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ORIGINAL ARTICLE

Nonstandard Work Arrangements among Women and Men Scientists and Engineers

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Abstract This paper draws on a sample of 48,444 scientists and engineers in the United States to analyze nonstandard work arrangements among women and men, 8,773 of whom worked in such arrangements. With few exceptions, women were overrepresented in these arrangements and particularly in those characterized by lower wages and benefits, but their overrepresentation in the worst arrangements failed to explain the gender pay gap. Unlike in the general labor force where "equality at the bottom" tends to prevail, the gender pay gap in science and engineering is greater in the worst nonstandard work arrangements than in the best, and gender equality is greater in the best arrangements than in the worst, possibly because of a selection effect.

Keywords Nonstandard work · Contingent workers · Scientists and engineers · Women's employment · Pay gap

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Introduction

This paper investigates the operation of gender segregation in nonstandard work arrangements among scientists and engineers in the U.S. Are women and men scientists and engineers equally likely to be in these less desirable arrangements? Are they equally distributed across the "best" and the "worst" nonstandard categories? Does women's and men's representation in nonstandard work arrangements help explain women scientists' and engineers' earnings shortfall vis-à-vis men? This paper seeks to answer these questions using cross-sectional data from the 1997 National Science Foundation's Scientists and Engineers Statistical Data System (SESTAT), a nationally-representative dataset made up of 48,444 professional scientists and engineers in the United States. It is imperative to answer these questions for at least three reasons: first, because of the need to challenge the resilience of stereotypes about women's scientific capabilities; second, because of the importance creating and maintaining women's access to prestigious and high quality jobs; and third, because of the increased demand for scientific workers worldwide.

Of all the social arenas characterized by gender inequality, the labor force is one of the most notable. Even in growth fields, such as science and engineering, women are underrepresented in the most prestigious fields, such as physics (Bystydzienski and Bird 2006; Fox and Stephan 2001; National Science Board 2008) and tend to be underpaid relative to men (National Science Foundation 2007; Stewart et al. 2007).

One dimension of gender inequality in workplaces is the distribution of women and men in nonstandard work arrangements, such as temporary agency work and independent contracting (Marler and Moen 2005). Nonstandard work arrangements are those that lack at least one of three

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markers of standard employment, including a direct relationship between employer and worker, full-time work, and an assumption that the employment relationship continues over time (Kalleberg 2001; Marler 2004). Nationally representative data from the U.S. demonstrate that such arrangements, which have been growing at a fast rate in recent years, tend to fall short on important dimensions such as pay and benefits (Blank 1998; Kalleberg et al. 2000). In the general, women are more likely than men to be employed in such arrangements and to be overrepresented in the worst arrangements—those characterized by low pay and a lesser likelihood of providing benefits (Kalleberg et al. 1997).

In this paper we show the complexity of nonstandard work arrangements and document gender segregation and the gender pay gap among science and engineering professionals. We found that women are generally overrepresented in the worst forms of nonstandard work arrangements (indicated by wages and fringe benefits), but that their representation in the best forms were roughly proportional to (or higher than) their representation in the science and engineering workforce as a whole. In the following section, we describe segregation and the pay gap in science and engineering before turning to a review of nonstandard work arrangements.

Segregation and the Earnings Gap in Science and Engineering

Segregation, a key underpinning of gender inequality, comes in many forms in the workplace. Of particular concern is women's underrepresentation in some of the most prestigious and best-paying positions in the labor force, such as science and engineering occupations. In the U.S. in 2005, women made up about half of the college-degree-holding labor force but were only one-quarter of scientists and engineers with college degrees (National Science Board 2008).

Far less is known about another type of segregation: that of women and men in nonstandard work arrangements. Nationally representative data from the U.S. indicate that in the late 1990s, about 30% of men and 40% of women were in nonstandard work arrangements (Kalleberg 2003). Although men's and women's distribution across various arrangements was similar, most women nonstandard workers were in part-time jobs (about 22%) and most men were in self-employment (about 14%). To date, researchers have examined neither the distribution of women and men across standard versus nonstandard work arrangements in science and engineering nor their distribution across the variety of nonstandard arrangements in those fields.

In the larger labor force, segregation and the gender pay gap are tightly linked: the overrepresentation of men in the highest-paying industries, occupations, and jobs and women in the lowest-paying ones explains the largest percent of variance in the pay gap in the U.S. (Padavic and Reskin 2002; Petersen and Morgan 1995). A similar pattern may be operative in science and engineering. In 2003, among scientists and engineers with bachelor's, master's, and doctoral degrees, women's annual median earnings were only 81% of men's (National Science Foundation 2007). Net of controls, the gender pay gap among scientists and engineers in 1997 ranged from zero to a 17% gap, depending on graduation cohort and science or engineering occupation (Prokos and Padavic 2005). An example of the consequences for earnings of this kind of segregation is that men in electrical engineering and computer science were more likely than their female counterparts to work in nonacademic fields, which offered the highest pay (Fox and Stephan 2001). We investigate how segregation in standard versus nonstandard work arrangements may contribute to the gender pay gap in science and engineering.

Nonstandard Employment, Women's Representation, and Gendered Consequences

In this section we consider what is known about women and men in nonstandard work arrangements in the U.S. during the period—the late 1990s—that our data cover. Standard work arrangements are marked by the presence a direct relationship between employer and worker, full-time work, and an assumption that the employment relationship continues over time. Nonstandard work arrangements lack one or more of these characteristics (Kalleberg 2001) and include temporary-agency employment, contract work, "on-call" work and some forms of part-time employment (Blank 1998; Kalleberg 2001; Kalleberg et al. 2000; Marler 2004). In 1995 nonstandard work arrangements comprised 29.4% of all jobs (Kalleberg et al. 1997). As noted below, a bit under one-third of men and a bit over one-third of women are in such arrangements (Kalleberg 2003).

Most nonstandard work arrangements are less desirable than standard ones on several counts. First, many nonstandard workers are unsure of the number of hours they will work per week or how long their job will last (Blank 1998; Kalleberg et al. 2000; Padavic 2005; Spalter-Roth and Hartmann 1998). Second, nonstandard workers typically earn less than permanent employees with comparable skills and education (Blank 1998). Third, even though health and retirement benefits are by no means standard in regular employment, they are even less likely in nonstandard work arrangements (Kalleberg et al. 2000; Spalter-Roth and Hartmann 1998).

