

# STATISTICAL ANALYSIS OF UBC FACULTY SALARIES: INVESTIGATION OF DIFFERENCES DUE TO SEX OR VISIBLE MINORITY STATUS.

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## SUMMARY

This paper uses a variety of statistical methods to investigate hypotheses about differences in salaries, promotions, and promotion rates arising from the sex or visible minority status of faculty. Clearly salaries vary for many reasons: years of experience, disciplinary differences, and most importantly, productivity. The purpose of this analysis is to use all of the existing data available on UBC systems to provide as much insight as possible into differentials. The most important shortcoming of the analysis is the absence of productivity data. No such data are available centrally, and there is no general agreement across the university on how to measure or collect quantitative data on faculty productivity. Nevertheless, by using the existing data we can provide some conclusions on the magnitude of differences, and the possible mechanisms underlying the differences.

The analysis proceeds according to the following stages:

1. Determine the absolute differences in salaries between men and women, overall and by faculty. We note the common observation that women faculty at UBC earn approximately 13% less than men.
2. Since we know that men and women faculty are distributed differently across disciplines, and that women faculty, on average have less experience than men we use regression analysis to adjust for these differences. In other words, we wish to know what the size of the differential would be if women and men were equal with respect to experience and discipline. At this stage of the modeling we also investigate the same question for visible minorities. The results show that about  $\frac{1}{2}$  of the salary differential between men and women can be “explained” by experience and discipline differences. The results also show that when controlling for experience and discipline, there are no differences due to visible minority status. Hence we continue the analysis looking only at sex differences.
3. The next stage of the analysis looks at the effects of rank on sex differences. The results here cannot be definitive, because while rank is clearly a measure of productivity, it has also been hypothesized that promotion is the principle mechanism by which women are disadvantaged in their career. Indeed the introduction of “rank” into the regression equation results in a much improved salary model, and almost entirely eliminates the sex salary differential.

We now take a closer look at promotion by sex. There are at least two hypotheses to investigate. First, women may experience differential promotion across all faculties as a result of “systematic factors”; that is, if women on average tend to devote more time to teaching (Singell et al. 1996) or family than to

research, it may take them longer to reach promotion, or they may have a higher probability of never reaching the rank of full professor. Since this hypothesis depends on systematic differences between men and women, we would expect to see the phenomenon across all disciplines. An alternative hypothesis would be that women experience some kind of promotional discrimination, in which case it is more likely that the promotional differences will vary by faculty.

4. Results show that overall the differences in time to promotion are small and not statistically significant with some faculty exceptions; average time to promotion from associate to full professor for men is 6.28 years and for women 6.36 years. This suggests that overall, time to promotion, or delayed promotion is not a major factor throughout the university.
5. We are still left with the possibility that the difference in rank distribution is the result of women not being promoted at all (to the full professor level, since promotion to associate is highly related to tenure). This hypothesis is difficult to test with simple statistics, because length of time in rank is a major factor in probability of promotion. In other words, we cannot simply calculate how many men and women have reached full professor as a proportion of the total, because in the last decade, disproportionate numbers of women have entered the rank of associate professor but have not had time to reach a promotion point. The analysis shown here (probit estimation) uses the probability of being a full professor as the dependent variable, as a function of discipline, sex and years of experience. The results show that there is a significant difference in the probability of promotion, with women being less likely to be promoted to full professor, and that this phenomenon is not discipline specific.

Hence, we have used the existing data to show that salary differences between men and women can be largely explained by differences in experience and discipline, but that a statistically significant differential exists after controlling for these factors, and that some of this difference can be explained by the fact that women are less likely to reach the rank of full professor. The implication is that women's careers are more likely to be impeded by a lack of promotion to the full professor level.

The paper is organized as follows. The section II describes the data. In the section III we talk about our empirical approach. Section IV provides regression results. Section V concludes.

## I. Data and Descriptive Statistics

For the salary analysis we use May 2007 Equity data set. 1822 full time tenure track faculty members were selected for the analysis. 70% of selected observations are men, and 30% are women (Table 1). Visible minorities represent 14.4% of the data set (Table 2).

Table 1: Gender

	Number	Percent
Men	1281	70.3%
Women	541	29.7%

Table 2: Visible Minorities

	Number	Percent
Non Visible Minorities	1561	85.6%
Visible Minorities	262	14.4%

Table 3 shows average salaries of full time tenure track faculty members. First row of the table shows that average salary of all UBC full time tenure track faculty members is \$114,457.5 where minimum salary is \$44,898 and maximum - \$385,294. For men average salary is \$118,309.6, minimum is \$49,298 and maximum is \$385,294. For women the average is \$105,353, minimum salary is \$44,898 and maximum salary is \$350,000.

