Testing the influence of course-level gender representation on postsecondary achievement and major choice

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Research question

This paper examines the question, does the gender representation in postsecondary classes influence achievement and field specialization? We use a unique data source that includes detailed course-taking information for multiple cohorts of students to test the influence of the sex ratio in introductory-level courses on achievement, persistence in field-specific course sequences, and major choice. We accomplish a more comprehensive examination of gender representation effects than exists in the extant literature by testing the nature of the influence of course demographics; specifically, we test whether it operates nonlinearly, whether the relationship varies across major fields, and if gender representation operates differently for male and female students.

Theoretical framework

Despite the increasing participation of women in postsecondary education (Bae et al. 2000; Jacobs 1996) and their growing advantage in degree attainment (Buchmann and DiPrete 2006; Diprete and Buchmann 2006), gender differences in type or quality of education remain significant. The segregation of college majors, labeled horizontal stratification by Charles and Bradley (2002), declined significantly starting in the mid-1960s, but progress toward integration slowed significantly in the mid-1980s (England and Li 2006; Jacobs 1995; Turner and Bowen 1999) and remains a salient characteristic of higher education in the US and other industrialized countries (Charles and Bradley 2002; 2009). Horizontal stratification in postsecondary education plays a significant role in the gender wage gap and occupational segregation in the labor force. Because men are overrepresented in engineering, physical science, and business majors that are associated with better-paying occupations, and women are overrepresented in less lucrative majors like education and the humanities, the segregation of college majors accounts for 15% to 25% of the gender gap in wages (Bobbitt-Zeher 2007; Joy 2000; Shauman 2006).

The segregation of majors places individual students in classroom contexts that have distinct sex ratios and this exposure to relatively male- or female-dominated environments may influence achievement and decisions about courses of study. In general, female representation is positively associated with the achievement of both boys and girls at all levels of education (Hoxby 2000; Lavy and Schlosser 2007; Sacerdote 2006), although the influence appears to be more positive for female than for male students. And while the female representation in college majors is positively associated with major choice among women, it negatively impacts the choice of major among men (England and Li 2006; Rogers and Menaghan 1991). Even in male-dominated majors such as economics and business, however, Oosterbeek and van Ewijk (2010) find that the representation of women is positively associated with persistence in the major, especially among male students. These findings fuel the speculation that the underrepresentation of women in science, technology, engineering, and mathematical majors is a self-perpetuating cause of the low rates of female participation and relatively high rates of female attrition from these majors (England and Li 2006; Rogers and Menaghan 1991).

Several mechanisms might generate a gender representation effect in postsecondary achievement and major choice. Kanter's theory of tokenism (Kanter 1977a; Kanter 1977b) posits that the representation of types of people within groups directly effects intergroup interactions and the success of individuals in the group context. From this perspective, individuals who belong to the group that is in the numerical minority face

elevated performance standards and role entrapment, i.e., being treated as an embodiment of the stereotypes applied to their group rather than as an individual. Kanter argues that these pressures negatively affect both the actual performance of the minority group members and how their work is evaluated, and thereby reduces their likelihood of successful group participation, achievement, and recognition. Rogers and Meneghan (1991) find that these mechanisms are at work in the context of undergraduate education. They find that the representation of women in a major is negatively associated with the likelihood that women students experience performance pressure and that the experience of such pressure is negatively associated with the likelihood of persistence.

From a social psychological perspective the relative representation of males and females in an educational context may act as an indicator of social expectations for gender-appropriate behavior and the degree to which one's behavior is consistent or incongruous with those norms. To the extent that the sex ratio within a particular class or major is perceived by individual students as an indication of the distribution of the skills that are germane for success in that field, the classroom demographic may influence actual performance, task self-assessments, and persistence in a course of study (Correll 2001; 2004). Furthermore, college students may be particularly sensitive to the demographics of classroom contexts given that they largely remain in the period of identity formation characteristic of adolescence. Research shows that adolescents choose social situations that reduce the psychological cost of being perceived as nonconformist and maximize their utility by building an identity that they perceive to be socially endorsed (Frank et al. 2008).

