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Author(s): Roberta Edgecombe Robb and A. Leslie Robb
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PETER KENNEDY, Section Editor

Gender and the Study of Economics: The Role of Gender of the Instructor

Roberta Edgecombe Robb and A. Leslie Robb

Considerable attention has been focused on the issue of declining economics enrollments across North America. This decline is well documented for the United States (Siegfried 1995). Although less work has been directed at this issue in Canada, discussion at the teaching and learning sessions of the June 1996 meeting of the Canadian Economics Association indicated that the issue is of equal concern in Canada. Although the reasons for this decline are not well understood, the desire of academic departments to protect their share of scarce resources has led to much soul-searching on how to attract more students. Because women now constitute an increasing proportion of university enrollments in general, some of the discussion has focused on the long-standing underrepresentation of women in the discipline. This situation, although well documented (e.g., Dynan and Rouse 1997; Ferber 1995; Siegfried 1995), is also not well understood.

The decision to pursue economics may be thought of as involving a two-stage process. In the first stage, the high school student decides to take economics (or a program requiring economics) in the first year at the university; in the second stage, the university student decides to take further courses in economics conditional on having taken the introductory course. Although the analyses of these decisions are quite limited, recent work by Dynan and Rouse (1997) for the United States indicates that women are significantly less likely than men to take intro-

***Roberta E. Robb** is a professor of economics at Brock University (e-mail: rrobb@spartan.ac.brocku.ca). **A. Leslie Robb** is a professor of economics at McMaster University.*

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ductory economics in the first place or to major in economics conditional on having taken the introductory course.

GENDER-BASED PERFORMANCE DIFFERENCE

To date, a number of studies have attempted to model academic choice (e.g., Dick and Rallis 1991; Meece et al. 1982). These studies suggest that one major determinant of choosing a field of study is the individual's perceived comparative aptitude for the area as evidenced by grades, test scores, related experience, and so forth. Although little is known about gender[1] performance in high school economics courses,[2] evidence is mounting that female students, on average, do worse than male students in university introductory economics courses (Dynan and Rouse 1997; Anderson, Benjamin, and Fuss 1994; Tay 1994), which may help explain why economics is male dominated; female students may get "turned off" by economics at the introductory level. The reasons for this gender-based performance differential are not clearly understood, although several hypotheses have been advanced. These hypotheses include differences by gender in mathematics ability and/or preparedness; possible subject-matter bias (economics does not "speak" to women); possible gender bias in testing methods (women do less well on multiple-choice exams, a common form of testing in introductory economics); and the absence of female role models.

It is clear that the issues are complex and that unraveling the threads of the puzzle will take considerable research. We focused on the possible influence of the absence (or presence) of female role models in economics by examining the role of the gender of the instructor in the performance of men and women in an introductory microeconomics course, as well as on the student's decision to take other courses in economics conditional on having taken introductory micro. We hypothesized that a female instructor might influence the performance and decisionmaking of female students in two ways. First, female instructors may teach introductory economics in a way that does not "disadvantage" female students and/or provide a classroom climate that women find more conducive to learning. Ferber (1995), for example, referred to the chilly classroom climate for women and minority students as a possible cause of low enrollments for these groups. Second, a female instructor might provide the traditional role-model effect because her presence signals that women can, and do, succeed in economics. (For an excellent discussion and some empirical analyses of these role-model effects, see Symposium: Role Models in Education [1995].) Both of these effects can influence performance and continuation in economics.[3] In the case of performance, it seems impossible to identify separately the two effects, and we refer to them generically as the role-model effect. In the case of continuation, the second effect can be distinguished by conditioning on performance.

PREVIOUS STUDIES OF IMPACT OF INSTRUCTOR'S GENDER

We built on recent work in this area by Anderson, Benjamin, and Fuss (1994); Canes and Rosen (1995); Bailey and Rask (1996); and Dynan and Rouse (1997).

Several earlier studies provided useful insights into students' performance in introductory economics, but none appeared to consider the impact of the gender of the instructor directly. Although Anderson, Benjamin, and Fuss recognized the potential importance of the gender of the instructor on performance, their analysis was hampered by the lack of the microdata required to test this hypothesis directly. Using a sample of students from the University of Toronto, which did not have any information about individual instructors, the best they could do was to include a dummy variable for the Erindale campus, which had more female instructors than the main St. George campus during their data period.

With respect to continuation, Canes and Rosen analyzed the effect of the proportion of female faculty in a department on the choice of students' major but found no role-model effect. They recognized, however, that having microdata on the gender of the instructor of the individual student, as opposed to the more aggregate data on percentage of female faculty at the department level, would allow a better test of the hypothesis. Bailey and Rask (1996) and Dynan and Rouse (1997) used microdata but found conflicting results. Looking solely at the decision to major in economics, Dynan and Rouse found no impact of the gender of the instructor; when looking at the choice of college major across a broad spectrum of disciplines, Bailey and Rask did find a role-model affect. Because of the mixed results from this limited research, further study seems warranted.

