

Why Women Earn Less

Economic Explanations for the Gender Salary Gap in Science



By Donna K. Ginther, PhD

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*The recent book, *From Scarcity to Visibility*, edited by sociologist Scott Long, documents the progress women have made in scientific careers. Women are increasingly represented at the PhD level in academic science across all fields. Although women have increased numerically and achieved more prestigious positions in scientific academia, the question remains as to whether the rewards of salary and promotion have achieved equality with those of men. This article examines gender differences in the salaries of academic science through the lens of economic theory. It finds that women's salaries lag behind those of men's and are not fully explained by differences in productivity.*

Previous research has documented a persistent gender gap in science. Congress established the Congressional Committee on the Advancement of Women and Minorities in Science, Engineering and Technological Developments (CAWMSET), to review the status of women in science. CAWMSET found that women are underrepresented in academia as a meager 23% of the workforce and are less likely to be tenured.¹ The CAWMSET report made specific recommendations on how to address the gender gap in science without fully exploring the reasons for these discrepancies. More recently, the American Association for the Advancement of Science (AAAS) sponsored a salary survey of life scientists.² The study found that women in the life sciences earn 23% less than

their male counterparts. Although some of these gender differences in the AAAS survey can be attributed to choice of field and work experience, the study found a 14% salary gap among full professors in academia. In *From Scarcity to Visibility*, Long finds an overall salary advantage of 25% for male academics in 1995.³

Even though women earn less than men in science, one cannot conclude from the above studies that gender discrimination is the underlying cause of the gender gap. Economic theory suggests that salary differences arise from differences in preferences and productivity. Factors such as time in rank, employer characteristics, or productivity may also explain a substantial portion of the gender salary gap. Simply comparing salaries of male and female aca-

demographic scientists without taking into consideration these factors could overstate the gender salary gap. In addition, empirical evidence supporting discrimination must be qualified by assuming that, in the absence of discrimination, men and women would be paid the same on average. Careful examination of data is needed in order to conclude that discrimination is evident.

This study uses data from the Survey of Earned Doctorates (SED) and the Survey of Doctorate Re-cipients (SDR) to examine the distribution of women across scientific fields and gender differences in salary. The SED is a census of doctorates awarded in the United States each year. The 1974-2000 waves of the survey are used in this study to evaluate changes in the distribution of women in scientific fields. The SDR is a nationally representative sample of PhD scientists in the United States used by the National Science Foundation to monitor the scientific workforce and fulfill its congressional mandate to monitor the status of women in science. This study uses data from the 1973-2001 waves of the SDR. The SDR collects detailed information on doctorate recipients including demographic characteristics, educational background, employer characteristics, academic rank, government support, primary work activity, productivity, and salary. Academics in the life sciences, physical sciences, and engineering are included in the analysis. Although the SDR has comprehensive measures of factors that influence academic salaries, the data lack information on some quantitative measures, such as laboratory space, and extensive measures of publications.

My evaluation begins with an examination of the distribution of women across scientific fields. Next, the gender salary gap in science is examined over time. Finally, potential economic explanations are considered for the gender salary gap.

The Distribution of Women in Science

Women are not equally distributed across scientific fields. Panel A of Figure 1 graphs the percentage of doctorates awarded to females between 1974 and 2000 using data from the SED. If we consider only life science fields, we may conclude, like Long,³ that women have indeed moved “from scarcity to visibility” in terms of doctorates granted. By 2000, almost half of all doctorates in life science were awarded to women. The same is true of most social science and humanities disciplines. However, both physical science and engineering awarded less than one-third of doctorates to women. In the year 2000, only 16% of engineering doctorates were granted to women.

