-major course grades increase relative to their major course grades, they may be more likely to change majors (Griffith, 2010; Ost, 2010). Students are also less inclined to persist in taking additional courses in an academic domain when they receive a low grade in an introductory course in that field (Sabot & Wakeman-Linn, 1991).

While some evidence suggests that women perform worse than men in economics courses, the results are mixed. Women may tend to earn lower grades than men in their introductory economics courses (Ballard & Johnson, 2005; Dynan & Rouse, 1997; Elzinga & Melaugh, 2009; Emerson et al., 2012). Other research, however, has found that women perform as well as or even better than their male counterparts in their introductory economics courses (Rask & Tiefenthaler, 2008; Swope & Schmitt, 2006; Terry, 2002). Additionally, women may outperform men in their intermediate and upper-level courses (Asarta, Butters, & Perumal, 2014; Rask & Tiefenthaler, 2008). Furthermore, a recent meta-analysis of studies on the gender gap in economics performance from 1980 to 2013 suggests that, while the majority of older studies indicate males outperform females, the gender performance gap has been shrinking (Johnson, Robson, & Taengnoi, 2014). In fact, the findings indicate that since 2005 there has been a notable increase in research showing women outperforming men in their economics courses.

Even if gender gaps in economics course performance are not significant, gender disparities in economics ability self-efficacy may exist. Confidence in economics ability is a significant predictor of economics course persistence and the intent to major in economics, and women exhibit less confidence in their economic understanding than men (Jensen & Owen, 2000; Jensen & Owen, 2001; Nowell & Alston, 2007). Women tend to view economics as more difficult and less easy to understand (Bansak & Starr, 2010; Bollinger, Hoyt, & McGoldrick, 2009). Women also express greater discomfort with graphs and more fear of freezing up on economics exams (Cohn, Cohn, Balch, & Bradley, 2004; Jensen & Owen, 2001). Furthermore, while male students tend to over-predict their economics course grades, women often expect lower grades than men in economics courses, especially in their introductory ones (Ballard &

Johnson, 2005; Grimes, 2002; Jensen & Owen, 2001; Nowell & Alston, 2007). The role of expectations in economics grades may also be self-fulfilling. In one study, students who expected a lower grade in their first economics course performed significantly worse than those with higher-grade expectations (Ballard & Johnson, 2005).

Women may also be more sensitive to their economics grades than men. Female students may need higher grades than male students in order to persist in taking additional economics courses and choose economics as a major (Emerson et al., 2012; Goldin, 2013; Goldin, 2015; Owen, 2010; Rask & Tiefenthaler, 2008). Women who receive low grades in their economics courses may be less likely to take additional courses in economics, while male students may continue to persist in taking subsequent economics courses regardless of poor performance (Goldin, 2013; Rask & Tiefenthaler, 2008). Yet higher grades alone do not necessarily predict greater course persistence, particularly for women. Although students who earn higher grades in their first economics course are more likely to continue in economics, the probability of persistence is still lower for females, even among those who earn letter grades of an “A” (Horvath et al., 1992).

Course grades also provide information to students about their comparative advantage in a particular academic field, allowing them to evaluate their relative strengths and weaknesses. Students with higher grades in their economics courses relative to their grades in other departments’ courses are significantly more likely to major in economics (Emerson et al., 2012; Jensen & Owen, 2001; Rask & Tiefenthaler, 2008). Both male and female students with higher relative economics course grades are more likely to take additional courses, but relative economics grades are a stronger determinant of course persistence for women than men (Emerson et al., 2012; Rask & Tiefenthaler, 2008). In addition, findings from a study on grade inflation and grading differentials across departments at an all-female liberal arts college support the theory that women may be highly sensitive to their relative course grades (Butcher et al., 2014). A policy was passed which required faculty in high-grading departments, such as the humanities and non-economic social sciences, to lower their average course grades. As a result, these departments experienced a 31% reduction in the number of majors. Women moved into what had

initially been low-grading departments, including economics (Butcher et al., 2014). Grading disparities across departments may distort the signals that grades provide to students. Students may perceive that they have more ability in a subject in which they earn higher grades even though the higher grades may be a result of grade inflation in a particular academic domain. Since issues of grade inflation and departmental grading differences exist in many institutions of higher education (Bar, Kadiyali, & Zussman, 2009; Kostal, Kuncel, & Sackett, 2016), women may choose majors in departments that offer higher average grades.

Economics instructors may also significantly influence student course persistence and major selection. For instance, instructor characteristics may affect the grades that students receive. Students who take courses with a same-gender instructor may earn higher course grades (Carrell, Page, & West, 2010; Griffith, 2014; Hoffmann & Oreopoulos, 2009). Female students who take courses in predominantly male academic fields may be especially likely to receive positive grade benefits (Griffith, 2013). Instructors may also serve as role models for students, which may encourage economics course persistence and an increased propensity to select economics as a major. Studies examining the effect of instructor gender have had mixed results, but some research suggests that female students may be more encouraged to major in economics if they have a female instructor (Bettinger & Long, 2005; Rask & Bailey, 2002; Saunders & Saunders, 1999). Women may be more likely to take additional economics courses if they take their initial economics course with a female instructor, especially if more women at the institution are studying the subject (Ashworth & Evans, 2001). Students may also be more likely to continue to take economics courses and major in economics if they take their principles courses with a graduate student instructor. Graduate students may serve as role models, encouraging students to take additional courses in a subject (Bettinger, Long, & Taylor, 2016). An increased presence of adjunct instructors, however, may negatively affect students' course persistence (Bettinger & Long, 2010; Ehrenberg & Zhang, 2005).

The structural characteristics of economics classes may also affect students' economics course persistence and their selection of an economics major. Some research indicates that students may perform

better if they are in smaller introductory economics classes (Arias & Walker, 2004; Emerson et al., 2012; Kokkelenberg, Dillon, & Christy, 2008). Other evidence suggests that male students who take their introductory economics course in a larger class have a greater likelihood of enrolling in a subsequent economics course although class size may not be a significant predictor of women's economics course persistence (Emerson et al., 2012; Rask & Tiefenthaler, 2008). In addition to class size, the percentage of women in a student's economics class may affect their economics course persistence. Findings indicate that both male and female students are less likely to take a second economic course if there are more women in their introductory economics class (Emerson et al., 2012; Rask & Tiefenthaler, 2008). On the other hand, women who take an intermediate-level economics course with a larger percentage of women may have a higher probability of selecting an economics major (Emerson et al., 2012). Women may also be more likely to choose an economics minor if they have more women in their economics courses (Rask & Tiefenthaler, 2008). The evidence for instructor and structural (class) effects on economics course persistence and degree selection, however, is limited.

Finally, institutional characteristics may affect course-taking behavior and the size of the gender gap among economics degree recipients. In general, public universities graduate fewer female economics majors than private ones (Goldin, 2015). Selective liberal arts colleges have the smallest gender gaps. At these schools, women have earned about 37% of the bachelor's degrees awarded in economics over the last ten years (Siegfried, 2016). Comparatively, at PhD-granting public universities the percentage of women earning undergraduate economics degrees has ranged from 28% to 32% during the last ten years (Siegfried, 2016). The type of institution may also affect program requirements and course offerings. Doctoral universities are more likely to require calculus and econometrics courses (Petkus, Perry, & Johnson, 2014; Siegfried & Walstad, 2014). Economics programs housed within business schools are significantly less likely to offer courses in gender, health, or environmental economics as well as courses in social issues, including poverty, inequality, and developing nations (Dean & Dolan, 2001).

Economics course curricula and course content, however, may affect students' attitudes and interest towards economics. Survey research indicates that women find economics courses to be less

practical, less relevant to their lives and careers, and less interesting than their courses in other subjects (Bansak & Starr, 2010; Bollinger et al., 2009; Jensen & Owen, 2000; Jensen & Owen, 2001). The traditional content taught in many introductory economics courses might do little to dispel such views, especially among women. One study found that, even after controlling for course performance and demographic characteristics, men's attitudes toward economics improved as a result of their experiences in an introductory economics course, while women's attitudes declined (Bollinger et al., 2009). In fact, the percentage of women who expressed agreement with the statement "I hate economics" increased after they completed their first economics course.

