Faculty Salary Equity Report (September 2019)

Executive Summary

To determine whether Southern Methodist University has faculty salary disparities based on gender or race/ethnicity, Steve Currall, former Provost and Vice President for Academic Affairs, appointed a committee of faculty chaired by the Associate Provost for Faculty Affairs to conduct a statistical analysis of salaries of tenured and tenure-track faculty. Multiple regression models were used to predict salaries based on several factors that potentially have an effect on pay including gender and race/ethnicity. The analysis did not find a statistically significant gender effect or race/ethnicity effect.

Introduction

Historically, the President's Commission on the Status of Women has identified possible compensation disparities based on gender for individual faculty members. This group has not attempted a statistical analysis of all tenure-line faculty salaries to determine whether faculty salary disparities exist on a broader scale based on gender.

The Office of the Provost with the support of the Faculty Senate created a group to develop a multiple regression model in order to undertake this more comprehensive study. The members of the task force are:

- **Nathan Balke** – Professor of Economics, Chair of the Faculty Senate All-University Finance Committee (nominated by Faculty Senate)
- **Thomas Coan** – Professor of Physics, Former Chair of the Faculty Senate Subcommittee on Economic Status of the Faculty (nominated by Faculty Senate)
- **Maribeth Kuenzi** – Associate Professor of Management and Organizations, Current Chair of the Faculty Senate Subcommittee on Economic Status of the Faculty
- **Douglas Reinelt** – Associate Provost for Faculty Affairs, Professor of Mathematics, Chair of the Task Force
- **Aurélie Thiele** – Associate Professor of Engineering Management, Information, and Systems, President-Elect of the Faculty Senate (nominated by Faculty Senate)
- **Xinlei (Sherry) Wang** – Professor of Statistical Science

This group was given the following charges:

> The task force is charged with developing a plan to examine the salaries of tenure-track and tenured faculty and test for patterns of possible salary disparities between genders and among races/ethnicities. Any additional tests that the task force believes should be considered would have to be added as an additional charge at a later date. Second, the task force is charged with conducting the salary equity analysis that they have designed, using available campus experts to carry out the analysis. Third, the task force will propose an appropriate way to make the findings available to the university community. Fourth, the task force will consider campus policies, procedures, and practices to ensure that faculty compensation is not based on gender and/or race/ethnicity and develop recommendations to address possible salary disparities that may arise from the analysis.

The group held its first meeting on 18 January 2018 and began to work on developing an appropriate mathematical model to analyze faculty salary data. There is no perfect mathematical or statistical

models for this kind of a study. Choices had to be made as to what factors to include in the model and what factors to leave out as discussed below. It is expected that similar studies will be conducted on a regular basis and that future groups may make different choices. For this study, the group was guided by faculty salary equity studies at University of Michigan and University of California at Davis. If at some point in the future an objective measure of faculty performance can be found and quantified, then the effect of performance on faculty salary could be included in the model.

Procedure

For the purpose of this study, the 2017-18 nine month academic salaries of tenure-line faculty were examined for disparities due to gender or race/ethnicity. There are many factors that would normally influence an individual faculty member's salary including discipline, rank, years at current rank, years since the completion of the highest degree, years in a tenure-line position at SMU, and whether the faculty member earned a terminal degree in the discipline. All of these factors are examined in this study. There are many other factors that account for differences in individual salaries including performance measures, scholarly reputation and impact, quality and quantity of the individual's contributions to the institution and to the academic profession. These factors are more difficult to quantify and are not examined here.

It is expected that there will be considerable individual variation around the salary predicted by the model because individuals who are identical in terms of discipline, rank, and other variables in the model are likely different in terms of their academic contributions. In large populations, these individual differences, not accounted for in the model, average out so that the model is still suitable for analyzing systematic differences on average for SMU faculty.

