

# NOTE: THIS IS A SAMPLE REPORT – CREATED USING REAL DATA YET A FICTITIOUS PLACE AND PEOPLE

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Dr. Freidson:

I am currently a researcher and doctoral candidate in Sociology at Stanford University. My primary areas of study are stratification and inequality, and survey methodology. I am a research fellow at the Stanford Center on Poverty and Inequality, the Institute for Research in the Social Sciences, and the National Science Foundation. My area of specialty is work and occupations and I routinely conduct wage and salary analyses. My research has been published in and is currently published in the Encyclopedia on the Sociology of Work and Emerging Trends in the Social and Behavioral Sciences, and How Global Migration Changes the Workforce Diversity Equation.

My work has been funded by the Horowitz Foundation for Social Policy, the U.S. Department of Labor, the Pew Charitable Trusts Economic Mobility Project, and the National Science Foundation. I have received national awards for my work on wages and inequality and have been asked to present my research nationally and internationally. My current work has also been covered by the Associated Press, BBC, Chronicle of Higher Education, Diverse Education, Inside Higher Education, NBC Today, New York Times, and USA Today. While at Stanford I have taught courses on research methodology, statistical analysis, and logic and reasoning. Prior to coming to Stanford I studied economic, demographic analysis, statistics, design and analysis of survey data, and criminal justice. I also have training in the social psychology of judgment and decision making. Previously, I conducted research on sex offender registration, racial bias in arrest rates, police bias in enforcement against unhoused individuals, and gender discrimination in salary wages. I provided in-person or affidavit testimony in 16 cases, and cited as an authority in briefs submitted to the Ohio Supreme Court.

Because of my background, you requested that I evaluate whether your salary shows signs of inequity, when compared to the rest of the Sociology Department faculty. In responding to this request, I used standard statistical methods to answer the following questions:

1. What is the appropriate standard against which your salary should be compared, in order to assess “equity”?
2. To what extent does your salary deviate from the selected standard?

A report with my findings is attached. As you will see, I find a high level of deviation between your salary and those of the rest of your department, and determine that you are presently being paid approximately eleven thousand dollars less than expected, based on your level of experience.

If you have any questions, please feel free to contact me at [bredbird@stanford.edu](mailto:bredbird@stanford.edu).

Thank you,

A handwritten signature in black ink that reads "Beth Red Bird". The signature is written in a cursive, flowing style with a large initial "B".

Beth Red Bird

## REPORT OF FINDINGS: DR. MARY BETH FREIDSON SALARY ANALYSIS

1. *What is the appropriate standard against which your salary should be compared, in order to assess “equity”?*

Based on my understanding of the nature of pay structures in the Department of Sociology, I concluded that four items may be of relevance in assessing how salaries are determined by the University: (1) years of experience at the Red Hills Community College (hereafter Red Hills); (2) total years of faculty experience at all institutions (including both Red Hills and prior employers); (3) current institutional rank (Assistant Professor, Associate Professor, or Professor); and (4) tenure status (tenured or untenured).

In order to assess whether your salary departs from an equitable standard, I first needed to determine the appropriate standard of comparison. To do this, I analyzed relationships between these factors and the salaries of other members of the Sociology Department faculty.

Analysis of each of these factors, in all possible combinations, indicates that rank and tenure are highly interrelated, and thus both are not needed in order to produce an accurate representation of salary.<sup>i</sup> Similarly, there is a strong relationship between years of experience at Red Hills and total years of experience, and thus inclusion of both is duplicative.<sup>ii</sup> Analysis of the best fit models is presented in Table 1. Additionally, you indicated that a promotion to Associate or full Professor increases salary, beginning in that year, by a flat amount.<sup>iii</sup> However, models that adjust for this bonus do not perform better than models that simply assess the impact of rank, and thus such a specification is rejected.<sup>iv</sup>

