RESEARCH ARTICLE

Gender, science, and academic rank: Key issues and approaches

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ABSTRACT

In the social study of science, gender is a critical research site because relations of gender are hierarchical and inequality is a central feature of science. The focus here is on a key dimension of gender and scientific careers: academic rank, particularly that of full professor. This article concentrates on quantitative and qualitative approaches that have occurred in two focal problem areas related to gender, science, and rank: collaboration patterns and evaluative practices. The approaches encompass analyses of large and small groups and comparative cases, with surveys, bibliometrics, experiments, and interviews. This breadth of approaches reflects a search for explanations of the pervasive and persistent relationships between gender and academic rank. The analyses presented here point to the complexities of gender disparities in collaboration. These appear in team compositions, divisions of labor and power dynamics, integration into departmental units, and international coauthorship. The analyses also reveal ways that limited clarity in evaluation bears on gender disparities. Continuing understandings of gender, science, and rank will result in multi level analyses: those at organizational levels along with those of individual scientists.

1. INTRODUCTION: KEY ISSUES

In the study of science, gender is a strategic research site. This is because relations of gender are fundamentally hierarchical and inequality is a central social feature of science. Categories of femininity and masculinity constitute systems of stratification, reflected in economies, religions, social structures, and behaviors built around women's and men's statuses (Lorber, 1994; Ridgeway, 2009). Scientific fields are powerful and influential domains (Hackett, 2008; Marginson & van der Wende, 2007) that are marked by vast disparities in research funding, equipment and materials available, and recognition and rewards (Stephan, 2012). Gender hierarchies are pervasive in science: in positions, network ties, performance, salaries, prizes, and other areas (Fox, Whittington, & Linkova, 2017; Larivière, Ni, et al., 2013). In sum, scientific fields are powerful and hierarchical, and inequalities of women and men are pervasive within them. Scientific fields, in turn, reflect, reproduce, and legitimize inequalities of women and men in societies (Fox, 2001, 2006). For these reasons, gender is a strategic analytical site in the study of science.

My focus here is on academic rank, specifically, as a key dimension of gender and scientific careers. I concentrate on approaches (quantitative, qualitative) taken within two focal problem areas that address the relationship between gender and academic rank: collaboration and evaluative practices for promotion (which appear in a subsequent section).

What is the rationale for this focus on academic rank? First, academia is an important sector because basic (as well as applied) research occurs in higher education; and academia trains students and awards educational degrees. Second, in academia, faculty positions and ranks are more standardized than are positions within industry or government, making it possible to assess ranks across different settings. Third, academic rank is consequential. Rank confers advantages of lead roles in teams, integration into scientific communities, capacities for organizational decision making, and levels of publication productivity attained (Abramo, D'Angelo, & DiCosta, 2009; Fox et al., 2017; Rørstad & Aksnes, 2015). Fundamental here is that gender predicts academic rank: Women are less likely than men to hold higher ranks, and the gender disparity is especially apparent at the rank of full professor (Fox et al., 2017). After allowing 10 or more years from receipt of a doctoral degree, men are more likely than women to attain the rank of full professor in the United States (National Science Foundation, 2015, Table 3.1). Gender disparities in timing and prospects of promotion to full professor appear in mathematics (Shaw & Stanton, 2012), computing (Fox & Kline, 2016), and other scientific fields (National Science Foundation, 2008).

2. APPROACHES

A question, then, is: What accounts for the slower and lower advancement of women to full academic rank? Addressing this question goes to focal areas of inquiry and approaches taken to them. My aim is to identify and explain these areas and their (quantitative, qualitative) approaches, broadly. The aim is not to analyze one set of methodological techniques compared to another. The latter is an extensive subject that occupies entire, classic volumes (for example, Morgan & Winship, 2015; Whyte, 1984), and is beyond the scope of this article.

Quantitative and qualitative approaches involve observations and meanings derived from them. Quantitative approaches tend to focus on frequencies, amounts, and levels (or intensities), and the relationships between variables as they influence each other, and in turn, plausible outcomes in one or more (dependent) variable(s) (Borrego, Douglas, & Amelink, 2009). The emphasis is on systematic measures, inferences, and explanations. Quantitative approaches are useful in understanding relatively large numbers of cases or events, with surveys, experiments, bibliometric, and other means. Qualitative approaches tend to focus on textual data from interviews, conversations, narratives, focus groups, life histories, and other sources (Yilmaz, 2013). The emphasis is on describing a "reality" that makes sense of a context, setting, or process (such as decision making) (Borrego et al., 2009; Yilmaz, 2013). These approaches are useful in depicting the details of smaller numbers of persons, places, or events, including case studies of groups and organizations. The qualitative methods are also useful in exploring outliers and explaining processes that underlie dichotomies (such as advantaged–disadvantaged or successful–unsuccessful) that exist between groups of people (Tarrow, 2010).

