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Gender Disparity in STEM Disciplines: A Study of Faculty Attrition and Turnover Intentions

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Abstract This study examines the underrepresentation of women faculty in science, technology, engineering, and mathematics (STEM) by comparing the intentions of attrition and turnover between genders in Research and Doctoral universities. It is found that the two genders did not differ in their intentions to depart from academia, but women faculty had a significantly higher likelihood to change positions within academia. The indications are that women and men are equally committed to their academic careers in STEM; nonetheless, women's stronger turnover intentions are highly correlated with dissatisfaction with research support, advancement opportunities, and free expression of ideas. The findings suggest that the underrepresentation of women is more convincingly explained by an academic culture that provides women fewer opportunities, limited support, and inequity in leadership, rather than by gender-based differences such as roles in family responsibilities. Changes in academic STEM culture are needed in order to attract more women scientists and narrow the current gender gap.

Keywords Faculty turnover · Gender disparity · Women faculty · Science, technology, engineering, and mathematics (STEM)

Introduction

A speech made by the former Harvard President Larry Summers in 2005 fueled a national debate over the causes of the underrepresentation of women in academic science, technology, engineering, and mathematics (STEM) disciplines (Frehill et al. 2006; Settles et al. 2006). The debate seems to divide the potential causal factors into gender-based versus structural categories. People holding similar views as Summers (2005) stress that fewer women have terminal degrees in these fields, and believe that the underrepresentation of women in STEM is mainly caused by innate differences or gender-oriented socialization.

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However, citing empirical evidence, many scholars contend that structural impediments, including discrimination at hire, "glass ceiling" in promotion, and inequity in salary and support, account for the significant disadvantages faced by women faculty in STEM (Settles et al. 1996; Sonnert and Holton 1996).

The reignited interest in gender inequity in academic STEM came many years after national committees and professional organizations initiated a number of programs to increase female participation in science and engineering (e.g., American Council on Education 1988; National Research Council [NRC] 1991). These programs, more or less resting on the belief that increasing the talent pool will lead to more women choosing a career in STEM disciplines (Chesler and Chesler 2002), mainly worked at school education programs or changing the attitudes of female students (see Frehill et al. 2006). Although the long term interventions have led to a steadily increasing number of women doctorates in some STEM disciplines, a proportional increase of women faculty members therein did not take place as expected (Barber 1995; Frehill et al. 2006; Kulis et al. 2002; Nelson and Rogers 2005; NSF 2003; Pell 1996). More research is needed to better understand the factors that hinder women scientists' presence in academia. With evidence already showing that the percentage of women doctorates hired into faculty positions is disproportionately lower than that of men (Nelson and Rogers 2005), this study focuses on faculty's attrition and turnover intentions in order to investigate the professional concerns unique to women scientists when making a career decision. Using a national sample of STEM faculty from Research and Doctoral institutions, two research questions are addressed: first, is there any difference in the intentions for voluntary turnover and attrition between men and women faculty members in STEM? And second, what are the specific factors that explain the different intentions for turnover and attrition between genders? The objective is to gain further information about factors that contribute to the underrepresentation of women faculty in STEM disciplines.

Theoretical Framework

Defining "STEM"

The growing number of studies on the disproportionately low presence of women in disciplines that have been traditionally dominated by men is generated from diverse areas including women's studies, education, sociology, and psychology. What is lacking is a consistent definition of "disciplines that have been traditionally dominated by men." In this article, "STEM" (see Nielson et al. 2005) is used because disciplines in science, technology, engineering, and math have clearly delineated paradigms and well-established rules and standards for scientific practice (Kuhn 1962). These disciplines have traditionally had low women presence (Nielson et al. 2005) and belong to the *Hard* dimension defined by the Biglan's classification of academic disciplines (Biglan 1973; Xu 2008).

Pipeline Model

The research concern of this study springs from two models explaining women's presence in STEM and the literature on faculty turnover. The two models, *pipeline* model (Kulis et al. 2002; Pell 1996) and *deficit* model (Sonnert and Holton 1996; see also Settles et al. 2006), deal with the supply and sustainment of women in STEM fields. The pipeline model is a metaphor with two possible aspects to the underrepresentation of women in STEM: the importance of increasing the volume of flow of females from grade school to graduate school and preventing "leakage" down the line at all stages (Kulis et al. 2002). It "assumes that an enlarged female doctoral labor pool (more flow) will expand the female professoriate" (Kulis et al. 2002, p. 658). However, in recent years little change has been reported with the presence of women faculty in STEM in spite of the increasing supply of women with terminal degrees in these disciplines (Barber 1995; Kulis et al. 2002; Leslie et al. 1998; Nelson and Rogers 2005). Under this circumstance, pipeline model suggests that there must be leakage problems: gender disparity at the hiring stage and/or women leaving academia in the midst of their career.

