Keeping Women in the Science Pipeline

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Premier science largely depends on the quality of the pool of future scientists. For this reason the United States has made a major effort over the past 30 years to attract more outstanding U.S. students, particularly women, into research science.[i] Women have risen to the challenge with significant increases in all physical sciences and engineering, and they have made a huge advance in the life sciences, where they now receive more than 50 percent of all Ph.D.s.[ii]

Women now represent a large part of the talent pool for research science, but many data sources indicate that they are more likely than men to "leak" out of the pipeline in the sciences before obtaining tenure at a college or university.[iii] The loss of these women, together with serious increases in European and Asian nations' capacity for research, means the long-term dependability of a highly trained U.S. workforce and global preeminence in the sciences may be in question.[iv]

Our research addresses the effect of family formation on both when and why women and men drop or opt out of the academic science career path and on those who remain on the path. It offers an extensive examination of the experiences of researchers as well as the role that institutions of higher education and federal granting agencies play in regard to the leaky pipeline in the sciences.

We collected data from a number of sources: A national longitudinal survey, the Survey of Doctorate Recipients, created by NSF;[v] and several original surveys. Our surveys covered four academic researcher populations in the University of California system, including doctoral students, postdoctoral scholars, academic researchers, and faculty; a survey of the 62 member institutions of the Association of American Universities, a nonprofit organization of leading public and private research universities in the United States and Canada;[vi] and a survey of 10 of the major federal granting agencies.[vii]

The United States is a global leader in science, but we risk losing our edge

Since the end of World War II, major research universities, federal agencies, and private industry have built a scientific infrastructure across the United States of unprecedented nature. Working together, we have established ourselves as the premier science nation, the master of innovation in areas such as information technology and processing, nanotechnology, biotechnology, genetics, semiconductor electronics, weapons technology, and engineering, and the standard by which other nations measure themselves. Our stellar programs in the sciences attract graduate students and postdoctoral scholars from around the globe, and our commitment to funding both basic and applied science has served as a model to aspiring nations.[viii]

Although recent debate is divided on whether we are maintaining our global preeminence in the sciences,[ix] certain patterns are generally accepted. Nations such as South Korea and China are experiencing relatively faster growth than the United States, and the European Union as a whole has achieved a magnitude similar to if not greater than our own.[x] Other nations are also investing heavily in higher education, including providing incentives for students to obtain science and engineering degrees.[xi]

Perhaps more troubling, multiple sources of evidence suggest that younger generations of Americans begin their educational careers with interest in science but all too often sour on the enterprise, opting out along the way in pursuit of more attractive endeavors. This trend appears particularly acute among girls and women and among underrepresented minorities.[xii]

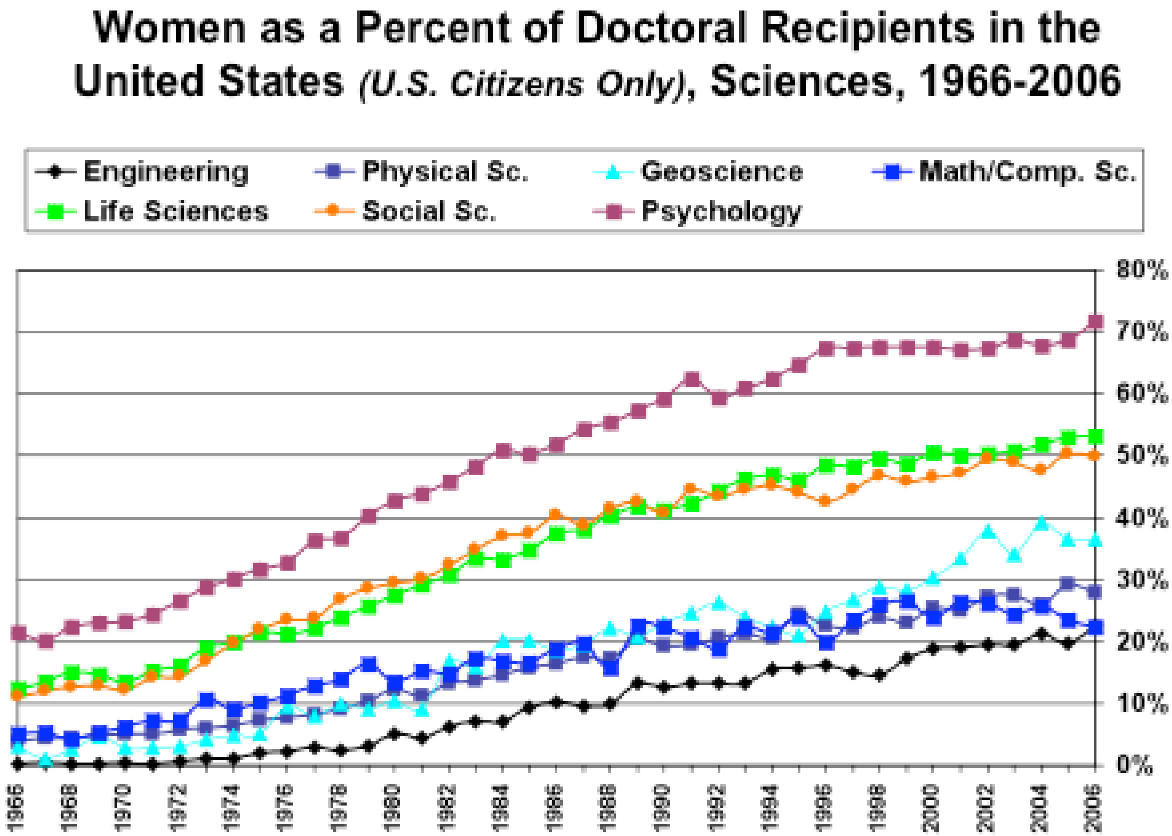
This general pattern of domestic attrition in the sciences has received greater attention in recent years, but the periodic sounds of alarm seem to have been subdued because our labor supply of talented scientists has been back-filled with large numbers of newly minted international Ph.D.s and postdoctoral fellows.[xiii] This so-called "brain drain" from other countries that has so greatly benefited the United States appears to have suppressed our concern about the loss of some of our domestic populations from the science pipeline.