3. TWO FOCAL AREAS OF INQUIRY

In understanding what accounts for the lower and slower promotion of women to full professor, two focal areas of inquiry are (a) collaborative patterns (including international research collaboration) and (b) evaluative practices in promotion. These are focal—not exhaustive—areas that illustrate a range of approaches.

In scientific fields, collaboration is the norm. Scientific research occurs predominantly in teams with peers, post-doctoral fellows, and students (Wuchty, Jones, & Uzzi, 2007). Collaboration provides ideas, skills, expertise, and equipment that potentially enhance publication productivity, as documented in survey and bibliometric analyses (Bozeman & Youtie, 2017).

Important is that large-scale, quantitative designs indicate that women are as likely as men to collaborate (coauthor their papers) in science (Abramo, D'Angelo, & Murgia, 2013; Bozeman & Gaughan, 2011). This is in keeping with collaboration as the predominant mode of scientific research. However, gender disparities in collaboration appear in (a) team compositions, (b) divisions of labor and power dynamics, (c) integration into departmental units, and (d) international coauthorship. First, survey responses among 1,200 U.S. faculty in doctoral-granting departments in five scientific fields point to patterns of gender and team composition, with consequences for publication productivity (Fox & Mohapatra, 2007). Specifically, being a male faculty member *together* with having higher numbers of male students accompanies higher levels of publication productivity. This may relate to styles of research, an issue addressed in Sonnert and Holton's classic (1995) study of career paths, based on interviews with a matched sample of women and men scientists. In this study, each of the women and men had been awarded prestigious postdoctoral fellowships, and subsequently they were more and less successful in academic careers. The interviews revealed that, compared to men, women were more likely to exercise care, caution, and attention to detail in their research and publications—with consequences for potential rates of publication.

Second are divisions of labor operating in research teams. In an analysis of 85,000 articles published from 2008 to 2013 in PLOS journals that require reports on contributions of authors (analysis of data, design of experiments, contributions of materials/tools/analysis, performing experiments, writing the paper), Macaluso, Larivière, et al. (2016) find that gender shapes collaborative roles and authorship. Women are significantly more likely than men to be performing the experiments. This holds with controls for professional age (measured as date of first publication). Men are more likely to make other contributions. Notably, the hierarchical position of senior author is associated with non-experimental roles.

Related to this is a qualitative study of collaboration, rank, and power dynamics, based on analysis of 177 open-ended responses in a survey and 60 semi-structured interviews with academic scientists in U.S. universities (Gaughan & Bozeman, 2016). The findings point to power and influence concentrated in the most senior scientists, and to gender narratives and dynamics that are reported exclusively by women.

Third is a study of women faculty members' reported chances for promotion from associate to full professor, including the ways that these chances relate to collaboration (Fox & Xiao, 2013). Data for this study come from a unique web-based survey of the universe of women associate professors in computing within U.S. institutions that are members of the Computing Research Association and within affiliated institutions in Canada. The reported chances, at focus, are not equivalent to actual promotion, but perceived chances have implications for whether faculty members will, in fact, put themselves forward for promotion to full professor. Promotion to this level (compared to that from assistant to associate) is not on a fixed timetable, and is more elective and subject to perceived prospects. Among the work activities, practices, and orientations assessed, the strongest predictor of excellent/good chances was having collaborated with faculty in the home unit on publications or proposals in the prior three years. Collaboration with faculty outside the home department did not predict positive chances. Faculty who collaborate with those in the home department may be more integrated into the prevailing research styles and standards of the department. The home department is the initial level at which the recommendations for promotion occur, and this sets the stage for subsequent levels of recommendations at higher levels in the institution.

Fourth is the issue of international, compared to national, research collaboration. International research collaboration is on the rise, especially in countries actively seeking transitions to knowledge-intensive economies with strong scientific and technological capacities (National Science Board, 2012). Gender shapes patterns of international research collaboration. Women are less likely than men to coauthor articles with others outside their home nation, as documented in large-scale bibliometric approaches (Abramo et al., 2013; Larivière et al., 2013).

Interviews with 100 scientists in 38 U.S. research universities help to uncover processes or mechanisms that challenge women's participation in international research collaboration (Zippel, 2017). Women are located, disproportionately, in institutions with inadequate resources to support international research collaboration, and when/if they acquire funding for this collaboration, they face the ambivalence of home institutions that regard the collaboration as a "travel perk." Cultural challenges occur in women being accepted into their international destinations, and family commitments can also constrain travel (Zippel, 2017).

