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Introduction to the Symposium: Women in Science

Monica Gaughan

Women in science is a subject that has gained attention among both academics and policy makers. The rise in the visibility of the topic is due to several factors. The most important was Title IX of the Education Amendments of 1972, which barred gender discrimination in universities receiving federal funds. Although today most focus is on athletic programs, Title IX is also what led to the surge in enrollment of women in science and engineering at all levels of the university. It also made it illegal to discriminate against female scientists in hiring and promotion decisions. The National Research Council has focused empirical attention on the issue since the late 1970's, issuing periodic reports on the representation of women in science and engineering fields. Women's representation in science and engineering professions has not met their gains in earning science and engineering degrees, and they continue to lag behind men in tenure, promotion, and productivity. Improved longitudinal data has translated into better explanatory models at the individual level, fostering academic attention to theoretical and empirical problems.

During the 1990's, new federal policy initiatives were implemented to affect the institutional contexts that create and recreate gender disparities. For example, the Family and Medical Leave Act of 1993 created a federal right to family leave when a person works for an organization employing more than 50 people. Later in the decade, the electrifying, "A Study on the Status of Women Faculty in Science at Massachusetts Institute of Technology," documented pervasive gender inequalities in access to resources at the Institute. This prompted other universities to complete climate assessments on the status of women at their institutions. The National Science Founda-

tion launched the ADVANCE initiative in 2001; instead of targeting individual investigators for funding, the ADVANCE initiative funds universities to address context-specific factors leading to gender inequalities in the advancement of female faculty. This crucial decade, like the 1970s, shifted the focus from an emphasis on individual-focused interventions to more systemic ones that recognize the role that institutions play in the creation and maintenance of gender disparities. This general shift in research and policy thinking may be part of the reason that Harvard President Lawrence Summers' comments in January 2005 seemed absurd and offensive to so many: his individualist focus was at odds with three decades of research and policy indicating that institutions and their practices have discriminatory effects on women scientists and engineers.

This is the first of two special issues related to women in science. The papers presented in this issue cover a variety of facets of women scientists in scientific institutions and careers using innovative sampling, data, and analysis. Each paper takes as its unit of analysis the individual scientist. Quite important, however, is that individual scientific careers, as conceptualized by these authors, occur in contexts that affect the operation of gender on various outcomes. The institutions represented include university, industry, and government settings. Three papers address scientific activity of university-based faculty only (Thursby and Thursby, Corley and Gaughan, and Beoku-Betts). Whittington and Smith-Doerr examine patenting across the sectors, as do Stephan and Levin, who also conceptualize the scientific domain as the information technology profession. Only Beoku-Betts' paper studies scientists working in a science system outside the United States, in anglophone Africa; this paper is also the only one that uses qualitative methodology.

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In addition to spanning institutional domains, the analyses within these papers encompass a variety of scientific activities. The papers by Thursby and Thursby and Whittington and Smith-Doerr address the issue of commercialization and intellectual property. As science, and in particular academic science, becomes more focused on industrial applications, the issue of commercialization is crucial. Thursby and Thursby collect disclosure data from university technology transfer offices to study academic scientists' propensity to disclose inventions to institutional technology transfer offices in major American research universities. The disclosure of inventions is considered a signal of licensing interest, if not intent. They find that despite similar publication patterns, women are less likely than their male colleagues to disclose potentially commercial research.

Whittington and Smith-Doerr use patent data to investigate the commercialization domain further. They demonstrate that women scientists are less likely to patent their work, a finding that makes sense in light of Thursby and Thursby's research on gender differences in invention disclosure. Whittington and Smith-Doerr focus in particular on the institutional contexts that underlie observed gender differences in patenting. Whittington and Smith-Doerr include scientists employed in academe, industry, and other types of scientific settings. Although women are less likely to patent across settings, academic women are least likely to patent relative to their institutional peers. However, patents produced by women scientists are as likely to be used as those produced by men, and may be of higher quality.

Returning to an analysis of the academic sector, Corley and Gaughan consider the impact of multidisciplinary research centers and gender on faculty work patterns. We use the new Research Value Mapping survey data, a nationally representative sample of Carnegie Research Extensive science and engineering faculty. We find that gender and multidisciplinary center affiliations have different direct effects on a variety of academic work patterns. While gender has a powerful impact on traditional indicators such as age, tenure, and rank, we found that center affiliation was a much more powerful indicator of research-related activities than gender. In other words, male and female scientists affiliated with

multidisciplinary science centers are mostly alike in terms of research activities and teaching; the major differences in research activity is between center-based and exclusively department-based faculty, not between men and women.

Much of the academic research related to women in science work—herein and elsewhere—focuses on Ph.D. level academic scientists. The reality is that most scientists and engineers do not work for universities, and they do not have Ph.D.s. They are, nevertheless, a crucial component of the American science and innovation system. In the only paper to investigate a profession as a whole, Stephan and Levin use National Science Foundation SESTAT data to assess determinants of retention in information technology careers. They find that women are less likely than men to remain employed in IT. It is important to note, however, that the women who are leaving IT are also tending to leave the workforce, presumably for family responsibilities. When the outcome is leaving IT for another profession, there is no difference between men and women. This work is the only one to refer, however indirectly, to gender roles in the home; it is a reminder that gender parity within the workforce does not necessarily translate into gender similarity in home responsibilities (as measured by leaving the labor force).

