Exploring Institutional Hiring Trends of Women in the U.S. STEM Professoriate

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Abstract

The presence of women in the United States science and technology professoriate depends on various factors, including the availability of a pool of qualified women with relevant doctorates and the elimination of policy constraints and institutional barriers to professional access. Recognizing that initial hiring in related science, technology, engineering, and mathematics (STEM) fields is a crucial step affecting gender composition and representation at all levels in the academic hierarchy, we focus on hiring profiles in institutions of higher learning to examine related trends and practices. In addition to the significant and inversely proportional influence of initial hiring on future trends, differences were noted relative to public or private control of the university and other institutional characteristics, providing a basis for further analyses of institutional dynamics restricting or enhancing favorable hiring policies and practices for STEM women faculty.

KEY WORDS: academic employment, women, science and technology workforce, higher education

Beginning particularly in the 1960s, the growth of civil rights and related social movements in the United States, such as the women’s movement, accentuated demands for more equality in education and society. Questions of fairness, equity, and democratic participation—particularly in regard to women, minorities, and other marginalized or disenfranchised groups—became central issues on the public agenda. These developments also drew attention to the “gendered” nature of science and technology in practice and representation in U.S. universities, politicizing and framing them as a social problem relative to various controversies and policy debates. This situation was punctuated by the fact that, with the increase in women earning advanced science, technology, engineering, and mathematics (STEM) degrees in significant numbers, it was assumed that in time they would achieve faculty representation proportionate to their level of participation. However, related progress has occurred much more slowly than expected (Valian, 1998, 2005). The number of women earning advanced STEM degrees has been on the rise, yet women remain underrepresented at all ranks of the academic hierarchy in STEM fields, with men remaining significantly overrepresented in the professoriate (Bellas, Ritchey, & Parmer, 2001; CPST, 2009; Hahm, 2006; Long, 2001; NAS, 2007).

As a policy issue, this means looking to women’s access and hiring into STEM faculty positions in the first place. It stands to reason that the presence of women in the professoriate would depend, first, on the availability of a sufficiently large pool of qualified women with doctorates in the desired field. After that, however, assuming available positions, the initial point of hire is the essential career transition that affects the faculty gender composition at all ranks in the academic hierarchy (Trower, 2002). Accordingly, hiring of female faculty is a crucial step or principal
mechanism in the process for achieving gender equity in the professoriate and, as such, is the focus of the issues that we address here. In other words, what are the trends in the hiring of women into faculty positions?

We take a straightforward approach to this question, examining the gender profiles of hiring trends among U.S. institutions of higher learning in our quest for a more revealing measure of gender differences among faculty. Traditionally, the effect of various institutional, state, and federal policies, as well as university faculty characteristics themselves, typically have been explored by looking at the overall percentage of female faculty employed by the university at various points in time. However, while such an approach provides meaningful information, we believe that it also tends to carry forward the effect of past policies, rather than isolating the result of new initiatives. In particular, the use of aggregate measures does not take into account the effect of low turnover rates among faculty, nor of the availability of tenure and tenure-track jobs that varies with the economy, state budgets, and an overreliance on adjunct faculty to keep up with a growing student population (Katz, 2006; Schuster & Finkelstein, 2006).

Thus, we suggest that an investigation of initial hiring trends, rather than relying on overall faculty measures and profiles, will provide us with further insight and a more nuanced understanding of the observed trends in faculty representation. After brief discussions of related theoretical issues as background and of relevant data and methods, we look to the attainment of advanced STEM degrees by women as the determinant of the potential applicant pool for faculty positions. We then explore existing research on the gender distribution of actual applicant pools, which we build upon and extend as a basis for exploring related hiring trends. Finally, to that end, we consider the percentage of newly hired women, examined at several data points over a 12-year interval and across 107 research universities. This general situation provides the basis on which we then analyze institutional hiring patterns and trends relative to questions of gender representation as framed by the theoretical considerations. We draw various policy implications from our findings and end with a general summary and conclusion, along with directions for future inquiry to provide further insights into questions of gender representation in the U.S. professoriate.