Gender disparity in hiring has been the finding of several studies. Nelson and Rogers (2005) identified a wide gap between the percentage of women among doctorate recipients and the percentage of women among assistant professors in a majority of STEM disciplines for a ten-year period (i.e., 1993–2002). In a literature review prepared by Bentley and Adamson (2003) as part of a NSF project, two possible reasons were cited for the small number of women faculty entering STEM fields: job preferences (gender-based) and limited opportunities (structural-related). *Job preferences* argue that women perceive careers in hard-science disciplines as research oriented and the work environment as isolating and competitive (Barbezat 1992). They voluntarily stay away because they prefer spending more time teaching and having more opportunities for collegial collaboration (Barbezat 1992; Benbow et al. 2000; see Bentley and Adamson 2003; Sonnert and Holton 1996). This perspective suggests that the low presence of women in STEM is a result of free choice, but it fails to explain or examine why those disciplines have a culture, or at least a public image, of being exclusive and lacking collegiality (Chesler and Chesler 2002). *Limited opportunities*, on the other hand, are caused by the social and political biases in STEM disciplines that "limit the set of job opportunities available to women or make some jobs less attractive because of the lower pay or reduced promotion possibilities" (Bentley and Adamson 2003, p. 4). In reality, such structural-related gender biases mean that women have a smaller chance of being hired; the small group of women who start faculty careers in STEM suffer isolation, marginalization, stereotyping, insufficient support, delay in advancement, and other adversity at work (Nelson and Rogers 2005; NSF 2001, 2003; Sonnert and Holton 1996).

Deficit Model

The "limited opportunities" faced by women scientists in a gender-biased academic environment, as discussed by Bentley and Adamson (2003) in their literature review, is the focal point of the "deficit model". With its roots in organizational theory, the deficit model tries to explain the career experiences and outcomes of women faculty in STEM disciplines by examining the structural (i.e., social, cultural, and political) obstacles in their career path (Sonnert and Holton 1996). The proposition is that formal and informal organizational mechanisms provide women faculty members with fewer opportunities, limited support, and inequity in pay and leadership. A deficient work climate and negative individual experiences directly hinder the success of women faculty, and lead to their low job satisfaction and high attrition and/or turnover rate (Settles et al. 2006; Valian 2005).

Not all people agree with the deficit model and its emphasis on structural obstacles. There are advocates for gender-difference arguments who believe that the low presence and inferior job outcome of women in STEM disciplines are mainly due to their innate or socialization differences from men. They uphold the opinion that women have aptitudinal disadvantages that result in their lower performance, lower professional status, and lower salary than men (e.g., Benbow 1988; Nowell and Hedges 1998; Summers 2005; see also Spelke 2005). They also argue that family responsibilities divert women's time commitment from work (Barbezat 1992). However, empirical evidence challenges gender differences as plausible causes for the disparity of women in STEM disciplines. For instance, studies have found that family responsibility may not interfere with the work responsibility (Sonnert and Holton 1996); married faculty have been found to have higher productivity than those who are single (Bellas and Toutkoushian 1999; Nielson et al. 2005; Sax et al. 2002). Meanwhile, the wealth of research in the last 40 years on cognition and cognitive development suggests that biological gender differences have little to do with the core cognitive foundations of mathematical thinking and science learning, and males and females at high school and college levels show similar rates of successful mastery of demanding materials in math and science (Spelke 2005; see also Frehill et al. 2006). By discounting gender-based differences, these findings support the deficit model indirectly and render further investigation of structural obstacles as alternative explanations for gender disparity in STEM disciplines.

Faculty Turnover

How the deficit model explains the underrepresentation of women in STEM can be better understood in connection with literature on faculty turnover and women's status in higher education. Research on turnover has identified an array of individual and contextual factors that are related to faculty members' intention to leave or stay at a position. At the individual level, both demographic (e.g., gender, race, marital status, and family responsibility) and professional variables (e.g., educational level, job experience, academic rank, productivity) can be influential (Hagedorn 1996; Smart 1990; Zhou and Volkwein 2004). For example, it has been argued that both gender and race play a role in turnover behaviors because women as well as minority faculty members are likely to be delayed in tenure and promotion, therefore, both groups are more prone to leave before gaining tenure (Rausch et al. 1989; Sanderson et al. 1999). In at least one study, nontenured faculty reported a higher potential to leave academia (Barnes et al. 1998). Generally speaking, career age and length of time in the institution have been found to be negatively related to turnover intention (Pfeffer and Lawler 1980; Smart 1990; Zhou and Volkwein 2004).

Contextual factors are classified by Daly and Dee (2006) into structural properties of an organization (e.g., work autonomy, support for professional activities, and role in decision making) and environmental conditions (e.g., dynamics of the labor market and institution's prestige) in accordance to the expectancy theory. This theoretical perspective posits that positive and nurturing structural properties permit the development of a sense of belonging and commitment and decrease individuals' turnover intention (Daly and Dee 2006; Johnsrud and Heck 1994; Rosser 2004). In particular, it emphasizes that the contextual factors impact personal turnover intention through the intermediation of sociopsychological variables such as perceived fairness, commitment, and job satisfaction (Daly and Dee 2006; Hagedorn 1996; Johnsrud et al. 2000; Rosser 2004; Price 1977; Smart 1990). In other words, subjective evaluation of the congruence between oneself and the work environment is the critical mediating layer between structural conditions and personal turnover intentions.

