Is MIT an Exception? Gender Pay Differences in Academic Science

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This study uses data from the Survey of Doctorate Recipients to evaluate gender differences in salaries for academic scientists. Over time gender salary differences can partly be explained by differences in observable characteristics for faculty at the assistant and associate ranks. Substantial gender salary differences for full professors are not explained by observable characteristics. Between 1973 and 1997, very little has changed in terms of gender salary and promotion differences for academics in science. After evaluating potential explanations, the author concludes that gender discrimination similar to that observed at MIT accounts for unexplained gender disparities.

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In March 1999, the Massachusetts Institute of Technology (MIT) shocked the academic world by admitting that female faculty "suffer from pervasive, if unintentional discrimination" (Goldberg, 1999). The MIT admission pinpointed the problem as it existed for senior faculty: "Many tenured women faculty feel marginalized and excluded from a significant role in their departments. Marginalization increases as women progress through their careers at MIT" (MIT Faculty Newsletter, 1999, p. 2). Marginalization at MIT took the form of differences in salaries, resources, and differential treatment "despite [women having] professional accomplishments equal to those of their male colleagues" (MIT Faculty Newsletter, 1999, p. 3).

The MIT report was greeted with recognition and derision. Following up on this report, the Ford Foundation awarded MIT a $1 million grant to spearhead an evaluation of the status of women in science at other academic institutions. As a result, nine elite universities agreed to share data on gender inequities in salaries and in the distribution of resources among faculty in the sciences and engineering and to compare methods for addressing these gender inequities (Zernike, 2001). However, in a series of special reports, the Independent Women's Forum (IWF) charged MIT with engaging in junk science: "The MIT study with its secret data, shrill rhetoric, and shoddy analysis tarnishes the reputation of a great and distinguished university" (Kleinfeld, 1999, p. 3). Given the controversy surrounding the MIT report, the question as to how pervasive "unintentional discrimination" is for academic women in science remains. This study evaluates gender differences in employment outcomes in the sciences to examine whether the findings by MIT were an exception in the scientific community.

Substantial gender differences in employment outcomes have been documented in science. Since 1982, the National Science Foundation (NSF) has had a congressional mandate to report biennially on the status of women and minorities in science. The latest report shows that since 1982, women are less likely to get tenure or become full professors than men (NSF, 2000). However, the report does not explore why these differences persist. In addition, Congress has established its own committee, 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 also found that women are underrepresented in the sciences, making up only 23% of academics in the sciences, and are less likely to be tenured (CAWMSET, 2000). The CAWMSET report makes specific recommendations on how to address the gender gap in science without fully exploring the reasons for such discrepancies. More recently, the American Association for the Advancement of Science (AAAS) sponsored a salary survey of life scientists (AAAS, 2001). The study found that women in

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the life sciences earn 23% less than their male counterparts. Although some of these gender differences can be attributed to choice of field and work experience, the study found a 14% salary gap among full professors in academia.

Even though women are underrepresented in science, one cannot conclude from the NSF, CAWMSET, and AAAS reports that gender discrimination is the underlying cause of the gender gap. First, it is unclear whether the differences in employment outcomes in science observed in these reports result from discriminatory practices or from the preferences of women scientists. For example, women in science are more likely to be employed at teaching colleges. Women might choose to work at 4-year colleges because such jobs are more compatible with work and family tradeoffs, as suggested in a recent Chronicle of Higher Education article (Schneider, 2000). On the other hand, women may be more likely to work at teaching colleges because of discriminatory hiring practices on the part of universities. Teaching colleges tend to pay less than research universities. Thus, simply comparing salaries of male and female academic scientists without taking into consideration the type of academic appointment 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 on average would be paid the same, and the estimated models are correctly specified. Close and careful examination of data is needed to conclude that discrimination is evident.