**Theoretical Background**

Increasing the numbers of women in STEM fields depends on a number of institutional and organizational conditions, and our approach here is informed by institutionalist theories on organizational culture and action as a lens through which to examine the hiring of women in the STEM professoriate. For example, at the organizational level, various policies and programs might be engaged to structure the opportunities and incentives available to women (cf. Bess & Dec, 2008; Birnbaum, 1988). At the university level, despite some programs supporting women across the institutional hierarchy of organizations, barriers to hiring and career advancement still exist (NAS, 2007). Indeed, the actual implementation of policies and innovations designed to change organizational culture and recruitment practices can be problematic in any case, and gender brings yet another level of complexity to understanding and implementing organizational change that confronts many workplace environments (Ely & Meyerson, 2000; Meyerson, 2001;
A variety of subtle—and not so subtle—barriers operate to minimize actual change. These can include, among others, exclusion from information networks, exclusion from grant writing opportunities, marginalization of women's research areas, smaller and less well-equipped offices and laboratories, and general denial of voice in institutional decision making (MIT, 1999/2002; Roos & Gatta, 2006). Moreover, academia poses unique challenges given, for example, the concurrency of years critical to earning tenure and childbearing, and the evolving work/life model that can conflict with faculty career advancement (Bailyn, 2003; Goulden, Frasch, & Mason, 2009). Programs supporting women often exist as symbolic affirmations that the university is enacting scripted roles, i.e., that the university is supporting the goal of gender equality. This then can be a source of disjuncture and decoupling between policy and actual practice or implementation. A source of disjuncture in coordination can lie in determining how to successfully achieve antidiscrimination goals for bringing more women into the STEM career pipeline. There is extensive research on the underlying factors that explain why women have historically entered STEM fields at lower rates than men, how women's experiences differ during STEM training, and the differential career paths of women in academic positions (e.g., Etzkowitz, Kemelgor, & Uzzi, 2000; Fox, 2001; NAS, 2007; Rosser, 2004; Xie & Shauman, 2003). This literature suggests that a variety of conditions have to be met simultaneously for programs seriously seeking to enlist women in science and technology fields to succeed. For example, universities can increase the number of women in tenure-track jobs by explicitly undertaking efforts to expand the female applicant pool, placing advertisements in outlets that specifically target women scientists, and increasing the gender diversity of search committees (Glass & Minnotte, 2008). For such efforts to have plausibility, credible career opportunities for women have to be visible, incentives have to exist, and organizational policies supporting women have to be in place, to name a few (Rosser & Taylor, 2009; Tilghman, 2004; Wotipka & Ramirez, 2003).

In light of these arguments, what kind of hiring outcomes might be expected given different institutional identities and organizational contexts? It is arguably the case that powerful and elite actors—in this case, more prestigious universities—are more influential than less central ones. Accordingly, hiring outcomes might vary with university prestige rankings (Wilson, 2004). However, we would also expect a continuing impact of elites on less central entities. On the other hand, research also has indicated that the public–private distinction represents a cultural boundary between organizational types (Tolbert & Zucker, 1983). Thus, for example, state universities are typically required by law to have official administrative units responsible for organizational oversight of diversity issues. If the public–private division is a boundary determining the cultural equivalence of organizations, we might expect to find barriers to diffusion along that divide. So, in the first instance following the passage of relevant legislation (e.g., affirmative action), research-based public institutions might be the first to adopt related reforms, given their political vulnerability and public status, and other public institutions attempting to gain status and credibility may be quick to copy related reforms (Bess & Dee, 2008; Frank & Gabler, 2006). However, in light of organizational boundaries, elite private universities may not adopt them, at least not in the same form; they might choose alternative
approaches to related issues (cf. Bess & Dee, 2008; Birnbaum, 1988). That is, private institutions may follow their own path of organizational adaptation to demands for more equality. Yet, over time, we still would expect to find convergence in hiring representations in either sector as programs and innovations gain acceptance and legitimacy. Viewing universities as organizational fields in which they evince analogous structures and exist under similar conditions in a broader sense, similar hiring trends would be the ultimate consequence.

