ABSTRACT

Advancement to the Highest Faculty Ranks in Academic STEM:
Explaining the Gender Gap at USU

by

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National status reports have documented the underrepresentation of women at senior ranks in academic STEM (Science, Technology, Engineering, Mathematics), but the causes for this gender gap in post-tenure career attainment have remained understudied. This thesis focused on the position and career trajectory of women faculty in four STEM colleges at Utah State University (USU), and sought to answer the following research questions: (1) What is the status, recruitment, and retention of women, (2) Is there a gender gap in the promotion rates to full professor, and (3) Are awards a source of gender inequality? A mixed methods approach was used combining quantitative faculty, leadership, promotion and awards data with faculty responses to multiple waves of a climate survey.

Mirroring national trends, the number of women hired in STEM has increased significantly since the late 1990s, but data showed considerable attrition among assistant and associate women faculty. The relative proportion of women full professors has
remained well below market availability. Promotion records indicated that prior to 2008, large variability existed in time to promotion to full professor for both men and women, and that women took longer to attain the rank of full professor. Faculty hired as associate professors, almost exclusively men, were promoted more rapidly. Greater awareness of the promotion process through workshops and formal codification of the post-tenure review timeline have accelerated the promotion rate to full professor for women and caused a decline in the variability in time to promotion for all STEM faculty and a narrowing of the gender gap. This was accompanied by an improvement in faculty morale and a greater understanding of and confidence in the promotion process.

Faculty recognition through awards at USU has remained a gendered process, in that women were numerically underrepresented among awardees and men were more likely than women to be recognized for their scientific accomplishments, especially at the university level. Women faculty reported being overlooked in the nomination process for all award types and were more likely to receive recognition non-research activities. This research has shown where institutional practices can cause or foil gender inequality.
PUBLIC ABSTRACT

Advancement to the Highest Faculty Ranks in Academic STEM:
Explaining the Gender Gap at USU
Helga Van Miegroet

Science and technology (S&T) disciplines at universities are still largely dominated by men, and few women are found in the highest employment ranks. Using the faculty data from Utah State University, this thesis explores the factors that help explain the difference in career trajectory between men and women in the S&T colleges. While there were few women in S&T colleges prior to the 1990s, more women have been hired since then, and the lower ranks of the faculty corps are starting to reflect the gender composition of the doctoral degree holders in the different fields. This is not the case for full professors and leadership positions, where women are still underrepresented.

Analysis of the university careers of faculty in S&T colleges revealed that in the absence of formal guidelines, promotions to full professor were inconsistent, but men were generally promoted faster, especially when hired as associate professors. However, conscious measures by the university to make the promotion process more transparent and formalized reduced the variability in time to promotion to full professor for all faculty and minimized differences between men and women. Recognition of faculty achievement through awards still shows gender bias. Women proportionally receive less awards, especially in recognition of research activities. This study illustrates that clear guidelines reduce gender bias in decisions and improve gender equity in the academia.
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Helga Van Miegroet
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CHAPTER 1
INTRODUCTION

“Our struggle today is not to have a female Einstein get appointed as an assistant professor. It is for a woman schlemiel to get as quickly promoted as a male schlemiel.”

Bella Abzug

Academic STEM (Science, Technology, Engineering, Mathematics) fields are still largely male dominated and women are especially underrepresented at the senior ranks (Long and Fox 1995; Valian 1999; Mason, Wolfinger, and Goulden 2013). Despite efforts to recruit more women into STEM colleges (Burelli 2008) and claims of meritocratic and gender-blind performance evaluation and promotion processes in academia, women still advance more slowly than their male counterparts, and not all attain the highest academic rank, that of full professor (Long and Fox 1995; Valian 1999; Mason et al. 2013). These patterns are particularly puzzling since these women scientists possess the human capital to be hired (Glass and Minotte 2010; Williams and Ceci 2015) and have successfully navigated the tenure process, the first critical gatekeeping event where significant performance-related attrition takes place. We would therefore expect a leveling of the playing field post-tenure with shrinking gender differences in career mobility.

This pattern of declining representation of women up the academic STEM ladder is often referred to as the “leaky pipeline” in STEM. While the underrepresentation of women across faculty ranks in academic STEM is undisputed, there is less consensus on the causes for this phenomenon. Some scholars adhere to the notion of academia as meritocratic and objective, and invoke individual decisions or traits (supply side factors),
such as early self-selection into/out-of science, attrition due to career choices away from academia, lack of motivation, or lack of success due lower overall productivity to explain gendered career outcomes (Ceci et al. 2014). Conclusions relative to gender differences in career success are often made without further exploration of structural or institutional conditions that may have caused differences in productivity between men and women faculty, such as academic division of labor and high demands for non-research activities, exclusion from information and collaboration networks, or limited mobility due to family obligations (Rosser 2004). Few studies have systematically analyzed gendered institutional practices and norms (structural barriers) that place women scientists at an evaluative disadvantage and produce gender inequity at every stage of the career ladder, and even less have focused on post-tenure processes (Blickenstaff 2005; Fox and Colatrella 2006; Roos and Gatta 2009; van den Brink and Benschop 2011). The emphasis on individual performance factors at the exclusion of institutional-level processes greatly limits our insights into what fosters an equitable academic work environment where all faculty, irrespective of gender, achieve their full potential. This thesis intends to address this important gap in our understanding of the nature of academic success, and particularly the institutional practices that promote or foil gender equality in career attainment within academic STEM.

Specifically the research described in this thesis focusses on the gender gap in the promotion to full professor of STEM faculty at Utah State University (USU), a public university considered representative of many doctoral universities in the western US where research productivity is highly valued. The overall objective of this research is to analyze whether women take longer than their male colleagues to attain the highest rank
and, if so, analyze to what extent individual and institutional factors contribute to
differential rates of upward mobility among STEM faculty. In this institutional-level
analysis a multi-method approach was used, combining secondary quantitative data with
faculty survey responses, to assess the proportion and upward mobility of women faculty
in STEM and to elucidate institutional factors influencing the career dynamics of STEM
faculty. This study is novel in that it focuses specifically on mid-career processes and
the advancement to full professor, in contrast to the more common early-career emphasis
on the attainment of tenure.

The thesis is organized into three results chapters constructed around distinct
themes. While each chapter constitutes a stand-alone essay, with its specific theoretical
framework, literature review, and data sources, collectively the three components of this
institutional analysis provide a more comprehensive overview of the career dynamics of
faculty in the four STEM colleges at USU. They also begin to identify institutional
practices that promote or foil gender equity in career attainment within STEM that may
be relevant to other similarly situated institutions of higher education.

Chapter 2, entitled “Status, recruitment and retention of women in STEM between
2008 and 2014” uses secondary faculty data for the four STEM colleges (College
Agriculture and Applied Sciences, College of Engineering, Quinney College of Natural
Resources, College of Science) from 2008 through 2014 obtained from the USU Office
of Analysis, Assessment and Accreditation (AAA) to evaluate the relative proportion of
women faculty by rank and over time, and to quantify trends in recruitment and retention
within this timeframe. Data collection and visualization has been identified as a crucial
step towards institutional change in that it objectively documents and makes visible
gender disparities if and where they exist (Rosser and Chameau 2006).

In Chapter 3, entitled “Unclogging the pipeline, advancement to full professor in academic STEM,” faculty demographics and promotion data between 2008 and 2014 are combined with faculty responses from two waves of a climate survey to evaluate mid-career faculty advancement in the four STEM colleges. In particular, the magnitude and the longevity of the impact of the ADVANCE project, funded through an institutional transformation grant from the National Science Foundation (NSF) (2003-2008), on the gender gap in promotion from associate to full professor is evaluated, both in terms changing gender distribution and the length of time in associate rank until promotion. This chapter also analyzes the influence of formal and informal institutional practices (e.g., rank at hire, faculty code changes) on augmenting or attenuating gender discrepancies in career advancement.

Chapter 4, entitled “Is recognition through awards a source of gender inequality in academic STEM?” explores one aspect in the construction of excellence, namely the nomination and selection for awards, which largely lies outside the control of the individual faculty member, yet may have a profound influence on status and overall career success. The full historic USU record (1958-2015) of recipients of STEM college and university awards are analyzed to evaluate awards as a source of gender inequality. Specifically, this chapter explores to what extent men dominate as recipients of high-status research awards and whether women proportionally receive more awards in recognition of non-research activities. The results are interpreted within the theoretical framework of academia as a prestige economy and universities as gendered organizations to explain observed gendered differences.
REFERENCES

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CHAPTER 2
STATUS, RECRUITMENT AND RETENTION OF WOMEN IN STEM
BETWEEN 2008 AND 2014

INTRODUCTION

Academic STEM (Science, Technology, Engineering, and Mathematics) fields are still largely male dominated and women are especially underrepresented at the senior ranks (Long and Fox 1995; Valian 1999; Mason, Wolfinger, and Goulden 2013). The number of women earning graduate degrees in STEM fields nation-wide has increased substantially in recent years, and women now receive more than 40% of all advanced degrees in science and engineering (Burelli 2008; NSF 2017). Despite these gains, women remain a minority among tenured and tenure-track STEM faculty at many research universities (Valian 1999; AAUW 2010; Mason et al. 2013; Ceci et al. 2014).

This pattern of declining representation of women up the academic ladder is often referred to as the “leaky pipeline” (Goulden, Mason and Frasch 2011). Some scholars attribute progressive attrition to individual choices and traits (Ceci et al. 2014) without further exploration of structural or institutional conditions that may have caused differences in productivity between men and women faculty, such as academic division of labor and high demands for non-research activities, exclusion from information and collaboration networks, or limited mobility due to family obligations (Rosser 2004).

From that viewpoint, to alleviate the problem of vertical gender segregation in STEM, programs should focus on fixing women’s deficiencies or individual barriers to success. The NSF POWRE awards program, for example, was one of the first national initiatives
to address women’s lagging behind in academic STEM, and provided support to individual women scientists to assist them in overcoming personal career challenges (Rosser 2004).

However, in recent years there has been a growing recognition of more systemic issues in academia, specifically institutional barriers that hamper women’s upward mobility. Accordingly, the lower participation of women in the upper levels of academia is considered less the result of their individual failure than of a systemic consequence of academic culture (Dean and Koster 2014). The initiation in 2001 of the NSF ADVANCE Program into the recruitment and retention of women in STEM reflects this sea change in perspective at the national level. That program aims at clarifying systemic barriers and seeks institutional solutions to the underrepresentation of women in the STEM disciplines by means of Institutional Transformation Awards to institutions of higher education. Utah State University (USU) was a recipient of such an NSF-ADVANCE grant (2003-2008).

In their essay on the institutionalization and the sustainability of ADVANCE initiatives, Rosser and Chameau (2006) identify data collection and access as a crucial step towards institutional change, in order to objectively document the need for changing institutional policies and practices. The objective of this chapter is to summarize the available data on faculty demographics within STEM colleges at USU’s Main Logan campus, starting in 2008, when the first centralized accessible digital data base for USU personnel became available. The specific focus is to document the status, recruitment, promotion, and retention of faculty in STEM colleges and identify gender differences in these variables.
DATA SOURCES

In this analysis, secondary faculty data for 2008 through 2014 were used, including college, gender, rank and hire date. Prior to 2008 no centralized searchable digital database of university personnel was available. During the ADVANCE project, the initial STEM faculty data base was extracted from individual personnel files and digitized. Maintenance and annual update of this university-wide data base has been institutionalized and is now under the purview of the Office of Analysis, Assessment and Accreditation (AAA). This analysis focusses on the faculty demographics within the four STEM Colleges [College of Agriculture and Applied Sciences (CAAS), College of Engineering (ENG); Quinney College of Natural Resources (CNR) and College of Science (SCIENCE) on the USU-Logan campus.

In addition, AAA prepared an anonymized database that linked the 2008 and 2014 census data and followed individual data records from 2008 to 2014. Faculty who appeared in the 2008 census but not in the 2014 were assumed to have left; those who were in the 2014 census but not in the 2008 census were categorized as new faculty hires. Faculty were further categorized by rank (in 2008 and 2014 census) and gender. For those faculty who appeared both in the 2008 and 2014 census, we noted whether during the intervening 6 years, faculty remained in rank or were promoted, and if so, to which rank.

The proportional representation of women in the different STEM colleges and for each faculty rank was compared to time- and discipline-specific gender composition of PhD recipients. Availability of Assistant Professors was compared to 2009-2013 availability data obtained from the Affirmative Action-Equal Opportunity Office.
(AA/EO) at USU. Availability data are only periodically updated, with the Census data and Survey of Earned Doctorates data sets updated every 5 to 10 years. In 2011, AA/EO changed data sets from manually-entered data from the Professional Women and Minorities: A Total Human Resources Data Compendium and Census data to the Census data and the Survey of Earned Doctorates, as the former data set (Professional Women and Minorities) was not consistently available. Availability data did not fluctuate significantly between 2009 and 2013, and were therefore averaged. Earlier availability data for Associate Professors and Full Professors were obtained from the ADVANCE team, based on the NSF data on earned doctorates in 2004 and 1999, respectively.

