Outline/Background

- In May 2014, a subcommittee of the President's Commission on Women and Gender Equity was formed to investigate salary issues.
- Data from IR contain salaries for tenured and tenure track faculty, FY1991-FY2014, with covariates.
- Previous statistical analysis: fit a single line to salaries, separately by department.
- New analysis: analyze all FY2014 salary data in one large model, to have more statistical power to find trends.
- In addition, we can look at retention by gender, and other trends over time.

Back
Close

Salary Analysis, Tenured/Tenure Track Faculty at CSU FY2014: Is there gender equity?

- In FY2014 there were 1045 tenured/tenure track faculty at CSU.
- Assistant Professors: 110 women, 124 men
- Associate Professors: 162 women, 216 men
- Full Professors: 109 women, 324 men

Percent women drops as rank increases. Why?

- Past discrimination?
- Retention issues?
- Hiring at the senior levels?

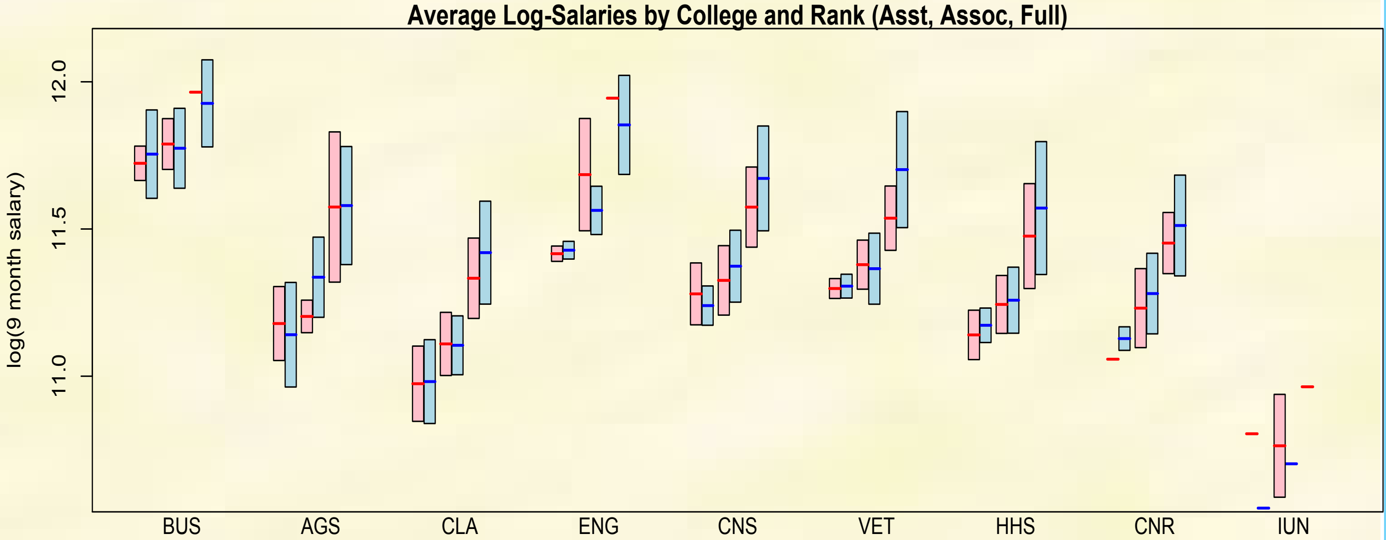
In addition to rank and gender, we have the following information for each faculty member:

- Salary (9 month)
- Department and College
- Year of PhD
- Years at CSU

We convert salaries to the log scale for the statistical analysis.