Women tend to be overrepresented among U.S. nonstandard workers, comprising slightly over half of all such workers in 1995 (Polivka 1996). In 1997, 29% of men worked in a variety of nonstandard arrangements, compared to 38% of women (Kalleberg 2001), and the nonstandard jobs in which women were overrepresented possessed more negative job characteristics than those held by men (Kalleberg et al. 1997).

Our analyses cover the nine types of nonstandard work arrangements available in our dataset: part-time work, contract work (consisting of contract, independent contract, and short-term contract work), temporary work (consisting of temporary agency employment and short-term noncontract), job-sharing, working at home, and other. We now turn to previous research on these forms of employment in the non-science arena, highlighting what is known about gender differences.

Part-time work, which entails fewer than 35 hours per week, is the most common form of nonstandard employment and is especially common for women, who constitute 65% of all part-time employees in the U.S. (Kalleberg 2000). While about 7% of male workers worked part-time in 1995, the figure was about 22% for women (Kalleberg et al. 2000). Part-timers earn substantially less per hour than full-timers and are less likely to receive health insurance, sick leave, maternity leave, and pension benefits (Blank 1998; Christensen 1987; Kalleberg et al. 2000), or to be on employment ladders leading to higher ranks (Padavic and Reskin 2002). A gender difference appears even within the ranks of part-time workers, with women earning 10% less than their male counterparts, net of personal characteristics (Kalleberg et al. 1997).

Contract work takes several forms and in this paper we make distinctions between contract arrangements, independent contract arrangements, and short-term contract arrangements. Contractors generally are employed by one organization but perform work for another (Kalleberg et al. 2000), while independent contractors lease their labor to employers for services that otherwise would have been performed in-house (Christensen 1987). Short-term contract work arrangements have relationships with the employer that tend to be more tenuous, unlike contract workers and independent contractors, whose employment can be permanent or semi-permanent (Kalleberg 2000). Men are overrepresented among both contract workers and independent contractors (68% of each category is male; derived from Kalleberg et al. 2000, Table 3). In contrast to other forms of nonstandard work, both contract work and independent contracting tend to outpay their standard-employment counterparts (Kalleberg et al. 1997). Net of occupational characteristics, however, women contract workers still earn less than their male counterparts, (Kalleberg et al. 1997). Moreover, while contract workers typically receive no health benefits, those who do are more commonly men (Kalleberg et al. 2000).

Temporary workers employed on a noncontract basis in our sample are comprised of people who work for temporary agencies and those in short-term arrangements such as on-call and day laborer. Women in general are overrepresented in temporary work (60.4% of all temporary workers in the U.S. in 1996). Temporary workers tend to earn less than permanent employees, with the exception of temporary engineers and technicians, who earn more than their permanent counterparts (Kalleberg 2000). Temporary workers (including technicians and engineers) are less likely than permanent ones to receive health and pension benefits (Blank 1998; Kalleberg 2000; Kalleberg et al. 2000). Women and men in temporary-agency work face a similar degree of negative job characteristics, net of occupation (Kalleberg et al. 2000), but among temporaries not working for an agency, women are more likely to encounter a greater number of negative job characteristics, including low wages, and a lack of health insurance and pension benefits (Kalleberg et al. 2000).

Two other forms of nonstandard work arrangements are of a different caliber: job share and work from home. We include these because our dataset considers them alternative work arrangements and the questionnaire solicited information concerning their use. Less is known about their prevalence, gender differences in use, wages associated with them, and their likelihood of having negative job attributes.

We control for characteristics of the work environment (geographic region, hours worked per week, weeks worked per year, occupation, industrial sector, and firm size) and of the individual's biography (education, age, underrepresented minority status, parenthood status, place of birth, and years of part and full-time employment experience) that affect wages and benefits.

Hypotheses

H1 Women will be overrepresented in all forms of nonstandard work arrangements except contract work. Specifically, women will be overrepresented in part-time, temporary agency, short-term arrangements, job share, and work from home. Men will be overrepresented in all forms of contract work, including contract, independent contract, and short-term contract. The rationale is that women scientists' and engineers' representation in these categories should appear in proportions similar to those of women in the non-science labor force (Barker 1998; Bernasek and Kinnear 1999; Kalleberg et al. 2000; Spalter-Roth and Hartmann 1998). If the percentage of women in nonstandard work arrangements (except contract work) is significantly higher than the percentage of women in the overall science and engineering labor force (based on chi square results), then the claim of women's overrepresentation is supported. If men's representation in contract work arrangements is significantly greater than it is in the overall science and engineering labor force, then the claim that men are overrepresented in those arrangements is supported.

H2 Scientists and engineers in nonstandard work arrangements (with the exception of contracting) will be more likely than their standard-employment counterparts to receive relatively low wages, no health benefits, and no retirement benefits, net of controls. In general, contract work pays higher wages than standard work, but all other nonstandard jobs pay lower wages than standard ones (Kalleberg et al. 1997), and this pattern is likely to hold in the science and engineering fields. For each dependent variable (relatively low wages, no health benefits, and no retirement benefits), if logistic regression results show significant positive coefficients for each nonstandard employment arrangement except contract work, then Hypothesis 2 is supported. Positive coefficients would indicate that workers in nonstandard work arrangements have greater odds of receiving relatively low wages, no health benefits, and no retirement benefits. Negative coefficients or non-significant results for contract workers (relative to standard employment arrangements) would further support this hypothesis.

H3 Women's overrepresentation in the worst nonstandard work arrangements and men's in the best—a form of segregation—will explain part of the gender pay gap among scientists and engineers, net of individual factors. Determination of "best" and "worst" nonstandard work arrangements is based on the arrangement's pay, provision of health benefits, and provision of retirement benefits. Just as segregation at the industrial, occupational, and job levels accounts for much of the pay gap, so should segregation by work arrangement. If women's overrepresentation in nonstandard work arrangements affects the wage gap among scientists and engineers, then we would expect to see the effect of *male* on (logged) *earnings* to significantly decline when controls for nonstandard work arrangements are introduced in an OLS regression.

H4 The gender pay gap will be smaller in all nonstandard work arrangements than in the science and engineering labor force as a whole. We expect this to be the case because both human capital (e.g., science and engineering-related education and experience) as well as multiple forms of segregation are controlled when examining the pay gap in nonstandard work arrangements. If interaction terms between gender and nonstandard work arrangements (in OLS regression with logged earnings as the dependent variable) indicate that the pay gaps within each nonstandard work arrangement are significantly smaller than those for the science and engineering labor force employed in standard work arrangements, then Hypothesis 4 is supported.