Although studies of continuation in economics with reference to the gender of the instructor are relatively few, the literature that addresses this issue builds on a larger, earlier literature on persistence.[4] Because the motivation for much of this earlier research was the need for institutions to predict (and/or influence) enrollments, it was institution based and often institution specific. The question addressed was: What influences this institution's ability to retain students? Rather than starting from a model of individual choice as we have and the articles cited above do, the starting point for these articles was a model of the group or aggregate of students and the institution(s) in which they studied. A seminal piece in this literature is the article by Tinto (1975) that influenced much of the later work. A good discussion and survey of this approach at the postsecondary or the college level generally is the monograph by Gillespie and Noble (1992). An example and extension of the econometric framework is the article by Cabrera, Nora, and Castaneda (1993). Horvath, Beaudin, and Wright (1992) focused on persistence in introductory economics and explored gender differences among students in this regard.

DATA

General Characteristics

We followed students who studied first-year microeconomics at Brock University—a midsize public university in Ontario—between fall 1989 and spring 1995. Our focus on micro rather than on both micro and macro was dictated by data availability and not by any expectation that macro would lead to different results. During the time period for which we had data, a number of instructors of each gender taught micro, whereas macro had mostly male instructors. For reasons cited below, we dropped spring and summer session offerings of the micro course, restricting our attention to the fall and winter sessions. This restriction left us with eight different instructors (four male and four female) in 22 different sections.

Fortunately for the purposes of this study, the characteristics of the instruction in the introductory micro course were homogeneous over the whole period. The same textbook (albeit two different editions) was used, and the course followed the same structure for lectures, tutorials, and exams.[5] Many of the tutorial leaders were the same from year to year, and when more than one section of the course was offered, the sections had common midterm and final exams (a university requirement). The method of student evaluation was also virtually constant over the whole period, with a final exam worth 50 percent and midterms accounting for the remaining 50 percent of the final grade. Midterm and final exams always had three sections: multiple-choice, short-answer (and/or true/false) questions, and problems, which accounted for about 50 percent of the grade. Although the section size varied by term and year, the average section size of 184.9 students for the male instructors was essentially the same as the average section size of 185.3 for female instructors. Of the eight instructors, no major differences were apparent between the male and female teachers, on average, in experience or training. Only two were nondoctorate (one man and one woman) and these two were part-time instructors. Of the rest, four were tenure track (three women and one man) and two (men) were on contractually limited appointments.

Sample

Because we wished to control for background characteristics of the students, especially their performance in high school (Ontario Academic Credits—OACs), we restricted our sample to those students who entered in the fall session (of any year) through the Guelph University Admissions Centre process (the required entry route for students coming straight out of an Ontario high school). Although this restriction ensured that we had similar information (control variables) on all the students, it required us to exclude students from other provinces and countries (a small fraction of students entering Brock), students who entered as mature students (with different admission information available), and transfer students from other universities or colleges.

We dropped from our sample any student who, after registering and enrolling in microeconomics, completed no courses within the year after admission. We also dropped spring and summer session courses because they contained so few students meeting our other criteria (especially normal admission from high school in the previous fall term). We conducted a parallel analysis to see if any of the substantive results were affected by the exclusion of the spring and summer sessions, and they were not.

Also, for all of the analyses reported here, we omitted from our sample those students who dropped or received a zero grade in the course (148 out of 2,552 observations). We treated these two groups in the same way. A zero grade indicated that no grades were recorded for the student, and we assumed that the student effectively dropped before the first midterm but that the information was not communicated to the registrar before the official drop date. Because omitting these "drops" could give rise to selection problems (Anderson, Benjamin, and Fuss 1994), we analyzed the drops to see if any systematic pattern was evident. We noted that female students dropped slightly more frequently than male students, and fewer students of either gender dropped in sections with female teachers than with male teachers. The differential in drop rates between male and female students, however, was essentially the same for sections with male teachers and female teachers. In short, there appeared to be no evidence of a systematic pattern of drops that would color our results. We also considered a sample selection approach to the problem to see if this influenced our results but were unable to find adequate instruments. In any event, a Heckman-type selectivity approach has problems of consistency in this context, where the dependent variable is a percentage grade and cannot possibly have normally distributed errors.