Increasingly, however, as high-tech regions have become established in other nations—India, Ireland, China, and South Korea, to name a few of the best known examples—and research universities around the world are seemingly closing the gap in regard to institutional excellence, the long-term dependability of this supply of highly trained readily available international work force is in question.

Demographic shifts in the U.S. academic science workforce

Our domestic supply of highly trained scientific researchers and scholars has undergone a tectonic shift in the last 40 years. Women, who once comprised a tiny fraction of our domestic Ph.D.s in the sciences, are becoming the majority population in large segments of the sciences: psychology, the social sciences, and perhaps most importantly, the large and rapidly expanding life sciences—the cornerstone of the new age of biology.

The gender split between the more human-centric and non-human-centric sciences remains, with women predisposed toward pursuits that tie more directly to human experience,[xiv] but even these lines are blurring. Women have made impressive gains in the least tractable of the sciences, breaking through into the once homogenous fields of physical sciences, technology, engineering, and mathematics. Over the last four decades, the relative proportion of women Ph.D. recipients has increased more than 100-fold in engineering (from a scant .2 percent in 1966 to 22.5 percent in 2006), 12-fold in the geosciences (3 percent to 36.6 percent), and 8-fold in the physical sciences (3.7 percent to 27.9 percent). Since these general trends appear unabated and women are outperforming men at the baccalaureate and master's level of education in the United States,[xv] it seems reasonable to conclude that further gains will occur.

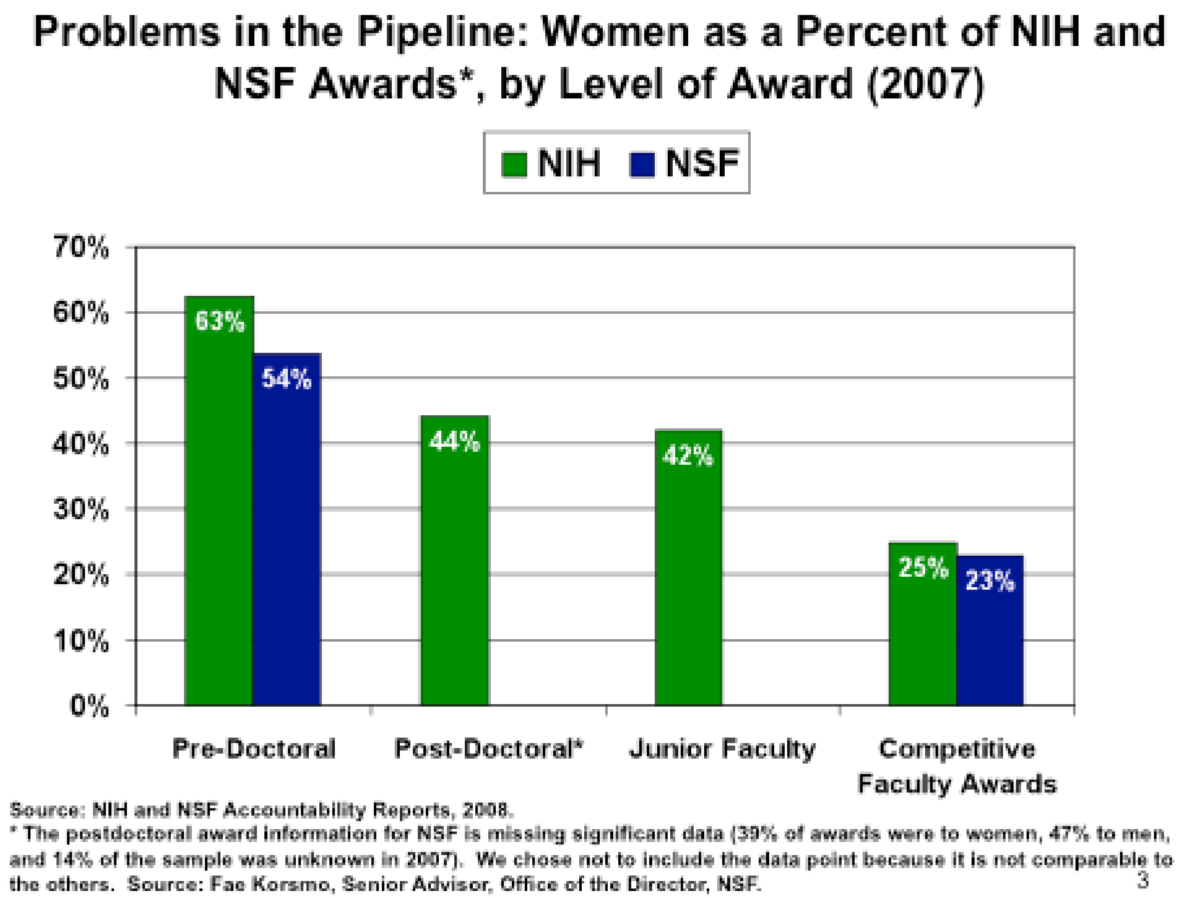


Source: National Science Foundation (NSF), Survey of Earned Doctorates, retrieved from WebCaspar, 4/15/2009.[2]

