

From Scarcity to Visibility

Gender
Differences
in the Careers
of Doctoral
Scientists
and Engineers

Summary

Panel for the Study of Gender Differences in the
Career Outcomes of Science and Engineering Ph.D.s

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**PANEL FOR THE STUDY OF GENDER DIFFERENCES IN THE
CAREER OUTCOMES OF SCIENCE AND ENGINEERING PH.D.S**

J. SCOTT LONG, *Chair*, Indiana University
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GEORGINE M. PION, Vanderbilt University
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Introduction

It is an unfortunate fact that women have lagged far behind men as participants in the science and engineering workforce. In the last two decades, the gender gap has narrowed dramatically in some fields, but it stubbornly persists. It cannot be explained solely by the variables one might imagine, and at any age women lag behind their male colleagues in career advancement. It appears likely that continued effort will be required to narrow, let alone close, the gender gap.

A new study from the National Research Council, *From Scarcity to Visibility: Gender Differences in the Career Outcomes of Scientists and Engineers*, indicates that the gender gap is most closely related to conditions that slow or interrupt careers, especially those in academia. To the degree that science and engineering are weakened by the loss of many talented people because of gender difference, efforts to improve the careers of women help to maximize the use of the nation's human resources.

Summary

Two decades ago, the Ahern and Scott study by the National Research Council confirmed that . . . *with male and female scientists and humanists closely matched by education, experience, type of employment, and even subfield in many cases, none of the differences we have previously noted in career progress disappear and few diminish. Women remain less likely to be employed although seeking employment, their careers are apt not to develop as fully, and they remain significantly less well paid.*¹

In 1986, partly in response to that report, the Office of Science and Engineering Personnel set out to monitor women's progress in science and engineering to ensure that an appropriate share of the best and the brightest people, regardless of gender, choose careers in science and engineering. *From Scarcity to Visibility* employs enhanced statistical methods of analysis to allow more flexible comparisons among cohorts of Ph.D.s.

Progress toward gender equity has been stimulated by women's advancement in higher education, enforcement of anti-discrimination laws, falling interest in science and engineering (S&E) among men, and declining popularity among women of degrees in non-scientific fields. Between 1973 and 1996, women's portion of baccalaureate degrees rose from 44% to 55%; of baccalaureate degrees in science and engineering, from 30% to 46%; and of Ph.D.s in S&E fields, from 8% to 32%. Still, while

¹Ahern and Scott, 1981, Committee on Education and Employment of Women in Science and Education, *Career Outcomes in a Matched Sample of Men and Women PhDs: an Analytical Study*.

women are now visible in fields in which they were virtually absent 25 years ago, notably engineering and mathematics, they continue to cast a very small shadow. This study, in trying to illuminate why this is so, examines cohorts of men and women who began their education at the same time.

One might assume that the members of matched cohorts would move through their careers at the same rate—that women who entered academia, for example, would attain tenure-track positions at the same rate as men. But statistics do not bear out this assumption. For any age, the rate of advancement for women falls below that of men. The present study attempts to “unwrap” this situation, to control statistically for all variables except gender and seek out factors that could cause dissimilar outcomes. Although the study did not attempt a causative analysis, this unwrapping and correcting reveals that women are, for example, more likely to have part-time positions or hold non-tenure track jobs or to spend more time out of the labor force than otherwise similar men. For academic jobs, such differences can delay or interrupt careers and reduce the likelihood of promotion and tenure. In the world of academic science, career delay is tantamount to lost opportunity and diminished achievement.²

