Do Faculty Serve as Role Models? The Impact of Instructor Gender on Female Students

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Although women have matched or surpassed men in many educational outcomes such as college access and persistence, female students remain much less likely to major in quantitative, technical, and science-related fields. While women have made progress in recent years, only 20 percent of engineering students are female, and the proportion of women receiving degrees in the sciences and engineering in the United States lags that of other industrialized countries (National Center for Education Statistics, 1995). This underrepresentation of women may have serious implications for women's returns to education and may relate to occupational segregation and earnings inequality by gender (Linda Loury, 1997). As the economy shifts to favor these more male-dominated fields, there is concern that women will not be prepared to succeed. Moreover, the health of the economy depends on the production of certain kinds of degrees, and the underrepresentation of women in certain areas may contribute to shortages in critical fields.

There have been many widely publicized efforts by the government, companies, and schools to increase female representation in male-dominated fields. One focus has been to increase mentoring opportunities for female students by hiring more women faculty members. Theory and evidence suggest that female instructors may be instrumental in encouraging women to enroll and excel in subjects in which they are underrepresented. Female students may avoid male-dominated fields due to biases against women (Sandra Hanson, 1996), and the presence of female faculty may mitigate these effects. David Neumark and Rosella Gardecki (1998) found that female doctoral students with female mentors were more likely to succeed. However, similar to student trends, women are underrepresented on university faculties, particularly in the sciences and quantitative fields, and many worry about the lack of potential role models for female undergraduates. For example, in 2003 Princeton University created a $10 million fund to hire and promote women faculty in science and engineering departments while Duke's president pledged $1 million per year for the same purpose (Robin Wilson, 2003). In addition, the National Science Foundation's ADVANCE program continues to push for "increased representation and advancement of women in academic careers and engineering careers" (National Science Foundation, 2004).

Does the presence of faculty members of the same gender impact student interest in a subject? This paper answers this question by estimating how having a female faculty member in an initial course affects the likelihood that a female student will take additional credit hours or major in a particular subject. If students choose their courses and major based on their experiences during their initial exposure to a subject, then the instructors they face early in a discipline could influence these decisions. Such an analysis is difficult because few data sets allow researchers to link student outcomes to faculty characteristics. However, using a comprehensive, longitudinal data set of nearly 54,000 students, this paper is among the first, large-scale studies to estimate the impact of faculty on the outcomes of students. Moreover,

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using detailed course information and an instrumental-variables strategy, we avoid biases due to course selection and student preferences. The findings provide insight into the potential impacts of policies designed to increase female representation on college faculties. The results suggest that female instructors do positively influence course selection and major choice in some disciplines, thus supporting a possible role-model effect. However, we fail to find positive and significant effects in some male-dominated fields.

I. Background: The Underrepresentation of Women and the Effect of Role Models

In Table 1, we present some descriptive statistics on the enrollment patterns of women across disciplines. The data represent all first-time, full-time freshmen who are of traditional age (18–20 years old) and entered one of the 12 public, four-year colleges in Ohio during fall 1998 or fall 1999. The data are based on university records and student transcripts and include information on student demographics, test scores, courses taken, and major. Additionally, from ACT exam records, we have information on each student's intended college major. Because this information is important in our empirical analysis to account for pre-college interests, we limit the sample to students with test information. Over 89 percent of students took the ACT, and this restriction does not significantly change the sample except in terms of favoring Ohio residents. One advantage of the data is we can follow students across the 51 public colleges in Ohio, and so our analysis tracks outcomes even for transfer students. There may be some leakage if students transfer to private or out-of-state institutions, but this is likely small (Eric Bettinger and Bridget Long, 2004).

Women comprise nearly 55 percent of the sample, and as Table 1 illustrates, they are fairly represented in most disciplines in terms of whether they ever took a course. For example, almost 55 percent of the nearly 54,000 students who ever took an English class were female. Even in physics, mathematics, computer science, and business, between 44 and 51 percent of students ever taking a course in these fields were women; however, of the students who eventually majored in these fields, women are clearly underrepresented. For example, only 14 percent of computer science majors were women in our data. Women are also underrepresented among economics majors. By contrast, women tend to be overrepresented in terms of majors in English, psychology, education, and social work. In engineering women are underrepresented among students ever taking a course (21 percent) and majoring in the subject (16 percent).