Some turnover studies included gender as a variable to examine the turnover differences between men and women faculty (e.g., McGee and Ford 1987; Smart 1990; Zhou and

Volkwein 2004). The findings have not been consistent, partly because gender seems to influence turnover indirectly through other factors, such as teaching and research productivity, tenure status, and job satisfaction (e.g., Gander 1999; Perna 2001). For example, Johnsrud and Heck (1994) found that women faculty had a higher turnover rate than men in a sample of tenure-track faculty in a major urban public research university. Smart (1990) found that tenured men were more likely to leave a position than tenured women, and gender made no difference for nontenured faculty. On the other hand, Zhou and Volkwein (2004) found that nontenured women showed a stronger intention to leave than men due to low satisfaction with job security. There are many unanswered questions as well. For example, it is remains unclear how teaching and research productivity impacts male and female faculty turnover behaviors differently even though gender disparity in teaching and research has been found in a few studies (e.g., Park 1996; Xie and Shauman 2003) and productivities have been shown to have bearing with turnover intentions and rates (McGee and Ford 1987; Rosser 2004; Smart 1990).

In spite of the insufficiency of and inconsistency among the research findings, empirical evidence supports that gender interacts with many professional variables in the academic environment, and women faculty members share negative experiences regardless of their disciplines (e.g., Hegedorn 2001; Perna 2005). By and large, women are in lower ranks and nontenured positions, earn lower salaries, have heavier teaching loads and less research support, and serve on more committees than their male colleagues (e.g., August and Waltman 2004; Gander 1999; Hagedorn 1996; Park 1996; Smart 1991; Stack 2004). These "deficits" at work may lead to the dissatisfaction of women faculty, and as previously indicated, satisfaction level determines the probability of individuals leaving or staying with an organization (Price 1977; Rosser 2004).

Research Purpose

The pipeline and deficit models relate the underrepresentation of women faculty to problems in *hiring* and *attrition* under the gender-unfriendly academic climate that plagues STEM disciplines with bias, stereotype, and inequity (Barber 1995; Nelson and Rogers 2005; Settles et al. 2006). Longitudinal statistics have shown that disparity at the hiring stage is definitely a "leakage" problem (Barber 1995; Nelson and Rogers 2005), but understanding of the attrition of women faculty from their academic STEM careers remains insufficient for two reasons. First, few studies have examined specifically the attrition and turnover of women faculty in STEM disciplines. Second, in studies of faculty turnover, the difference between turnover within academia or attrition from academic careers has been overlooked. When changing positions within academia (i.e., turnover), the individual continues her academic career in a different environment. Abandoning her academic career (i.e., attrition), on the other hand, is the real "leakage" that decreases the female professoriate in STEM.

The purposes of this study, therefore, are (1) to compare empirically turnover and attrition intentions between men and women faculty in STEM disciplines, and (2) to examine the factors that may explain the identified gender differences, if any, in faculty turnover and attrition intentions. One specific contribution of this study is that turnover and attrition intentions are modeled separately for men and women in the analysis, an approach allowing direct comparison between genders (see details in the next section). In addition, the differentiation of turnover and attrition helps to pinpoint the problems faced by women faculty in STEM disciplines and offers useful information to guide institutional policies on recruitment and retention of women faculty.

Method

Data and Sample

Data of the National Study of Postsecondary Faculty:1999 (NSOPF:99) were used in this study (NSOPF 2004 has been released, but unfortunately it no longer has questions about intentions to leave). The NSOPF:99 survey was sponsored by the National Center of Educational Statistics (NCES). It started with an original sample of 960 degree-granting postsecondary institutions and approximately 27,000 full- and part-time faculty employed at these institutions. The sampling frame was stratified at the institutional level by Carnegie institutional types and at the individual faculty level by gender and ethnicity. For the faculty survey, more than 18,000 responses resulted in a weighted return rate of 83%. In this study, only tenured and tenure-track fulltime faculty in STEM disciplines from Research and Doctoral universities were kept because (1) the highest nonretirement departure rate was found in these types of institutions (Zhou and Volkwein 2004), (2) faculties at different types of institutions may have different patterns of professional behaviors and controlling institutional types helped to maintain sample homogeneity (e.g., Gander 1999; Perna 2005), and (3) faculty on tenure tracks may have different departure patterns than those on other types of appointments (Smart 1990; Zhou and Volkwein 2004). The total number of faculty in the weighted sample was 1,231, of which 74.5% were male and 25.5% were female. Table 1 shows that women accounted for less than 20% of the tenured faculty and 14% of full professorships.

The stratified sampling by the Carnegie classification of institutions and by gender and ethnicity determined that the data must be weighted in the analyses to ensure the validity and generalizability of the findings (Thomas and Heck 2001). In the data set, a raw weight was provided by the NCES (2002), but it had a mean much larger than 1. To obtain the correctly weighted statistics in the statistical software (i.e., SPSS), a relative weight had to be created by dividing the raw weight by its mean. Further, this relative weight was

Table 1 Faculty count and salary by tenure status, academic rank, and gender

		Men		Women		Total
Tenure status	Tenured	724	(78.9%)	178	(56.8%)	902
	Mean salary	$79,649		$70,250		
	On probation	193	(21.1%)	136	(43.2%)	329
	Mean salary	$57,803		$47,741		
Academic rank	Full professor	466	(50.8%)	76	(24.2%)	542
	Mean salary	$89,692		$84,376		
	Associate professor	264	(28.8%)	110	(35.0%)	374
	Mean salary	$63,650		$58,543		
	Assistant professor	163	(17.8%)	119	(38.0%)	283
	Mean salary	$52,096		$48,860		
	Others	24	(2.6%)	9	(2.8%)	33
	Mean Salary	$72,023		$37,224		
Total	Count	917	(74.5%)	314	(25.5%)	1231
	Mean salary	$75,043		$60,516		

Note: All numbers are weighted statistics adjusted for the average design effect from the multistage cluster sampling procedure in order to produce correct standard errors for hypothesis testing. Details about this weight adjustment procedure are available in Thomas and Heck (2001).