Female students may tend to have more negative opinions about economics because they are interested in topics that are often not included in many economics course curricula. For instance, women express greater interest in economics issues with a social impact, such as poverty, inequality, race/ethnicity, discrimination, and gender differences in labor markets. Men, on the other hand, are more interested in financial topics, including global capital markets, the stock market, international trade, and social security reform (Bansak & Starr, 2010). Jensen and Owen (2001) found that economics classes that spend a greater proportion of time on "female" topics lead to greater student confidence, increasing the likelihood of a student enrolling in an additional economics course. Moreover, the lack of variety in course offerings may cause women who choose an economics major to feel less satisfaction with their programs than their male counterparts. In one study, female economics majors indicated that economics programs need to change their emphasis by catering to a broader range of interests and by emphasizing citizenship preparation and living within a diverse, global society (Jones, Hoest, Fuld, Dahal, & Colander, 2008). These findings suggest that economics departments may increase women's participation in economics by increasing the number of women's topics taught in introductory economics course and by expanding their overall course offerings.

3 Data

The data are from institutional records for undergraduate students who took economics courses at the University of Delaware (UD) between Fall 2007 and Fall 2015. Each student record contains

demographic characteristics, measures of ability and high school preparation, and college coursework. The student records are augmented by data regarding course instructors and class enrollments to assess the effect of instructors and peers. Table 1 defines the student, instructor, and class variables used in this study.

The University of Delaware is a large, public institution with an enrollment of approximately 17,500 undergraduate and 3,700 graduate students (Office of Institutional Research and Effectiveness, “UD Facts & Figures, 2014-2015”). The university also offers courses at several satellite campuses as part of its Associate in Arts Program (AAP). This program allows Delaware students to complete their first two years of college without relocating to the main campus. University faculty teach all of the courses, which are the same as the courses offered at the main campus. Course credits earned through the AAP fulfill core requirements for an associate’s degrees as well as a bachelor’s degree, and students can transition to the main campus to complete their four-year degree.

3.1 Economics at the University of Delaware

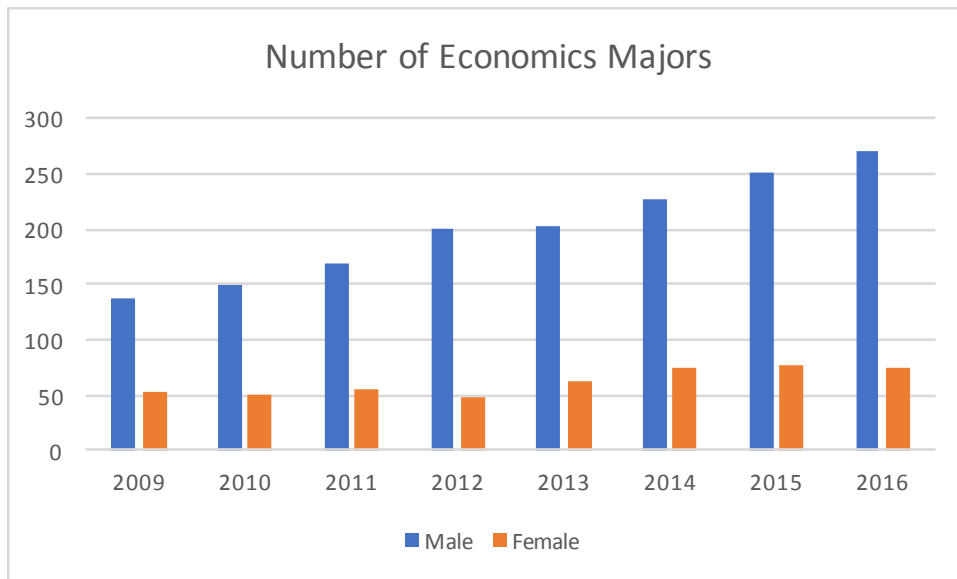
At the main campus, the Department of Economics is housed within the Alfred Lerner College of Business and Economics, which offers 15 undergraduate majors within five departments. Students may choose from three different economics degrees: a Bachelor of Science (B.S.) in economics, a Bachelor of Arts (B.A.) in economics, and a minor in economics. Both the B.S. degree and the B.A. degree require completion of 30 credit hours in economics, including introductory courses in microeconomics and macroeconomics as well as courses in intermediate microeconomic and macroeconomic theory. Both degree also programs require students to complete two courses in statistics. Students must pass all economics courses with a C- letter grade or better. For the B.S. degree, students must complete a course in calculus and fulfill a quantitative proficiency requirement of nine additional credits in mathematics or business courses that require calculus. The B.A. degree does not require calculus but does require demonstrated proficiency in an ancient or modern foreign language at the intermediate-level or better. The economics minor requires completion of 18 credits hours in economics and has no specific math requirements.

Table 1: Summary of Variables

Variable	Description
Age at Micro	Student's age in years at microeconomics
Age at Macro	Student's age in years at macroeconomics
Age at Int. Micro	Student's age in years at intermediate microeconomics
Minority	1 if student is non-white
SAT Math	Student's SAT Math score divided by 10
SAT Verbal	Student's SAT Verbal score divided by 10
HS Econ Required	1 if student's state required economics course for high school graduation
Econ Major Entry	1 if student matriculated as an economics major
Bus Major Entry	1 if student matriculated as a business major
AP Micro Pass	1 if student passed AP Microeconomics exam (grade=3,4,5)
AP Micro/Macro Pass	1 if student passed both AP economics exams (grade=3,4,5)
Non-Fresh at Micro	1 if student has greater than 27 cumulative credits at microeconomics
Non-Fresh at Macro	1 if student has greater than 27 cumulative credits at macroeconomics
Senior at Int. Micro	1 if student has 90 or more cumulative credits at intermediate microeconomics
Econ Major at Macro	1 if student is an economics major at macroeconomics
Econ Major at Int. Micro	1 if student is an economics major at intermediate microeconomics
Bus Major at Macro	1 if student is a business major at macroeconomics
Micro Grade	Student's microeconomics course grade
Macro Grade	Student's macroeconomics course grade
Int. Micro Grade	Student's intermediate microeconomics course grade
Relative Micro Grade	Student's micro grade/cum GPA from micro term but without micro grade
Relative Macro Grade	Student's macro grade/cum GPA from macro term but without macro grade
Relative Int. Micro Grade	Student's int. micro grade/cum GPA from int. micro term but without int. micro grade
Micro Repeater	1 if student repeated microeconomics
Macro Repeater	1 if student repeated macroeconomics
AAP at Micro	1 if student took microeconomics through the Associate in Arts Program
AAP at Macro	1 if student took macroeconomics through the Associate in Arts Program
Calculus	1 if student took a calculus course or passed either AP Calculus exam (grade=5)
Fem Micro Prof	1 if microeconomics instructor was a female professor
Fem Macro Prof	1 if macroeconomics instructor was a female professor
Fem Micro Adjunct	1 if microeconomics instructor was a female adjunct
Fem Macro Adjunct	1 if macroeconomics instructor was a female adjunct
Male Micro Adjunct	1 if microeconomics instructor was a male adjunct
Male Macro Adjunct	1 if macroeconomics instructor was a male adjunct
Fem Micro Grad TA	1 if microeconomics instructor was a female graduate student
Fem Macro Grad TA	1 if macroeconomics instructor was a female graduate student
Male Micro Grad TA	1 if microeconomics instructor was a male graduate student
Male Macro Grad TA	1 if macroeconomics instructor was a male graduate student
Micro Class Size	Number of students in microeconomics class
Macro Class Size	Number of students in microeconomics class
Micro Percent Female	Percentage of female students in microeconomics class
Macro Percent Female	Percentage of female students in microeconomics class
B.S. Econ	1 if student graduated with a Bachelor of Science in economics
B.A. Econ	1 if student graduated with a Bachelor of Arts in economics
Econ Minor	1 if student graduated with a minor in economics

Within Lerner College, the Department of Economics has the smallest proportion of female majors. In Fall 2015, approximately one-quarter of economics majors were female, a percentage much lower than the national average among comparable doctoral universities (Siegfried, 2016). Figure 1 displays the quantity of male and female economics majors between 2009 and 2016. While the number of male economics majors nearly doubled, the quantity of female economics majors grew by only a small amount. As a result, the proportion of female economics majors declined during this time.