Finally, the gender distribution in leadership positions was determined in summer 2017 for the four STEM colleges, by identifying the individuals occupying college and/or department leadership positions from college and departmental websites. At the college level, this included dean and (executive) associate dean; at the department level this included department head, assistant or associate department head, director of graduate programs, and undergraduate director. Data was coded for college, department, specific leadership position and gender.

FINDINGS

Women are still underrepresented among tenure-track faculty

There were very few tenured and tenure-track (T&TT) female faculty in STEM at USU prior to the 1980s, and the first wave of women hires within STEM colleges took place between 1988 and 1995 (Figure 2.1). Since then hiring has continued at a steady pace, and in 2008 there were a total of 62 T&TT women faculty across the four STEM
Colleges on the main Logan campus. This number increased to 72 in the 2014 AAA census.

In 2014, 27% of all faculty in the STEM colleges were women (288 men to 105 women) compared to non-STEM colleges where the distribution approaches parity (253 men to 212 women). This proportion of women faculty is still well below the overall percentage of women earning advanced degrees in across all sciences, engineering and health fields in 2014 (42%; NSF 2017). It also remains below the national average for all doctorate-granting research universities, where in 2013 on average 34% of the science, engineering and health doctorate holders in academia were women (ranging from 32-40% depending on research activity ranking; NSF 2017).

Furthermore, there are distinct gender differences in position and rank. The majority of men in STEM colleges are in T&TT positions (81%) with the majority holding the rank of full professor (41%). By comparison, almost one-third (31%) of women faculty in the STEM colleges occupy less secure non-tenure track positions, compared to 15% of all men. This ratio between T&TT vs. non-tenure track positions for women at USU (69% to 31% or 2 to 1), however, is better than the national average across universities and 4-year colleges, where only 55% of women are in T&TT faculty positions, corresponding to a ratio of T&TT to non-tenure track positions slightly greater than one. Overall, T&TT women account for only 18% of the entire STEM faculty corps, which is at par with the national average (NSF 2017). Expressed as a percentage of the T&TT faculty in STEM, the proportion of women in T&TT position is 23% at USU (Table 2.1), slightly below the national average of 29% (NSF 2017). By discipline, the
national average of the percentage T&TT faculty that are women ranges from 30% in biological sciences, 22% in physical sciences, to 14% in engineering (NSF 2017).

Women are especially underrepresented at the full professor rank, with 14% of all women faculty (Figure 2.2) and only 6% of all T&TT faculty at USU (Table 2.1) being women full professors. The situation at USU is comparable to the national trend across science and engineering disciplines, where women in the full professor rank still represent only 7% of the professoriate across universities and 4-year colleges (NSF 2017).

*Women are hired in increasing numbers but the gender composition of the faculty relative to market availability varies among STEM colleges and by faculty rank*

Figures 2.3 through 2.6 summarize the relative distribution of women faculty by rank and census year (2010 to 2014) in the different STEM colleges. The NSF-derived gender distribution in science degrees in 1999, 2004, and the average for the period 2009-2013 can be used as benchmarks for historic availability of women in the full, associate, and assistant professor ranks, respectively, and permit evaluation of relative goal attainment of gender equity by college and faculty rank.

The national availability of women with advanced degrees differs by discipline and is lowest for engineering (19%) and highest for the sciences (39%) with agriculture (35%) and natural resources (36%) slightly below. When considering all faculty (non-tenure track and TT&T) collectively, three of the STEM colleges (CAAS, ENG, CNR) are approaching the availability goal, with SCIENCE lagging behind considerably at 24% women among its faculty vs. 39% in the market place (Figure 2.6). Parsing the faculty by tenure status suggests that among non-tenure track faculty in STEM, women are
somewhat overrepresented relative to availability in three of the four colleges (CAAS, ENG, CNR) and on target in SCIENCE.

The situation is more complex for the T&TT faculty, and differs significantly by faculty rank. In most STEM colleges (CAAS, ENG, CNR), hiring of women increased significantly during and after ADVANCE, indicated by the noticeable upswing in women faculty hiring that started around 2004 (Figure 2.1). With a few exceptions, most T&TT women faculty have been hired as assistant professors: prior to 2008 only two women started their faculty appointment at a higher rank, with an additional five in the 2008-2014 period (see Chapter 3). Hiring rates are generally above the current market availability as indicated by the proportional representation of women among assistant professors; the exception being SCIENCE where the proportion of women in assistant professor rank is still below availability (Figure 2.6).

The hire wave, which started when the ADVANCE project was active on campus, is reflected post-tenure, such that the gender distribution for associate professors is in line with availability in 2004 in two colleges (ENG and CAAS), but still below availability in CNR and SCIENCE. The discrepancy between gender distribution of faculty in STEM and historic availability levels is most pronounced for the rank of full professor in all STEM colleges.

Promotion to full professor has accelerated for women since 2004 but women are still underrepresented at the highest faculty ranks

As described in greater detail in Chapter 3, prior to 2003, the promotion process to full professor was very inconsistent, leading to disparate outcomes among male and female faculty and low promotion rates for women faculty in STEM. With the onset of
the ADVANCE program at USU, promotion dynamics changed drastically, especially for women (Figure 2.7). This change resulted from departmental and university-wide workshops and panel discussions that created greater transparency in the promotion process and clarified expectations and culminated in the implementation of Faculty Code changes (in 2005) that more clearly codified post-tenure review procedures (for details see Chapter 3). As a consequence, women are now more regularly promoted to full professor (Figure 2.7) – with an average promotion rate of two per year over the last 10 years – and gender gaps in time until promotion have virtually disappeared (see Chapter 3 for further discussion). The relative proportion of T&TT faculty who are women at the full professor rank has essentially doubled from 3% (n=11) in 2008 to 6% (n=19) in 2014.

Despite this positive trend in promotion rates, and an overall increase in the number of women that are associate professors (from 22 in 2008 to 29 in 2014; Table 2.1), the number and proportion of women with full professor rank still remains well below historic availability levels in all colleges. The CAAS has the best gender representation (17% full professors vs. 29% availability) and ENG the worst (0% women full professor\(^1\) vs. 15% availability). Both CNR (10% full professors vs. 34% availability) and SCIENCE (14% full professors vs. 32% availability) are still far removed for gender parity in the full professor ranks based on gender distribution of the PhD pool in 1999 (Figures 2.3 through 2.6).

\(^1\) In 2015 two women were promoted to full professor in the College of Engineering
Gender distribution in leadership positions is inconsistent among colleges and levels

Across colleges and administrative levels, women occupy 21% of all leadership positions (Table 2.2), closely mirroring the gender distribution among the T&TT faculty in STEM (23%; Table 2.1). The relative proportion of women in leadership positions, however, is highly variable by STEM college and by administrative level. One quarter of the dean and associate dean positions are occupied by women. In SCIENCE, which has the highest number of leadership positions (24), 29% of these positions are occupied by women, with two women in the top position, that of Dean and Executive Associate Dean. The other five women serve as Graduate Directors at the departmental level. Similarly, in ENG three women (23% of all leadership position) serve as Graduate Directors at the departmental level. By contrast, CAAS currently has no women in any of the 15 leadership positions (Table 2.2). It should be noted that over the last 5 years three of its women faculty were recruited into higher administration at USU, as vice-provosts, provost and now president. CNR, one of the smaller colleges, only has 6 leadership positions, two at the college and four at the departmental level, with women occupying two of these (33%), namely that of Associate Dean and that of Associate Department Head (Table 2.2 and Figure 2.8). Most noticeable is that none of the 21 department heads in STEM are female.

Faculty retention remains an issue especially for untenured women faculty

Although the 2008 and 2014 census snapshots suggest relative stability in the STEM faculty population (n=326 in both years) (Table 2.1), there was considerable turnover at all faculty ranks, irrespective of gender. Almost one third (29%) of all T&TT
faculty in the STEM colleges that were in the 2008 census left USU by 2014 (Figure 2.9). Attrition rates were highest among the assistant professors, and 42% of untenured faculty in STEM colleges were no longer affiliated with USU in 2014. The attrition for women assistant professors was slightly higher than that for men (45% of all untenured women vs. 41% of untenured men).

There was also considerable attrition post-tenure, where almost one quarter of all associate professors (24 out of 102 associate professors, 22%) in the 2008 census had left USU by 2014. Opposite the trend for assistant professors, the attrition rate for women associate professors was lower than for men in STEM colleges (14% of women in associate professor rank vs. 24% for men).

Thus, there was a noticeable gender difference in the career stage where attrition occurred. Men in STEM colleges predominantly left USU at full professor rank (47% of total male faculty attrition in STEM), likely reflecting retirement as the main reason for this pattern. Attrition was fairly similar albeit slightly higher for untenured assistant professors (29%) than associate professors (24% of male faculty attrition in STEM colleges). For women faculty, attrition occurred predominantly at ranks below full professor (94% of total female faculty attrition in STEM), with major faculty losses occurring at the assistant professor level (13 out of 17 or 76% of total female faculty attrition in STEM). This suggests women faculty are leaving USU for other reasons and long before retirement age.

DISCUSSION

The demographics of our institution are very similar to STEM disciplines at other
doctoral research universities (AAUW 2010; NSF 2017), with men still dominating the TT&T faculty ranks, and the proportional representation of women steadily increasing over time, especially in the untenured ranks. Men occupy all 21 department head positions in the STEM colleges.

The ADVANCE program had a positive effect on the number of women being hired and promoted within the STEM colleges. Despite these marked improvements, a few patterns deserve our attention, as they point at potential sources of gender inequity career attainment of faculty, especially at the early stages of their academic career.

Rank at hire presents one of the areas where significant gender differences still remain. Most women enter their academic position as assistant professors, whereas for men entry rank is more variable, suggesting negotiations at point of hire. As shown in Chapter 3, rank at hire positively impacts rate of upward mobility, by shortening the time until promotion to full professor, an advantage extended primarily to men. The impact of gender differences at the hiring point on subsequent career trajectories that tend to advantage men have also been documented in other universities (Roos and Gatta 2009) and research institutions (Sabatier, Carrere, and Mangemantin 2006).

The observation that more than 40% of the untenured assistant professors (41% for men; 45% for women) left within a six-year period is somewhat at odds with actual tenure and promotion data provided by the Provost office, which indicate that as many as 91% of those faculty submitting tenure and promotion files were actually granted tenure and promoted to associate professor (L. Smith, Personal communication before USU Faculty Senate on 1 May 2017). This would suggest that attrition of untenured faculty occurred well before the tenure decision point, and that faculty may have been “advised
out” of USU. This is especially acute for women, as nearly three-quarter of the losses of women faculty in STEM occur in the junior faculty ranks. Thus, current institutional conditions at the onset (hiring as assistant professors mainly) and within in the first five years in the academic career (pre-tenure attrition) do not seem conducive for achieving gender parity at higher ranks. While these census data are unable to provide insights into causes of pre-tenure attrition, they nevertheless suggest that early career barriers remain in STEM that are likely to reverberate for many years and up the academic ladder. It might therefore be of interest to further investigate the reasons for this early attrition among STEM women faculty.

Also, while USU has made a concerted effort to recruit women into leadership positions, women’s participation in leadership remains inconsistent among the STEM colleges. Women are also notably absent as department heads, which may have repercussions on the career attainment of women faculty within these department. In the business world, there has been increasing recognition of the crucially important role of mid-level managers to the retention of employees and the creation of a positive workplace culture and employee satisfaction (Starner 2016). In academia, department heads closely approximate this mid-level management position. Lack of gender diversity at this nexus of influence, more so than the gender composition of the faculty ranks within STEM colleges, may stifle transformative change towards a more gender-equitable university culture (Acker 2006; Chambliss and Uggen 2000). As noted in Chapter 4, the social proximity of department heads vis-à-vis faculty is important in recognition of scientific achievements and other decisions (e.g., resource access) that may have direct and indirect effects on faculty career trajectory.
CONCLUSION

A process of demographic data collection that was initiated by the ADVANCE project has become institutionalized and, as intended, allows objective assessment of the magnitude of gender gaps in STEM and changes with time. From the USU census data through 2014, it is apparent that STEM colleges have been hiring women faculty at or above availability rates, nearly doubling the number of T&TT women in STEM over a 5-year period when the ADVANCE Project was active (2004-2008). Despite this accelerated hiring rate which continued through 2014, the benefits to the gender distribution in associate and full professor ranks have remained somewhat attenuated. Women are also noticeably absent in mid-level leadership positions. Retention of associate professors and promotion to the highest rank (full professor) remain of considerable concern.

