

SEX DISCRIMINATION IN FACULTY SALARIES:  
A METHOD FOR DETECTION AND CORRECTION

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1. INTRODUCTION

In addition to Federal law, common sense demands that persons having the same qualifications and performing the same work be paid the same salary. However, evidence of substantial sex discrimination in faculty salaries has been documented ([1], [2], [3], [6]). Using data from 78 universities, 168 four-year colleges and 57 two-year colleges, Darland, Dawkins, Lovasich, Scott, Sherman and Whipple [6] estimate that female faculty members are underpaid by an average of approximately \$1500 annually.

Assuming that some sex discrimination does exist in a university, how can the administrators responsible for setting salaries best identify those discriminated against and remedy the situation? In some cases, detailed pay scales with precise formulas for salary determination may be feasible. However, factors such as differential marketability for various fields and quality of teaching, research and service should be taken into account in an institution attempting to attract and retain faculty members of the highest caliber. The methods presented in this paper provide a means for generating salary information which can be used by administrators to diagnose and correct instances of sex discrimination in salaries. It should be kept in mind that our purpose is not to develop a computer program for determining salaries but rather to provide information to decision makers so that they can more effectively deal with this difficult problem. We acknowledge the Office of Civil Rights of the Department of Health, Education, and Welfare, which

through a letter to the Purdue University administration, provided the impetus and a certain degree of urgency in the development of these methods.

## 2. POPULATION

There are no random samples considered in this paper. The population of interest is assumed to be the faculty of a large university. This population would be considered a sample of faculties from similar universities if inferences are desired. The basic unit for job classification is the department-rank. Since our primary purpose is to study sex discrimination, only individuals in department-rank combinations having both male and female faculty members are considered. Thus, if the full professors in one department are all female while those in another are all male, these individuals are excluded from the study. For such individuals, it is impossible to distinguish between sex discrimination and salary differences due to differential market conditions for the departments in question. It should be noted that a substantial number of individuals may be excluded as a result of this criterion. Of course, it cannot be asserted that no discrimination is present in this excluded group. The proposed methodology, however, is inadequate for detecting such cases.

In addition to the above, deans, department heads, distinguished professors, lecturers, instructors and various types of visiting and temporary faculty are also excluded. Salaries of such individuals can usually be examined by comparison with the respective group means.

In summary, the methods to be presented in the next sections are appropriate for studying salaries of assistant, associate and full professors having a peer of the opposite sex in the same department-rank.

### 3. METHODOLOGY

For each of the three ranks, a regression equation for predicting monthly salary is computed. Variables used as predictors are: D-departmental designators, V-vita variables, A-articles, books and consulting and Q-questionnaire variables.

(D) Departmental designators are dummy variables indicating the department to which the individual is assigned. For joint appointments, the department which pays the largest percentage of the individual's salary is used.

(V) Vita variables include: a dummy variable indicating whether or not a doctorate is held, number of years in current rank, age, year highest degree completed, year hired, a dummy variable indicating an academic year or fiscal year employee, and a dummy variable indicating whether or not the individual is tenured (used for assistant professors only.) To account for some nonlinear effects of years in rank and age, quadratic terms for these variables are also included.

(A) "Articles" is the total number of articles published, truncated at 50. "Books" is the total number of books published, truncated at 5. "Consulting" is a dummy variable indicating whether or not the individual has engaged in outside consulting.

(Q) Questionnaire variables are obtained by compiling the results of questionnaires sent to departmental promotion committees (usually these consist of all full professors in the department.) Each faculty member studied is rated by all promotion committee members on teaching, research, service, marketability and overall. A seven point scale is used with a "no opportunity to observe" option available. Valid responses are averaged to obtain a score on each of these variables for each individual.

4

Missing values are replaced by departmental averages except in the case of the marketability question. For a person about to retire, the lowest score is given. This procedure is consistent with cases where valid data was available for such individuals.

#### 4. FORMAT AND USE OF RESULTS

The regression equations described in the previous section are used to compute residuals. Through a careful inspection of these residuals, administrators can pinpoint cases of possible discrimination. In addition, general patterns can be discerned and a measure of the earnings differential can be calculated.

For each department an ordered list of residuals is provided. By examining the relative positions of males and females in the list, along with the magnitude of the residuals, discrepancies can be detected. Of course, other factors not included in the regression equations contribute to the determination of salaries. The size of the residuals is an indication of the importance of these other factors. Clearly, salaries of all (female and male) individuals with large negative residuals should be carefully reviewed. Unusual patterns also indicate the need for further study of the salaries involved. In many cases, this procedure will uncover bad data or misclassified individuals. Such errors are then corrected and the equations recomputed.

