2014

Salary Equity Analysis

University of California, Santa Barbara

Office of the Executive Vice Chancellor
Introduction

2014 marks the tenth year of UC Santa Barbara’s annual Faculty Salary Equity Analysis. The methodological approach used this year closely follows that for earlier campus studies. Previous salary studies have been shared with the Academic Senate’s Committee on Diversity and Equity and the Chancellor’s Advisory Committee on the Status of Women. Their responses have been incorporated into subsequent analyses.

Salary Data

The 2014 pay equity study at UC Santa Barbara was conducted for ladder rank faculty based on October 1, 2014 snapshot data from the Office of Academic Personnel. The data analyzed here include only ladder rank faculty members who were on active pay status, and the salaries are the annual 9-month academic salaries; they do not include summer salary or administrative stipends.

The data are considered for the University of California, Santa Barbara, as a whole. They are also divided into the Divisions of Humanities and Fine Arts (HFA); Mathematical, Life, and Physical Sciences (MLPS); and Social Sciences (DSS) in the College of Letters and Science; the Gevirtz Graduate School of Education (GGSE), the Donald Bren School of Environmental Science and Management (BREN), and the College of Engineering (ENGR).

The salary data are shown for the campus and each division/college as a function of rank and step for White Males, Women, and Male Minorities in Figure 1. Years at Step by Rank and Step are shown in Figure 2 as a function of gender and ethnicity, included at the request of the Office of the President. The use of the term "minority" here includes Black/African-American, Asian/Pacific Islander, Native American, and Hispanic regardless of citizenship or country of origin. This is consistent with federal affirmative action definitions, and with other studies referenced above. Analyzing sub-populations is complicated by decreasing population sizes (and thus poorer statistics) and problems in self-reporting, including multiple affiliations.

The average salary and average birth year for each of these groupings for the campus and for each academic division is given in Table A below. At first glance salaries for women and male minorities appear systematically lower than their male counterparts for the campus as a whole as well as by academic division, and the salaries vary by academic discipline as well. But the white male population tends to be older.
Table A

Average 9-Month Academic Salaries and Birth Year by Group and Academic Unit

<table>
<thead>
<tr>
<th>Academic Unit</th>
<th>White Males (Avg Birth Year)</th>
<th>Women (Avg Birth Year)</th>
<th>Male Minorities (Avg Birth Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLPS</td>
<td>155,120 (1957)</td>
<td>126,972 (1964)</td>
<td>127,339 (1965)</td>
</tr>
<tr>
<td>DSS</td>
<td>154,541 (1956)</td>
<td>118,524 (1963)</td>
<td>114,135 (1962)</td>
</tr>
<tr>
<td>BREN</td>
<td>160,893 (1959)</td>
<td>120,400 (1968)</td>
<td>N/A</td>
</tr>
<tr>
<td>ENGR</td>
<td>166,456 (1961)</td>
<td>147,321 (1968)</td>
<td>165,555 (1964)</td>
</tr>
<tr>
<td>UCSB</td>
<td>148,176 (1958)</td>
<td>118,400 (1963)</td>
<td>132,500 (1963)</td>
</tr>
</tbody>
</table>

Birth year likely matters because it is a good proxy for work experience. The American Association of University Professors (AAUP) suggests accounting for differences in experience by controlling for year of appointment and year of degree to determine to what extent salaries for women and male minorities differ systematically from salaries for white males. The regression analysis detailed below finds that, at UCSB, these variables, plus birth year, account for between 48 percent and 88 percent of salary difference among white males in the various academic units.

