

University Faculty Salaries: Comparing Patterns of Gender Inequity to Those in the General Workforce



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Abstract Patterns of gender inequity seen in the general workforce also occur among university faculty, despite faculty having strong similarities in education and job description. Identifying causes for these patterns and eliminating barriers for women in academia could set the example and promote gender equity in the general population.

Introduction and Background

A 2010 report of the Joint Economics Committee (Democratic staff of the Joint Economics Committee 2010) noted that women in the USA earned 77 cents, on average, for every dollar earned by men. This is in spite of women comprising half the work force and being awarded almost 60% of the bachelor's degrees. Common "explanations" of the gap include type of job, with men tending to populate the more lucrative career tracks, and gender differences in family and household burdens, with women shouldering a greater load and hence having less time to build a career (Feder and Collins 2016).

Within type of job, the gender pay gap is smaller. Traditionally male occupations often have more prestige and higher salaries, whether or not they have more economic value and social importance; this causes the overall gap to be larger than the individual gaps within job category. Further accounting for rank within the job category as well as time in rank, the gap persists but is still smaller. Women are typically underrepresented in the higher-paying ranks of large companies, compared to their representation in the lower ranks (Democratic staff of the Joint Economics Committee 2010).

A 2012 report by the American Association of University Women (AAUW) (Corbett and Hill 2012) describes a gender gap in pay at the very start of careers

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of graduates with bachelor's degrees, even within field of study. They examined the salaries of college graduates 1 year after graduation and found that women working full time made just 82% of their male counterparts. Accounting for field of study, women made 93%, on average, of male salaries. The report notes, "Explaining or accounting for a portion of the pay gap simply means that we understand the effect of certain factors, not that the gender differences related to those factors are necessarily fair or problem-free. Both discrimination and cultural gender norms can play a role in the 'explained' portion of the pay gap."

In the university setting, we observe the same patterns, although for faculty, all have roughly the same level of education and duties. Especially within an institution, the job descriptions of research, teaching, and service are similar across departments, and it is easy to control for field and seniority. In this work, we examine salaries at Colorado State University (CSU) in the years 2017 through 2019 and specifically compare salaries for female and male tenured and tenure-track faculty (TTF).

In response to concerns of senior women faculty, the CSU provost's office appointed a committee in 2016 to determine salary equity, specifically if there are gender gaps in the TTF salaries. Committee members consisted of (mostly female) faculty from each college, as well as administrators including the director of Institutional Research. In addition to determining the overall status of salary equity at CSU, the committee was charged to make recommendations for an annual procedure at the department level to determine where equity raises may be appropriate.

In fiscal year 2017, the average salary for male TTF was 14.7% higher than that for female TTF; that is, female faculty were paid 85.3 cents on the dollar paid to male faculty. This is a somewhat smaller gap compared to that in the general public, but because we have a closer equality of education level, job description, and responsibilities among faculty members, this gap may be considered surprisingly large.

This gender gap varied by faculty rank: the salary was 2.6% higher for male assistant professors, 9.3% higher for male associate professors, and 13.4% higher for male full professors. The gaps in each rank were smaller than the overall gap, because the percentage of women faculty decreases as rank increases and decreases more sharply in higher-paying departments. This is similar to the patterns in the general public, with women becoming more scarce as salary and prestige increase.

In universities within the USA, faculty compensation varies by field. As in the general public, fields that have a higher proportion of male faculty tend also to have higher salaries. For example, salaries in the Engineering College tend to be considerably higher than salaries in the College of Liberal Arts. Again, arguments can be made that this difference in salaries is unjust, reflecting the gender bias of our culture, or market-force arguments can be made to defend the difference. Without conceding this argument, it is of interest to determine if the gender gap persists when field, rank, and seniority are accounted for.

The Statistical Model

The CSU salary committee debated which predictors of salary to use in the statistical model. They agreed that job descriptors only should be used to predict salary. That is, no indicator of awards or appointments to distinguished professor status were used, as these appointments or awards might themselves have an element of gender bias. Rank, department, and years in rank were the only variables that were controlled for to determine the gender equity status of faculty salaries. Department chairs were included in the analysis, but no administrative ranks at the assistant/associate dean level or above. Nine-month salaries were used, so that salaries for faculty on 12-month appointments were multiplied by 0.75.¹ Data were provided by the CSU Office of Institutional Research.