The model that best represented the current salaries of Sociology faculty includes rank and total years of experience.<sup>v</sup> This model accurately represents 77 percent of the data, a very high level, given that wage analysis models which explain 50-60 percent are generally considered to be successful. Therefore, this is the model that will be used going forward.<sup>vi</sup>

Development of this model requires several important assumptions. First, I assume that salaries in the department are generally equitable. While the model controls for some deviation, the assumption will not hold under conditions of racial or gender discrimination, or other circumstances under which department salaries are inequitably distributed. Second, I make the assumption that salaries in the department are determined utilizing the factors discussed. In other words, I assume that the school intends to pay faculty based on experience, rank, and tenure. Again, some variation for unobserved factors (such as research publications or student evaluations of instructor’s course performance) is acceptable without undermining findings. Lastly, I make the assumption that analysis of your salary and those of other Sociology

department faculty provides an appropriate comparison. If you differ in substantial ways from your fellow department faculty (for example, you teach special classes, have differential credentials, etc.), then the Sociology faculty would be an inappropriate peer group for comparison.

2. *To what extent does your salary deviate from the selected standard?*

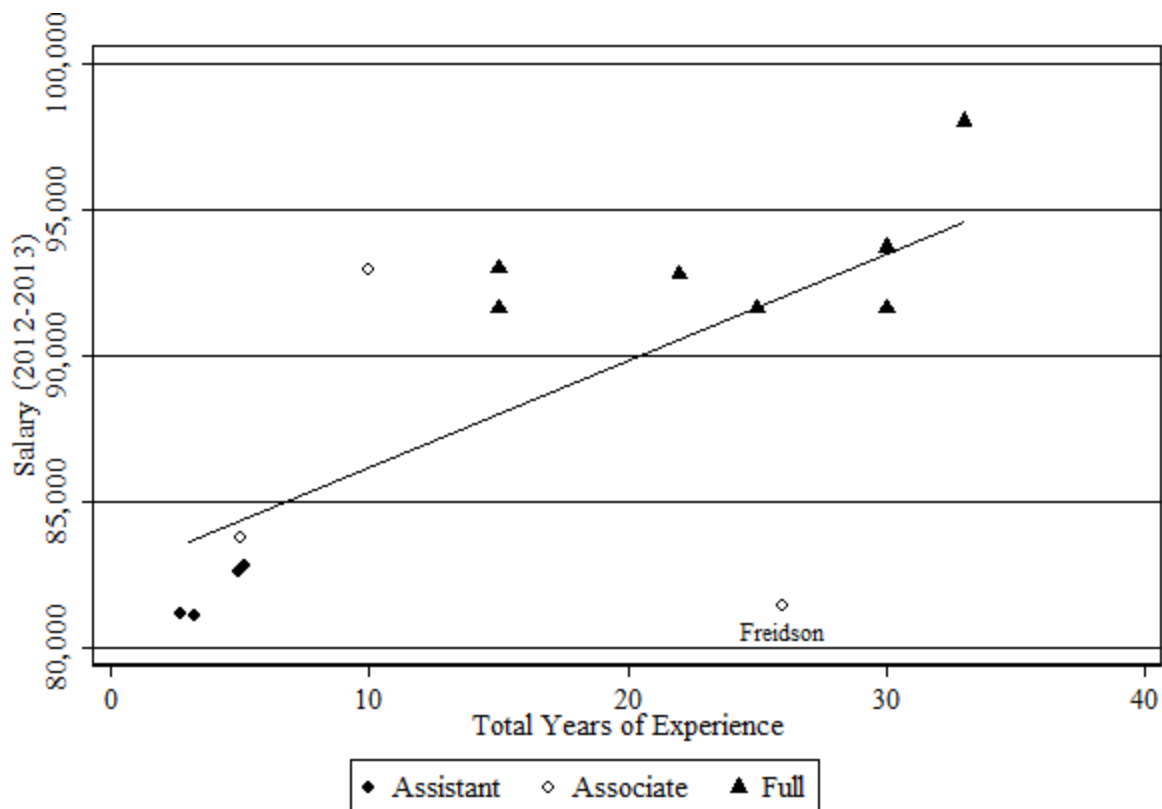
In a comparison of other Sociology Department salaries to the standard developed above, more than half of the department makes within two thousand dollars (\$2,000) of the predicted value. Not counting you, seven professors (54 percent) are undercompensated and six professors (46 percent) are overcompensated.