Despite this fundamental shift federal agencies and academic institutions as a whole have been slow to understand some of the implications of a labor supply that is increasingly comprised of women. The "leaky pipeline" for women in the sciences, sometimes referred to as the "pool problem" because of the low number of women in job applicant pools relative to their rates of doctoral degrees granted, has become a point of debate in recent years. Discussions about the reasons for the leaks range from "chilly" institutional and departmental climates to gender bias and discrimination, to innate differences in cognition to lack of mentoring to the role of marriage and children.[xvi] This debate was perhaps best brought to national attention in the aftermath of comments by former President of Harvard University Lawrence Summers in 2005, when he referenced theories that women might have less intrinsic aptitude to excel at academic science careers.[xvii]

The story is becoming clearer. A recent report by the National Research Council of the National Academy of Sciences , “Gender Differences at Critical Transitions in the Careers of Science, Engineering and Mathematics Faculty,” discusses in detail the underrepresentation of women in many of the scientific disciplines at academic institutions across the country, particularly in the higher faculty ranks.[xviii] The report confirmed that women who receive Ph.D.s in the sciences were less likely than men to seek academic research positions—the path to cutting-edge discovery—and they were more likely to drop out before attaining tenure if they did take on a faculty post.7 However, the NRC report stated that their surveys did not shed light on many of the potential reasons why women were more likely to drop out. It states: “The report does not explore the impact of children and family obligations (including elder care) on women’s willingness to pursuefaculty positions in R1 institutions or the duration of postdoctoral positions.”8

And data from both NIH and NSF, the two agencies providing the greatest amount of funds to researchers in U.S. universities and colleges also suggest that the leaky pipeline is not an aspect of the past. Women comprise a much larger proportion of the predoctoral fellowships given by these agencies than they do postdoctoral fellowships and competitive faculty grants. The drop-off in relative proportion is dramatic, with women comprising 63 percent and 54 percent of NIH and NSF’s predoctoral awards in 2007, respectively, but just 25 percent and 23 percent of the competitive faculty grants awarded in the same year.[xix] The recent demographic surge in proportion of women Ph.D.s may account for some but not all of this dramatic drop.



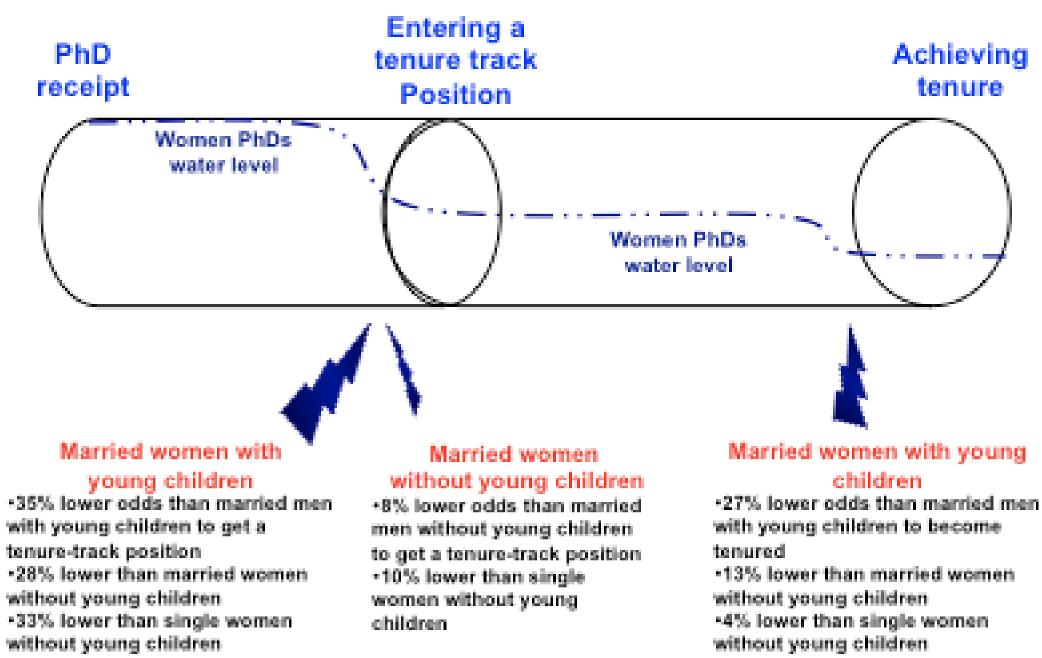
Effect of Family Formation

The best way to assess what is truly going on in the pipeline of women in the sciences is to conduct careful longitudinal analysis that follows the same individuals over time, from Ph.D. receipt onward. The Survey of Doctorate Recipients, or SDR, sponsored by NSF and other federal agencies, makes this analysis possible.[xx] The SDR, a longitudinal, biennial, nationally representative survey of Ph.D. recipients' post -degree employment status with almost 170,000 participants from 1973-2003, has included family related questions since 1981 and is therefore the ideal data source to measure the effects of gender and family on men and women's academic career progress.[xxi]

Analyzing the SDR data, we found that family formation—most importantly marriage and childbirth—accounts for the largest leaks in the pipeline between Ph.D. receipt and the acquisition of tenure for women in the sciences.