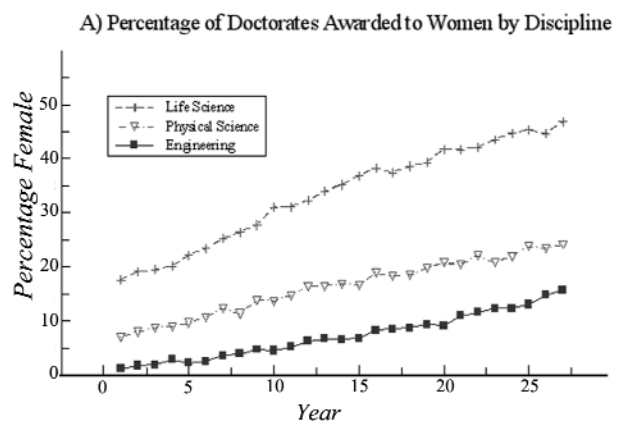
Despite the increasing numbers of doctorates awarded to women, the representation of women among tenured academic scientists remains quite low. Panel B of Figure 1 uses data from the 1973-1999 waves of the SDR to graph the percentage of tenured faculty who are female in life science, physical science, and engineering. As expected, life science has the highest percentage of tenured female faculty at over 20% by 1999. Physical science and engineering have far fewer tenured female faculty at 10% and 5% respectively. Figure 1 tells us that women have made progress in terms of entering science, but they are less likely to join the tenured academic ranks.

For example, on average, marriage increases male salaries while having a negative effect on female salaries.

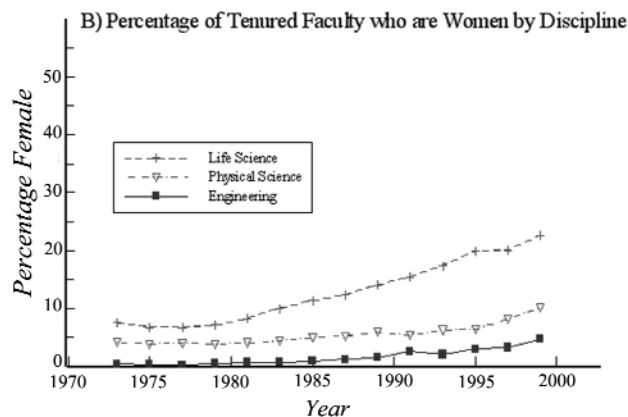
The Gender Salary Gap in Science

The study continues with an evaluation of the gender salary structure. Salary regressions are estimated for men and women separately over time as a function of those factors that influence salaries such as demographic characteristics, academic background, and employer characteristics. The difference between estimated male and female salaries can be decomposed using a method developed by Oaxaca.⁴ This method separates the gender salary gap into two components, the “explained” portion of the gap attributable to differences in observable characteristics (such as academic rank and differences in productivity), and the “unexplained” portion of the gap attributable to gender differences in the estimated regression coefficients. The sum of the explained and unexplained portions is the total gender salary gap. The unexplained gap resulting from gender differences in coefficients should equal zero provided that men and women are paid the same for a given level of observable characteristics. When it is nonzero, the unexplained portion of the gender salary gap has often been interpreted as accounting for the effect of discrimination. However, in order to do so, the model must contain all relevant observable characteristics that have an impact on salaries.

Figure 1: Women's Representation in Science by Discipline: 1973 - 2000



Source: 1974-2000 Survey of Earned Doctorates



Source: 1973-1999 Survey of Doctorate Recipients

There are several factors that affect the salaries of academics. Demographic characteristics such as race, marital status, fertility, and years of work experience may have a positive or negative effect on salaries. For example, on average, marriage increases male salaries while having a negative effect on female salaries. Employer characteristics such as working at a public or private institution, liberal arts or a doctoral institution, and the Carnegie ranking of the employer may also affect salaries. Top research institutions pay more than liberal arts colleges. Public institutions have state-mandated salary scales that tend to be more restrictive than those at private institutions. Employee characteristics such as the academic rank and tenure status of the individual also influence salaries, with salaries increasing with academic rank and tenure.

