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RESEARCH IN ECONOMIC EDUCATION

Women and the Choice to Study Economics

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Underrepresentation of women in economics is documented in many studies. Investigation of its sources at the undergraduate level is examined through students' decisions to persist in economics, either beyond an introductory course or in their major choices. The authors add to the literature by analyzing students' decisions to take their first introductory economics course, an intermediate theory course, and ultimately major in economics, using the Multiple-Institution Database for Investigating Engineering Longitudinal Development. Results indicate that a smaller percentage of women take economics at all levels—introductory courses, theory courses, and majoring in economics. Even after controlling for aptitude, demographic characteristics, prior interest, course performance, environment, and course timing, persistent gender differences in the likelihood of partaking in economic education beyond the introductory course decision endure.

Keywords *economics education, economics major, undergraduate economics*

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Due in part to variations in economics course enrollments and periods of sizeable major count declines, a considerable literature focused on investigating the decision to study economics has developed. Some of this work has addressed the gender gap in economics—women are less likely to study economics, and they perform less well when they do. The gender gap is of particular note as the share of undergraduate enrollments accounted for by women rises. In recent reports, women constitute roughly 58 percent of all undergraduates (Siegfried 2012). Thus, current trends could translate to lower enrollments and fewer majors simply due to the fact that the group (men) that tends to favor economics is shrinking. Beyond enrollment concerns, apprehension over the gender gap also includes suggestions that the absence of peers and role models may have a dampening effect on female interest in the discipline (Ferber 1990, 1995). Thus, the gender gap could be (partially) self-perpetuating. In this study, we revisit the decision to study economics

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with particular attention to gender differences. We confirm previous results that significantly fewer women enroll in introductory and intermediate theory courses or major in economics, and find that these differences at the intermediate and major-decision levels cannot be fully explained by differences in aptitude, prior interest, absolute and relative performance in economics, class size, gender composition of the course, and course timing.

LITERATURE

A multitude of factors affects a student's decision to study economics (or not)—including gender, aptitude, relative performance in courses, career aspirations, interests, the presence (or absence) of same-sex peers and role models, pedagogical choices and techniques, class size, and methodological approaches (Jensen and Owen 2001; Dynan and Rouse 1997; Fournier and Sass 2000; Hughes 1998).

Of all the possible explanatory factors regarding students' decisions to study economics, gender is the most consistent, significant predictor. Females are generally less likely to take a principles course, less likely to persist in studying economics beyond an introductory course, and less likely to major in economics. The research on students' course and major choice suggests that these sex differences are significant, even after controlling for aptitude, instructor gender, gender balance in classes, as well as other demographic class and institutional characteristics (Jensen and Owen 2001; Dynan and Rouse 1997; Fournier and Sass 2000; Rask and Tiefenthaler 2008). Some of these factors have similar effects for both males and females, while others have differential effects. Researchers in other studies, however, fail to find differences in female and male persistence. Chizmar (2000) found that once a student decided to major in economics, gender was not a significant determinant of switching out of the economics major. Similarly, Ashworth and Evans (1999) found that once students enroll in economics, no gender difference exists in either reported opinion of or interest in the subject.

Aptitude is also a significant predictor of the decision to study economics that could differ in its effect by gender. SAT scores (math in particular) and indicators of math aptitude are positively correlated with the decision to take an introductory economics course, to persist to subsequent courses (Rask and Tiefenthaler 2008), and to major in economics (Jensen and Owen 2001). However, conditional on having taken a principles course, Dynan and Rouse (1997) found that students with higher math SAT scores would actually be less likely to major in economics.

Performance (both relative and absolute) in previous economics courses is also a significant positive predictor of persistence in the discipline (Dynan and Rouse 1997; Chizmar 2000; Jensen and Owen 2001; Calkins and Welki 2006). Evidence suggests that males and females may differ in their responsiveness to course grades, with females demonstrating relatively higher sensitivity to grades (Rask and Tiefenthaler 2008; Jensen and Owen 2001).