REFERENCES


(https://www.hrdive.com/news/why-middle-managers-are-an-employers-most-important-leaders/425140/)

Table 2.1 Number of tenured and tenure-track faculty (and percent of all T&TT faculty) in all four STEM colleges combined by rank and gender in 2008 and 2014

<table>
<thead>
<tr>
<th>Faculty rank and Gender</th>
<th>2008</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>56 (17%)</td>
<td>52 (16%)</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>80 (25%)</td>
<td>75 (23%)</td>
</tr>
<tr>
<td>Full Professor</td>
<td>128 (39%)</td>
<td>124 (38%)</td>
</tr>
<tr>
<td>WOMEN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>29 (9%)</td>
<td>27 (8%)</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>22 (7%)</td>
<td>29 (9%)</td>
</tr>
<tr>
<td>Full Professor</td>
<td>11 (3%)</td>
<td>19 (6%)</td>
</tr>
<tr>
<td>TOTAL T&amp;TT FACULTY</td>
<td><strong>326</strong></td>
<td><strong>326</strong></td>
</tr>
</tbody>
</table>
Table 2.2 Number of men and women in leadership positions in the four STEM colleges

<table>
<thead>
<tr>
<th>STEM College</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>College of Engineering</td>
<td>10 (77%)</td>
<td>3 (23%)</td>
<td>13</td>
</tr>
<tr>
<td>College of Science</td>
<td>17 (71%)</td>
<td>7 (29%)</td>
<td>24</td>
</tr>
<tr>
<td>Quinney College of Natural Resources</td>
<td>4 (67%)</td>
<td>2 (33%)</td>
<td>6</td>
</tr>
<tr>
<td>College of Agriculture and Applied Sciences</td>
<td>15 (100%)</td>
<td>0 (0%)</td>
<td>15</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>46 (79%)</strong></td>
<td><strong>12 (21%)</strong></td>
<td><strong>58</strong></td>
</tr>
</tbody>
</table>
Figure 2.1 Number of tenure-track women faculty in STEM hired by year of hire, based on faculty present in 2008 AAA census combined with hire data between 2008 and 2014 (open circles).
**Figure 2.2** Relative distribution male and female STEM faculty in 2014 census into non-tenure track and by tenure-track positions.
Figure 2.3 Relative proportion of women among College of Agriculture and Applied Sciences faculty between 2010 and 2014 by tenure status and rank and compared to availability in the respective PhD cohorts.
Figure 2.4 Relative proportion of women among College of Engineering faculty between 2010 and 2014 by tenure status and rank and compared to availability in the respective PhD cohorts.
Figure 2.5 Relative proportion of women among College of Natural Resources faculty between 2010 and 2014 by tenure status and rank and compared to availability in the respective PhD cohorts.
**Figure 2.6** Relative proportion of women among College of Science faculty between 2010 and 2014 by tenure status and rank and compared to availability in the respective PhD cohorts.
Figure 2.7 Number of women faculty in STEM colleges promoted to full professor between 1989 and 2015.
Figure 2.8 Gender distribution in leadership across STEM colleges in 2017.
Figure 2.9 Status change for male (left) and female (right) faculty in STEM colleges between 2008 and 2014 for Assistant Professors (blue), Associate Professors (pink), and Full Professor (green); Color change between 2008 and 2014 indicates either tenure and promotion (blue to pink); promotion to full professor (pink to green) or faculty leaving USU (grey).

Explanation of the numbers and the flow diagrams

**Men Associate (pink):** of 80 Associate professor in 2008, 24 (30%, green) were promoted to full professor, 19 (24%, grey) left, and 37 (46%, pink) stayed in rank; adding 6 new hires and promotion of 32 assistant professors brings total associate professors to 75 in 2014.

**Women Associate (pink):** of 22 Associate professor in 2008, 8 (36%, green) were promoted to full professor, 3 (14%, grey) left; and 11 (50%, pink) stayed in rank; adding 3 new hires and promotion of 15 assistant professors brings total associate professors to 29 in 2014.
CHAPTER 3
UNCLOGGING THE PIPELINE: ADVANCEMENT TO FULL PROFESSOR IN ACADEMIC STEM

INTRODUCTION

Women have been entering academic STEM disciplines in increasing numbers since the 1980s (Burelli 2008), yet they remain underrepresented at the senior ranks (Long and Fox 1995; Valian 1999; Mason, Wolfinger, and Goulden 2013; Corbett and Hill 2015). The National Science Foundation (NSF) ADVANCE program was initiated in 2001 with the specific goal of developing strategies to increase the representation and advancement of women in science and engineering. This paper analyzes gender differences in the rate of advancement to full professor within academic STEM at a mid-size public doctoral university in the western US, before and after their participation in the NSF-ADVANCE Program (2003-2008). Using quantitative personnel data augmented with findings from two waves of a faculty climate survey, we investigate the magnitude and longevity of the impact of ADVANCE on mid-career faculty advancement across gender.

The pattern of declining representation of women up the academic STEM ladder is frequently compared to a “leaky pipeline” (Goulden, Mason, and Frasch 2011). Some scholars attribute this progressive filtering of women scientists out of academic STEM solely to supply side factors, such as early self-selection out of science, individual career choices away from academia, lack of motivation, or lower success by women (Ceci and Williams 2011; Ceci et al. 2014). An alternative metaphor, that of the “clogged pipeline”,
might be more apt in describing the slower upward mobility of mid-career women. Due to structural barriers or institutional practices that create chilly working conditions or put women at an evaluative disadvantage, women’s advancement into these higher ranks is slowed or stalled, causing some to leave academia before reaching full professor rank (Cech and Blair-Loy 2010; Goulden et al. 2011; Corbett and Hill 2015). If significant gender gaps in mid-career advancement indeed exist, they are particularly puzzling since women scientists possess the human capital to be hired (Glass and Minotte 2010; Williams and Ceci 2015) and have successfully navigated the tenure process – the first critical gatekeeping event where significant faculty attrition takes place (Ceci et al. 2014).

Creating a balanced gender representation at all levels in STEM is important as it contributes to diversity of thinking and innovation in the sciences (Rosser 2004; Corbett and Hill 2015). Women’s advancement also maintains our scientific competitiveness worldwide, by providing role models that entice young talent, especially underrepresented groups, to become part of the domestic, highly trained, scientific labor force (Rosser 2004; Goulden et al. 2011). Within academia, career support for women faculty at all ranks also serves as an important mechanism for achieving gender equity in leadership and administrative positions as administrators are drawn from among tenure-track faculty ranks. This in turn engenders diversity in thinking and management style, instrumental in the recruitment and retention of a diverse faculty corps.

With a few exceptions (e.g., Sabatier, Carrere, and Mangematin 2006; van den Brink and Benschop 2011), the majority of studies on gender gaps in career attainment within academic STEM have focused on early-career, particularly personal challenges and institutional barriers to women faculty’s success in attaining tenure (e.g., Goulden et
There has been much less focus on mid-career dynamics and potential gender gaps in the promotion to full professor, especially for the US. This remains a critical component in understanding factors that promote or foil gender equality in academia. The objective of this paper is to fill this knowledge gap by conducting a quantitative analysis of gender differences in the average time to promotion from associate to full professor at a single doctoral university in the western U.S. before and after the implementation of the NSF-funded ADVANCE project. We were particularly interested to determine (i) the existence and size of the gender gap in career advancement prior to ADVANCE and (ii) whether there was a lasting post-ADVANCE impact on mid-career mobility for women. While this paper relies on institution-specific data, it provides valuable insights into what institutional practices are effective in mitigating gender differences in career attainment among STEM faculty and yielding positive outcomes that are sustainable in the long term. Thus, our findings can provide guidance to other universities that face similar challenges.

The underrepresentation of women across ranks in academic STEM is undisputed, but potential causes for this phenomenon or the best approach to normalize women’s movement up the academic ladder are still the subject of considerable debate. One viewpoint, framed around the belief in academia as an objective gender-blind meritocracy, focuses on innate individual traits or personal choices and decisions (e.g., family formation) to explain divergent career outcomes, without considering the institutional context that may influence these choices and career trajectories (e.g., Ceci et al. 2014). Scientific achievement, the cornerstone of academic success, according to this point of view, is judged against objective criteria and with quantitative metrics,
irrespective of gender. If some women are less successful, it is because they are simply less productive, divert their attentions elsewhere, or choose to not fully commit to their careers (Ceci et al. 2014). When controlling for productivity and personal or family characteristics, there is no evidence of gender bias in academic career attainment (Ceci et al. 2014). According to this “women as deficient” model, to fix the problem, we need to fix the women (Rosser 2004).

Of course, meritocracy as a concept in itself is vulnerable to critique as the reliance on seemingly “objective” criteria in the evaluations of a scientist’s cumulative accomplishments does not automatically translate into gender-neutral decisions (Acker 2006). Universities are gendered organizations in that judgments on what constitutes scientific quality or what activities are deemed valuable often reflect implicit bias along gender lines (van den Brink and Benschop 2011). The image of the ideal scientist continues to be framed around largely masculine characteristics, such as competitiveness and complete dedication to the job, yet are presented as gender-neutral (Acker 1990; Cech and Blair-Loy 2010) and put women at an evaluative disadvantage as lacking competence or commitment. It is thus not uncommon to find statements in the STEM literature regarding the lower productivity of women (see citations in Leahey 2007 and Ceci et al. 2014), which are then invoked as a supply-side explanation for slower advancement (Ceci et al. 2014). Such claims often lack further exploration of structural or institutional conditions that may have caused differences in productivity between men and women faculty, such as academic division of labor and high demands for non-research activities, exclusion from information and collaboration networks, or limited mobility due to family obligations (Rosser 2004).
In recent years, however, there is an increasing recognition that institutional barriers have prevented women from having a level playing field, and that reduced level of participation of women in the upper levels of academia is less the result of their individual failure than a consequence of systemic barriers present within academic settings (Rosser 2004). The NSF ADVANCE Program, which supported research into the recruitment and retention of women in STEM, reflects this sea change in perspective at the national level. The program was initiated in 2001 specifically to clarify structural barriers and seek institutional solutions to the underrepresentation of women in the STEM disciplines.

THE ADVANCE PROGRAM

Among the various goals of the NSF-ADVANCE project at our university (2003-2008), three aspects were particularly pertinent to the mid-career advancement issue: (1) data transparency, i.e., development of a demographic database to provide an objective and tractable record of gender distribution among faculty ranks over time; (2) awareness and intervention through workshops, panel discussion, and departmental meetings – sanctioned by the university administration – intended to provide information to all faculty on the promotion process; and (3) policy changes in the faculty code clarifying post-tenure review.

The ADVANCE team was instrumental in compiling and digitizing the initial faculty database in 2007 for STEM, as no centralized accessible digital database of university personnel was available prior to this date. Maintenance and annual update of this university-wide data base has been institutionalized and is now under the purview of
the Office of Analysis, Assessment and Accreditation (AAA). The centralized collection,
maintenance, and annual update of this data base has enabled objective reporting of the
proportion of women (and minorities) in various tenure and non-tenure track faculty and
leadership positions, and has allowed us to quantify longitudinal changes in faculty
composition. Data tracking and access has been identified as one of the key elements in
the sustainability of the programs towards institutional transformation (Rosser and
Chameau 2006).

A second component of the ADVANCE project focused on improving tenure and
promotion processes by creating greater transparency in institutional practices. Codified
university policy at this university – hereafter referred to as ”faculty code”– clearly
outlines processes and procedures for tenure, but remained obscure on promotion, often
resulting in faculty confusion. Information on initiation of post-tenure review and the
steps towards promotion to full professor were less formalized and were conveyed mostly
informally through (largely male) friendship networks, rather than systematically to all
faculty. The ADVANCE team discovered this deficit through interviews with STEM
women who expressed frustration about the opaqueness of the promotion process. The
ADVANCE team conducted faculty climate surveys that focused on identifying
perceived barriers to faculty promotion. In addition, departmental and university-wide
workshops and panel discussions were held to provide information to all faculty on
expectations and actual steps in the promotion process, thus creating much-needed
transparency especially with respect to the promotion to full professor.

During the funding period and as a result of the ADVANCE team members’
effort with the faculty senate, faculty code changes were implemented (2005) that more
clearly codified the post-tenure review procedures. Specifically, the faculty code now stipulates that no later than three years after tenure (or earlier at the request of tenured faculty member), a post-tenure review committee must be assigned to each faculty member to evaluate progress and “consider recommendation for promotion.” This formalization of the post-tenure review timeline ensures that accomplishments of all tenured faculty are reviewed in a timely manner and that evaluations of faculty portfolios are framed within the context of potential promotion.