To conclude that discrimination was a problem, MIT collected data and conducted interviews with senior female faculty. Data were collected on "salary, space, resources for research, named chairs, prizes, awards" (MIT Faculty Newsletter, 1999, p. 5). The data were then compared for men and women in the sciences; the comparisons have not been released to the public. Given the small number of senior women faculty in the sciences at MIT (15 out of 194), statistical tests of mean differences by gender would likely have proven inconclusive.[1] The inequities observed in salaries, space, 9-month salary paid by grants, and awards and distinctions (MIT Faculty Newsletter, 1999, p. 6) were based on the institutional knowledge and judgment of the committee evaluating gender differences. Personal interviews of senior women faculty revealed that women had little say in their departments. This combination of quantitative and qualitative data led MIT to admit discrimination.

In contrast to the MIT report, this study uses a nationally representative sample of scientists from the NSF-sponsored Survey of Doctorate Recipients (SDR) to evaluate gender differences in salaries. The SDR is a nationally representative sample of Ph.D. scientists in the United States, and it is used by the NSF to monitor the scientific workforce and fulfill its congressional mandate to monitor the status of women in science. This study uses data from the 1973-1997 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. Scientists in the life sciences, computers and mathematical 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 the qualitative information available to those conducting internal reviews similar to that at MIT. On balance, the information available in the SDR allows the researcher to control for detailed individual and employer characteristics while evaluating gender differences in salaries.

The study begins with an evaluation of the gender wage structure. Wage regressions are estimated for men and women separately as a function of those factors that influence salaries such as demographic characteristics, academic background, employer characteristics, and academic productivity. The analysis continues by evaluating gender salary differentials over time using a wage decomposition developed by Oaxaca (1973). Using regressions estimated separately for men and women, the gender salary gap can be decomposed into differences in average endowments (characteristics such as academic rank and differences in productivity), and the differences in estimated regression coefficients (salary structure), the term that accounts for the effect of discrimination. However, to interpret coefficient differences as discrimination, the model must contain all relevant explanatory variables and the researcher assumes that in the absence of discrimination the coefficients would be the same for men and women.[2]

Empirical Results

Estimates of the Gender Salary Structure in the Sciences

There are several factors that affect the salaries of academics. Demographic characteristics such as race, marital status, fertility, and years of work experience can have a positive or negative effect on salaries. For example, on average, marriage increases male salaries, whereas it has 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 can 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 and the quality of the doctorate-granting institution also influence salaries. Salaries increase with academic rank and tenure. Measures of productivity are also assumed to affect salaries. These include factors such as whether the individual receives government support, primary work activities, and publications. Having a greater (or lesser) endowment of this factor can have an effect on salaries. For example, 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.

This analysis begins by evaluating whether these factors have the same effect on the salaries of male and female scientists by comparing the regression coefficients from the two groups. In doing so, I assume that in the absence of discrimination, the coefficients in the salary regressions would be the same for men and women. The regressions estimated use data from 1973 to 1997; Ginther (2001) reported the coefficient estimates. Overall, several coefficients differ between men and women. Some of the largest differences are apparent in demographic characteristics. Marriage has a positive and significant effect on the salaries of men whereas it has a smaller and insignificant effect on the salaries of women. Presence of children has a positive effect on the salaries of men and women, increasing salaries by about 1%. Coefficients on the indicator of having young children are not significantly different from zero for men and women. Hence, the fertility choices of women do not explain salary differences.

When characteristics of Ph.D. institution and academic rank are included in the models, we continue to observe gender differences in the salary structure. Women earn more than twice the salary premium for receiving their degree from a top research institution compared to their male counterparts. In addition, being an assistant or associate professor has a larger negative effect on salaries for men than for women. The coefficient on receiving tenure is positive and statistically significant for women, whereas it is not significantly different from zero for men. These differences are most likely the result of differences in sample composition—76% of men have tenure in the sample compared to 58% of the women.

Employer characteristics and primary work activities also have a differential effect by gender. Working at a top-ranked 4-year or liberal arts college increases the salaries earned by women whereas it decreases the salaries earned by men. Working at a private institution reduces women's salaries by almost 5%, compared to a 1% decrease for men. Both men and women earn a large salary premium for working in a medical school; however, the male premium is larger at 18% compared to the 14% premium for women. Government support of research and primarily working as a teacher have similar effects for men and women, whereas men receive a premium for management and other primary work activities.

