Keeping Women in the Science Pipeline

By
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Premier science largely depends on the quality of the pool of future scientists. Women now represent a large part of the talent pool in the United States, but many data sources indicate that they are more likely than men to "leak" out of the science pipeline before obtaining tenure at a college or university. The authors' research examines this issue in detail, drawing on multiple sources, including the Survey of Doctorate Recipients and several original surveys. Their findings show that family formation—most important marriage and childbirth—accounts for the largest leaks in the pipeline from graduate school to the acquisition of tenure for women in the sciences. The authors also find that researchers receive limited benefits when it comes to family responsive policies, such as paid maternity and parental leave, and that young scientists receive the least. Together, federal agencies and universities can make headway in solving this systemic problem.

Keywords: women; science; family formation; researchers; universities; federal agencies; family policies

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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 (Congressional Commission on the Advancement of Women and Minorities 2000, 20; Burke and Mattis 2007). 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 PhDs (U.S. Census Bureau 2008; National Science Foundation [NSF] 2009).

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 (Long 2001; Mason and Goulden 2002, 2004a, 2004b; American Council on Education 2005; Nelson 2007; Committee on Maximizing the Potential of Women 2007; Ceci, Williams, and Barnett 2009; Goulden, Frasch, and Mason 2009). 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 (Hill et al. 2007; Committee on Prospering in the Global Economy 2007; Kazmierczak, James, and Archey 2005, 2007; Galama and Hosek 2008; Lane 2008; Adams 2009).

Our research addresses the effect of family formation on both when and why women and men drop out 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 and analyzed data from a number of sources: a national longitudinal survey, the Survey of Doctorate Recipients (SDR), sponsored by the NSF and other federal agencies,[1] 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 sixty-two-member institutions of the Association of American Universities, a nonprofit organization of leading public and private research universities in the United States and Canada;[2] and a survey of ten of the major federal granting agencies.[3]

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 the private industry have built a scientific infrastructure across the United States of an 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 for aspiring nations (Jackson 2003; Galama and Hosek 2008; Lane 2008).

Although recent debate is divided on whether we are maintaining our global preeminence in the sciences, 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. Other nations are also investing heavily in higher education, including providing incentives for students to obtain science and engineering degrees (Hill et al. 2007; Kazmierczak, James, and Archey 2005, 2007; Committee on Prospering in the Global Economy 2007; Galama and Hosek 2008; Lane 2008; Adams 2009; National Science Board 2010).

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 (Long 2001; Mason and Goulden 2002, 2004a, 2004b; American Council on Education 2005; Nelson 2007; Committee on Maximizing the Potential of Women 2007; Ceci, Williams, and Barnett 2009; Goulden, Frasch, and Mason 2009).

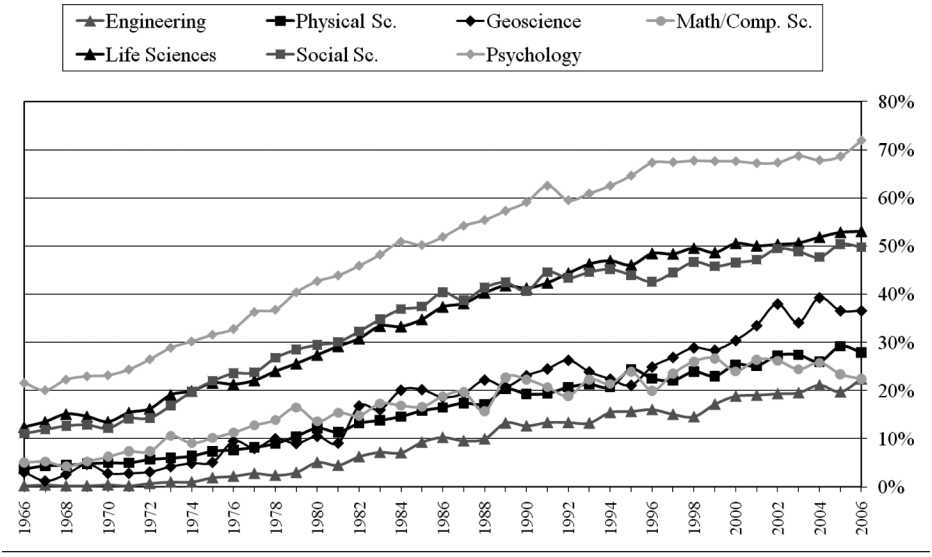
This general pattern of domestic attrition in the sciences has received greater attention in recent years, but the periodic sounds of alarm seem to have been subdued because our labor supply of talented scientists has been back-filled with large numbers of newly minted international PhDs and postdoctoral fellows (Committee on Policy Implications of International Graduate Students and Postdoctoral Scholars 2005; Davis 2005). 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 a highly trained, readily available international workforce 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 past 40 years. Women, who once composed a tiny fraction of our domestic PhDs in the sciences, are becoming the majority