These restrictions on the data left us with 1,581 male and 823 female students for the main analysis. The means of key variables are shown in Table 1. Seventy-one percent of the men and 69 percent of the women had a female instructor in first-year microeconomics.[6] It is interesting to note that the female students appeared better qualified for university entrance than did the men. The overall final OAC average was 2.3 percentage points higher for women than for men; a higher proportion of the female students took OAC mathematics (often thought to be important in economics performance) and received better grades in those math courses than did the men. Finally, whereas a slightly lower proportion of

TABLE 1
Means of Key Variables by Gender

	Men		Women	
Variable	Mean	*SD*	Mean	*SD*
Microeconomics grade	62.0	15.23	62.3	14.68
HS final average	74.6	5.65	76.9	5.89
School's average	75.2	2.61	75.9	2.84
HS economics average	75.5	7.57	76.7	8.48
HS calculus average	70.7	11.76	72.2	11.08
HS finite math average	73.9	11.28	76.5	10.58
HS algebra/geometry average	71.9	11.20	73.4	11.02
HS English average	70.4	7.93	74.0	7.96
Fraction with HS econ	0.34	0.47	0.30	0.46
Fraction with HS calculus	0.76	0.42	0.81	0.39
Fraction with HS finite math	0.64	0.48	0.66	0.47
Fraction with HS algebra/geometry	0.34	0.47	0.39	0.49
Fraction with HS English	0.99	0.11	0.99	0.11
Fraction with two math classes	0.43	0.50	0.43	0.50
Fraction with three math classes	0.20	0.40	0.25	0.43
Fraction with female teacher	0.71	0.45	0.69	0.46
Observations	1,581		823	

Note: HS = high school.

women took OAC economics (.30 v. .34 for males), their mean grade was somewhat higher (76.7 v. 75.5). In spite of being better qualified at entrance to the university, the women performed no better than men in the micro course.[7] Moreover, as we show later, once we controlled for preparedness, the women performed substantially and significantly worse than did the men in this course—a finding that has been reported elsewhere (Anderson, Benjamin, and Fuss 1994; Tay 1994; Siegfried 1979).

STUDENT PERFORMANCE IN INTRODUCTORY MICROECONOMICS

Modeling the Effects of Gender of Instructor

Our interest was in the effect of the gender of the instructor on student performance in the introductory micro course and on the student's decision to continue in economics. Our basic model for performance in economic was

$$\text{micro} = f(\mathbf{hsvar}, \textit{studentg}, \mathbf{teacher}, \textit{teacherg}) + e, \tag{1}$$

where micro is the percentage grade in microeconomics, **hsvar** is a vector of background characteristics of the student (basically high school performance) likely to influence university performance in general and first-year economics performance in particular, *studentg* is a dummy variable for the gender of the student, **teacher** is a vector of dichotomous variables representing individual teacher effects, *teacherg* is a dummy variable indicating the gender of the instructor, and e is an error term. We looked at this in a regression context, and the focus was on teacher gender. That is, controlling for other influences, does teacher gender influence performance in microeconomics? Do female teachers have a differential impact on the performance of female students?

An identification problem existed in distinguishing between individual teacher effects and the effects of the gender of the teacher. If we included a set of teacher dummies and a dummy variable representing the gender of the teacher in a regression equation to explain student performance, we would not be able to identify the effects separately because the gender variable was an exact linear combination of the teacher variables. Fortunately, in the framework we had in mind, we could overcome this problem. Our view was that each teacher or instructor might indeed have an individual effect on the class mean (on both male and female students). This might be because the teacher was more productive in imparting knowledge, the teacher had different standards, the teacher had more or fewer sick days, and so forth. We did not explore these reasons. We simply included these dummy variables for teachers as controls and thought of this effect as improving (or reducing) the marks of all students in the class. This differed from the role-model effect in which we were interested. The idea in this latter case was that female students perform better when in a class with a female teacher, and this effect can be distinguished from the general teacher effect. In particular, if this role-model effect was present in the sense that female students did better in classes with female teachers, then a significant interaction should exist in a regression context between a dummy for student gender and one for the gender of the instructor (*Studentg* × *Teacherg*).

We used the following variables to control for background and abilities (**hsvar**): *final avg* (the final average of the best six high school OAC grades),[8] *calculus* and *calculus gr* (an indicator of whether OAC calculus was taken and, if it was taken, the grade achieved); *economics* and *economics gr* (a similar pair of variables for OAC economics); *English* and *English gr* (a similar pair of variables for OAC English); *finite* and *finite gr* (a similar pair of variables for OAC finite math); and, finally, *algebra* and *algebra gr* (a similar pair of variables for OAC algebra-geometry).

Modeling High School Grading Differences

One additional variable—*school's avg*—appeared in the regressions; with this variable, we attempted to control for grading differences across high schools in the province. Some 337 high schools were represented in our database, some with as few as two students who came to Brock and enrolled in microeconomics. Given that exams are set and grades determined at the local school level, it is unlikely that a grade of say, 80, means exactly the same thing in every school. We considered including a categorical variable for each school in the province (a school-specific effect), although this seemed cumbersome. The alternative we employed was to standardize for the difference in school grading standards.