Early exposure to, or a positive predisposition toward economics and environmental factors also affect the likelihood of studying economics. Early interest in economics is shown to have a positive impact on the choice to major in it, and women are less likely to have an interest in the subject (Calkins and Welki 2006; Jensen and Owen 2001; Ashworth and Evans 1999). Taking introductory economics courses later in their college careers decreases the likelihood that students will major in economics (Fournier and Sass 2000), and women start their study of economics later than men (Rask and Tiefenthaler 2008). The environment within the economics

class may also matter, but the evidence is mixed. Rask and Tiefenthaler (2008) found that the gender composition of courses matters; the greater the percentage of men in the class, the more likely students will persist in economics. Ashworth and Evans (2000) found that female students were more likely to choose to study economics if more women were studying the subject.

A final and important note relates to the datasets analyzed in previous studies. Many studies are based on data drawn predominantly from a single institution, liberal arts institution(s), or both. In contrast, we utilized the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD), which contains student-level observations from 11 public institutions for multiple years. By analyzing student decisions to study economics at multiple public institutions, we gained new insights that we could not from a study of liberal arts colleges or single institutions alone. For example, single institution studies are subject to peculiarities of the institution, and thus the findings may not be generalizable to the larger population.

Further, there is reason to believe that there might be differences between economics programs at private liberal arts colleges and those at large public universities. Siegfried and Bidani (1992) reported that economics programs were more likely to be housed in a business school at doctoral and comprehensive institutions than at liberal arts colleges. Program requirements differ depending on the location of the economics department, with slightly higher average hours required in liberal arts programs, but such programs are less likely to require a course in statistics. Business programs generally also have more specific course requirements, whereas liberal arts programs are more likely to require a senior thesis and comprehensive senior exams. This is consistent with McGoldrick's (2008) findings that economics programs at liberal arts institutions were more likely to require formal writing components including term papers, comprehensive written exams, senior seminars, and senior theses. To the extent that females are sensitive to grades and perform better when less weight is placed on exams (Jensen and Owen 2001), they may be more attracted to studying economics in the liberal arts environment where writing appears to have greater weight.

Finally, there also appear to be differences in the output between liberal arts institutions and large public universities. Siegfried and Stock (2007) documented a moderate increase (from 10 percent to 14 percent between 1970 and 2000) in the share of new PhD economists from selective private liberal arts colleges. After norming for institution and economics program size, they found that the top 50 liberal arts colleges generated roughly three times the number of PhDs per BA/BS degree awarded (and more than twice as many PhDs per economics BA/BS degree awarded) as PhD-granting institutions. Thus, either the experience students receive at liberal arts institutions or the type of student that selects a liberal arts institution appears to differ from those attending larger PhD-granting universities. These differences in graduate studies may be reflected in undergraduate enrollment patterns. As a result, investigating course enrollment and major-selection patterns at public institutions would provide valuable insights.

DATA

The MIDFIELD contains a comprehensive set of undergraduate student records from Clemson, Florida State, Georgia Tech, North Carolina State University, Purdue, the University of Florida, Virginia Tech, Florida A&M, North Carolina A&T, the University of North Carolina at Charlotte,

and the University of Colorado. Although construction of the database began in 1987 (and runs to the present), the number of participating institutions has varied over time, and thus not all institutions are represented in every year of the database. Each student record includes both academic (e.g., SAT, college courses, and choice of major) and demographic (e.g., sex, minority status) information.

Each participating institution offers a two-semester principles sequence, and also has (or had) a combined one-semester economic principles course for nonmajors. While over 40 percent of students in the entire database take an introductory course in economics[1] (consistent with findings of Bosshardt and Watts [2008] and Siegfried [2000]), far fewer (less than one percent) actually major in economics, likely due in large part to the existence of engineering and business schools at each institution.[2]

As expected, a smaller percentage of all students take an intermediate economics course (3.34 percent) in comparison to those who enroll in introductory courses (44.02 percent), and even fewer graduate with a major in economics (0.25 percent). This declining enrollment pattern is consistent across female and male students; however, smaller percentages of female students take introductory (38.0 percent versus 49.3 percent) or theory courses (1.9 percent versus 4.6 percent), and fewer graduate with a major in economics (0.2 percent versus 0.3 percent).

