The Underrepresentation of Women in Economics: A Study of Undergraduate Economics Students

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In 1994, women represented only about one-quarter of the doctoral degrees granted in economics and of the new assistant professors in economics departments. The share of women was even lower at the tenured ranks, with women representing 11 percent of tenured associates and only 4 percent of full professors in the top 20 economics departments (Committee on the Status of Women in the Economics Profession 1996). This underrepresentation was also apparent at the undergraduate level, where women received only 30 percent of the bachelor's degrees in economics in 1991–92 as compared with 54 percent of the bachelor's degrees in all fields (*Digest of Education Statistics* 1994). The number of economics bachelor's and doctoral degrees granted to women in 1991–92 was considerably lower than the corresponding numbers for the other social sciences, the humanities, and the life sciences (see Figure 1 on p. 357). The gender distribution of degrees in the physical sciences was similar to that in economics; only in math and engineering were there proportionally fewer women than in economics.[1]

Although the evidence indicates that women are underrepresented in the field of economics, it is not clear whether efforts to change the gender balance are justified. Many people see little need for intervention, arguing that women are inherently less interested in economics or are less willing or able to acquire the math skills needed to do well in the subject. Others support active efforts to increase the number of women in the field, pointing to other possible causes of their current underrepresentation. They argue, for example, that women are deterred from entering the field because of a lack of female role models or by an unappealing classroom environment (Ferber 1990, 1995).

In this study, we try to identify some of the factors that explain the gender difference in undergraduate students' decisions to major in economics. Although having an undergraduate degree in economics is not a prerequisite for earning a doctorate in the field or becoming a faculty member, most economics graduate

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students do have a bachelor's degree in economics. Thus, understanding the decisions made by undergraduate women should improve our understanding of the underrepresentation of women in the economics profession as a whole.[2] We examined the results from a survey of students enrolled in the introductory economics course at Harvard University in 1991 and 1992. Many of the respondents had chosen their major just prior to answering the survey.[3] They were asked for information about their choice of major, personal characteristics, math background, as well as their performance and classroom experience in this course. We also obtained data on an entire class of students from the Harvard registrar in order to assess the potential biases from reporting error and from sampling only students who were already enrolled in an economics course.

DATA

Survey of Introductory Economics Students

Our primary data were drawn from a survey of students, both male and female, in the introductory economics course at Harvard University. Roughly one-half of each class at Harvard enrolls in this course at some point in their undergraduate careers. The course is taught for the full academic year, focusing on microeconomics in the fall term and macroeconomics in the spring term. We sampled students in April 1991 and April 1992, shortly after first-year students were asked to declare their majors. In both years, about half of the students sampled were in their first year at Harvard.

In the survey, we asked about the students' characteristics, backgrounds, perceived performance in the course, and choice of major. We also asked about their attitudes regarding different features of the course, particularly the classroom environment and the amount of math used.[4] In addition, we collected information about the sex of each student's instructor. Because most of the course's meetings were in small classes (sections) taught by different instructors, we were able to use variation in the instructor's gender to investigate the importance of role models in the choice of major.

It should be emphasized that this survey covered only students who had already chosen to study introductory economics. Thus, the estimates of the effect of gender on the probability of majoring in economics are *conditional* on taking an economics class, and they should generally be interpreted as the effect of the class on the decision to major in economics. Despite the inherent limitations of this sample, we believe that many important questions can be answered by looking at the decisions of women and men who already display some interest in economics.

Data from the Registrar

We also obtained data from the Harvard registrar on 1,475 students in the class of 1989. This data set included information on whether and when each student in the class took the introductory economics course, as well as each student's major,

grade in the course, sex, math SAT score, and overall grade point average (GPA) at the time of graduation. We could not properly correct for the sample selection in our estimates based on the introductory course sample, and the registrar's data enabled us to gauge the extent to which our introductory course estimates would differ from estimates based on all students. Further, the registrar's data set helped us to evaluate the role of reporting error because it included information about actual (not first declared) major, actual (not recalled) math SAT score, and actual (not mid-year) grade in introductory economics.

Comparability with National Data

A concern was that students at Harvard University may not be representative of college students nationwide. The registrar's data indicated that 5.3 percent of the women in the Harvard class of 1989 majored in economics, compared with 13.6 percent of the men. These percentages were high compared with the national numbers on bachelor's degrees awarded in economics: According to the *Digest of Education Statistics* (1994), 1.1 percent of women who graduated from four-year colleges during the academic year 1991–92 majored in economics, compared with 3.2 percent of men.[5] The difference may be explained largely by Harvard's limited selection of majors as a liberal arts college—some students selecting economics as a major at Harvard might have chosen business or accounting at universities offering a wider range of fields. In any case, both nationally and at Harvard, men were almost three times as likely as women to major in economics.[6]

In addition, there is evidence at the national level that lower retention rates from introductory economics into the major for women contribute to the underrepresentation of women in the field. Siegfried et al. (1996) have argued this point, based on results from the third edition of the Test of Understanding College Economics showing that the fraction of introductory economics students who are female is considerably higher than the fraction of economics bachelor's degrees received by women.