Survey approaches to gender and international research collaboration bring together the assets of relatively large numbers of cases and systematic measures of experiences and conditions related to the collaboration. These appear in survey-based studies that show positive effects on women's international research collaboration of having an academic domestic partner (Uhly, Visser, & Zippel, 2017), and having numbers of projects and broad professional networks (Ynalvez & Shrum, 2009). Such conditions that support (or hinder) international research collaboration have implications for understandings of gender, rank, and academic careers. This is because knowledge is increasingly global and advancement to full professor may involve evidence of "international stature." At the same time, the meanings and expectations of international research collaboration vary by nations. The European Commission has emphasized the flow of researchers between institutions, fields, and countries, as well as global research collaboration. However, this does not entail a single policy or set of expectations (and rewards) for international research collaboration that operates across European nations (European Commission, 2009).

The second focal area of inquiry is that of evaluative practices in academic science. Evaluative practices are organizational "levers of advancement." These practices are among the most fundamental processes in organizations, reflecting priorities of units and institutions. The clarity of criteria for tenure and promotion is especially salient for women, who are more likely than men to say that they do not understand "what counts" in assessment (Britton, 2010; Fox, 2015; Roth & Sonnert, 2011). The criteria are especially murky—less clear and transparent—for promotion to full professor (Britton, 2010; Fox, 2015; Misra, Lundquist, et al., 2011). This is consequential because experimental studies have shown that, when the criteria of evaluation are loosely defined and a matter of judgment, biased assessments (based on gender, race, and social characteristics) are more likely to occur (Long & Fox, 1995).

Also telling are results about clarity of evaluation in a survey of over a thousand tenured and tenure-track faculty in six scientific fields within nine U.S. research universities (Fox, 2015). Among men faculty, both formal (rank, seniority) and informal (frequency of speaking with faculty, collegial climate) factors predict clarity of evaluation. Among women, only the informal factors are predictive. Overall, the informal indicators are stronger. What this means is that time in the institution and exposure to outcomes of evaluative processes do not necessarily increase very clear criteria of evaluation. Other informal factors are more important. Noteworthy is that informal factors of departmental climate and patterns of speaking about research are resistant to policies and interventions. This is because faculty members exercise autonomy in choosing persons with whom they speak about research, and social circles of inclusion and exclusion are difficult to modify (Fox, 2015).

4. BROADER IMPLICATIONS AND CONCLUSIONS

The focal inquiries of collaboration and evaluative practices point to complex hierarchical arrangements related to gender and rank. Institutions such as family and households, and cultures broadly, also shape outcomes of gender and rank; and race, ethnicity, and sexual identities intersect with meanings of gender as well. These are significant topics that require separate treatment.

The approaches identified encompass analyses of large and small groups and comparative cases, with means including surveys, bibliometrics, experiments, and interviews (with both more and less structured sets of questions). This breadth in approaches relates, potentially, to the search for explanations of pervasive and persistent relationships between gender and full academic rank. The hierarchies of gender and rank pervade institutions, departments, laboratories and teams, and social relations within them. They also persist. Despite increases in the numbers of women receiving degrees in scientific fields over the past four decades, and the passage of years for them to mature in professional time, the proportion of women in the United States who are full professors has not kept pace with the growth of women doctoral-holders (Fox et al., 2017). This holds when taking into account "demographic inertia"—the point that representation of women at given ranks is subject to existing age and gender distributions that affect proportional representations of newer doctoral-holders, including women (Shaw & Stanton, 2012).

In 1983, the Rockefeller Foundation issued a report (Berryman, 1983) depicting the representation of women and minorities with a pipeline metaphor of straight links between educational stages and occupational outcomes. The model emphasized unidirectional progressions, individual preferences and choices, and deficits that result in "leakage" from the pipeline. The pathways model, in contrast, has evolved, and emphasizes dynamic processes in the settings in which women (and other groups) are educated and employed and complex outcomes that are not necessarily orderly progressions from one stage to another (Branch, 2016; Fox & Kline, 2016; Xie & Shaumann, 2003).

In broader implications, these conceptual frameworks are also are part of continuing inquiries and approaches in the study of scientific careers, and the search for explanations of relationships between gender and academic rank. Toward this, promising approaches are multi-level analyses. This means, for example, organizational analyses, along with those of individual scientists. With this approach, an organizational analysis may include indicators (quantitative, qualitative) of the operations of academic institutions and departments, their priorities, cultures, conflicts, decision-making, and relations with external environments. Individual analyses include indicators (quantitative, qualitative) of scientists' perceptions, experiences, networks, roles, performance, and other areas. Such multi-level analyses are important because they go to links that exist between institutions, departments, research groups, and individuals—producing complex outcomes of gender, rank, and academic careers.

COMPETING INTERESTS

The author has no competing interests.

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DATA AVAILABILITY

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