Table 3: Average Annual Salary

	Mean	Std. Dev.	Minimum	Maximum
All FT Tenure Track Faculty	114,457.5	38,597.2	44,898.0	385,294.0
Men	118,309.6	39,745.0	49,298.0	385,294.0
Women	105,353.0	34,081.7	44,898.0	350,000.0

Second and third rows of the table show that on average female full time tenure track faculty members earn less than their male counterparts.

Table 4 presents average salaries as well as minimum and maximum salaries for all 12 UBC faculties separately.

Table 4: Average Annual Salary - By Faculty

	Mean	Std. Dev.	Minimum	Maximum
College for Interdisciplinary Studies	111,351.1	29,822.8	75,000.0	224,000.0
Faculty of Pharmaceutical Sciences	112,323.0	12,893.3	85,000.0	145,450.0
Faculty of Applied Science	107,476.8	19,156.8	73,500.0	177,328.0
Faculty of Arts	99,978.7	22,584.1	49,298.0	242,011.0
Faculty of Dentistry	121,134.2	20,612.7	91,979.0	168,749.0
Faculty of Education	105,723.2	23,057.3	70,500.0	173,538.0
Faculty of Forestry	107,156.9	13,972.6	74,930.0	136,879.0
Faculty of Land and Food Systems	111,916.9	24,654.8	77,757.0	207,900.0
Faculty of Law	125,691.4	21,376.7	70,000.0	174,599.0
Faculty of Medicine	126,227.0	59,323.7	44,898.0	385,294.0
Faculty of Science	113,417.7	24,803.4	78,000.0	222,797.0
The Sauder School of Business	151,107.1	26,830.8	98,936.0	208,169.0

The data shows that significant salary variation can be explained by differences among 5 faculties. These faculties are identified in the modeling process. The selected faculties are: Faculty of Arts, Faculty of Science, Faculty of Medicine, Faculty of Law and The Sauder School of Business. The next five tables (Table 4.1 to Table 4.5) present average salaries in above faculties separately for men and women. In all of the five selected faculties women's average salaries, as well as maximum salaries, are lower than men's average and maximum salaries. Men's minimum salary at the Faculty of Arts, Faculty of Science and The Sauder School of Business are lower than those of women.

Table 4.1: Average Annual Salary by Sex - Faculty of Arts

	Mean	Std. Dev.	Minimum	Maximum
Men	103,098.1	24,492.2	49,298.0	242,011.0
Women	94,919.8	18,048.9	60,000.0	178,048.0

Table 4.2: Average Annual Salary by Sex - Faculty of Science

	Mean	Std. Dev.	Minimum	Maximum
Men	115,926.8	25,491.2	78,000.0	222,797.0
Women	101,875.5	17,319.6	79,000.0	157,068.0

Table 4.3: Average Annual Salary by Sex - Faculty of Medicine

	Mean	Std. Dev.	Minimum	Maximum
Men	129,899.0	60,833.0	50,468.0	385,294.0
Women	117,239.6	54,623.9	44,898.0	350,000.0

Table 4.4: Average Annual Salary by Sex - Faculty of Law

	Mean	Std. Dev.	Minimum	Maximum
Men	130,275.0	22,611.4	78,000.0	174,599.0
Women	119,885.6	18,845.4	70,000.0	154,166.0

Table 4.5: Average Annual Salary by Sex - The Sauder School of Business

	Mean	Std. Dev.	Minimum	Maximum
Men	152,635.3	27,378.1	98,936.0	208,169.0
Women	143,348.5	23,262.5	120,042.0	196,647.0

To examine the source of the differences in salaries between male and female UBC full time tenure track faculty members we use regression analysis.

## II. Empirical Approach

The tables above show that the differential between men and women persists even when we control for the faculty differences. However, other factors may also be contributing to the salary differential. In particular, years of experience is clearly also a factor in determining salaries, and may explain some or the entire differential.

In order to examine the difference in salaries between men and women we use a linear regression model. The dependent variable is annual salary rate. We examine 4 different specification of the model. Independent variables in the first specification are years since PhD was obtained (experience), a variable for sex that takes on value 0 for men and 1 for women, and variable for the employees who identify themselves as visible minorities, which has value 1 for those people and 0 otherwise. Typically salary models also include a term to capture the non-linear nature of salary growth over time; we use “years since PhD squared”.