Figure 1: Economics Majors at UD from 2009-2016



Notes: The number of economics majors is measured in the fall semester of each year.
 Source: (Office of Equity and Inclusion)

All students majoring in business or economics must pass Introduction to Microeconomics and Introduction to Macroeconomics with a C- letter grade or better. These introductory courses are offered at both the main campus and as part of the Associate in Arts Program. All economics majors and minors must also pass an intermediate microeconomics course with a C- letter grade or better. Intermediate microeconomics is not required for any of the business degrees. UD offers four different intermediate microeconomics courses, two at the 300-level that are required for economics majors and two at the 200-level that are offered to economics minors. The B.S. in economics majors must take a quantitative

intermediate microeconomics theory course, which requires calculus, while the B.A. in economics majors may take either a non-quantitative intermediate theory course or the quantitative theory course required of the B.S. degree students. Economics minors may choose from among any of the four intermediate courses. Since some students take more than one of these courses, I use the data for the highest-level course in which each student received a passing C- letter grade or better. Course grades are measured on a 4.0 scale.

Given that students must receive some form of initial exposure to a subject in order to select it as their major, the student sample includes only students who took at least one economics course at UD. Although some students may have their initial economics experience in high school, many matriculating freshmen may have had no formal exposure to the field prior to college. All states include economics in their curricular standards, but not all of them require school districts to implement the economics standards. Furthermore, less than half of the states require school districts to offer a high school economics course, and even fewer states require students to complete an economics course in high school to graduate (Council for Economic Education, 2016). Presumably, students who choose not to take any economics courses in college are either uninterested in doing so or do not need to take them to fulfill any requirements. These individuals, however, will not become economics majors or minors and are thus excluded from the sample. The final student sample includes students who took Introduction to Microeconomics at UD as well as students who passed AP Microeconomics and/or AP Macroeconomics prior to entering the university.

3.2 Descriptive Statistics

Table 2 provides the descriptive statistics by gender for students who took all coursework at UD. Among students who take Introduction to Microeconomics and Introduction to Macroeconomics, women represent approximately 48% and 46%, respectively. A significantly smaller proportion of students who matriculate as economics majors are female; however, the gender difference for economics majors upon entry disappears for students who complete intermediate microeconomics. With the exception of those who take intermediate microeconomics, men have significantly higher mean SAT math scores. The mean

Table 2: Summary Statistics for Students Who Took All Courses at UD

Variable	Male Students		Female Students		Mean Difference
	Mean	SD	Mean	SD	
<u>Panel A: Took Intro to Microeconomics</u>					
Minority	0.199	0.399	0.191	0.393	
Age at Micro	18.465	0.848	18.354	0.806	***
SAT Math	620.076	76.865	594.359	75.000	***
SAT Verbal	582.051	78.109	588.793	79.940	***
HS Econ Required	0.172	0.377	0.194	0.396	**
Econ Major Entry	0.020	0.139	0.006	0.077	***
Bus Major Entry	0.358	0.479	0.287	0.452	***
Econ Major at Micro	0.022	0.145	0.008	0.087	***
Bus Major at Micro	0.359	0.480	0.296	0.457	***
Non-Fresh at Micro	0.469	0.006	0.520	0.006	***
Micro Grade	2.703	0.859	2.656	0.864	**
Relative Micro Grade	0.965	2.653	0.848	0.238	***
Micro Repeater	0.015	0.120	0.011	0.104	
AAP at Micro	0.071	0.256	0.064	0.003	
Fem Micro Prof	0.041	0.198	0.041	0.199	
Male Micro Adjunct	0.031	0.174	0.009	0.092	**
Fem Micro Adjunct	0.051	0.219	0.013	0.112	*
Male Micro Grad TA	0.195	0.396	0.162	0.368	*
Fem Micro Grad TA	0.098	0.297	0.054	0.226	
Micro Class Size	141.446	114.379	145.246	115.028	***
Micro Percent Female	0.457	0.081	0.484	0.080	***
N	6,720		6,095		
<u>Panel B: Took Intro to Macroeconomics</u>					
Minority	0.196	0.397	0.176	0.381	*
Age at Macro	18.844	0.867	18.682	0.766	***
SAT Math	622.053	73.715	601.383	68.530	***
SAT Verbal	583.871	75.750	592.568	75.821	***
HS Econ Required	0.185	0.388	0.202	0.402	
Econ Major Entry	0.022	0.146	0.008	0.086	***
Bus Major Entry	0.455	0.498	0.395	0.489	***
Econ Major at Macro	0.046	0.210	0.019	0.137	***
Bus Major at Macro	0.456	0.498	0.420	0.494	**
Non-Fresh at Macro	0.912	0.005	0.971	0.003	***
Macro Grade	2.858	0.817	2.871	0.801	
Relative Macro Grade	0.978	0.253	0.905	0.222	***
Macro Repeater	0.011	0.102	0.008	0.088	
AAP at Macro	0.035	0.185	0.027	0.162	
Fem Macro Prof	0.071	0.257	0.075	0.263	
Male Macro Adjunct	0.012	0.1808	0.015	0.123	
Fem Macro Adjunct	0.027	0.163	0.023	0.149	
Male Macro Grad TA	0.287	0.452	0.289	0.453	
Fem Macro Grad TA	0.079	0.269	0.097	0.296	**
Macro Class Size	139.680	118.024	135.381	117.581	
Macro Percent Female	0.438	0.091	0.474	0.090	***
N	3,878		3,333		

Gender mean differences * <0.05 ** <0.01 *** <0.001

SAT verbal score is higher for women at each course level although the mean SAT math and verbal scores increase for students of both genders who complete macroeconomics. Compared to their male counterparts, a larger proportion of female students take both introductory courses after their freshman year. Male students, on average, earn a higher mean microeconomics grade than female students, but there is no significant gender difference in students' average macroeconomics course grades. When comparing students' economics course grades with the grades received in other courses taken during the same term, male students earn significantly higher relative grades in both microeconomics and macroeconomics. Significant gender differences also exist among the instructor and class variables. More men take microeconomics with an adjunct faculty member of either gender or with a male graduate student instructor. A larger percentage of women, however, take macroeconomics with a female graduate instructor. Women are also more likely to have a larger average microeconomics class size and a larger percentage of women in both of their introductory courses.

The summary statistics for students who received course equivalencies for the two introductory courses via AP credit are listed in Table 3. In the larger student sample, the gender gaps in average male and female SAT scores remain. In the full sample of students, men have significantly higher pass rates for AP Microeconomics alone and for both AP economics courses. Male students who take macroeconomics are more likely to pass AP Microeconomics than women. Among students who enroll in an intermediate microeconomics course, men are more likely than women to have passed both AP economics exams.

Table 4 provides the descriptive statistics for students who completed an intermediate microeconomics course and graduated. Among students who take intermediate microeconomics, no significant gender differences exist in male and female verbal SAT scores, but the mean math SAT score for men remains consistently greater than the mean math SAT score for women. Men are more likely than women to be economics or business majors at the time of taking an intermediate microeconomics course. Men are also significantly more likely than women to select the B.S. in economics degree, and nearly twice the number of men choose the B.S. degree over the B.A. degree. On the other hand, the proportion of women choosing to minor in economics is significantly larger than the percentage of male