FIGURE 1
Women as a Percent of Doctoral Recipients in the United States (U.S. Citizens Only), Sciences, 1966–2006



Source: National Science Foundation (2008b).

population in large segments of the sciences: psychology; the social sciences; and, perhaps most important, the large and rapidly expanding life sciences—the cornerstone of the new age of biology.

The gender split between the more human-centric and nonhuman-centric sciences remains, with women predisposed toward pursuits that tie more directly to human experience (Jacobs 2005; Lubinski and Benbow 2006; Rosenbloom et al. 2008), but even these lines are blurring. Women have made impressive gains in the least tractable of the sciences, breaking through into the once homogeneous fields of physical sciences, technology, engineering, and mathematics (NSF 2008b). Over the past four decades (see Figure 1), the relative proportion of women PhD recipients has increased more than one hundred–fold in engineering (from a scant 0.2 percent in 1966 to 22.5 percent in 2006), twelve-fold in the geosciences (3 percent to 36.6 percent), and eight-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 (U.S. Census Bureau 2008), it seems reasonable to conclude that further gains will occur.

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 composed 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, from innate differences in cognition to lack of mentoring to the role of marriage and children (Valian 1998; Massachusetts Institute of Technology 1999; Committee on Maximizing the Potential of Women 2007; Committee on Gender Differences 2009; American Association of University Professors 2001; Mason and Goulden 2002, 2004a, 2004b; Ward and Wolf-Wendel 2004; Van Anders 2004; Wolfinger, Mason, and Goulden 2008; Goulden, Frasch, and Mason 2009). This debate was perhaps best brought to national attention in the aftermath of comments by former Harvard University President Lawrence Summers in 2005, when he referenced theories that women might have less intrinsic aptitude to excel at academic science careers (Jaschik 2005).

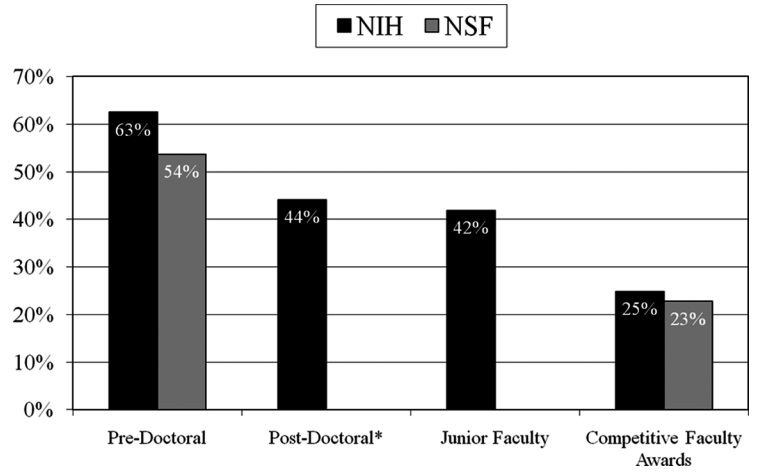
The story is becoming clearer. A recent report from the National Academy of Sciences, *Gender Differences at Critical Transitions in the Careers of Science, Engineering, and Mathematics Faculty* (Committee on Gender Differences 2009), discusses in detail the underrepresentation of women in many of the scientific disciplines at academic institutions across the country, particularly in the higher faculty ranks. The report confirmed that women who received PhDs 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. However, the 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 pursue faculty positions in R1 institutions or the duration of postdoctoral positions" (Committee on Gender Differences 2009, 3).

Data from both the National Institutes of Health (NIH) and NSF (see Figure 2)—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 compose 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 composing 63 percent and 54 percent of NIH's 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 (NSF 2008a, 2009; NIH Office of Extramural Research 2008b; Schaffer 2008). The recent demographic surge in the proportion of women PhDs may account for some, but not all, of this dramatic drop.