In contrast, your salary is approximately eleven thousand dollars (\$11,000) less than it should be. In determining whether this undercompensation is a sign of inequity, rather than the product of expected variance within a normal distribution, I examined whether your salary met generally accepted criteria for classification as an outlier or statistical aberration.<sup>vii</sup> I conclude that your salary indeed shows signs of being an outlier, and falls significantly below the standard developed above. Table 2 contains outlier analysis and predicted salaries for the three most explanatory models. Predicted salary is the amount you would need to receive in order to fall within the standard.

Figure 1 displays all Sociology Department salaries, including your own, and shows their relationship with the standard developed for this analysis, shown as a line. As you can see, most members of the department fall close to the standard, but you fall significantly below it, to the point of being an outlier. In fact, in a normal distribution of salaries, the probability of observing a salary this far below the standard would be less than 0.0001.<sup>viii</sup>

In an equity analysis such as this one, it might normally be possible to include all members of a department in the analysis, and then report on the subject employee's standing with respect to the projected standard. However, because your salary is so far outside the norm, compared to all of your colleagues, inclusion in the model biases the estimate so far as to generate an overwhelming amount of error and produce meaningless results. As such, the only way to mathematically understand your position within the department is to perform this regression on *everyone else*, and then describe your position with reference to the standard that comes from analysis of your more normal-salaried cohort.

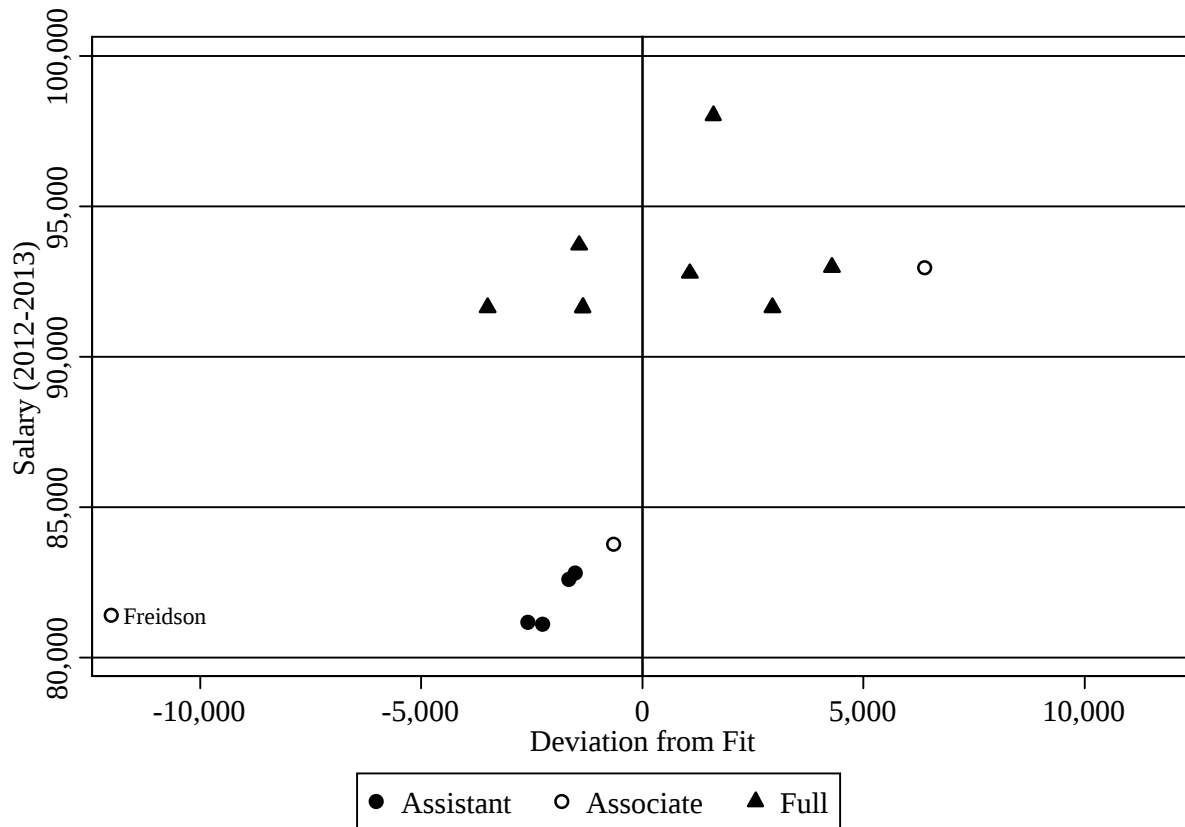
Figure 1 – Relationship between equitability standard and Sociology faculty salaries.