**Data and Methods**

To investigate these points, we drew on a broadly representative sample of 107 major U.S. research universities, selected and differentially classified according to region, prestige rating, consortium membership, and ownership status.2 Region was coded for university location in the northeast, midwest, south, and west, along with related subdivisions, based on U.S. Census designations.3 Consortium membership was coded according to whether or not a university belonged to a university consortium (dummy variable) and to a specific consortium or conference membership. Prestige ratings were taken from composite measures offered by the Center for Measuring University Performance (Capaldi, Lombardi, Abbey, & Craig, 2008).4 Ownership reflected indication of public or private status.

Methodologically, we departed from the more traditional way of measuring disparities through aggregate numbers of existing faculty by gender and look to actual university hires at different points in time to account for low turnover and variations in the number of tenure and tenure-track jobs available. More specifically, we analyzed trends in percentages of newly hired female faculty across universities over a 12-year period. For a first look at the hiring trends, we used data from the Integrated Postsecondary Education Data System (IPEDS), provided by the U.S. Department of Education, for several data points between 1993 and 2007, the earliest and most recent years for which data were available (Zimbler, 2006). IPEDS includes institutional-level data from which we drew information on numbers of newly hired full-time faculty by gender and tenure or tenure-track status.5 Percentages of newly hired women faculty were calculated for each institution, along with differences in percentages of new hires between the beginning and the end of the interval, as well as differences between the first (before 2001) and the second half of the interval (after 2001). Along with other related sources, we also used information from the National Science Foundation on STEM degree attainment for various years.

**Gender Shifts in Educational Attainment**

Advanced degree attainment obviously affects the possible proportion of females constituting the applicant pool and, thus, the likelihood of female hires. Regarding academic attainment, female enrollments in higher education have steadily increased since 1965. Although males had higher enrollment than women until 1975, they now in fact have a lower college enrollment rate than women,6 as is, of course, also reflected in actual degree attainment. However, note that, when we observe degree attainment in terms of the percentage of women (U.S. citizen and
permanent resident) by degree level, this rate drops precipitously by level of
degree, and this is particularly the case when it comes to STEM degrees, as shown
in Table 1. Still, while the proportion of women with degrees can vary greatly by
field, the overall number of women earning STEM degrees at both undergraduate
and graduate levels has increased substantially since the 1960s. Women now earn
nearly 50 percent of all bachelor degrees and nearly 40 percent of all advanced
degrees in STEM fields (NSF, 2007).

Gender Distribution in Applicant Pools

Given this pool of potential applicants, one might expect that, once they apply,
women may be likely to be selected for interviews and offered jobs. This appears to
hold true for some research universities, especially those that have been expanding
efforts to recruit women faculty in STEM fields (NRC, 2009). However, there are
also indications that aggregated data used in most reporting masks the overall
attrition of women along the educational and career STEM pipeline (Rosser &
Taylor, 2009). Moreover, there are significant differences among STEM disciplines.
Interestingly, as a simple matter of numbers, fields with a lower number of women
doctorates and faculty have shown a proportionally larger pool of female applicants
compared with fields with higher female representation, such as biology and
chemistry (see Table 2).