The Effect of Family Formation on Faculty Careers in the Sciences

The best way to assess what is truly going on in the pipeline for women in the sciences is to conduct careful longitudinal analyses that follow the same individuals over time, from PhD receipt onward. The SDR that NSF and other federal

FIGURE 2
Problems in the Pipeline: Women as a Percent of NIH and NSF Awards*, by Level of Award (2007)



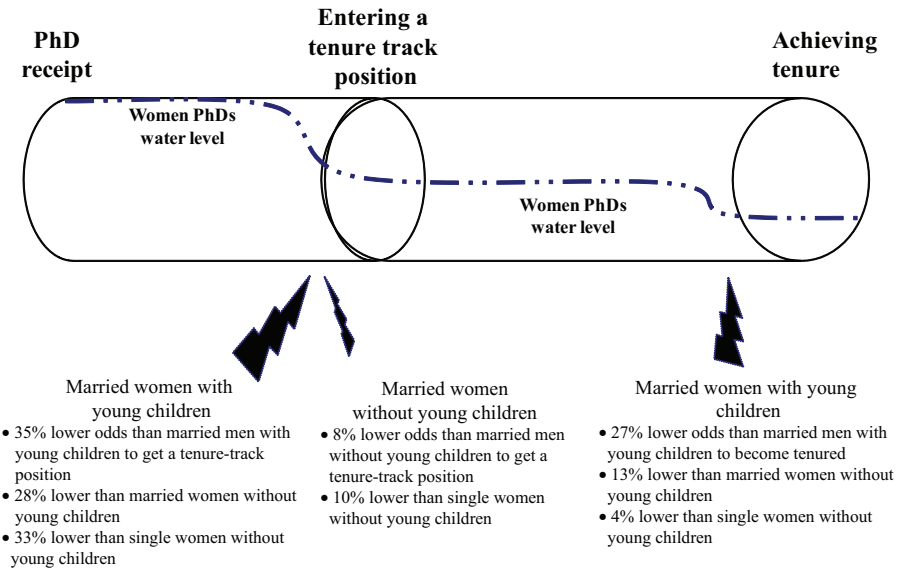
Sources: NSF (2008); NSF (2009); NIH (2008b); Schaffer (2008).
*The postdoctoral award information for NSF is missing significant data (39% of awards were to women, 47% to men, and 14% of the sample was unknown in 2007). We chose not to include the data point because it is not comparable to the others.
Source: Fae Korsmo, Senior Advisor, Office of the Director, NSF.

agencies sponsored makes this analysis possible. The SDR—a longitudinal, biennial, nationally representative survey of PhD recipients' postdegree employment status with almost 170,000 participants under age 76 from 1973 to 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's and women's academic career progress (Clark 1994; NSF 1995, 2010).

Most well-known scholarly studies on faculty rank advancement and academic productivity have used other data sources (Cole and Zuckerman 1987; Long, Allison, and McGinnis 1993; Jacobs 1996; Perna 2001). Only more recently have scholars turned their attention to the SDR as a significant data source for exploring the diversity of the doctoral scientific workforce (Ginther 2001; Long 2001; Mason and Goulden 2002, 2004a, 2004b; Wolfinger, Mason, and Goulden 2008; Goulden, Frasch, and Mason 2009).

Building on this existing work, and using discrete-time event history analyses (Allison 1995), we have modeled the effects of gender and family on the likelihood of individuals leaking out of the pipeline in the sciences, including the physical sciences, biological sciences, and social sciences, from (1) PhD receipt to entering a tenure-track position and (2) entering a tenure-track position to the achievement of tenure (see Figure 3). These analyses control for disciplinary fields within the sciences, age, ethnicity, PhD calendar year, time to PhD

FIGURE 3
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 dataset 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. TT = tenure track.

degree, and National Research Council PhD degree program reputation ranking. Moreover, our analysis uses survey weights designed to adjust for attrition and thereby yield a sample that is comparable to the overall U.S. population of scientists.[4]

Our findings show that family formation—most importantly marriage and childbirth—account for the largest leaks in the pipeline between PhD receipt and the acquisition of tenure for women in the sciences. Specifically, women who are married with children in the sciences are 35 percent less likely to enter a tenure-track position after receipt of their PhD than married men with children, and they are 27 percent less likely than their male counterparts to achieve tenure upon entering a tenure-track job.

Early Career Decisions among Young Scientists

Young scientists often make decisions about their career path while still in training. Our doctoral student and postdoctoral scholar surveys provide unparalleled data on these students' experiences in the University of California (UC) system (Goulden and Mason 2006; Goulden, Frasch, and Mason 2008). We have found that the problems in the science pipeline are not restricted to the post-PhD pursuit of tenure—they start early and are persistent along the way. In particular, career-life issues in regard to future career goals are of pressing concern to many aspiring academics, particularly women in the sciences.