Women in the sciences who are married with children are 35 percent less likely to enter a tenure track position after receiving a Ph.D. than married men with children 27 percent less likely than their male counterparts to achieve tenure upon entering a tenure-track job.[xxii] ***By contrast, single women without young children are roughly as successful as married men with children in attaining a tenure-track job***, and a little more successful than married women with children in achieving tenure. Married women without children also do not fare quite as well as men.

Leaks in the Pipeline to Tenure for Women PhDs in the Sciences*



*Results are based on survival analysis of the *Survey of Doctorate Recipients* (a national biennial longitudinal data set funded by the National Science Foundation and others, 1981 to 2003) in all sciences, including social sciences. The analysis takes into account discipline, age, ethnicity, PhD calendar year, time-to-PhD degree, and National Research Council academic reputation rankings of PhD program effects. For each event (PhD to TT job procurement, or TT job to tenure), data are limited to a maximum of 16 years. The waterline is an artistic rendering of the statistical effects of family and gender. Note: The use of NSF Data does not imply the endorsement of research methods or conclusions contained in this report. Person-year N for entering tenure track=140,275. Person-year N for achieving tenure=46,883. 6

EARLY DECISIONS

Young scientists often make decisions about their career path while still in training. Research-intensive careers in university settings have a bad reputation with both men and women. The majority of doctoral students and postdoctoral scholars in our surveys indicated that they were concerned about the family friendliness of possible career paths, but research-intensive universities were considered the least family friendly of a range of possible career choices including tenure-track careers at teaching-intensive institutions, non-tenure track faculty positions, policy and managerial careers inside and outside academia, and research careers within and outside academia.[xxiii]

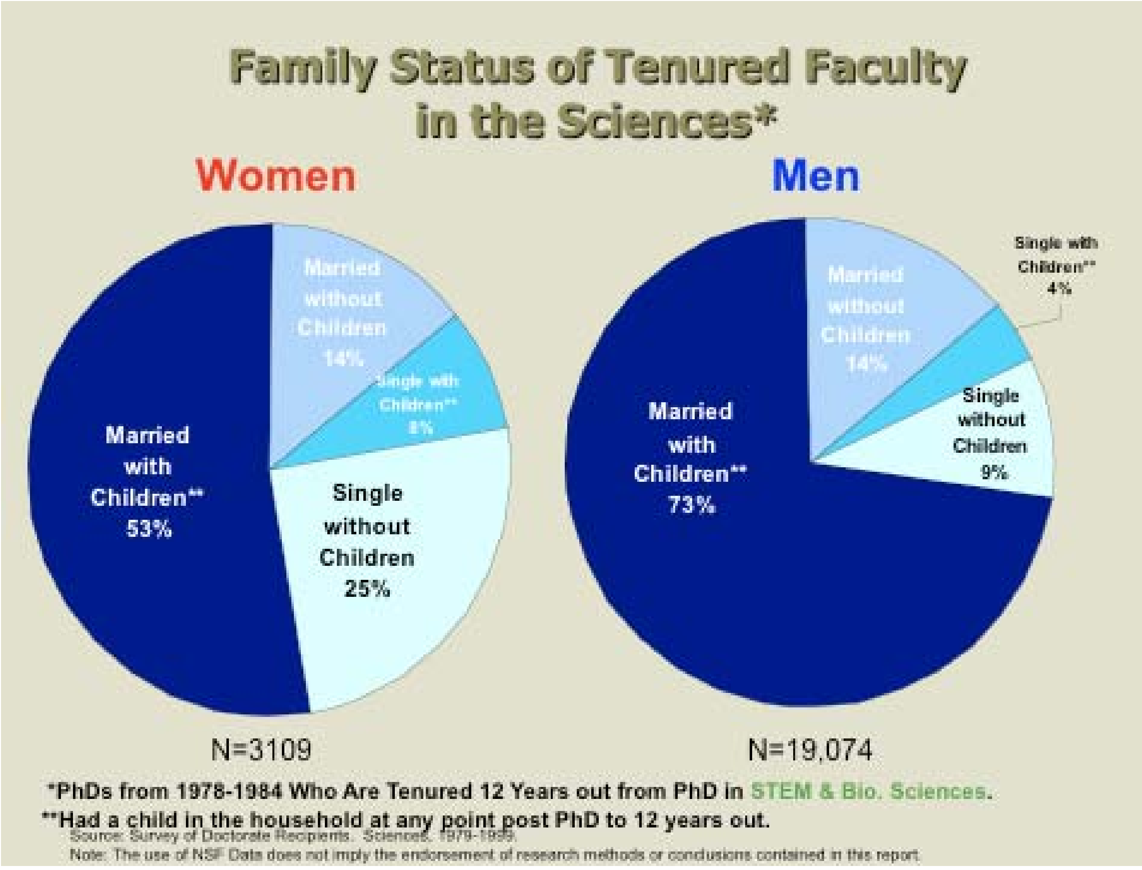
Among the graduate students neither men nor women consider tenure-track faculty positions in research-intensive universities to be family-friendly career choices. Less than half of men (46 percent) and a only third of women (29 percent) imagine jobs in these settings to be somewhat or very family friendly. Among new parents supported by federal grants (from agencies such as the National Science Foundation or the National Institutes of Health) at the time of the birth or adoption of a child, the perception is even stronger—only 35 percent of men and 16 percent of women think that tenure-track faculty careers at research-intensive universities are family friendly. Although men are more optimistic about most possible career tracks than are women, both men and women (82 percent and 73 percent, respectively) rate faculty careers at teaching-intensive colleges as the most family friendly. All other career choices, including policy or managerial careers, research careers outside academia, and non-tenure track faculty positions, are more likely to be considered family friendly than careers at research-intensive universities.