The differences among the proportion of women who graduate, apply, or are
offered jobs are almost linearly—and inversely—dependent of the overall number
of women in that particular academic field. The numbers in the fields with less
women overall (e.g., engineering and physics) suggest extra efforts to recruit
women in their applicant pools. At the same time, efforts to ensure higher repre-

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Table 1. Percent of Women by Degree Level, 1966–2006

<table>
<thead>
<tr>
<th>Year</th>
<th>Baccalaureates All</th>
<th>Baccalaureates STEM</th>
<th>Master’s All</th>
<th>Master’s STEM</th>
<th>Doctorates All</th>
<th>Doctorates STEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>42.6</td>
<td>24.8</td>
<td>33.8</td>
<td>13.3</td>
<td>11.6</td>
<td>8.0</td>
</tr>
<tr>
<td>1976</td>
<td>45.6</td>
<td>33.6</td>
<td>46.4</td>
<td>23.1</td>
<td>23.3</td>
<td>16.8</td>
</tr>
<tr>
<td>1986</td>
<td>51.0</td>
<td>39.0</td>
<td>50.3</td>
<td>32.3</td>
<td>35.4</td>
<td>26.6</td>
</tr>
<tr>
<td>1996</td>
<td>55.2</td>
<td>47.1</td>
<td>55.9</td>
<td>39.3</td>
<td>40.1</td>
<td>31.9</td>
</tr>
<tr>
<td>2006</td>
<td>57.8</td>
<td>50.5</td>
<td>60.0</td>
<td>44.9</td>
<td>45.1</td>
<td>38.5</td>
</tr>
</tbody>
</table>


Table 2. Percent of Women Applicants and Academic Employment Opportunities

<table>
<thead>
<tr>
<th>Discipline</th>
<th>% Women Doctorates</th>
<th>% Difference Doctorates/Applicants</th>
<th>% Difference Doctorates/Interviewed</th>
<th>% Difference Doctorates/Offered Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>45</td>
<td>-19</td>
<td>-17</td>
<td>-11</td>
</tr>
<tr>
<td>Chemistry</td>
<td>32</td>
<td>-14</td>
<td>-7</td>
<td>-3</td>
</tr>
<tr>
<td>Mathematics</td>
<td>25</td>
<td>-5</td>
<td>+3</td>
<td>+7</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>18</td>
<td>-2</td>
<td>+12</td>
<td>+14</td>
</tr>
<tr>
<td>Electrical engineering</td>
<td>12</td>
<td>-1</td>
<td>+7</td>
<td>+20</td>
</tr>
<tr>
<td>Physics</td>
<td>14</td>
<td>-2</td>
<td>+5</td>
<td>+6</td>
</tr>
</tbody>
</table>

sentation of women in STEM fields currently depicted as “female-friendly” based on higher levels of degree attainment, such as biology and chemistry, appear either insufficient or ineffective. That is, attrition rates are quite high among women scientists in these fields between their doctoral attainment and the entry point into academic careers at research universities.

While it is usually at the institutional level where related policy directives might be found (McNeely & Kamens, 2008), it is also the case that most departments rarely report concerted strategies to increase the diversity of their applicant pool (NRC, 2009). Clearly, further investigation is needed to identify successful strategies for ensuring a better representation of women in STEM applicant pools. Moreover, it would be worth investigating what triggers institutions to implement such policies, as well as how they define success—in other words, if they use some “magic number” to decide whether efforts should be stopped or slowed down, or if these policies become institutionalized as part of the regular hiring process independent of the number of women hired.

**Gendered Faculty Hiring Trends**

In any case, despite dramatic increases in the number of women obtaining STEM doctorates, evidence indicates that qualified women are not entering or advancing in the academic workforce at rates that would be expected based on their educational attainment and on indications of early professional goals and plans (Fox & Stephan, 2001; Hahm, 2006). In fact, the academic career path itself has been characterized as a “gender sieve,” referring to the drops in numbers of women at each step along the academic career path, in which the rate of women’s representation and participation declines precipitously in most STEM disciplines (Trower, 2002). Despite major educational advancements and substantial gains in the number of women scientists and engineers over the past decade, women remain underrepresented on STEM faculties, as reflected in Figure 1.

We refer particularly to “regular” tenure-track positions, rather than the more tenuous contingent non-tenure-track employment. Research on women holding tenured or tenure-track academic positions in STEM fields has typically focused on these kinds of overall numbers within particular fields or institutions. However, while it is well-known that more women with STEM doctorates are graduating each year, the number of hires compared with positions available each year has been less investigated. Therefore, we look to provide a simple, yet more dynamic look at female faculty employment, focusing on hiring outcomes across universities.