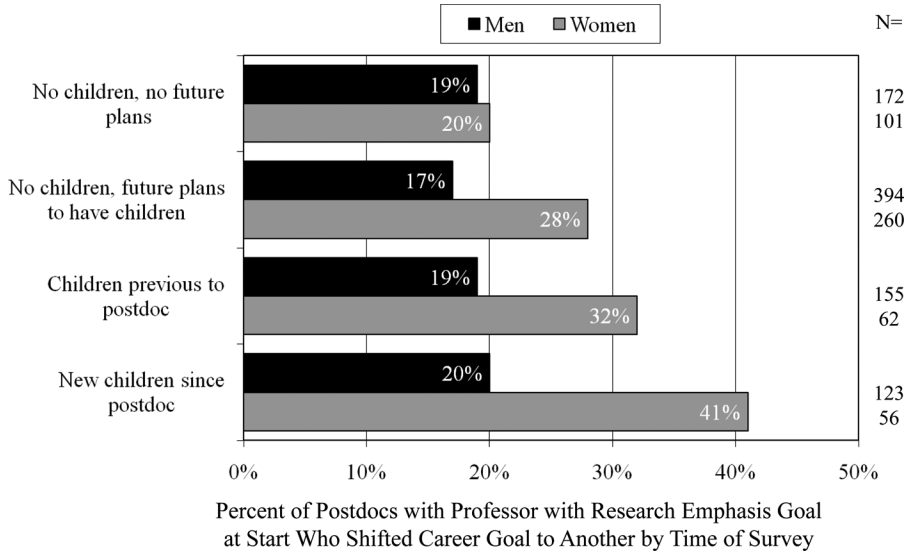
Our data from both the UC doctoral student survey and UC postdoctoral scholar survey[5] indicate that both populations in aggregate report a shifting away from the career goal of professor with research emphasis, with the women's move being more pronounced (Goulden, Frasch, and Mason 2009). A recent study of NIH postdoctoral fellows observed a similar pattern (Martinez et al. 2007). Professors with a research emphasis are arguably key players in our national science infrastructure, both from the knowledge building and discovery perspective and in training our future scientific labor force. Although private industry plays a significant role, particularly in development, scientists at academic institutions often receive funding to push forward basic research in areas that industry is less likely to pursue because of technical or financial risks (National Science Board 2010).

In both surveys, we asked individuals who had shifted their career goal away from professor with research emphasis what factors were important in their decision-making process. Among doctoral students in the sciences, negative experiences as a PhD student were most commonly cited as very important in their decision. After this item, however, career-life issues populated the remaining top five most commonly cited factors, including other life interests, professional activities being too time-consuming, issues related to children, and geographical location issues (frequently considered a career-life issue because of proximity to family and impact on various quality-of-life issues, such as housing and schools [Goulden, Frasch, and Mason 2009]).

In all cases, women doctoral students were statistically more likely than men to cite these career-life issues as very important in their decision-making process. In the most dramatic example, they were more than twice as likely as men to cite issues related to children (44 percent vs. 20 percent) as very important in their decision to shift their career goal away from professor with research emphasis.

The factors that men and women postdoctoral scholars cited for shifting their career goal away from professor with research emphasis show both similar patterns and notable differences to those of doctoral students. In aggregate, career issues related to advancement, job market, security, and money populate four out of the top five issues most commonly cited as very important (unlike doctoral students), but there are major gender divisions among postdoctoral scholars. Issues related to children was the only career-life issue in the top five that both

FIGURE 4
Shifting Career Goal Away from Professor with Research Emphasis: UC Postdoctoral Scholars, by Gender and Family Status/Future Plans



Source: Goulden, Frasch, and Mason (2008).

men and women cited, but for women it was the most important reason for shifting their career goal away from professor with research emphasis (Goulden, Frasch, and Mason 2009).

The issue of children is quite dramatic in influencing UC postdoctoral women's decisions to abandon professorial career goals with research emphasis. 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 (see Figure 4). Future plans to have children, however, affect female and male postdoctoral scholars differently, with women more likely to shift their career goal (28 percent of women vs. 17 percent of men). Having children prior to entering a postdoctoral position in the UC system and having a new child since entering the position appear to ratchet up the pressure further on women to drop their professor with research emphasis career goal, but does not do so for men. Women postdoctoral scholars who had children after they became a postdoctoral scholar in the UC system were twice as likely as men who experienced a similar life-changing event to change their career goal (41 percent vs. 20 percent) and twice as likely to do so as women with no children and no future plans to have children (41 percent vs. 20 percent [Goulden, Frasch, and Mason 2009]).