METHODS

The study used secondary faculty data (AAA census data) for 2008 and 2014, including college, gender, date and rank at hire, as well as year of tenure and promotion, and date of promotion to full professor. During the ADVANCE project, promotion rates prior to 2008 were extracted from personnel files. In addition, the provost office provided an anonymized list of promotions to full professor by college between 2008 and 2015, which also included gender, date and rank at hire, and year of tenure. The 2008 census data was used retrospectively, in that we examined the past career trajectory of those faculty who were listed as full professors in the 2008 ADVANCE/AAA census. It could not, by its very nature (static snapshot), provide any information on promotion dynamics of faculty who had left the university prior to 2008. Those faculty who were full professors in the 2008 census are considered to have been promoted using the pre-ADVANCE institutional practices in faculty promotions. The 2014 census and the 2008-2015 promotion data were used to reflect post-ADVANCE institutional practices as they pertained to the promotion to full professor.
Because data on entire faculty populations (census data) were used, rather than samples, averages were calculated by gender and reported at face value, rather than being analyzed statistically. Furthermore, variability (range) in the data on time in associate rank until promotion to full professor was in itself pertinent to illustrate the level of consistency in the promotion process and changes over time. All data was analyzed using SPSS (Version 21).

In fall 2016, an online Qualtrics survey was distributed to all faculty in the colleges of Science, Natural Resources and Engineering that included demographic information and core work climate-related questions from the previous ADVANCE surveys. In addition, tenured faculty were queried on their perceptions of the promotion process to full professor. The overall response rate was 50% (n=131), but after retaining only those participants who had completed the entire survey and specifically identified their gender, response rate was 32%. The survey population was comprised of 19% non-tenure track faculty, 25% untenured faculty, 17% associate professors, and 39% full professor, capturing around 28% of the tenured faculty in the three colleges. Men and women respondents were represented in a two to one ratio overall and in all ranks, except for non-tenure track faculty, which were more evenly distributed by gender.

RESULTS

Status of women

The first wave of women hires within STEM colleges took place between 1988 and 1995 (see Chapter 2; Figure 2.1). In the 2008 census there were a total 264 male and 62 female tenure-track and tenured faculty (TT&T) in STEM. Women represented less
than 20% TT&T faculty in the STEM colleges at the university, with only 3% of STEM women faculty holding the rank of full professor. In 2008 the ratio of men over women in this rank was 12 to 1 (Figure 3.1). By 2014, the total number of women STEM faculty had increased to 75 (vs. 251 men), representing 23% of all STEM TT&T faculty, with increases mostly in the rank of associate professor (22 in 2008 to 29 in 2014) and full professor (11 in 2008 to 19 in 2014).

*Time as associate until promotion to full professor*

Retrospective analysis of the 2008 census data indicates inconsistent mid-career trajectories for all STEM faculty, and a large gender gap in the time as associate professor until promotion to full professor. While it took men on average 6.5 years as associate professor to be promoted to full professor (range 1-22 years), women on average took more than two years longer (mean 8.75 years, range 4-12 years). Cumulative distributions of time in associate professor rank by gender (Figure 3.2) show that 41% of male associate professors were promoted to full professor within 5 years of being tenured, while only 25% of the female associate professors had attained the rank of full professor by that time. The majority (81%) of men but only a little over one-third (37% for) of women had been promoted after 8 years in the associate professor rank. Characteristic of the pre-ADVANCE cohort was the large variability in time to promotion for both men and women, suggesting a highly inconsistent promotion process.

One possible mechanism that may have contributed to this variability within and between gender groups is the rank at hire and associated employment-related negotiations. Indeed, faculty who started their university appointment as associate


professors took significantly less time until promotion to full (Mean = 5 years, median = 4 years when hired as associate professor vs. mean = 7 years, median = 6 years for those hired as assistant professor; Kruskall-Wallis non-parametric test at p<0.05). The 2008 census data revealed that all but two women faculty (who were originally hired in administrative ranks) had started their appointment as assistant professors, while hiring rank was more variable among male STEM faculty. Consequently, rank at hire constituted an indirect gender effect on career advancement.

Few women were promoted to full professor prior to 2003 (see Chapter 2; Figure 2.7). This partly reflected the relative scarcity of eligible women faculty hired before the late 1980s. However, there were at least six faculty women who had been hired prior to 1991, and should have been under consideration for promotion (assuming “normal” 6 years pre-tenure and 6 years as associate professor). It is noteworthy that by 2008 these women had still not reached the full professor rank, despite faculty appointments spanning 17 to 30 years. Because the full professor population in 2008 likely reflected past legacies and potential variability in procedures over time, a direct gender comparison was made by year of hire (Figure 3.3). Once again, this comparison revealed high variability in STEM faculty promotion outcomes, both for women and men. The data also showed that within the same hire cohort, the average time from associate to full professor was always longer for women compared to men.

Promotions of women to full professor started to occur more frequently and at higher rates with the onset of the ADVANCE project, and this trend has continued through the present (see Chapter 2; Figure 2.7). Since 2008, men and women have been promoted in roughly a two to one ratio (33 men vs. 16 women). There has been a decline
in variability in career outcomes for all faculty and a closing of the gender gap (Figure 3.4), especially for the more recent hires. For those promoted since 2008, average time as associate professor was just under 9 years for both men and women (median 7 years for men; 8 years for women). After parsing out the 25\% that were hired prior to 1996 – considered pre-ADVANCE legacies given the time since hire was greater than 12 years and these faculty should reasonably have been considered for promotion – patterns were even more favorable. The average time as associate until promotion to full professor was 13 years from women (range 10-18 years) and 15 years for men (range 11-25 years) in the legacy group. The more recent hires (i.e., those hired since 1996) have been moving through the process more swiftly and consistently (on average in 7 years) and any gender gap has disappeared for these cohorts (median 7 years for women, range 5-9 years; median 6 years for men, range 3-14 years) (Figure 3.4). The changes in promotion dynamics between 2008 and 2014 resulted in a doubling of the number of female full professors in STEM (from 3\% to 6\% of TT&T faculty), such that the ratio of male to female full professors is now 6.5 to 1 (Figure 3.1).

Past legacies and changes in promotion dynamics are further illustrated in overall time to promotion (years in assistant and associate professor rank combined) before, during and after the ADVANCE program. The period prior to 2003 (before ADVANCE) reflects a male-dominated legacy, with more than two thirds of the (male) faculty promoted to full professor within 12 years of being hired, and only 31 \% of the men taking longer to achieve that rank (Table 3.1). During and following ADVANCE, promotion standards were raised and portfolios were scrutinized more systematically. This resulted in some men moving through the process more slowly, such that less than
half of the men (vs. 69% previously) were promoted to full professor in less than 12 years after starting employment at the university, while those taking longer increased to 50% (from 31% previously). On the other hand, only one-quarter of women achieving full professor rank have done so within 12 years of being hired (22% of women for during the period 2003-2008; 29% of women after 2008), while the majority of women typically take longer (Table 3.1).

**Women’s perception of the institutional climate**

The 2016 climate survey indicated significant improvement in women’s attitude vis-à-vis the climate at the university compared to similar surveys conducted at the onset or immediately after the ADVANCE project (Figure 3.5). The majority of the women expressed job satisfaction (87%) and indicated that they felt valued (74%), fit in their respective departments (65%) and felt they regularly received all important information needed to conduct their work. This represented a 20% increase in positive responses compared to the pre-ADVANCE survey. Fewer women reported being excluded from informal networks (44% in 2003 vs. 26% in 2016). In addition, metrics signifying distrust or disappointment with the university, such a frustration over their treatment, anger, or feelings that promises had not been kept, simultaneously declined and virtually disappeared (< 5% of women respondents).

**Faculty perception of the promotion process**

In 2016, almost a decade after the ADVANCE project came to an end, the majority of all tenured faculty (64%) agreed that guidelines, criteria, and expectations related to the promotion process had generally been communicated clearly to them.
There was no significant difference in response by rank ($\chi^2=0.443$, $p=0.382$) or gender ($\chi^2=0.000$, $p=0.647$). Furthermore, over 80% of the male faculty indicated that guidelines to promotion, committee formation, standards of excellence and portfolio preparation were clearly communicated by their respective departments. The proportion of women responding positively (i.e., selecting “extremely clearly” and “somewhat clearly”) to questions related the promotion guidelines, committee formation, standards of excellence and binder preparation were slightly lower (ranging from 57% to 79% of tenured women) but these gender differences were not statistically significant. There were statistically significant differences in response distribution between associate and full professors, with the latter more frequently selecting “extremely clearly”, whereas associate professors were slightly more judicious in their responses, selecting “somewhat clearly,” 45-55% of the time (promotion guidelines: $\chi^2=13.548$, $p=0.004$; committee formation: $\chi^2=13.548$, $p=0.004$; standards of excellence: $\chi^2=8.141$, $p=0.087$; binder preparation: $\chi^2=2.036$, $p=0.565$). Nevertheless, almost all associate professors in the survey (87% of men and 80% of women) indicated intent to go up for promotion and a similar proportion (71% of men and 75% of women) expressed confidence in a successful outcome (i.e., responded “confident” or “very confident”), with women actually expressing greater confidence (75% of women selected “very confident” vs. 27% of the men). None of the above patterns were significantly influenced by gender of the faculty.

DISCUSSION

The initial climate survey conducted in 2003 by the ADVANCE team into the perceived barriers to career attainment among all STEM faculty revealed the mediating
effect of departmental climate in the lower job satisfaction of women faculty (Callister 2006). In particular, confusion about promotion criteria and process (Fox and Colatrella 2006) or lack of access to information (Hult, Sullivan, and Callister 2006) have been documented as causes for lower job satisfaction and career attainment for women faculty in STEM. This study shows significant post-ADVANCE improvement in women’s perception of the academic climate for advancement and provides evidence of positive feelings towards and confidence in the promotion process by the majority of tenured faculty, irrespective of gender.

The institutional practices prior to 2008 lead to inconsistent outcomes for both men and women, as indicated by the large variability in time to promotion to full professor. It also clearly disadvantaged women faculty, as it took longer for them to be considered for promotion. The first women moving through the ranks were largely in token positions within their respective departments, which is often associated with hyperscrutiny and negative evaluation bias (Kanter 1977), such that women have to work harder and accomplish more in order to be recognized compared to their similarly positioned males colleagues (Rosser 2004). Exclusion from critical information networks and the lack of senior role models further contributes to women being overlooked as potential candidates for promotion in the absence of clear guidance on process and timeline (Rosser 2004). An empirical study by Roos and Gatta (2009), combining personnel data with faculty interviews, reported similar large inequities and subtle gender discrimination in the promotion process, as (some) men but not women were encouraged to seek early promotion. This dynamic is suggested in our study by the observation that the majority of men promoted to full professor prior to 2003 did so in less than 12 years
after being hired. A study in France further showed that being overlooked and lingering in rank tends to reduce one’s chances of future promotion to professor (Sabatier et al. 2006). The initial focus of the ADVANCE project was to move some of these legacies through the process.

The impact of gender differences in the rank at hire on subsequent career trajectories have also been documented in other universities (Roos and Gatta 2009) and research institutions (Sabatier et al. 2006). Merton (1973) refers to this dynamic as the “Matthew effect”, the self-reinforcing process that increases inequality, when higher-status individuals (generally men) are given the benefit of the doubt and accrue more recognition for their scientific contributions than lower status individuals. Conversely, similarly situated women, according to Valian (1999) tend to accumulate disadvantages. These tendencies underscore the crucial role of early career recognition (and decision at hire point) to a scientist’s future success via the positive feedback between status, resource access, and subsequent productivity (DiPrete and Eirich 2006). Several empirical studies in STEM have documented that men often have greater access to institutional resources and support (Rosser 2004; Duch et al. 2012; Ceci et al. 2014) and such differences in resource allocation can present indirectly as gender differences in career trajectory (Roos and Gatta 2009). When there is a high level of ambiguity during pre-hire negotiations, gender gaps in outcomes tend to be more pronounced (Bowles, Babcock, and McGinn 2005). Women often find themselves at a disadvantage, as they cannot negotiate their start-up packages with the same vigor as their male counterpart as agentic women who adopt more normative masculine behaviors in order to succeed are often perceived negatively (Rudman and Glick 2001; Williams and Dempsey 2014), may
be considered less competent, even if equally qualified (Ridgeway 1991; Coate and Howson 2016) and receive more negative evaluations with respect to hirability (Rudman 1998; Rudman and Glick 2001) or overall job performance (Valian 1999). Men are not similarly constrained and therefore can accrue more resources at the onset of their academic career.

The ADVANCE project had a positive effect on the number of women hired within STEM (Hult, Sullivan, and Callister. 2008; see Chapter 2). By 2014, the relative proportion of women was at availability for associate professors and at or above availability for assistant professors, based on the gender composition of the respective discipline-specific cohorts of PhD recipients (Burelli 2008; see Chapter 2). This had a twofold positive effect on the mid-career dynamics for women: (1) women were no longer in token positions and (2) the pool of women eligible for promotion increased gradually over time. However, increased representation of minorities by itself is insufficient as a transforming force (Acker 1990). Thus, the additional efforts of by the ADVANCE team in transforming institutional climate were critical.