As previously mentioned, this research started as a quest for a more revealing dependent variable, an outcome measure to judge institutional initiatives and policies aimed at increasing the representation of women in academia. We have found that most research looks at aggregate numbers, comparing percentages of women/men among existing faculty. However, we note that the initial point of hire is obviously essential to future advancement of women faculty. Thus, we focus on hiring outcomes as a foundational measure for understanding and exploring the overall observed representation patterns. While the overall number of positions available varies each year, we expected a relatively upward trend in percentage of newly hired female faculty in keeping with the general arguments discussed above.
In an ideal world, and assuming no major gender differences in the applicant pool, the percentage of newly hired female faculty should somewhat resemble the increase in the number of doctoral graduates.

Our use of percentage of newly hired women is somewhat novel in this area and has two major benefits: (1) accounting for job turnover, and (2) considering variations in availability of jobs. Since turnover in academia is notoriously low, looking at the overall number of women among existing faculty may mask recent trends (Rosser & Taylor, 2009). The use of newly hired numbers can provide a clearer and more accurate picture of recent developments. Moreover, we also know that the number of available academic tenured or tenure-track positions can vary with changes in the economy and university budgets. The use of percentages rather than base numbers also allows accounting for fluctuations in the total number of positions available each year. That is, rather than general aggregate counts as typically reported, we consider percentages of women among newly hired faculty (tenured or tenure-track) for a clearer and more contextualized look at the trends in question, as reflected in Figure 2.

Based on differences in percentages of newly hired female faculty in 2007 compared with 1995 (percentage of women out of total new hires), we could distinguish six hiring categories of institutions in our sample of 107 universities, indicated by gains in newly hired women faculty or overall losses of women faculty. As delineated in Table 3, these categories range from substantial, moderate, and modest gains to modest, moderate, and substantial losses.
On average, the universities with the largest gains in female faculty started with lower percentages of new female faculty hires. There is an evident linear relationship between gains and the percentage of female faculty being hired in the early period. That is, universities with lower percentages of female faculty hired in 1995 were significantly more likely to show gains over the time interval, perhaps in an attempt to “catch up” with peer institutions. While the universities in the first category (substantial gains) show gains in the first half of the interval, most of the increases in female faculty hires took place between 2001 and 2007, and particularly after 2005. For those universities showing losses, most of these happened in the first half of the time period, with smaller losses in female faculty hires between 2001 and 2007. Regression analysis also confirmed that the best predictor of university hiring patterns over the 12-year study interval was the percentage of women hired at the beginning of the interval. In fact, of all variables included in the analysis, it was the only one reaching statistical significance at the .01 level. Figure 3 shows the linear and inverse relationship between the two variables.

Table 3. Gains/Losses Categories of Newly Hired Women Faculty

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage Range*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantial gains</td>
<td>10.39–32.81</td>
</tr>
<tr>
<td>Moderate gains</td>
<td>5.10–9.98</td>
</tr>
<tr>
<td>Modest gains</td>
<td>0.06–4.85</td>
</tr>
<tr>
<td>Modest losses</td>
<td>−0.13 to −4.29</td>
</tr>
<tr>
<td>Moderate losses</td>
<td>−5.96 to −9.44</td>
</tr>
<tr>
<td>Substantial losses</td>
<td>−11.51 to −32.62</td>
</tr>
</tbody>
</table>

*Based on 1995–2007 percentage differences.

Source: Department of Education, IPEDS.
While there were no significant differences among groups on the basis of region or prestige rankings, a nonlinear relationship could be observed between gain/loss categories and university ownership. Public universities were more likely to be at either end of the scale, with significant gains or losses, while private universities tended to register more moderate or modest changes on either side. Overall, as shown in Figures 4 and 5, increases in percentage of newly hired female faculty have been more apparent among public universities, as expected. However, although growth among private universities was somewhat slower, they too evinced an upward female hiring trend. Private universities appear somewhat slower in following these trends and also perhaps more risk-averse, favoring somewhat less dramatic changes than their publicly controlled counterparts.