In 2017, there were 1060 tenure-track faculty in the data set: 410 women and 650 men. Because the distribution of salaries tends to be skewed, we used the logarithm of the salary as the response variable. For each of the three ranks, we obtained a least-squares fit for the following model:

$$\begin{aligned} \log(\text{salary}) = & \text{constant} + \text{effect of male} + \text{department effect} \\ & + f(\text{years in rank}) + \varepsilon. \end{aligned} \tag{1}$$

The function f is assumed to be smooth and increasing; no other assumptions are made about its functional form. The term represented by ε is the component of salary that is unexplained by gender, department, and years in rank.

For assistant and associate professors, no gender gap was found after the effects of department and years in rank are accounted for. The overall gaps at these ranks have been “explained” by the difference in field; that is, men tend to be in departments with higher salaries. For full professors, however, a substantial salary gap was found even after department and years in rank were accounted for: male full professors made 5.1% more than female full professors. This gap was statistically significant with a p -value of 0.0054.

The news of a gender gap at the full professor level generated discussion within the university as well as in the surrounding community (Coltrain 2017), and some measures were put in place to determine where equity raises would be appropriate. The next year, in fiscal year 2018, the gap was reduced. When controlling for department and years in rank, male full professors made 3.5% more than female full professors. The p -value for this gap was 0.056, and because this is larger than the usual 0.05 level for statistical significance, an announcement was made that gender equity was achieved (Coltrain 2017). In FY19, the gap was further reduced to 3.1% and the p -value increased to 0.079 (Jackson 2018).

¹This multiplier is sometimes taken as 0.82 or 9/11, but the 0.75 multiplier is used to convert salaries for department chairs, before and after appointment.

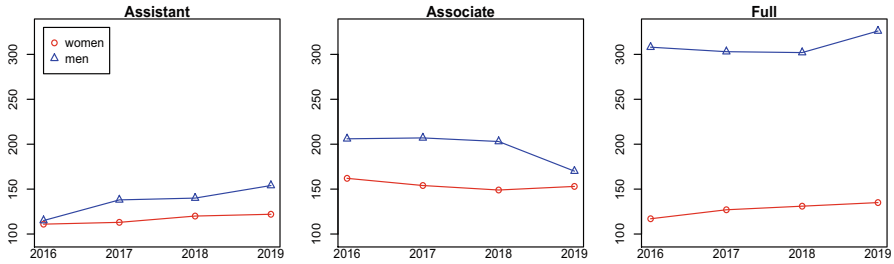


Fig. 1 Trends of numbers of tenure-track and tenured faculty at Colorado State University

The current salary gap of 3.1%, which amounts to about \$3800 per year on average, is practically significant even if the *p*-value is larger than 0.05. The larger *p*-value is in part a reflection of the lack of statistical power for the test, due to small numbers of senior women. Figure 1 shows numbers of women and men faculty at CSU for a 4-year span. Mirroring the patterns of female and male employees in the general population, women become scarcer as the rank increases.

A larger number of senior women faculty, with the same gap, would result in a smaller *p*-value. To demonstrate this, we created a new data set, using the same data but doubling the number of female full professors (note that this still leaves the women in the minority). Each female full professor at CSU got a “twin” in the same department, with the same years in rank and the same salary. For this fabricated data set, the salary gap is the same, but the *p*-value is less than half the size, making it smaller than 0.05 so that the gap is considered “statistically significant.” Although the gap has been diminishing over the past several years, finding a *p*-value slightly greater than 0.05 should not be taken as an indication that equity is achieved; it might be a lack of power due to a small number of women at the full professor rank. The statistical fallacy of concluding that equality holds because the *p*-value is greater than 0.05 is discussed in more detail in Wasserstein et al. (2019).

The methods discussed here may also be used to determine if a salary gap exists for under-represented minorities, simply by changing the gender variable to indicate minority status.

Conclusions and Recommendations

The ability to negotiate a higher salary requires the knowledge of expected salary and the salaries of peers. Transparency of salaries and salary analysis is a starting point of achieving pay equity. The CSU salary committee recommended that annual reports and accessible graphics be provided to facilitate the assessment of relative pay within departments, for individual faculty as well as chairs and deans. An example of such a report is shown in Fig. 2, where salary is plotted against years in rank for all TTF in an example department. The color and plot character reflect