TABLE 1—SHARE OF FEMALE STUDENTS AND FEMALE FACULTY BY DEPARTMENT

	Female students		Female instructors in initial courses	
Department	Percentage of course-takers	Percentage of majors	Percentage of overall faculty	Percentage of full-time faculty
Humanities				
English	54.6	70.6	56.5	12.2
History	51.8	39.5	32.2	11.8
Social Sciences				
Economics	47.0	29.8	24.9	10.9
Polit. Science	51.8	46.0	27.2	9.9
Psychology	58.4	77.7	48.7	13.1
Sociology	59.0	61.8	48.9	17.4
Journalism	58.0	60.5	43.9	21.7
Sciences				
Biology	62.4	64.3	34.4	11.9
Chemistry	52.4	53.5	30.2	7.6
Physics	43.5	24.0	15.5	2.9
Geology	53.8	14.2	32.3	6.0
Mathematics	51.0	41.6	30.8	6.8
Business	47.1	44.6	32.2	18.3
Computers	45.9	14.4	26.5	6.5
Engineering	21.3	16.1	16.5	10.4
Education	63.3	76.8	57.7	2.1
Social Work	78.9	94.3	57.0	27.7

Notes: The sample is restricted to first-time, full-time freshmen of traditional age who took the ACT, and entered a public, four-year college in Ohio during fall 1998 or fall 1999. The subgroups shown under the major discipline groupings are not a complete list of departments.
Source: Ohio Board of Regents HEI System.

The underrepresentation of women has been the cause of concern among educators and policymakers. Many note the lack of same-gender mentors that are available, as evidenced by the paucity of female faculty members in most disciplines. As Table 1 shows, less than one-third of all faculty teaching introductory courses in history, economics, political science, chemistry, physics, math, business, computer science, and engineering were female. Female representation among full-time faculty was even smaller. In English, for example, while 57 percent of instructors teaching introductory courses were female, women professors comprised only 12 percent of the full-time faculty in this group. Much of this difference comes from the use in introductory courses of part-time, adjunct faculty, who are more likely to be women.

Policymakers have attempted to increase female representation among majors by increasing the number of women professors, with the hope of making it easier for female students to find role models. Whether underrepresented students benefit from instructors with similar characteristics has been explored by many researchers.[1] For example, several studies of primary and secondary education have found that African-American students who have African-American instructors have higher test scores (e.g., Ronald Ehrenberg and Dominic Brewer, 1995). Many scholars interpret these findings as evidence that same-group instructors act as role models, perhaps because they serve as examples to students or can better empathize with their particular needs.

A small number of studies also attempt to identify the effects of instructor gender on student outcomes in higher education, but the results from these studies are mixed. For example, Brandice Canes and Harvey Rosen (1995) find that the proportion of a department that is female had no effect on female major choice at Princeton University, the University of Michigan, and Whittier College. On the other hand, Kevin Rask and Elizabeth Bailey (2002) and John Ashworth and J. Lynne Evans (2001) find that female faculty members encourage women students to select a major. The authors argue that the increased major choice is evidence that female instructors are role models.

While the research on the role of gender in higher education has produced conflicting results, each of the existing studies is relatively small in scale. All are case studies or limited analyses of a particular university. It is unclear whether the results differ because their samples vary, and few sources exist to perform large-scale analyses that might be more informative for larger populations. While there are major data sets of faculty (e.g., National Study of Postsecondary Faculty) and students (e.g., National Education Longitudinal Study of 1988), one is unable to link these sources. Another limitation of the existing studies is that they do not account for selection issues. One might worry that certain kinds of female students may be more likely to select women professors due to preferences or interest in a particular discipline. Such sorting may bias studies that simply compare the outcomes of female students who take classes from women versus men. A final limitation is that the previous research fails to control for whether a female instructor is an adjunct or graduate student. Work by Bettinger and Long (2004) shows that women are more likely to serve in those positions, and adjuncts and graduate students may have distinct effects on student outcomes unrelated to gender.

Our analysis addresses these concerns in several ways. First, using a student-level data set of an entire state's higher-education system, we provide a large-scale analysis that is more representative of the national population of four-year college students and includes selective and nonselective institutions. Moreover, we control for other faculty characteristics including the rank and position of the instructor. Finally, the wealth of longitudinal data used in this analysis allows us to identify exogenous variation in the proportion of a department that is female, and so we are able to address selection issues.