In response to open-ended questions on our survey, many respondents said that they did not want lifestyles like those of their advisers or other faculty in their departments. Women doctoral students in particular seem not to see enough role models of women faculty who successfully combine work and family, and they rate the family friendliness of research-intensive universities based on this fact. The fewer women faculty with children they see or know in their departments or units, the less likely women doctoral students are to feel that tenure-track faculty careers at research-intensive universities are family friendly—only 12 percent of women doctoral students who reported that it is not at all common for women faculty in their departments or units to have children said that they viewed research-intensive universities as somewhat or very family friendly. In contrast, 46 percent of women doctoral students who said that it is very common for women faculty in their departments or units to have children rated careers at research-intensive universities as family friendly.

These graduate students are taught by a science faculties in which there may be few women professors, and those that are, are far less likely to be married with children. According to the SDR, Using the SDR data set, we analyzed the life courses of PhD recipients, including their decisions about marriage and fertility, to determine whether an academic career affects family formation. This survey also allowed us to look more closely at the child-bearing patterns of men and women faculty members. The average age for receiving a PhD is thirty-three. Many professors do not secure tenure before they are forty. The busy career-building years as agraduate student, an assistant professor, and, in some fields, a postdoctoral fellow are important reproductive years, particularly for women. These are the years when the fast track and the reproductive track are on a collision course. We found that careers matter: the life trajectories of tenured women scientists differ from those of tenured men.

Tenured male scientists are far more likely to be married with children (73%) than tenured women scientists (53%). And women are nearly three times more likely than men to be single without children. The divorce rate among tenured women faculty is also high; more than 50% higher than that of tenured men.[xxiv]

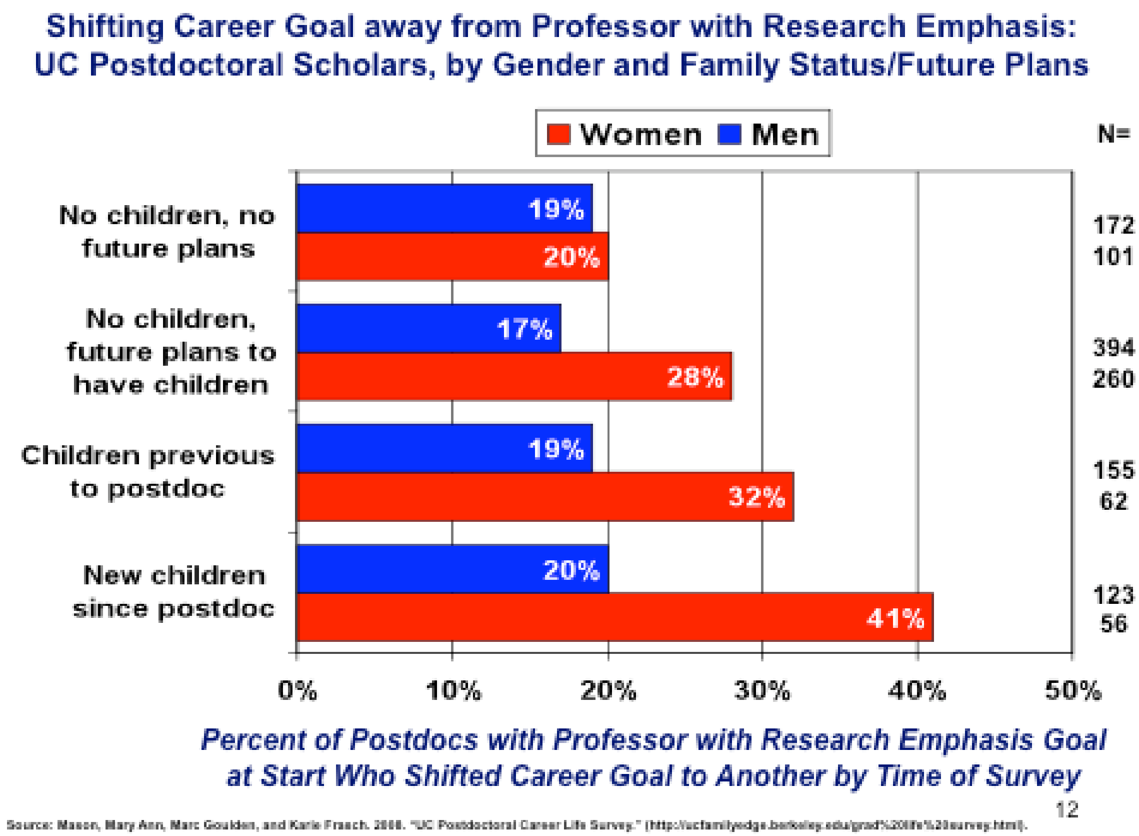
Of course, not all women want children or marriage. As one faculty colleague put it, "Motherhood would only keep me from my passion: science." And many men and women enjoy partnerships not revealed by this traditional survey, which inquires only about marriage.



Postdoctoral Fellows

The issue of children is even more dramatic in influencing postdoctoral women's decisions to abandon professorial career goals with research emphasis—but not so for men. Among postdoctoral scholars with no children and no future plans to have them, women and men are essentially equally likely to indicate that they shifted their career goal away from professor with research emphasis, with roughly one in five doing so.