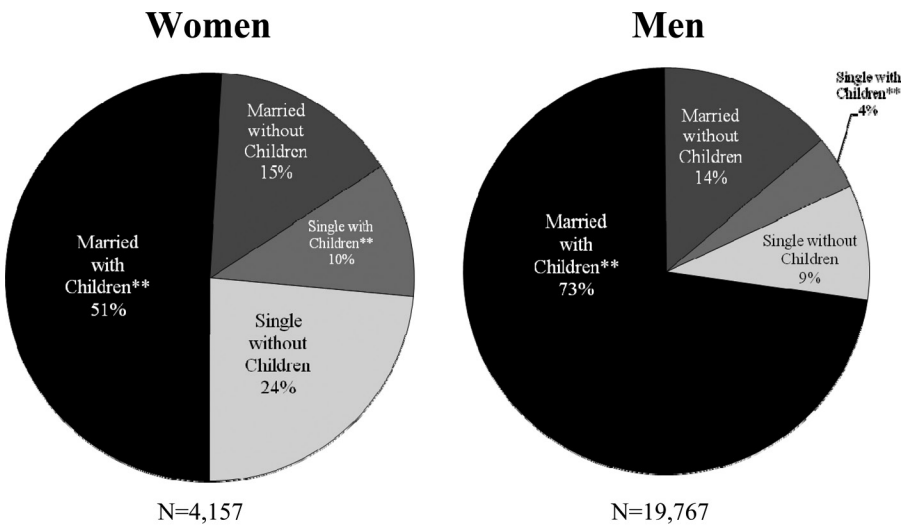
Similarly, female doctoral students who became new mothers and were paid from federal grants at the time of the birth/adoption event displayed an intensified flight response away from professorships with research emphasis. In the case of this small population (only forty-five women in the UC system survey), the reported career shift was particularly marked, with 46 percent of these women indicating that they wanted to pursue a career goal of professor with research emphasis at the beginning of their doctoral studies but just a mere 11 percent still reporting this goal at the time of the survey. Men, too, showed a large decline in relative proportion (from 59 percent to 45 percent from start to time of survey), but it paled in comparison to the relative decline among women (Goulden, Frasch, and Mason 2009).

We asked the women in this group to explain in their own words why they had changed their career goal. Thirteen out of the sixteen new mothers chose to explain what had led to their career shift (a notably high rate of response to this particular open-ended question). Overwhelmingly these individuals cited family life issues in their decision to alter their career goals. For example, one woman wrote, "I think it might be easier to balance work and family in a faculty position where the emphasis is on teaching." And another said, "I feel that for me, research demands too much time away from my family. Also, as a woman, I don't feel as if the current academic environments are any more supportive of women with families."

Among our UC postdoctoral scholars and doctoral students in the sciences, research-intensive careers in university settings have a bad reputation. They are viewed as 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). Specifically, only 36 percent of postdoctoral women and 52 percent of postdoctoral men view tenure-track careers at research-intensive institutions as family friendly, compared with the majority who consider policy or managerial careers outside of academia to be family friendly (77 percent of postdoctoral women and 73 percent of postdoctoral men). Doctoral students in the sciences also cast a skeptical eye toward tenure-track careers at research-intensive universities, with just 28 percent of the women and 44 percent of the men viewing these careers as family friendly. In contrast, about three-fourths of female doctoral students and male doctoral students in the sciences view research careers and policy or managerial careers outside academia as family friendly.

Since most UC postdoctoral scholars (89 percent of women and 83 percent of men) and doctoral students in the sciences (86 percent of women and 76 percent of men) indicate that they are very or somewhat concerned with the family friendliness of possible career paths, these findings on the perception of the family friendliness of career types bode ill for fast-track academic careers. Unless a concerted effort is undertaken by research universities and federal agencies to remedy the current situation, women with familial concerns are likely to disproportionately leak out of the science pipeline to the detriment of our future global competitiveness (Goulden, Frasch, and Mason 2009).