The presence of the ADVANCE team on campus made the issue of gender inequality more visible by collecting and making transparent demographic and promotion data, in line with the recommendations for sustainable impact by Rosser and Chameau (2006), who identified data collection and access as a crucial step towards institutional change, by objectively documenting the need for changing institutional policies and practices. The faculty data at this university are now updated annually and the process of data collection and visualization has become institutionalized.
The 2003 climate survey revealed the critical role of departmental climate in job satisfaction, especially among women in STEM (Callister 2006). Specifically, lack of access to information was cited by women faculty as one cause for lower job satisfaction (Hult et al. 2006). The workshops and dialogues on campus transformed the process of informal and inconsistent information transfer to the privileged network-connected and those “in the know” into a more objective and egalitarian information flow. These efforts also created greater transparency in expectations and promotion procedures that seemed to have had an overall positive influence on the promotion trajectories, both in terms of overall reduction in the length of time until promotion to full for all STEM faculty, as well as in reducing differences in career attainment between male and female STEM faculty. These workshops are still ongoing, albeit at lower intensity and frequency than during the ADVANCE program, but are now largely organized by the university administration (provost office), and thus have become institutionalized.

While these information transfer sessions were instrumental in alleviating faculty anxiety and improving morale, enduring changes in promotion dynamics were achieved through faculty code language in 2005 that systematized the process of post-tenure review, and clarified the faculty’s right to such review. After a transition period, during which STEM college administrators were accountable through queries by ADVANCE team members about the relative compliance with the requirement of post-tenure review within three years, this codified procedure is now routinely implemented across colleges, although compliance is not universal. Consistent with the literature (Reskin 2000; Fox and Colatrella 2006), this study indicates that greater transparency, accountability, and formalization in the post-tenure review process initiated by ADVANCE improved the
promotion outcomes for both men and women and also significantly reduced the gender gap. In other words, the codification of procedures and responsibilities neutralized the subjectivity stemming from variable departmental climates. Analysis of the 2016 faculty survey on workplace climate seems to confirm greater overall job satisfaction of women faculty and a positive attitude towards the promotion process among all tenured STEM faculty. This study demonstrates that long-lasting improvements in the upwards mobility for women in STEM was achieved by ADVANCE through a combination of three factors: (1) greater transparency in the institutional expectations and necessary steps towards promotion, (2) reduced barriers to information flow, and (3) standardization and codification of the process.

CONCLUSIONS AND IMPLICATIONS

On the basis of faculty demographics and promotion data between 2008 and 2014 linked to multiple waves of climate surveys, this study was able to demonstrate the impact of the ADVANCE project on the mid-career upward mobility of women faculty in STEM. While the fact that data were collected at a single university can be construed as a limitation, the demographics of this institution are very similar to that of other doctoral research universities (AAUW 2010; Corbett and Hill 2015). Furthermore, Rosser (2004) showed that while different institutions of higher education (IHE) and disciplines may have their particular cultures, women faculty in STEM have remained surprisingly consistent in their response about barriers and challenges to their respective academic career, despite institutional variability. Therefore, we think that our results are not unique and should mirror experiences at other IHEs. More importantly, insights into how
effective and sustainable changes in promotion practices can be achieved should be useful to other IHEs.

What this study showed is that variability in promotion outcomes was not a gender issue *per se*, and a program aimed at improving working environment for women faculty, in fact benefited all faculty, irrespective of their gender. More importantly, it had a transformative and lasting influence on institutional practices. As institutional climate matters to job satisfaction (Callister 2006) and career outcomes for women in STEM (Valian 1999; Rosser 2004), the critical question becomes “How can lasting changes in academic climate be achieved?” The effectiveness and sustainability of this ADVANCE project was in part achieved by adhering to many of the recommendations outlined by Rosser and Chameau (2006), including the buy-in and involvement into the process by university administration, and subsequent institutionalization of many of the project activities (e.g., data collection, information dissemination). The longevity of the program’s success rests on two essential components: (1) it created greater awareness of actual gender gaps (by collecting quantitative data) and clarified expectations of promotion (through information workshops); and (2) it put in place policies that translated these findings into objective and enforceable action items. While the first step was essential in making problems visible and creating greater gender sensitivity at departmental and college levels (at least temporarily), this in itself can prove ineffective in achieving gender equity if not associated with structural (i.e., policy) changes (Kalev, Dobbin, and Kelly 2006).

This ADVANCE project had a transformative and lasting influence on the institutional promotion practices, despite the modest funding size of the “Promotion to
Full Professor” program component, by responding to institution-specific conditions. The project first identified the specific obstacles to the career success of women within the context of the institution and then worked on removing sources of inequality appropriate for the institution. In this case, it occurred through modification in the faculty code, the locus of all personnel procedures at this particular university. Institutional policies and procedures likely differ among IHEs. Yet, the fundamental principles of this project can be applied elsewhere. Key is to identify what (if any) aspect of the promotion process is opaque (e.g., timeline/responsibility for initiation, expectations), what potential obstacles or sources of inequality exist in the path to promotion (e.g., is review automatic or opt-in), and where control over implementation of these promotion procedures resides (e.g., faculty code; administrative procedures manuals). Within the institution-specific governance structure, efforts can then be focused on creating greater clarity and accountability especially to higher levels in the institutional hierarchy (Goodwin, Operario, and Fiske 1998) when and where it is needed, and implementing necessary changes at the appropriate level within the institution.

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**Table 3.1** Distribution of men and women faculty by total years between date of hire and promotion to full professor before, during and after the ADVANCE project.

<table>
<thead>
<tr>
<th>Total years until promotion to full</th>
<th>Prior to 2003*</th>
<th>2003-2008</th>
<th>After 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 12 years</td>
<td>53 (69%)#$</td>
<td>12 (43%)</td>
<td>15 (45%)</td>
</tr>
<tr>
<td>&gt;12 years</td>
<td>24 (31%)</td>
<td>16 (57%)</td>
<td>18 (55%)</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 12 years</td>
<td>2</td>
<td>2 (22%)#$</td>
<td>4 (29%)</td>
</tr>
<tr>
<td>&gt;12 years</td>
<td>0</td>
<td>7 (78%)</td>
<td>10 (71%)</td>
</tr>
</tbody>
</table>

(*) promotion rates prior to 2003 are for faculty in the 2008 census
(#$) does not include faculty hired at full professor rank
Figure 3.1 Distribution of STEM faculty by rank and gender in 2008 and 2014 census.
Figure 3.2 Cumulative distribution of number of years in associate professor rank prior to promotion for men and women in STEM who were full professors in 2008.
Figure 3.3 Average time (in years) in associate professor rank until promotion by appointment year at university for men and women who were full professor in 2008 (n=1 for women except in 1993 hire year, where n=2).
Figure 3.4 Average time (in years) in associate professor rank until promotion by year appointment at university for men and women promoted between 2008 and 2015.
Figure 3.5 Percentage of women faculty who agreed with the statements (selected “strongly agree” or “agree”) in the 2003, 2011 and 2016 faculty climate survey.
CHAPTER 4

IS RECOGNITION THROUGH AWARDS A SOURCE OF GENDER INEQUALITY IN ACADEMIC STEM?

INTRODUCTION

Women have entered careers in academic STEM (Science, Technology, Engineering, Mathematics) disciplines in increasing numbers since the 1980s (Burelli 2008), yet remain underrepresented at senior ranks (Long and Fox 1995; Valian 1999; Mason, Wolfinger, and Goulden 2013). While legally shielded from overt discrimination, women encounter male-dominated work environments marked by intense competition for and uneven distribution of available scientific resources (Preston 1995), and a pronounced “winner-take-all” ethos based on reputation and prestige of institutions and individual faculty (Frank and Cook 1995). Women scientists still advance more slowly than their male counterparts (Long and Fox 1995; Valian 1999; Mason et al. 2013) and leave science at double the rates of their male colleagues (Preston 1995). Scholars still disagree on the causes for this phenomenon. This study explores the awards history at a mid-size public doctoral university in the western U.S. and investigates whether recognition through awards it is a source of gender inequality with repercussions on career success.

Some scholars attribute the declining representation of women up the academic ladder, often likened to a leaky pipeline (Goulden, Mason, and Frasch 2011), solely to supply side factors and posit that academia is meritocratic and that the unequal career attainment between men and women largely reflects personal traits or choices (Ceci and
Williams 2011; Ceci et al. 2014). According to this viewpoint, women are less successful because they are less productive (Fox 2005; Leahy 2007; Ceci et al. 2014) – although this contention is not undisputed (Cameron, White, and Grey 2016) – they divert their attentions elsewhere, or chose to not fully commit to their careers (Ceci et al. 2014). Such claims, which are prevalent in the STEM literature, seem too simplistic as they often lack any exploration of structural barriers underlying these gender differences in productivity, such as academic division of labor and high demands for non-research activities (Burke and Lauenroth 1997; Misra et al. 2011; Mason et al. 2013), exclusion from critical information and collaboration networks, or limited mobility due to family obligations (Rosser 2004; Dean and Koster 2014).

An alternative perspective focusses on gendered institutional practices (Acker 1990; 2006), especially in the assessment of scientific achievement, that systematically disadvantage women relative to their male counterparts, without overt acts of gender discrimination (Valian 1999). Indeed, some scholars assert that the construction of academic excellence – the key element in career advancement within institutions that espouse objectivity, gender neutrality and meritocracy – masks a complex structure of interconnected processes that are highly gendered and infused with subjectivity (Roos and Gatta 2009; van den Brink and Benschop 2011; Coate and Howson 2016). Despite a strong faith in meritocracy (Ceci et al. 2014) and objective rationality (Blickenstaff 2005), scientists are socialized to view masculine behavior as more professional (Rhoton 2011). Visibility and reputation – based on the perception of others not necessarily reflecting objective measures of skill or productivity by the individual – frequently emerge as cornerstones in the construction of excellence (e.g., Fox and Colatrella 2006;
van den Brink and Benschop 2011). The bestowing of awards is one mechanism that signals status and prestige within the scientific community. It is based on the perception by others of that individual’s contribution to the advancement of science, and therefore subject to cognitive bias and homosocial reproduction by men who still dominate many STEM disciplines. This places women at an evaluative disadvantage both at the level of nomination and final selection (e.g., Holmes et al. 2011; Hurley 2014). Inequality in awards allocation is not without career consequences, as a positive feedback exists between recognition, resource access, and future productivity (DiPrete and Eirich 2006). The selectivity of awards recognition can thus stifle the upward career mobility of low-status individuals, either directly, when it is used as a metric of excellence; or indirectly, when it results in uneven access to resources that underpin research output and thus suitability for promotion.

If numeric representation or seniority within the profession were the main drivers in the allocation of awards and honors, we should see a rapid narrowing of the gender gap in scientific awards recognition over the last three decades as more women have entered STEM fields. Global and national awards data, however, do not reflect such temporal trend and present us with a fundamental puzzle: Why do these disparities remain? Out of the 585 Science Nobel prize winners since 1901, only 17 (3%) have been women, with a total of 6 in the last 20 years (4%), of which 5 have been in the last 10 years (7%). Similarly, a comprehensive analysis by the Association for Women in Science (AWIS) in collaboration with several STEM society partners found that while the number of women receiving scholarly awards has increased over time in some societies, the proportion of women recipients is still well below the expected rates based on their academic rank,
their seniority within societies, or even the composition of the nomination pool (Holmes et al. 2011; Lincoln, Pincus, and Leboy 2001; Lincoln et al. 2012; Popejoy and Leboy 2012; Popejoy et al. 2011).

If awards matter in the construction of excellence, and fewer women are recipients of awards recognizing their scientific contributions, then this may constitute a source of gender inequality that negatively affects the upward career trajectory of women. Only within the last decade, have scholars begun to analyze the role of gender bias in formal recognition within discipline-specific professional STEM societies (e.g., Lincoln et al. 2012). Specifically, several studies have shown how evaluations reflect and reinforce seemingly gender neutral processes built around hegemonic male standards that result in the devaluation of women’s achievements in all critical aspects of the construction of excellence, including the selection for national awards (e.g., Monroe et al. 2008; Holmes et al. 2011; Lincoln et al. 2012). Comparatively little information is available on the awards process at the level of a given institution. The objective of this study is to fill this knowledge gap, by combining quantitative institution-level awards data with a faculty survey into perceptions of individual productivity and institutional process to assess whether gender gaps emerge from the awards process. Insights gleaned from this analysis may inform institutional practices that foster greater gender equality and create a supportive work environment for a diverse faculty corps.

Bourdieu’s theory on the struggle for status and the power of symbolic capital in academia and Merton’s Matthew effect, i.e., the disproportionate accumulation of scientific rewards by a selected few on the basis of reputation, are relevant in explaining the emergence of a scientific class structure that distinguishes and privileges high-status,
highly visible scientific elites from so-called “artisans of research.” Neither theory, however, explicitly considers gender as an axis of inequality. In this chapter, we expand the theoretical framework on scientific stratification by linking it to Acker’s theory of gendered organizations to elucidate how the bestowing of awards can reproduce gender inequality that disadvantages women scientists. Indeed, empirical research by the AWIS team (Holmes et al. 2011; Lincoln et al. 2011) suggests that in the absence of structured guidelines, awards committees tend to access gender stereotypes such that men are considered inherently more competent, high-status and deserving of praise for their scientific accomplishments, while women are rewarded for activities that are congruent with feminine nurturing and care labor. Applying these findings to the meso-level of a single institution, this study uses the complete historical record of research and non-research awards at a western doctoral university institution to answer the following research questions: (1) do women receive proportionally fewer awards than their male colleagues? and (2) is there a gender differences in the type of awards granted? Specifically, do women receive proportionally more awards in recognition of (lower-status) non-research activities and fewer awards for highly valued research accomplishments, while men are more dominant as recipients of research awards? In addition, survey responses of tenured faculty are used to elucidate the factors and underlying mechanisms that drive these disparities.