HYPOTHESES

One of the most common hypotheses about why women are less likely to major in economics than men is that women are less proficient or less comfortable using the math needed to do economics. Measuring math aptitude or comfort using math is difficult, however. Even students with sophisticated mathematics backgrounds may find it difficult to apply their skills in a new context. In addition, it is not clear whether women may be uncomfortable using math because of raw ability or because of math anxiety.[7] We attempted to measure math ability/comfort in several ways. We asked the students for their math SAT scores and the highest level of math that they had taken before starting introductory economics. Finally, because introductory economics does not typically require high levels of math but does require skill at interpreting graphs, we asked students to complete the following sentence:

When my teacher uses graphs,

1. they make sense immediately.
2. they don't always make sense, but I easily figure them out.
3. they don't always make sense, but after some work I figure them out.
4. there are some that are very difficult to figure out.

Perceived aptitude for economics may also influence the choice of major because students are presumably more likely to choose a subject in which they expect to do well. More precisely, a student may respond to how well he or she does in economics *relative* to other classes, rather than how well the student does in an *absolute* sense. For example, Sabot and Wakeman-Linn (1991) studied students at Williams College and found that as students' ranks in the introductory economics class increased relative to their grade-point-average ranks, their probability of taking a second course in the subject increased. Our data set from the introductory class survey contained absolute aptitude, as measured by the grade that the student received for the first semester of introductory economics, and "relative" aptitude, as measured by whether the student reported doing better in introductory economics than in other courses.

A student's choice of major may also depend on whether the student believes she or he will fit in or be comfortable in the field. Thus, another determinant of a student's choice of major might be the presence or absence of role models. Students uncertain about whether they will do well in economics or whether they will enjoy the subject may be reassured if they observe someone with similar characteristics who is accomplished in the field.[8] Similarly, the classroom environment may influence a student's choice of major.[9] Hall and Sandler (1982) argued that instructors may create a "chilly" classroom climate where women are either singled out or ignored and that this climate may deter female students' academic development.[10] The fraction of women in the section might also alter a student's likelihood of majoring in economics by changing the dynamic in the classroom or by providing more (or fewer) peer role models.

The introductory class data set included three variables that we thought might help assess these hypotheses. First, we knew the sex of each student's instructor in the introductory course sample. Although instructors are by no means the only economist role models that affect students' perceptions of the profession, the teachers in this course tended to have fairly close contact with many of their students. Second, we asked students how comfortable they felt asking questions in class and participating in class discussion. Finally, we calculated the fraction of women in each student's introductory economics section.[11]

Of course, the underrepresentation of women among economics majors may be a matter of taste or of the information they have about the nature of economics before arriving at college. Although it is difficult to gauge taste and information, we tried to assess a student's predisposition for majoring in economics by asking whether he or she was considering majoring in economics at the beginning of the academic year. We also attempted to learn about students' tastes by asking their principal reason for taking introductory economics.

To test the various hypotheses, we estimated binary probit models of choosing economics as a college major with the basic equation

$$Econ_i = \beta_0 + \beta_1 Fem_i + \beta_2 Math_i + \beta_3 RelAdv_i + \beta_4 RMod_i + \beta_5 Class_i + \varepsilon_i, \quad (1)$$

where $Econ_i$ takes the value of 1 if student i reported at the time of the survey that he or she intended to major in economics and 0 otherwise. Fem_i indicates whether student i is female, $Math_i$ measures student i's math ability, $RelAdv_i$ is student i's performance in introductory economics relative to other classes, $RMod_i$ is a dummy variable indicating whether student i's instructor was female (we also tried interacting the sex of the instructor with the sex of the student), $Class_i$ represents variables related to student i's perception of the classroom environment, and ε_i is a normally distributed error term.

Descriptive Statistics

Descriptive statistics on first-year students from the survey of the introductory economics class are presented in Table 1.[12] We pooled data from the two years of the survey because there was no discernible difference between the years. Approximately 28 percent of the first-year women in the introductory class chose to major in economics compared with 36 percent of the men. The p value of .05 indicates that this difference was statistically significant. Women were more likely than men to major in the humanities and other social sciences and less likely to major in the sciences. These findings are consistent with the national statistics shown in Figure 1.

The first-semester grades of the men tended to be better than those of the women. The mean grade for men was about a B+, while the mean grade for women was just below a B. This difference was statistically significant but did not seem very large in practical terms.[13] The gender differences in the responses to the question about performance in introductory economics relative to performance in other courses were consistent with the distribution of grades. Men were twice as likely as women to report that they did better in introductory economics than in their other courses and only two-thirds as likely to report that they did worse.

The various measures of math aptitude also showed differences between the sexes, with female students having more limited math backgrounds and expressing less comfort using graphs. Men were roughly twice as likely as women to have completed a course in linear algebra before starting college and less likely to have completed only the first semester of calculus or less. In addition, the mean math SAT score among male students was roughly 10 points higher than the mean score for female students. This difference was statistically significant, although small. Finally, the results for the question regarding interpreting the graphs showed that first-year male students were significantly more likely to report that the graphs used in class "make sense immediately."[14]

Perhaps surprisingly, although first-year women were somewhat less comfortable participating in class than first-year men were, the difference was not statis-

TABLE 1
Descriptive Statistics: Survey of First-Year Introductory Economics Students, 1991 and 1992 (Percentage of Gender)