Table 1 defines variables included in this study, and table 2 provides descriptive statistics, by sex, for the unrestricted sample (panel A); for those students who have taken an introductory economics course (panel B); and for students who have taken intermediate economic theory and subsequently graduated (panel C). In the samples, males have significantly higher standardized combined SAT/ACT scores, and women are more likely to be minority (black or Hispanic). Female students are less likely to take an introductory economics course or an intermediate theory course, and to major in economics. Male students are significantly more likely to have declared a major in economics at the time they enroll in their first introductory economics course, although female students are more likely to major in business. Women have a higher cumulative GPA at the time they are enrolled in their first introductory economic course.[3] Male students earn significantly higher grades than their female counterparts in the introductory course, both in absolute terms and relative to their cumulative GPA.[4] Both males and females perform worse in introductory economics relative to their cumulative GPA (as indicated by relative grades less than 1). There is no significant difference between the genders with regard to the timing of their first introductory economics course—where average enrollment occurs sometime between the third and fourth semesters. The introductory course environment for female and male students is significantly different; female students enrolled in introductory economics are in slightly smaller classes, and have a greater percentage of classmates who are female.

For students who have taken an introductory economics course and subsequently enrolled in an economic theory course, patterns of sex differences in course-specific measures of aptitude (absolute and relative course grades as well as cumulative GPA) and environment (percentage of female enrollment in theory courses) also persist.

MODELING PROGRESSION THROUGH THE MAJOR

The decision to major in economics is modeled in the spirit of Rask and Tiefenthaler (2008), and we estimate the probability of progressing through the major beginning with the decision to

TABLE 1
Variable Definitions

Variable	Definition
SAT/ACT standardized score	= standardized ACT/SAT combined score
Minority	= 1 if race/ethnicity is either black or Hispanic
Female	= 1 if female
Intro course	= 1 if took introductory course
Cumulative semesters at intro course	= cumulative number of semesters at point of taking first introductory economics course(s) (including introductory course(s) term)
Business major at intro course	= 1 if business major at time of introductory course(s)
Econ major at intro course	= 1 if economics major at time of introductory course(s)
Intro course grade	numerical grade of introductory course(s)
Cumulative GPA at intro course	cumulative GPA including term of introductory course(s) but excluding introductory course grades
Relative grade in intro course	= grade in introductory course(s) / cumulative GPA including term of introductory course(s) but excluding introductory course grade(s)
Intro course size	= number of students in introductory course(s)
Intro course % female enrollment	= percentage of female students in introductory course(s)
Theory course	= 1 if took an intermediate theory course (micro or macro)
Business major at theory course	= 1 if business major at time of theory course(s)
Econ major at theory course	= 1 if economics major at time of theory course(s)
Cumulative semesters at theory course	= cumulative number of semesters including term of theory course(s)
Theory course grade	numerical grade of theory course(s)
Cumulative GPA at theory course	cumulative GPA including term of theory course(s) but excluding theory course grade(s)
Relative grade in theory course	= grade in theory course(s) / cumulative GPA including term of theory course(s) but excluding theory course grade(s)
Theory course size	= number of students in theory course(s)
Theory course % female enrollment	= percentage of female students in theory course(s)
Econ major	= 1 if graduated with an economics major

enroll in an introductory course (microeconomics, macroeconomics, a survey course, or some combination of these simultaneously). The next important step in the decision process is estimated as the likelihood of taking an intermediate theory (micro or macro) course conditional on having taken an introductory course. Similarly, the decision to major in economics is estimated conditional on having completed intermediate theory.

The decision to take an introductory course in economics has been shown to differ by a student's aptitude, sex, and race, controlling for institution and time trends. We used a probit model of the decision to enroll in their first introductory economics course:

$$\Pr(intro_{ijt} = 1) = \Phi(\alpha + \delta\, female_{ijt} + \boldsymbol{X}_{ijt}\boldsymbol{\beta} + \lambda year_t + \theta_j + u_{ijt}) \tag{1}$$

where Φ is the CDF of the normal distribution, i denotes the individual, j denotes the university, and t denotes the year. The controls for demographics and aptitude are contained in $\boldsymbol{X}$. A linear time trend is indicated by $year_t$, and university fixed effects are represented by θ_j. In addition to estimating equation (1), we estimated a model in which the female indicator is interacted with each of the other independent variables.