The number of tenure-line faculty at SMU is much smaller than at many larger state universities. Dividing up the SMU faculty by discipline, rank, gender, and race/ethnicity would mean that there are some groups with only one person in a group. As discussed above, the model works best when individual differences based on factors not considered in the model are averaged out. For this reason, we chose not to divide the faculty into groups based on discipline so that groups based on rank, gender, and race/ethnicity are larger. Given that discipline is a major factor in determining salary, we account for variations in salary due to discipline by dividing each faculty member's salary by the mean salary of faculty at other institutions within the discipline at the same rank as the faculty member. The other institutions were members of three groups for which we have discipline/rank salary information: Colonial Group (private institutions that share data with SMU), OSU Group 1 (mainly public institutions ranked 1-50 in US News Ranking), and OSU Group 2 (mainly public institutions ranked 51-100 in US News Ranking).

This ratio of the faculty member's salary to the mean salary is less than one, equal to one, or greater than one depending on whether the faculty member's salary is lower, equal, or higher than the mean discipline based salary at the same rank as the faculty member. The purpose of this faculty salary equity study is not to compare SMU salaries with salaries at other institutions; thus, it is not important whether the other institutions for which we have available discipline/rank salary data are comparable to SMU in terms of stature, size, public/private, etc. It is only important that the relative discipline based differences in salary at these institutions are representative of the relative discipline based differences at SMU. Comparisons between SMU salaries based on rank to institutions in our aspirational and cohort

peer groups and in Texas are presented annually to the Board of Trustees and Faculty Senate. These comparisons are not discussed here as they are not the purpose of this study.

For some disciplines at SMU, there was not a direct comparison group for salary data or the direct comparison group did not have enough data to be reliable because the discipline only existed at a few universities in the data set. For these disciplines, a similar discipline was chosen as follows: (1) computer science and engineering management and information systems were grouped with electrical engineering, (2) applied physiology & wellness was grouped with education, (3) information technology & operations management, management & organizations, and strategy & entrepreneurship were grouped with business administration, (4) creative computing and arts management & entrepreneurship were grouped with fine and studio art, (5) art history was grouped with history, (6) dance was grouped with theatre, (7) corporate communications & public affairs was grouped with advertising, and (8) film & media arts was grouped with journalism. Again, the focus of this study is to compare salaries internally to test for salary disparities based on gender or race/ethnicity and not to compare SMU salaries with other institutions. This means that even though some disciplines do not have a direct comparison group, the choices made for the comparison groups is likely to only have a small effect on the results.

There were a few faculty members with unusual situations that were not included in the study. These faculty fell into three categories: (1) former provosts and deans (not including persons that served on an interim basis) that have returned to the faculty - 5 persons, (2) faculty currently on reduced salary (e.g. phased retirement) or higher than normal salary (e.g. temporarily working for NSF, but paid through SMU) – 6 persons, and (3) faculty currently at the assistant professor or senior lecturer level that were tenured many years ago – 3 persons. There was one additional person that was not included in the study because this person was hired for a leadership position at SMU at a salary comparable to a full professor even though the person was hired at the rank of associate professor. In order to not distort the results in the associate professor category, the committee chose to not include this person in the analysis after receiving a satisfactory explanation of the situation. Alternatively, the person could have been moved to the full professor category.

The data set for the remaining 465 tenure-line faculty members included the following information:

- ID – random integer number assigned to faculty member by the Provost's Office
- RATIO – dependent variable is the ratio of the faculty member's salary divided by a mean salary based on the faculty member's discipline and rank, a positive number
- GENDER – factor with two levels: MALE or FEMALE
- ASIAN – factor with two levels: YES or NO
- URM (under-represented minority) – factor with two levels: YES or NO
- RANK – factor with four levels: ASSISTANT PROFESSOR, ASSOCIATE PROFESSOR I (0 to 8 years), ASSOCIATE PROFESSOR II (9 years or more), PROFESSOR
- YEARS AT RANK – number of years in current rank, non-negative integer number
- NO TERMINAL DEGREE – factor with two levels: YES or NO
- YEARS SINCE DEGREE – number of years since highest degree, non-negative integer number
- YEARS AS TENURE-LINE FACULTY AT SMU – non-negative integer number