Characteristic	Women	Men	χ^2 test of independence (p value)
Major			0.03[a]
Economics	28.0	35.6	0.05
Other social science	36.5	30.3	0.10
Humanities	19.9	14.4	0.06
Science	10.9	16.1	0.07
Other	4.7	3.6.	0.49
Grade in introductory economics			0.19[a]
A	13.3	20.7	0.02
A–	20.4	19.0	0.66
B+	17.5	19.7	0.49
B	20.4	16.7	0.26
B–	17.1	15.5	0.61
C+ or below	10.9	8.1	0.22
Pass	0.5	0.2	0.51
Performance relative to other courses			0.00[a]
Better	11.9	23.3	0.00
About the same	46.9	49.0	0.60
Worse in introductory economics	41.2	26.6	0.00
Math SAT score[b]	723	733	−10.01 (4.30)
Highest level math class taken prior to introductory economics			0.04[a]
Precalculus	9.5	12.8	0.20
First semester calculus	37.4	29.3	0.03
Second semester calculus	42.7	42.1	0.90
Multivariate calculus	8.1	9.0	0.68
Linear algebra or higher	2.4	6.7	0.02
Percentage of other students in class who are female[b]	30.5	29.6	0.92 (0.76)
Ease in interpreting graphs			0.11[a]
Graphs make sense immediately	25.6	34.1	0.03
They don't always make sense, but I easily figure them out	46.5	43.9	0.53
They don't always make sense, but after some work, I figure them out	25.6	19.7	0.08
There are some that are very difficult to figure out	2.4	2.3	0.95
Female section leader	38.4	33.3	0.19
Comfort asking questions/participating in class			0.45[a]
Very comfortable	37.0	42.3	0.18
Fairly comfortable	42.7	40.6	0.61
Uncomfortable	17.1	13.4	0.20
So uncomfortable, I do not participate	3.3	3.6	0.83

(Continued)

TABLE 1 — continued

Characteristic	Women	Men	χ^2 test of independence (p value)
Principal reason for taking economics			0.24[a]
Interested in subject	61.1	68.4	0.06
Thought it would help get job or get into business school	5.7	6.1	0.82
A requirement for major	22.3	18.8	0.28
Satisfies a distribution requirement	4.3	2.5	0.20
Other	6.6	4.2	0.17
Considering majoring in economics when began introductory economics	69.2	77.8	0.01
Number of observations	211	522	

[a]The p value for the χ^2 test of independence of all characteristics in the set together.
[b]Means for women and men and coefficient and standard error from a regression of percent female or SAT on female.

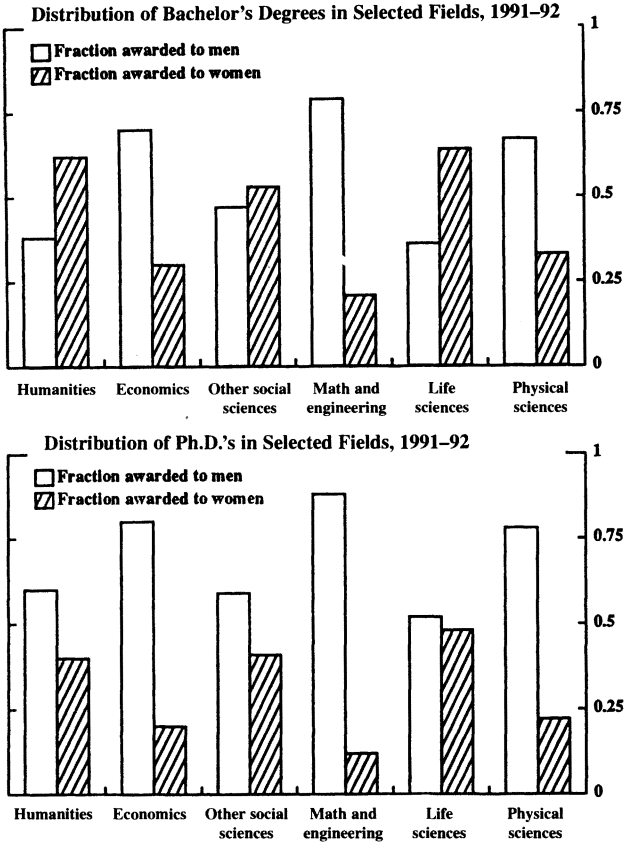
tically significant. Further, first-year women's comfort in class was not significantly affected by the presence of a female section leader or the proportion of the class that was female.[15]

The final questions on the survey were designed to shed some light on the role of tastes and, to some extent, knowledge about economics before arriving at college. Women were less likely than men to take the course principally because they were interested in the field and marginally more likely to take the course because it satisfied a curricular requirement. Further, first-year women were significantly less likely to have considered majoring in economics when they began the course than were first-year men.

The descriptive statistics from the registrar's data on the class of 1989, for comparison with the class surveys for the spring semesters of 1991 and 1992, are presented in Table 2. The proportion of women in the class of 1989 who took introductory economics and majored in economics was slightly lower than the proportion of women in the introductory economics course in 1991 and 1992 who decided to major in the field, and the difference between the sexes was statistically significant. As indicated in Table 1, men tended to receive higher grades in introductory economics than women did and were twice as likely to receive a grade in introductory economics that was higher than their (overall) average grade.[16]

Statistics for the entire Harvard class of 1989 show that women in this class were more likely than men to major in the humanities or social sciences other than economics and were underrepresented in the sciences (Table 2). As in the subsample of students who took introductory economics in their first year, women graduated with lower overall GPAs, although the difference was smaller than in the subsample. Women's math SAT scores averaged 26 points lower than men's scores, a statistically significant difference that was somewhat larger than that for the students who took the introductory course. On balance, however, the statistics for the entire class looked similar to those for the subsample who took introductory economics.