A structural perspective links gender representation to achievement and major choice via its effect on the characteristics of classrooms and/or majors. Alon and Gelbgiser (Forthcoming:3) argue that majors differ in "class size, culture, level of student integration, availability of study groups, accessibility of faculty, and social climate" and that these are structural characteristics that influence male and female participation, performance, and persistence through to graduation (DesJardins, Ahlburg, and McCall 2002; Hearn and Olzak 1981; Leppel 2001; Sabot and Wakeman-Linn 1991). They find that female-dominated majors tend to be larger, to have more relaxed grading norms and to have more socially supportive cultures as measured by the frequency of participation in study groups and contact with faculty (Alon and Gelbgiser Forthcoming).

These mechanisms may operate differently for male and female students, nonlinearly, and in interaction with other characteristics. Studies of peer effects on achievement and educational decision-making show that women and girls tend to be more affected by social contexts and peers (Correll 2001; 2004; Eagly 1978; Eccles, Adler, and Meece 1984; Frank et al. 2008; Han and Li 2009; Hoxby 2000; Lavy and Schlosser 2007; Lavy, Silva, and Weinhardt 2009; Oosterbeek and van Ewijk 2010; Riegle-Crumb, Farkas, and Muller 2006). The expectation of nonlinearities, that may indicate threshold or "critical mass" effects, is supported by tokenism theory. Kanter (1977b) posited that the effects of token status would strongly influence the experience of individual minority group status in "skewed groups," i.e., groups in which a majority-minority ratio of up to 85:15 generates a distinct, observable minority subgroup, whereas minority group member in "tilted groups" – in which the ratio of representation may be up to 65:35 – are more likely to be viewed as individuals and exempted from performance pressures and role entrapment. The research examining the influence of gender representation also shows that the influence varies across disciplines, but since much of this research focuses on specific majors it cannot measure the significance of major-specific effects (Margolis and Fisher 2001; Oosterbeek and van Ewijk 2010). The studies that examine the effect of sex ratios across the broad spectrum of majors often measure gender representation at the level of major

(rather than at the level of the course or classroom) so they cannot disentangle the influence of sex-ratio from the influence of field sex-typing (England and Li 2006). It is likely that the culture of a major will condition the influence of female representation. For example, the effect of sex ratio may operate differently in majors that are male-typed, i.e., in which the culture is dominated by the norms, desires, and interests of men as opposed to those that are female-typed (Margolis and Fisher 2001).

Research design

For this analysis we use data from the University of California, Davis (UCD), a large, land-grant university in the University of California (UC) system that serves about 22,735 undergraduates. As part of the UC system, UCD affords entry to only the top 12.5 percent of the state's graduating high school class and boasts recent cohorts of admitted students with average combined SAT scores of 1180. It has the third highest enrollment of all 10 UC campuses (behind UCLA and UC Berkeley).

To test the hypothesis that the course-level gender representation influences educational outcomes, we utilize individual-level longitudinal data for four cohorts of students (roughly 15,000 students), employing course specific information about the level of gender representation. The focal explanatory variable of our analysis is the sex ratio students experienced in the introductory-level courses in their declared major (or in the intro-level courses taken by "undeclared" first-year students). We operationalize the sex ratio as the proportionate representation of women. Our analysis examines several interrelated outcomes: achievement (measured by course grade), persistence in the major (measured using data on subsequent course enrollments), and major choice for students who begin college undeclared.

Our analysis will employ methods appropriate to the measurement of our dependent variables and will include a rich set of explanatory variables that include grades in prior courses, pre-college measures of aptitude, and students' demographic characteristics. Linear regression models will be used for the analysis of achievement. To estimate the effect of course sex ratio on academic achievement, we specify a model where an individual student's achievement in a specific subject s, Y_{is}, is a function of the level of female representation in the course and individual characteristics, X_i :

$$Y_{is} = \alpha(\%Female)_i + \beta X_i + \varepsilon_{is}$$

Individual characteristics in the vector X_i include gender, race/ethnicity, several measures of academic ability, and parental educational attainment. The error term represents subject-specific or major fixed effects, though additional analyses will test whether gender representation has different effects across subject areas. To investigate persistence in the major, we will use discrete-time survival analysis (Singer & Willett 2003), where the outcome is a binary variable that equals one if individual i persists in college major m at time t and zero otherwise. Here course-specific sex ratios will be included as time-varying predictors, along with other time invariant covariates (gender, race/ethnicity, prior academic achievement), and a set of other time variant controls (e.g. credit load and academic standing given a particular term). For each model specification we test for gender-specific effects of course sex ratios with gender-interaction terms and we use spline specifications of %Female to test for nonlinearities in the effect of course-level sex ratio.

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