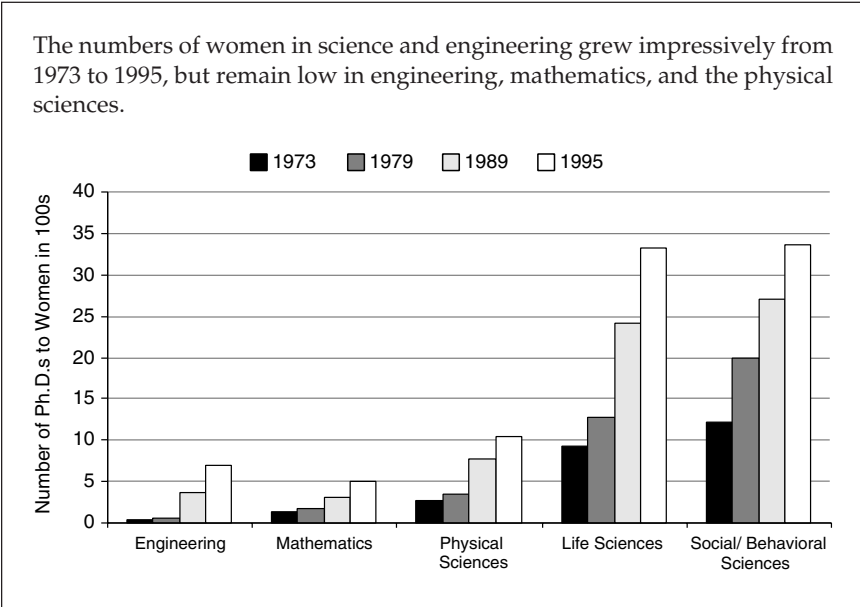
Among doctoral scientists and engineers, women's participation has grown much closer to parity in the life and social sciences, but lags far behind in engineering and the physical sciences.

The participation of women in the labor force has improved impressively. Between 1973 and 1995, the number of women working full time in the doctoral S&E labor force more than doubled, from 187,236 to 412,497. During the same period the proportion of women in the full-time S&E workforce grew from 6.5% to nearly 20%, and in the total S&E workforce from 9 to 21%.

Their participation varied widely by field, however. In the life sciences the number of women rose by a factor of six, from 4,598 (9.5%) to 29,885 (26%), while the number of men doubled. In agricultural sciences they rose from a virtually invisible 1% to a barely visible 12%.

In the social and behavioral sciences, the rise of women was almost as rapid, from 12 to 33%. In 1995 they formed 40% of the workforce in anthropology, 39% in psychology, 36% in sociology, and 15% in economics.

²The present report draws on two databases of the National Science Foundation. The Survey of Doctoral Recipients for 1973, 1979, 1989, and 1995 describes the employment and demographic characteristics of a longitudinal sample of the S&E doctoral workforce. This survey, in turn, draws on the Survey of Earned Doctorates for new Ph.D.s which has been conducted annually since 1960.



Except for economics, the figures in these fields indicate substantial progress, but women stand far below parity in other fields:

- The number of women in the full-time engineering workforce rose forty-fold between 1973 and 1995, from 82 to 3,589, but even that spurt brought women's representation to only 5%.
- In mathematics, including computer science, participation by women rose from 677 in 1973 to 3,728 in 1995 (450% vs. 121% for men), but this improvement brought women to only 13% of the workforce.
- In the physical sciences, the percentage of women rose from 4% to 14% in chemistry and from 1.3% to 5% in physics.

The study also showed that between 1975 and 1995, 10% of the potential professional workforce of female S&E doctorates has been less than fully employed in S&E. Compared to men, relatively more women seek full-time work outside S&E (2 percentage points more), more hold part-time positions than men do (11% vs. 4%), and those unemployed and not seeking work rose from 3% to 4.6% from 1989-1995 while the rate for men rose from 0.2% to 1.0%. Taken together, these distinctions explain why

17% of women scientists and engineers (S&Es) were not employed full time in S&E in 1995, vs. 6% for men, despite a marked decline since 1973.

Low levels of participation, in addition to signifying the absence of many talented women, can also diminish the contribution of those who do participate. The report notes, "A given field . . . may need at least a minimum number of women before these women attain a *critical mass* whereby they are no longer viewed as an oddity. Having a critical mass can minimize socialization difficulties otherwise encountered in a male-dominated environment."

Women S&Es come from different backgrounds and take longer to complete their degree.