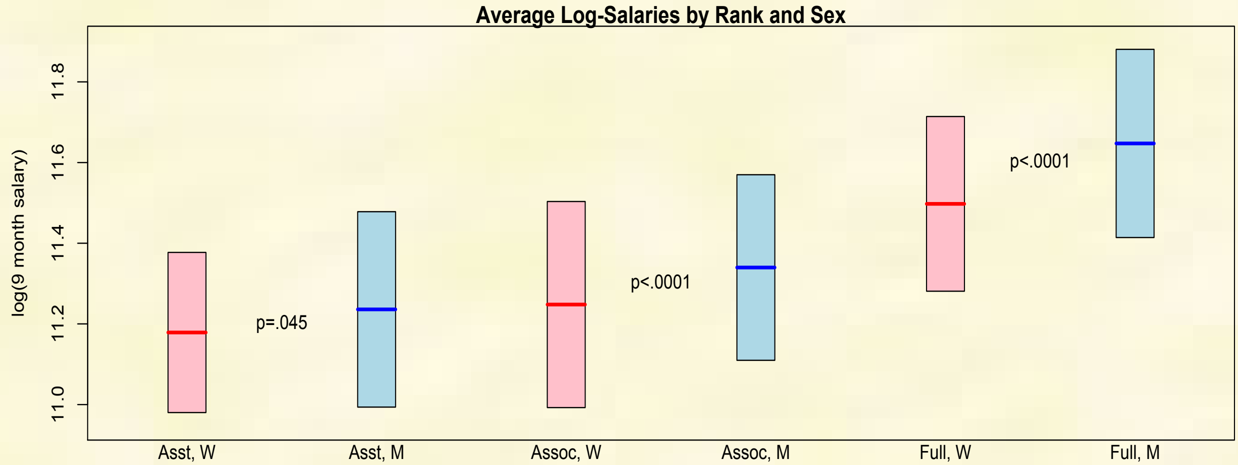
- statistical methods assume symmetric distributions
- comparing salaries more natural as percentages

Summary of Log(salaries) at CSU, by college, rank, and gender.



- variation in salary among colleges
- more men in the higher-paying colleges
- variation in salaries is greatest in the rank of full professor

Back
Close



We find that, on average across CSU,

- male assistant professors make 5.9% more than female asst profs,
- male associate professors make 9.6% more than female assoc profs,
- male full professors make 16.2% more than female full professors.

The p-values for statistical significance are shown; 37.8% of the variation in log(salary) is explained by gender and rank.

Some technical details:

Let y_i be the log(salary) for the ith faculty, $i = 1, \ldots, 1045$. Let

- $r_{1i} = 1$ if the ith faculty member is a female assistant professor, and $r_{1i} = 0$ otherwise, $i = 1, \ldots, 1045$;
- r_{2i} ditto, male assistant professor;
- r_{3i} ditto, female associate professor;
- r_{4i} ditto, male associate professor;
- r_{5i} ditto, female full professor;
- r_{6i} ditto, male full professor.

We use the model:

$$y_i = \beta_1 r_{1i} + \beta_2 r_{2i} + \beta_3 r_{3i} + \beta_4 r_{4i} + \beta_5 r_{5i} + \beta_6 r_{6i} + \varepsilon_i, \quad i = 1, \ldots, n,$$

where we assume that β_1 is the "true average" log-salary for women assistant professors at CSU, and the other coefficients are defined similarly. The term ε_i is a "random error" or more accurately "variation that is unexplained by gender and rank."

The coefficients can be interpreted as follows: $\exp(\beta_2 - \beta_1)$ is the ratio of male assistant professor salaries to female assistant professor salaries, across CSU. The estimates of these are:

- $\exp(\hat{\beta}_2 - \hat{\beta}_1) = 1.059$,
- $\exp(\hat{\beta}_4 - \hat{\beta}_3) = 1.096$, and
- $\exp(\hat{\beta}_6 - \hat{\beta}_5) = 1.162$.

We perform three (separate) two-sided t-tests:

- $H_0 : \beta_1 = \beta_2$ versus $H_a : \beta_1 \neq \beta_2$: $p = .045$
- $H_0 : \beta_3 = \beta_4$ versus $H_a : \beta_3 \neq \beta_4$: $p < .0001$
- $H_0 : \beta_5 = \beta_6$ versus $H_a : \beta_5 \neq \beta_6$: $p < .0001$

Controlling for Effect of Department

There is a lot of variation in salary among the 54 departments:

the highest average 9-month salary is \$143,461 (Marketing)

while the lowest is \$48,248 (Library).