FIGURE 5
Family Status of Tenured Faculty in the Sciences*

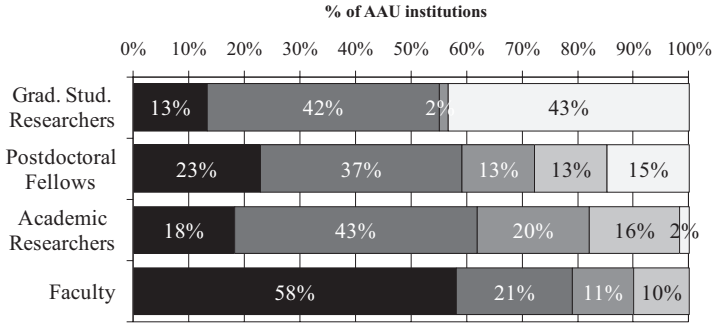


*PhDs from 1978–1984 who are tenured 12 years out from PhD in Phys., Bio., Health Sc., Eng., Math, & Tech.
**Had a child in the household at any point post-PhD to 12 years out.
Source: NSF, *Survey of Doctorate Recipients*. Sciences, 1979-1999.
Note: The use of NSF data does not imply the endorsement of research methods or conclusions contained in this report.

Of course, in part, the concern that these young women express simply reflects the familial patterns that they can readily observe among science faculty in their own institutions and the United States. Our data from the UC doctoral student survey illustrate the fact that among female doctoral students, the perception of how family friendly tenure-track careers are at research-intensive universities is strongly associated with how common they think it is for female faculty to have children (Mason, Goulden, and Frasch 2009). Furthermore, our analysis of SDR data has demonstrated that the life trajectories of tenured female scientists differ from those of tenured males (see Figure 5). Tenured male scientists are far more likely to be married with children (73 percent) than tenured female scientists (51 percent). And women are nearly three times more likely than men to be single without children (NSF 2010). The divorce rate among tenured female faculty is also high; more than 50 percent higher than that of tenured men (Mason and Goulden 2004a).

Of course, not all women want children or marriage. As one 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.

FIGURE 6
Provision of *Paid Maternity Leave* for Academic Populations at Association of American Universities (AAU) (62 total)



Black = Entitlement to at least 6 weeks of paid leave.
Dark Gray = Limitations to paid leave (e.g., only for particular groups, partial pay, less than 6 weeks, requirements for previous service time, etc.).
Medium Gray = Paid leave depends on sick and/or vacation leave accruals.
Light Gray = Delay in availability of sick and/or vacation leave accruals, ie., FMLA.
Off-White = Less, ad hoc, or no paid leave available.

Source: Frasch, Goulden, and Mason (2008b).

America's Researchers and Family Responsive Benefits

Compounding these concerns, 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 (family responsive policies also include benefits such as modified duties, stopping the clock, flex time, and part-time work, among others).

Our in-depth analysis of these trends and surveys of the sixty-two-member institutions of the Association of American Universities (AAU) and ten of the major federal granting agencies (Frasch, Goulden, and Mason 2008a, 2008b) indicate that a significant contributor to these issues is the under-benefiting of America's researchers. A lack of coordination between research universities and federal agencies in providing America's researchers with family responsive policies appears to be a major part of the problem (Goulden, Frasch, and Mason 2009).

Federal agencies that fund the lion's share of research activities at universities across the nation defer to the local personnel policies of institutions for fringe benefits, including family responsive policies, based on Office of Management and Budget (OMB) Circular A-21, *Cost Principles for Educational Institutions* (OMB 2000). Although this approach has the clear advantage of protecting the autonomy of local institutions—a hard-fought-for and protected principle among universities and colleges—the lack of guidance and oversight has resulted

in porous benefiting of America's researchers that unintentionally reinforces the sense or current reality that fast-track academic careers, particularly those in the sciences, are not family friendly. There are compelling reasons for federal agencies to take a proactive role in ensuring family responsive policies that will help women scientists to achieve their career goals. First, there is the public commitment of federal agencies to assure gender equity in the science pipeline; and second, there is the mandated role of federal agencies in assuring Title IX compliance by federal grant-contract recipients, including research universities (Goulden, Frasch, and Mason 2009).