FIGURE 1



Source: Based on data from the *Digest of Education Statistics*, 1994.

REGRESSION RESULTS

Gender, Math Background, and Grades

Binary probit estimates of the effects of gender, math background, and grades on the decision to major in economics, using the data from the survey, are reported in Table 3.[17] To interpret the probit coefficient of a continuous variable, we first predicted a "base" probability for each student using the variable's actual value. We then changed the variable by a specific amount (e.g., for the SAT score, added 10 points) and calculated a new probability for the student. We report the mean difference between the original and new probabilities in brackets. For binary variables, we predicted a base probability assuming that each student was in the variable's base group and then calculated a new probability assuming that the student was in the other group. Again, the brackets show the mean difference in probabilities across individuals. For all calculations, the other explanatory variables were held at their actual values.

TABLE 2
Descriptive Statistics: Registrar Data, 1989 (Percentage of Gender)

	Sample					
	Students who took intro. econ. first year			Entire class		
	Women	Men	χ^2 test of independence (p value)	Women	Men	χ^2 test of independence (p value)
Major[a]			0.03[b]			0.00[b]
Economics	22.3	36.5	0.01	5.0	13.2	0.00
Other social science	56.3	44.0	0.03	49.1	42.5	0.01
Humanities	14.6	10.1	0.23	29.1	17.7	0.00
Science	6.8	9.4	0.43	16.9	26.6	0.00
Grade in introductory economics			0.01[b]			
A	4.9	12.4	0.03			
A–	6.8	13.5	0.07			
B+	27.2	18.1	0.05			
B	23.3	17.7	0.22			
B–	16.5	24.4	0.10			
C+ or below	21.4	13.9	0.08			
Cumulative GPA			0.05[b]			0.00[b]
A/A–	10.7	18.1	0.08	12.2	16.0	0.04
B+/B/B–	48.5	32.7	0.01	48.0	40.7	0.01
C+/C/C–	33.0	38.0	0.37	33.4	33.0	0.88
D or Lower	7.8	11.3	0.32	6.4	10.3	0.01
Grade in introductory economics greater than graduating GPA	10.7	24.8	0.00			
SAT math score[c]	697	715	−17.65 (7.24)	695	721	−26.27 (3.33)
Number of observations	103	266		581	894	

[a]The registrar assigned each student's major to one of these four groups, whereas the survey allowed student to classify their majors as "other."
[b]The p value for χ^2 test of independence of all characteristics in the set together.
[c]Means for women and men and coefficient and standard error from a regression of percent female or SAT on female.

The data in column (1) show that women were 7.7 percentage points less likely to major in economics than men, a difference that was statistically significant at the 5 percent level. The data in columns (2) through (5) show the effect of including variables related to math aptitude or comfort using graphs. Adding a quadratic in the math SAT score lowered the gender difference in the probability of majoring in economics by about .8 percentage point, amounting to 10 percent of the original gap estimated in column (1). Controlling for whether the student had completed at least two semesters of calculus *increased* the gender gap, while controlling for ease in interpreting graphs lowered the gap by 10 percent and changed the p value on the female coefficient to .07. The math-related variables were jointly significant determinants of the decision to major in economics, although together they reduced the gender gap by only about 15 percent relative to the original gap.[18]

TABLE 3
Probit Estimates of the Decision to Major in Economics: Effects of Gender, Math Ability, and Grades, 1991 and 1992
(Based on Responses of First-Year Students in Introductory Economics Class)

Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Female	–0.216	–0.194	–0.230	–0.195	–0.185	–0.188	–0.156
	(0.108)	(0.109)	(0.108)	(0.108)	(0.110)	(0.111)	(0.111)
	[–0.077]	[–0.069]	[–0.081]	[–0.069]	[–0.065]	[–0.065]	[–0.054]
SAT math score (÷10)[a]		–0.257			–0.234	–0.187	–0.172
		(0.178)			(0.180)	(0.182)	(0.183)
		[0.006]			[0.008]	[0.002]	[0.001]
SAT math score, squared (÷100)		0.019			0.017	0.013	0.012
		(0.013)			(0.013)	(0.013)	(0.013)
Completed at least two semesters of calculus			–0.245		–0.362	–0.377	–0.372
			(0.097)		(0.107)	(0.108)	(0.108)
			[–0.089]		[–0.129]	[–0.133]	[–0.130]
Interprets graphs easily				0.249	0.290	0.243	0.223
				(0.102)	(0.107)	(0.109)	(0.110)
				[0.092]	[0.105]	[0.087]	[0.079]
Grade in intro. economics[b]						0.069	0.049
						(0.024)	(0.025)
						[0.024]	[0.017]
Did better in intro. econ. than in other courses							0.322
							(0.128)
							[0.117]
Log likelihood	–465.002	–463.836	–461.800	–462.045	–455.601	–450.344	–447.209

Notes: The dependent variable equals 1 if student is planning to major in economics and 0 otherwise. Asymptotic standard errors are in parentheses. All probits include a constant. Sample size is 733. Changes in probabilities are in brackets; see text for an explanation of how they are calculated.