Previous studies have made the point that differences in the way women are raised or educated have dissuaded them from careers in S&E. The current study reveals fewer differences in such background characteristics as parents' education, encouragement and support of mothers, fathers who have Ph.D.s, and mothers who graduated from college. Women S&Es, however, are still more likely than men to attend non-Ph.D.-granting institutions, which may put them at a disadvantage in preparing for a career. Also, in all fields except engineering, women are more likely to take a year or more longer than men to complete a Ph.D. At any point in her career, a woman on average has fewer years' work experience than a man who received a Ph.D. at the same time. This gap shrank between 1979 and 1989, and yet 12 years after receipt of the Ph.D., the average woman had one year less work experience than her male counterpart. This distinction in work experience matters for career outcomes.

Timely degree completion and the quality of doctoral research may also be affected by differences in financing of graduate education. Grad students with research assistantships are most likely to complete dissertations. Those with teaching assistantships gain practice in teaching, but lose research time and opportunities to work with an advisor. Except in engineering, men are more likely to rely primarily on research assistantships and women are more likely to rely primarily on teaching assistantships or to use loans.

The number of years working in the profession affects the tenure and promotion of S&Es in academia. The average female faculty member has had fewer years of professional experience than the average male, so that proportionately fewer women are full professors. The same holds for administrative and gatekeeping roles, such as journal editorships and department heads.



Women who are married and have small children are less likely to have full-time careers in S&E.

As recently as 1965, Bruno Bettelheim could write the following: “. . . as much as women may want to be good scientists or engineers, we must remember that they want first and foremost to be companions of men and to be mothers.”³ Although such a conclusion seems out of place today, clear and significant differences in marital and parental status still exist. Among S&Es who are married and have children, men show higher rates of full-time employment than women, although the negative effect for women has declined over time. A statistical model predicts that single women are

³In *Women and the scientific professions: The M.I.T. Symposium on American Women in Science and Engineering*, edited by J. A. Mattfeld, C. G. Van Aken, and Massachusetts Institute of Technology. Association of Women Students. Cambridge: Massachusetts Institute of Technology Press. 1965.

more than 30% more likely to be working full time than women with children (91% vs. 61%). By 1995, the predicted rate for women with children had increased to 71% and the gap was down to 22%. Despite these improvements, women who are married and have small children are still less likely to have a full-time career in S&E.

In all fields, men were more likely than women to be managers.

As employment in academia leveled off, more women and men moved to S&E positions in industry. Between 1973 and 1995 the proportion of women who worked in industry rose from 8% to 26%, while the number of men in industry rose from 26% to 37%. In all fields, gender differences narrowed or stayed nearly the same. By 1995, the largest difference was in engineering, where 11% more men than women worked in industry, and in the life sciences, where the gap was 7.5%.

In academia, S&Es are more likely to spend most of their working time in teaching and basic research. In industry, they spend most of their time in management and applied research. Because men still far outnumber women in industrial positions in S&E, they are more likely than women in all fields to be managers.