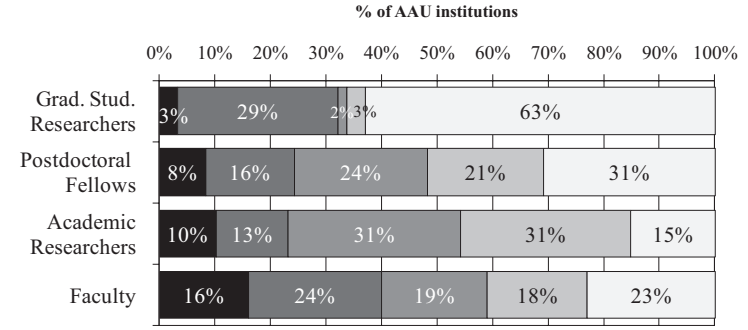
Based on our survey of AAU institutions, the benefiting of America's researchers through baseline family responsive policies—specifically paid maternity and parental leave at the time of a birth event or adoption event in the case of new parents—is erratic at best.[6] As seen in the black bars in Figure 6, faculty are the only population of researchers to which a majority of the AAU universities (58 percent) provide what can be considered a baseline family responsive maternity leave policy: at least six weeks of guaranteed paid leave following childbirth, *without limitations*. 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). Six weeks is typically considered to be a minimum normal period of recovery from childbirth (for cesarean sections the length is at least eight weeks [Cunningham et al. 2009]). Less than one-quarter of the research universities offer this standard to graduate student researchers, postdoctoral scholars, and academic researchers (a mere 13 percent of universities offer this baseline policy to graduate students, 23 percent to postdoctoral scholars, and 18 percent to academic researchers).

Many universities do provide some maternity leave, but the limitations associated with this policy significantly affect contingent classes of researchers, such as graduate students, postdoctoral scholars, and academic researchers. These limitations include a limit on 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.

Policies that depend on the accrual of sick or vacation leave can be especially problematic, particularly for contingent workers. Since accrual requires time, many of these classes of researchers are unlikely to have enough accrued time available (particularly in the case of pregnant women at institutions that provide no paid leave *prior* to childbirth, requiring women to use existing sick or vacation leave if they want or need that time). For example, a typical full-time postdoctoral birth mother would have to work for about one full year (if she earns one day of sick leave per month and one and a half days of vacation leave per month) with no previous use of this time to have the baseline six weeks of maternity leave.

If university policies for these populations model Family and Medical Leave Act (FMLA) eligibility requirements, many graduate student researchers,

FIGURE 7
Provision of Paid Parental Leave for Academic Populations at Association of American Universities (AAU) (62 total)



Black = Entitlement to at least 1 week of paid leave.
Dark Gray = Limitations to paid leave (e.g., only available to primary caregiver, only for particular groups, partial pay, requirements for previous service time, etc.).
Medium Gray = Paid leave depends on sick and/or vacation leave accruals.

Source: Frasch, Goulden, and Mason (2008b).

postdoctoral scholars, and even academic researchers may not qualify because of their contingent nature. In general, few if any graduate students satisfy the FMLA requirement of having worked for one full year and at least 1,250 hours over the year. Newly appointed postdoctoral fellows, newly appointed academic researchers, and part-time academic researchers are not likely to satisfy this requirement either. In fact, FMLA was purposefully designed to exclude contingent and most part-time employees from its protections, which makes it a poor choice to use for designing family responsive policies for nonfaculty academic researchers (Goulden, Frasch, and Mason 2009).

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 (see Figure 7). Using this standard, a paltry 3 percent of institutions offer paid leave to graduate student researchers and a lackluster 16 percent offer it to faculty. For family responsive policies to be viewed as a normal part of the academic experience, this low level of paid parental leave needs to be increased; or paid maternity leave will stand as the only visible policy, and mothers who use it may be at an increased risk of being stigmatized for doing so. Ideally, both women and men need access to family responsive policies that are equitable and take into account both the biological and caregiving components of family formation, most notably childbirth.

Some Universities May Not Be in Compliance with Title IX Requirements

According to findings from our AAU survey, some universities may not be complying with Title IX, which requires research universities receiving federal funds to (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 (Goulden, Frasch, and Mason 2009).

When asked about the provision of unpaid leave to postdoctoral 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.

Grants and Contracts in Fast-Track Academic Science

In 2002, nearly half (48 percent) of tenure-track faculty ages 25 to 45 in the sciences and social sciences (U.S. PhDs only) had work in the previous year that was partially or fully supported by contracts or grants from the federal government, with the largest support provided by NIH or NSF (NSF 2010). 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 (Goulden, Frasch, and Mason 2009).

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 (Hosek et al. 2005). 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 that men and women, with or without children, would secure federal funding, or the population of people who did not apply for these grants.