[a]Change in probability based on 10-point increase in the SAT math score; change includes the effect of quadratic.
[b]Grade variable is numerical translation of first-semester letter grade. The change in probability is based on a 1-point increase in grade variable (about one-half of a letter grade). Probits that include grade also include a dummy variable indicating that the grade is a pass, audit, or missing.

Results in columns (6) and (7) were based on probits that included the grade attained in the first semester of introductory economics and a dummy variable indicating whether the student reported doing better in economics than in other classes.[19] Adding the grade received in introductory economics did not contribute further to explaining the gender gap.[20] However, controlling for the student's perceived relative advantage in economics further decreased the coefficient on the female dummy by 17 percent; the coefficient on female also became insignificant with a p value of 0.16.[21] Thus, the results suggest that an important part of the reason that women are less likely to major in economics is that they have more aptitude for other subjects, or at least perceive that they do.

From the registrar's data, we obtained information on the gender gap for the entire student population, rather than the gender gap conditional on taking the introductory economics course. The data also provided a more reliable measure of SAT math score because they did not rely on self-reported data. We analyzed these data by modeling the decision to take introductory economics and then by modeling the decision to major in economics. The latter decision is modeled for the sample restricted to students who took the introductory course in their first year and for the entire class.

The probit results for the decision to take introductory economics are shown in Table 4. Women were 12 percentage points less likely to take introductory economics in their first year than were men, a difference that was substantively and statistically significant (see column 1). Conditioning on the math SAT score marginally increased the gender gap because of the net negative relationship between the math SAT score and the likelihood of taking introductory economics in the first year.[22] However, an interaction term between female and math SAT score had a positive albeit insignificant coefficient, with a p value of .17, suggesting that the effect of math preparation *may* differ by sex.[23]

Probit results based on the registrar's data for the decision to major in economics are in Table 5. The first five columns contain data from the analysis of the decisions of students who took introductory economics in their first year; the data in columns (6) and (7) refer to the entire class. Among those who took introductory economics in their first year, the gender difference in the likelihood of majoring in economics was 14 percentage points. In contrast to the results based on the introductory class survey, the (total) effect of SAT on the probability of majoring was negative, and controlling for math SAT score *increased* the gender gap by about 4 percent.[24] We are uncertain as to why the two samples differed in the effect of SAT on the likelihood that individuals choose to major in economics. It is interesting, however, that the two samples yielded similar results when only a linear term in math SAT score was included, indicating that the difference lay in the tails of the SAT distributions of the two samples.[25]

The importance of performance in introductory economics is indicated in the next columns. The student's grade in introductory economics had a positive and significant effect on majoring in economics, and it explained approximately 9 percent of the original gender gap and 5 percent of the gender difference conditional on math SAT score. Further, having a relative advantage in economics, as measured by whether a student's grade in introductory economics was greater

TABLE 4
Probit Estimates of Who Takes Introductory Economics in First Year
(Based on Class of 1989 Data from Registrar)

Independent variable	(1)	(2)	(3)
Female	–0.397	–0.422	–1.599
	(0.075)	(0.077)	(0.866)
	[–0.122]	[–0.129]	[–0.127][a]
SAT math score (÷10)[b]		0.120	0.096
		(0.096)	(0.098)
		[–0.003]	[–0.003]]
Math score, squared (÷100)		–0.009	–0.008
		(0.007)	(0.007)
Female math score (÷100)			0.017
			(0.012)
Log likelihood	–822.980	–821.552	–820.617

Notes: The dependent variable equals 1 if student took introductory economics in first year and 0 otherwise. Asymptotic standard errors are in parentheses. All probits include a constant. Results based on 1,475 observations. Changes in probabilities are in brackets; see text for an explanation of how they are calculated.

[a]Total change in probability (including the effects of the interaction term).
[b]Total change in probability for a 10-point increase in the SAT math score (including the effects of the interaction term).

than his or her graduating GPA, had a positive and statistically significant effect on majoring in economics. This effect was substantively large as well, explaining an additional 17 percent of the original gender gap and 10 percent of the gender difference conditional on math SAT and grade in economics.[26]

The final two columns of Table 5 contain results based on the entire class of 1989. The data in column (6) show that women in the class of 1989 were about 8 percentage points less likely to major in economics than were men, a smaller gap than that estimated using only students who had taken the introductory class in their first year. In addition, we find in column (7), again using the entire class, that conditioning on the math SAT score widened gender gap slightly.[27]

Our results on the effect of math background, using both the registrar's data and the introductory course data, warrant further discussion. Our data indicate that math background (as proxied by the math SAT score) is a fairly good predictor of the absolute grade in introductory economics, with a correlation coefficient of .46. In fact, controlling for SAT math score explained most of the gender gap in the absolute introductory economics course grade in the registrar's data and almost one-half of the gender gap in the course grade in the introductory economics class survey. Our results on the determinants of the grade in economics are consistent with those of Anderson, Benjamin, and Fuss (1994) and Brasfield, McCoy, and Milkman (1992), who found that students with some calculus background do better in introductory economics courses than students without that background, and with those of Cohn and Cohn (1994), who reported a significant positive relationship between graph skills and success in introductory economics. We also found that ease with interpreting graphs explained about 20 percent of the gender gap in