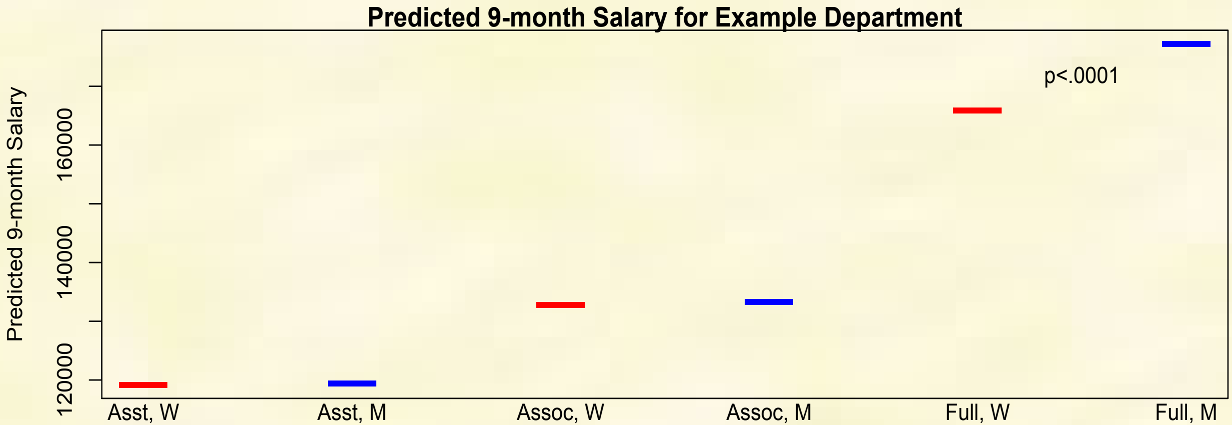
We can model the department effect by creating 54 indicator variables for departments, and adding 53 of these to the above model. Suppose $d_{ji} = 1$ if the ith faculty member is in department j, and $d_{ji} = 0$ otherwise, for $j = 1, \ldots, 54$. Then our model is

$$y_i = \beta_1 r_{1i} + \cdots + \beta_6 r_{6i} + \alpha_1 d_{1i} + \cdots + \alpha_{53} d_{53i} + \varepsilon_i, \quad i = 1, \ldots, n,$$

where now β_1 is the expected log-salary for women assistant professors in department #54, and $\beta_1 + \alpha_j$ is the expected log-salary for women assistant professors in the jth department, and ditto for other rank/gender combinations.

Back
Close

Controlling for Effect of Department



When department is "added to the model," we find that the gender differences disappear for assistant and associate professors, however there is still a big gap for full professors, with male full professors making 6.8% more than female full professors, on average across CSU.

Predicted salaries for other departments can be found by multiplying these salaries by factors estimated from the data.

81.0% of the variation is explained by gender, rank, and department.

Back
Close

Accounting for seniority

Let x_{1i} be the years since degree for the ith faculty, and

let x_{2i} be the years at CSU for the ith faculty.

Our new model is:

$$y_i = \beta_1 r_{1i} + \cdots + \beta_6 r_{6i} + \alpha_1 d_{1i} + \cdots + \alpha_{53} d_{53i} + f_1(x_{1i}) + f_2(x_{2i}) + \varepsilon_i,$$

for $i = 1, \ldots, 1045$.