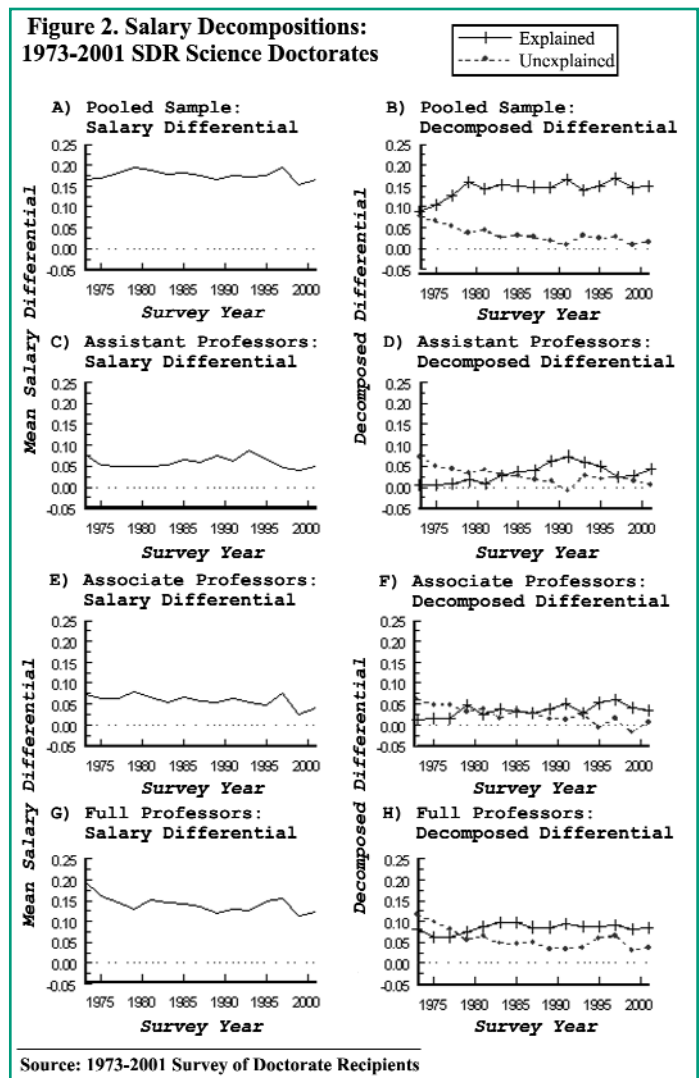
Measures of productivity also affect salaries. These include factors such as whether the individual receives government support, primary work activities, and publications. Having a greater (or lesser) amount of these factors will have an impact on salaries. If men are more likely to work at top-ranked research universities, the gender salary gap will be larger. Salary differences may also result from differential treatment reflected in differences in estimated coefficients. For example, at private institutions if men are paid more than women and private institutions are equally likely to employ both, then the gender salary gap will increase.

These observable characteristics may also reflect the preferences and choices of women in science. For example, women in science are more likely to be employed at teaching colleges. Women might choose to work at four-year colleges because such jobs are more compatible with work and family trade-offs, as suggested in a *Chronicle of Higher Education* article.⁵ However, these characteristics potentially reflect discriminatory practices in science; women may be more likely to work at teaching colleges because of discriminatory hiring practices on the part of research universities. On average, teaching colleges tend to pay less than research universities and this will have an impact on the gender salary gap. My analysis will not be able to distinguish between those observable characteristics that result from individual choices and those that may reflect discrimination. Yet, taken together, these observable characteristics may explain a substantial portion of the gender salary gap.

The Gender Salary Gap Over Time. Previous research shows significant changes in the gender salary differential in academia over time.⁶⁻⁸ I examine these salary differentials by estimating separate models for each survey year and using the Oaxaca salary decomposition to examine trends in the salary differential over time. Panel A of Figure 2 graphs the gender difference in mean log salaries between 1973 and 2001 for all academic ranks combined. One may interpret the gender difference in mean log salaries as the percentage difference in salaries. Thus, the 0.17 mean log salary difference in Panel A of Figure 2 in 1973 indicates that male scientists employed with tenure or on the tenure track earned 17% more on average than women scientists. This salary differential remains roughly constant through 2001. The gender salary gap can be decomposed into two components — the explained gap resulting from gender differences in observable characteristics and the unexplained gap resulting from gender differences in estimated coefficients in Panel B. Between 1973 and 2001 most of the gender salary gap can be explained by differences in observable characteristics, and the remaining gap is unexplained by observables (attributable to gender differences in coefficients) falls to 2%.