Operationalization of Major Concepts

Operationalization of "STEM" disciplines was based on an empirical framework proposed by Biglan (1973), in which academic disciplines were classified into eight mutually exclusive clusters defined by three dimensions: *Hard* versus *Soft*, *Pure* versus *Applied*, and *Life* versus *Nonlife*. For the purpose of this study, STEM disciplines are the *hard* discipline areas with clearly delineated paradigms, such as mathematics, chemistry, and other science and engineering programs (Xu 2008). Thus, the 140 plus academic programs in the NSOPF:99 data were classified into either *Hard* or *Soft* clusters based on the evidence provided by Biglan (1973) and Malaney (1986). Faculty members in *Hard* disciplines became the sample of this study. It is worth mentioning that this three-dimensional model has been cross-validated by a number of studies and found to be robust across different institutional settings (Braxton and Hargens 1996).

Another important concept is the turnover and attrition of faculty members. As in most studies of faculty turnover, the sample was limited to members with active teaching and research responsibilities at the time of data collection. To measure turnover and attrition, the NSOPF:99 asked the respondents for four likelihood ratings of leaving the current position for another full-time or part-time position in academic (turnover) or nonacademic (attrition) institutions in the next three years. These four likelihood variables were used as measures of attrition and turnover because the intention to leave a position has been found as the single strongest predictor of actual departure as early as in the 1970s (e.g., Kraut 1975; Mobley 1977, 1982; Steers and Mowday 1981) and has recently been reconfirmed by a meta-analysis of studies on voluntary turnover by Griffeth et al. (2000). Turnover intention has been used as the indicator of actual turnover in many studies of faculty turnover in higher education (e.g., Barnes et al. 1998; Rosser 2004; Smart 1990; Zhou and Volkwein 2004) and in organizational studies of employee turnover (e.g., McKay et al. 2007).

Analytical Procedures

The analysis was completed in two phases. First, two likelihood ratings of turnover (leaving for another fulltime or part-time position in academia) and two likelihood ratings of attrition (leaving for another fulltime or part-time position outside academia) were set as the four dependent variables in a MANOVA test to identify gender differences in turnover and attrition intentions. If any of the turnover or attribution ratings were found to be significantly different between genders, in the second phase, that rating would be used as the dependent variable in two regression models, one for men and the other for women, to explore the factors that may explain the variability in the self-reported intention.

For the regression models in the second phase, the independent variables were the major influential factors identified in the literature on faculty turnover (e.g., Rosser 2004; Smart 1990; Zhou and Volkwein 2004). Following another study on faculty turnover using the NSOPF data (Xu 2008), the independent variables were entered into the regression models in five sequential blocks. The first block had demographic information including age, marital status, and number of dependents. Racial/ethnic minority groups were not considered as variables because of their extremely low representation (Native Americans

$n = 2$, Hispanics $n = 9$, Blacks $n = 13$, and Asians $n = 26$) in women faculty ($n = 314$). The second block consisted of professional factors including years in the current position, academic rank, and tenure status. The third block had measures of workload and productivity, of which teaching load was quantified as hours per week teaching classes and working with advisees; research productivity as the career total publications and publications in the last two years; and community service as hours per week spent on administrative committee work. The fourth block entered individual faculty member's satisfaction with research supports (sum of ratings on equipment, space, graduate assistant, and secretarial support), time constraint (measured as the discrepancy between time spent on tasks and time preferred), self-rated work autonomy (sum of five ratings on making teaching-related and time allocation decisions), and satisfaction with salary. The last block had personal evaluation of the structural factors of the institution, including opportunity for advancement, job security, effectiveness of faculty leadership, and free expression of ideas.

To compare gender differences, the regression model R^2 is an indicator of how much variance in turnover/attrition intentions was explained by the set of independent variables. The unstandardized regression coefficients of the same variable are compared across models to know the effects of that variable on men and women. Within a model, the relative importance of individual variables for faculty turnover or attrition is shown by their corresponding standardized regression coefficient (β).

Limitations

There are some weaknesses in this study. Data used in this study were collected in 1999. Even though no significant changes in the status of women faculty have been witnessed in the intervening years, the findings could be more convincing with more recent data. The analyses were also limited by the adequacy of the variables that were available in the NSOPF:99 data. For instance, turnover/attrition intentions were the outcome variables of the regression models. Even though the intention to leave the current position has been repeatedly confirmed as the single best indicator of the actual turnover, progress from the intention to a final turnover decision is complicated by external "pulling factors" (Ambrose et al. 2005; Matier 1990) as well as the expected gross return of changing to a new position (Ehrenberg et al. 1990; Weiler 1985). Measures on external factors and expected return were not part of this study because they are not available in the NSOPF data. Finally, even though the analysis was based on a national sample, the sample of women professors was still relatively small. Therefore, the reported findings should be received as suggestive rather than conclusive.