TABLE 5
Probit Estimates of the Decision to Major in Economics: Effects of Gender, Math Ability, and Grades
(Based on Class of 1989 Data from Registrar)

	Sample						
	Students who took introductory economics in their first year					Entire class	
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Female	–0.415 (0.158) [–0.141]	–0.434 (0.161) [–0.146]	–0.380 (0.160) [–0.128]	–0.421 (0.162) [–0.139]	–0.380 (0.164) [–0.125]	–0.529 (0.102) [–0.082]	–0.548 (0.105) [–0.085]
SAT math score (+10)[a]		0.502 (0.237) [–0.003]		0.574 (0.241) [–0.010]	0.585 (0.244) [–0.009]		0.306 (0.145) [–0.002]
SAT math score, squared (+100)		–0.035 (0.017)		–0.042 (0.017)	–0.043 (0.018)		–0.022 (0.010)
Grade in introductory economics[b]			0.071 (0.029) [0.025]	0.089 (0.034) [0.031]	0.063 (0.036) [0.022]		
Introductory economics grade higher than graduating GPA					0.361 (0.180) [0.130]		
Log likelihood	–229.209	–226.243	–226.166	–222.687	–220.665	–463.988	–461.484
Number of observations	369	369	369	369	369	1,475	1,475

Notes: The dependent variable equals 1 if student is planning to major in economics and 0 otherwise. Asymptotic standard errors are in parentheses. All probits include a constant. Changes in probabilities are in brackets; see text for an explanation of how they are calculated.

[a]Change in probability based on 10-point increase in the SAT math score; change includes the effect of quadratic.
[b]Change in probability is based on a 1-point increase in grade variable (about one-half of a letter grade).

the grade in introductory economics. However, having a female instructor or more female classmates did not affect the gender gap in economics grades (contrary to the findings reported by Ferber [1995]).[28]

One possible reason that math background is not a more important determinant of the gender gap among economics majors is that a student who did not major in economics may have chosen either a humanities major or a science major. Students with strong math backgrounds may have been more likely to major in economics than in the humanities but less likely to major in economics than in the sciences. Indeed, taking higher levels of math is often a prerequisite for some science majors, so having a strong math background may simply reflect a desire to major in science. As a result, estimates of the effect of math in a binary choice model may show only a small effect. We tried to control for this to some extent by including a quadratic in the math SAT score.[29] In results not presented here, we estimated multinomial logits of choice of major, using data from both the introductory class and the entire class of 1989. Our results were virtually identical to the binary estimates reported in Tables 3 and 5.[30]

In summary, the results in Tables 3 through 5 suggest that math background, as proxied by math SAT score, highest level of math attained, ease in interpreting graphs, and absolute grade in introductory economics, explained only about 15 percent of the gender gap in the decision to major in economics in the introductory class sample and much less of the gender gap in the registrar's data. In both cases, adding performance in introductory economics relative to that in other courses reduced the gender gap noticeably further.

Other Hypotheses

We used the sample from the survey to consider additional hypotheses about the gender gap in choosing to major in economics (Table 6). In all cases, we first presented the unconditional effect of the additional variable and then showed the effect of the additional variable while controlling for math background, grade in introductory economics, and relative advantage in economics.

We studied the effect of having a female section leader, which we interpreted as having a potential role model for women. We found that controlling for having a female teacher explained only a small portion of the gender gap, and that although the interaction between whether the student was female and whether the student had a female section leader was positive, it was not significantly different from zero (see the first three columns of Table 6). These results are consistent with those of Canes and Rosen (1995) who studied female undergraduates' choices of majors at several institutions and found that the fraction of faculty in a discipline who were female did not appear to influence the proportion of female students majoring in that discipline.

Data in columns (4) and (5) show that a student's comfort in asking questions in class was not significantly correlated with the probability of majoring in economics. We do not know whether this lack of correlation was evidence that the classroom environment was unimportant to students' decisions about choice of major or whether it simply reflected similar levels of comfort in other fields that

TABLE 6

Probit Estimates of the Decision to Major in Economics: Other Hypotheses (Based on Responses of First-Year Students in Introductory Economics Class)

Independent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Female	–0.212 (0.108) [–0.075]	–0.152 (0.112) [–0.052]	–0.207 (0.139) [–0.053]*	–0.211 (0.108) [–0.075]	–0.156 (0.111) [–0.054]	–0.224 (0.108) [–0.079]	–0.165 (0.112) [–0.057]	–0.160 (0.112) [–0.055]	–0.077 (0.117) [–0.025]
Female teacher	–0.077 (0.101) [–0.028]	–0.073 (0.104) [–0.025]	–0.117 (0.123) [–0.026]*					–0.082 (0.104) [–0.028]	–0.145 (0.109) [–0.046]
Female Teacher × Female			0.154 (0.229)						
Comfort asking question during class {*p* value}[a]				{0.709}	{0.962}			{0.956}	{0.902}
Percentage of other students in class who are female[b]						0.692 (0.523) [0.025]	0.601 (0.530) [0.021]	0.642 (0.532) [0.023]	0.721 (0.551) [0.023]
Considering majoring in econ. when started intro. econ.									1.094 (0.144) [0.306]
Includes math and economics grade[c]		Yes	Yes		Yes		Yes	Yes	Yes
Log likelihood	–464.708	–446.958	–446.731	–464.304	–447.063	–464.124	–446.567	–446.088	–412.109

Notes: The dependent variable equals 1 if student is planning to major in economics and 0 otherwise. Asymptotic standard errors are in parentheses. All probits include a constant. Sample size is 733. Changes in probabilities are in brackets; see text for an explanation of how they are calculated.