Future plans to have children, however, affect women and men postdoctoral scholars differently, with women more likely to shift their career goal (28 percent of women versus 17 percent of men). Having children prior to entering a postdoctoral position at the UC system and having a new child since entering the position appears to ratchet up the pressure further on women to drop their professor with research emphasis career goal, but not so for men. Women postdoctoral scholars who had children after they became a postdoctoral scholar at the UC system were twice as likely as men who experienced a similar life-changing event to change their career goal (41 percent versus 20 percent), and twice as likely to do so as women with no children and no future plans to have children (41 percent versus 20 percent). [xxv]



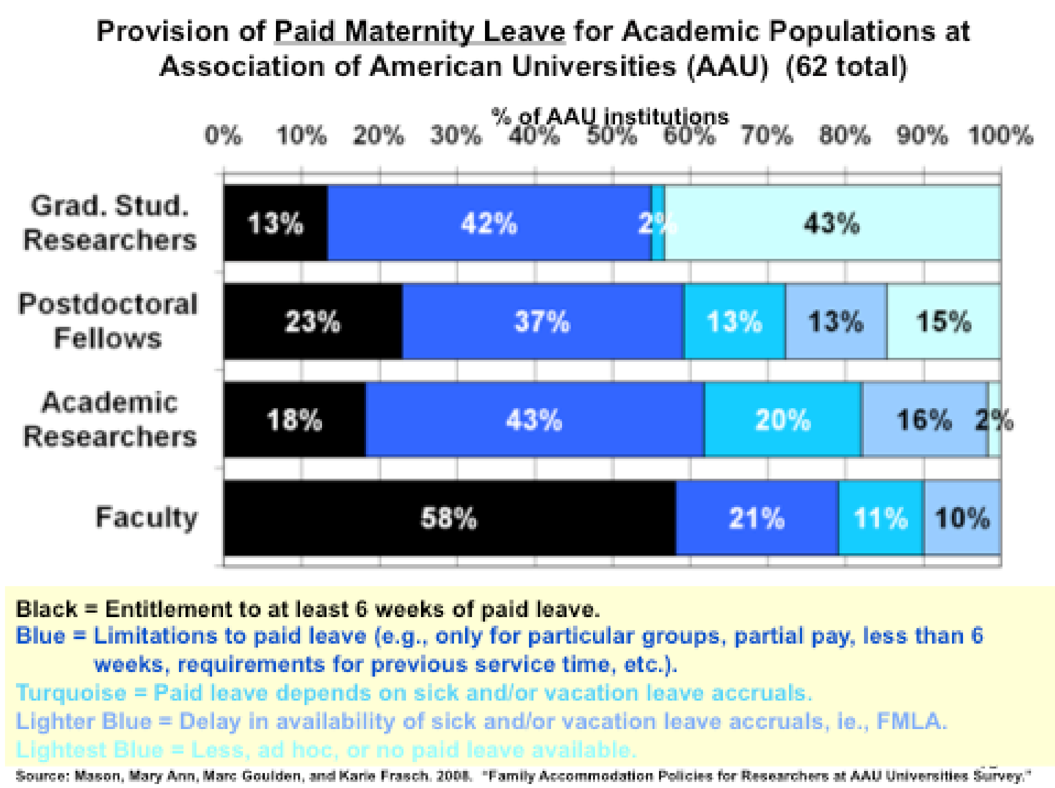
Family Responsive Benefits

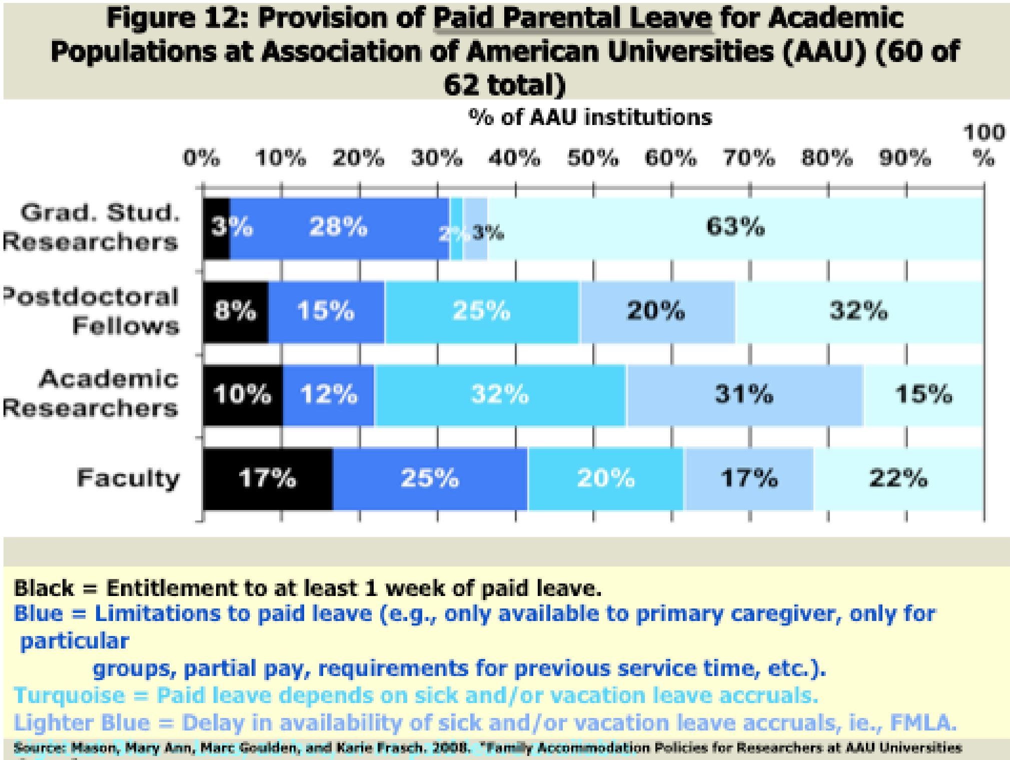
America's researchers receive limited benefits when it comes to family-responsive policies such as paid maternity and parental leave. Young scientists early in the pipeline are the least likely to receive these benefits**.**