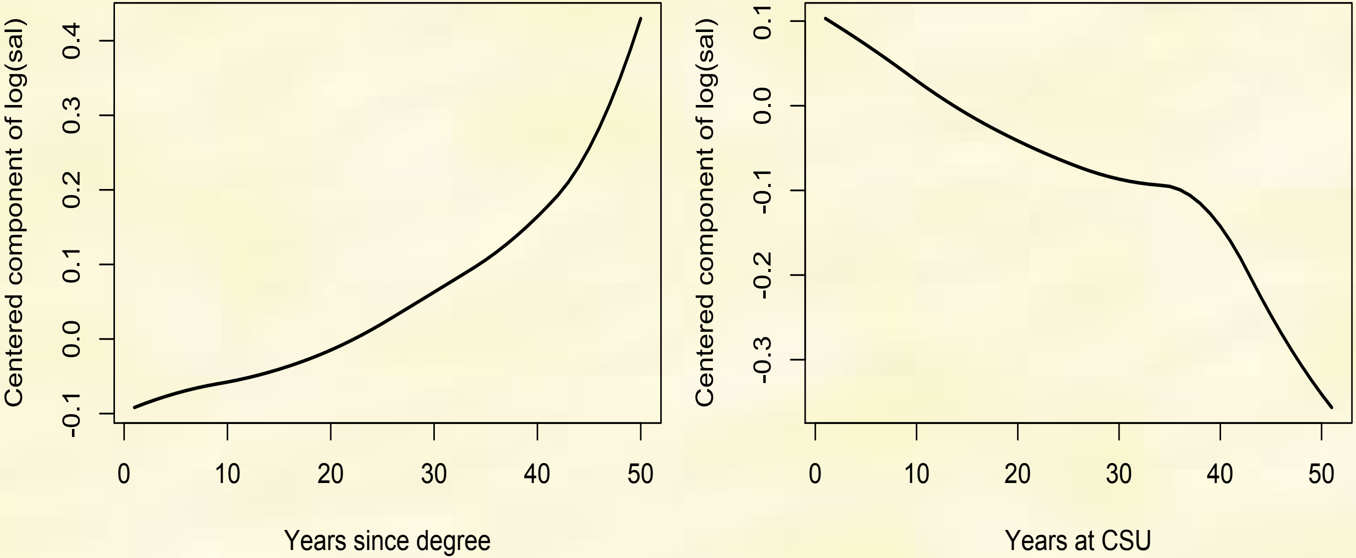
We assume f_1 is "smooth" and increasing, while f_2 is smooth and decreasing.

Given rank, department, and years since degree, salaries are, on average, decreasing in years at CSU.

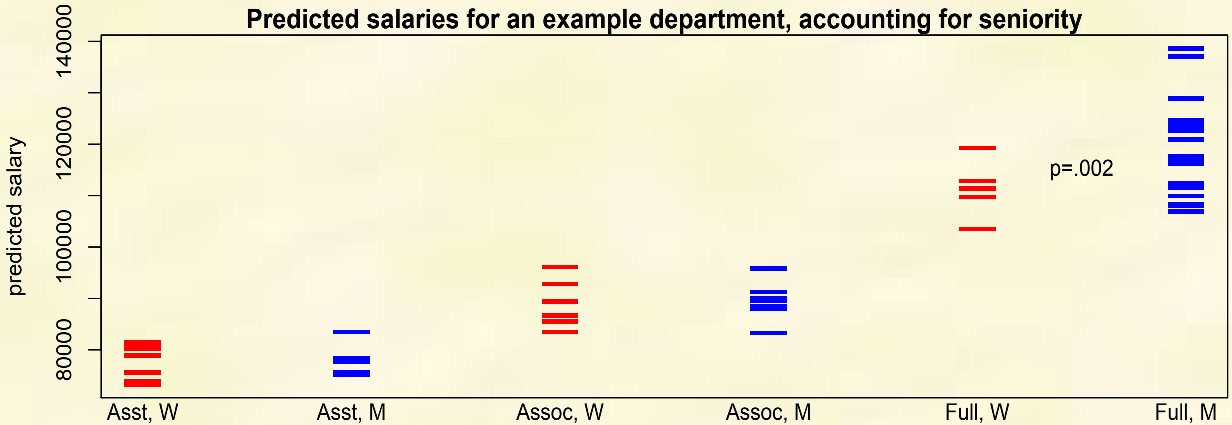
If two professors (in the same department and at the same rank) both got their degree 25 years ago, the one who arrived at CSU recently will be making more than the one who has been at CSU the whole time.

Back
Close

The estimated curves show a rapid increase in salary with years since degree, which is just about cancelled out by years at CSU.



If two professors (in the same department and at the same rank) both have been at CSU since they got their degrees, they will be making approximately the same salary, even if one has been out 10 years longer.



The seniority variables explain a little more of the variation in salary: now 83.5% of the variation in log(salary) has been explained.

Male full professors at CSU make 4.6% more than female full professors at CSU, after effects of department and seniority are accounted for, and this difference is still statistically significant.

The same analysis was done by college..... results pending.