Methodology

The pay equity study employed here applies the regression methodology recommended by the American Association of University Professors (AAUP – see, for instance, http://www.aaup.org). The University of California, Irvine, has employed a similar methodology (see, for instance, http://www.ap.uci.edu/Equity/studies/index.html). The methodology is designed to test whether women and minority faculty members are paid differently than their white male counterparts, holding constant their birth year, date of degree, and UCSB appointment date. The methodology does not include any measures of quality or merit. Therefore it is expected that some faculty members will have results that are not explained well by the methodology, which relies exclusively on quantifiable demographic measures. Nonetheless, it serves as a tool for identifying broad trends.\(^1\)

A synopsis of the methodology intended for readers with non-technical backgrounds can be stated as follows: Data on white men’s salary, appointment year, birth year, and degree year are used to estimate a statistical “regression” model which can then be used to derive a predicted salary for each faculty member. Models and predictions are created

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within each academic division to account for disciplinary differences in salary. Predicted salary is then compared to a given faculty member’s actual salary and the difference, referred to as a residual, is calculated. We would expect some salaries to be higher than our prediction, and others to be lower. By closely examining the pattern of residuals for groups of faculty members within each division (e.g., females, or male minorities) we may see some indication of a potential problem. For example, a concern might be raised if the preponderance of residuals for a group of faculty members is lower than predicted and beyond the statistical margin of error. A more detailed discussion of the methodology follows.

### Methodology Details

The model is based on a multivariate linear regression, with salary as the dependent variable and appointment year, birth year, and degree year as the independent variables. The first step is to fit the salary data for white males on the campus or in a College/Division. In previous analyses, the fit has been made by a linear regression analysis to an equation of the form:

\[
\text{SALARY} = A \times (\text{Appointment year}) + B \times (\text{Birth Year}) + C \times (\text{Degree Year}) + D
\]

where \(A, B, C\) and \(D\) are regression coefficients. But the UC salary scale increases with rank and step (and therefore normative length of appointment/age) faster than a linear scale. So a linear fit to the UC salary scale produces a slight negative bias for early and late career appointments and slight positive bias in between as shown below in Figure A:
Figure A. Illustration of salary as a function of age for the UC salary scale versus a linear dependence

Moreover, a critique of a recent systemwide salary analysis\(^2\) pointed out that such non-linearities are better captured by using a log fit. For instance, if Salary (S) varies with age (T) in a non-linear way as:

\[ S = A \ T^a, \]

where A and a are constants. Then taking log of both sides of the equation produces:

\[ \log S = \log A + a \log T \]

Figure B illustrates that the log correlation better fits the curvature of salary versus Birth Year compared to the linear fit.

Figure B. Illustrations of linear and log fits to annual salary data as a function of birth year.

Therefore, for purposes of this analysis, a fit was made to the white male salaries by a linear regression analysis to an equation of the form:

\[ \log(\text{SALARY}) = A \ \log(\text{Appointment year}) + B \ \log(\text{Birth Year}) + C \ \log(\text{Degree Year}) + D \]

where A, B, and C are regression coefficients corresponding to the three predictor variables and D is the intercept.

\(^2\) Systemwide University Committee on Affirmative Action and Diversity (UCAAD), *Analysis of Pay Equity By Sex and , Among Men, Ethnicity*, 2009-2010
The illustration in Figure C shows a plot of predicted versus actual salary, with the bounds (dotted lines) corresponding to the standard error (SE). A linear regression does a reasonable job of predicting the broad trend, but it is imperfect, with data falling off the solid line of “actual salary = predicted salary.” Most, but not all, of the data fall within one standard error of the line.

Figure C. Illustration of predicted salary versus actual salary and the bracketing of the data by the standard error (SE).

To further test salary equity, residuals (the difference between actual salary and salary predicted by the regression equation) are calculated for the white male population, and then for women (white and minority) and male minority faculty members for the campus as a whole and in each College/Division. A negative residual indicates that the actual salary is lower than the amount predicted for a white male faculty in the same academic unit with the same attributes. A positive residual indicates that the salary is higher than the predicted value.

The illustration in Figure D shows the residual value of one data point, where the faculty member’s actual salary is $50,000 less than the predicted salary:
As a final step, the residuals for each population (white males, women, male minorities) for the campus as a whole and for each College/Division are plotted on frequency histograms (the number of times a residual is calculated in a particular range of values), along with a line indicating the range of the standard error (SE) on salary. The distribution provides some measure of the salary equity – or inequity – for the campus or College/Division.