Previous research by Ginther and Hayes^{7,9} shows that the majority of the gender salary gap in the humanities disappears when separate salary regressions are estimated for each academic rank. To examine whether the gender salary gap in the sciences may be explained by rank, I estimated salary differences for each rank (Panels C-H of Figure 2). The salary gap decreased from more than 17% in 1973 for the estimates that combines all ranks together (Panel A) to a high of 8% for assistant professors (Panel C). The gender salary gap for assistant professors falls to five percent by 2001. The salary decomposition in Panel D shows a change in the proportion of the gap explained by observable characteristics and unexplained by coefficient differences over time. Prior to 1985, the majority of the gap is unexplained. Afterwards, differences in observable characteristics explain the gender salary differential. By 2001, less than 1% of the gender salary gap is unexplained.

Similar results are apparent for associate professors in Panels E and F. In 1973, male associate professors earned 7% more salary than their female counterparts. This earnings differential falls to 4% by 2001. Prior to 1985, most of the gender gap is unexplained. After 1985, the gender salary gap between male and female associate professors is almost entirely explained by differences in observable characteristics.



The marked decrease in the gender salary gap observed for assistant and associate professors is not apparent for full professors in Panels G and H of Figure 2. The salary gap for full professors is larger over time than for the lower academic ranks. In 1973, male full professors earned a 20% salary premium over female full professors. By 2001 this gap fell to 12%. The decomposed salary differential shows a decrease in the unexplained gap over time in Panel H; however, one-third of the full professor salary gap remains unexplained.

In particular, women who have children are often paid less than women without children.

A separate analysis was performed for life scientists. Despite the fact that women have made the greatest strides in terms of representation in the life sciences, trends in the gender salary gap in life science mirror those for all science and engineering fields combined. This suggests that although women in life science have achieved a critical mass, rewards have yet to be equally distributed at the full professor level.

Economic Explanations for the Gender Salary Gap. Economic theory suggests that salary differences arise from differences in preferences or productivity. The above analysis does not include measures of academic productivity such as publications because these data are missing from most survey years. However, researchers have found that the productivity gap in science has been virtually eliminated. Xie and Shauman¹⁰ find that the raw gender publications gap in science has narrowed over time. When the authors control for factors including age, rank, and field, gender differences in publications in the sciences disappeared.

To determine whether publication differences could account for a substantial portion of the unexplained salary gap for full professors, we examined the 1995 and 2001 waves of the SDR. Both samples include measures of papers published and papers presented at conferences within the last five years. In 1995, the estimated salary gap for full professors was 14.9% with 6% attributed to unexplained factors. Including productivity measures reduces the unexplained portion of the gap negligibly from 6% to 5.8%. In 2001, the gender salary gap for full professors is 12.2%. Including productivity measures only reduced the unexplained portion of the gap from 3.8% to 3.5%. Thus, productivity does not appreciably reduce the unexplained gender salary gap for full professors.

Next, we consider other factors that may explain the gender salary gap. In particular, women who have children are often paid less than women without children.¹¹ Since women are often the primary caregivers for children, having a child may reduce a woman's productivity. Our analysis shows that the total number of children and presence of children under the age of six have little or no impact on either the explained or unexplained portion of the gender salary gap.

Economic models of monopsony (where the university acts as the sole purchaser of labor) may also explain the gender salary gap. In monopsonistic models of academic labor markets developed by Ransom,¹² senior faculty have higher moving costs and receive lower salary offers. It is possible that tenured women faculty have higher moving costs than their male colleagues because of dual career considerations or fewer job opportunities. In related research, Booth, Frank, and Blackaby¹³ suggest that universities may consider women to be "loyal servants" who are less likely to change

academic employers. As a result, universities can make lower salary offers and adjustments to women scientists. Both the monopsony and loyal servant explanations would be evident in the effect of job tenure on wages. If women have higher moving costs due to monopsony or are perceived to be "loyal servants," their wages would be reduced more than men's for each additional year of job tenure with the same employer. However, the data show the opposite is true. Male salaries are reduced more than female salaries for each additional year of job tenure. Thus, neither monopsony models nor the loyal servant hypothesis provide an adequate explanation of the gender salary gap in science.