In the second specification we include five additional variables for the five selected faculties – Faculty of Arts, Faculty of Science, Faculty of Law, Faculty of Medicine and for The Sauder School of Business. By addition of those variables we are able to examine sex differences while controlling for the known differences in salaries among faculties.

In the third specification we add interactions of faculty variables and sex to examine the hypothesis that the differential varies across faculties (or may not even exist in some faculties).

In the final model we exclude faculty-sex interactions however include two additional variables to control for the rank of the faculty member. First variable takes on value of 1 if the person is Associate Professor and 0 otherwise. Second, takes on value of 1 those faculty members who are in the rank of Full Professor. The hypothesis to be tested here is one of mechanism. That is, it has often been hypothesized in the literature that the primary mechanism by which a salary differential is established is by differential promotion rates. Hence the purpose of this step in the analysis is not to show that the differential is “explained” or justified by rank differences, but to illustrate whether the focus of further policy work should concentrate primarily on the criteria and process of promotion.

Next, we test the hypothesis that women are promoted slower than men. In order to do this, we use faculty data from the year 2000 till year 2006. First, we calculate promotion time separately for men and women for all faculties and then separately for six faculties with sufficient amount of cases. Those faculties are: Faculty of Science, Faculty of Arts, Faculty of Medicine, Faculty of Education, Faculty of Applied Science and Faculty of Graduate Studies. We examine significance of promotion time differences by applying a t-test.

As the final step, we test the existence of so called “glass ceiling”, hypothesis according to which women do not get promoted above certain level at all. We estimate a Probit model, which, in our case, predicts probability to become a Full Professor for men and women, controlling for years of experience and faculties. The dependent variable takes on the value of 1 for faculty members who reached the rank of the Full Professor, and 0 otherwise. The Independent variables are sex, years of experience and five faculty variables.

### III. Results

Linear regression results are presented in table 5. Column 1 shows unadjusted wage differentials. Coefficients of experience and sex variables are highly significant. According to the first specification, women earn on average \$6,769.38 less than men. Each additional year of experience since PhD was obtained adds \$2,129.24. The coefficient for employees who identify themselves as visible minorities is insignificant; therefore one can conclude that there is no difference in earnings between visible minorities and non visible minorities. The percentage of the variance in salaries that was explained by this model (specification I) is 16.43% (last row, column 1).

The addition of faculty variables raises explained variance significantly to 25.19%. The coefficient of sex variable decreases though remains highly significant, suggesting that women earn on average \$4882.34 less than men after controlling for the differential employment of men and women in different faculties. The results show that members of Faculty of Arts earn \$8,607.34 less (on average) than members of non-identified faculties, whereas members of Faculty of Law earn \$16,262.6 more on average, Faculty of Medicine - \$12,150.22 more, and The Sauder School of Business - \$ 44,571.16 more. Difference in earnings of members of Faculty of Science is insignificant.

In order to examine whether there is a difference in wages between male and female faculty members in the selected faculties beyond the difference already explained by the overall sex variable, we add interactions between faculty and sex variables (specification III). Those variables take on value one when both faculty and sex dummy variables take on value one. For example, for female employee of Faculty of Arts, sex and faculty of arts interactions will be equal to 1, otherwise – 0.

Addition of interactions didn't change the percent of explained variance. Coefficients of experience and faculty variables are not significantly different from those in previous specification. Therefore we conclude that sex differential is uniformly distributed through faculties, not faculty specific, model II, with a statistically significant sex differential is the appropriate model.

In the final specification we take into account differences between salaries of assistant professors, associate professors and full professors. Two additional variables are now entered into equation – first, a variable that takes on value 1 for employees in rank of associate professor and 0 – otherwise; and second, a variable which takes on value 1 for employees in full professor rank. As a result, explained variance increased to 33.54%. The coefficient of sex variable is -3,025.94, suggesting that women on average earn \$3,025.94 less, even after rank has been taken into account. However in Model IV, sex is only marginally significant at 10%. The experience variable does not have any effect on wage when rank variables are added. Earnings of members of Faculty of Law, Faculty of Medicine and the Sauder School of Business are still significantly higher than earnings at the other faculties, while salaries at the Faculty of Arts are still lower on average. The Coefficient for the Faculty of Science is insignificant. The results also show that Associate Professors earn on average \$14,863.45 more than assistant professors, and full professors earn \$39,770.21 more than assistant professors on average. Both numbers are highly significant.