Method

Data come from the 1997 National Science Foundation's Scientists and Engineers Statistical Data System (SESTAT), a compilation of data from three national sample surveys: the Survey of Doctorate Recipients (SDR), the National Survey of Recent College Graduates (NSRCG), and the National Survey of College Graduates (NSCG) (Kannankutty and Wilkinson 1999). These data provide employment, education, and demographic information on people educated in science and engineering fields and those employed in scientific fields (regardless of their educational background). The 1997 SESTAT survey included a special module on alternative or temporary work experiences, from which we selected individuals employed in computer and mathematical sciences, life sciences, physical sciences, social sciences, and engineering with earnings greater than zero (N= 48,444), eliminating those educated but not employed in the field. This subsample includes 12,170 women—28% of whom were employed in some form of nonstandard work arrangement—and 36,274 men—18% of whom worked in nonstandard work arrangements. A Heckman selection adjustment to account for the possible sample selection bias stemming from the omission of unemployed scientists and engineers did not change key findings.

We use four dependent variables, three of which measure job quality and allow us to test Hypothesis 2, and one of which—a measure of earnings—allows us to test Hypotheses 3 and 4. The first is relatively low wages, operationalized as annual earnings below \$36,000 (the bottom quintile of the earnings distribution for all employed scientists and engineers in the sample). Access to health benefits and retirement benefits are also indicators of job quality and are the second and third measures of job quality (for both, yes=1, no=0). Together these three indicators allow us to rank nonstandard work arrangements into best, mid-level, and worst arrangements. The final dependent variable, the log of annual earnings, allows us to test Hypotheses 3 and 4. It is measured in \$1,000 increments and is capped at \$150,000. Tobit analyses to correct for top-coding did not change results.

Key independent variables are male (yes=1, no=0) and type of nonstandard work arrangement. Nonstandard work arrangements are a series of dummy variables where 1 equals one of the following: contract work, independent contract work, short-term contract work, part-time, work from home, job share, temporary agency, short-term noncontract work, and other nonstandard arrangement. For all, 0 equals "not in the category." "Standard work arrangements" serves as the omitted category in regression equations. The measure for part-time work is a dummy variable indicating whether respondents worked fewer than 35 hours during a typical work week (yes=1). With the exception of part-time (which was asked separately), respondents were able to check multiple nonstandard work arrangements, yielding 823,543 possible combinations. Of the 6,088 people who reported a nonstandard work arrangement other than part-time, 72% checked one, 20% checked two, and 8% checked three or more categories.

To categorize workers who checked more than one box, we used a two-step process of creating master categories and fine-tuning them. We used logical inference to create master categories as follows: 1) contract, 2) self-employed, 3) short-term, 4) job share, 5) work from home, 6) temporary agency, and 7) other. With few exceptions, workers who checked two or more of these categories were placed in the higher category. We also include a dummy variable that indicates whether respondents checked more than one box (1=checked more than one, 0=checked only one) to account for any potential problems resulting from possible systematic reasons that someone checked more than one box.

The vast majority of multiple cases fell cleanly into master categories. We occasionally made exceptions, however. For example, the 68 people who checked short-term contract and temporary agency, along with either job-sharing, working at home, or other categories would seem to go into category 3 (short-term) rather than 6 (temporary agency). Yet when we examined these cases, it became clear that working for a temporary agency distinguished them uniquely from other short-term workers, and so we categorized them as 6 (temporary agency). In another case, the 54 people who checked 2 (self-employed), and 3 (short-term) resembled neither the group of self-employed nor the group of short-term workers in wages or on other dimensions (e.g., age and gender composition), and so we placed them in the "other" category, where they would not influence key analyses. Conducting analyses with a truncated sample that eliminated anyone who checked multiple boxes changed results only minimally.

We control for several variables. Underrepresented minority status is coded as a dummy variable (underrepresented minority=1, non-underrepresented minority=0) where 1 includes African Americans, Native Americans, and Hispanics (Asian Americans are not underrepresented in the science and engineering fields). Educational attainment is measured by three dummy variables for respondents who hold a Bachelor's Degree (yes=1, no=0), Master's Degree (yes=1, no=0), or Ph.D. (yes=1, no=0); professional degree was the omitted category for each). Age is measured in five-year intervals, ranging from 27 to 72. Because preschoolers make the most extensive time demands on parents (Maume 1999), we use a dummy variable (presence of children under age six=1, absence=0) to control for their presence, and we also construct an interaction term with male, since the effect of the presence of a young child affects women and men differently (Morgan 1998). Immigrant status is measured by place of birth (United States =1; elsewhere=0). We also include a 10-category measure of employers' region, nine of which are inside and one of which is outside of the U.S. (for each, residence in the region is coded 1, and outside the region is coded as 0; the omitted category in regressions is "outside the U.S.").

Occupational group is represented as four dummy variables indicating the five major scientific occupational groups: computer and math sciences, life and related sciences, physical and related sciences, and engineering; social and related sciences is the omitted category (for each variable, 1=being in the occupational group and=0 not in the occupational group). These controls are included because of their possible effect on the pay gap and because nonstandard employment may be more prevalent in some occupational groups. Employment sector is measured by two dummy variables (business=1, non-business=0; education=1, non-education=0; government is the omitted category), which ensures that gender effects are not conflated with effects stemming from women's and men's disproportionate sector representation. We control for work experience because of the relationship between experience and the pay gap (Blau and Kahn 2006). Full-time work experience and part-time work experience are both measured in years. We control weeks worked per year to account for people who worked part-year. The number of weeks respondents worked in the previous year is measured in four categories: 1–10, 11–20, 21–39, and 40–52 (for each, in the category=1 and not in it=0; the omitted category is 40–52 weeks). The number of hours respondents worked per week is measured by a continuous variable ranging from 1 to 80, and firm size comprises seven categories ranging from under 10 employees to over 5,000 (for each category 1=in the category and 0=not in the category; greater than 5,000 employees serves as the omitted category in regression analyses).

Results

Table 1 reports means and percentages for women and men for all variables used in the analysis. A MANOVA analysis

Table 1 Percentages, means and standard deviations for variables in the analysis: SESTAT 1997. Standard deviations are reported as proportions for categorical variables. Means and percentages are based on weighted data.