Analysis and Results

In the first phase of the analysis, $\alpha = .01$ was used for the MANOVA test given the large sample size. The Hotelling's T-square test showed that gender made a significant difference in this multivariate model ($F = 8.450$, $p < .001$). With a Bonferroni adjustment to the α value, the univariate test of the four ratings of attrition/turnover intentions indicated that the only significant difference between genders was that women faculty had significantly stronger intention to seek another full-time position in academia than men ($F = 23.418$, $p < .001$). Women and men did not differ significantly in terms of their intentions to leave for a nonacademic position, be it part-time or full time, or a part-time academic position.

Therefore, in the second phase of the analysis, the self-reported likelihood of moving to another fulltime academic position served as the dependent variable in two hierarchical models of eighteen independent variables (correlations are shown in Table 2) separated into five blocks. Because the sample size of men was much larger than that of women, significance tests were conducted at $\alpha = .01$ for men's model and $\alpha = .05$ for women's model. The two hierarchical regression models had identical structure and both were free of multicollinearity (all independent variables had a VIF < 5). Comparisons of the R^2 change (ΔR^2) associated with each of the five blocks (see Table 3) showed the varied experiences of men and women faculty members. Demographic variables (Block 1) contributed $\Delta R^2 = .103$ to the model of men, but their effect was reduced to only $\Delta R^2 = 0.029$ for women. Satisfaction with structural factors of the institution (Block 5), on the other hand, explained about 8.3% of the turnover variance for women ($\Delta R^2 = 0.083$), but only about 2.4% for men ($\Delta R^2 = 0.024$). Women's turnover intention was also better predicted by their satisfaction with the immediate work environment (Block 4, $\Delta R^2 = 0.097$), including research support, time constraints, work autonomy, and salary, than it was for men ($\Delta R^2 = 0.082$). The two genders were not very different in terms of the variances explained by their professional seniority (Block 2) and work productivity (Block 3).

Examination of the individual independent variables in the two models revealed gender differences in turnover-related concerns from two different perspectives. First, prioritization of these factors in turnover consideration was different between genders. In the men's model, four significant variables ($p < .01$ in Table 3) were identified, with all of them having a standardized regression coefficient β greater than 0.10: age ($\beta = -0.152$, $p = .002$), years in current position ($\beta = -0.203$, $p < .001$), satisfaction with salary ($\beta = -0.121$, $p = .001$), and satisfaction with the effectiveness of faculty leadership ($\beta = -0.131$, $p < .001$). In the women's model, different variables topped the list in terms of their relative importance. With a relatively small weighted sample size, eight variables were statistically significant ($p < .05$), while ten variables had a standardized regression coefficient β greater than 0.10. More years in current position ($\beta = -0.314$, $p < .001$) and stronger satisfaction with the effectiveness of faculty leadership ($\beta = -0.153$, $p = .004$) were associated with lower turnover intention as they were for men. However, rather than being concerned with salary, women faculty's turnover intention was strongly related to advancement opportunity ($\beta = -0.161$, $p = .007$), research support ($\beta = -0.157$, $p = .002$), and free expression of ideas ($\beta = -0.112$, $p = .020$). Women faculty at higher ranks ($\beta = -0.159$, $p = .042$) and/or with a stronger career publication record ($\beta = -0.131$, $p = .049$) were less likely to leave their current position. However, women with higher numbers of publications in the last two years expressed stronger turnover intention ($\beta = 0.129$, $p = .033$).

Second, the same variables had different effects in the models for the two genders. Unstandardized regression coefficients of the same variables were used for cross-model comparison. It is clear that male and female faculty members had quite different considerations when making a turnover decision. Specifically, effect of age was strong and significant for men ($b = -0.010$, $p = .002$), weak and nonsignificant for women ($b = -0.005$, $p = .294$); higher academic ranks may lower women's turnover intention ($b = -0.135$, $p = .042$), but made no difference for men ($b = 0.032$, $p = .322$). It is not surprising to see the striking differences between the unstandardized regression coefficients of career total publications, recent total publications, research support, advancement opportunity, and free expression of ideas in the two models because the five factors were all related to women's turnover intention in a significant manner, but none exhibited a significant association with men's likelihood to leave for another position. In addition, the