Although this is a statistical conclusion, it can also be easily understood visually – in Figure 1, we can see thirteen faculty members in reasonable proximity to the estimate and one faculty member (you) far outside the pattern. Figure 2 depicts this relationship, showing each faculty member's position above or below the standard for the department. As you can see, your salary is approximately eleven thousand dollars (\$11,000) below the standard and is the most deviated by a substantial margin.

Table 3 presents modeling of the standard developed above and comparison of your salary to the standard. Each model offers a prediction as to what your salary would/should be, and a margin of error as to that prediction. As mentioned above, the model accounts for approximately 77 percent of the data, and thus the margin of error reflects the unknown factors influencing salary that contribute to the unexplained 23 percent of variation. Thus, if you rate very well in the unexplained factors that make up the 23 percent, you would fall at the high end of the range created by the margin of error. Under the best model, the predicted salary range, based on your experience at Red Hills, would be \$88,860 to \$93,001.

Figure 2 – Distance of Sociology faculty salaries from predicted standard.



- i Inclusion of both rank and tenure reduced significance in all models of this specification. This is not an unexpected result, given that all Associate Professors are untenured but only one Professor is currently untenured. Inclusion of rank reduces error more than inclusion of tenure. Thus, tenure is omitted from all further models.
- ii Correlation between Red Hills experience and total experience is 0.831. This relationship is not surprising, given that many members of the department have an extensive record of service at the university. Total experience has a more substantive relationship with salary than Red Hills experience. Thus, Red Hills experience is omitted from all further models.
- iii Currently this amount is \$4,000 for promotion to Associate and an additional \$6,000 for promotion to Professor.
- iv In order to address the issue of promotion-linked salary increases, I tested the hypothesis that such increases reduced the linear relationship between salary and experience. I adjusted salary by the promotion bonus amount, to produce an 'unbonused' salary level, and this level was used to test the relationship between experience, tenure, and adjusted compensation. The models are rejected as failing to improve explanatory power or goodness-of-fit.

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- <sup>v</sup> These conclusions hold even when the assumption of normality in the outcome variable is relaxed. Transformations of salary resulted in no increase in goodness-of-fit.
- <sup>vi</sup> Adj.R-Sq.=0.767; RMSE=2673.0; F=15.24 (p-value<0.001).
- <sup>vii</sup> This analysis is conducted using an externally studentized residual, constructed from model residuals that have been standardized using a jackknife procedure. Residuals with an absolute value greater than 2.5 occur in normally distributed data less than one percent of the time. Residuals with an absolute value greater than 3.0 are considered to be outliers or statistically anomalous. Under different modeling specifications, your studentized residual ranges from -3.328 to -3.645.
- <sup>viii</sup> This p-value is based on a left-tailed Z-score distribution calculation.