	Women	Men	Women	Men
	Full sample		Nonstandard workers[a]	
	%	%	%	%
All work arrangments	23	77	–	–
Standard work	21	79	–	–
Nonstandard arrangements	–	–	31	69
Contract	–	–	20	80
Short-term contract	–	–	19	81
Independent contract	–	–	28	72
Part-time	–	–	52	48
Work from home	–	–	27	73
Job share	–	–	56	44
Other nonstandard	–	–	25	75
Temporary agency	–	–	20	80
Short-term noncontract	–	–	38	62
N (unweighted)	12,170	36,274	2,898	5,875
	Full sample[b]		Nonstandard workers[c]	
Annual earnings ($1,000–$150,000)	44,581 (22,683)	58,498 (24,617)	35,805 (27,219)	51,741 (32,839)
Age (27–72)	41.31 (10.05)	44.36 (10.92)	42.67 (11.14)	46.45 (13.36)
Years full-time experience (0–54)	10.90 (8.59)	16.12 (10.90)	9.54 (8.67)	17.11 (12.97)
Years part-time experience (0–34)	1.99 (3.63)	1.13 (2.80)	3.72 (4.85)	1.83 (3.62)
Hours worked per week (1–80)	40.29 (12.01)	44.64 (9.71)	29.37 (14.56)	38.73 (15.36)
Underrepresented minority (1=yes, 0=no)	9.22 (.29)	6.04 (.24)	7.89 (.27)	5.52 (.23)
Child under six (1=yes, 0=no)	18.91 (.39)	22.33 (.42)	22.49 (.42)	17.63 (.38)
Birthplace U.S. (1=yes, 0=no)	83.77 (.37)	82.64 (.38)	87.85 (.33)	83.04 (.38)
Region: new england (1=yes, 0=no)	.08 (.27)	.07 (.25)	.09 (.28)	.07 (.25)
Region: mid atlantic (1=yes, 0=no)	.15 (.35)	.14 (.34)	.15 (.35)	.14 (.34)
Region: east north central (1=yes, 0=no)	.15 (.36)	.15 (.36)	.15 (.36)	.13 (.33)
Region: west north central (1=yes, 0=no)	.06 (.24)	.07 (.25)	.06 (.23)	.06 (.25)
Region: south atlantic (1=yes, 0=no)	.20 (.40)	.17 (.38)	.20 (.40)	.18 (.39)
Region: east south central (1=yes, 0=no)	.04 (.19)	.04 (.19)	.03 (.18)	.03 (.18)
Region: west south central (1=yes, 0=no)	.08 (.27)	.10 (.30)	.07 (.26)	.10 (.30)
Region: mountain (1=yes, 0=no)	.06 (.25)	.07 (.26)	.06 (.24)	.08 (.26)
Region: pacific (1=yes, 0=no)	.18 (.38)	.19 (.39)	.20 (.40)	.20 (.40)
Region: outside the US (1=yes, 0=no)	.00 (.02)	.00 (.04)	.00 (.01)	.00 (.06)
Bachelor's degree (1=yes, 0=no)	51.72 (.50)	58.40 (.49)	44.44 (.50)	59.16 (.49)
Master's degree (1=yes, 0=no)	33.11 (.47)	27.45 (.45)	41.11 (.49)	29.71 (.45)
Ph.D. (1=yes, 0=no)	13.94 (.35)	13.36 (.34)	13.39 (.34)	11.28 (.32)
Professional degree (1=yes, 0=no)	1.23 (.11)	.79 (.09)	1.07 (.10)	.84 (.09)
Weeks worked last year: 1–10 (1=yes, 0=no)	.01 (.11)	.02 (.12)	.01 (.12)	.02 (.13)
Weeks worked last year: 11–20 (1=yes, 0=no)	.01 (.10)	.00 (.07)	.03 (.17)	.02 (.15)
Weeks worked last year: 21–39 (1=yes, 0=no)	.08 (.27)	.04 (.20)	.15 (.36)	.08 (.27)
Weeks worked last year: 40–52 (1=yes, 0=no)	.90 (.30)	.94 (.24)	.81 (.39)	.88 (.33)
Computer and math sciences (1=yes, 0=no)	36.76 (.48)	29.10 (.45)	32.72 (.47)	36.36 (.48)
Engineering (1=yes, 0=no)	16.22 (.37)	48.00 (.50)	10.74 (.31)	37.67 (.48)
Life sciences (1=yes, 0=no)	15.20 (.36)	7.90 (.27)	10.54 (.31)	7.08 (.26)
Physical sciences (1=yes, 0=no)	8.10 (.27)	8.56 (.28)	6.06 (.24)	7.45 (.26)
Social sciences (1=yes, 0=no)	23.72 (.43)	6.44 (.25)	39.94 (.50)	11.44 (.32)

Table 1 (continued)

	Women	Men	Women	Men
	Full sample		Nonstandard workers	
Education sector (1=yes, 0=no)	26.65 (.44)	14.69 (.35)	31.90 (.47)	19.11 (.39)
Business sector (1=yes, 0=no)	60.31 (.49)	72.27 (.45)	62.37 (.48)	76.96 (.42)
Government sector (1=yes, 0=no)	13.03 (.34)	13.04 (.34)	5.74 (.23)	3.93 (.19)
Firm size: <10 employees (1=yes, 0=no)	.09 (.28)	.08 (.27)	.27 (.44)	.32 (.47)
Firm size: 10–24 employees (1=yes, 0=no)	.03 (.16)	.03 (.18)	.04 (.19)	.05 (.22)
Firm size: 25–99 employees (1=yes, 0=no)	.06 (.23)	.07 (.25)	.06 (.24)	.08 (.27)
Firm size: 100–499 employees (1=yes, 0=no)	.13 (.34)	.12 (.33)	.12 (.33)	.12 (.32)
Firm size: 500–999 employees (1=yes, 0=no)	.06 (.25)	.06 (.23)	.06 (.23)	.05 (.21)
Firm size: 1000–4,999 employees (1=yes, 0=no)	.17 (.37)	.15 (.36)	.12 (.33)	.11 (.32)
Firm size: 5,000 or greater (1=yes, 0=no)	.47 (.50)	.49 (.50)	.33 (.47)	.27 (.44)
Relatively low wages (1=yes, 0=no)	35.65 (.48)	14.79 (.35)	56.98 (.50)	33.31 (.47)
No health benefits (1=yes, 0=no)	15.62 (.36)	9.73 (.30)	48.76 (.50)	40.78 (.49)
No retirement benefits (1=yes, 0=no)	24.12 (.43)	18.63 (.39)	55.37 (.50)	54.54 (.50)

[a] The coding for each nonstandard arrangement is 1=yes and 0=no. Chi square analyses show that all gender differences among nonstandard workers are significant at the $p<.001$ level except for the following: Short-term contract, Other nonstandard, and Temporary (not statistically significant).