Table 3: Summary Statistics for Students Who Earned Course Equivalency

Variable	Male Students		Female Students		Mean Difference
	Mean	SD	Mean	SD	
<u>Panel A: Full Sample</u>					
Minority	0.205	0.404	0.199	0.399	
SAT Math	618.652	85.437	591.416	82.360	***
SAT Verbal	580.921	86.118	585.253	86.425	**
HS Econ Required	0.158	0.364	0.184	0.387	***
Econ Major Entry	0.023	0.150	0.007	0.026	***
Bus Major Entry	0.342	0.475	0.276	0.447	***
AP Micro Pass	0.008	0.091	0.004	0.061	***
AP Micro/Macro Pass	0.015	0.122	0.005	0.067	***
N	7,977		6,988		
<u>Panel B: Took Intro to Macroeconomics</u>					
Minority	0.201	0.401	0.179	0.384	*
SAT Math	621.365	74.890	600.172	69.322	***
SAT Verbal	583.477	77.195	591.388	76.269	***
HS Econ Required	0.173	0.378	0.192	0.394	*
Econ Major Entry	0.022	0.147	0.007	0.085	***
Bus Major Entry	0.427	0.495	0.373	0.172	***
AP Micro Pass	0.008	0.089	0.002	0.049	***
AP Micro/Macro Pass	0.001	0.004	0.001	0.028	
N	4,409		3,726		
<u>Panel C: Took Intermediate Microeconomics</u>					
Minority	0.205	0.404	0.200	0.400	
SAT Math	645.180	74.542	633.964	72.203	***
SAT Verbal	597.431	79.692	611.088	83.834	***
HS Econ Required	0.162	0.369	0.165	0.372	
Econ Major Entry	0.055	0.229	0.058	0.234	
Bus Major Entry	0.324	0.468	0.244	0.43	***
AP Micro Pass	0.007	0.081	0.004	0.067	
AP Micro/Macro Pass	0.043	0.203	0.027	0.162	*
N	1,946		671		

Gender mean differences *<0.05 **<0.01 ***<0.001

Table 4: Summary Statistics for Students Who Completed Intermediate Microeconomics

Variable	Male Students		Female Students		Mean Difference
	Mean	SD	Mean	SD	
Minority	0.195	0.397	0.198	0.399	
Age at Int. Micro	20.249	0.961	19.940	0.955	***
SAT Math	643.995	85.415	631.742	82.885	*
SAT Verbal	597.637	87.711	607.838	88.461	
HS Econ Required	0.183	0.387	0.168	0.375	
Econ Major Entry	0.041	0.199	0.054	0.227	
Bus Major Entry	0.375	0.484	0.223	0.417	***
Econ Major at Int. Micro	0.395	0.489	0.312	0.464	**
Bus Major at Int. Micro	0.489	0.500	0.366	0.483	***
Senior at Int. Micro	0.539	0.499	0.529	0.500	
Int. Micro Grade	2.782	0.841	2.877	0.825	
Relative Int. Micro Grade	0.893	0.217	0.891	0.210	
Calculus	0.689	0.471	0.598	0.491	*
B.S. Econ	0.255	0.436	0.153	0.361	***
B.A. Econ	0.119	0.324	0.126	0.332	
Econ Minor	0.380	0.486	0.465	0.500	**
N	876		333		

Gender mean differences * <0.05 ** <0.01 *** <0.001

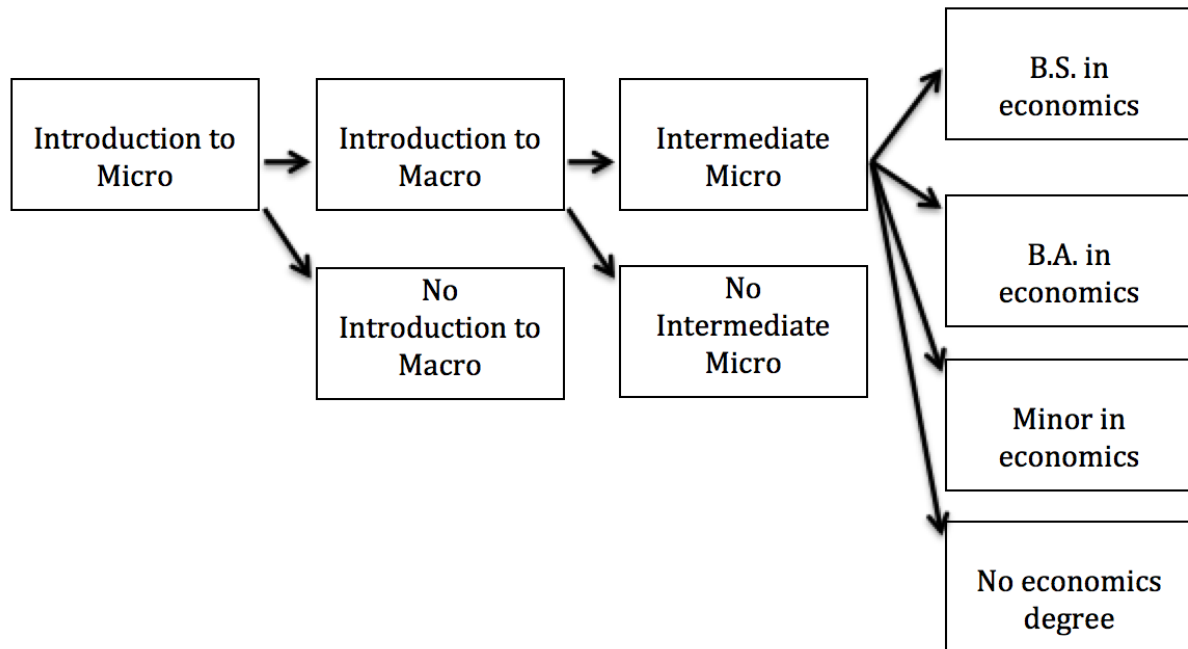
economics minors. In addition, a higher percentage of men take calculus at the university or receive calculus course equivalency by passing an AP Calculus course in high school. No significant gender disparities exist in students' grades in intermediate microeconomics, either in absolute or relative terms.

4 Methodology

Following prior research on students' economic course persistence (Emerson et al., 2012; Rask & Tiefenthaler, 2008), I use binary logistic regressions to assess students' propensity to continue taking economics courses beyond the first.¹ Students' degree selection is then modeled using a multinomial logit regression, conditional upon students having completed an intermediate microeconomics course. Figure 2 shows the progression of courses and degree selection. Microeconomics is a prerequisite for macroeconomics; therefore, I measure the probability of a student enrolling in macroeconomics, conditional on their having successfully completed microeconomics. All course grades are measured on a

¹ These two studies used binary probity models, but logistic regression provides a better fit for the data used in this study.

Figure 2: Economics Course Persistence and Degree Selection



scale of zero to 4, including plus and minus grades. To control for students' prior exposure to economics, I include a variable for whether a student's home state requires students to complete a course in economics as a high school graduation requirement. I also control for prior interest in economics or business with dummy variables based on their major upon matriculation. Recognizing that male and female students may have different propensities to persist in taking economics courses, I estimate separate models for males and females.

$$\begin{aligned}
 \Pr^{M,F}(Macro_i = 1) = & \beta_0 + \beta_1 Minority + \beta_2 Age\ at\ Micro + \beta_3 Age\ at\ Micro^2 + \beta_4 SAT\ Math \\
 & + \beta_5 SAT\ Verbal + \beta_6 HS\ Econ\ Required + \beta_7 Econ\ Major\ Entry \\
 & + \beta_8 Bus\ Major\ Entry + \beta_9 Non - Fresh\ at\ Micro + \beta_{10} Micro\ Grade \\
 & + \beta_{11} Relative\ Micro\ Grade + \beta_{12} Micro\ Repeater + \beta_{13} AAP\ at\ Micro
 \end{aligned}$$

I also estimate two additional regressions. In model 2, I assess the likelihood of persistence to macroeconomics, including students who pass an AP Microeconomics exam with a score of 3 or better.

The third regression uses the same students as in the first regression, but the student characteristics are augmented with instructor and class variables.

The probability of persistence to an intermediate microeconomics course is modeled in a similar manner, conditional upon students having completed Introduction to Macroeconomics. Thus, all student demographic characteristics and grades are measured based on their values during the term in which a student completed macroeconomics. I also include a control for whether a student had declared an economics or business major during the semester in which they took macroeconomics.

$$\begin{aligned} \Pr^{M,F}(Int. Micro = 1) = & \beta_0 + \beta_1 Minority + \beta_2 Age at Macro + \beta_3 Age at Macro^2 + \beta_4 SAT Math \\ & + \beta_5 SAT Verbal + \beta_6 Econ Major at Macro + \beta_7 Bus Major at Macro \\ & + \beta_8 Non - Fresh at Macro + \beta_9 Macro Grade + \beta_{10} Relative Macro Grade \\ & + \beta_{11} Macro Repeater + \beta_{12} AAP at Macro \end{aligned}$$

As with macroeconomics course persistence, I include three different models. In the second regression, I use data from students who passed either AP Microeconomics only or both AP economics courses.