This study is novel in that (1) it focuses on the awards process within a single university i.e., across scientific fields and within the faculty’s home institution where they are typically better known; and (2) takes a multi-methods approach combining quantitative institution-level awards data with a faculty survey to explore potential gender
differences in career attainment. This analysis is expected to advance the field of gender inequality in academia (1) by unpacking one specific aspect in the construction of excellence that lies outside the control of the recipient, and (2) by making visible institutional patterns in the recognition of success and achievement, which are typically construed as positive acts, yet by their selective and exclusive nature, advantage some while disadvantaging others, and can thus affect in career success in divergent ways. The study thus provides insights into institutional practices that promote or foil gender equality in career attainment within academic STEM.

THEORETICAL FRAMEWORK

Within the world of scholarly and intellectual pursuits, academics wield very little economic power. Reputation and prestige are the coin of the realm. Bourdieu (1988; 1989) posits that the world of science and academia, even more so than society at large, presents itself as a symbolic system of difference, organized by and around symbolic power (Bourdieu 1989) derived from prestige, renown and status (Bourdieu 1988). The accumulation of symbolic capital creates and maintains a class of elites whose reputation as valuable and distinct is produced and reproduced through the perception of others. Status and rank imparts greater weight to their judgements and grants those endowed with symbolic capital (i.e., high status scientists) the power to impose their views on what is valuable (Bourdieu 1989), effectively contributing to the reproduction of class hierarchy in the absence of “a genuine institutional criterion of scientific value….in a field that claims to recognize only scientific value” (Bourdieu 1988: 297). Thus, the subjective becomes objectified and officially sanctioned – with scientific prizes one of
the most objectified indices of symbolic capital in academia – and reputation and status are transformed into authority and mistaken for legitimate competence (Bourdieu 1988: 76).

In their studies on the use of bibliometrics to circumscribe excellence, van den Brink and Benschop (2011) and Putnam (2009) invoke Bourdieu’s critique of academic objectivity and impartiality as a myth and his contention that all circles around the power to designate what is valuable. Evaluations frequently have tacit dimensions that are imbued with value judgements, such that scientists with network connections to eminent academics accrue more favorable ratings (van den Brink and Benschop 2011), effectively misrepresenting prestige and status, or the proximity to it, as an indicator of competence. Similarly, the status of publication outlets are routinely used to judge the quality of an individual’s scientific research output, and journal rankings have become a form of symbolic capital that academics collect in their struggle to augment status and reputation (Putnam 2009).

Merton (1973) similarly argues that science as a social institution utilizes an elaborate reward system for varying grades of scientific performance that enhances both individual as well as institutional prestige, but invariably creates prestige strata of scientists among and within fields, which sets into motion a stratified distribution of opportunities and resource access. The very notion of an upper stratum is inherently numerically restrictive and exclusionary, such that some with the prerequisite scientific credentials may nevertheless be excluded from recognition and elite status. More importantly, Merton notes that visibility or recognition of scientific accomplishment, while largely honorific and symbolic in its intent, can in effect be converted into real
assets, such as resources and facilities that are made available to the honoree and act to further enhance that scientist’s future productivity (DiPrete and Eirich 2006). Merton refers to this as the “Matthew effect”, the self-reinforcing process that increases inequality, when eminent scientists accrue more recognition for their scientific contributions than lower status individuals, thus benefitting disproportionately from their high-status position. That same selective dynamic is active in scientific citation, when only the work of a few highly cited, high-status scientists is highlighted, thus increasing the gap between the symbolically rich and symbolically poor (Small 2004).

Both Bourdieu and Merton agree in their assessment of the scientific and academic world as a prestige economy that is inherently unequal and stratified, where – based on the judgement of others – only a select few are allowed into an upper class of highly esteemed and symbolically rich elites, at the exclusion of other competent and deserving individuals. This stratification of position and opportunity, which may influence career trajectory, is reproduced through two mechanisms (1) Bourdieu’s symbolic power granted to elites to define what is valuable, allowing them to set the norms of what accomplishments are considered meritorious and worthy of elite status; and (2) Merton’s Matthew effect, or the unequal distribution of resources among scientific classes, granting high-status elites preferential access to the means of scientific production and opportunities for scientific achievement. Thus, the rich and famous become richer, more famous, and more scientifically influential; and the gap between the scientific elites and the lower status “artisans of research” increases over time, a trend that has not gone unnoticed in the recent scientific literature (e.g., Xie 2014).

Neither theory explicitly considers gender as a dimension of scientific class
stratification and the emergence of scientific elites, however. Yet there is mounting
evidence of the so-called “Mathilda effect” whereby the scientific achievements by
women are systematically overlooked or receive less recognition than those of men
offers valuable insights into the unequal access by men and women to these tokens of
success when cultural hegemonic beliefs about gender differences shape institutional
decisions. There are several gendered processes that are pertinent to the scientific honors
and awards system in STEM and are supported through empirical evidence in the STEM
literature.

Division of labor along gender lines grants more weight or status to tasks and
responsibilities performed by men (Acker 2006). Eveline (2004) coined the term
“elasticity of merit” to signify the subjectivity in what is judged significant and important
scientifically, based for example, on choice of fields, methods utilized, or theoretical
approach to science (Rosser 2004; Roos and Gatta 2009). There is evidence that women
concentrate in certain fields or subfields within STEM that are considered less prestigious
(e.g., life sciences, biology) (Blickenstaff 2005; Burelli 2008) and tend to specialize less
compared to men who are more often active in high-value fields or specialty areas
(Leahey 2007). The Nobel prize categories, for example, reflect these prevalent norms of
high-status science (e.g., Physics, Chemistry, Physiology and Medicine, Economics),
with only two women Nobel laureates in physics (1% of total).

In most doctoral universities, research-related activities receive high priority and
are often given more status than teaching and student mentoring (Eveline 2004; Rosser
2004; Monroe et al. 2008). Befitting the cultural gender norms of women as caring and
nurturing, women faculty frequently take on a considerable service and teaching load in their academic institution, especially when few women are present (Rosser 2004), and these activities are considered lower-status (Mason et al. 2013; Monroe et al. 2008; Misra et al. 2011; Coate and Howson 2016). Some scholars have cited a higher expectation for women to perform non-research tasks and career penalties for doing so (van den Brink and Benschop 2011); others have suggested that women actually prefer performing these tasks (Ceci et al. 2014). Nevertheless, men accrue relative professional advantage by spending significantly more time on research and less time on mentoring and service than women (Ceci et al. 2014). Furthermore, women, have additional domestic responsibilities and may experience reduced work-time flexibility or structural constraints on their mobility, while men can more freely pursue heightened visibility and networking opportunities as they are less burdened by family obligations that impinge on the job (Dean and Koster 2014). As a result of institutional division between high- and low-status labor, women are more likely to receive recognition for service and teaching than for scientific achievement in their professional societies (Holmes et al. 2011).

*Norms of success* further augments the gender division of labor in that we often unconsciously evoke images of success and competence in masculine terms, such as highly skilled, assertive, competitive, and focused on work. As the normative standard for success, male scientists are often judged on their potential for success. They receive micro-advantages earlier in their career (Steinpreis, Anders, and Ritzke 1999; Roos and Gatta 2009), such as negotiated access to more institutional resources and support (Rosser, 2004; Duch et al. 2012) or higher rank at hire (see Chapter 2), that disproportionately augment productive capacity (DiPrete and Eirich 2006), in turn
enhancing their status as successful scientists. There is some empirical evidence that
gender plays a role in the acquisition of research funds that advantages men, both in
terms of success of grant application (van der Lee and Ellemers 2015; but see opposing
stance in Ceci et al. 2014), the size of the grants (Ceci et al. 2014), or even the type of
funding (Rosser 2004). By contrast, similarly situated women must continually prove
their accomplishments are deserving of recognition (Rosser 2004; Roos and Gatta 2009;
Williams and Dempsey 2014) or must work harder to be invited to prestigious positions
(Coate and Howson 2016). The perception of men as more competent is further
augmented by a greater tendency of men to self-promote (Rudman 1998; Coate and
Howson 2016), also expressed through greater self-citation of their published work
(Cameron et al. 2016; King et al. 2016). By contrast, women tend to underplay their
achievements (Valian 1999), show a reluctance to assert themselves and their
achievements (Rudman 1998; Coate and Howson 2016), or cannot negotiate their
academic start-up package with the same vigor as men (Williams and Dempsey 2014)
lest they be perceived negatively (Rudman and Glick 2001). Consequently, they may be
considered less competent, even if equally qualified (Ridgeway 1991; Coate and Howson
2016) and their accomplishments may go unnoticed when research awards are bestowed
(Lincoln et al. 2012).

Institutional logic that appears gender neutral reflects the historical dominance of
men in STEM fields, in that the notion of the ideal scientist continues to be framed
around largely masculine traits. Successful scientists are presented as unemotional,
decisive, objective, aggressive, competitive, and fully dedicated to their work at the
expense of other obligations (Rhoton 2011). Women are considered more emotional, a
trait that aligns better with their service role (Monroe et al. 2008) but is perceived by some as irreconcilable with the notion of a successful scientist (Cech and Blair-Loy 2010; Rhoton 2011). Women’s choices or any deviation from these hidden masculine norms (e.g., part time work, interruption in career path, inability to put in long hours, visible commitments to teaching, mentoring or service-related activities) result in negative judgements of their professional commitment and scientific acumen (Ridgeway 1991; Valian 1999; Risman 2004; Acker 2006). Furthermore, women must walk a fine line between demonstrating sufficient assertiveness to be considered competent without violating prescriptive female niceness (Williams and Dempsey 2014). Agentic women who adopt more normative masculine behaviors in order to succeed (Cech and Blair-Loy 2010; Rhoton 2011) are likely to receive more negative evaluations with respect to hirability (Rudman 1998; Rudman and Glick 2001) or overall job performance (Valian 1999).

Membership in scientific networks allows accumulation of symbolic and social capital that is critical in gaining visibility and recognition of achievement, both in direct and indirect ways (Cech and Blair-Loy 2010; van den Brink and Benschop 2011). The density and range of professional network connections directly augment the metrics of success by increasing the number of co-authored publications (van den Brink and Benschop 2011; Ceci et al. 2014) and citations (Johnson and Oppenheim 2007; van den Brink and Benschop 2011; Nielsen 2016). STEM networks remain highly gendered (Rhoton 2011; Lincoln et al. 2012), and women often find themselves excluded from information-rich professional networks (Rosser 2004). In selecting potential collaborators, colleagues, students or protégés, dominant males show a cognitive
preference for their own sex (homophily) or people who are similar to them (homo-social reproduction) (Valian 1999; McPherson, Smith-Lovin, and Cook 2001; Rosser 2004; van den Brink and Benschop 2011; Sheltzer and Smith 2014), thereby limiting women’s opportunities to access these network benefits (Rosser 2004; van den Brink and Benschop 2011). A recent quantitative analysis of biology labs in the US, for example, found that high-status elite male faculty employ and mentor fewer women as PhD and postdocs than their female counterparts or lesser-known male colleagues (Sheltzer and Smith 2014). Affiliation with high-status elites can also bestow indirect benefits in terms of heightened status (Merton 1973), access to critical information (Rosser 2004), or opportunities for career advancement (van den Brink and Benschop 2011).

Collectively, these processes can introduce implicit gender bias during the nomination and selection for a given award, or in considering candidates suitable for some but not other types of awards. In the AWIS study, homosocial reproduction by men, still the dominant group in STEM, is thought to contribute to the lower nomination rates of women in many science organizations (e.g., Holmes et al. 2011; Hurley 2014) that can, in part, be linked to the underrepresentation of women among the nominators (Holmes et al. 2011; Ball 2014). In other words, lack of representation at the high-status decision-making levels, re-enforces and reproduces gender imbalance in bestowing status within these organizations. Without formal guidelines and transparent rules in the decision making process, evaluators (irrespective of gender) tend to activate cognitive shortcuts that favor men (Holmes et al. 2011; Lincoln et al. 2011). Heavy reliance on letters of recommendation, rather than portfolio analysis or use of structured evaluation forms, further exacerbate this gender bias (Holmes et al. 2011). Content analysis of letters
recommendations reveals longer letters for male nominees containing more status terms and standout adjectives speaking to professional aptitude, whereas letters for women tend to be significantly shorter and highlight personal traits rather than scientific achievement (Trix and Psenka 2003; Schmader, Whitehead, and Wysocki 2007; Holmes et al. 2011) or describe women in more communal than agentic terms, implying lower leadership fitness (Madera, Hebl, and Martin 2009). Overall, women are less likely to receive excellent letters (Dutt et al. 2016). Thus, if the selection committee is looking for clear indicators of scientific excellence in letters of recommendation, they are less likely to find it among women nominees. Conversely and congruent with female stereotypes, the number of women recipients is more in line with the membership demographics of STEM societies for education and service awards (Holmes et al. 2011; Lincoln et al. 2011).