As was done with a similar study at the University of Michigan, we separated ASIAN and URM (Black, Hispanic, and Native American) into their own groups and used YEARS AT RANK to further separate the

rank of ASSOCIATE PROFESSOR. We chose two groups: ASSOCIATE PROFESSOR I (0 to 8 years) and ASSOCIATE PROFESSOR II (9 or more years). This is a proxy for associate professors that are more likely to be promoted to full professor and those that are less likely to be promoted to full professor and remain at the rank of associate professor. For faculty members that were hired at SMU at their current rank, curriculum vitas were examined to determine if they had been promoted to the current rank at another institution. This information was used to determine YEARS AT RANK (not just years at rank at SMU). Some current SMU faculty began their careers at SMU in a non-tenure track position such as a visiting position. These years are not included in YEARS AS TENURE-LINE FACULTY AT SMU.

Summary Statistics

Table 1 and **Table 2** provide summary demographic statistics for faculty by gender and minority status, respectively.

Table 1: Summary demographic statistics by gender

	Women	Men	All
Number of faculty	151	314	465
Mean years since highest degree	16.5	23.0	20.9
Mean years at SMU	11.1	15.6	14.1
Rank			
Assistant Professor	48 (32%)	47 (15%)	95 (20%)
Associate Professor I (0-8 years)	37 (25%)	59 (19%)	96 (21%)
Associate Professor II (9+ years)	21 (14%)	44 (14%)	65 (14%)
Full Professor	45 (30%)	164 (52%)	209 (45%)

Table 2: Summary demographic statistics by minority status

	Asian	URM	Neither
Number of faculty	63	50	352
Mean years since highest degree	15.9	17.7	22.2
Mean years at SMU	10.1	11.0	15.3
Rank			
Assistant Professor	20 (32%)	13 (26%)	62 (18%)
Associate Professor I (0-8 years)	13 (21%)	12 (24%)	71 (20%)
Associate Professor II (9+ years)	3 (5%)	9 (18%)	53 (15%)
Full Professor	27 (43%)	16 (32%)	166 (47%)

For each of the groups listed in the above tables, the mean of the ratios (as defined above) for each faculty member in the group was determined. **Table 3** provides comparisons of those means between two different groups. The Associate Professor groups were joined together due to the small number of persons in the Associate II group when separated by minority status.

Table 3: Summary salary statistics for mean salary ratios.

	Female to Male	Asian or URM to Neither	Asian to Neither	URM to Neither
Assistant Professor	1.0070	0.9953	1.0122	0.9694
Associate Professor	1.0233	1.0076	1.0330	0.9883
Full Professor	0.9280	1.0131	1.0300	0.9871
All	0.9907	1.0105	1.0304	0.9854

For example, the first entry in the table represents the mean of all female assistant professors' ratios divided by the mean of all male assistant professors' ratios. This shows that female assistant professors are paid slightly better relative to discipline/rank based salaries than male assistant professors when each person in each group is treated exactly the same. The largest difference in the table is the comparison of the mean of all female full professors' ratios and the mean of all male full professors' ratios. It is important to note that the analysis has yet to account for other factors that may influence salary such as years at rank and years as tenure-line faculty at SMU. These other factors tend to be more significant at the full professor level where the average years in rank for male full professors (14.4) is five years greater than the average years in rank for female full professors (9.3). As will be discussed later, another major factor that influences salary is being hired at the full professor level from another institution.

Regression Analysis

For mathematical reasons, the statistical technique of multiple regression works best if the distribution of the data is close to a normal distribution. In probability and statistics, skewness is a measure of the asymmetry of the distribution about its mean. Unlike a normal distribution, the data for RATIO has a lower bound (zero) and no upper bound and it is likely that the data has a positive skew. To reduce the skewness of the data and to make it closer to a normal distribution, we first compute the natural logarithm of the RATIO and apply the multiple regression technique using LN (RATIO) as the dependent variable. As noted in the table below, the skewness of the LN (RATIO) data is much smaller than the skewness of the RATIO data and linear regression works best on unskewed data.