Typically, for a large population of faculty members in a College or Division, the residual distribution for the white male population will be symmetric and peaked about the origin (a residual of 0), with approximately two-thirds of the residuals falling within one standard error (SE) above or below the predicted amount. The residual frequency will fall off with greater residual values on both sides of the origin, and a relatively small number of faculty (low frequency) will fall outside of the SE at both the low (negative residual) and high (positive residual) ends.

If there is salary equity in the population, the residual distributions for women and minorities in the College/Division should show a similar distribution to the white male distribution. An example is given below in Figure E. Here there are 26 faculty whose salaries fall within ±$5000 of the predicted salary (residuals equal to or less than plus or minus $5000) and 1 each whose salaries are more than and less than $35,000 of the predicted value. Most of the faculty have salaries that fall within $18,000, the standard error (SE), of the predicted amount.
Figure E. Example of a residual frequency plot for a population in which there is no salary inequity. The distribution of residuals is symmetric about zero residual and the frequency diminishes as the residual increases.

In all cases (white males, women and male minorities), for a smaller population of faculty, the distributions may not be symmetric, nor peaked at the origin. Even in these cases, the degree of salary equity should be reflected by the extent to which the residuals fall within a standard error of the origin. Two examples are shown below: one in which there is no apparent salary inequity (Figure F) and one in which there is apparent salary inequity (Figure G):
Figure F. Illustration of a residual frequency plot in which there is no apparent salary inequity.

Figure G. Illustration of a residual frequency plot in which there is an apparent salary inequity.
Results

For most academic units, the linear regression model does a reasonable job of correlating the salary of white males with a goodness of fit parameter, \( r^2 \), of 0.49 to 0.89. The \( r^2 \) goodness of fit is a statistical parameter demonstrating how well a regression model fits the data, with a perfect fit leading to an \( r^2 \) of 1.0 and no fit at all leading to an \( r^2 \) of 0.

A standard error (SE) on SALARY is also calculated as part of the regression analysis. Since the salary is not entirely captured by the three independent variables (Appointment, Birth and Degree years), the standard error indicates how large the potential error is in predicting a white male faculty member’s salary.

The regression analysis, standard errors and goodness of fit parameters are listed for each of the academic units below in Table B.

Table B

<table>
<thead>
<tr>
<th>Unit</th>
<th>A (Log Appt. Year)</th>
<th>B (Log Birth Year)</th>
<th>C (Log Degree Year)</th>
<th>D (Intercept / Constant)</th>
<th>( r^2 )</th>
<th>SE (k$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFA</td>
<td>18.94</td>
<td>-17.18</td>
<td>-33.64</td>
<td>110.09</td>
<td>.57</td>
<td>28</td>
</tr>
<tr>
<td>MLPS</td>
<td>27.11</td>
<td>40.74</td>
<td>-91.52</td>
<td>83.46</td>
<td>.48</td>
<td>44</td>
</tr>
<tr>
<td>DSS</td>
<td>22.01</td>
<td>-3.94</td>
<td>-42.77</td>
<td>86.55</td>
<td>.51</td>
<td>44</td>
</tr>
<tr>
<td>DSS (No Econ)</td>
<td>15.96</td>
<td>11.55</td>
<td>-58.06</td>
<td>105.96</td>
<td>.64</td>
<td>33</td>
</tr>
<tr>
<td>BREN</td>
<td>16.89</td>
<td>81.94</td>
<td>-127.2</td>
<td>99.28</td>
<td>.88</td>
<td>26</td>
</tr>
<tr>
<td>GGSE</td>
<td>-20.19</td>
<td>-1.21</td>
<td>-28.39</td>
<td>169.34</td>
<td>.85</td>
<td>22</td>
</tr>
<tr>
<td>ENGR</td>
<td>-6.42</td>
<td>35.85</td>
<td>-69.15</td>
<td>136.43</td>
<td>.60</td>
<td>38</td>
</tr>
</tbody>
</table>

Figure 3 shows the ACTUAL SALARY vs PREDICTED SALARY for the campus as a whole and each of the divisions/colleges based on the data for white males. For comparison, the ACTUAL SALARY and PREDICTED SALARY (again based on white male data) for women and male minorities are shown on these same plots. The population of individual faculty making up each category in each division/college is given by the number N in each plot. A significant salary inequity in the women and/or male minority data would show up as a preponderance of data points on one side or the other of the “ACTUAL SALARY = PREDICTED SALARY” line. Such a preponderance is not evident for most of the data points in Figure 3, but the correlation does systematically underpredict salaries of the highest-paid faculty (above $225,000), who are predominantly white males.
Residual histograms for white male, women, and male minority populations for the campus as a whole and for each of the Colleges/Divisions are given in Figures 4-10. Residuals are given in units of k$ = $1000. Again, the population of individual faculty making up each category is given by the number N in each plot. No systematic changes were detected when compared to the results reported in previous years.