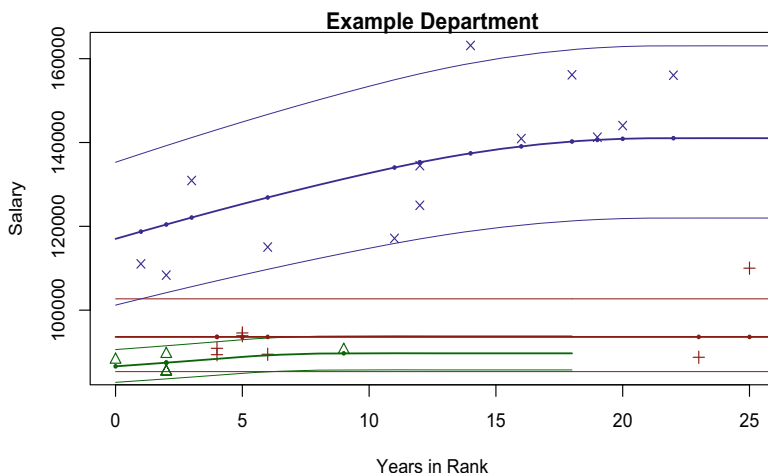


Fig. 2 Snapshot of current salaries with superimposed model fit, for an example department at CSU. The plot characters are different for the three ranks, the dark curves represent the trends of CSU salaries with years in rank, and the lighter curves are placed at one standard error from the trend

the rank, with \times indicating full professors, $+$ indicating associate professors, and triangles indicating assistant professors. The darker curves are the fits to the model using the trend functions and the department effects for each rank. (The “trend function” can be thought of as the expected salary for an “average” department member with a given number of years in rank.) The lighter curves are placed at one model standard error from the trend curves. The variance in salaries is highest for full professors and lowest for assistant professors. The trend for associate professors is flat, in part because of a recent CSU policy to increase the pay raise at the time of tenure and promotion to associate professor. That is, more recent associate professors often make as much or more than those senior in that rank. In addition, associate professors who have been many years in rank without promotion often have salaries that are lagging compared to faculty more recently promoted to that rank.

With such plots available to faculty, department chairs, and deans, assessment of an individual’s salary relative to others in the department is clear; this can be used as a starting point for ensuring fair and equitable assessment and correction of individual salaries.

The patterns of gender and rank at CSU are similar to those in Category-I universities² nationwide, where we see that about 47% of assistant professors are women, but 41% of associate professors and only 24% of full professors are women (AAUP 2014). Is the scarcity of women at the senior level due to previous scarcity at

²Carnegie classification indicating research university.

the lower levels, or are women leaving academia at greater rates than men? Statistics given in a TIAA report (Finkelstein et al. 2016) suggest the latter. In 1993, 37% of tenure-track faculty at public research universities were women; this increased to 40% in 2003 and 45% in 2013. While this trend in percentage of female assistant professors is encouraging, we would expect a higher percentage of female full professors today if women were being retained and promoted at the same rates as men. The problem of recruiting and retaining senior women in academia could be considered as great a problem as gaps in salary.

The degree of this problem varies by field. For CSU departments with above-average salary effects from the fitted model (1), women comprise less than 20% of the full professors, down from about 40% women at the assistant and associate ranks. In contrast, departments with below-average salaries have about 50% women at the assistant and associate levels, and about 39% of the full professors are women. The attrition of women seems to be greater in the departments with higher salaries. As these departments tend to be the traditionally male fields, a cultural climate detrimental to women may be the cause.

Cultural climates in academic departments were described by Britton (2017) and references therein. They cite the following barriers to success for women in academia: biases in hiring practices and award distribution as well as in teaching and service burdens, exclusions from professional networks, and biased perceptions of women's research productivity. Awareness and open discussion about climate and the effects on women is a crucial first step toward resolution. Canetto et al. (2017) examined the reasons given by female graduate students in STEM disciplines for not choosing an academic career; concerns about having a family were prominent. On-site childcare and parental and family leave policies that encourage men to take an equal share of responsibilities might alleviate some of these concerns and make choosing and staying in an academic career more attractive to women.

In academia, patterns of salary inequity and differences in gender composition by field and rank mirror those in general employment. Reasons for these differences also mirror those in the general population. Cultural patterns are difficult to change, but the academic world should be in the forefront, taking the necessary steps to ensure equality.

Action Points for Colleges and Universities

- Yearly assessment of gender gaps in salaries can identify problems and track trends in salary differences across time. These assessments should not rely on *p*-values alone, as small sample sizes could result in insufficient power to detect practically significant difference in salaries. Women should be well represented in salary equity committees.
- Differences in salaries that are due to retention raises should not be allowed to persist—salaries of equally qualified faculty who do not have retention raises should gradually be brought up to the same level. This recognizes that factors

other than merit often prompt faculty to seek outside offers and that faculty with family are at a disadvantage.