Table 4: Summary of statistics for RATIO and LN (RATIO).

Measure	Value using RATIO	Value using LN (RATIO)
1st quartile	0.9143	- 0.0897
Median	1.0070	0.0070
Mean	1.0319	0.0147
3rd quartile	1.1330	0.1249
Standard Deviation	0.1983	0.1804
Skewness	1.8570	0.2930

- LN (RATIO) – the natural logarithm of the RATIO. It is positive if the faculty salary is above the benchmark rate and negative if the faculty salary is below the benchmark rate.

In line with a study at the University of Michigan, the results for two models are presented in **Table 5**. Model (1) uses gender, Asian status, URM status, years since highest degree, no terminal degree, years on tenure track at SMU as independent variables. Model (2) uses all independent variables of Model (1) as well as rank and years at rank.

When using regression models to analyze possible faculty salary disparities based on gender or race/ethnicity, there are two possibilities: (1) there are no faculty salary disparities based on gender or race/ethnicity and the results from the data set are one of the many possible outcomes that one might expect to observe based on the number of data points and the variation in the data around the mean (null hypothesis) or (2) there are faculty salary disparities based on gender and/or race/ethnicity.

The p-value for each coefficient determines which factors are statistically significant in determining salary and specify the degree of certainty that the null hypothesis (possibility #1 above) may be ruled out. The analysis was done in RStudio, a well-known statistical computation and graphing software package. Three stars (***) means that a coefficient is statistically significant at the 99.9% level. Two stars (**), one star (*) and one dot (.) mean that a coefficient is statistically significant at the 99%, 95% and 90% level, respectively.

The value of R^2 is a measure of how well the model explains the variation in the dependent variable, as a proportion between 0 and 1. The value of R^2 for Model 1 is 0.1203 and Model 2 is 0.2288. While a high value of R^2 (close to 1) is typically desirable, it is rare when data is collected from organizations. In this case a low value of R^2 can also indicate the scaling by rank and discipline properly accounts for salary data fluctuations at SMU.

Table 5: Effects of gender and minority status on faculty salary ratio.

	Model 1	Model 2
	Coefficient (p-value)	Coefficient (p-value)
(Intercept)	0.0251 (0.1715)	0.0484 (0.0158 *)
FEMALE	0.0009 (0.9562)	0.0026 (0.8720)
ASIAN	0.0111 (0.6299)	0.0126 (0.5637)
URM	-0.0214 (0.3955)	-0.0263 (0.2686)
YEARS.SINCE.DEG	0.0054 (3.73e-07 ***)	0.0005 (0.7650)
NO.TERM.DEG	-0.0781 (0.0755 .)	-0.0063 (0.8829)
YEARS.AS.TL.FAC.AT.SMU	-0.0086 (1.70e-13 ***)	-0.0126 (<2e-16 ***)
RANK:Associate Professor I	NA	0.0178 (0.4814)
RANK:Associate Professor II	NA	0.0348 (0.2967)
RANK:Professor	NA	0.0244 (0.4484)
YEARS.AT.RANK.	NA	0.0116 (3.89e-12 ***)

The analysis shows that in Model 1 (no rank, years in rank), the only statistically significant factors in determining salary are years since degree and years as tenure-line (tenure-track) faculty at SMU. In Model 2, the only statistically significant factors for determining salary are years as tenure-line (tenure-track) faculty at SMU and years in rank. In both models, the two statistically significant factors are both

based on number of years and have an opposite effect on salary (one coefficient is positive and increases salary and the other is negative and decreases salary).

Based on the p-values, it is not possible to conclude that the gender or race/ethnicity of the faculty member is a statistically significant factor in determining salary. There is not enough evidence that we can reject the null hypothesis (no discrimination based on gender or race/ethnicity) with 90% confidence.