Suppose that every school in the province has equally capable students who learn the high school material in any course equally well. Some schools, however, grade easier and some harder. Suppose school A differs from school B by adding some amount, say five points, to each student's mark. We think of this as the *local-grades* model. A natural way to standardize these grades is to subtract five from every grade earned in school A (the difference in the school means). Equally, one could simply subtract the mean grade for the school from every student's grade and use this difference as an index. With hundreds of schools to deal with, subtracting the mean grade of the school is easier to implement. If this model is correct and we incorporate in a regression equation both a student's OAC average and the school's average OAC (the average for the school of the OAC averages of all the students), these two variables should enter the regression with equal magnitude and opposite signs. Whether they do, in fact, enter this way can allow a test of the local-grades model.

Suppose, alternatively, that the differences in school average grades is not caused by grade inflation but reflects differences in the underlying populations of students. Call this the *real-student-differences* model. The student's OAC average would be the appropriate variable to include as a control in this case, and incorporating the school average should be uninformative. If the school average is subtracted from the student's grade, it should just add noise and cause the coefficient to tend toward zero, and if it enters separately, it should have a coefficient of zero.

Finally, suppose that the difference among the mean grades at the various schools is partly caused by grading differences and partly reflects average differences in students, or more precisely, average differences in the students who come to Brock (and take first-year economics) from the schools. We call this the *mixed model*. If this is a reasonable model and if the two variables are entered separately in the regressions, as discussed earlier, we would no longer expect the coefficient on the school average to be equal in magnitude (and opposite in sign). Rather, we would expect the coefficient on the school average to lie somewhere between zero (the real-student-differences model) and the negative of the coefficient on the student's own grade (the local-grades model). We started from this mixed model, as it was the most general model, and tested whether either of the two pure models could be supported by the data.

ESTIMATION RESULTS

We began our analysis with a general representation of the determinants of performance in first-year micro and adopted a testing-down strategy to obtain a parsimonious representation. The starting point can be represented in general terms by

$$\text{micro} = g(\mathbf{hsvar}, \textit{studentg}, \mathbf{hsvar} \times \textit{studentg}, \mathbf{teacher}, \textit{Studentg} \times \textit{Teacherg}) + e, \tag{2}$$

where the variables are as described earlier and all variables (and combinations of variables) enter linearly. Thus, all of the high school grade variables enter linearly as does student gender, and they enter also in interactive form (**hsvar** × *studentg*) so that the background variables can have a differential effect on men and women. The vector of teacher dummies enters linearly allowing each teacher to have an independent impact on performance. Finally, the *teacherg* enters interactively with the *studentg*. Both female students and female teachers are coded 1, and if there is a role-model effect, we anticipated a positive and significant coefficient on this variable.

Testing Down

The order of testing when testing down is arbitrary, and different orders of tests could lead to different outcomes. We record here the order we followed and the results obtained. We tried a number of alternative testing-down strategies, and they all led to the same final outcome.

We first tested and rejected the local-grades model and real-student-differences model in favor of the mixed model. Next, we tested and rejected the presence of interactions between student gender and OAC course variables. Third, we used F tests on pairs of course variables and course grades to test for significance, which led to the dropping of English and finite math. Finally, we tested and rejected the hypothesis that a single variable representing teacher gender could replace the set of individual instructor dummy variables.[9]

We report in Table 2 the regression results from the equation that was selected after testing down. The equation was estimated on a combined sample of men and women in a form that allowed a test for the effect of a female role model by allowing the interaction between gender of student and gender of instructor (*Studentg* ×

TABLE 2
Regression Results for Student Performance in Microeconomics

Variable[a]	Coefficient	t	p
Studentg	−3.31	−3.37	.00
Studentg × *Teacherg*	0.89	0.76	.45
Final average (%)	1.19	18.31	.00
School's average (%)	−0.38	−3.60	.00
Economics	−10.35	−2.23	.03
Economics grade (%)	0.17	2.76	.01
Calculus	1.52	0.69	.49
Calculus grade (%)	0.05	1.73	.08
Algebra	0.68	0.22	.83
Algebra grade (%)	0.02	0.57	.57
Constant	−8.34	−1.07	.28

Note: N = 2,404; adjusted $R^2 = 0.32$.
[a]Teacher dummies are not reported here.

Teacherg). Except for the effect of gender of instructor, this specification forced the control variables to have the same effect on both male and female student performance (indicated as being appropriate by the testing-down procedure).