TABLE 2
Descriptive Statistics

Variable	Male students			Female students		
	N	Mean	St dev	*N*	Mean	St dev
Panel A: Full sample						
SAT/ACT standardized score***	313,080	0.240	0.985	274, 911	−0.058	0.961
Minority***	313,080	0.145	0.352	274, 911	0.200	0.400
Intro course***	313,080	0.493	0.500	274, 911	0.380	0.485
Theory course***	313,080	0.046	0.209	274, 911	0.019	0.138
Econ major***	313,080	0.003	0.051	274, 911	0.002	0.041
Panel B: Students who took an Introductory Economics Course						
SAT/ACT standardized score***	153,941	0.208	0.957	104, 312	−0.051	0.945
Minority***	153,941	0.133	0.340	104, 312	0.197	0.398
Business major at intro course***	153,941	0.228	0.420	104, 312	0.267	0.443
Econ major at intro course***	153,941	0.005	0.072	104, 312	0.004	0.061
Cumulative semesters at intro course	153,621	3.535	2.234	104, 120	3.531	2.096
Intro course grade***	153,941	2.567	1.091	104, 312	2.467	1.096
Cumulative GPA at intro course***	153,754	2.751	0.665	104, 252	2.909	0.615
Relative grade in intro course***	153,754	0.937	0.455	104, 252	0.840	0.372
Intro course size***	110,315	168.745	165.501	82, 236	164.432	158.480
Intro course % female enrollment***	110,315	0.391	0.103	82, 236	0.439	0.100
Theory course***	153,941	0.081	0.273	104, 312	0.044	0.295
Econ major***	153,941	0.005	0.068	104, 312	0.004	0.061
Panel C: Students who took an Intermediate Theory Course, and Graduated						
Minority***	4,153	0.153	0.360	1, 979	0.315	0.465
Business major at theory course***	4,153	0.276	0.447	1, 979	0.343	0.475
Econ major at theory course**	4,153	0.160	0.367	1, 979	0.181	0.385
Cumulative semesters at theory course	4,134	6.798	2.279	1, 975	6.619	2.140
Theory course grade	4,122	2.770	1.042	1, 973	2.754	1.002
Cumulative GPA at theory course***	4,153	2.877	0.576	1, 979	2.955	0.560
Relative grade in theory course***	4,122	0.971	0.360	1, 973	0.935	0.330
Theory course size**	2,765	43.614	25.488	1, 609	44.990	23.842
Theory course % female enrollment***	2,752	0.300	0.089	1, 597	0.371	0.102
Econ major***	4,253	0.196	0.397	1, 979	0.233	0.423

Note: Gender mean differences significant at *10%; **5%; ***1%.

Because the decision to progress in the economics major is based (at least in part) on the student's past experience in the introductory economics course, we estimated the probability of taking an intermediate theory course, controlling for relative measures associated with the student's introductory course experience: the point in their academic career that their first introductory economics course was taken, the student's grade in their first introductory economics course, cumulative GPA, introductory course grade relative to cumulative GPA, introductory class size, and the percentage of students in their introductory course who are female. We included a control for prior interest in economics, specified as whether the student had declared a major in business or economics when they enrolled in the introductory course. The following model

specifies the decision to enroll in an intermediate theory course:

$$\Pr(interm_{ijt} = 1) = \Phi(\alpha + \delta female_{ijt} + \boldsymbol{Z}_{ijt}\boldsymbol{\beta} + \lambda year_t + \theta_j + u_{ijt}) \quad (2)$$

where $\boldsymbol{Z}$ contains the variables discussed above, in addition to an indicator for race.