Conclusion

While sensitivity to the institutional environment can vary over time and across units, a kind of spiraling institutional dynamic also occurs such that, with the recruitment and hiring of more women, it can become increasingly difficult to maintain barriers to entry across universities in general. Through the use of a straightforward, yet innovative measure, we examined gender hiring patterns relative to several institutional features, including geographic region, membership in a consortium, prestige rating, and private/public status. While there were no major differences in hiring patterns across universities relative to region, consortium

Figure 3. Percentage Comparison of Initial and Later Women Faculty Hires, 1995–2007

Source: Department of Education, IPEDS
Figure 4. Percentage Gains in Newly Hired Women Faculty, by University Ownership, 1995–2007

Figure 5. Gains and Losses in Percentage of Newly Hired Women Faculty by University Ownership, 1995–2007
membership, or prestige, the increase in percentage of newly hired female faculty, although in the same direction among private universities, was more substantial among public universities, as expected.

However, by far the most important finding of this study is that the percentage of newly hired women faculty is a viable outcome measure which, in fact, can help to untangle the contextual effects of academic turnover and job availability. We believe that use of this measure will allow for a better assessment of policy effects on hiring and will provide a more detailed understanding of related institutional employment practices and outcomes over time. Our results confirm that the focus on newly hired faculty in this regard is a promising approach, and set the stage for its use as a dependent variable in further investigations.

A critical consideration here might be the extent to which gender-equitable hiring practices might become institutionalized in STEM and other fields and determining why or why not that might be the case. Based on existing research, we expected that the percentage of newly hired female faculty should be either independent of the overall number of female faculty members or favored by it, since universities would seem more welcoming to women, increasing the probability that more would apply, be offered, and accept jobs. Our analysis, at least in this first take, shows exactly the opposite, confirming some trends noted in recent research on female representation in applicant pools (NRC, 2009). However, as we discussed, efforts to recruit more women into the academic applicant pool seem to diminish in fields with a higher percentage of female doctorates and existing faculty. Similarly, we found that institutions seem to reduce their efforts to identify and hire qualified female faculty once they have reached a certain number that “looks good,” based on some institutional target quotas. As our data show, universities with lower initial numbers of women had much higher gains than their peers, but the upward trend in hiring starts to flatten out once the percentage of newly hired women reaches a number that could be considered “average” among this peer group.

Finally, we treat the analysis presented here as an exploratory first step in an attempt to gain insight and direction into the overall process and a general depiction of hiring trends among STEM women faculty. Next steps might include, for example, augmenting the data to expand the analysis to provide a better look at the impact of policy and societal changes on diversity in the STEM professoriate. Research might involve the engagement of other related issues and questions, such as what happened to institutions that evinced significant “losses” in the initial analysis, and whether the loss was a one-time event or part of a downward trend. At the same time, we hope that future research will shed light on factors that determine when, where, and why some efforts, as opposed to others, are institutionalized and become standard university policy and practice, ultimately affecting the presence of women in the STEM professoriate.

Notes

1 This research was supported in part by a grant from the National Science Foundation (NSF 0633950). We also thank the anonymous reviewers for their helpful comments and insights on an earlier version of this work.
2 The list of universities is available in a technical appendix available upon request.
3 http://www.census.gov/econ/census07/www/geography
4 http://mup.asu.edu/
5 The hiring data were not available by field, so we, unfortunately, could not disaggregate the numbers by STEM fields. However, supplemental analysis suggests that they generally follow the same directions as the overall analysis.
6 Enrollment of 16–24-year-old high school completers in 2005: males = 67 percent, women = 71 percent.
7 It appears that women and minorities are increasingly channeled into contingent, non-tenure-track positions (see discussion in McNeely & Kamens, 2007).

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