*Total change in probability (including the effects of the interaction term).

[a]Probits include dummy variables for "Fairly comfortable," "Uncomfortable," "So Uncomfortable Does Not Participate."

[b]Change in probability is based on a 10 percentage point increase in the percent female in the class.

[c]Includes SAT math score, SAT math score squared, grade in introductory economics, a dummy variable indicating that the grade is a pass, audit, or missing, and dummies for whether completed at least two semesters of calculus, interpret graphs easily, did better in introductory economics relative to other classes, and whether grade in introductory economics is missing.

students had considered choosing as a major. In any event, including this variable had little effect on the magnitude of the gender difference. This result is not surprising given the similarity in the distribution of male answers and female answers in Table 1. Columns (6) and (7) include data on the percentage of the individual's class that was female, another possible proxy for the student's classroom environment. The coefficient on the percent female in the class was positive, although statistically insignificant. Including the measure increases the gender gap slightly.

As further evidence that the introductory economics course, per se, is not a significant deterrent to women majoring in economics, the gender gap decreased significantly when we controlled for whether the student was considering majoring in economics when she started introductory economics (column 9). The coefficient on female was now insignificantly different from zero at the 5 percent level, and its magnitude had dropped by one-half. Unfortunately, we could not judge the extent of recall error in the student responses to whether they had been considering majoring in economics at the beginning of the course. It is possible that the responses told more about the students' actual decisions than about their intentions seven months earlier.

CONCLUSION

Both nationally and at Harvard, there is a significant difference between the fraction of female students who choose to major in economics and the fraction of male students who do so. Although the measures of math aptitude in our two Harvard samples suggest that female students tend to have somewhat weaker math skills than their male counterparts, math background appears to have little influence on students' decisions about whether to take introductory economics in their first year and explains only a limited part of the gender difference in the decisions of first-year students to major in economics after they have taken the introductory course. We also find that women do less well in economics relative to their other courses than men do and that controlling for this difference in relative performance significantly diminishes the gender gap in choice of economics as a major. However, our proxies for classroom environment and the presence or absence of role models explained little of the gender gap.

After these factors were controlled, the estimated gender gap in the introductory course data was 5.5 percentage points, 27 percent smaller than the original gap. Although the coefficient is not statistically different from zero, its magnitude indicates that some difference in the probability of majoring in economics across sexes (conditional on taking introductory economics) probably remains. This remaining gap may arise from differences in tastes or other unmeasured characteristics such as knowledge about the nature of economics upon entering college. As evidence, our registrar data show a significant gender gap in the decision to take introductory economics in the first year, and we find that women who reported they were considering majoring in economics when they began introductory economics were about as likely to choose economics as were men.

We do not know whether women perform less well in economics relative to

other classes because of differences in innate aptitude for economics, work effort in economics (possibly related to interest in the subject), aspects of the classroom environment we have not captured, or differences related to the other courses they take. We also do not know what determines the taste for economics that students bring to college. Women may arrive at college with preconceptions about the nature of the field, having already decided not to major in it. It is worth noting that when upperclass students were asked why they did not take introductory economics in their first year, women were over twice as likely as men to respond that they "did not think that economics was interesting."

NOTES

1. Bartlett (1995) pointed out that the percentage of female economics majors has shown a downward trend since peaking at 34.5 percent in 1984–85. Although this trend may be an additional source for concern, it is outside the scope of the cross-sectional analysis in this article.
2. Kahn (1995) reviewed the evidence concerning the underrepresentation of women at other levels in the economics profession.
3. We did not follow the students over time, so we could not test the hypothesis that women are more likely to change out of economics than men. Misol and Ramachandran (1994) presented information about whether female economics majors at Duke University and Wellesley College had considered switching to a different major.
4. The survey instrument is available from the authors upon request.
5. The variation across institutions was large. For example, according to Phillip Levine of Wellesley College, about 14 percent of the all-female class at Wellesley typically choose to major in economics. See Misol and Ramachandran (1994) for a comparison of the experiences of economics students at Duke University and Wellesley College.
6. The same point can be made by noting the following facts. In 1991 nationwide, 30 percent of economics bachelor's degrees were awarded to women and 54 percent of all bachelor's degrees were received by women. In the Harvard class of 1989, 20 percent of the economics majors were female, compared with 39 percent of the student class. (In a typical year at Harvard, approximately 24 percent of the economics majors are women; thus, the share of women in 1989 was a little lower than average.)
7. See Bartlett (1995) for references concerning gender differences in math aptitude. Kahn (1995) discounted the hypothesis that math is an important force behind the underrepresentation of women among undergraduate economics majors, pointing out that math as a major has a higher proportion of women than economics.
8. For more detailed discussions of the potential importance of role models, see Ehrhart and Sandler (1987) and Blau and Ferber (1986).
9. Another argument is that the content and pedagogy in introductory classes deter women from majoring in economics (Bartlett 1995; Ferber 1995). Because our data came from a class with fairly standardized course material, we could not readily test this hypothesis.
10. More specifically, Hall and Sandler (1982) contended that instructors make more eye contact with male students, allow male students to talk more, and take male students' questions more seriously. See Ferber (1990) and Bartlett (1995) for more discussion and references to statistical studies of these patterns.
11. To calculate the fraction of women in each individual's section, we used all students in the section *except* for that individual.
12. Although it is possible for students to major in economics at Harvard if they take introductory economics in their second (or even third) year, about 85 percent of economics majors take the course in their first year and choose to major in the field at that time. Thus, we base our descriptive statistics and probit results on the first-year students in the introductory economics class. In general, the statistics are similar for first-year students and for all students.
13. Durden and Ellis (1995) studied student performance in introductory economics at a medium-size state university and found no gender-related differences after controlling for a variety of factors. They pointed out, however, that most of the previous evidence on this topic suggested significant gender differences (e.g., Anderson, Benjamin, and Fuss [1994]). Hirschfield, Moore, and Brown (1995) reviewed the literature on undergraduate grades in economics and concluded that there are no consistent gender differences in grades in economics courses beyond the introductory level.