- Universities should recognize the difficulties of combining the tenure track with parenting and that these difficulties unfairly burden women more. On-site childcare is a reasonable expectation at any large institution. At CSU and other universities, “lactation rooms” have been established with some fanfare, but they are not as useful if the baby is many miles away at day care.
- Service load should be measured more precisely than counting the number of committees each faculty member serves on. In every department, an effort should be made to estimate and equalize the number of hours spent on service.
- Exit interviews for women leaving the university might shed light on the particular changes needed to attract and retain women in academia. Some of those conducting interviews should be independent of the department or unit.

Technical Appendix

The discussion of the model uses the rank of full professor; for other ranks, the same model is used. Three separate models were used because of differences in variance—the full professor salaries have higher variance than the assistant or associate professor salaries.

Let y_{ji} be the logarithm of the salary of the i th full professor in the j th department, let x_{ji} be her or his years in rank, and let $z_{ji} = 1$ if the j, i th professor is male and $z_{ji} = 0$ if the j, i th professor is female. The model to predict log-salary is

$$y_{ji} = \beta_j + \alpha z_{ji} + f(x_{ji}) + \varepsilon_{ji},$$

where β_j is the average log-salary for a woman full professor in the j th department with zero years in rank. The parameter α represents the effect of being male; male full professors in the j th department with zero years in rank have average log-salary of $\alpha + \beta_j$. Male full professors make $100e^\alpha\%$ more than female full professors; for example, if $\alpha = 0.036$, the gender gap in pay is 3.7%. This salary gap is modeled to be the same across departments. That is, the interaction between gender and department was not found to be statistically significant.

The function f has zero intercept and is assumed to be smooth and increasing. The “error” term ε_{ji} represents the deviation of the j, i th salary from the expected, and these errors are assumed to have mean zero and to be approximately normally distributed.

This model can be fit with the R package `cgam` (Liao and Meyer 2019). For example, the command in R for the appropriately defined data vectors is

```
fit=cgam(y=factor(department)+male+s.incr(yrs_in
                                             _rank)).
```

The predicted log-salaries are in the vector `fit$muhat`, and the residuals are `y-fit$muhat`. The command `summary(fit)` provides estimates of the effects

of department, years in rank, and gender, along with standard errors and p -values. For the CSU data, residual analyses showed no substantial deviations from the model assumptions for any of the ranks.

For the annual department plots to reveal salaries and expected salaries for the purposes of determining raises, it is crucial to omit the gender variable and model salary as depending only on department, rank, and years in rank.

References

- AAUP. (2014). 2013-14 annual report on the economic status of the profession. https://www.aaup.org/sites/default/files/files/2014%20salary%20report/zreport_0.pdf
- Britton, D. M. (2017). Beyond the chilly climate: The salience of gender in women's academic careers. *Gender and Society*, *31*(1), 5–27.
- Canetto, S. S., Trott, C., Winterrowd, E., Haruyama, D., & Johnson, A. (2017). Challenges to the choice discourse: Women's views of their family and academic-science career options and constraints. *Journal of Feminist Family Therapy*, *29*(1–2), 4–27.
- Coltrain, N. (2017, November 19). CSU reports it's [sic] closing gender pay gap. *The Coloradoan*.
- Corbett, C., & Hill, C. (2012). Graduating to a pay gap. Technical report, American Association of University Women.
- Democratic staff of the Joint Economics Committee. (2010). Gender pay inequality: Consequences for women, families, and the economy. Technical report, U.S. Senate.
- Feder, J., & Collins, B. (2016). Pay equity: legislative and legal developments. Technical Report 7-5700-www.crs.gov/RL31867, Congressional Research Service.
- Finkelstein, M. J., Conley, V. M., & Schuster, J. H. (2016, April). Taking the measure of faculty diversity. Technical report, TIAA Institute.
- Jackson, P. (2018). Channels: FY19 faculty salary equity study shows no statistically significant gaps by gender, race. <https://source.colostate.edu/fy19-faculty-salary-equity-study-shows-no-statistically-significant-gaps-by-gender-race/>
- Liao, X., & Meyer, M. (2019). cgam: An R package for the constrained generalized additive model. *Journal of Statistical Software*, *89*(5), 1–24.
- Wasserstein, R. L., Shirm, A. L., & Lazar, N. A. (2019). Moving to a world beyond $p < .05$. *The American Statistician*, *73*(1), 1–19.