While not statistically significant at conventional levels, the p-value for URM is the smallest of the p-values among FEMALE, ASIAN, and URM. Taken at face value, the negative coefficient for URM suggests that under-represented minority salaries are roughly 2.0% to 2.6% lower that white male salaries controlling for discipline, rank, and experience. The relatively small sample size for these faculty, in part, might account for why this coefficient is not statistically significant at conventional levels.

As discussed above for Model 2, the only statistically significant factors for determining salary are years as tenure-line (tenure-track) faculty at SMU and years in rank. Since the two coefficients are similar in size with one being positive and one being negative and both are based on number of years, it suggests replacing one of the independent variables with the difference of the two variables. In Model 3 below, we replace YEARS AS TENURE-LINE FACULTY AT SMU by the new independent variable:

- YEARS AT SMU BEFORE CURRENT RANK – integer number defined as YEARS AS TENURE-LINE FACULTY AT SMU minus YEARS AT RANK. This value is a positive number if the faculty member was promoted to his/her current rank through the regular promotion process at SMU, zero if the faculty member was promoted to the current rank when hired at SMU, and negative if the faculty member was promoted to the current rank at another institution and then later hired at SMU at the same rank.

Table 6: Effects of gender and minority status on faculty salary ratio.

	Model 3	Model 4
	Coefficient (p-value)	Coefficient (p-value)
(Intercept)	0.0458 (0.1390)	0.0638 (2e-13 ***)
FEMALE	0.0026 (0.8720)	NA
ASIAN	0.0126 (0.5637)	NA
URM	-0.0263 (0.2686)	NA
YEARS.SINCE.DEG	0.0005 (0.7650)	NA
NO.TERM.DEG	-0.0063 (0.8829)	NA
YEARS.AT.SMU.BEFORE. RANK	-0.0126 (<2e-16 ***)	-0.0119 (<2e-16 ***)
RANK: Associate Professor I	0.0178 (0.4814)	NA
RANK: Associate Professor II	0.0348 (0.2967)	NA
RANK: Professor	0.0244 (0.4484)	NA
YEARS.AT.RANK.	-0.0010 (0.5260)	NA

Note that the new independent variable is the only one that is statistically significant. Model 4 uses the forward selection method to identify the linear regression model with the most prediction power and the fewest independent variables among those used in Model 3. The forward method selects the variables that lead to the most improvement in a performance criterion known as Akaike Information Criterion (AIC). This selection is done by the computer going from a constant model (same prediction for every faculty member) to the model with all the independent variables listed for Model 3. The computer stops when adding more independent variables does not result in sufficient improvement in the AIC. All parameters in the algorithm are kept to their default values. In Model 4, the computer does not find that the independent variables for gender or race/ethnicity improve the predictive power of the model and so does not include them.

The simpler model (Model 4) has value due to its greater interpretability and because all the coefficients are statistically significant at the 99.9% confidence level. It is given by

LN (RATIO) = 0.0638 – 0.0119 * YEARS AT SMU BEFORE CURRENT RANK.

This equation shows that the greatest impact on salaries other than discipline and rank, which have already been taken into account in creating the ratios, is YEARS AT SMU BEFORE CURRENT RANK. For example, faculty that remain at the Associate Professor rank for a long time before being promoted to Professor will have the largest number of years at SMU before achieving the current rank. The model predicts that all of these years will have a negative effect on salary relative to a person who was hired at SMU and simultaneously promoted to the rank of Professor (approximately 1.19% per year). On the other hand, a faculty member that was promoted to the rank of Professor at another institution ten years prior to being hired at SMU will have a value of -10 for YEARS AT SMU BEFORE CURRENT RANK. The model predicts that this person's salary will be approximately 1.19% x 10 or 11.9% higher than a person who has zero years at SMU before current rank.

It is not surprising that faculty who have strong academic records and reputations and are willing to move from one institution to another often receive better pay than those that remain at the same institution for their entire career. The above equation quantifies this effect based on SMU salaries.