TABLE 1. - OLS LINEAR REGRESSION MODELS OF FACULTY SALARY IN THE SOCIOLOGY DEPARTMENT

| Coef.                            | (1)<br>Salary (2012-2013) | (2)<br>Salary (2012-2013) | (3)<br>Salary (2012-2013) | (4)<br>Salary (2012-2013) | (5)<br>Salary (2012-2013) | (6)<br>Salary (2012-2013) | (7)<br>Salary (2012-2013) | (8)<br>Rank Adj. Salary <sup>a</sup> | (9)<br>Rank Adj. Salary |
|----------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------------------|-------------------------|
| Experience at Red Hills (Yrs.)   | 252.8<br>(1.90)           |                           |                           |                           |                           |                           | -403.4**<br>(-3.95)       |                                      | -276.4*<br>(-3.01)      |
| Total Experience (Yrs.)          |                           | 417.0***<br>(5.50)        |                           |                           | 161.2<br>(1.05)           | 401.2**<br>(4.02)         | 665.7***<br>(7.11)        | 256.3**<br>(3.31)                    | 437.5***<br>(5.21)      |
| Associate Professor <sup>b</sup> |                           |                           | 6381.0*<br>(2.74)         |                           | 5413.9<br>(2.17)          |                           |                           |                                      |                         |
| Professor <sup>b</sup>           |                           |                           | 10910.1***<br>(6.63)      |                           | 7464.8<br>(2.04)          |                           |                           |                                      |                         |
| Tenure (=1)                      |                           |                           |                           | 6121.8*<br>(2.28)         |                           | 585.5<br>(0.26)           | 2350.1<br>(1.52)          | -1770.2<br>(-1.01)                   | -561.2<br>(-0.41)       |
| Constant                         | 85974.7***<br>(40.29)     | 81997.2***<br>(53.50)     | 81970.5***<br>(61.04)     | 85181.0***<br>(39.60)     | 81325.8***<br>(55.30)     | 81891.3***<br>(49.72)     | 81255.5***<br>(74.44)     | 81879.6***<br>(64.13)                | 81444.0***<br>(83.11)   |
| Observations <sup>c</sup>        | 14                        | 14                        | 14                        | 14                        | 14                        | 14                        | 14                        | 14                                   | 14                      |
| Adj. R-Sq <sup>d</sup>           | 0.167                     | 0.692                     | 0.764                     | 0.244                     | 0.767                     | 0.666                     | 0.857                     | 0.45                                 | 0.683                   |
| RMSE <sup>e</sup>                | 5,049.9                   | 3,069.9                   | 2,685.7                   | 4,810.3                   | 2,673.0                   | 3,196.6                   | 2,095.3                   | 2,477.9                              | 1,881.1                 |
| F <sup>f</sup>                   | 3.612                     | 30.24                     | 22.1                      | 5.206                     | 15.24                     | 13.98                     | 26.89                     | 6.308                                | 10.33                   |
| P-value                          | 0.082                     | 0.000                     | 0.000                     | 0.042                     | 0.000                     | 0.001                     | 0.000                     | 0.015                                | 0.002                   |

## NOTES. -

a. Rank adjusted salary is calculated as current salary minus an adjustment for current faculty rank of \$4,000 for Associate Professor and an additional \$6,000 for Professor. The model assumes that the promotional bonus granted to faculty is independent of the linear relationship between experience and salary.

b. Associate Professor and full Professor coefficients are dummy variables; omitted comparison group is Assistant Professor.

c. Salary for Freidson is omitted from all models. Review indicates that Freidson's salary is such a large outlier that estimation of models with value included resulted in strange, counter-intuitive results. Analysis suggests that leverage exerted by Freidson data value is unacceptably high and error increases substantially when the value is included.

d. R-squared is the proportional improvement in prediction from the regression model, compared to the mean model and indicates the goodness-of-fit of the model. R-squared ranges from zero to one, and indicates the proportion of variance in the outcome variable explained by included predictors. The R-squared included here is adjusted for the number of predictors included in the model through incorporation of the model's degrees of freedom. When assessing salary, an R-squared in the range of .5 to .6 is reasonable.