To evaluate the full effect of productivity on salaries, I estimated separate models using the 1983 and 1995 SDR samples. In all specifications, productivity (measured by number of publications and number of papers presented) is positive and significant in the models, and the coefficients have a 1.5% positive effect on salaries for men and women. The coefficient estimates on productivity are small in magnitude, indicating that productivity does not explain much of the observed gender salary difference. In both the 1995 and 1983 estimates, the coefficient on experience is larger for men than for women when productivity is included in the estimated model. In general, the coefficients on the salary regressions differ significantly by gender. The next section considers the impact of the coefficient differences on the gender salary gap.

Estimates of the Changes in the Gender Salary Gap Over Time

Previous research shows significant changes in the gender earnings differential in academia over time (Ginther & Hayes, 2001; Ransom & Megdal, 1993). 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. Combining all academic ranks, the gender salary gap is large and persistent. In 1973, male scientists employed with tenure or on the tenure track earned 17% more on average than female scientists. This salary differential remains roughly constant through 1997. The gender salary gap can be decomposed as a function of endowments (differences in average characteristics) and coefficients (often interpreted as discrimination). Between 1973 and 1997, most of the gender salary gap can be explained by differences in endowments, and the proportion of the gap due to coefficients falls to 3%.

Previous research by Ginther and Hayes (1999, 2001) showed that the majority of the gender salary gap in the humanities disappears when separate salary regressions are estimated for each academic rank. I estimate salary differences for each rank to examine whether the gender salary gap may be explained by differences in endowments captured by rank. The salary gap decreased from more than 17% in 1973 for the estimates that pool rank to a high of 9% for assistant professors. The gender salary gap for assistant professors falls to 5% by 1997. The salary decomposition shows a change in the proportion of the gap explained by endowments and coefficients over time. Prior to 1985, differences in coefficients underlie the majority of the gap. Afterward, differences in endowments explain the gender salary differential.

Similar results are apparent for associate professors. In 1973, male associate professors earned 7% more salary than their female counterparts. Again, this earnings differential persists through 1997. Prior to 1985, differences in coefficients favoring male associate professors explain a significant portion of the gender gap. After 1985, the gender salary gap between male and female associate professors is explained by differences in endowments.

The marked decrease in the gender salary gap observed for assistant and associate professors is not apparent for full professors. 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 1997, this gap fell to 15%. The decomposed salary differential shows a decreasing effect of coefficients on the gender salary differential over time; however, a substantial portion of the gap remains a function of coefficient differences. This result suggests that the differential treatment of male and female full professors of science is not a phenomenon isolated to MIT.

Putting Gender Differences in Career Attainments Into Perspective

The estimated gender salary and promotion differences presented in the previous sections are not new and have been observed by other researchers (Zukerman, 1987). The most striking aspect of these findings is that very little has changed for women in science in terms of the gender salary gap during the past 24 years. In her 1987 review of the careers of men and women scientists, Harriet Zukerman asked, "Why do these disparities [in career attainments] grow as men and women get older?" My results show we are still confronted with the same question. I now consider the implications of my results and attempt to put them in perspective when compared to the careers of nonscience academics.

This article has shown that the gender salary difference for full professors in the sciences is large, and a substantial proportion of the gap remains unexplained by observable characteristics. These results contrast sharply with findings by Ginther and Hayes (1999, 2001) for faculty in the humanities. Using the 1977-1995 waves of the SDR and performing similar estimates by rank, Ginther and Hayes found salary gaps for assistant, associate, and full professors in the humanities similar to those in the sciences in the 1970s. However, by 1995 the average salary gap for all ranks in the humanities is not significantly different from zero. Compared to the humanities, the average gender salary gap in the sciences remained roughly stable and persistently high.

Potential explanations for the gender salary gap in the academic sciences abound. First, researchers have argued that average career attainments differ by gender because of women's preferences. Women choose to have children and these choices affect their career placements and productivity. However, the results show that the effect of children on the employment outcomes of women is small at best. First, descriptive statistics show that women are less likely to have children and have fewer children than their male colleagues; in 1995, only 38% of female full professors have children. Second, children contribute at most 1.7% to the unexplained salary difference for full professors. Overall, I cannot attribute the gender salary gap to women's preferences for children.