- Smaller sample sizes in colleges – less power for tests
- One college showed very substantial and significant salary gap for full professors.
- No significant salary gaps for other eight colleges.
- When that college is removed from the data set, and analysis re-computed (for about 850 faculty), the gap at the full professor level is reduced to 2.8%, $p = .075$.

Residuals

The analysis was re-run, with all of the variables except sex.

Each faculty member has a residual:

Residual = actual salary - predicted salary,

where predicted salary is based on department, rank, and the two seniority variables.

Example: if your residual is -.071, then

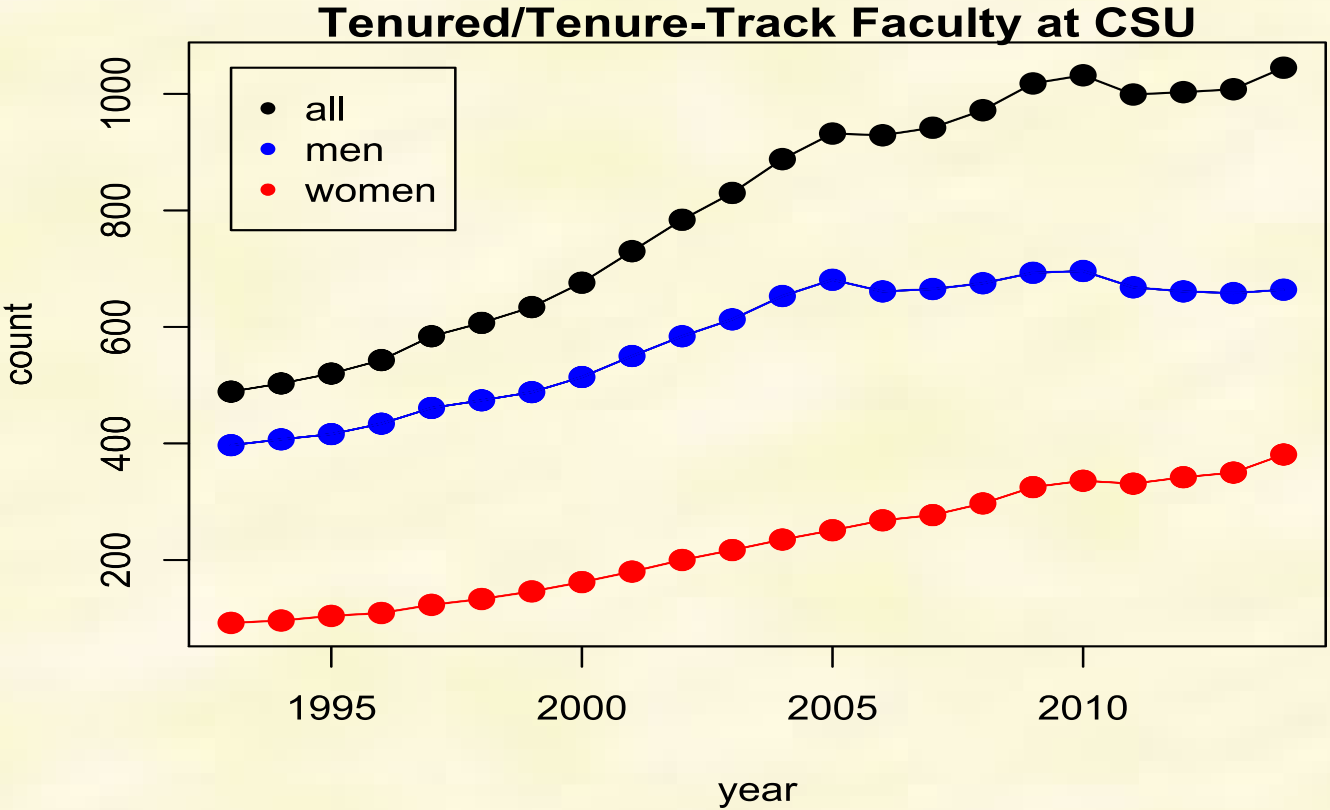
log(your salary) - your predicted log(salary) = -.071,