Table 2 Correlations of variables in the regression analysis

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Likelihood to accept another academic fulltime job in 3 yr	–																	
2	Age: In 1999	−0.29	–																
3	Marital status	−0.05	0.08	–															
4	No. of dependents	0.01	−0.11	0.35	–														
5	Academic Rank	−0.20	0.50	0.13	−0.09	–													
6	Tenure status	−0.18	0.54	0.13	0.05	0.61	–												
7	Years in current position	−0.32	0.69	0.07	−0.06	0.48	0.56	–											
8	Teaching load	0.04	0.01	−0.05	−0.05	−0.08	−0.05	−0.02	–										
9	Career total publications	−0.17	0.40	0.15	0.04	0.39	0.37	0.33	−0.07	–									
10	Recent total publications	−0.03	0.11	0.12	0.09	0.15	0.18	0.09	−0.01	0.56	–								
11	Hrs/week on committee work	0.00	0.07	0.04	−0.01	0.11	0.17	0.07	0.06	0.06	0.01	–							
12	Research support	−0.24	0.12	0.08	0.05	0.13	0.11	0.14	−0.09	0.17	0.06	0.07	–						
13	Time constraint	0.05	0.07	−0.02	−0.06	0.03	0.04	0.07	0.05	−0.05	−0.02	0.10	−0.12	–					
14	Work autonomy	−0.23	0.15	0.07	0.03	0.20	0.14	0.16	−0.01	0.21	0.08	0.03	0.23	−0.14	–				
15	Satisfaction w/salary	−0.26	0.06	0.05	0.02	0.12	0.12	0.03	−0.12	0.18	0.10	0.05	0.30	−0.09	0.28	–			
16	Satisfaction w/job security	−0.26	0.27	0.07	0.04	0.34	0.50	0.29	−0.05	0.20	0.13	0.12	0.22	−0.06	0.34	0.36	–		
17	Satisfaction w/advancement opportunity	−0.26	0.09	0.00	0.01	0.17	0.16	0.07	−0.05	0.10	0.06	0.03	0.23	−0.02	0.30	0.42	0.50	–	
18	Satisfaction w/effectiveness of faculty leadership	−0.28	0.07	0.03	0.02	0.07	0.06	0.03	0.01	0.10	0.05	0.00	0.28	−0.18	0.31	0.35	0.33	0.37	–
19	Free expression of ideas	−0.14	0.04	0.02	−0.05	0.06	0.02	0.03	−0.07	−0.03	−0.05	−0.06	0.19	−0.03	0.22	0.13	0.16	0.24	0.21

Note: 1. Sample size $N = 1231$ (weighted)

Table 3 Hierarchical regression models of faculty turnover by genders

		Men			Women		
		$R^2 = 0.240$			$R^2 = 0.255$		
	Variable	*b*	*β*	*p*	*b*	*β*	*p*
	(Regression constant)	3.060		0.000	3.716		0.000
Block 1		$\Delta R^2 = 0.103$			$\Delta R^2 = 0.029$		
	Age: In 1999	***−0.010***	***−0.152***	***0.002***	−0.005	−0.060	0.294
	Marital status	−0.052	−0.031	0.355	0.018	0.012	0.794
	No. of dependents	0.014	0.031	0.370	−0.010	−0.016	0.738
Block 2		$\Delta R^2 = 0.026$			$\Delta R^2 = 0.036$		
	Academic Rank	0.032	0.044	0.322	***−0.135***	***−0.159***	***0.042***
	Tenure status	0.120	0.081	0.081	*0.149*	*0.104*	*0.193*
	Years in current position	***−0.012***	***−0.203***	***0.000***	***−0.028***	***−0.314***	***0.000***
Block 3		$\Delta R^2 = 0.006$			$\Delta R^2 = 0.010$		
	Teaching load	0.003	0.038	0.223	−0.006	−0.070	0.128
	Career total publications	0.000	0.012	0.778	**−0.002**	**−0.131**	**0.049**
	Recent total publications	0.001	0.037	0.323	**0.006**	**0.129**	**0.033**
	Committee work	0.001	0.010	0.740	0.009	0.054	0.245
Block 4		$\Delta R^2 = 0.082$			$\Delta R^2 = 0.097$		
	Research support	−0.044	−0.052	0.124	***−0.152***	***−0.157***	***0.002***
	Time constraint	0.001	0.039	0.224	−0.002	−0.086	0.069
	Work autonomy	−0.070	−0.079	0.023	0.080	0.078	0.136
	Satisfaction w/salary	**−0.075**	**−0.121**	**0.001**	−0.060	−0.078	0.136
Block 5		$\Delta R^2 = 0.024$			$\Delta R^2 = 0.083$		
	Satisfaction w/job security	0.000	0.000	0.995	*−0.088*	*−0.114*	*0.080*
	Satisfaction w/advancement opportunity	−0.056	−0.088	0.022	***−0.120***	***−0.161***	***0.007***
	Satisfaction w/faculty leadership	**−0.088**	**−0.131**	**0.000**	***−0.119***	***−0.153***	***0.004***
	Free expression of ideas	−0.013	−0.018	0.577	***−0.107***	***−0.112***	***0.020***

Note. 1. The dependent variable is the self-reported likelihood to leave for another fulltime academic position within the next three years

2. Due to different sample sizes, $\alpha = .01$ was used for men's model and $\alpha = .05$ for women's model

3. Numbers in bold indicate statistical significance and numbers in Italic indicates a $\beta > 0.10$

effect of years in current position was significant for both genders, but its impact on women ($b = -0.028, p < .001$) was more than twice that for men ($b = -0.012, p < .001$), and a t test found the difference between the two unstandardized regression coefficients to be statistically significant ($t = 2.50$, $p = .006$). Both genders valued faculty leadership equally; a test of the two unstandardized regression coefficients ($b = -0.088$ for men and $b = -0.119$ for women) shows $t = .639$ at $p = .239$.

As shown in Table 3, some variables were not correlated with turnover intention for both men and women. In particular, marital status and number of dependents, as measures of family responsibility, did not significantly influence the turnover intention of both men and women. Faculty of both genders had comparable levels of time constraints (women = 47.30, men = 42.49, $t = 1.93$ and $p = 0.053$), and in both models time constraints did not have a significant relationship with faculty turnover intention.