Table 5: OLS Estimation

	Specification I	Specification II	Specification III	Specification IV
Experience	2,129.24 <b>(6.34)**</b>	2,135.97 <b>(6.64)**</b>	2,140.30 <b>(6.64)**</b>	-328.99 (-0.88)
Sex (0=male, 1=female)	-6,769.38 <b>(-3.64)**</b>	-4,882.34 <b>(-2.74)**</b>	-5,743.40 (-1.78)*	-3,025.94 (-1.79)*
Visible Minority (0=Not VM, 1=VM)	-1,303.91 (-0.54)	X	x	x
Faculty of Arts (0=no, 1=yes)	x	-8,607.34 <b>(-3.94)**</b>	-9,853.80 <b>(-3.53)**</b>	-5911.72 <b>(-2.78)**</b>
Faculty of Law (0=not, 1=yes)	x	16,262.60 <b>(2.70)**</b>	13,898.95 (1.71)*	16,232.98 <b>(2.85)**</b>
Faculty of Medicine (0=not, 1=yes)	x	12,150.22 <b>(5.61)**</b>	12,398.36 <b>(4.78)**</b>	17,535.20 <b>(8.38)**</b>
Faculty of Science (0=not, 1=yes)	x	2,817.87 (1.15)	2,715.74 (0.97)	1,527.56 (0.66)
The Sauder School of Business (0=not, 1=yes)	x	44,571.16 <b>(10.80)**</b>	43,713.28 <b>(9.52)**</b>	43,589.88 <b>(11.20)**</b>
Arts*Sex	x	X	3,429.29 (0.73)	x
Law*Sex	x	X	5,457.60 (0.45)	x
Medi*Sex	x	X	-964.85 (-0.21)	x
Scie*Sex	x	X	-120.76 (-0.02)	x
Busi*Sex	x	X	4,285.73 (0.40)	x
Associate Professor (0=no, 1=yes)	x	X	x	14,863.45 <b>(6.25)**</b>



Table 5: OLS Estimation (cont.)

	Specification I	Specification II	Specification III	Specification IV
Full Professor (0=no, 1=yes)	x	X	x	39,770.21 <b>(14.06)**</b>
R-squared	16.43%	25.19%	25.25%	33.54%

T statistics are in parentheses

\*\* Significant at the 5% level

\* Significant at the 10% level

Tables 6a presents average promotion time from the rank of Assistant Professor to the rank of Associate Professor, as well as T-Tests for significance of differences in the time of promotion. Overall, for men it takes 5.10 years to make a promotion from Assistant to Associate rank and 5.44 years – for women. However, the difference (0.34 years) is insignificant. Similarly, there is insignificant gender difference in the time of promotion in Faculty of Arts, Faculty of Medicine, Faculty of Education, Faculty of Applied Science and Faculty of Graduate Studies. In the Faculty of Science, the gender difference in average promotion times is 1.58 years and is significant at 5% level. In other words, on average it takes 1.58 years longer for women to get promoted to the rank of Associate Professor.

Table 6b provides results for gender differences in promotion time from the rank of Associate Professor to the rank of Full Professor. Overall, there is no significant difference in promotion time of men and women. First row of the table shows that average time for men is 6.28 years and the average time for women is 6.36 years. The difference (0.08 years) is insignificant. However, in the Faculty of Arts men get promotion 1.85 years faster (on average) than women. This difference is significant at 5% level.

Table 6a: Comparison of Promotion time from Assistant to Associate Professor Rank for Men and Women

	Men	Women	Mean Difference	T-Statistic
All Faculties	5.10	5.44	-0.34	-1.01
Faculty of Science	4.92	6.50	<b>-1.58**</b>	-2.15
Faculty of Arts	5.06	5.19	-0.13	-0.18
Faculty of Medicine	5.60	6.79	-1.19	-0.96
Faculty of Education	4.25	3.95	0.3	0.55
Faculty of Applied Science	4.52	6.14	-1.62*	-1.51
Faculty of Graduate Studies	5.44	4.67	0.77	0.52

\*\* Significant at the 5% level

\* Significant at the 10% level

Table 6b: Comparison of Promotion time from Associate to Full Professor Rank for Men and Women