II. Empirical Strategy

To identify the effects of faculty gender on course-taking behavior and major choice, we focus on female students' first experiences in a subject and whether they had female instructors in these initial courses. These classes are often introductory, and the experience with faculty in them may affect student interest and success in subsequent courses. The key explanatory variable is defined as the proportion of the courses in subject k that student i took from female instructors during the first semester student i was exposed to the department. For example, if

[1] This research is related to a larger literature examining the effects of teacher characteristics on student outcomes. While most of that literature focuses on primary and secondary education, several recent studies extend this research to colleges. Bettinger and Long (2004) compare the impact of adjunct and graduate student instructors to full-time faculty on student interests. George Borjas (2000) examines the impact of foreign teaching assistants on student performance.

a student took her first course in subject k from a female professor, the variable would equal 1. For cases in which students take multiple courses in a subject during the first semester of exposure, we set the variable equal to the proportion of faculty that were female, weighted by number of credits for each course. The analysis then tracks subsequent behavior, y_{ik}, in subject k after this introductory course (or set of courses) and tests whether there are differences by instructor gender using the following equation:

$$(1)\qquad y_{ik} = \alpha + \beta(\text{Female Instructor})_{ik} + \boldsymbol{\gamma}\mathbf{X}_i + \boldsymbol{\delta}\mathbf{Z}_{ik} + \varepsilon_{ik}$$

where $\mathbf{X}_i$ includes controls for student demographics and ability (age, gender, race, state of residency, and ACT score), and $\mathbf{Z}_{ik}$ controls for individuals' interactions with a particular subject including whether the subject is in the student's intended major, the semester the student took the course, and the number of credit hours students attempted that semester. Because we have multiple observations per student, we control for within-student correlation by clustering the standard errors throughout the paper. Additionally, because different kinds of instructors may affect student interest as shown by Bettinger and Long (2004), we also include controls for whether the faculty member is a part-time (i.e., adjunct) or graduate-student instructor. The sample excludes remedial courses in which students are placed.

The distribution of students across courses taught by faculty members of different genders may not be random. For example, if female instructors are more likely to teach in particular majors, then students with particular interests will be more likely to have them in courses. While we do control for the student's intended college major, students seeking potential mentors may also choose courses based on a preference for an instructor of the same gender. In fact, the preference for a particular type of instructor may be strongest within a student's intended major. For these reasons, students who have female professors may be systematically different from other students, and this would cause our basic model to be biased.

The analysis uses an instrumental-variables (IV) strategy to deal with this potential endogeneity. Due to sabbaticals, hirings, retirements, and temporary shifts in the number of sections offered in a particular course, there is variation term-by-term in the proportion of courses taught by female faculty in a department. Therefore, while a particular department may staff 30 percent of their classes with female professors in "steady-state," this fluctuates term-to-term. We use this variation as the IV that is related to a student's likelihood of having a female instructor but unrelated to a student's pre-college interest in a subject.[2] We augment this instrumental strategy by including course fixed effects to compare students who take the same courses but have different types of instructors due to multiple sections being offered or the fact that the course was taken in different years. With this framework, we run the following first-stage equation to explain the likelihood a student has a female instructor:

$$(2)\qquad (\text{Female Faculty})_{ik} = \alpha + \eta(\text{Deviation from Steady-State Female Composition})_{ik} + \boldsymbol{\gamma}\mathbf{X}_i + \varepsilon_{ik}$$

where η measures the effect of a deviation from the steady-state composition of female instructors in department k.[3] The model includes controls for school and department, so we are identifying off deviations from a department's steady state rather than differences across subjects or schools.

III. The Impact of Female Faculty on Female Students

To determine the impact of female faculty on female students, we examine three outcomes: whether the student took any additional courses

[2] The departmental steady states are defined over five years (fall 1998–spring 2003), while student outcomes are observed over four years. The analysis calculates term-specific steady states so that the fall norm differs from the spring norm, thereby utilizing even more variation.

[3] We also treat the controls for whether the instructor is part-time or a graduate student as endogenous. As described in Bettinger and Long (2004), we use deviations in the proportion of the department made up of tenure-track faculty to instrument for the likelihood that a student has an adjunct or graduate student instructor. However, our results are not sensitive to this specification.

in the subject, the total number of subsequent credit hours taken, and major choice. Estimating equation (1) using ordinary least squares (OLS) gives a simple comparison of the outcomes of female students who did and did not have female instructors in their first course in a subject. When not accounting for differences in course selection, the OLS estimates suggest that the presence of female faculty members slightly increases the likelihood a female student majors in the subject. Once we include course fixed effects to compare students who took the same classes, we find small positive effects in terms of course selection. However, due to concerns about student preferences between different types of instructors, we employ the IV strategy described in the above section. Table 2 displays the IV estimates of the impact of female faculty on the interests of female students.