Faculty are the only population where a majority of the 62 AAU universities (58 percent)[xxvi] provide a baseline family-responsive maternity leave policy of at least six weeks of guaranteed paid leave following childbirth, *without limitations that prohibit access to it*. Only a fraction of research universities offer this level of paid maternity leave to graduate students, postdoctoral scholars, and academic researchers, with only 13 percent of universities making this baseline policy available to graduate students (43 percent of them offer only ad hoc paid leave, or no paid leave at all).

Many universities do provide some maternity and parental leave, but the limitations associated with these policies significantly affect contingent classes of researchers such as graduate students, postdoctoral scholars, and academic researchers. These limitations include requirements that limit the number of individuals who qualify for the policy, limitations on the length of the policy or the percentage of salary paid, and limitations focused on the accrual of sick and/or vacation leave.

The level of paid parental leave is even less encouraging—only a tiny number of institutions provide a baseline of at least one week of guaranteed paid parental leave *without limitations* to any of the four populations.





Federal Agencies

Federal agencies that fund the lion's share of research at universities across the nation defer to the family responsive policies of the institutions.[xxvii] However, there are compelling reasons for federal agencies to take a proactive role in assuring family responsive policies that will help women scientists to achieve their career goals.[xxviii] First is the public commitment of federal agencies to assure gender equity in the science pipeline; and second, the mandated role of federal agencies in assuring Title IX compliance by federal grant-contract recipients, including research universities.[xxix]

Grants and contracts in fast-track academic science

In 2002 nearly half (48 percent) of tenure-track faculty aged 25 to 45 in the sciences and social sciences (U.S. Ph.D.s only) had work in the previous year that was partially or fully supported by contracts or grants from the federal government, with the largest receiving support from NIH or NSF.[xxx] Federal grants play a critical role in achieving promotion and tenure in academia; among tenure-track faculty in the sciences, support from federal grants and contracts is strongly associated with career advancement, particularly at Carnegie Research I institutions, or R1s.[xxxi]

As a result of the NSF Authorization Act of 2002 the RAND Corporation conducted and released a report examining gender differences in federal grant funding outcomes at NIH, NSF, and the U.S. Department of Agriculture.[xxxii] While this study found few or no differences between men and women in funding requested, the probability of getting funded, or the size of the award, it did not examine the likelihood of men and women, with or without children, in securing federal funding, or the population of people who did not apply for these grants.

The RAND report did find that at NSF and NIH, women first-time applicants, whether successful or not, were less likely than men to apply again within two years. This finding is supported by research from two other studies that found that women were less likely than men to apply for funding from federal agencies.[xxxiii]

Analyzing the SDR (from 1981 to 2003) we found that tenure-track faculty women who were married with young children were 21 percent less likely than tenure-track men who are married with young children, 26 percent less likely than tenure-track women who were married without young children, and 19 percent less likely than single women without children to have their work partially or fully supported by federal grants or contracts on a year-to-year basis.[xxxiv]

There is also great pressure on principal investigators who hold grants which support young scientists. In our focus groups principal investigators observed that when researchers paid by grants need family leave or modification of duties that it puts them in a very difficult position, wanting to support the individual but also knowing that their research projects will likely suffer. With no existing method for receiving remuneration for this loss, faculty PIs reported tremendous frustration with this dynamic. In fact data from our survey of faculty PIs at UC Berkeley make clear the extent to which this is a difficult issue for them—32 percent observed that granting family responsive leave to researchers paid off their grants had a negative impact on their work.[xxxv]

Evidence from the SDR suggests that the collision course between career timing and family timing may only be getting worse. Our analysis of SDR data indicates that while the average age for tenure receipt among tenure-track faculty in the sciences was 36 in 1985, the average age extended out past age 39 by 2003. Similarly, the average age at receipt of the first NIH RO1-equivalent grant (major research project grant) increased from about 34 years of age in 1970 to 42 years in 2007.[xxxvi]

Some universities may be out of compliance with Title IX requirements.

According to findings from our survey, some universities may not be complying with Title IX, which requires that research universities receiving federal funds 1) treat pregnancy as a temporary disability for purposes of calculating job-related benefits, including any employer-provided leave, and 2) provide unpaid, job-protected leave for "a reasonable period of time" if the institution does not maintain a leave policy for employees.[xxxvii]

When asked about the provision of unpaid leave to postdoctoral scholar birth mothers, one university respondent indicated that they do not provide it, and six indicated that they did not know whether or not it was provided. All universities and colleges should have in place a clear policy regarding unpaid leave for birth mothers. And Title IX reviews should look at these policies to ensure that universities are in compliance.

THE LIFELONG EFFECTS OF FAMILY FORMATION ON CAREER

Family responsibilities do not end with childbirth. The lock-step structure of academia is unforgiving. Parents, but particularly women, experience significant caregiving responsibilities up through age 50, making it hard for them to keep up with academic career pressures.

