SECTION 1. INTRODUCTION

The typical postsecondary academic career follows a well-ordered path with several discrete milestones. The first of these is securing a tenure-track position at an academic institution, at which point the individual is usually assigned to a junior rank, such as assistant professor. Junior faculty members ordinarily are employed on probation and are given a specified number of years to earn tenure. The second milestone, the tenure decision, is perhaps the most critical point on the academic career path. Earning tenure usually means lifetime employment and arrival at another milestone, promotion to the rank of associate professor. Failing to earn tenure often results in termination of employment at the institution. Some doctorate holders, presumably those who establish distinguished records, reach a final milestone with promotion to the rank of full professor.[1]

This study uses data from a nationally representative sample of recipients of doctorates in science and engineering (S&E). With these data we examined gender differences for four critical outcomes that reflect successful movement along the postsecondary academic career path. These four critical outcomes are tenure-track placement, earning tenure, promotion to the rank of associate professor, and promotion to the rank of full professor.

STUDY DESIGN

We conducted this study in two phases. Phase I examines whether a doctorate recipient's sex is related to the likelihood of successfully achieving outcomes at specific points in time along the academic career path. Phase II, which is longitudinal, examines whether their sex is related to the amount of time it takes doctorate recipients to achieve career milestones.

DATA

Both phases of this study used data from the Survey of Doctorate Recipients (SDR).[2] The SDR surveys individuals who earned doctorates in S&E in the United States. The survey is conducted every two years and provides information on individual doctorate recipients' academic field, career outcomes, and many personal characteristics (e.g., birth date, sex, and race/ethnicity).

The Phase I data include individuals who reported working full-time in academia and who appeared in the 1981 through 1997 waves of the SDR. The Phase II data include doctorate recipients reporting full-time academic employment in the 1997 SDR wave. Because the Phase II analysis tracked individuals from the time they earned their doctorates until the time of the 1997 survey, it also used some data from earlier SDR waves. These data include information required to construct work and family histories.

We emphasize that the SDR data include only those individuals who have earned doctorates in S&E[3] in the United States. As a result, our analyses do not consider career outcomes of individuals employed in academia who have not earned doctorates, individuals who have earned degrees in fields other than S&E, or individuals who earned doctorates outside the United States.

MODELING APPROACH

In both phases of our study we used multivariate statistical techniques that allowed us to control for factors other than sex that might be related to career outcomes.[4] All of the models we estimated include measures of human capital,[5] variables distinguishing academic fields and personal and family characteristics, and controls for when the doctorate was earned. Some of the models we estimated also include a set of selection variables reflecting characteristics of the employer and the primary work activity. These models should be interpreted cautiously because the selection variables themselves are outcomes that could be determined by the same processes that cause gender differences in tenure-track placements, tenure, and promotions to senior academic ranks.

[1] There are, of course, meritorious promotions beyond the full professor rank. Endowed chairs and promotions to high-level administrative positions are examples.

[2] The National Science Foundation (NSF) provides principal support for the SDR.

[3] The sciences include both the natural and social sciences. Engineering fields include chemical engineering, electrical engineering, and other engineering fields. See table 2-2 for a detailed list of academic fields included in this study.

[4] We estimate multivariate logit models in Phase I and multivariate hazard models in Phase II.

[5] Human capital is the accumulated set of skills and ability that enable individuals to perform jobs.

We imposed restrictions on the samples we used to estimate some models. These restricted models exclude doctorate recipients who reported employment in nontenure-track positions and/or those who reported employment in positions for which the outcomes of interest (tenure or academic rank) were not applicable.[6] We also urge caution in interpreting the results of these models. The individuals excluded from the samples are, in a sense, off the career path, and we must be concerned that their positions are influenced by their sex. For example, our analyses of tenure-track placements indicate that women are less likely than men to be employed in tenure-track positions.

Last, we estimated a set of models that include female-interaction variables as controls. These models, which allow for gender differences in the influence of family characteristics on career outcomes, enabled us to test hypotheses about whether being married or having children affects the careers of women and men differently. We have been careful to measure family characteristics at common points in individuals' postdoctoral careers, because we suspect that the timing of decisions about marital status and fertility are important. For example, we might expect that women who postpone childbirth until after the tenure decision might realize different career outcomes than women who are raising children at the same time they are being evaluated for tenure.

Study Limitations

Section 2 of this report describes several limitations of this study. We urge readers to consider these when interpreting the study's findings. Perhaps the most serious of these limitations is the potential for selection bias.

Doctorate recipients included in our analyses were not randomly assigned to the samples we used. They selected science or engineering as a field of study and completed requirements for a doctorate. They also must have selected and obtained a full-time position in academia rather than employment in a nonacademic job or a part-time academic position. Moreover, because we excluded nonacademic positions, the samples we used suffer from attrition in that they exclude doctorate holders who may have left academia, possibly because of failure to earn tenure or promotion.

One problem is that the selection process itself may be determined in part by differences in individual preferences or by discriminatory treatment that could be related to both a person's sex and chances for career success. Although we attempted to control for differences among individuals in our analyses, we were limited to characteristics that are measurable and available in the data we used. As is typically the case in empirical work, we could not control for remaining unobserved differences among individuals that could affect outcomes. These unobserved differences could be related to an individual's sex and the selection process, thus raising the possibility of selection bias.

Selection issues are present even within the sample of doctorates employed in academia. For example, doctorate recipients must select the kind of institution at which they seek employment and choose how to allocate their time among work activities. Given that promotion requirements vary across institutions, and chances for promotion depend on research and teaching credentials, these decisions are likely to affect chances for career success.