Model 3 includes data for students' macroeconomics instructors and class characteristics for the same student sample as in model 1.

I then use a multinomial logistic regression to model students' choice of degree, conditional upon them having completed an intermediate microeconomics course. This model includes only students who took all of their economics courses at UD. In choosing a degree, students may select between a B.S. and B.A. in economics, an economics minor, or a non-economics degree. Because the B.S. in economics requires quantitative microeconomics, I include a dummy variable to control for whether or not a student took a calculus course, either at UD or by receiving credit from a passing grade on an AP Calculus exam. As in the prior models, I estimate the marginal effects separately for male and female students.

$$\begin{aligned} \Pr^{M,F}(B.S./B.A./Minor/Non = 1) = & \beta_0 + \beta_1 \text{Minority} + \beta_2 \text{Age at Int. Micro} + \beta_3 \text{Age at Int. Micro}^2 \\ & + \beta_4 \text{SAT Math} + \beta_5 \text{SAT Verbal} + \beta_6 \text{Econ Major at Int. Micro} + \beta_7 \text{Senior at Int. Micro} \\ & + \beta_8 \text{Int. Micro Grade} + \beta_9 \text{Relative Int. Micro Grade} + \beta_{10} \text{Calculus} \end{aligned}$$

Finally, I use a multinomial logit model to compare the differences between men and women who graduated with either a B.S. in economics or a B.A. in economics. I use the same variables as in the above model.

5 Results

Tables 5 and 6 present the marginal effects at the mean estimates for the impact of student, instructor, and class characteristics on men and women's decisions to enroll in Introduction to Macroeconomics and an intermediate microeconomics course, respectively. In each table, model 1 shows the effect of student characteristics for students who took all of their courses at UD. Model 2 incorporates students who received course equivalency through an AP exam, and model 3 uses the same student sample as in model 1 with the addition of instructor and class variables.

5.1 Macroeconomics Course Persistence

The results from Table 5 indicate that female minority students are less likely to take a subsequent course in macroeconomics after taking microeconomics. In terms of high school preparation, male students with higher math SAT scores are significantly less likely to enroll in macroeconomics, while neither the math nor verbal SAT scores are a significant predictor of persistence for women. Both male and female students have an increased probability of persistence if they are business majors upon matriculation, though the effect is slightly larger for women than men. Among students who received course equivalency for microeconomics, men who come from a state that requires students to complete a high school course in economics for graduation are more likely to persist in taking macroeconomics. Additionally, men who pass Advanced Placement Microeconomics with a score of 3 or higher have higher probabilities of persistence. Neither of these variables, however, are a significant determinant of macroeconomics course persistence for women.

Table 5: Marginal Effects for Macroeconomics Course Persistence

Variable	Model 1		Model 2		Model 3	
	Male	Female	Male	Female	Male	Female
Minority	0.009 (0.016)	-0.044* (0.018)	-0.004 (0.014)	-0.062*** (0.015)	0.009 (0.016)	-0.047** (0.018)
Age at Micro	0.032 (0.198)	0.091 (0.256)			0.042 (0.202)	0.105 (0.258)
Age at Micro ²	-0.003 (0.005)	-0.005 (0.007)			-0.003 (0.005)	-0.006 (0.007)
SAT Math	-0.004** (0.001)	-0.002 (0.001)			-0.004*** (0.001)	-0.002 (0.001)
SAT Verbal	-0.001 (0.001)	-0.0001 (0.001)			-0.001 (0.001)	-0.0002 (0.001)
HS Econ Required	-0.002 (0.017)	-0.009 (0.018)	0.036* (0.016)	0.022 (0.016)	-0.002 (0.017)	-0.008 (0.018)
Econ Major Entry	0.028 (0.044)	0.095 (0.084)	0.015 (0.038)	0.061 (0.072)	0.031 (0.044)	0.097 (0.084)
Bus Major Entry	0.166*** (0.015)	0.191*** (0.016)	0.203*** (0.011)	0.259*** (0.012)	0.167*** (0.015)	0.193*** (0.016)
Non-Fresh at Micro	-0.064*** (0.016)	-0.090*** (0.017)			-0.067*** (0.016)	-0.092*** (0.017)
Micro Grade	0.057*** (0.009)	0.021 (0.015)			0.056*** (0.009)	-0.021 (0.049)
Relative Micro Grade	-0.027 (0.016)	0.102* (0.050)			-0.025 (0.016)	0.102* (0.050)
Micro Repeater	0.152** (0.044)	0.229*** (0.049)			0.147** (0.045)	0.225*** (0.049)
AAP at Micro	-0.084** (0.027)	-0.176*** (0.032)			-0.168*** (0.042)	-0.267*** (0.042)
AP Micro Pass			0.250** (0.078)	0.124 (0.109)		
Fem Micro Prof					-0.112** (0.039)	-0.068 (0.040)
Fem Micro Adjunct					0.043 (0.040)	0.088 (0.046)
Male Micro Adjunct					-0.043 (0.042)	-0.067 (0.050)
Fem Micro Grad TA					-0.115*** (0.030)	-0.054 (0.031)
Male Micro Grad TA					-0.041 (0.026)	-0.025 (0.025)
Micro Class Size					-0.0004** (0.0001)	-0.0002* (0.0001)
Micro Percent Female					0.381*** (0.080)	0.145 (0.088)
Observations	6,270	6,095	7,951	6,988	6,270	6,095
% Correctly predicted	64.0%	65.5%	58.6%	58.9%	64.1%	65.7%
Log Likelihood	-4,268.03	-3,814.87	-5,293.07	-4,622.57	-4,246.38	-3,807.61

Notes: The marginal effects are evaluated at the means. Standard errors are in parenthesis.

*p < 0.05 **p < 0.01 ***p < 0.001

Although both male and female students are significantly affected by their microeconomics course grade, they are influenced much differently. For male students, a higher absolute grade in microeconomics is a significant, positive predictor of persistence. Specifically, men who earn a one-unit letter grade above the sample average (from a B- to an A-) are 6% more likely to take macroeconomics. On the other hand, men's grade in microeconomics relative to their grades in other departments' courses completed during the term in which they take microeconomics does not have significant effects. For women, the absolute microeconomics course grade is not a significant predictor of persistence; however, women who earn a relative microeconomics grade one-unit above the sample average are 10% more likely to enroll in a macroeconomics. A student's year in college is also a significant determinant of persistence for both men and women. Students who take microeconomics after their freshman year have a decreased probability of persistence to macroeconomics. Additionally, male and female students who repeat microeconomics have a higher likelihood of persistence, though the effect is stronger on female course repeaters than it is on their male counterparts. Finally, both men and women who complete microeconomics through the Associate in Arts Program are significantly less likely to enroll in macroeconomics.

The results from model 3 indicate that, with the exception of class size, instructor and structural characteristics are not significantly correlated with female macroeconomics course persistence. For both men and women, the number of students in their economics class is a significant, negative predictor of enrolling in a second economics course, but the size of the marginal effect is very small. In addition, male students who take their microeconomics course with a female professor or a female graduate student instructor are approximately 11% less likely to take macroeconomics. In contrast with prior research, men who have a larger percentage of women in their microeconomics course are more likely to enroll in macroeconomics.