14. This result differed for the full sample of students in the introductory course, where men and women reported roughly equal ease in interpreting the graphs used in class.
15. In the full sample of students, the statistical significance of the gender differences in comfort levels was somewhat larger, and female students were significantly more comfortable asking questions in classes that had a higher percentage of women.
16. Ideally, we would have liked to compare the grade in introductory economics with other first-year grades, but we did not have such information.
17. We report probit results without a year dummy. The results including a year dummy were very similar and are available from the authors upon request.
18. The p value of the F test on the joint significance of the math-related variables was .001. We also interacted the female dummy variable with the math variables. Although the results suggest that women with higher math SAT scores and greater facility with math were more likely to major in economics than men, the interactions were never (independently or jointly) significantly different from zero.
19. We converted the letter grades to a continuous numerical variable according to Harvard's system that assigns 15 to an A, 14 to an A–, 12 to a B+, 11 to a B, 9 to a C+, 8 to a C, and so forth. Twenty-seven students took the course pass/fail or audited the course, and 2 students were missing grades. We assigned them the mean grade and included a dummy variable equal to 1 for them. We also tried including unrestricted dummy variables for the grade and found similar results.
20. Including the absolute grade in economics but excluding the math variables changed the gender gap in the likelihood of majoring in economics to –.069. Thus, it appears that absolute grade in economics and our math variables captured similar underlying determinants of the gender gap.
21. Further, when "relative advantage" was included without the math variables and the grade in economics, the gender gap fell by 2 percentage points, or by 26 percent.
22. The math SAT scores, however, were not jointly significant at the 5 percent level (the p value for the F statistic was 0.12).
23. We also interacted the quadratic term in SAT with "female" with almost identical results.
24. On the other hand, the data suggest that "math ability" may explain a large portion of the gender difference in the likelihood of choosing science as a major. Regressing (using a linear probability model) whether the person is a science major on a female dummy yielded a coefficient of –0.103 with a t statistic of –4.83; when the regression controlled for math SAT score, the female coefficient dropped to -0.037 with a t statistic of –1.73. These results are similar to those reported by Ware, Steckler, and Leserman (1985).
25. The mean SAT score was higher and the variance lower in the introductory class sample than in the registrar's sample. There are several possible explanations for these differences. First, first-year students who finished the course in 1991 and 1992 may simply have had better math backgrounds than first-year students (from the class of 1989) who finished the course in 1986. Second, students in the introductory class sample may have exaggerated their actual SAT scores. Third, lower-scoring students may have skipped the introductory class on the days the survey was administered. Finally, the students who took introductory economics in their first year and who later changed their major either into or out of economics may be drawn from the tails of the SAT distribution. Under the latter three explanations, one would want to down-weight the results from the introductory class sample relative to those from the registrar sample.
26. Measuring relative advantage as receiving a grade in introductory economics that is greater than *or equal to* the graduating GPA decreased the gender gap (conditional on math and grade in economics) by 11 percent in these data.
27. The similarity between the results for the entire class and those for students who took introductory economics in their first year is not particularly surprising. Although the sample-selected gender gap (columns 1 and 2) was larger than the non-sample-selected gender gap (columns 6 and 7), this difference does not necessarily affect inferences about the determinants of the gap. In particular, only those factors that affect the gender gap in both the probability of taking the introductory course and the decision to major in economics will bias the conditional estimates of determinants of the gap. Because the SAT math score had only a small effect on the gender gap among students in the introductory class and was not significantly related to who chooses to take introductory economics, our estimate of the importance of the SAT math score on the sample-selected gap was similar to that on the non-sample-selected gap.
28. Because the grade in introductory economics could be endogenous in the sense that those who know they want to major in economics work harder, we tried instrumenting the grade with the SAT math score. The results did not change.
29. Furthermore, unrestricted dummy variables for SAT math score yielded similar results.
30. Another problem with our math variables is that the "interprets graphs easily" variable may be more a reflection of a student's confidence than it is of his or her ability.

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