If assignment to the samples we used were truly random, our results might have been different; thus, we do not claim that our estimates of gender differences in career success rates reflect the effects of discriminatory treatment. The same caveat applies to cases where we find no statistical differences in success rates for women and men.

Summary of Findings

We find evidence that female scientists and engineers are less successful than their male counterparts in traveling along the academic career path. Some of this disparity appears to be related to differences between the sexes in the influence of family characteristics. Typically, married women and women with children are less successful than men who are married and have children. Our estimates of gender differences in success rates are relatively insensitive to characteristics of academic employers and to primary work activity. Below, we summarize our findings for each of the career outcomes examined in this study.

[6] Relative to men, a higher proportion of women in our samples reported employment in nontenure-track positions. However, the percentages of women and men reporting employment in tenure and rank "not applicable" positions are about the same.

Tenure-Track Placement

After accounting for controls, women with eight or nine years of postdoctoral experience who are employed full-time in academia are about 3.3 percentage points less likely than men to be employed in tenure-track positions. The comparable estimate for women with 14 or 15 years of experience is about 4.5 percentage points. If we allow for gender differences in the influence of family characteristics, gender differences in tenure-track placements are statistically insignificant. Our estimates suggest that being married or having children reduces women's chances to be employed in tenure-track positions relative to men who are married or have children.

Tenure

In Phase I of the analysis we examined gender differences in tenure rates for individuals with specific levels of postdoctoral experience. The findings that follow are based on the results of this analysis.

After accounting for controls, women with eight or nine years of postdoctoral experience who are employed full time in academia are about 6.9 percentage points less likely than men to be tenured. The comparable estimate for women with 14 or 15 years of experience is about 8.5 percentage points. When we restrict our analysis to tenure-track positions only, women with eight or nine years of postdoctoral experience are about 5.9 percentage points less likely than men to be tenured. The comparable estimate for women with 14 or 15 years of experience is about 4.1 percentage points.

Our analysis suggests that women's chances for earning tenure are related to the influence of family characteristics. In most of the models we estimated, gender differences in tenure rates are statistically insignificant when we allow for gender differences in the influence of family characteristics. Having young children later in their careers is positively related to women's chances for earning tenure. We interpret this as indirect evidence suggesting that women who do not have children early in their careers increase their chances for earning tenure.

The Phase II tenure analysis estimated gender differences in the likelihood of doctorate recipients earning tenure at any given time in their careers. For the most part, the results of our Phase II tenure analysis are consistent with the findings reported above for Phase I. After accounting for controls, women are less likely than men to be tenured, and, if we allow for gender differences in the influence of family characteristics, gender differences in the probability of being tenured are statistically insignificant.

Academic Rank

Our Phase I analysis examined the likelihood that individuals will be employed in any one of three different academic ranks—junior ranks, rank of associate professor, and rank of full professor—at specific points in their postdoctoral careers.

We found that, after accounting for controls, women with 14 or 15 years of postdoctoral experience who are employed full-time in academia are about 8 percentage points more likely than men to be employed in junior ranks. The estimate for women with 20 or 21 years of postdoctoral experience is similar. After accounting for controls, women with 14 or 15 years of postdoctoral experience who are employed full-time in academia are almost 14 percentage points less likely than men to be employed at the rank of full professor. The comparable estimate for women with 20 or 21 years of postdoctoral experience is similar. Our analysis suggests some of the gender differences in academic rank are related to differential influences of family characteristics. For example, if we allow for gender differences in the influence of family variables, the relative difference in employment at the full-professor rank for full-time academicians with 20 or 21 years of postdoctoral experience falls to about 7 percentage points, but it remains statistically significant. Gender differences in academic rank decline if we exclude from our samples doctorate recipients who reported employment in nontenure-track positions. This finding is consistent with our Phase I tenure analysis, which shows that women are more likely than men to be employed in these positions.

The Phase II rank analysis estimated differences between women and men in the likelihood of doctorate recipients holding either the associate- or full-professor rank at any given time in their postdoctoral careers. Most of our Phase II findings are consistent with the results of our Phase I rank analysis. The Phase II rank analysis indicates that, after accounting for controls, women are less likely than men to be promoted to senior ranks. We also find that after allowing for gender differences in the influence of family characteristics, gender differences in promotions to the full-professor rank are statistically insignificant. We are concerned, however, that the data we used in our Phase II analysis overstate the relative

amount of time it takes men to earn promotions, causing us to understate gender differences in promotion rates in the Phase II analyses.[7]

Organization of Report

Sections 2 through 4 of this report provide a description of the study design, our report and interpretation of the results of the tenure track and tenure analyses, and our analysis of gender differences in academic rank.

Additional information is provided in five appendices. Appendix A provides descriptions of the statistical models used in this study. Appendix B is an alphabetical glossary of all variable acronyms. Appendix C reports full-model estimates and associated statistics for the Phase I analyses, and Appendix D reports detailed statistics for the Phase II analyses. Appendix E describes the procedures we used to construct the databases used in the analyses and discusses several data issues that surfaced during this study.

[7] We measured time to promotion by searching SDR waves for the first occurrence of an individual reporting employment at a senior rank. Missing information on academic rank in the SDR files, however, is a potential problem. If an individual fails to complete the section of the SDR questionnaire on academic rank after being promoted, we will overstate the time the individual took to achieve the senior ranks. In the sample we used, men are about 3.5 percent more likely than women to have failed to report academic rank before promotion to associate professor and are about 3.0 percent more likely to have failed to report this information before promotion to full professor. This issue holds for the Phase II tenure analysis as well. Men are about 3.5 percent more likely than women to have failed to report tenure status before earning tenure.