e. The Root Mean-Squared-Error (RMSE) is the square root of the variance of the residuals, indicating the absolute fit of the model to the data, specifically how close the observed data points are to the model's predicted values. As the square root of a variance, RMSE can be interpreted as the standard deviation of the unexplained variance, expressed in the same units as the outcome variable. Lower values of RMSE indicate better fit. RMSE is a good measure of how accurately the model predicts the response, and is the most important criterion for assessing fit of the models included in this report, as the purpose of the modeling is prediction.

f. F-statistic, and subsequent p-value, test the hypothesis that all coefficients in the model are equal to zero. Larger F-statistics indicate the model is a better predictor than the grand mean.

TABLE 2. - MODELING DATA, EXTERNALLY STUDENTIZED RESIDUALS, AND PREDICTED OUTCOME FOR SOCIOLOGY FACULTY

| Faculty  | Current Salary | Red Hills Experience | Total Experience | Rank | (1)                    |            | (2)                    |            | (3)                    |            |
|----------|----------------|----------------------|------------------|------|------------------------|------------|------------------------|------------|------------------------|------------|
|          |                |                      |                  |      | Std. Res. <sup>a</sup> | Prediction | Std. Res. <sup>a</sup> | Prediction | Std. Res. <sup>a</sup> | Prediction |
| Albert   | 93,708         | 31                   | 31               | 3    | 0.072                  | 94,925.03  | 0.380                  | 93,787.29  | 0.290                  | 98,821.88  |
| Breuer   | 81,159         | 3                    | 3                | 1    | -0.552                 | 83,248.25  | -0.303                 | 81,809.31  | -0.332                 | 82,184.58  |
| Calloway | 91,639         | 31                   | 34               | 3    | -0.760                 | 96,176.11  | -0.280                 | 94,270.84  | -0.511                 | 98,821.88  |
| Freidson | 81,406         | 26                   | 26               | 2    | -3.519                 | 92,839.89  | -3.328                 | 90,930.46  | -3.645                 | 94,362.72  |
| Gills    | 92,982         | 19                   | 19               | 3    | 0.957                  | 89,920.70  | -0.080                 | 91,853.07  | 0.633                  | 97,719.90  |
| Hanson   | 98,023         | 3                    | 25               | 3    | 1.846                  | 92,422.86  | 1.934                  | 92,820.18  | 2.143                  | 96,250.59  |
| Jiminez  | 91,639         | 20                   | 26               | 3    | 0.006                  | 92,839.89  | -0.392                 | 92,981.37  | -0.092                 | 97,811.73  |
| Keller   | 91,639         | 24                   | 30               | 3    | -0.355                 | 94,508.00  | -0.332                 | 93,626.11  | -0.291                 | 98,179.05  |
| Lee      | 82,782         | 5                    | 5                | 1    | -0.311                 | 84,082.31  | 0.303                  | 82,131.69  | 0.069                  | 82,601.29  |
| Morgan   | 81,159         | 3                    | 3                | 1    | -0.552                 | 83,248.25  | -0.303                 | 81,809.31  | -0.332                 | 82,184.58  |
| Nu       | 82,782         | 5                    | 5                | 1    | -0.311                 | 84,082.31  | 0.303                  | 82,131.69  | 0.069                  | 82,601.29  |
| Ott      | 91,776         | 7                    | 19               | 3    | 0.648                  | 89,920.70  | -0.495                 | 91,853.07  | 0.276                  | 96,617.91  |
| Pullman  | 91,639         | 13                   | 19               | 3    | 0.614                  | 89,920.70  | -0.543                 | 91,853.07  | 0.237                  | 97,168.91  |
| Rodgers  | 83,759         | 5                    | 5                | 2    | -0.066                 | 84,082.31  | -1.400                 | 87,545.58  | -0.873                 | 92,434.25  |
| Steller  | 92,944         | 5                    | 15               | 2    | 1.350                  | 88,252.59  | 4.277                  | 89,157.42  | 1.498                  | 92,434.25  |