5.2 Intermediate Microeconomics Course Persistence

Table 6 provides the marginal effect estimates for persistence to an intermediate microeconomics course, conditional on having completed or received equivalency for both introductory courses. Consistent with

Table 6: Marginal Effects for Intermediate Microeconomics Course Persistence

Variable	Model 1		Model 2		Model 3	
	Male	Female	Male	Female	Male	Female
Minority	0.023 (0.020)	0.022 (0.013)	0.024 (0.013)	0.012 (0.009)	0.025 (0.020)	0.021 (0.013)
Age at Macro	0.221 (0.260)	-0.040 (0.195)			0.242 (0.261)	-0.030 (0.192)
Age at Macro ²	-0.007 (0.007)	0.001 (0.005)			-0.007 (0.007)	0.0004 (0.005)
SAT Math	0.008*** (0.001)	0.005*** (0.001)	0.010*** (0.001)	0.006*** (0.0005)	0.008*** (0.001)	0.005*** (0.001)
SAT Verbal	-0.004** (0.001)	0.00003 (0.001)	-0.0003 (0.001)	-0.0002 (0.0005)	-0.004** (0.001)	-0.0001 (0.001)
Econ Major Entry			0.276*** (0.041)	0.658*** (0.075)		
Bus Major Entry			-0.031** (0.010)	-0.023*** (0.006)		
Econ Major at Macro	0.455*** (0.041)	0.650*** (0.071)			0.454*** (0.041)	0.644*** (0.072)
Bus Major at Macro	-0.149*** (0.016)	-0.058*** (0.009)			-0.154*** (0.017)	-0.058*** (0.009)
Non-Fresh at Macro	0.014 (0.030)	-0.004 (0.031)			0.015 (0.030)	-0.003 (0.030)
Macro Grade	0.053** (0.015)	0.010 (0.010)			0.052** (0.015)	0.009 (0.011)
Relative Macro Grade	0.127** (0.045)	0.182*** (0.034)			0.138*** (0.115)	0.183*** (0.034)
Macro Repeater	0.087 (0.092)	0.190 (0.135)			0.095 (0.093)	0.195 (0.135)
AAP at Macro	-0.189*** (0.028)	0.015 (0.037)			-0.159** (0.045)	-0.007 (0.038)
AP Micro Pass			0.218*** (0.046)	0.169*** (0.032)		
AP Micro/Macro Pass			0.289*** (0.038)	0.121*** (0.031)		
Fem Macro Prof					0.054 (0.043)	0.030 (0.027)
Fem Macro Adjunct					-0.025 (0.072)	0.050 (0.057)
Male Macro Adjunct					0.177* (0.089)	0.024 (0.042)
Fem Macro Grad TA					-0.021 (0.039)	-0.013 (0.020)
Male Macro Grad TA					0.040 (0.034)	0.007 (0.019)
Macro Class Size					0.0002 (0.0001)	0.00001 (0.0001)
Macro Percent Female					0.101 (0.087)	-0.001 (0.051)
Observations	3,878	3,333	7,926	6,968	3,878	3,333
% Correctly Predicted	72.9%	89.9%	76.6%	90.8%	73.1%	89.9%
Log Likelihood	-2,145.19	-983.714	-4,193.62	-2,004.84	-2,139.53	-980.786

Notes: The marginal effects are evaluated at the means. Standard errors are in parentheses.

*p < 0.05 **p < 0.01 ***p < 0.001

prior research, math SAT scores have a strong positive effect on both male and female enrollment in an intermediate course. Additionally, a higher verbal SAT score decreases men's probability of persistence, while verbal SAT scores have no effect on female persistence. Both male and female students who pass Advanced Placement economics courses have a significantly positive likelihood of persistence, even when they pass only AP Microeconomics. The magnitudes of the effects for passing an AP exam differ by gender, however. The effect sizes are larger for men. Students who select economics as their major upon matriculation are also significantly more likely to enroll in an intermediate microeconomics course, and the effect size for women is over twice the size of the effect for men. A student's choice of major by the time they complete their macroeconomics course is the largest predictor of persistence to intermediate microeconomics for both men and women. Relative to students who choose a major outside of Lerner College, women who select an economics major are approximately 65% more likely to persist, while male economics majors are 46% more likely to persist. Conversely, both male and female students who choose to major in business are less likely to enroll in an intermediate microeconomics course relative to their counterparts who major in an academic domain outside of Lerner College. The magnitude of effect for this variable is also much larger for men than for women.

A student's macroeconomics course grade is also a significant predictor of enrolling in an intermediate microeconomics course, but male and female students have differential responses to their grades. Consistent with the prior literature, women are more sensitive to their relative macroeconomics course grade even though their absolute macroeconomics grade is not correlated with persistence to an intermediate course. For men, both their absolute and relative macroeconomics course grades are significant, positive predictors of persistence. The strength of the effect for the relative macroeconomics grade is larger for women. In addition, male students who take microeconomics through the Associate in Arts Program are 19% less likely to persist although this variable is not significant for women.

With the exception of men who take their macroeconomics course with a male adjunct instructor, macroeconomics course instructors are not significant predictors of enrolling in an intermediate course. Men who take macroeconomics with a male adjunct instructor are nearly 18% more likely to persist.

Additionally, neither the class size nor the percentage of women in a student's macroeconomics class is correlated with the decision to enroll in an intermediate course.

5.3 Economics Degree Selection

Table 7 provides the marginal effects at the mean estimates from a multinomial logit model of economics degree selection, conditional upon students having taken an intermediate microeconomics course.

Relative to students who choose a non-economics degree, the biggest determinant of graduating with a degree in economics is whether the student was an economics major at the time of completing their intermediate microeconomics course. This variable has differential effects for men and women. Relative to their non-economics major counterparts, men who have declared economics as a major at the time of taking an intermediate course have a higher probability of completing a B.S. degree by 63% compared to 53% for women. Female economics majors are 30% more likely than non-majors to complete a B.A. degree in economics compared to 19% of men. Students of both genders who are economics majors are significantly less likely to earn a minor in economics though the magnitude of this effect is stronger for women.

In addition, men's math ability is a significant predictor of the type of economics degree selected. Men with a higher math SAT score, and men who take calculus or pass an AP Calculus exam have a higher probability of selecting a B.S. degree in economics. On the other hand, men with a higher math SAT score are less inclined to choose an economics minor. Although men's math SAT score has no effect on their choice to complete a Bachelor of Arts in economics, men who take calculus are significantly less likely to earn a B.A. degree. In contrast, neither taking calculus nor their math SAT score is a significant predictor of women's economics degree selection. Furthermore, male students' verbal SAT scores have no effect on their choice of any type of economics degree. For women, the verbal SAT score has only a small, positive effect on their choice to minor in economics.

Finally, course grades in intermediate microeconomics are a predictor of economics degree selection for men only. Men who earn a one-letter grade above the sample average are 8% less likely to choose the B.A. in economics but 23% more likely to earn an economics minor. Male students' relative

Table 7: Marginal Effects for Multinomial Logit of Economics Degree Selection

Variable	Male			Female		
	B.S. Econ	B.A. Econ	Econ Minor	B.S. Econ	B.A. Econ	Econ Minor
Minority	0.014 (0.044)	0.046 (0.035)	-0.049 (0.056)	0.006 (0.046)	-0.014 (0.017)	0.080 (0.096)
Age at Int. Micro	-0.858 (0.511)	-0.086 (0.342)	1.904* (0.739)	0.965 (0.761)	0.039 (0.293)	0.976 (1.480)
Age at Int. Micro ²	0.021 (0.013)	0.003 (0.008)	-0.047* (0.018)	-0.025 (0.019)	-0.0002 (0.007)	-0.025 (0.037)
SAT Math	0.006* (0.003)	-0.001 (0.002)	-0.007* (0.003)	0.002 (0.003)	-0.002 (0.001)	-0.009 (0.006)
SAT Verbal	-0.0001 (0.002)	0.001 (0.002)	0.001 (0.003)	0.0003 (0.003)	0.003 (0.002)	0.013* (0.006)
Econ Major at Int. Micro	0.634*** (0.030)	0.194*** (0.026)	-0.532*** (0.027)	0.529*** (0.074)	0.302*** (0.068)	-0.608*** (0.046)
Senior at Int. Micro	-0.067 (0.040)	-0.097** (0.033)	0.149** (0.054)	-0.022 (0.042)	-0.083 (0.047)	0.420*** (0.086)
Int. Micro Grade	-0.051 (0.041)	-0.080** (0.028)	0.233*** (0.056)	0.060 (0.050)	-0.008 (0.022)	0.071 (0.113)
Relative Int. Micro Grade	0.194 (0.146)	0.404** (0.103)	-0.496* (0.202)	-0.087 (0.176)	0.129 (0.096)	-0.232 (0.412)
Calculus	0.089** (0.031)	-0.081** (0.031)	-0.071 (0.048)	0.044 (0.034)	-0.021 (0.021)	0.041 (0.078)
Observations		876			333	
Log Likelihood		-736.242			-237.057	

Notes: Standard errors are in parentheses. The reference group is students who graduate with a non-economics degree. *p < 0.05 **p < 0.01 ***p < 0.001

intermediate microeconomics grade is also correlated with the type of degree chosen. Men's relative course grade has a positive effect on their selection of a B.A. degree but a negative effect on the decision to earn an economics minor.