[b] MANOVA indicates that all gender differences in the full sample are significant at the $p<.001$ level except for the following: Birthplace US, Region: Mid Atlantic, Region: Pacific, Firm Size 10–24, Firm Size 500–999, Firm Size 1,000–4,999 ($p<.01$); Region: Mountain, Weeks worked last year: <10 ($p<.05$); Region: East North Central, Region: West North Central, Region: East South Central, Region: Outside the US, Ph.D., and Physical Sciences (not statistically significant).

[c] MANOVA indicates that all gender differences among workers with nonstandard arrangements are significant at the $p<.001$ level except for the following: Region: New England, Ph.D., Firm size 10–24, Firm size 25–99 ($p<.01$); Weeks worked last year: 11–20, Physical Sciences ($p<.05$); Region: Mid Atlantic, Region: West North Central, Region: South Atlantic, Region: East South Central, Region: West South Central, Region: Mountain, Region: outside US, Firm Size 100–499, Firm Size 500–999, Firm Size 1,000–4,999 (not statistically significant).

using all variables indicates that women and men differ in their earnings, age, work experience, and hours worked per week in the full sample and in the nonstandard worker subsample (for each, $P<.001$). Means show that men generally outearn women, are slightly older, have more years of full-time and part-time employment experience, and work slightly longer hours. The percentage of women and men who report low wages, no health benefits, and no retirement benefits also differs significantly ($P<.001$), with women in worse positions.

Women's Overrepresentation in Nonstandard Employment Arrangements

We examine bivariate relationships between gender and nonstandard work arrangements to address Hypothesis 1, that women scientists and engineers are overrepresented in all nonstandard work categories except for contract work. If the percentage of women in nonstandard work arrangements is significantly higher than the percentage of women in the overall science and engineering labor force (based on chi square results), then Hypothesis 1 about women's overrepresentation is supported. Examining each type of nonstandard work arrangement separately allows us to determine if men's representation is higher than women's in contract work.

Column 1 of Table 1 indicates that women scientists and engineers were overrepresented in nonstandard work arrangements, with some exceptions, supporting Hypothesis 1. The row presenting results for "all work arrangements" indicates that 23% of workers were women, yet the "nonstandard work arrangements" row indicates women were 31% in this category. Men constituted 77% of all workers, and only 69% of people in nonstandard work arrangements. (Statistical significance is reported in Table 1, note b.) Column 3 of Table 1 reveals women's overrepresentation in every type of arrangement except for temporary agency employment, two forms of contract work (contract and short-term contract), and other nonstandard arrangements. They were 52% of workers in part-time arrangements and 38% of workers in short-term noncontract arrangements, both significantly higher than their representation in the overall science and engineering labor force ($P<.001$). In contrast, men were slightly overrepresented in contract work ($P<.001$), which also lends support for Hypothesis 1. Differences between women's representation in the full sample and short-term contract arrangements, temporary work arrangements, and other nonstandard work arrangements were not statistically significant. These results largely support our predictions in regard to women: they were overrepresented in the categories we anticipated, with the exception of temporary agency employment, where they were proportionally represented. The results offered only weak support for our expectations for men, who were only slightly overrepresented in contract work in general and were underrepresented in independent contract arrangements, in particular. In sum, women's statistically significant overrepresentation in five of the nine forms of nonstandard employment arrangements and underrepresentation in contract work arrangements offers moderate to strong support for Hypothesis 1, although the strength of this support is mitigated somewhat by men's lack of strong showing in contract work categories.

Quality of Nonstandard Employment Arrangements

We use three logistic regressions to address Hypothesis 2, which claims that with the exception of contract work, nonstandard work arrangements in sciences and engineering, like those in the wider society, will have more negative attributes than standard arrangements, net of controls. The first model regresses *relatively low wages* on nonstandard work arrangements and on *male,* net of controls. The second and third models differ only in the dependent variable, which becomes *no health benefits* and *no retirement benefits,* respectively. If we find that people in nonstandard work arrangements except for contract work have a greater likelihood of each negative job characteristic than those in standard arrangements (the omitted comparison category), then Hypothesis 2 is confirmed.

Table 2 reports logistic regression coefficients for nonstandard work arrangements for our three job-quality indicators: relatively low wages, no health insurance benefits, and no retirement benefits. Results offer strong support for Hypothesis 2: in science and engineering occupations, workers in nonstandard work arrangements were more likely than those in standard work arrangements to possess all three negative job characteristics. For example, the odds of people working from home having relatively low wages are 63% greater than the odds for standard workers, their odds of having no health benefits are 585% greater, and their odds of having no retirement benefits are 254% greater. The trend is the same for all forms of nonstandard work arrangements except contract work. The results also indicate that the gender differences for relatively low wages and no retirement benefits are

Table 2 Logistic regression of low-quality job indicators on type of nonstandard work arrangement.