Control Variables

Before considering the effect of the gender of instructor, we will consider the effects of the other control variables. From the data in Table 2, one sees that a 1 percentage point increase in the high school final average grade of the student, male or female, translated into a little over 1 percentage-point improvement (1.19) in the grade in micro. On the other hand, coming from a school with a higher average grade of admission of 1 percentage point translated into around a 0.38 percentage-point lower performance in first-year micro (all other things, including high school performance, held constant). These results were quite robust over alternative versions of this equation (specifically, in the various versions of estimating equations we considered in the testing-down procedure). As discussed in the previous section, the local-grades model would have these coefficients of equal and opposite sign, the real-differences model would have the school average variable with a zero coefficient, and the mixed model would have an intermediate result such as the one we find here.

Female students were coded as 1 (male students as 0) for the variable *studentg*, so that the regression results reported in Table 2 imply that women entering Brock with the same high school grades tended to receive a micro grade about 3.3 percentage points lower than men (other things held constant).[10] This is an effect commonly found in the literature—women do less well than men in introductory economics courses (Anderson et al. 1994).

To evaluate the effect of performance in individual high school courses on the micro grade, one must take account of two variables—the variable indicating whether or not the course was taken, and if taken, the grade attained.[11] The indicator variable was coded 0 if the course was not taken and 1 if taken, the grade was coded as 0 if the course was not taken. The effect on the first-year university micro grade of taking high school economics and getting a grade of 76 (roughly the mean value in our sample), for example, was calculated from Table 2 as 2.41 percentage points [$-10.35 + (.17 \times 76)$].[12] That is, a student who had taken the high school course and achieved the mean grade could expect to do 2.41 percentage points better than one who had not taken the course. For each of the three courses included in the final specification (economics, calculus, and algebra), we report in Table 3 the effect of having taken the course in high school and receiving the mean grade (shown in Table 1) as well as the effect of having taken the course and receiving a grade of 10 percentage points above the mean grade. All three courses show improvements at the mean plus 10 (relative to the mean grade). The calculus course had the biggest effect overall, although the economics course had the biggest incremental or marginal effect.

Influence of Instructor

Regarding the effect of the gender of the instructor as it interacts with the gender of the student, we expected a positive and significant coefficient if female instructors had a differential role-model effect on female students. We found no evidence of such an effect.[13] This result was quite robust, appearing in every variation of the model encountered in our testing-down strategy. We concluded that there was no evidence of a female-role-model effect on performance in microeconomic principles. In the next section, we look into the possibility that a role-model effect was present but took the form of influencing continuing in economics rather than course performance.

Because the female students in this sample entered university somewhat better prepared than the male students—including having better grades in OAC math and economics—the result that women did worse than men in this introductory micro course was somewhat puzzling. It could be, of course, that women do poorly in all their first-year courses—although evidence from other sources does not suggest that this is so. We did some further work in this area and found the same to be true for this sample. This poor performance phenomenon was associated with economics performance and not first-year performance generally.[14]

TABLE 3
Effect on First-Year University Microeconomics Performance of Attaining a Mean Grade or a Grade of 10 Points Higher, in Selected OAC Courses

High school course	Effect at mean[a]	Effect at mean plus 10[a]
Economics	2.41	4.09
Calculus	5.40	5.94
Algebra	2.43	2.67

[a]Calculated from Table 2 coefficients.

CONTINUATION IN ECONOMICS

We considered the impact of the gender of the instructor on the likelihood that a female student would continue in economics. Our study is most comparable to Dynan and Rouse (1997), although there are significant differences. First, we were studying a very different population of students (those at a medium-size Canadian undergraduate school versus those at a world-class research institution—Harvard), although with a similar method. Second, as a consequence of combining data over a number of years, our sample was far larger than the sample in Dynan and Rouse. Finally, we investigated the choice of additional courses in economics in the next academic year as opposed to the choice of major.

Modeling Continuation

To estimate a probit equation for the likelihood that a student will take additional courses in economics after the first year, we attempted to determine whether the gender of the instructor influenced this decision—in particular, for female students. The general structure we explored can be written as follows:

$$\text{Prob}\ (I > 0) = f(\mathbf{X}, \textit{studentg}, \textit{Studentg} \times \textit{Teacherg}), \qquad (3)$$

where **X** is a vector of control variables that are expected to influence continuation in economics, *studentg* and *Studentg* × *Teacherg* are as defined earlier, and *I* is an indicator variable that takes the value 1 if the continuation condition is met and 0 otherwise. We were looking at the probability of taking additional courses in economics (after taking the introductory course) and not at the probability that the student would major in economics, which we were unable to do. Our data set allowed us to identify the student's program at the point of admission to the university and the last recorded program (i.e., at graduation). Because we had no program information in between these two events,[15] we could not identify if the student changed programs between admission and graduation. Even in the cases in which program information was available, it was too broad to be useful because the information was recorded as, say, bachelor of arts rather than as bachelor of arts in economics. Consequently, we considered enrollment in additional economics courses.