so

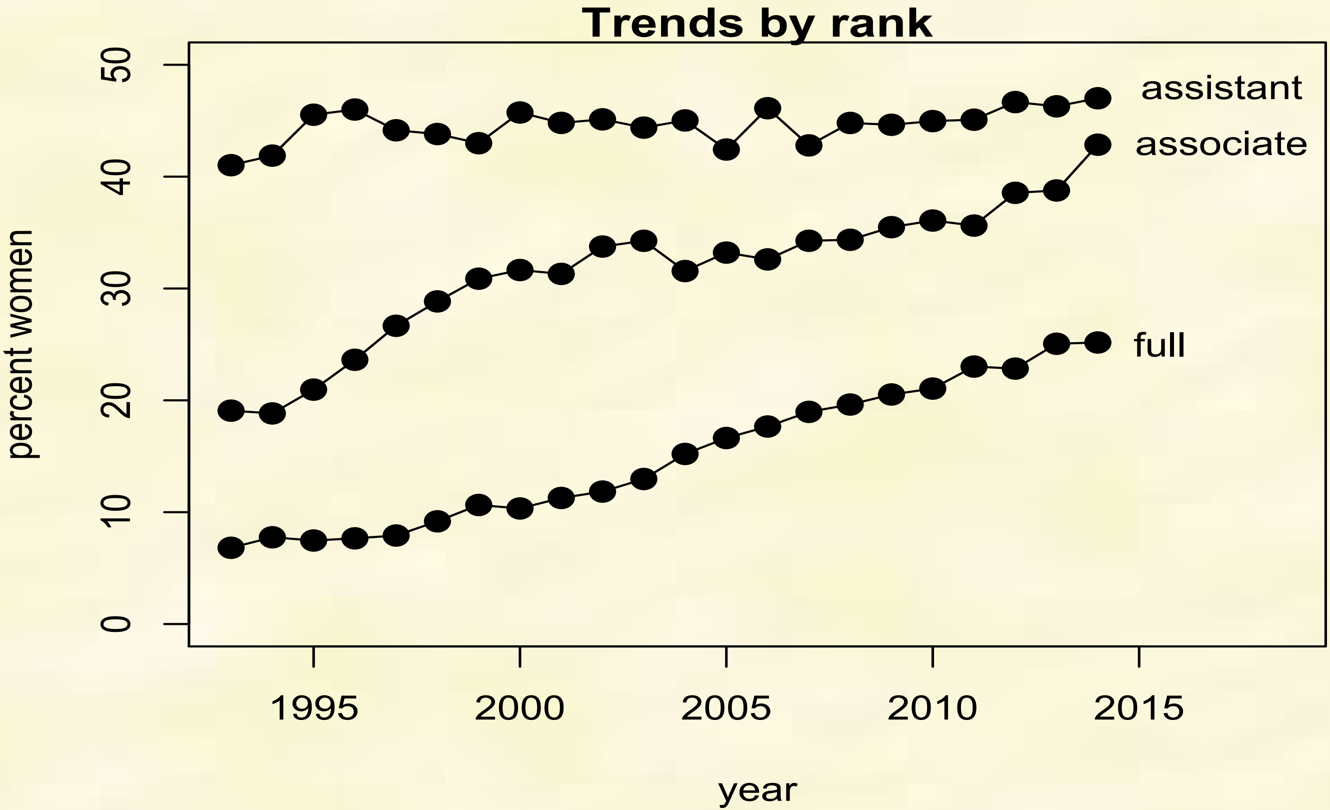
$$\frac{\text{your salary}}{\text{your predicted salary}} = e^{-.071} = .931,$$

which means your salary is 93.1% of the salary that is "average" for your department, rank, and seniority.

Looking at numbers by sex, over the years:



Looking at percent women by rank, over the years:



Retention by gender

There were 455 new assistant professors in 1991-2006 (rank=3 and years at CSU$\leq$1):

These were 241 male and 213 female, or 46.9% female.

Of these, 140 females (65.7%) and 182 males (75.5%) were still here 7 years later.

This gap is statistically significant (p=.022).

Hiring by gender

Between 1991 and 2013, there were 687 new assistant professors:

311 women (45.3%)

Between 1991 and 2013, there were 124 new associate professors:

29 women (23.4%)

Between 1991 and 2013, there were 105 new full professors:

18 women (17.1%)