	Model 1		Model 2		Model 3	
	Relatively low wages		No health benefits		No retirement benefits	
	B (S.E.)	exp(B)	*B* (S.E.)	exp(B)	*B* (S.E.)	exp(B)
Nonstandard Arrangements						
Contract (1=yes, 0=no)	−.13 (.07)	.88	1.10*** (.08)	3.00	.70*** (.06)	2.00
Short-term contract (1=yes, 0=no)	.38* (.16)	1.45	1.69*** (.14)	5.43	1.26*** (.13)	3.52
Independent contractors (1=yes, 0=no)	.40*** (.09)	1.49	2.19*** (.08)	8.94	1.54*** (.08)	4.67
Part-time (1=yes, 0=no)	1.11*** (.08)	3.03	1.77*** (.08)	5.90	1.58*** (.07)	4.87
Work from home (1=yes, 0=no)	.94*** (.09)	2.63	1.92*** (.09)	6.85	1.27*** (.08)	3.54
Job share (1=yes, 0=no)	1.95*** (.27)	7.06	1.80*** (.23)	6.06	1.55*** (.22)	4.17
Other nonstandard (1=yes, 0=no)	.82*** (.18)	2.27	1.77*** (.19)	5.86	1.52*** (.16)	4.56
Temporary agency (1=yes, 0=no)	1.28*** (.17)	3.59	3.94*** (.15)	51.33	3.31*** (.16)	27.33
Short-term noncontract (1=yes, 0=no)	2.25 (.12)	9.45	2.77*** (.10)	15.90	2.31*** (.09)	10.09
Male (1=yes, 0=no)	−.17 (.04)	.85	.08 (.05)	1.09	.23*** (.04)	1.26
Controls[a]	*X*		*X*		*X*	
Constant	6.47 (.42)	.68	−.90 (.50)	.41	.56 (.40)	1.76
−2 log likelihood	28,705.43		18702.87		32,870.16	
df	47		47		47	
N	48,438		47,508		47,508	

*$p<.05$, **$p<.01$, ***$p<.001$

Standard errors are in parentheses.

[a] Controls include: age, underrepresented minority, child under 6, child under 6 * male, birthplace U.S., region (nine categories), highest degree (Bachelor's, Master's, Ph.D), years full-time experience, years part-time experience, hours worked per week, weeks worked last year, occupational group, employment sector, firm size, predicted employment in 1997, more than 1 nonstandard arrangement.

statistically significant and those for no health benefits are not.

To ease interpretation of the logistic coefficients presented in Table 2, Table 3 reports predicted probabilities for the bad job characteristics presented in Table 2. We present the probabilities for women and men for each type of nonstandard work arrangement, calculating predicted probabilities as:

$$P_i = \exp(Z_i)/[1 + \exp(Z_i)]$$

where P represents the probability of a woman or man holding a job with a bad job characteristic (when control variables are set at their means), and Z_i represents the sum of the products created by multiplying each referenced control variable by the coefficient estimates (Brewster and Padavic 2002; Aldrich and Nelson 1984).

Columns 1 and 2 of Table 3 show that workers in nonstandard work arrangements, with the exception of contract, have a greater likelihood of low wages than standard workers, offering support for Hypothesis 2 (statistical significance for all estimates is reported in Table 2). Specifically, workers in short-term noncontract arrangements had the highest likelihood of relatively low wages (P<.001; .47 for men and .51 for women), followed by job share (P<.001; .40 for men and .44 for women). Contract workers' likelihood of low wages did not differ significantly from standard workers' (.07 for male contract workers and .09 for female contract workers versus .08 for male standard workers and .11 for female standard workers).

As for health insurance, Columns 3 and 4 of Table 3 indicate that the probability of lacking access to health insurance was far greater for every type of nonstandard work arrangement than it was for standard work arrangements (P<.001). Contract work proved superior to other nonstandard work arrangements, and the worst arrangements were temporary agency work and short-term (noncontract) work (P<.001).

Columns 5 and 6 show the predicted probabilities of having no access to employer-provided retirement coverage. As with health benefits, no form of nonstandard employment was as likely to offer retirement benefits as was standard employment (P<.001). Contract was better than all other types of nonstandard work, with male contract workers' likelihood of having no retirement benefits at .20 and women's at .17 (P<.001); the likelihoods for standard workers were .11 for men and .09 for women, (P<.001) Workers in temporary agency employment fared worst on this dimension, followed by short-term noncontract.

Overall, results support Hypothesis 2 and show that workers in nonstandard work arrangements faced more negative attributes than workers in standard employment. As expected, workers in contract and standard arrangements fared better than all other categories of workers on all three measures of bad jobs.

These analyses also allowed us to rank nonstandard work arrangements on job-quality, enabling us to test Hypothesis 3. We ranked all arrangements relative to each other on negative job characteristic (low wages, no health benefits and no retirement benefits). The arrangements that fell in the bottom half on all negative job characteristic indicators were considered the worst arrangements. Temporary agency employment and short-term noncontract employment were clearly the worst. Contract work was by far the best nonstandard arrangement, on some dimensions almost as good as standard work. The remaining arrangements (part-time, independent contractor, job share, short-term contract, work from home, and "other" nonstandard arrangements) fell in the middle range.

Table 3 Predicted probabilities from logistic regression predicting low-quality characteristics from work arrangments and other independent variables, by gender.

	Relatively low wages		No health benefits		No retirement benefits	
	Men	Women	Men	Women	Men	Women
Best arrangements						
Standard	.08	.11	.03	.03	.11	.09
Contract	.07	.09	.09	.08	.20	.17
Mid-level arrangements						
Short-term contract	.12	.14	.15	.14	.31	.26
Independent contractors	.12	.14	.23	.22	.37	.32
Part-time	.22	.25	.16	.15	.38	.33
Work from home	.19	.24	.19	.18	.31	.26
Job share	.40	.44	.17	.17	.37	.32
Other nonstandard	.17	.20	.16	.15	.36	.31
Worst arrangements						
Temporary agency	.25	.28	.63	.62	.77	.73
Short-term noncontract	.47	.51	.35	.33	.56	.50

Equations include controls reported in Table 2 and control variables were set to their means. The statistical significance levels for the difference between standard and each nonstandard work arrangement is noted in Table 2.

Women's and Men's Earnings in Nonstandard Work Arrangements

We use sequential OLS regression models to test Hypothesis 3, that women's overrepresentation in the worst forms of nonstandard work contributes to the gender pay gap among scientists and engineers. Model 1 regresses (ln) *earnings* on *male*, controlling for demographic, human capital, and occupational variables. Model 2 adds nonstandard work arrangements to see if this addition reduces the effect of *male* on (ln)*earnings*. If the *male* coefficient declines significantly, then results support Hypothesis 3 and nonstandard work arrangements can be considered part of the explanation of women scientists' and engineers' lower pay relative to men. We use a semilog model (the dependent variable is logged and the independent variables are not), and thus "the slope coefficient measures the proportional change in Y for a given absolute change in the explanatory variable," which is *male* in this case (Gujarati 1992, p. 229). Thus, the coefficient for the male variable, once converted, represents the proportional difference in earnings between women and men. The conversion from effect of *male* to earnings differential percentage is: Earnings differential percentage = $(\exp B_{male}-1)*100\%$ (Allison 1999).