The RAND report did find that at NSF and NIH, female 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 (Grant and Low 1997; Blake and La Valle 2000). Analyzing the SDR (from 1981 to 2003), we found that female tenure-track faculty who were married with young children were 21 percent less likely than tenure-track men who were 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 (Goulden, Frasch, and Mason 2009).

There is also great pressure on principal investigators (PIs) who hold grants that support young scientists. In our focus groups, PIs reported that when researchers paid by grants needed family leave or modification of duties, it put them in a very difficult position in which they wanted to support the individual but also knew that their research projects would likely suffer. With no existing method for receiving remuneration for this loss, faculty PIs reported 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—32 percent reported that granting family responsive leave to researchers paid from their grants had a negative impact on their work (Zedeck, Stacy, and Goulden 2009).

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 39 by 2003 (Goulden, Frasch, and Mason 2009). 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 in 2007 (NIH Office of Extramural Research 2008a).

This elongated career timeline creates a host of challenges for individuals, particularly women, who want to pursue fast-track academic careers in the sciences without forgoing childbirth and child-rearing. Our data from the UC system suggest that for many years large proportions of women faculty have purposely waited to have children until they knew they would receive or already had received tenure. In fact, the most common age for women faculty in the UC system to have children is between 38 and 40 years of age (Mason, Stacy, and Goulden 2002).

As the tenure timeline pushes out, the possibility of having a child after tenure receipt but before a significant decline in fertility decreases. Given that delaying fertility is so common among fast-track academic women (only roughly 14 percent of our female UC doctoral students were parents at the time of the survey), the current strategy of delayed fertility may come under an even greater challenge. This is of great concern because even in 2002–2003, 40 percent of our UC faculty female respondents who were past the likely age of fertility indicated that they had fewer children than they wanted (compared to 20 percent of men [Mason et al. 2005]).

As all of the fast-track academic timelines have pushed out—age at PhD 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 from their grants or completely avoid hiring individuals they fear might end up giving birth to children. Sadly, this will undoubtedly have an additional negative impact on the earlier pipeline in the sciences, with young

scholars sensing the tension experienced by the faculty PIs and knowing that choosing to have a family will be met with concern among their mentors (and yet their own career timeline pressures may argue that the time is now or never to have a child).

The Lifelong Effects of Family Formation on Career

Family responsibilities do not end with childbirth. The lockstep 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 add 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 (Goulden, Frasch, and Mason 2009). Some felt that if they took the time off that they were entitled to, they would get behind on their federally funded projects, create a productivity gap, and lessen their ability to secure future grants. Moreover, the fear of "bias against caregiving" in academia, and those who make use of family responsive policies, has been well documented (Drago et al. 2004; Williams 2000, 2004).

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 housework, UC female faculty ages 30 to 50 with children report a weekly average of over 100 hours of combined activities (compared to 86 hours for men with children [Mason, Stacy, and Goulden 2002]). Female faculty with children spend an average of more than 30 hours a week on caregiving up through age 50, while family responsive policies rarely address this long-term career-life issue.

Early Steps at Family Responsive Policies, Benefits, and Resources

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 childcare 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 (Goulden, Frasch, and Mason 2009). 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 in this article and our earlier report (Goulden, Frasch, and Mason 2009), 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 NIH, NSF, and the nonprofit organization the American Association for the Advancement of Science (AAAS), 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 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 from grants take necessary leaves/modifications.

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

All major research universities should look into building a family friendly package of policies and resources, and federal agencies should 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 lockstep 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 PhD—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 efforts are yielding positive results and whether Title IX requirements are being met. To achieve this, federal agencies can provide more grant programs to help determine whether 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 make 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 to preserve our competitive edge.

Notes

1. The use of NSF data does not imply endorsement of research methods or conclusions contained in that report.

2. See Association of American Universities (AAU), available at www.aau.edu/.

3. These agencies include NSF, NIH, U.S. Department of Agriculture, National Aeronautics and Space Administration, Department of Defense, Department of Energy, U.S. Agency for International Development, National Endowment for the Humanities, Department of Commerce, and the Department of Education.

4. Results are based on Survival Analysis of the SDR, 1981 to 2003 in all sciences, including social sciences.

5. The data were cut to doctoral students in the sciences because of the substantial proportion of students in nonscience fields, and the postdoctoral survey was inclusive of all respondents because of the small fraction of nonscience postdoctoral fellows.

6. We received completed surveys from fifty-six of the sixty-two AAU institutions (90 percent) and searched policy documents for the remaining six.

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