DATA AND METHODS

Awards data

In this analysis we used entire awards record from a public doctoral research university in the western U.S. (n= 591) at the level of the university and for four STEM colleges (Agriculture and Applied Sciences, Engineering, Natural Resources, and Science). Based on the nomination criteria, awards were coded as research or non-research recognition. In one college, the “distinguished professor” award recognized both teaching and research and was assigned 0.5 unit to research and 0.5 unit to the non-research category. Recognition for service was inconsistent among colleges, and only recently initiated at university-level; therefore, that data was not included in this analysis. Awards were coded for gender of the recipients and level of award (university vs.
college). For those years where a particular award was shared between two or more male faculty, recipient gender was coded as male; when it was shared between male and female faculty member, the recipient gender was coded as female. For university-level awards, which are open to all colleges, a distinction was further made between recipients from STEM or non-STEM colleges. The length of the data record differed among awards, among STEM colleges, and between college and university-level awards, with the longest record for the “University Teacher of the Year” (1958-2014) and the shortest for “University Researcher of the Year” (2008-2014). To glean patterns over time, data were aggregated across three time periods: prior to 1995, 1995-2004 and 2005 and onward, reflecting changes in faculty demographics and gender awareness at this university. In the earliest period, women in STEM were largely in token positions, 1995-2004 coincides with a significant increase in the number of women among STEM faculty (Chapter 2), and the most recent period reflects a change in faculty demographics and the impact of climate and policy changes in the wake of the NSF-funded ADVANCE project (2003-2008) towards the recruitment and retention of women in STEM (see Chapter 3).

The ratio of research to non-research awards for male and female recipients was calculated for each calendar year across STEM colleges and then averaged by time period. Because the denominator was zero in some years for women, research awards as a proportions of all awards received by gender was also calculated. Due to the limited number of awards received by women at the university level, research-to-non-research ratios were calculated for each of the three time periods only.
Faculty survey

In Fall 2016, we supplemented the quantitative awards data with an online Qualtrics Survey to faculty in the colleges of Engineering, Natural Resources and Science. The survey contained closed-ended questions addressing basic demographic, career advancements (dates of hire, tenure and promotion; rank at hire), professional activities and metrics of productivity (grants, publications, mentoring, external committees, invited talks). In addition we queried tenured faculty on their perception of institutional policies and processes, including those pertaining to awards nominations. The overall response rate was 50% (n=131), but after retaining only those participants who had completed the entire survey and specifically identified their gender, response rate was 32%. The survey population was comprised of 19% non-tenure track faculty, 25% untenured faculty, 17% associate professors, and 39% full professor, capturing around 28% of the tenured faculty in the three colleges. Men and women respondents were represented in a two to one ratio overall and in all tenure-track ranks. In this analysis, the focus is mostly on questions related to the awards process and perception of standing by leadership and peers.

Statistical analysis

Logistic regression analysis was used to discern gender influences on the distribution of research vs. non-research awards within STEM colleges and at the university level. Because differences in productivity are sometimes invoked as an explanatory variable for gender differences in academic success (see Ceci et al. 2014), we also analyzed self-reported metrics of productivity, including hours work, number and
size of grants, number of publications and graduate students mentored; and metrics of external recognition such external boards or committees and invited talks. All metrics were characterized by a 5-categorical scale. Using the raw data, there was a positive correlation between all metrics used, except hours worked, which was excluded from further analysis. Factor analysis with oblique rotation yielded 2 factors that collectively explained 64% of the variability in productivity among the respondents. Factor 1, comprised of grant metrics, number of graduate students and invited talks (Cronbach \( \alpha = 0.779 \)) was considered indicative of resource input and status, and was combined into single “resource and status” score; Factor 2 comprised of number of publications, number of graduate students, invited talks and outside committees (Cronbach \( \alpha = 0.729 \)) reflected tangible outputs and was combined into an “output” score. T-tests were used to detect gender differences in the original and combined productivity metrics. All data was analyzed with SPSS (Version 21).

RESULTS

*STEM college awards*

Across all STEM colleges and dates, women have received a total of 66 out of 429 (~15%) awards. Prior to 1995, women received < 4% of the STEM college awards (research or non-research awards), with 1989 marking the first year for a woman in STEM to receive a college-level award. This pattern likely reflects the underrepresentation of women among STEM faculty, especially at the mid-career and senior level. The 2008 university faculty census data confirm that prior to 1990, the STEM colleges combined counted less than 10 women among the faculty. The number
of women faculty in STEM colleges has steadily increased since then, and in 2014, 27% of all STEM faculty and 23% of tenured and tenure-track STEM faculty were women (see Chapter 2). The relative proportion of women receiving awards has also increased over time, but more so for non-research than research awards (Figure 4.1; Table 4.1). Over the last 10 years, almost 26% of the non-research awards have gone to women faculty, approaching their demographic representation in STEM. The rate of increase has been slower for research awards (10% in 1995-2004 vs. 16% in last 10 years) but has not kept pace with growing number of women in the STEM faculty ranks (Figure 4.1).

For both men and women faculty, the ratio of research to non-research awards was less than 1, indicating a greater number of non-research honors awarded in the STEM colleges (Table 4.1). Men received research and non-research awards in a 1:2 ratio; i.e., on average one third of the awards received by men were in recognition of research achievements. That ratio always remained lower for women faculty, ranging from 1:6 to 1:5 over the last 20 years. While the $\chi^2$ tests and logistical regression by period and across the entire data set does not support a statistically significant gender influence on the type of awards received, residual error ($z$) of -1.1 (2005-2014), -1.0 (1995-2004), and -1.2 (entire period) for women faculty suggests that they received research awards at slightly lower than expected rates. Odds were slightly higher for men [odds ratio (exp(B)) of 1.947 (2005-2014), 2.515 (1995-2004), and 1.740 (entire period)], suggesting they were nearly twice as likely to receive research awards. When data were broken down to specific awards, women were recognized as undergraduate mentor of the year significantly more frequently than expected across the entire period of record. [$z = +3.5$ and $\chi^2(1)=17.62$ (p<0.003)].
University awards

Of the 160 university awards, 19% went to women faculty and 55% STEM faculty, slightly above the proportion of STEM faculty at the university (46% of all faculty). Consistent with the college awards data and university demographics, women comprised an increasing percentage of the STEM faculty recipients over time: 7% (prior to 1995), 17% (1995-2004) and 20% (2004 onward). This remained lower than for non-STEM disciplines where 12% (prior to 1995), 43% (1995-2004) and 22% (2004 onward) of the faculty award recipients have been women. At the university level and among the STEM recipients, men received research vs. non-research awards in almost equal proportion (40 research vs. 35 non-research awards; average ratio of 1.14), but in the last 10 years the ratio of research over non-research has gone up even further (17 research vs. 11 non-research awards; average ratio of 1.55) (Table 4.1). In contrast, women have remained markedly under-represented as recipients of research awards. Across the entire data record, only 2 STEM and 2 non-STEM faculty women have been recognized for their research achievements at the university level. This suggests that the under-recognition of research achievements of women faculty is not solely an issue in STEM disciplines, but may indeed be more systemic. There was a statistically significant gender effect on the awards distribution at the university level [$\chi^2(1)=10.932$ (p=0.001) for 2005-2014; $\chi^2(1)=5.047$ (p=0.025) for 1995-2004; and $\chi^2(1)=10.885$ (p=0.001) for the

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2 In 2017, a female faculty in Psychology received D. Wynne Thorne career research award
3 Absence of awards data for non-STEM colleges does not allow extrapolation to the college-level.
entire period], with women in receiving research award at rates lower than expected [residual error (z) of -1.9 (2005-2014), -1.4 (1995-2004), and -2.2 (entire period)] and non-research awards at rates higher than expected [z of +2.0 (2005-2014), and +1.7 (entire period). This pattern was most pronounced among STEM faculty recipients \( \chi^2(1)=7.001 \) (p=0.008) for entire period vs. \( \chi^2(1)=2.335 \) (p=0.126) for non-STEM faculty recipients] and was driven mostly by the last 10 years [\( \chi^2(1)=10.971 \) (p=0.001) for STEM recipients vs. \( \chi^2(1)=1.983 \) (p=0.175) for non-STEM faculty recipients]. Overall, men in STEM on average had six times greater odds than women of receiving a research award \([(exp(B)) = 6.286; CI 1.303-30.318; R^2= 0.083 (Cox and Snell); Model \chi^2(1)=7.001 (p=0.008)]\}. Women faculty in STEM received proportionally more non-research awards (n=11) at the university level, yielding a ratio of research to non-research awards of 1:5, similar to the ratio in STEM college awards (Table 4.1).

Faculty survey

The faculty perception of the nomination process gleaned from the survey provided insight into potential mechanisms underlying the uneven awards distribution between men and women in STEM. In general, a lower proportion of tenured women compared to men reported being nominated for an university award, (gender difference of around 15-27% depending on whether award was at the departmental, college or university level), with gender differences less pronounced for award nominations in professional organizations outside the university (8% gender difference) (Figure 4.2). This gender difference in reported award nominations held across all types of awards, except for service awards, where both men and women reported equally low nomination
rates (10% and 13%, respectively) (Figure 4.3). Almost two-thirds of male faculty vs. 40% of women reported being nominated for research-related awards, in line with actual awards data showing the preponderance of men as research awards recipients. Women also consistently reported lower nominations rates for non-research activities such as teaching (48% of men vs. 33% of women) and mentoring (38% of men vs. 7% of women). There was also a greater perception among women that they had been overlooked by colleagues and administrators in the nomination process (33% of women vs. 18% of men).

Analysis of self-reported productivity did not indicate substantial differences in individual metrics of research productivity between tenured men and women, except for a slightly higher number of invited talks reported by male faculty (p=0.043). Similarly, combined status and output scores obtained after factor analysis indicated similar relative distributions (and median values) in productivity (p=0.195 for factor 1 and p=0.108 for factor 2), irrespective of gender (Figure 4.4). It is interesting to note that in this analysis, grant size (i.e., resource input) and publication output were poorly correlated (Pearson R=0.089, p=0.601). On the other hand, the survey data did not allow us to specifically assess whether women faculty were engaged in more teaching, mentoring or service activities.

When queried about whether they were considered outstanding by their peers and leadership in research, teaching or service, no consistent gender patterns emerged. Overall approval rating of faculty accomplishments progressively declined from department head (70% for men and 56% for women), to peers (50% for men and 47% for women) to college deans (26% for men and 33% for women), and a substantial portion of the faculty reported that they were unsure how their dean rated their performance in these
three areas (Table 4.2). Men reported higher positive ratings by their peers in the area of
research (66% vs. 47% of women) and by their department head for service (71% vs.
47% of women); while a higher proportion of women indicated recognition for teaching
by their dean (33% vs. 14% of men). None of the observed gender differences in
response rates were statistically significant.

DISCUSSION AND CONCLUSION

The awards data at this doctoral research university mimic the trends observed at
the national level in professional and scientific organizations as documented by the
AWIS project (Lincoln et al. 2011; 2012). The granting of awards and honors remains a
highly gendered process. Despite the proliferation of awards over time at this institution,
there has been only a modest improvement towards gender equity. While a growing
number of women have received research awards in the STEM colleges in the last 10
years, these changes were not commensurate with the increased representation of women
among (senior) faculty. Especially at the university level, the gender discrepancies in
awards distribution among faculty are even more pronounced, with men clearly
dominating the research awards. Compared to their male colleagues, women are
generally less likely to be recognized for their scientific achievement, but proportionally
more for non-research activities such as teaching and undergraduate student mentoring,
consistent with the caring and nurturing female stereotype. While this analysis primarily
focused on STEM faculty, women are underrepresented as university-level research
awardees in the non-STEM disciplines also, suggesting a highly gendered process that is
systemic rather than discipline-specific.
The faculty survey data, while reflecting faculty perceptions that are not free of personal bias, nevertheless provide some insights into institutional practices that lead to these divergent outcomes for men and women. The self-reported productivity metrics do not support the notion, often espoused in the STEM literature (e.g., Ceci et al. 2014), that women are less productive than their male colleagues, and that this may partly explain differences in career attainment between men and women in STEM. Rather, the survey data suggests that the gender inequality starts at the nomination process, and that women feel their scientific achievements are frequently overlooked. Informal conversations with leadership from two STEM colleges document nomination and selection processes that are inconsistent among STEM colleges and types of awards and often lack transparency.