Although productivity, children, and economic models do not provide an adequate explanation for the gender salary gap, there are other variables that are associated with the gender gap. In my analysis, the single most important factor contributing to both the explained and unexplained gender gap is work experience — measured by years since PhD. Virtually all of the explained salary gap for full professors results from men having relatively more work experience. In addition, virtually all of the unexplained salary gap for full professors results from men having a higher return on experience than women. Although the effect of experience on wages is almost the same for men and women in the assistant and associate professor ranks, it differs for men and women at the full professor rank. Each additional year of work experience increases the salaries for male full professors but has zero effect on the salaries of female full professors, thus contributing to the unexplained salary gap.

Does Discrimination Explain the Gender Salary Gap? None of the above explanations for the gender wage gap is consistent with the empirical results reported in this analysis, leading us to consider whether gender discrimination is responsible for the observed salary differences. Discrimination may operate through a subtle mechanism such as the cumulative advantage model described by Zukerman.¹⁴ In this model, some groups receive greater opportunities than others. Recipients are enriched and non-recipients are impoverished. Over time as advantages and disadvantages accumulate, a gender gap develops. The effect of experience is also consistent with Valian's¹⁵ notion of "gender schemas." Valian defines schemas as "hypotheses used to interpret social events" (p. 103). Schemas are similar to stereotypes, but are generally broader and may be accurate, inaccurate, or neutral. Valian¹⁵ argues that the effect of schemas may lead to discrimination:

"Employers faced with a man and a woman matched on the qualities relevant to success in a particular field may believe they are judging the candidates objectively. Yet, if their schemas represent men as more capable than women, they are likely to overestimate the male's qualifications and underestimate the female's." (p. 7)

Although presence of children, productivity differences, and monopsony do not square with the observed empirical results, gender discrimination that accumulates throughout the career may provide a better explanation. However, this conclusion must be tempered by the possibility that there are some factors omitted from this analysis (such as grant awards) that would serve to narrow the unexplained gender salary gap.

Conclusions

The data show a persistent salary gap between male and female science academics over time. Although considering academic rank reduces the gender salary gap, it does not entirely explain the difference. Between 1973 and 2001 the average gender salary difference remained at roughly five percent for tenure-track assistant and associate professors, with more than half of that difference attributable to observable characteristics. Gender salary differences for full professors are persistently high, averaging 15% throughout the sample time frame, with one-third of the salary difference remaining unexplained by observable characteristics.

Economic theory suggests several potential explanations for observed gender differences in career attainment. However, when presence of children, productivity differences, and monopsony are evaluated they are found to be inconsistent with the evidence presented in this study. The results are more consistent with the cumulative advantage and gender schema models of gender discrimination. In the cumulative advantage model, men's careers are more likely to be enhanced than women's and these advantages and disadvantages accumulate over time leading to the salary gap. In the gender schema model, women's accomplishments are downplayed relative to men's leading to lower salary increments.

So why is it that the average female academic scientist continues to fare worse than her male colleagues? Research by Ginther and Hayes⁷ shows that this is not the case for women in the humanities. At all ranks, the gender salary gap in the humanities is not significantly different from zero. It could be that women in science are required to negotiate for resources and salary more than faculty in the humanities. Recent research suggests that women are less likely to initiate negotiation than men, and when they do negotiate for salaries, they make lower salary demands.¹⁶ In addition, women in science may be less likely to embrace the possibility of gender discrimination in career outcomes. Etzkowitz *et al.*¹⁷ found in interviews of female faculty that, "Fear of stigmatization led some women ... to deny the existence of gender related obstacles." This contrasts sharply with the humanities, where feminism is a mainstream field of intellectual inquiry, and the concept of equal pay for equal work is sacrosanct.

As a result of these findings, colleges and universities should undertake an evaluation of the status of women in science similar to recent reviews by MIT and other elite institutions.¹⁸ Raising awareness among faculty and administrators is the first step towards addressing gender disparities. In addition, the National Science Foundation sponsors ADVANCE grants designed to help women scientists further their careers, to support women's leadership initiatives, and to allow for institutional transformation to make academia more hospitable for women scientists. Despite having moved from scarcity to visibility in science careers, women's salaries at the full professor rank do not reflect the same kind of progress. ●

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"We will have equality when a female schlemiel moves ahead as fast as a male schlemiel." -Estelle Ramey