We used a somewhat ad hoc approach in determining the specification of the variables in the model. It was not clear exactly which measure would best capture the idea of continuation in economics. Should we examine whether any additional courses at all in economics were taken, whether at least a few more courses were taken, or what? Because it is likely that performance in a subject bears on the likelihood of continuation in the subject, how should we best control for performance in economics in the first year? Should we use the percentage grade in economics; the performance in economics relative to other first-year courses; an indicator of whether economics was the best course, or among the best, of the student's first-year courses; or some other measure? Fortunately, our conclusions, as they relate to continuation in economics, were unaffected by which of these alternatives we chose.

The Dependent Variable

The dependent variable for the models reported below was an indicator variable taking the value of 1 when the student took more than one full-year course (or two half-year courses) in economics in his or her second year of study and the value of 0 otherwise. We chose this dependent variable on the basis of fit and because we wanted a dependent variable that would mainly reflect the choices of the students. Some students in noneconomics programs are required to take both of the two half-year principles courses, and some are also required to take a second half-year course (microeconomics). If a student takes the second half of principles (macro) and the second year micro course in the second year to fulfill program requirements, we did not want to think of this as indicating choice. We thus selected the indicator variable to differentiate between those who took more than two additional half-year courses and those who did not. This selection corresponded closely with the choice of major, which has been the focus of other studies. Any student choosing an economics major would almost certainly take more than two half courses in the second year. Even though this was our preferred definition, we experimented with the dependent variable based on more than one half course (rather than two). The conclusions regarding role-model effects in that alternative model were the same as in the present one, although the explanatory power was much lower.

Finally, we focused only on courses taken in the next academic year (students' second year). Any role-model effect could be enhanced, or undone, by whoever teaches the student in the second year and thereafter. Our view was role-model effects should be easier to detect in the first year after the micro course was taken. We did, however, check models using a two-year or more time horizon (following the introductory micro course) to define the indicator variable to confirm that our results were not sensitive to this choice. These alternative classes of models had lower explanatory power than the one reported here (according to the pseudo R^2 statistic). However, the conclusions as they relate to the *studentg teacherg* interaction were essentially the same.

Control Variables

We included in equation (3) *studentg* and *Studentg Teacherg* interaction variables, defined in the earlier section on student performance. These were the main focus of our interest. The identification problem arose here as well, and we handled the problem in the same way. We allowed an individual instructor to have a general effect on the likelihood of students', both men and women, continuing in economics. More students of instructor A might continue than those of instructor B. We allowed for this with individual instructor dummies. But the role-model effect was hypothesized to involve an interaction between female students and female instructors. We captured this effect by looking at the student gender instructor gender interaction. As before, we could not identify separate male and female student effects for each instructor as well as a role-model effect.

The instructor dummies were part of the vector of control variables indicated by **X** in equation (3). The other control variables are as follows. To represent economics performance, we employed two alternative measures: *economics gr*, the student's absolute grade in the introductory micro course, or alternatively, *relative grade*, the ratio of the microeconomics grade to the average of the student's grades in all first-year courses. We included these variables to capture the student's perception of his or her absolute or relative aptitude in economics, because success in a course is often suggested as influencing the decision to continue in the subject.[16] We experimented also with including both of these variables in a single equation, but the two variables were highly correlated; including them both added nothing to the explanatory power of the equation and tended to increase the standard errors on the coefficients of the individual variables. We also considered a categorical variable, *bestec*, indicating if micro was the best grade of the student's first year because this also has been suggested as an influence on student choice. This model, too, had less explanatory power than the versions discussed here.

Economics is one of the more mathematical courses in the social sciences. Performance in first-year economics is influenced by previous mathematics performance, and it seems reasonable for students to expect future success in economics to be related to mathematics ability and background. We, therefore, wanted to control for university mathematics. For this purpose, we created a pair of variables similar to the ones we employed earlier. The first was a categorical variable indicating if any university mathematics courses were taken in the first year at the university (*any umath*). The second variable, for those taking any math, indicated the average grade attained (*umath gr*) in university math courses taken in first year (coded 0 if none were taken). It would not make much sense to include the second variable without the first, although it would not be unreasonable to include the first variable without the second. It may be that students did not select further economics courses if they did not take mathematics in the first year.

We also included a variable that measured the percentage of the student's introductory micro class who were women, *pcfem*. Dynan and Rouse (1997) introduced this variable as a control variable representing the classroom environment. Women, we hypothesized, may feel more comfortable pursuing a discipline in which some critical mass of women are in their classes. We expected a positive effect here for women but not for men. We modeled this by including both *pcfem* and the interaction between *pcfem* and *studentg* (*pcfem* × *gen*).[17] If all instructors taught only one section of micro, *pcfem* would be collinear with the set of individual instructor dummy variables. In our data, all the men taught only one section of micro, and this caused problems if *pcfem* was included as well as instructor dummies. Consequently, when we discuss probit equations later that include *pcfem*, instead of instructor-specific dummies, we use a single dummy for the gender of instructor.