Second, women are less productive than men and this could explain the observed pay and promotion differences. The estimates I have computed suggest that productivity explains around 1.5% of the salary gap for full professors in 1995. The productivity gap does partly explain why we do not observe more women in the senior ranks. However, it does not fully account for the persistent salary gap observed for full professors.

Third, economic models of monopsony in academic labor markets and job match quality could also explain different employment outcomes for women in science. In a monopsonistic model of academic labor markets developed by Ransom (1993), senior faculty "presumably with tenure" have higher moving costs and receive lower salary offers. It is possible that tenured women faculty in the sciences have higher moving costs than their male colleagues. However, one would also expect to see these differences for senior faculty in the humanities, and that is not the case. In fact, monopsony would be more likely for faculty in the humanities because of limited nonacademic employment opportunities.

Fourth, the job matching model provides an alternative explanation. In the matching model, when individuals are well-suited to the job (employer) they are more productive and earn higher salaries. Thus, if match quality mattered, we would expect to see larger salary differences in the lower ranks because women who are poor matches would earn less than their male counterparts. Furthermore, women with poor match quality would not be promoted to full professor.

None of the above explanations are entirely consistent with the empirical results presented in this article, leading me to consider whether gender discrimination is responsible for the observed salary differentials. Discrimination may operate through a subtle and pervasive mechanism such as the cumulative advantage model described by Zukerman (1987). In this model, some groups receive greater opportunities than others. Recipients are enriched and nonrecipients are impoverished. This was apparently the case at MIT, where "often it is difficult to establish discrimination as a factor because any one case, no matter how disturbing or aberrant, can usually be ascribed to its special circumstances" (MIT Faculty Newsletter, 1999, p. 4). Although presence of children, productivity differences, monopsony, and job matching models do not entirely fit the observed empirical results, gender discrimination that accumulates throughout the career is the more likely explanation.

Conclusion

This study has evaluated gender differences in salaries in the sciences using the 1973-1997 Survey of Doctorate Recipients. The data show a persistent salary gap between male and female science academics over time. Although academic rank reduces the gender salary gap, it does not entirely explain the difference. Between 1973 and 1997 the average gender salary difference remained at roughly 6% for tenure-track assistant and associate professors, with less than half of that difference attributable to unobservables. Salary differences for full professors are persistently high, averaging 15% throughout the sample time frame, with over 6% of the salary difference remaining unexplained by observable characteristics. These results suggest that discrimination against female full professors may not be isolated to MIT.

Viewing the gender salary gap in the sciences in isolation suggests several potential explanations for observed differences in career attainment. However, when fertility preferences, productivity differences, monopsony, and job matching explanations are evaluated in light of similar estimates for academics in the humanities by Ginther and Hayes (1999), it is clear that the "pervasive, if unintentional discrimination" found at MIT is playing a role.

So why is it that the average female academic scientist continued to fare worse than her male colleagues when compared to the women in the humanities across campus? I suggest that up until the MIT report, women in science have not been willing to embrace the possibility of gender discrimination in career outcomes. Etzkowitz, Kemelgor, Neuschatz, Uzzi, and Alonzo (1994) found in interviews of female faculty that "fear of stigmatization led some women . . . to deny the existence of gender related obstacles" (p. 53). In fact, before 1994 the women faculty at MIT had never discussed whether gender mattered in their professional lives (MIT Faculty Newsletter, 1999). 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.

These results suggest that the experiences of female faculty at MIT were not an exception. As a result of these findings, other colleges and universities should undertake an evaluation of the status of women in science similar to the one at MIT. At this time eight other institutions have agreed to join MIT in doing so (Zernike, 2001). Raising awareness among faculty and administrators is the first step toward addressing gender disparities. In addition, the NSF should consider asking respondents to the SDR detailed questions about resource allocation such as lab space and funding at academic institutions. Data on such questions would allow researchers to quantify whether gender disparities in treatment exist along other margins.

Notes

1. The regression analysis used in this study would also have proven problematic.

2. A mathematical derivation of the Oaxaca decomposition may be found in Ginther (2001).

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