Beoku-Betts' critical analysis of original interviews with African female scientists constitutes an important contribution on many levels. I include it as the closing work to remind us of how much we still do not understand about science, scientific careers, and the role scientists play in understanding these global dynamics. Methodologically, this is the only research in this issue that relies on qualitative research. The rich insight we gain into these women's lives flows from this methodological choice. As researchers and policy makers, we must always remember the real people who are represented by our numbers and who are the objects of our policy initiatives. Each has a story that is both unique and common. Beoku-Betts' accounts of outright sexism, discrimination and sexual harassment experienced by some of her respondents reminds us that working conditions of women scientists in the U.S. may have improved somewhat—but still need to be followed and documented.

An extensive literature documents gender disparities in a host of scientific indicators. However, there has also been significant attention paid to the issue at the national and institutional levels over many decades. Perhaps due to this policy attention, perhaps not, I would argue there has been some improvement in the status of women in science. In the U.S., at least, the movement in the indicators has generally suggested steadily increasing representation of women in scientific work. In this issue, none of the papers document gross gender inequities. Indeed, in many, the finding of larger effects than gender, or the finding of no gender effects, is welcome news to those of us who would like to see gender disparities disappear in science and engineering.

At the same time that these papers provide a perspective on women scientists' successes, the finding of any gender difference in the processes of scientific success suggests there is still work to be done to achieve more equitable processes. Technology transfer offices could play an important role in disseminating information to faculty about the importance of protecting intellectual property. In the case of Thursby and Thursby's research, one policy implication is that universities may wish to ensure that there are formal mechanisms for informing faculty members about the purpose and importance of intellectual disclosure agreements. Formal programs are more likely to reach faculty than informal networks, especially faculty in under-represented groups. Similarly, academic women's lower propensity to patent their work also suggests that technology transfer offices could do a better job of educating faculty members in active ways about how to proceed with patent applications. Senior faculty who are also entrepreneurial could be called upon to mentor younger colleagues. Given the prominence of intellectual property issues, there is much to learn about best practices in technology transfer administration—especially in its interface with individual scientists and engineers.

An interesting finding of the Corley and Gaughan paper is that multidisciplinary centers tend to create a leveling context in which male and female scientists tend to prosper equally. Indeed, they are equally likely to affiliate with centers. Much work remains to elucidate the selection mechanisms by which scientists affiliate with

multidisciplinary centers, but this is clear: women do so at the same rate, and enjoy the same benefits of that affiliation. One implication—worthy of further investigation—is whether new institutional forms (like the multidisciplinary science center) create more equitable processes, or foster more equitable work cultures than traditional academic departments. In any case, documenting how multidisciplinary science centers achieve gender equity could provide some insight into how other kinds of scientific work settings can be organized to achieve the same.

Stephan and Levin's work points to a general lack of alternatives for working parents, and perhaps a particular problem in the information technology industry. This assumes that some of the female IT professionals who left the workforce would prefer to stay in the labor force. If that is the case, further research should address both the push and pull factors that make leaving the labor force the preferred alternative to remaining in an IT career. The persistence of male culture in IT may make family responsibilities especially difficult to combine with work. At a much larger policy level, female IT professionals may be responding to the more general phenomenon of American employment practices in all sectors, which tend to be unfriendly to family responsibilities, and relatively ungoverned by federal or state regulation. The implication of these findings is to investigate further how women make decisions about remaining in the labor force in the face of family responsibilities. Do female scientists and engineers who work for institutions with more family-friendly policies and practices tend to be more likely to be retained in the workforce?

Most important, perhaps, Beoku-Betts reminds us that our construction of the challenges of women in science is cultural and contextual. As we consider science as a truly global institution, we must bear in mind that those who work within it face many constraints of which a typical North American or European would not dream. How many scientists in developed countries—male or female—worry about how to sustain their research during a civil war? How many western women scientists are likely to consider the impact of a new "democratic" regime that will not allow them to go to work alone—or go to work? How many western scientists can imagine living in a country

full of war and AIDS orphans, much less bearing personal responsibility for raising them? These are the issues Beoku-Betts' respondents face, and it does not take a giant leap to imagine these same stories being told by scientists in Latin and South America, in the Middle-East, Near East, and Far East. In our quest to make American institutions more gender equitable, we must not forget the growing importance of science and scientists working outside the U.S. context.

The second special issue on women in science will include papers written by university affiliates

of the National Science Foundation's ADVANCE initiative. In that issue, specific methodological approaches are reported to assess various aspects of university climate for women faculty. University administrators, faculty, and others will be able to use these techniques, as locally appropriate, to conduct needs assessments at their university. In this way, we think of the second issue as a technology transfer issue in its purest sense: we hope the methodological techniques described will be adopted by others wishing to evaluate the climate for faculty women at their universities.