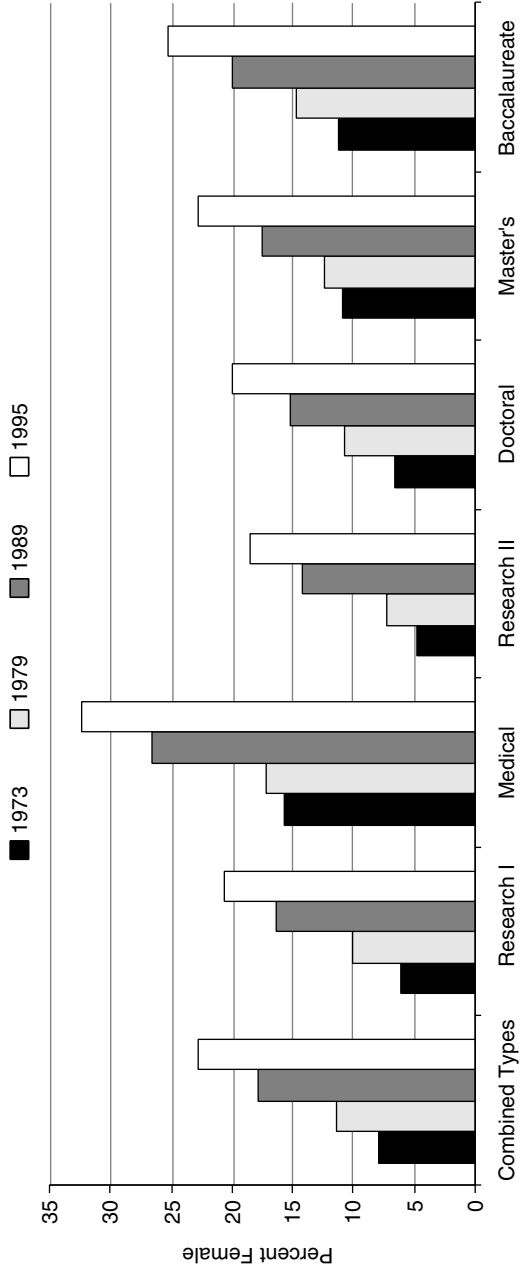
In academia, women are underrepresented in senior faculty positions and at Research I universities.

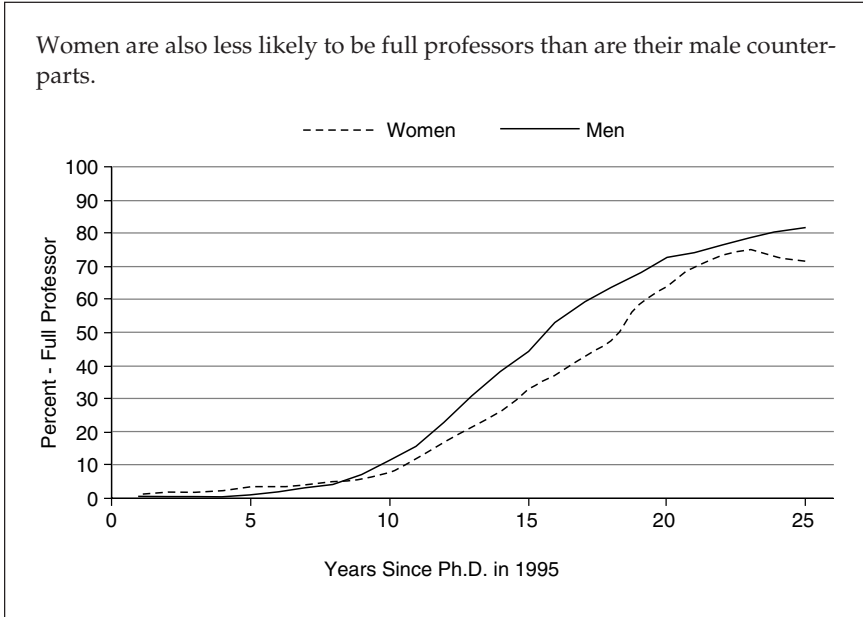
In most fields of S&E, the Ph.D. is still the sine qua non of research status, and academia is the sector with the largest share of doctoral employment. From 1973 to 1995, the proportion of women doctoral S&Es employed in academia shrank, as did that of men, even as women's representation in full-time academic employment rose from 8% to 23%.

The greatest increase in both new Ph.D.s and in academic positions was seen in the life sciences and social/behavioral sciences. However, employment in academia has experienced little growth in recent years so that today it may be more difficult for women to attain senior faculty positions than it was for men in the 1970s and 1980s when growth was rapid.

Men and women are distributed more evenly among types of institutions. The 11% preponderance of men in Research I institutions in 1973 shrank to 5% in 1995. In social/behavioral sciences, women in Research I institutions grew from 10% to 37%. In the life sciences, growth in the same period was from 8% to 26%. In engineering, however, women represented only 6% of the population in 1995 and only about 12% of the population in mathematics and the physical sciences. Their scarcity makes it difficult for young women to find same sex role models in these fields.