	Men	Women	Mean Difference	T-Statistic
All Faculties	6.28	6.36	-0.08	-0.19
Faculty of Science	6.14	4.78	1.37	1.45
Faculty of Arts	5.48	7.33	<b>-1.85**</b>	-1.75
Faculty of Medicine	5.88	5.56	0.33	0.39
Faculty of Education	7.75	6.67	1.08	0.91
Faculty of Applied Science	6.56	6.60	-0.04	-0.03
Faculty of Graduate Studies	6.79	6.67	0.12	0.06

\*\* Significant at the 5% level

The results of Probit estimation are shown in the Table 7. We used two alternative specifications. In the first (column I), we assume, that if there is a difference in probability to become Full Professor for male and female faculty members, then the difference does not depend on the faculty. In the second (Column II), we release this assumption by adding interactions between sex and faculty variables. However, coefficients of the interaction variables are not significant, which confirms our assumption about gender differences being independent from faculties. Furthermore, the percentage of explained variance did not change as a result of addition of the interactions.

Coefficients of the sex variable in both specifications suggest that there is a significant gender difference in probability to make a promotion to the rank of Full Professor. Unlike in the case of linear regression, those coefficients cannot be interpreted as the impact of a small change in dependent variable on the outcome variable (probability of being Full Professor). Therefore, we calculated marginal effects of discrete change in sex (from 0 for men to 1 for women). Marginal effects are reported in columns II and IV of the table. According to the first specification the probability of becoming Full Professor is 9.77% lower for women. According to the second specification, women are 11.8% less likely to become a Full Professor. Coefficients of experience are highly significant (as expected) and show that every year of experience add 11% to the probability of reaching Full Professor rank.

Table 7: Probit Estimation

	Specification I	Marginal Effects I	Specification II	Marginal Effects II
Sex (0=male, 1=female)	-0.28 <b>(-3.33)**</b>	-9.77% <b>(-3.45)**</b>	-0.34 <b>(-2.24)**</b>	-11.80% <b>(-2.24)**</b>
Experience	0.11 <b>(24.01)**</b>	3.80% <b>(24.59)**</b>	0.11 <b>(23.95)**</b>	3.80% <b>(24.53)**</b>

Table 7: Probit Estimation (cont.)

	Specification I	Marginal Effects I	Specification II	Marginal Effects II
Faculty of Arts (0=no, 1=yes)	-0.36 <b>(-3.35)**</b>		-0.4 <b>(-3.08)**</b>	
Faculty of Law (0=not, 1=yes)	-0.28 (-0.94)		0.03 (0.07)	
Faculty of Medicine (0=not, 1=yes)	-0.37 <b>(-3.69)**</b>		-0.43 <b>(-3.63)**</b>	
Faculty of Science (0=not, 1=yes)	0.28 <b>(2.5)**</b>		0.3 <b>(2.26)**</b>	
The Sauder School of Business (0=not, 1=yes)	0.07 (0.37)		0.08 (0.35)	
Arts*Sex	x		0.13 (0.54)	
Law*Sex	x		-0.78 (-1.20)	
Medi*Sex	x		0.21 (0.95)	
Scie*Sex	x		-0.08 (-0.29)	
Busi*Sex	x		-0.08 (-0.14)	
R-squared	37.42%		37.57%	

T statistics are in parentheses

\*\* Significant at the 5% level

\* Significant at the 10% level

## IV. Conclusion

Salaries of employees who identify themselves as visible minorities are not significantly different from those who are not.

Significant differences in salaries of men and women faculty members were found. The differences are similar for each of the five selected faculties.

When the rank of employees entered into equation in the last specification, the difference became smaller and significant only at 10% level.

Most of the wage gap between men and women is explained by the rank.

The theory of the “glass ceiling” suggests that the mechanism that holds women’s salaries down works through promotions. We did not find overall significant gender differences in promotion time except in Science . However, we found that some women might not get promoted to the rank of Full Professor at all. Probit model estimation suggests that women are 9.77% less likely to become Full Professors.

In our research we did not take into account gender differences in productivity. Those differences are hard to measure. Recent studies find that female professors dedicate more time to teaching duties than to research activities (Singell et al. 1996) which affect their research productivity. Once productivities differences are controlled for, the existence of “glass ceiling” becomes questionable. At UBC no central data on teaching time or faculty research productivity exists. To further investigate the origins of the sex differential, we would need to gather this data from individual departments or faculties.

## V. References

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