Table 4, Model 1 shows the baseline model, which includes *male* and control variables. It reveals a gender pay gap of 5.5% in the science and engineering labor force ($[\exp B_{male}-1]*100$), slightly lower than 8% found in the overall workforce (Blau and Kahn 2006), a difference that may stem from some unmeasured characteristic of this specialized and highly educated labor force.

Comparing Model 2, which controls for nonstandard arrangements, to Model 1 indicates no support for Hypothesis 3. If women's overrepresentation in nonstandard arrangements affected the wage gap, we would see a decrease in the effect of *male* compared to Model 1, and we do not. In short, women's overrepresentation in the worst nonstandard arrangements failed to explain any part of the gender pay gap.

Model 2 also reveals that nonstandard work arrangements have an overall negative effect on earnings, net of

Table 4 OLS regression of earnings (ln) on male, nonstandard work arrangments and interactions.

Independent variables	Model 1 *B* (S.E.)	Model 2 *B* (S.E.)	Model 3 *B* (S.E.)
Male	.05*** (.01)	.06*** (.01)	.06 (.01)***
Nonstandard arrangements			
Contract (1=yes, 0=no)	–	.03*** (.01)	.09 (.02)***
Short-term contract (1=yes, 0=no)	–	−.13*** (.02)	.09 (.04)*
Independent contract (1=yes, 0=no)	–	−.02 (.01)	−.02 (.02)
Part-time (1=yes, 0=no)	–	−.28*** (.01)	−.23 (.02)***
Work from home (1=yes, 0=no)	–	−.18*** (.01)	−.26 (.02)***
Job share (1=yes, 0=no)	–	−.33*** (.04)	−.41 (.05)***
Other nonstandard (1=yes, 0=no)	–	−.15*** (.03)	−.03 (.05)
Temporary agency (1=yes, 0=no)	–	−.16*** (.03)	−.35 (.06)
Short-term noncontract (1=yes, 0=no)	–	−.53*** (.01)	−.56 (.02)***
Interactions			
Male * contract	–	–	−.08 (.02)***
Male * short-term contract	–	–	−.27 (.05)***
Male * independent contract	–	–	.00 (.02)
Male * part-time	–	–	−.10 (.02)***
Male * work from home	–	–	.11 (.03)***
Male * job share	–	–	.18 (.08)*
Male * other nonstandard	–	–	−.16 (.06)**
Male * temporary agency	–	–	.24 (.06)***
Male * short-term noncontract	–	–	.05*
Controls[a]	X	X	X
Constant	8.69*** (.05)	8.95*** (.05)	8.95*** (.05)
R^2	.53	.55	.55
F change	1572.79***	222.44***	15.02***
df	39	48	57

**p*<.05, ***p*<.01, ****p*<.001

Standard errors are in parentheses

[a] Controls include: age, underrepresented minority, child under 6, child under 6 * male, birthplace U.S., region (nine categories), highest degree (Bachelor's, Master's, Ph.D), years full-time experience, years part-time experience, hours worked per week, weeks worked last year, occupational group, employment sector, firm size, predicted employment in 1997, more than 1 nonstandard arrangement.

controls, with the exception of two forms of contract work (contract and independent contract). Short-term noncontract employment had the strongest negative effect on earnings, with short-term workers earning only 59% of their standard counterparts' earnings, on average ($P<.001$). Workers in job-sharing arrangements earned 72% of standard workers' earnings. Part-time work had a strong negative effect on earnings: part-timers earned 76% of standard workers' earnings, on average. Working at home, in "other" nonstandard arrangements, and for a temporary agency also negatively affected earnings (these workers averaged 84%, 86%, and 85% of standard workers' earnings, respectively).

To test the final hypothesis, we include interactions between gender and nonstandard work arrangements in Model 3 and present predicted mean earnings for women and men. Model 3 allows us to test Hypothesis 4 (and seeks to explain why Hypothesis 3 was unsupported) by testing for interaction effects between nonstandard arrangements and gender. Tests of Hypotheses 1 and 2 showed that women were overrepresented in the nonstandard work arrangements characterized by negative attributes and low earnings (with the exception of temporary agency employment, a low-quality arrangement in which women were not overrepresented), so why does this overrepresentation fail to explain any of the pay gap among scientists and engineers? The answer, as Model 3 shows, is that large gender pay gaps exist *within* particular arrangements. These results, therefore, fail to support Hypothesis 4 because the gender pay gap within each nonstandard work arrangement was not consistently lower than the 5.5% gender pay gap reported in Model 1.

We constructed Table 5 to aid interpretation of Model 3 in Table 4. It illustrates the interactions of gender and work arrangement by presenting point estimates that are predicted mean earnings for women and men based on the regression results in Table 4. The point estimates are calculated from the regression equation and coefficients by varying only the values of nonstandard work arrangements and *male* (and the corresponding interaction effects) and setting all control variables to their means. The statistical significance of the gender earnings gap comes from where Table 4 indicates significant interaction effects between nonstandard work arrangements and *male* (as well as the main effect of *male* for workers with standard arrangements).

Table 5 shows that in four nonstandard work arrangements the pay gap favored men. Women who worked in temporary agency arrangements, shared a job, worked from home, or had short-term noncontract arrangements, earned 74, 79, 84, and 90 cents per men's dollar on average, respectively. Unexpectedly, in a few arrangements the pay gap clearly favored women: women in short-term contract arrangements earned 24 cents per dollar more than men, women in part-time earned 5 cents more, and women in "other" nonstandard work arrangements earned 11 cents more, on average. In contract arrangements women's and men's earnings were roughly equal; women outearned men by 2%. Among independent contractors, differences between women's and men's earnings were insignificant.

We highlight two interesting results from Table 5. First, the overall pattern shows that arrangements with pay gaps favoring men also tend to be among the worst in pay and benefits and to be disproportionately staffed by women. It is notable that two of the four arrangements where the pay gap favored men (temporary agency and short-term noncontract) are also the most likely to have negative job characteristics. Second, women fared well in some of the highest-quality arrangements. In three of the five arrangements where the pay gap favored women or was insubstantial (contract, short-term contract, and "other" nonstandard), women's representation was proportional (or near-proportional) to their representation in the science and engineering workforce. Two of these arrangements—con-

Table 5 Predicted mean earnings by type of work arrangement for women and men, the gap between women's and men's earnings, and women's average earnings as a proportion of men's.