In the academic sector, which is especially important because it is where young women are recruited to careers in science and engineering, women are least represented among the most research-intensive institutions (Research I and Research II).





In addition, the semblance of growing equality fades further when one looks more closely at employment. Men hold a 14% advantage in tenure-track positions at a time when these positions are declining as a percentage of academic jobs. It is possible that women's representation will grow over time; a logit analysis reveals that much of the difference is due to the lower career age of women.

At any professional age, men are more likely than women to hold tenure. Although this difference has declined over time, it persists, especially in research universities. Some of it can be explained by lower productivity as measured by publications. It seems clear, however, that differences in the positions held by women are likely to be a major cause of lower productivity, rather than lower productivity being the cause of lower-status positions.

Finally, both Research I and other institutions have increased their representation of women. Comparatively, however, the increase for women has been greater in non-Research I institutions, where women are less well represented than men in all academic ranks and measures of status.

The gender gap in salaries has diminished, but stubbornly persists.

The salary gap has declined over the years, but improvement for women may have topped out. When one controls for differing characteristics of men and women, such as years of experience and field, gender differences persist. Overall, male doctoral S&Es had about a 20% salary advantage over women between 1973 and 1995. When one controls for the above factors by regression analysis, the gender gap in salaries in 1995 diminishes from 21% to 6%, with the largest effects resulting from career age and field. These effects vary by survey year and are smallest in the early survey years, suggesting greater gender discrimination then. Some good news is that this gap is smaller than the gender gap in salaries for all professionals and for the labor force generally.

Data up to 1995 indicate that women's salaries reached a plateau when they achieve 20 years of experience, while men's salaries continued to rise. This does not predict what will happen to recent Ph.D.s as they gain experience. In fact, there is evidence that the salary gap had narrowed somewhat for recent cohorts as they entered mid-career.

There are significant differentials across fields. The gap is wider in engineering and mathematics than in the life and social/behavioral sciences—fields that have relatively more women. And there are some sectoral differences: women are more concentrated in academia, where the median salary is lower, than in industry, where there are more men.

In general, the more restricted the population, the smaller the gender gap in salaries. Thus the gap for all full professors is 11%, whereas the gap for all tenure-track faculty is 20%, reflecting the concentration of women in the lower academic ranks. This demonstrates the importance of making comparisons only for groups that are as comparable as possible.

Conclusion

In summary, men and women have increasingly similar educational backgrounds and demographics, which tend to narrow career outcomes. Nonetheless, women continue to show systematic differences in labor force participation, full-time status, and the effect of children on careers. These differences significantly shape career outcomes.

The report did not go behind the numbers to investigate the web of decision making by those who have the power to influence careers. Both men and women encounter such guidance and gatekeeping at all stages of their careers. Nor has it looked at decision making by the men and women themselves as they balance pursuit of career with marriage, children, and geographical location.

Thus the report presents only outcomes, which indicate that women, although they have made great progress toward equality in S&E in the past 25 years, are still more likely than their male counterparts to have lower status and lower pay. The authors of the study hope this documentation will help those who wish to see more equal use of talented women to the overall benefit of S&E.

Although this report does not make recommendations, it seems clear that several options are open to those who would increase both the extent and the quality of the participation of women S&Es, especially in academia. For example, those involved in tenure searches can ensure women's presence on search committees. The availability of child care, willingness by men to share responsibilities of raising children, and greater flexibility by employers can all promote the careers of women. In

general, those in authority can help locate women mentors, appoint women to influential committees, and generally take steps to ensure that people who are equal receive equal treatment.⁴

⁴Massachusetts Institute of Technology. (1999). *A Study on the Status of Women Faculty in Science at MIT*. How a Committee on Women Faculty came to be established by the Dean of the School of Science, what the Committee and the Dean learned and accomplished, and recommendations for the future. Cambridge, MA.