For faculty and researchers in the sciences the need to secure initial grant money and then pursue additional funding to continue research projects and support graduate students and postdoctoral scholars adds an additional layer of unrelenting time pressure. In focus groups conducted by our research team with faculty and academic researchers with federal funding, the theme of never being able to take a break was continually returned to by participants. [xxxviii]

The time pressures of academia are unrelenting for most faculty in the sciences, who work on average about 50 hours a week up through age 62. When combined with caregiving hours and house work, UC women faculty with children, ages 30 to 50, report a weekly average of over 100 hours of combined activities (—compared to 86 hours for men with children).[xxxix] And women faculty with children provide an average of more than 30 hours a week of caregiving up through age 50, while family responsive policies rarely address this long-term career-life issue.

Evidence indicates that the collision course between career timing and family timing may be worsening—the average age for tenure receipt among tenure-track faculty in the sciences was 36

in 1985, and extended out past age 39 by 2003. As all of the fast-track academic timelines have pushed out—age at Ph.D. receipt, number of years in postdoctoral positions, and age at start of tenure-track positions—faculty PIs may find themselves in an increasingly difficult situation as the pressure on them may intensify to either deny family responsive accommodations to researchers paid off their grants or completely avoid hiring individuals they fear might end up giving birth to children.

Early Steps

Although much remains to be done, some AAU institutions have put in place family responsive policies, benefits, and resources, including time-based policies and benefits such as stopping the clock (i.e., tenure-clock extension), various child care supports such as on- and off-campus centers, monetary supplements such as tuition remissions, and other resources such as lactation rooms.

Federal agencies have made similar efforts, with some agencies—particularly NIH and NSF—standing above the rest. Efforts include the provision of no-cost extensions for caregiving purposes (typically providing an additional year to complete the project, with no additional funds), grant supplements to support family responsive policies or needs, gender equity workshops, formalized agency policies or statements supporting women in the academic pipeline, allowing part-time effort on fellowships or grants, and extending the fellowship period for caregiving. [xl]

However, the lack of coordination between research universities and federal agencies creates inconsistent and inadequate coverage.

Recommendations for federal agencies and universities

Promote clear, well-communicated, baseline family responsive policies for all classes of researchers.

As described at length in this report, America's researchers do not receive enough family responsive benefits, particularly the more junior researchers. Together, federal agencies and universities can make headway in solving this systemic problem.

Federal agencies, particularly the National Institutes of Health, the National Science Foundation, and the nonprofit organization The American Association for the Advancement of Science, which oversees federally funded research fellows for many of the federal granting agencies, can help by setting equitable, clearly communicated baseline family responsive policies for their fellows. At the same time, universities need to adopt baseline family responsive policies for all of their classes of researchers—not just faculty. Graduate student researchers and postdoctoral scholars receive the most limited benefits and are arguably the most important in affecting the future of U.S. science.

Provide federal agency or university supplements to offset family event productivity loss.

Without providing additional financial supplements in association with family responsive policies, faculty principal investigators, or PIs—those with primary responsibility for the design, execution, and management of a research project—will continue to bear the brunt of supporting family-related absences from their research dollars. This dynamic is unfair to PIs and may create a situation where they will find it to their advantage to avoid hiring researchers who might eventually need family responsive policies. This becomes an unintended form of discrimination against women. To avoid this structural difficulty, supplementary funding needs to be provided when researchers paid off of grants take necessary leaves/modifications.

Collaboratively move toward a full package of family friendly policies that take into account the career-family life course.

All major research universities should look to build a family-friendly package of policies and resources, and federal agencies can provide much more than they already do. Sharing and wide-scale adoption of proven practices are necessary.

Remove time-based criteria for fellowships and productivity assessments that do not acknowledge family events and their impact on career timing.

The lock-step timing of academia needs to be more flexible. Time caps and barriers to entry—such as those that require a postdoctoral scholar position to begin within a certain number of years following receipt of the Ph.D.—that set rigid sequential deadlines should be removed. Universities and federal agencies need to examine all of their policies in this regard and look for ways to encourage reentry into the pipeline for academic researchers who take time off for giving birth or caring for children and promote a more holistic concept of career patterns that honors the larger needs of individuals.

Collect and analyze the necessary data to make sure existing and future policy initiatives are effective in meeting researchers' needs and comply with Title IX.

The lack of necessary data and multiyear commitments to these efforts continues to hamper our delivery of truly effective initiatives. Decisions about family responsive policies, programs, and benefits will continue to be made on intuition and anecdote if they are not tracked by systematic longitudinal data. Both federal agencies and universities need to build and maintain the necessary datasets to assess whether our efforts are yielding positive results and whether Title IX requirements are being met. Federal agencies can provide more grant programs to help determine whether our efforts are working, and Title IX compliance reviews should include questions on family responsive policies.

Our current inadequate family responsive benefits for America's researchers makes no economic sense. In the world of federal grants individuals who drop out of science after years of training represent a huge economic loss and are a detriment to our nation's future excellence. Given the nation's interest in maintaining America's competitive advantage, future federal investments should be focused on patching the leaky pipeline in the sciences. Doing so will help us preserve our competitive edge.

****Thanks to the Alfred P. Sloan Foundation, who generously funded this research.***

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[v] The Survey of Doctorate Recipients is a biennial weighted, longitudinal study following almost 170,000 Ph.D. recipients across all disciplines until they reach age 76. The SDR is sponsored by the National Science Foundation and other government agencies. The use of NSF data does not imply endorsement of research methods or conclusions contained in this report.

[vi] See Association of American Universities, available at http://www.aau.edu/.

[vii] National Science Foundation, National Institutes of Health, US Department of Agriculture, National Aeronautics and Space Administration, Department of Defense, Department of Energy, US Agency for International Development, National Endowment for the Humanities, Department of Commerce, and the Department of Education.

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