Variables associated with the first introductory economics course such as the grade, class size, and the percentage of students who are female are only observed for students who completed an introductory economics course. This meant that we could only use data from students who had completed the introductory economics course in estimating model (2). However, students who chose to take an introductory economics course may differ from other students in ways that we did not observe in the data, which could bias our estimates. For example, if male students were more likely to take an introductory economics course, then it must be the case that female students who decided to take the introductory course had a larger value for the error term, u, on average. A large value for the error term can be interpreted as a stronger than average unobserved preference for taking an economics course. So, if among female students, only those with a stronger than average unobserved preference for taking economics were selected into the data for the estimation of equation (2), we would create correlation between the error term and the female indicator even if none exists in the full sample conditional on the other regressors.

To address this concern, we estimated equation (2) using the Heckman procedure, where equation (1) is used to estimate selection into the introductory economics course. While there is no obvious exclusion restriction that can be used to provide additional identification, we estimated equation (2) using only the college-level indicators of aptitude (grade in the first introductory economics course, cumulative GPA, and introductory course grade relative to cumulative GPA), with the SAT/ACT standardized score excluded.

The decision to progress further and major in economics is modeled similarly to that of the theory course, controlling for aptitude, relative performance, prior interest, course environment at the theory course level:

$$\Pr(major = 1) = \Phi(\alpha + \delta female_{ijt} + \boldsymbol{W}_{ijt}\boldsymbol{\beta} + \lambda year_t + \theta_j + u_{ijt}) \quad (3)$$

where $\boldsymbol{W}$ includes the variables discussed above. Only data for students who have taken an intermediate economics course were used in the estimation of equation (3). Again, a Heckman procedure is employed with equation (2), used to estimate selection into the intermediate economics course. Given the nature of the data, some of our observations are right-censored. Since we ultimately seek to model the decision to major in economics, it would be impossible to model this decision for students whom we do not observe for their entire undergraduate career. As a result, for the economics major decision we restricted our data to students who have graduated (eliminating right-censored observations).

RESULTS

Tables 3, 4 and 5 present marginal effect estimates for the impact of demographic characteristics, aptitude, relative and absolute course performance, student prior interest, and course environment on taking an introductory economics course, enrolling in an intermediate theory course, and majoring in economics, respectively. Each decision is estimated including both males and females in the sample and using interaction terms to estimate gender differences.

TABLE 3
Introductory Economics Course Decision

Variable	(1) Probit	(2) Probit
Female	−0.1325***	−0.1439***
	(0.001)	(0.001)
SAT/ACT standardized score	−0.0314***	−0.0385***
	(0.001)	(0.001)
Minority	−0.0524***	−0.0827***
	(0.002)	(0.003)
Female * SAT/ACT standardized score		0.0155***
		(0.004)
Female * Minority		0.0622***
		(0.004)
Observations	587,991	587,991
Log Likelihood	−389,700.85	−389,544.22

Notes: The reported marginal effects are evaluated at the mean of the data (the marginal effect for the average student). All specifications include a constant term, time trend, and university fixed effects. Standard errors are given in parentheses: *significant at 10%; **5%; ***1%.

As shown in table 3, we found that females and minorities are less likely to take an introductory economics course. Further, students with higher standardized SAT/ACT scores are significantly less likely to enroll in introductory economics courses. However, women with higher aptitude are relatively more likely to enroll in an introductory course as are female minorities.

We estimated the probability of students taking intermediate theory conditional on having taken an introductory course employing three model specifications (see table 4). At the intermediate theory level, we found significant differences in the probability of majoring by gender, which remain even after accounting for gender differences in the influence of aptitude and course performance. Business majors and students taking introductory economics later in their college careers are less likely to enroll in theory, while economics majors are more likely to do so (where major declaration is measured at the time of their introductory course). Female students who have declared a business or economics major are more likely to enroll in intermediate economics in comparison to their male counterparts. Interestingly, minority females are more likely to take intermediate theory than nonminority females. We found no differential effect of course timing across genders.