Outliers

For the models discussed above, we identified the outliers whose residuals (defined as the difference between observations and predictions) in absolute value are at least two times the standard deviation of the residuals. Using this definition, there were twelve outliers whose value of LN (RATIO) is much higher than predicted and seven whose value of LN (RATIO) is much lower than predicted. All nineteen outliers are male. Among the twelve higher outliers, all are full professors except one. There is one Asian and one URM. Among the seven lower outliers, all are full professors except one. There is one Asian. The list of outliers was provided to the Provost's Office.

Regression Tree

An alternative explanatory model, which helps to interpret the data, may be obtained via regression tree. The software RStudio creates splits in the tree based upon the independent variables that it finds to hold the most explanatory power in explaining variations in the dependent variable LN (RATIO). It continues to create further splits as long as the explanatory power is improved by a minimum amount (1%). As above, YEARS AT SMU BEFORE CURRENT RANK is the most important independent variable.

Table 7 shows the division of the faculty into groups that the software determined had the most explanatory power to explain the independent variable LN (RATIO).

Table 7: Predictions obtained by regression tree for YEARS AT SMU BEFORE CURRENT RANK.

Range	*YEARS* ≤ -1	0 ≤ *YEARS* ≤ 5	6 ≤ *YEARS* ≤ 8	9 ≤ *YEARS*
Prediction of LN (RATIO) to Benchmark	0.190	0.041	-0.015	-0.110
Percentage of SMU faculty	12%	40%	26%	21%

The column with negative values for *YEARS* corresponds to faculty (12%) who were hired by SMU at the same rank that they had already obtained at another institution. This group has 6 Assistant Professors (3 Male, 3 Female), 10 Associate Professors (6 Male, 4 Female), and 42 Full Professors (37 Male, 5 Female). The variability of the LN (RATIO) measured by standard deviation is much greater for males than females. This group has 9 Asian faculty members (2 Assistant, 7 Full) and 5 faculty members from under-represented minorities (1 Assistant, 1 Associate, 3 Full). As can be seen from the table, being hired from another institution has a significantly positive effect on the value of LN (RATIO) and salary on average. The rightmost cell in the table corresponds to faculty members who have spent at least nine years at SMU before their current rank. The predicted value is lowest for this group.

The regression tree model also included the additional independent variables YEARS AT RANK and YEARS SINCE DEGREE, but these variables were less important than the variable discussed above. No other variables were determined to have sufficient explanatory power for explaining variations in LN(RATIO).

Conclusions and Future Considerations

Discipline and rank are the factors that have the greatest effect on determining salary. Scaling faculty salaries by discipline/rank based data removes this variation from the data. The next most important factor as discussed above is YEARS AT SMU BEFORE CURRENT RANK. The results show that faculty hired from other institutions particularly at the senior ranks have higher salaries on average than faculty that are promoted by SMU. The task force did not find any statistically significant disparities in salaries based upon gender or race/ethnicity when one accounts for the other factors discussed above. Nonetheless, the percentage of full professors hired from other institutions that are female (12%) is much smaller than the percentage that are male (88%). This likely explains the gender variation in full professor salaries shown in Table 3. As always, careful consideration should be given to the hiring process to ensure equal opportunities for all job candidates.

This analysis did not account for differences in individual salaries based on performance measures. While some schools quantify performance in the areas of teaching, scholarship, and service when determining merit raises, many others do not. If at some point in the future there is a university-wide process for quantifying academic performance, this factor could be included in the analysis and may explain some of the individual variation around the salary predicted by the model.

Even without including performance in the model, individual outliers have been identified. The task force encourages the Provost's Office to share the identity of these persons with the faculty member's dean to make sure that this disparity is due to academic performance or another factor not considered

as part of this study. As discussed in the introduction, it is expected that similar studies will be conducted on a regular basis and that future groups may make different choices in how the data is analyzed.