Discussion

Discussion of the findings of this study is organized around the popular "theories" explaining the persistent gender disparities in STEM: (1) traditional role in family raising, as argued by people who believe in gender-based differences, distracts women from professional dedication and lowers their job status and presence in STEM disciplines; (2) the insufficient supply and/or possible leakages, as suggested by the pipeline model, explains women's underrepresentation; and (3) existing structural problems in the male-dominant culture, as suggested by the deficit model, impede the growth and success of women faculty and discourage their participation in academic STEM. Based on the findings, possible policy changes are suggested in order to increase the retention and presence of women faculty in STEM.

Family Responsibility vs. Work Commitment?

The analysis finds a lack of correlation between family responsibility, measured by marital status and number of dependants, and the turnover intention for faculty of both genders (see also Sonnert and Holton 1996). In addition, men and women reported comparable levels of time constraints; after the work productivity measures were controlled for, neither of the genders show time constraints leading to an increased turnover intention. Two interpretations of these findings are possible. First, women faculty anticipate an equally demanding workload after moving to another academic position, so their turnover intention was not influenced by family responsibility. Second, women are as committed to their career as men. If women were distracted more by their family and household responsibilities, they would have reported stronger time constraints. This information makes it less convincing to argue that women's household responsibilities divert their time commitment and are partly to be blamed for their underrepresentation in academic STEM disciplines (e.g., Becker 1985). The findings are consistent with the conclusions of a number of other studies (e.g., Creamer 1998; Nielson et al. 2005; Sax et al. 2002) that family responsibility and time constraint are not significant factors in explaining gender differences in the professoriate.

Insufficient Supply or Leakage?

Statistics have shown that the number of women with doctoral degrees in many STEM disciplines increased substantially in recent years (NSF 2003), but the increased supply has yet to create proportional increases in the number of women faculty (Nelson and Rogers 2005). By differentiating turnover and attrition, the study shows that women scientists do not intend to leave their academic profession any more often than their men colleagues. This indicates that women faculty's attrition from academic STEM disciplines may not be a plausible explanation for their underrepresentation. Subsequently, it suggests the major "leakage" in the supply pipeline is more likely to be the disproportionately small number of women hired into faculty positions. It can be argued that, to increase the presence of women, a greater effort is needed to attract more female applicants and ensure them equal opportunity at hiring. For instance, it is important that advertisement of position openings always reaches potential women candidates, and search committees are composed of both genders to avoid gender-related biases or subtle discrimination.

Structural Problems?

This study finds that women have stronger intentions to change positions within academia even though they do not have higher attrition than men. On the one hand, the even attrition rates between men and women suggest, at least for those who joined academia, that women are as equally interested in their academic areas as men are and their dedication keeps them from leaving the career at the same level as their male counterparts (Sonnert and Holton 1996). The significantly higher turnover intention of women faculty, on the other hand, could indicate differences in work experience between genders. The regression models suggest systematic gender-specific patterns with regard to the factors that explained turnover intention. Most of all, it is difficult to dismiss the highly predictive structural factors in the turnover model of women faculty. Although the turnover intention of both genders is associated with their perception of the academic work environment, only women sense the pain of insufficient research support. Men, like women, prefer an institutional culture with effective faculty leadership, but they do not share women faculty members' concerns with advancement opportunity and free expression of ideas. These findings imply that the structural factors in STEM disciplines contribute to the stronger turnover intention of women faculty. The same factors may also discourage women from seeking an academic career in these disciplines when the workplace culture is anticipated not to meet their expectations of supportive leadership, equal access to resources, and equal advancement and promotion opportunities (Nelson and Rogers 2005; Valian 2005).

Policy Implications

Findings of this study suggest several directions for changes in retention policy. For instance, in comparison with the lower turnover intention of women faculty at higher ranks and/or with higher numbers of career total publications, it is intriguing to note that women faculty with more publications in recent years reported a stronger turnover intention than those with fewer recent publications. Note that the same effect is not observed for their male counterparts: the implication is two-fold. First, before reaching an established and stable professional status, women faculty members with growing professional capital are more likely to seek better work conditions (and likely, stronger compensation packages) because of their increased marketability that is enpowered by academic STEM programs at many universities competing for women of great potentials to improve gender equity. The relatively high mobility of achieving women faculty, in connection with the statistics showing disproportionately small number of women hired into faculty position, may suggest that most STEM disciplines prefer hiring rising women "stars" to attracting newly-minted female doctorates. It could be that these "stars" bring instant advantages to the program not only in gender equity, but also in academic quality and profile. The problem would be that, if fewer women doctorates are hired, where will the future rising "stars" come from? Administrators may want to take a closer look at their hiring practices and make sure fresh women doctorates are given ample opportunities and resources to start and develop an academic career.

Second, previous research has shown that women are less mobile than men (Rosenfeld and Jones 1987). Without apparent existing pulling factors from other institutions, the greater turnover *intention* of women with growing professional assets could also be an indication that these women scientists are less satisfied with their work experience and eager to find a place that fairly values and rewards their achievement. If the high likelihood of turnover of women "achievers" is indeed a sign of their struggle in an unfriendly work environment, it is at odds with the argument that aptitudinal differences between genders are to be blamed for women's inferior professional status and disadvantages at work. Arguably then, the organizational culture needs to be changed toward gender equity, as suggested in this study, by providing fair advancement opportunity and additional research support to women faculty, especially junior members.