Our proxy for aptitude is cumulative GPA, and we found that students with a higher GPA are less likely to enroll in intermediate theory. Specifically, students[5] (male and female) who have a cumulative GPA at the time of their introductory economics course of one standard deviation above the sample average have a 4 percent lower likelihood of enrolling in intermediate theory.[6] Introductory course performance, measured in either an absolute or relative sense, is also a significant determinant of enrollment in theory. Although earning higher grades in an introductory economics course increases the likelihood that a student will take intermediate theory, this impact is tempered by the relative grade channel. Students (male and female) who earn an incremental letter grade higher in their introductory economics course (from the average of C+ to a B−) have less than a 2 percent greater likelihood of progressing to intermediate.[7]

TABLE 4
Intermediate Theory Course Decision

Variable	(1) Heckman	(2) Heckman	(3) Heckman
Female	−0.026***	−0.026**	0.011
	(0.001)	(0.009)	(0.021)
Minority	−0.006***	0.001	0.008
	(0.001)	(0.003)	(0.005)
Business major at intro course	−0.012***	−0.031***	−0.047***
	(0.001)	(0.004)	(0.004)
Econ major at intro course	0.072***	0.181***	0.379***
	(0.005)	(0.019)	(0.026)
Cumulative semesters at intro course	−0.004***	−0.009***	−0.015***
	(0.0003)	(0.001)	(0.001)
Intro course grade		0.058***	0.101***
		(0.006)	(0.007)
Cumulative GPA at intro course		−0.051***	−0.089***
		(0.006)	(0.006)
Relative grade in intro course		−0.048***	−0.094***
		(0.006)	(0.009)
Intro course size			0.00004***
			(0.00001)
Intro course % female enrollment			0.004
			(0.015)
Female * Minority	0.010***	0.011***	0.019***
	(0.002)	(0.004)	(0.007)
Female * Business major at intro course	0.003***	0.007**	0.014**
	(0.001)	(0.003)	(0.005)
Female * Econ major at intro course	0.021***	0.049***	0.060**
	(0.005)	(0.012)	(0.026)
Female * Cumulative semesters at intro course	−0.0001	−0.0002	0.0004
	(0.0003)	(0.0007)	(0.001)
Female * Intro course grade		−0.004	−0.010
		(0.004)	(0.007)
Female * Cumulative GPA at intro course		−0.004	−0.0004
		(0.004)	(0.007)
Female * Relative grade in intro course		0.009	0.027*
		(0.009)	(0.016)
Female * Intro course size			−0.00002
			(0.00001)
Female * Intro course % female enrollment			−0.097***
			(0.023)
Observations	257,741	257,494	191,964
Log Likelihood	−446,710.3	−444,977	−328,091.3

Notes: The reported marginal effects are evaluated at the mean of the data (the average student). The selection equation used is column (2) of table 3. All specifications include a constant term, time trend, and university fixed effects. Standard errors are given in parentheses: *significant at 10%; **5%; ***1%.

TABLE 5
Economics Major Decision

Variable	(1) Heckman	(2) Heckman	(3) Heckman
Female	0.208***	0.487	0.459
	(0.072)	(0.267)	(0.320)
Minority	0.026	0.007	0.038
	(0.039)	(0.041)	(0.050)
Business major at theory course	0.005	0.007	0.038
	(0.029)	(0.029)	(0.035)
Econ major at theory course	0.906***	0.895***	0.899***
	(0.035)	(0.049)	(0.095)
Cumulative semesters at theory course	0.038***	0.029***	0.042***
	(0.006)	(0.006)	(0.007)
Theory course grade		–0.259***	–0.294***
		(0.057)	(0.088)
Cumulative GPA at theory course		0.137**	0.266***
		(0.057)	(0.080)
Relative grade in theory course		0.607***	0.652**
		(0.146)	(0.218)
Theory course size			0.002**
			(0.001)
Theory course % female enrollment			–0.138
			(0.222)
Female * Minority	0.135***	0.127**	0.105
	(0.050)	(0.051)	(0.067)
Female * Business major at theory course	0.010	0.009	0.025
	(0.046)	(0.046)	(0.054)
Female * Econ major at theory course	–0.133**	–0.117**	–0.135
	(0.056)	(0.057)	(0.078)
Female * Cumulative semesters at theory course	–0.023**	–0.025**	–0.135**
	(0.010)	(0.011)	(0.013)
Female * Theory course grade		0.083	0.068
		(0.110)	(0.139)
Female * Cumulative GPA at theory course		–0.138	–0.203
		(0.113)	(0.136)
Female * Relative grade in theory course		–0.115	–0.042
		(0.280)	(0.354)
Female * Theory course size			−0.0002
			(0.001)
Female * Theory course % female enrollment			0.591**
			(0.275)
Observations	5,673	5,640	4,110
Log Likelihood	−20,905.67	−20,404.01	−13,100.89