In Figure 4, the residual distribution for White Males for the campus as a whole is not quite symmetric, and the center of the distribution is slightly biased toward the negative residual, which biases the distributions for women and minorities as well. There continues to be a slight negative bias in the distribution for women which is further biased by the higher salary scales for engineering and economics faculty—disciplines that have higher than campus average populations of white males. Figures 5-6 and 8-10 show no apparent or systemic biases in salary for women or male minorities in the respective disciplines, at least within the statistical uncertainty of this analysis. In previous analyses, the possible bias in the social sciences indicated by the distributions for women and male minorities in Figure 7a appears to be largely the result of including economics faculty in the analysis, since the economics faculty are on a higher salary scale and tend to have a white male component that is higher than the average for the social sciences. As shown in Figure 7b, removing economics faculty from the analysis produces a residual distribution that is only slightly more symmetric this year.

This year’s Faculty Salary Equity Study Committee recommends analyzing the salary data in the larger colleges and divisions by department. The difficulty of interpreting these data is illustrated for male minorities in GGSE (Figure 8), women and male minorities in BREN (Figure 9) and women in ENGR (Figure 10). In each case, the residuals are approximately distributed equally on both sides of the zero residual line, but the sample sizes are so small that it is hard to make much statistical sense beyond this. There have been additional suggestions to account for time-off-the-clock and for other indicators, such as prizes, marital status, children, etc. These data are difficult to assemble, given the nature of our data base, so these continue to be work in progress.

The administration will continue to use the results of this analysis to examine reasons for large negative residuals for individual faculty. The Study Committee recommends that Academic Personnel conduct a review of female faculty members with large negative residuals with a view to explaining why their salaries are lower than the statistical model predicts. Institutional factors that might affect individual salaries include rank and step at initial hire, different rates of advancement (e.g., via accelerations or no-actions), and off-scale salaries due to retention offers.
Figure 1 – Salary comparisons by rank and step for UCSB and Colleges/Divisions
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Figure 1 – Salary comparisons by rank and step for UCSB and Colleges/Divisions
Figure 2 – Years at step comparison by rank and step for UCSB and Colleges/Divisions
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Figure 2 – Years at step comparison by rank and step for UCSB and Colleges/Divisions
Figure 3 – Predicted vs Actual Salary for UCSB and Colleges/Divisions
Legend: Entries above the diagonal indicate a salary less than the amount predicted based on appointment year, birth year, and degree year. Entries below the diagonal indicate a salary more than the amount predicted.
Figure 3 – Predicted vs Actual Salary for UCSB and Colleges/Divisions
Figure 3 – Predicted vs Actual Salary for UCSB and Colleges/Divisions
Figure 4 – Residual histograms for UCSB for white males, women, and male minority faculty. Legend: Each bar indicates the number of faculty, for which the difference in actual and predicted salaries, expressed in thousands of dollars per year, falls into the respective range.
Figure 5 – Residual histograms for HFA for white males, women, and male minority faculty.
Figure 6 – Residual histograms for MLPS for white males, women, and male minority faculty.
Figure 7a – Residual histograms for DSS for white males, women, and male minority faculty.
Figure 7b – Residual histograms for DSS for white males, women and male minority faculty (without Economics in the white male data base)
Figure 8 – Residual histograms for GGSE for white males, women, and male minority faculty.
Figure 9 – Residual histograms for BREN for white males, women, and minority faculty.
Figure 10 – Residual histograms for ENGR for white males, women, and male minority faculty.
Respectfully Submitted,

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