Among students who have chosen an economics major, gender differences exist in the type of economics degree earned. Marginal effect estimates for a multinomial logit model comparing students' selection of either a Bachelor of Science or Bachelor of Arts in economics are presented in Table 8. Women are more likely to choose the B.S. degree if they earn a math SAT score that is one-unit above the sample mean and if they take calculus at UD or passed an AP Calculus exam in high school. On the other hand, women who earn a verbal SAT score that is higher than the sample average have a higher probability of choosing the B.A. degree in economics. Comparatively, a male student's choice of

Table 8: Marginal Effects for Multinomial Logit of Economics Major Choice

Variable	Male	Female
	B.A. Econ	B.A. Econ
Minority	0.075 (0.075)	-0.164 (0.165)
Age at Int. Micro	1.194 (0.820)	-4.593 (3.493)
Age at Int. Micro ²	-0.029 (0.020)	0.124 (0.089)
SAT Math	-0.010* (0.005)	-0.024* (0.010)
SAT Verbal	0.002 (0.004)	0.025* (0.011)
Econ Major at Int. Micro	-0.157 (0.113)	0.309 (0.186)
Senior at Int. Micro	-0.115 (0.062)	-0.469** (0.131)
Int. Micro Grade	-0.102 (0.062)	-0.422* (0.199)
Relative Int. Micro Grade	0.685** (0.228)	2.036** (0.751)
Calculus	-0.326*** (0.060)	-0.331** (0.120)
Observations	327	93
Log Likelihood	-173.333	-45.107

Notes: Standard errors are in parenthesis. The reference group is students who earn a B.S. degree.

*p < 0.05 **p < 0.01 ***p < 0.001

economics degree is determined only by his math achievement. Men's verbal SAT scores are not a significant predictor of the type of economics degree they select. Men with stronger math ability are less likely to choose the B.A. degree. Additionally, female economics majors who earn a higher absolute grade in their intermediate microeconomics course are less likely to choose the B.A. in economics, while earning a higher relative intermediate course grade has a positive effect on the choice of a B.A. degree. For men, the relative intermediate microeconomics course grade is a significant, positive predictor of selecting the B.A. in economics, but men's absolute grades do not affect their degree selection. In addition, the magnitude of the effect for the relative course grade is nearly three times larger for women than men.

6 Discussion

The findings presented in this paper indicate that one of the greatest determinants of economics course persistence and the propensity to graduate with an economics degree is students choosing to major in economics early in their college career. Although only a small percentage of students, both male and female, are economics majors upon matriculation, the number of majors increases among students who persist into higher-level courses. Women who choose to major in economics by the time they complete their second economics course have a higher probability of persistence than men, suggesting that women's experiences in their introductory economics courses may either encourage or dissuade women from entering into the economics major.

After completion of the first course in microeconomics, fewer women persist to the second course, which is consistent with prior research. Many students who do enroll in macroeconomics may do so because of requirements for another degree program. For instance, anyone who chooses a business major within Lerner College must pass both Introduction to Microeconomics and Introduction to Macroeconomics. Since the effect on macroeconomics persistence of being a business major at the time of matriculation is stronger for women than for men, many of the women who do enroll in a second economics course may do so only to fulfill the requirements for the business major. Furthermore, only economics majors and minors are required to take an intermediate microeconomics course, so it is not surprising that business students are less likely to enroll in an intermediate-level course. In addition, students may also consider economics and business degrees as substitutes (Brasfield, Harrison, McCoy, & Milkman, 1996; Salemi & Eubanks, 1996). Because Lerner College offers both business and economics degrees, business students may display a lower likelihood of persistence to an intermediate-level course as a result. Students who major in business may also be attracted to a minor in economics, and economics minors must complete one of the four intermediate microeconomics courses that the Department of Economics offers. More women than men earn an economics minor, and the probability of persistence to intermediate microeconomics is more negative for men who major in business than for women. In fact,

male business majors are two times less likely to enroll in intermediate microeconomics than their female counterparts. Thus, female business majors may be more inclined to select an economics minor.

Students' economics course grades are also a significant determinant of economics course persistence and degree selection (Butcher et al., 2014; Calkins & Welki, 2006; Chizmar, 2000; Ohland et al., 2004; Rask & Bailey, 2002; Riegle-Crumb et al., 2016). Prior research has indicated that women have a greater sensitivity than men to their economics course grades (Goldin, 2015; Rask & Tiefenthaler, 2008; Sabot & Wakeman-Linn, 1991). The results of this study support that conclusion. Calkins and Welki (2006) found that women are more likely to perceive that their grades in introductory economics are too low and are thus less likely to select an economics major. Female students may need an A or A- in their initial economics course in order for them to continue to study economics (Goldin, 2015). In this study, the mean grade for women who take Introduction to Microeconomics is equivalent to a B- letter grade. Although the mean economics course grades increase for women who take subsequent classes, women may base their decision to take additional courses heavily on the grade they receive in their very first economics course. They may perceive that their microeconomics course grade is simply too low, and that a low grade in an introductory course suggests they will continue to earn low grades if they take additional economics courses (Beyer, 1999; S. Correll, 2001).

Grades are also linked to students' ability self-efficacy, and women may be more inclined to perceive performance feedback in the form of grades as an indication of their ability in a particular academic domain (Beyer & Langenfeld, 2000; S. J. Correll, 2004; Ost, 2010; Sabot & Wakeman-Linn, 1991). In addition, the grades a student receives in one department's courses relative to the grades they earn in courses within other departments may be linked to ability self-efficacy. Findings from this study strengthen the results from prior research, which indicate that women's relative microeconomics and macroeconomics course grades, but not their absolute grades, are a significant predictor of persistence to a subsequent course (Emerson et al., 2012; Rask & Tiefenthaler, 2008). Female students' mean relative microeconomics and macroeconomics course grades are also significantly lower than men's mean relative grades in these economics courses. As a result, women may perceive that a low relative grade is an

indication that economics is not an academic strength. They may believe that they will not do well in future economics courses and may decide not to take additional economics courses for that reason.

On the other hand, departmental grading disparities may distort the information that course grades provide to students. For instance, economics tends to be among the lower grading departments at many colleges and universities (Butcher et al., 2014; Ost, 2010). At UD, the Department of Economics has lower grades than any of the four other departments within Lerner College. During the years covered by this study, the average grade given in the economics department remained fairly constant at a B-, and even though the average grades in the business departments varied, mean grades ranged from a B to a B+ (Office of Institutional Research and Effectiveness, “University of Delaware Undergraduate Standard Grade Distribution”). Therefore, students’ economics course grades may be lower than their grades in other departments’ courses, even for students who choose a major within Lerner College. Given the impact of women’s relative economics grades on their economics course persistence, grading differentials may further reinforce women’s perceptions of low economics self-efficacy. Departmental grading differentials may have less of an effect on male students because they may be less sensitive to grades.

In addition, some evidence suggests that male students who major in economics actually have lower grades in their economics courses and lower grades overall. Students may view economics and business as close substitutes, and men may be more likely to earn an economics degree because they cannot satisfy the minimum grade requirements needed to complete a degree in business (Goldin, 2015; Marangos, 2012; Salemi & Eubanks, 1996). The Department of Economics has a lower minimum GPA requirement than any of the other departments within Lerner College. The results from this study, however, indicate that men who have higher grades in economics are more likely to persist, suggesting that men who continue to take economics courses may do so because they earn higher grades.