The estimates suggest that female instructors have mixed effects on the interests of female students. In the sciences, female students who initially had women professors were less likely to take additional courses in biology and physics than similar female students who had male faculty members in their first course. On the other hand, female instructors positively impacted the likelihood of taking an additional course and the total number of subsequent credit hours in geology and mathematics and statistics. Particularly in the most quantitative major, women students who initially had a female faculty member were nearly twice as likely to take an additional course and on average took 5.2 more credits than other female students. In terms of major choice, we find no positive or negative effects.

In the humanities and social sciences, women faculty members increased either the likelihood female students took an additional course or the total number of subsequent credits hours in psychology, sociology, journalism and communications, and education. For example, female students who initially had a female faculty member took six additional credits hours more than similar female students who initially had a male professor. Only in political science and in terms of total credit hours in education did female instructors negatively impact the course selection of female students. Less-favorable effects were found in terms of major choice. Having a female faculty member initially reduced the likelihood of majoring in economics, psychology, and education, while increasing the probability in sociology.

The results suggest that female faculty members do have the potential to increase student interest in a subject as measured by course selection and major choice. The results are particularly positive and strong in mathematics and statistics, geology, sociology, and journalism. Most notably, women are underrepresented as majors in mathematics and geology, and so the results support the notion of female faculty serving as role models. However, in other fields in which women are underrepresented, such as engineering, physics,

TABLE 2—INSTRUMENTAL-VARIABLES ESTIMATES OF THE EFFECTS OF FEMALE FACULTY ON FEMALE STUDENTS

	Subsequent credit hours		
Department	Any additional hours	Total hours	Major choice
Science, Quantitative, and Technical Fields:			
Biology	−0.5015**	1.208	−0.0964
	(0.2287)	(2.622)	(0.0929)
Chemistry	0.8359	10.007	−0.1091
	(0.6435)	(8.325)	(0.1573)
Physics	−0.6623**	−2.144	0.022
	(0.2662)	(1.581)	(0.0279)
Geology	0.1514*	1.384**	0.0005
	(0.0838)	(0.4237)	(0.0081)
Mathematics and statistics	0.8298**	5.203*	0.0054
	(0.3105)	(2.688)	(0.0272)
Engineering	−0.4735	−3.901	−0.4472
	(0.4034)	(16.638)	(0.2749)
Computer science	−0.3098	−1.106	0.0921
	(0.1892)	(1.560)	(0.0566)
Business	0.2112	1.026	0.0118
	(0.3842)	(13.202)	(0.2933)
Humanities and Social Sciences:			
Humanities	−0.0578	−0.9175	0.0135
	(0.0744)	(0.785)	(0.0124)
Economics	−0.1057	0.1447	−0.0353**
	(0.1221)	(0.8464)	(0.0159)
Political science	−0.9604**	−15.200**	−0.045
	(0.4178)	(6.165)	(0.1255)
Psychology	0.1501**	0.4919	−0.0951**
	(0.0623)	(0.889)	(0.0308)
Sociology	0.0488	2.175**	0.0589**
	(0.0865)	(1.069)	(0.0246)
Journalism and communications	0.1704	6.101**	0.1882
	(0.1467)	(3.042)	(0.1496)
Education	0.5268**	−29.850**	−0.7428**
	(0.1448)	(4.970)	(0.1194)

* Statistically significant at the 5-percent level.
** Statistically significant at the 1-percent level.

and computer science, we do not find female faculty to have statistically significant effects. The small proportions of female faculty (especially once course fixed effects are included) make it difficult to estimate accurately the effects of women in these disciplines. The results could change as the proportion of females in a department increases to near equity with males. Moreover, additional analysis is necessary to measure whether female faculty influence male student outcomes as well.

IV. Do Male Faculty Serve as Role Models for Male Students?

Similar to their female counterparts, men are underrepresented in certain fields such as education and social work. For example, men comprised only 23 percent of majors in education, and male instructors comprised only 42 percent of the department. We repeated the analysis to determine whether having a male faculty member in a female-dominated disciplined had a positive effect on the interests of male students. While no effect was found in any other discipline except business, strong effects were found in education. Male students with male professors initially in education courses took 12.9 more subsequent credit hours and were much more likely to major in the subject. These results further lend support to the idea that same-gender faculty may positively impact student interest in a subject. More research is needed to explore further the impact faculty may have on students interests and performance.

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