NOTES. -

Model (1) regresses salary on total experience only. Model (2) regresses salary on total experience and rank (as control indicator variables) and is the preferred model for this analysis. Model (3) regresses experience on rank adjusted salary calculated by removing rank adjustment bonuses (\$4,000 for assistant and \$6,000 for professor) from the baseline salary level.

a. An "externally studentized" residual is the studentized residual of an observation with respect to the model built after discarding this observation from the data set (jackknifed). Standard deviations of residuals in a sample typically vary greatly from one data point to another even under the assumption of uniform error variance (homoskedasticity). Thus, comparison of residuals depends on standardization. A point is generally considered to be an outlier, or statistical anomaly, if the value of the studentized residual exceeds an absolute value of 3.0. In the context of these models, a negative value represents undercompensation and a positive value indicates overcompensation, based on the predicted values.

TABLE 3. - OLS LINEAR REGRESSION MODELS AND PREDICTED SALARY FOR FREIDISON

| Coef.                                       | (1)<br>Salary (2012-2013) | (2)<br>Salary (2012-2013) | (3)<br>Rank Adj. Salary <sup>a</sup> |
|---------------------------------------------|---------------------------|---------------------------|--------------------------------------|
| Total Experience (Yrs.)                     | 417.0***<br>(75.8)        | 161.2<br>(153.3)          | 208.4**<br>(61.3)                    |
| Associate Professor <sup>b</sup>            |                           | 5413.9<br>(2491.0)        |                                      |
| Professor <sup>b</sup>                      |                           | 7464.8<br>(3663.6)        |                                      |
| Constant                                    | 81,997.2***<br>(1,532.7)  | 81,325.8***<br>(1,470.5)  | 81,559.5***<br>(1,238.5)             |
| Observations                                | 14                        | 14                        | 14                                   |
| Adj. R-Sq <sup>c</sup>                      | 0.692                     | 0.767                     | 0.448                                |
| RMSE <sup>d</sup>                           | 3,069.9                   | 2,673.0                   | 2,480.8                              |
| Predicted Salary for Freidson <sup>e</sup>  | 92,839.89                 | 90,930.46                 | 94,362.72                            |
| Margin of Error for Prediction <sup>f</sup> | 2,084.97                  | 2,070.12                  | 1,684.84                             |

## NOTES. -

a. Rank adjusted salary is calculated as current salary minus an adjustment for current faculty rank of \$4,000 for Associate Professor and an additional \$6,000 for Professor. The model assumes that the promotional bonus granted to faculty is independent of the linear relationship between experience and salary.

b. Associate Professor and Professor coefficients are dummy variables; omitted comparison group is Assistant Professor.

c. R-squared is the proportional improvement in prediction from the regression model, compared to the mean model and indicates the goodness-of-fit of the model. R-squared ranges from zero to one, and indicates the proportion of variance in the outcome variable explained by included predictors. The R-squared included here is adjusted for the number of predictors included in the model through incorporation of the model's degrees of freedom. When assessing salary, an R-squared in the range of .5 to .6 is reasonable.

d. The Root Mean-Squared-Error (RMSE) is the square root of the variance of the residuals, indicating the absolute fit of the model to the data, specifically how close the observed data points are to the model's predicted values. As the square root of a variance, RMSE can be interpreted as the standard deviation of the unexplained variance, expressed in the same units as the outcome variable. Lower values of RMSE indicate better fit. RMSE is a good measure of how accurately the model predicts the response, and is the most important criterion for assessing fit of the models included in this report, as the purpose of the modeling is prediction.

e. Salary for Freidson is omitted from all models. Review indicates that Freidson's salary is such a large outlier that estimation of models with value included resulted in strange, counter-intuitive results. Analysis suggests that leverage exerted by Freidson data value is unacceptably high and error increases substantially when the value is included.

f. Margin of error is generated using a 95 percent confidence level.