The severity of women faculty's concerns with research support, advancement opportunities, and free expression of ideas can be gauged by the finding related to their satisfaction with salary. Data used in this study suggests that women were paid much less than men (see Table 1), which is expected because numerous studies have documented salary disparity for women faculty even after salary-generating factors are controlled for (Becker and Toutkoushian 2003; Hagedorn 1996; Smart 1991; Toutkoushian 1998; Toutkoushian and Conely 2005; Umbach 2007). Interestingly though, men are the ones more likely to leave for another position when dissatisfied with salary. Apparently, even though women faculty are not satisfied with their salary, they suffer more from lower visibility, lower power, and lower support from the leadership (Sonnert and Holton 1996; Valian 2005).

In the future, possible changes can be made at both individual and institutional levels in order to improve the work environment for women faculty in STEM disciplines. On the individual level, women faculty may need to actively construct their own support networks as a numeric minority (Chesler and Chesler 2002). It is equally important for them to seek opportunities in leadership and make their voices heard at the management level. Male faculty, as colleagues, can help to make positive changes by increasing their sensitivity to and understanding of gender differences. For example, the work environment can be supportive to both genders if men can appreciate that women may have different preferences and styles in their research and teaching activities (Perna 2005; Sonnert and Holton 1996). In sum, the cultural norms of the profession could be broadened to create a friendly and supportive work climate for both genders (Nelson and Rogers 2005; NRC 1991; Pell 1996).

At the institutional level, awareness of gender equity may need to go beyond basic fairness. Campus leadership may want to organize workshops and seminars to educate the community about the importance of gender equity and women's participation in STEM (August and Waltman 2004; Nielson et al. 2005). Supports for women faculty members may take the form of professional mentoring and social/professional networking (August and Waltman 2004; Chesler and Chesler 2002). Also, for all faculty members, clear and specific guidelines for tenure and promotion can help to minimize inequity and unfair treatment (Bronstein and Farnsworth 1998). A work environment free of gender bias is the best recruitment and retention policy for women faculty. Faculty members of the opposite sex have no reason to feel threatened by the elimination of gender inequity given that the ultimate goal is not to force an equal number of women and men at all costs, but to provide equal access to career opportunities and equal resources and support for success to all talented scientists, be they men or women.

Conclusions

The importance of gender equity in STEM disciplines has long been recognized (Barber 1995; Frehill et al. 2006; NRC 1991; Valian 2005). Not only will the increased participation of women scientists promote diversity and enhance innovative power, but it also impacts the education and career development of future generations (Nelson and Rogers 2005; NRC 1991; Pell 1996; Sonnert and Holton 1996). However, gender equity would not be possible without increasing the presence and success of women faculty members in STEM disciplines. Among the potential causes of underrepresentation of women professoriate, hiring disparity has been confirmed by statistics at the national level in many STEM fields (Kulis et al. 2002; Nelson and Rogers 2005). Differentiating attrition and turnover, this study suggests that women faculty members do not depart from their academic careers any more often than their male counterparts; however, they have a higher turnover intention than men, a systematic gender difference illustrated by the factors explaining faculty turnover intentions. Additionally, the findings challenge gender-based differences as the fundamental reasons for the low presence of women faculty in STEM, and instead correlate the higher likelihood of women turnover with dissatisfying factors in the *deficit* work environment and institutional culture. This conclusion, echoing many other studies on women faculty, calls for cultural transformation in academic STEM in order to attract more women scientists and narrow the current gender gap (Barber 1995; Chesler and Chesler 2002; Settles et al. 2006).

Turnover is a complicated decision-making process which many personal, professorial, and contextual factors may influence. In some cases turnover may be a personal choice in response to changes in family conditions, or individuals moving to a better position in order to gain career advancement, but too often, job changes mean disrupted research and teaching agendas, lower probability of tenure, or even delayed promotion and advancement to women scientists (McElrath 1992). Putting high turnover intentions and low hiring rates of women into the context of gender-biased academic culture, this study serves as a reminder that subtle but systematic imbalances need to be underlined so that they could be addressed before adding up to long-term career disadvantages for women scientists (Sonnert and Holton 1996; Valian 2005).

Future Research

This study examined gender differences in STEM faculty's intention to change positions voluntarily using a national sample from Research and Doctoral universities. In spite of the revealing findings, understanding of gender disparity remains incomplete because involuntary leaves are not considered. With evidence indicating that women are more often denied tenure in academia than men (August and Waltman 2004; Bronstein and Farnsworth 1998), future research needs to investigate possible gender disparity in involuntary leaves.

The final conclusions of this study were reached based on a sample of women faculty in STEM disciplines; nonetheless, some of the findings might describe part of the reality for all women in academia. Low satisfaction at work has been identified as a critical determinant of turnover (Mobley 1977; Price 1977; Rosser 2004; Smart 1990) and women faculty in general have reported lower satisfaction than their male colleagues in areas including job security, gender equity, rewards, and free expression of ideas (August and Waltman 2004; Bronstein and Farnsworth 1998; Hagedorn 2001). Future research may compare the turnover intentions between women faculty in STEM and non-STEM disciplines and explore what turnover factors are particular to women scientists and what describe the overall experience of women faculty as a gender group.

Finally, additional research may be necessary to look into the underlying factors of faculty turnover intentions to part-time alternatives or nonacademic fulltime positions.

Even though this study found non-significant gender differences in these attrition/turnover intentions, the factors that lead to these intentions may exhibits gender-specific reasons and shed more light on the work experience of women faculty in male-dominated disciplines.

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