We can also infer the role of social proximity in mitigating implicit bias, (1) by more pronounced gender differences in awards distribution at the university compared to the college level, and (2) by the observation that both men and women are more ambiguous about whether and how college deans value their research, teaching and service activities compared to their department heads. This would suggest that the more distant evaluators are from actual faculty being evaluated, the more likely they are to access biased gender perceptions in their evaluations. This is consistent with research on cognitive processes in decision making (Goodwin, Operario, and Fiske 1998) which demonstrated that those granted the ability to judge and control the outcome of others (e.g., selection of nominee or awards recipient) tend to activate stereotype bias, unless they have a stake in the outcome or are held accountable especially to higher levels of power. Contact theory of intergroup interactions further suggests close and sustained contact, interdependence and the sharing of a common goals among people (e.g., within
the context of an academic department) tends to promote reliance on individuating information rather than stereotype expectations by those who judge (Reskin 2000). Department heads are more likely to have more frequent contact with and better understanding of faculty and their achievements than for example college deans, reflected in the differential approval ratings reported by STEM faculty, irrespective of gender. Likewise, colleagues within the same department or college are more likely to have intimate knowledge of the accomplishments of their colleagues and may even collaborate with them compared to university-level selection committees. This may account for the somewhat more gender balanced awards distribution at college-level awards compared to the university level awards.

Collectively, the quantitative awards data combined with the survey responses substantiate a gender bias in the awards process that tends to preferentially reward research accomplishments of men. While there are limitations to the inferences that can be drawn from this data as to causation, the results are nevertheless in line with patterns observed at the level of national professional STEM societies. They are consistent with theory on power as a source of inequality (Goodwin et al. 1998; Reskin 2000) which states that in the absence of deliberate counter measures, groups with the power to judge tend to utilize cognitive shortcuts and access stereotypical role expectations, such that male faculty are more likely to be considered scientifically more competent and worthy of recognition, while women’s accomplishments is more in line with a stereotypical nurturing role.

The first step towards institutional change is to acknowledge the possibility of cognitive bias in the decision-making process and to implement counter measures to
prevent (unintended) gender inequality (Reskin 2000). This research points at best practices that can alleviate the effect of gender bias at all levels of the awards process at this institution that are consistent with the existing literature. First, the nomination process itself needs greater consistency, transparency, and time and resource allocation such that it is clear to all who can nominate (including self nomination), nominations are not made in haste (to counter stereotype-driven assessments, Reskin 2000), and nominators are incentivized by real support (to counter potential negative consequence of loss of individual productivity). The composition of evaluation committees is also critically important in terms of gender composition, disciplinary representation, position within the institution, and overall status to break the cycle of homo-social reproduction or ingroup preference (Hurley 2014). Especially at the university level, relying solely on the input of past award recipients or high-status individuals at the exclusion of various other constituencies is counter to achieving diversity among future awardees. Finally, to avoid cognitive distortions along gender lines, evaluations should be based on clear and objective performance criteria and decision matrices, and those making the decisions should be held accountable (Reskin 2000). In short, the awards process can become truly meritocratic and objective only if it relies on individuating information and minimizes the influence of stereotype bias. This requires deliberate actions at all levels within the institution that engender transparency, achieve diverse participation in the nomination and selection process, and holds decision-makers accountable for the criteria and the accuracy of the information utilized in selecting awards recipients. Furthermore, long-term institutional change can only be achieved through sustained implementation of best practices and continued monitoring of progress towards institutional gender equity goals,
as progress tends to stall when issues fall out of focus and attention within the organization is distracted (Fine 2014).

As illustrated by this institutional analysis, academia remains a gendered prestige economy that is socially stratified and places women at a distinct evaluative disadvantage with respect to research awards, not because they are less accomplished, but because their accomplishments are overlooked or given more scrutiny. Such gender inequalities can only be addressed though conscious and sustained implementation of best practices that include greater transparency, formalization and accountability in the nomination and selection process, and diversification of the nomination pools and decision-making entities.

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### Table 4.1
Relative distribution of research vs. non-research awards received by STEM women and men faculty in the STEM colleges and at university-level prior to 1995, between 1995-2004, and during the last 10 years

<table>
<thead>
<tr>
<th>University Awards - STEM Recipients</th>
<th>CLASSIFICATION</th>
<th></th>
<th></th>
<th></th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Research</td>
<td>Non-Research</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 2005-2014</td>
<td>17</td>
<td>11</td>
<td></td>
<td></td>
<td>1.55</td>
</tr>
<tr>
<td>1995-2004</td>
<td>11</td>
<td>9</td>
<td></td>
<td></td>
<td>1.22</td>
</tr>
<tr>
<td>Prior to 1995</td>
<td>12</td>
<td>15</td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>40</td>
<td>35</td>
<td></td>
<td></td>
<td>1.14</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 2005-2014</td>
<td>0</td>
<td>7</td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>1995-2004</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>0.33</td>
</tr>
<tr>
<td>Prior to 1995</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2</td>
<td>11</td>
<td></td>
<td></td>
<td>0.18</td>
</tr>
<tr>
<td><strong>STEM Colleges</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 2005-2014</td>
<td>42</td>
<td>87</td>
<td></td>
<td></td>
<td>0.57</td>
</tr>
<tr>
<td>1995-2004</td>
<td>22</td>
<td>72</td>
<td></td>
<td></td>
<td>0.31</td>
</tr>
<tr>
<td>Prior to 1995</td>
<td>35</td>
<td>107</td>
<td></td>
<td></td>
<td>0.48</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>98</td>
<td>265</td>
<td></td>
<td></td>
<td>0.47</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 2005-2014</td>
<td>8</td>
<td>30</td>
<td></td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>1995-2004</td>
<td>3</td>
<td>20</td>
<td></td>
<td></td>
<td>0.16</td>
</tr>
<tr>
<td>Prior to 1995</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12</td>
<td>54</td>
<td></td>
<td></td>
<td>0.17</td>
</tr>
</tbody>
</table>

$^¥$ includes "professor of year" in CAAS

* insufficient data to calculate average
Table 4.2 Relative proportion of tenured men and women who confirmed being considered outstanding, by level of evaluator and type of activity.

<table>
<thead>
<tr>
<th>Level</th>
<th>Area</th>
<th>Men</th>
<th>Women</th>
<th>Gender differences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Department Head</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>61%</td>
<td>53%</td>
<td>-7%</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>79%</td>
<td>67%</td>
<td>-12%</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>71%</td>
<td>47%</td>
<td>-25%</td>
<td></td>
</tr>
<tr>
<td><strong>Peers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>31%</td>
<td>40%</td>
<td>+9%</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>66%</td>
<td>47%</td>
<td>-19%</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>52%</td>
<td>53%</td>
<td>+2%</td>
<td></td>
</tr>
<tr>
<td><strong>Dean</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>14%</td>
<td>33%</td>
<td>+20%</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>41%</td>
<td>33%</td>
<td>-8%</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>24%</td>
<td>33%</td>
<td>+9%</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.1 Number of men and women in STEM colleges receiving research vs. non-research awards over time (excludes mixed-designation awards).
Figure 4.2 Percentage of tenured male and female faculty who report being nominated for awards at different levels inside and outside the university.
Figure 4.3 Percentage of male and female tenured faculty who report being nominated for different types of university awards.
Figure 4.4 Distribution of productivity scores for male and female tenured faculty respondents.
CHAPTER 5
SUMMARY AND CONCLUSIONS

This thesis research focused on the position and career advancement of women in STEM (Science, Technology, Engineering, Mathematics) colleges at Utah State University (USU). It centered around three broad research questions: (1) What is the current status of women in STEM? (2) Is there a gender gap in the advancement to full professor in STEM, and if so, why? and (3) Is the awards program a potential source of gender inequality?

The demographics at USU are similar to STEM disciplines at other doctoral research universities, with men dominating the faculty, especially at the higher ranks. Despite concerted efforts to hire women faculty in the STEM colleges, job security, retention and upwards mobility remain an issue in these colleges. A larger proportion of women than men occupy non-tenure track positions. Gender composition of the faculty corps is becoming more balanced as women have been hired at accelerated rates for tenure-track faculty positions since the late 1990s, but with a few exceptions women are hired mostly at the assistant professor level. As a consequence, the gender composition in untenured faculty ranks approaches or exceeds that of national availability of PhD holders in the various STEM disciplines. However, between 2008 and 2014, almost half of these untenured women faculty have left USU, comprising the largest attrition cohort among women faculty (75% of total attrition among women). Compared to corresponding historic market availability, women remain underrepresented in the highest faculty ranks. They are also underrepresented in leadership positions, and are noticeably
missing as department heads among all 21 STEM departments, or in any leadership position in some colleges.

This pattern of declining representation of women up the academic STEM ladder is often referred to as the “leaky pipeline” in STEM. Chapter 3 specifically focused on potential gender disparities in the promotion from associate to full professor. Specifically, historic promotion records at USU were used to assess whether it took women longer than their male colleagues to attain the highest rank and, if so, to determine the extent to which individual and institutional factors contributed to differential rates of upward mobility among STEM faculty.

Our analysis showed that prior to 2008, there was considerable variability in time to promotion for both men and women, reflective of an inconsistent promotion process. There was an indirect gender effect on promotion outcome, in that faculty hired at associate level—a privilege reserved almost exclusively to male faculty—took considerably less time until promotion to full professor.

In 2001, NSF initiated the ADVANCE Program to clarify structural barriers and seek institutional solutions to the underrepresentation of women in STEM, and USU participated the NSF-ADVANCE Program between 2003 and 2009. Among the various project activities at USU, two were particularly pertinent to the promotion process: (1) workshops and panel discussions to create greater awareness of and transparency in the promotion process, and (2) a change in codified university policy that formalized the post-tenure review timeline and framed these reviews within the context of potential promotion. Promotions of women to full professor started to occur at higher rates with the onset of the ADVANCE project. Post-ADVANCE promotions to full professor are
now occurring more swiftly and consistently, variability in promotion outcomes within and among gender groups has decreased, and for the recently hired faculty cohort there is no longer a gender gap in time from associate to full professor. Furthermore, comparisons of different waves of a faculty survey indicate an improvement in faculty morale, specifically a greater understanding of and confidence in the promotion process.

The granting of awards at USU, on the other hand, remains a highly gendered process, with men clearly dominating the research awards. While the number of award recipients that are women has increased over time – reflecting the increasing representation of women among STEM faculty – women are still significantly less likely to be recognized for their research achievements, especially at the university level. Analysis of self-reported productivity does not substantiate measurable differences in accomplishments as the cause for this discrepancy. Rather, women faculty feel that their scientific achievements are frequently overlooked by peers and leadership in the nomination and selection process. Consistent with the caring and nurturing stereotype, women in STEM tend to be receive proportionally more awards in recognition of non-research activities such as teaching and undergraduate mentoring.

While there are obvious limitations to the use of data from a single institution, this research nevertheless is able to demonstrate the role of institutional practices (i.e., structural factors) in shaping career outcomes and especially in limiting gender gaps in career attainment within STEM. The first step towards institutional change is to collect information and objectively document areas where changes are needed. Prior to 2008, no centralized readily accessible digital data base for USU personnel existed and the NSF-ADVANCE team was instrumental in compiling and digitizing the faculty data base for
STEM. Maintenance and annual update of the university-wide data base has been institutionalized as part of routine operations by the Office of Analysis, Assessment, and Accreditation (AAA). This has enabled us to objectively document temporal shifts in the gender composition of the faculty, by college, rank and/or position, and quantify retention, promotions and attrition rates. Multiple waves of a faculty climate survey, initiated during the ADVANCE project and repeated in Fall 2016 further allow insights into overall job satisfaction and barriers to career attainment perceived by individual faculty. The self-reported productivity metrics gleaned from most recent faculty survey do not support the notion, often espoused in the STEM literature, that women are less productive than their male colleagues.

This research points at the influence of academic culture and institutional practices and policies in shaping the collective experience of women faculty in STEM. In the absence of clear guidelines, decision makers at all levels are more likely to access gendered stereotype expectations that lead to gender bias in career outcomes. This is exemplified by the hiring, awards, and pre-ADVANCE promotion processes that disproportionately advantaged men over women faculty in terms of status and recognition of achievement. On the other hand, deliberate and sustained implementation of best practices that include greater transparency and information flow with regard to the process, formalization of rules and criteria, and accountability by decision makers can neutralize such unconscious bias and result in a more equitable work environment. This study has demonstrated that codification of procedures and responsibilities instigated by ADVANCE improved time to promotion to full professor for both male and female associate professors and significantly reduced the gender gap in promotion outcomes. It
also resulted in greater job satisfaction by women and a positive attitude towards the promotion process among all tenured STEM faculty. While different institutions of higher education and disciplines may have their particular cultures and institutional practices, insights gleaned from this research should nevertheless be useful to other research universities.