Notes: The reported marginal effects on the conditional predicted probability of majoring in economics are evaluated at the mean of the data (the average student). The selection equations used in specifications (1–3) are columns (1–3) of table 4, respectively. All specifications include a constant term, time trend, and university fixed effects. Standard errors are given in parentheses: *significant at 10%; **5%; ***1%

Except in one case (and then only marginally so), there is no differential response to aptitude or absolute/relative introductory course performance across gender.

Principles course environment also serves as a significant predictor of theory course enrollment. Students in larger enrollment introductory courses are more likely to take theory. Additionally, we found that a 1-percent increase in the percentage of male students in their introductory economics course increases a female student's probability of enrolling in theory by 10 percent.

Table 5 provides estimates of the likelihood of majoring in economics conditional on having taken an intermediate theory course. We found no significant major decision differences for minorities or business majors, but not surprisingly found that economics majors (where major declaration is measured at the time of their theory course) are more likely to ultimately graduate with a degree in economics. In some specifications, minority females are more likely to major in economics. Delaying enrollment in intermediate theory by a semester increases the likelihood that male students will major in economics by 4 percent, but decreases the likelihood that female students will major in economics by 9 percent. Surprisingly, students with higher theory course grades are less likely to major in economics, while those with higher cumulative GPAs at the time of their theory course are more likely to major in economics. Specifically, students who earn an incremental letter grade higher (from a C+ to a B−) in their economic theory course have a 2 percent lesser likelihood of majoring in economics.[8] A one standard deviation improvement in cumulative GPA (compared to the sample average) at the time a student enrolls in theory increases the likelihood of majoring in economics by over 3 percent.[9] We found no differential response to aptitude or absolute/relative theory course performance across gender. Finally, theory course environment helps predict the likelihood of majoring in economics, where theory class size is positively correlated with the major decision. Further, the probability that females major in economics is positively correlated with the proportion of women in their theory course. A 1-percent increase in the percentage of male students in their theory course actually decreases a female student's likelihood of majoring in economics by 59 percent.

DISCUSSION AND CONCLUSION

Our main contribution to the existing literature is the utilization of a unique database primarily consisting of large, public institutions to investigate gender differences impacting the likelihood of enrolling in introductory economics courses, progressing to take an intermediate theory course, and graduating with a major in economics. Whereas the majority of published studies are based on student samples drawn from liberal arts colleges, the data used in this study shed light on the decision to study and major in economics in a different educational environment. For example, the schools in our sample award both business and engineering degrees, and thus offer a different set of major choices to students. Additionally, the student sample itself may well differ because evidence suggests that students selecting into a liberal arts environment may systematically vary from those who choose to attend large public universities.

Here we highlight some of the more noteworthy findings and offer some comments on each. First, by several measures and at more than one decision point, it appears that stronger students opt not to study economics. This finding may be the result of competition faced by economics in the universities constituting our sample. Stronger students may simply be selecting into

engineering or other quantitative disciplines. Second, the differential impact of absolute and relative grades in this study in comparison to previous research (which typically report absolute and relative performance positively influencing persistence, although the magnitude varies by gender) suggests that this result is sensitive to the way relative performance is measured. Indeed, previous studies use a range of measurements such as cumulative GPA including all courses as a basis for their relative measure (Dynan and Rouse 1997), cumulative economics GPA relative to cumulative GPA for other courses (Chizmar 2000), or student self-reported cumulative GPA (Jensen and Owen 2001). Whatever the direction, though, course performance matters, and our grading practices and policies relative to that of other disciplines may either draw or repel students.