We included controls for the program of admission out of high school, not to be confused with programs chosen after the first year is complete. Economics is a required course in many programs, but so many courses are proscribed in other programs that little room exists for more economics courses. We believed it was necessary to control for program in the probit equations if we wished to isolate the independent effect of gender of instructor. The set of program dummies included *accounting, business administration, bach. arts, bach. science, bach. bus. econ.*, plus an omitted category.[18]

Testing Down

In the probit analysis, we followed the same testing-down approach as that described in the performance section of this article. We began with a general form of the model and tested down to find a parsimonious specification (Table 4).[19] Before turning to that specification, we discuss briefly the testing. First, in all the different specifications we considered, we found no statistically significant positive coefficient on the *Studentg Teacherg* interaction variable. In other words, we found no role-model effect, and we did not include the interaction variable in the final specification so we could focus on the determinants of continuation. Second, both the absolute- and relative-grades versions of the model indicated that better performance in first-year economics improved the chances of continuation in economics. There was very little difference between the two models in terms of other coefficients, although the absolute-grades version had a slightly higher likelihood; we report only this one in the parsimonious version of the model (Table 4).

Testing down led to the following variables being dropped from the equation: (1) The role-model variable (*studentg* interacted with *teacherg*), (2) both the percent female (*pcfem*) and percent female interaction variables that were included to capture the classroom environment, (3) the math grade (but not the categorical variable indicating math was taken), and (4) the bachelor of arts category which was combined with the omitted category of program variables (bachelor of arts in specialized programs). The elimination of these five variables changed the goodness of fit (as measured by the pseudo R^2) hardly at all. One last variation in the final version of the probit model is worth pointing out. As noted ear-

TABLE 4
Probit Equations Determining Continuation Probability (After Testing)

Variable[a]	Coefficient	z stat	$P > \|z\|$
Economics grade	0.010	3.6	.000
Studentg	−0.197	−2.3	.024
Any umath	1.031	6.0	.000
Accounting	−1.753	−8.5	.000
Business administration	−1.086	−6.2	.000
Bach. science	−0.559	−2.3	.022
Bach. bus. econ.	0.400	2.4	.019
Constant	−2.017	−6.0	.000

Notes: The column labeled z stat reports the coefficients divided by the asymptotic standard errors, whereas the column labeled $P > |z|$ reports p values. The number of observations (2,028) is reduced from the earlier regressions because some students did not continue to second year. Pseudo $R^2 = 0.2550$.
[a]Teacher dummies are not reported here.

lier, if *pcfem* was included, one could not include the teacher-specific effects (dummies). However, once we determined (in testing down) that the percent-female variable would not be included in the final specification, we were free to return to the teacher-specific effects (Table 4). A test for the set of teacher dummies showed that they were highly significant, and an additional test revealed that the use of a single instructor-gender dummy variable could be rejected in favor of the set of teacher dummies.[20]

Results

Table 4 reports the final version of the model, and the noteworthy results are as follows. Better performance in economics and enrollment simultaneously in mathematics increased the likelihood of a student continuing in economics. The negative and significant coefficient on student gender indicated that, other things held constant, women were less likely to continue in economics. This result is consistent with earlier findings in the literature.

CONCLUSIONS

We have explored the question of whether the gender of the instructor in first-year university microeconomics might play a role either in the performance of students, especially female students, or in the likelihood that students would continue in economics. We found no evidence that the gender of instructor matters. As other studies have found, we found that female students fared worse in economics than do the male students, in spite of having better high school averages on entering the university. Fewer women continued in economics than did men, even conditioning on first-year performance, yet we found no indication that a female instructor made any difference to the probability of continuation for female students. Perhaps it is worth thinking about this result a bit more. Should one interpret this as saying female economics professors will not have any role-model effects? Perhaps not. Suppose that women are discouraged from entering economics by the style of their male teachers. This discouragement also could have applied to the female teachers who previously went through a university education but went on to become female economists. It may be that they selected the economics profession because in some way they were more like the men who were their teachers. This similarity may be in their mannerisms, their thought processes, or whatever. In other words, there may be a role-model effect that we could not find because of the particular set of female instructors we were looking at. In any event, we were unable to contribute to the explanation of the puzzle of female performance or continuation in economics through a role-model effect—although there are other hypotheses to be explored.[21]

We view this study as one additional piece of evidence regarding role-model effects as influenced by the gender of instructor. We had a sample with a small number of male and female instructors, and it may be that much larger samples of instructors are needed. For example, there may be instructor-specific effects (on male and female relative performance), which make an effect common to male or female instructors difficult to identify without more variation in instructors. We look forward to additional studies on this topic.