Type of work arrangement	Women	Men	Gap	Women/Men
All workers	$46,311	$48,937	$2,625	.95***
Standard	47,682	50,385	2,703	.95***
Contract	52,277	51,219	−1,058	1.02***
Short-term Contract	51,955	42,009	−9,946	1.24***
Independent Contract	46,863	49,440	2,577	.95
Part-time	37,831	36,073	−1,758	1.05***
Work from home	36,747	43,528	6,781	.84***
Job share	31,737	40,244	8,506	.79*
Other Nonstandard	46,288	41,559	−4,729	1.11*
Temporary agency	33,507	45,076	11,569	.74***
Short-term noncontract	27,152	30,263	3,111	.90*

*$p<.05$, **$p<.01$, ***$p<.001$

Equation includes controls for variables in Model 3, Table 4, and predicted earnings were calculated with control variables set to their means.

tract and short-term contract—were among the best nonstandard arrangements in wages, health benefits, and retirement benefits.

Discussion

This paper contributes to the goal of creating a deeper understanding of how women and men fare in the intersection of two social trends: the growing prevalence of nonstandard work arrangements and the increasing importance of science and technology workers (Brush 1991; Spalter-Roth and Hartmann 1998). We sought to answer three questions pertaining to scientists and engineers: 1) Are women overrepresented in nonstandard work arrangements? 2) Are people holding nonstandard employment arrangements more likely than their standard-employment counterparts to hold jobs with negative attributes (i.e., relatively low wages, no health benefits, and no retirement benefits)? 3) Does women's overrepresentation in some nonstandard work arrangements explain any of the gender pay gap among scientists and engineers?

Descriptive analyses indicated that women were overrepresented in all forms of nonstandard work arrangements except temporary agency, two types of contract arrangements (contract and short-term contract), and "other" nonstandard work arrangements. This finding is similar to that for the general labor force, where women are overrepresented in nonstandard work arrangements. The findings differ from those in the general labor force, however, in that women were not markedly underrepresented in all forms of contract work. In fact, contrary to our expectations, they were overrepresented in contract work and for the most part proportionately represented in short-term and independent contracting.

Multivariate analyses revealed that nonstandard work arrangements (with the exception of contract work) in the science and engineering field were characterized by a greater number of negative job characteristics than were standard arrangements. Results also showed that women were overrepresented in some of the worst forms of nonstandard work arrangements (short-term work and temporary agency). Men were less likely to be in these arrangements, and therefore less likely to hold jobs offering low wages and no benefits. Although it is unsurprising that nonstandard work arrangements were less likely to provide health and retirement benefits, we have now documented this trend in a highly educated population of scientists and engineers, showing that the negative attributes associated with this work apply to high-skilled workers.

We expected that nonstandard work arrangements would explain a portion of the gender pay gap among scientists and engineers, but regression analyses showed they did not. Our results nevertheless reveal meaningful patterns in the science and engineering earnings gap. We found that, unlike in the nonstandard labor force more generally (Spalter-Roth and Hartmann 1998), there is a large wage gap in men's favor in the worst nonstandard arrangements and gender equality or a pay gap in women's favor in the best. This pattern is in sharp distinction to what Spalter-Roth and Hartmann (1998) termed "equality at the bottom." Part-time work was an exception, since women's wages were slightly higher than men's (by 5%). When men were employed in the worst arrangements, they still earned more than women (ranging from 5 to 26% more).

Why did our finding contravene the tendency for "equality at the bottom" that others note (Padavic and Reskin 2002; Spalter-Roth and Hartmann 1998)? Our finding probably stems from the relatively high wages in the science and engineering fields, so that even workers near the bottom of our population are not truly at the bottom of the larger labor force. In the arrangements where the pay gap favored men and where conditions were poor (independent contracting, short-term noncontract work, job share, work from home and temporary agency employment) women's median annual earnings were $33,321, still substantially higher than the median of $25,362 for women in the general labor force who worked full-time, year-round in the same year (1997; U.S. Census Bureau 2005).

Our findings also revealed equality at the top. Given that in nonstandard work arrangements in the U.S. as a whole women are underrepresented in the best arrangements (Kalleberg et al. 1997), it is surprising that we found that not only were women equally represented or better, but their pay was similar to (or better than) their male counterparts'. Contract work was far-and-away the best arrangement, and women contract workers fared better than men contract workers in wages and were proportionally represented (i.e. their representation was similar to that of women's representation in science and engineering). In another arrangement that ranked highly, short-term contract work, women also fared well, earning well above their male counterparts (24% higher) and represented proportionally to their presence in science and engineering.

Why do women scientists and engineers in the top arrangements fare so well, when this is not the case more broadly? We suspect that a selection effect may be operating. It is possible that these women are the "crème-de-la-crème" of women scientists and engineers, able to "call the shots" when it comes to what they seek in employment arrangements. In other words, these women may systematically differ from other women in the science and engineering workforce on unmeasured human capital characteristics that make them highly competitive in the labor market. Given gender schemas (Marler and Moen

2005) that encourage women to seek jobs that allow time for family care, the most marketable women—those in the position to choose from an array of the best job options—may favor the hours-flexibility of contract work. In contrast, the most marketable men, responding to gender schemas that deem full-time standard employment the most appropriate work arrangement, would most likely choose standard arrangements.

The question of why women's overrepresentation in nonstandard work arrangements fails to explain the pay gap among scientists and engineers remains. One answer is that combining disparate categories into one, in this case "nonstandard work arrangements," is problematic because there is more variation across the nonstandard arrangements than between standard and nonstandard work arrangements. In other words, examining the wage gap in each particular nonstandard work arrangement reveals earnings disparities, but looking at all the nonstandard categories in aggregate obscures the internal variation. For example, women's greater returns than men in short-term contract work (where they earn $1.24 for a man's dollar) balances their lower returns in temporary agency work (where they earn 74 cents for a man's dollar), and implies a parity that exists only in the aggregate.

Adding to what we know about women in the science and engineering workforce is crucial. Social equity requires that gender have no bearing on qualified people's access to occupations as prestigious and profitable as those in science and engineering and that the accompanying wages and benefits are fairly distributed. Moreover, science and engineering occupations are experiencing rapid growth and will be increasingly important in the economy of the 21st century (National Science Board 2008). As the demand for scientists and engineers grows, the number of women entering such occupations is likely to increase as well, making it imperative to address the inequality women in such occupations confront.

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