Third, while the tendency for students declaring a business major at the time of their introductory economics course is not surprising, the magnitude is. We estimate that the decrease in the likelihood of persisting to an intermediate theory course for declared business majors is less than 5 percent. This finding suggests that there is room for instructors at the introductory course level to influence persistence and economics major outcomes. Fourth, because once students commit to an economics major they stick by that decision, one possible channel for increasing the number of women who major in economics is to generate significant interest in the subject prior to their first course, perhaps through greater exposure to economics at the high school level. Previous studies, in fact, highlight the importance of early exposure to economics on the decision to major in the subject, but they measure this as either exposure in high school (Calkins and Welki 2006) or timing of a principles course regardless of the decision stage (Fournier and Sass 2000). We contribute to a better understanding of this mechanism by measuring the timing of previous courses specific to the decision point (i.e., the timing of enrollment in introductory economics for the intermediate theory decision, and the timing of enrollment in theory for the major decision). Our findings suggest that motivating students to take introductory economics earlier in their academic careers would increase persistence in the discipline to the theory course, while postponing theory may increase the number of economics majors—but neither of these impacts is particularly large nor would they help to equalize gender composition in the discipline.

Fifth, while Rask and Tiefenthaler (2008) found that all students were more likely to persist in economics the greater the percentage of men enrolled in their economics classes, we found that gender only affects the choices of female students, and in different directions at different decision points. Future research is needed to better understand the role classroom environment plays in students' persistence in economics.

In sum, we found that a student's aptitude, course performance, exposure, and predisposition towards the subject all impact their persistence in economics. We also found that classroom environment matters. In some cases, these predictors have differential effects by gender. Together, our findings suggest considerable room for further research on the decision to study economics. Gender differences in factors that influence the decision to persist in economics in comparison to previous studies raise questions as to the extent to which such influences can be generalized across institution types. Furthermore, additional decision points in the economics major could be analyzed to determine if these results hold only for key decision points (first introductory course, theory course, major), or if they hold for each incremental course taken.

NOTES

1. Some students enroll in introductory micro, introductory macro, an introductory concepts course, or some combination of all three courses simultaneously. We do not differentiate which or how many introductory courses the student has taken in the first semester that they enroll in an introductory economics course.
2. Dynan and Rouse (1997) found considerably higher proportions of students majoring in economics than national averages, and suggested that this difference lay in the fact that their data were drawn exclusively from a liberal arts institution with limited major selections. In a similar line of reasoning, the presence of schools of business and engineering at the institutions in the MIDFIELD database likely decreases the number of majors in our sample.
3. The cumulative GPA is measured through the semester of enrollment in the student's first introductory economics course, but does not include their grade from the introductory course. This cumulative GPA is used to calculate the student's relative grade measure.
4. Because the first introductory course in economics can be introductory microeconomics, introductory macroeconomics, an introductory concepts course, or some combination of all three courses, we define a student's grade in the introductory course as the average of the introductory courses they took in the first semester they took any introductory course.
5. Because relative grade is a composite of course grade and the student's overall GPA, the impact of changes in grades or GPA on persistence will differ across students with different initial grades or GPAs. Thus, we describe the impact of changes in GPA using a student with an average course grade. Similarly, the impact of changes in cumulative GPA is demonstrated for a student with an average course grade and GPA.
6. The sample average cumulative GPA (at the point of completing the first introductory course) is 2.571 for male and 2.909 for female students, as reported in table 2. The standard deviation for male and female students is 0.665 and 0.615, respectively. Calculations for percentages are based on coefficients in model 3.
7. This partial letter grade improvement translates into a 0.3 increase in course grade. While the direct impact of this on the probability of taking intermediate theory is to increase it by 3.0 percent (based on model [3]), the relative grade influence reduces this probability by 1.0 percent.
8. This partial letter grade improvement translates into a 0.3 increase in course grade. While the direct impact of this on the probability of majoring is to decrease it by 8.8 percent (based on model [3]), the relative grade influence increases the probability by 6.7 percent.
9. The sample average cumulative GPA (at the point of completing the first theory course) is 2.848 for male and 2.958 for female students. The standard deviation of cumulative GPA for male and female students is 0.627 and 0.603, respectively. Calculations for percentages are based on coefficients in model (3).

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