NOTES

1. In this article, we use gender as a synonym for biological sex.
2. Studies of economic knowledge (as distinct from performance in coursework) suggest that male students at the high school level are better informed than female students (Heath 1989).
3. Continuation is also known as persistence, particularly in the education literature (Becker 1997).
4. Persistence is also referred to in this literature as participation, retention, and sometimes the reverse of these concepts, student attrition.
5. The instructors all used a standard lecture format with directed audience participation.
6. The higher proportion of students with a female instructor is attributable to more sections being taught by women. More detail on the distribution of male and female students by lecture section is reported in Robb and Robb (1997, Table 2).
7. Both the OAC grades and the Brock grades are percentage grades, so no conversion from letter grades was involved.
8. Students are required to complete a minimum of six OACs, and the mean of the best six is of key importance in admission decisions in Ontario universities. Students may take additional OACs. Whether one should include all OACs in the mean for students taking more than six is a complicated issue. Because it is the best six that count for admission, the grades of courses beyond six can reflect various sorts of behavior that one might want to exclude. For example, a student may be required to have a particular course to enter a program, but the grade might not count in the mean used for admission. The student's efforts might concentrate on getting good grades in the six that count for admission and just making sure the seventh is a passing grade. It is unclear whether the seventh grade should be included as a control. If the mean is meant to serve as a measure of background and preparedness, then the extra course might be included. If the mean grade serves mainly as a measure of ability to perform in a course, then a course that is taken but not worked at with the same diligence should probably be excluded from the calculation. Given the offsetting considerations and the fact that we can always count on six grades for every student, we concentrated on the mean of the six courses.
9. More details on the testing down are provided in Robb and Robb (1997).
10. Strictly speaking, this is the effect when the female students have a male teacher. When they have a female teacher, one would also take into account the interactive variable (*Studentg* × *Teacherg*). However, this effect was not statistically significant, and we ignored it in the current discussion.
11. We have indicated in the discussion of the selection of the final equation that all three courses test as significant (because we could not eliminate them from the equation). The p values for the joint F tests on the pairs of variables were in each case less than 0.001.
12. The calculation actually used .1679 rather than the rounded value of .17 that appears in Table 2 (as well as here in the text for consistency).
13. The reader might wonder whether the teacher dummies not reported (for reasons of confidentiality) shed any additional light on the role-model effect; the answer is no—the effects were separate. It would be possible to have major differences in average performance by gender of instructor with no differences in relative performance, or vice versa. In fact, the estimated teacher dummies showed no clear pattern between male and female instructors—some male and some female instructors were above and some below the average instructor.
14. We considered the student's performance in economics relative to the student's performance in other first-year courses and found women did relatively worse in economics (Robb and Robb 1997).
15. Our data set was for the time period from the fall of 1989 through the winter of 1995. For the class entering in 1993 and thereafter (the end of our data period), the data set allowed us to identify the student's program in both 1993 and again in 1994. In addition to the obvious problem of a small sample for one year only, there was no variation in the gender of the instructor in the introductory class in that year; all students in introductory micro during 1993/94 were taught by female instructors.
16. Of course, the absolute performance may also influence subsequent course enrollment by affecting whether or not the individual qualifies for certain programs or is allowed to continue in the current program.

17. Dynan and Rouse (1997) who introduced this variable did not find it to be significant, but that may be because they did not include the interaction term and, hence, implicitly considered the same effect to apply for men as for women. One might argue that we should have included only the interaction variable here, and that is a reasonable position. We included both terms because if we had found a positive effect when the interactive variable was included on its own, the reader would have wondered whether this effect was truly only for women or for men as well. We also considered a model with only the interactive term and the teacher dummies. None of the coefficients was appreciably changed—neither in magnitude nor significance. In any event, we eliminated both terms in testing down.
18. More specifically, *accounting* represents bachelor of accounting and co-op accounting program; *business administration* is bachelor of business administration; *bacharts* is bachelor of arts, general; *bachscience* is bachelor of science in biology, computer science, earth science, mathematics, physical geography, and bachelor of environmental science; *bachbusecon* is bachelor of business economics; the omitted category is bachelor of arts in specialized programs (Canadian studies, child studies, film studies, liberal studies, theatre, visual arts), bachelor physical education, and bachelor of recreation and leisure studies.
19. The full specification, both for the absolute and relative-grades versions of the model, can be found in Robb and Robb (1997).
20. As in the analysis of performance, no systematic pattern was found in these dummies as between male and female instructors.
21. Possible hypotheses include the subject matter itself, the overwhelmingly male student body, and so on.

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