Another important factor in economics degree selection may be related to students’ math and verbal abilities. Students’ scores on standardized tests have only a small effect on their economics degree selection, a finding that is consistent with prior research (Dynan & Rouse, 1997; Horvath et al., 1992; Keys & Turner, 2006). Even though students’ SAT scores may not have a strong effect on the selection

of an economics degree relative to a non-economics degree, the results from this study suggest that women may choose a particular type of economics degree based on their relative math and verbal abilities. Women who earn a verbal SAT score that is greater than their math SAT score may choose the B.A. in economics because the B.A. degree does not require students to take calculus. They may also perceive they have an advantage in the required foreign language component for that degree when they earn a higher verbal SAT score. On the other hand, women who have a comparative advantage in math over English may be more likely to choose the B.S. in economics degree. Fewer women take a college-level calculus course, and women who do may feel that they have strong enough math skills to satisfy the quantitative requirements of the B.S. degree. These results suggest that women with different academic skills may be attracted to the two different economics degrees offered at the University of Delaware. Men are more likely to take calculus, and men tend to have a comparative advantage in math over English. Thus, they may primarily consider their math ability when determining which type of economics degree to select.

Additionally, the findings from this study are consistent with the mixed results related to instructor characteristics found in the literature. Taking a course with a female instructor is not a significant predictor of course persistence for women, which is consistent with some of the research on the gender role-model effect of instructors (Fournier & Sass, 2000; Robb & Robb, 1999). Although instructor gender does not significantly affect women's decisions to take additional classes, a larger percentage of female students enroll in a macroeconomics course taught by a female graduate student, suggesting that there may still be some positive gender role model effect for women. Women may be self-selecting into classes taught by a female graduate student, perhaps because they identify with young women who are pursuing an advanced academic degree (Griffith, 2010). For male students, taking microeconomics with a full-time female professor or a female graduate student, relative to a full-time male professor, results in a lower probability of enrolling in macroeconomics. Male professors may increase their male students interest in taking a subsequent economics class because they perceive the instructor to be similar to themselves (Carrell et al., 2010; Jensen & Owen, 2001; Rask & Bailey, 2002).

Another way in which instructors may influence student persistence is indirectly through course grades. Griffith (2014) found that students receive higher grades from instructors who are the same gender. Since male students are significantly more likely to enroll in macroeconomics when they earn a higher grade in their microeconomics course, they may be deterred from doing so if they receive a low grade from a female instructor.

In terms of the structural characteristics, the finding that students who take microeconomics in a larger class are less likely to persist is supported indirectly through research about the effect of class size on introductory economics course grades. Students tend to perform better if they take their introductory courses in a smaller class (Arias & Walker, 2004; Kokkelenberg et al., 2008). On the other hand, the results indicating that men are more likely to enroll in macroeconomics if they have a greater proportion of women in their microeconomics class is the opposite of what prior studies have found. In fact, some prior research has suggested that female students' persistence is positively influenced by having more women in their economics courses, while male students' persistence is negatively affected by more women in the class (Dynan & Rouse, 1997; Emerson et al., 2012; Jensen & Owen, 2001; Rask & Tiefenthaler, 2008). One possible explanation for the finding from this study is that some research suggests that college students who are exposed to academic environments with greater gender diversity have more positive performance outcomes (Fenwick & Neal, 2001; Umans, Collin, & Tagesson, 2008). Since men's absolute economics course grades are a positive predictor of their economics course persistence, men who take their introductory classes with a larger percentage of females may earn higher grades and be more likely to enroll in subsequent economics courses. Also, over half of men take microeconomics as a freshman. The mean cumulative GPA for men at the time of taking microeconomics is significantly lower than the mean female cumulative GPA, so male students may actually experience better course performance when they are around higher ability peers (Ost, 2010). The research on peer effects, however, is very limited, and more research is needed on how peer attributes and interactions affect outcomes in economics courses.

7 Conclusion

This research uses a series of logistic regressions to analyze gender differences in economics course persistence and degree selection. The results indicate that the most important factors of a student's decision to enroll in subsequent economics courses and to earn an economics degree are the major a student has selected and a student's absolute and relative economics course grades. In addition, for students who graduate with an economics degree, their math and verbal abilities are the most significant determinants affecting their selection of either the B.S. degree or the B.A. degree. I also found a significant number of gender differences, both in terms of responsiveness to economics course grades as well as how much students' math and verbal SAT scores affect their degree-selection process. While male students' choices are affected by both their absolute and relative economics course grades, female students' decisions are influenced primarily by their relative economics grades. Female students are also more likely to select the type of economics degree based on the relative strength of their math and verbal abilities while men choose their economics degree based on their math aptitude only.

Several studies have indicated that women's relative economics course grades are a strong determinant of female economics course persistence. The reason may be due to women's greater responsiveness and sensitivity toward academic feedback as well as their perceptions of their economics skills and understanding, i.e. their ability self-efficacy. Women, especially those with strong academic ability, may choose not to take additional economics courses if they earn a grade in their first economics course that is significantly lower than their grades in other courses. They also may never even consider choosing an economics degree if they perceive that lower relative economics course grades represent a signal that they will not be successful in economics. Thus, female students may choose to put their efforts into other subjects in which they perceive they have stronger ability. Women may also feel less confident than men about their economics aptitude or their level of economics understanding leading to women having lower economics ability self-efficacy than men.

My findings also indicate that female students earn a significantly lower grade in microeconomics relative to male students. For many students, their introductory microeconomics course represents their

first formal exposure to the field of economics. Female students may enter these courses with greater anxiety about graphs and more fear of freezing up on exams, which may lead to lower performance as a sort of self-fulfilling prophecy. Women may also have stereotypes and biases about the field of economics and women's economics ability relative to men's, which results in their underperformance in economics courses much in the same way that gender biases may undermine women's performance in math and science (Kiefer & Sekaquaptewa, 2007; Nosek et al., 2009). While the issues of ability self-efficacy, stereotypes, and biases have been analyzed among math and science students, little to no research has been conducted on these issues among economics students.

The finding that a female student's choice between a B.A. degree and a B.S. degree is correlated with her math and verbal abilities may be related to a comparative advantage in math or English. Based on their relative SAT scores, female students who have a comparative advantage in English over math may be particularly attracted to the B.A. in economics because it has fewer math requirements. Women with a high verbal SAT score may also perceive that they have an academic strength in languages and can fulfill the requirement to demonstrate proficiency in a foreign language more easily than they can meet the math requirements for the B.S. degree. Alternatively, women who perform better on the math SAT relative to the verbal SAT may be more inclined to choose the quantitative B.S. in economics. Fewer women take calculus, and women with a high math SAT score may feel more confident in their math ability than women who select the B.A. degree. Women are more likely to have a comparative advantage in English over math; therefore, economics departments that offer both a more humanities-oriented economics degree and a more quantitative degree may provide more options for women to pursue economics as a major. By allowing students to choose between different types of economics degrees, they may attract a broader range of students. However, offering more than one type of economics degree alone does not necessarily attract more women into economics. The results from this study indicate that, even when a university offers different types of economics degrees, women are still less likely than men to enroll in economics classes beyond the first one and to graduate with a degree in economics.

The question, then, is what can be done to encourage more women to participate in economics. The findings from this study suggest that students are more likely to persist in taking macroeconomics if they complete microeconomics during their freshman year. Women are more likely to take microeconomics after their freshman year; therefore, encouraging women to complete microeconomics earlier in their college years may lead to greater economics course persistence. Another consideration may be to alter the content that is taught in introductory economics courses. Some economists have argued that more women may be attracted to field if the traditional curricula taught in introductory economics courses is modified by including more topics of interest to women and by reducing the amount of graphs and math in microeconomics (Bartlett, 1995; Feigenbaum, 2013; Ferber, 1995; Hughes, 1998; Okoye, 2011). Evidence suggests that making these curricular changes may increase women's confidence in their economics ability, leading to greater economics course persistence.

Economics departments may also consider examining grading patterns in their economics courses and whether departmental grading disparities exist. For women, their relative economics course grades are a stronger predictor of economics course persistence than for men; therefore, female students may be more heavily influenced by differences in grading among departments. Grading disparities between economics and business departments may be particularly important because at many institutions business students are required to complete both introductory microeconomics and macroeconomics. Additionally, research is needed related to women's economics ability self-efficacy and biases towards economics, which may undermine women's performance in their economics courses. These issues may be especially important for women who take their first economics course in college because they may enter the course with negative perceptions that are hard to overcome. If women perceive that they will not be successful, their expectations of poor performance may indeed lead to the lower grades they anticipate. Economics departments may also want to consider ways in which to address and combat female students negative attitudes towards economics. Taking these steps may help to reduce the gender gap in economics course persistence and degree selection.

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