In addition to the residual lists, residuals are categorized in a 2 x 5 table by sex and magnitude for each rank. Boundary points for the magnitude categories are approximately  $\pm 2\%$  and  $\pm 5\%$  of the average salary for each rank. From these tables of observed frequencies, "expected" frequencies can be computed in the usual manner. Comparisons of

expected and observed frequencies give an indication of the extent of possible sex discrimination. The tables and lists of residuals with a brief explanation of the methodology, are transmitted to the University, Equal Employment Opportunity Officer, and the Provost. From these, deans and department heads receive lists of residuals for individuals in their schools and departments, respectively.

The residual tables provide an overall picture of the extent of possible sex discrimination. It is desirable, also, to summarize this information in a statistic which can be computed for each rank. Gastwirth [4], [5] has proposed the use of a measure, here denoted by  $G$ , based on the Wilcoxin test. Applied to the residuals, this statistic can be described as the probability that a randomly selected female residual is greater than or equal to a randomly selected male residual. A value of .5 corresponds to "equality" while smaller values are indicative of a salary differential. A standard error is easily calculated [5].

For institutions striving to improve the situation regarding sex discrimination, values of  $G$  can be calculated yearly. Progress toward a nondiscriminatory state can thus be monitored.

## 6. EXAMPLE

The procedures described above were applied to 1974-75 salaries of Purdue University faculty. On the basis of these results, it was decided to drop the articles, books and consulting variables. We believe that the information sought from these variables is more validly measured by the  $Q$  variables. Regression equation statistics for models using  $D$ ,  $V$  and  $Q$  variables are presented in Table I.

Table I  
REGRESSION EQUATION STATISTICS

YEAR	RANK	SAMPLE SIZE	SQUARED MULTIPLE CORRELATION	STANDARD DEVIATION (\$)	COEFFICIENT OF VARIABILITY (%)
1974-75	Assistant	255	.630	101.	7.69
	Associate	131	.599	136.	8.07
	Full	75	.634	273.	12.28
1975-76	Assistant	245	.708	101.	7.10
	Associate	185	.635	141.	8.01
	Full	91	.776	220.	9.22

Most of the increase in correlations from 1974-75 to 1975-76 is probably due to correction of bad data.

Values of the statistic G ranged from  $.39 \pm .07$  to  $.55 \pm .11$  for the 1974-75 data. Since the results of our analysis were not available until after the 1975-76 salaries had been finalized, anticipated improvements should be observed in the 1976-77 data which is currently being analyzed.

The value ranges for the residual categories are given in Table

II.

Table II

VALUE RANGES FOR RESIDUAL CATEGORIES

RANK	-2	-1	0	+1	+2
Assistant	<-75	-75, -30	-30, +30	+30, +75	>+75
Associate	<-100	-100, -40	-40, +40	+40, +100	>+100
Full	<-125	-125, -50	-50, +50	+50, +125	>+125

Since the detailed results of this analysis are private, the residual tables for the full model are not presented. To illustrate the use of such tables, however, the tables for regression equations using only D and V variables are given in Table III. Note that we do not recommend using residuals based on only these variables. The "expected" frequencies are given in parenthesis.

Table III

RESIDUAL TABLES FOR DV MODEL  
OBSERVED AND EXPECTED FREQUENCIES

RANK	SEX	-2	-1	0	+1	+2	Total
Full	Male	26 (23)	11 (11)	7 (8)	1 (3)	22 (21)	67
	Female	2 (3)	1 (1)	2 (1)	2 (0)	1 (2)	8
	Total	28	12	9	3	23	75
Associate	Male	23 (24)	14 (17)	9 (28)	19 (19)	25 (22)	110
	Female	6 (5)	6 (3)	4 (5)	4 (4)	1 (4)	21
	Total	29	20	33	23	26	131
Assistant	Male	24 (32)	39 (39)	64 (60)	32 (25)	27 (30)	186
	Female	20 (12)	15 (15)	18 (22)	2 (9)	14 (11)	69
	Total	44	54	82	34	41	255

If the results in Table III were based on the full equation, one would conclude that there is a problem with the assistant professors in the lower categories. In addition, the pattern for the associate professors deserves some attention.

Further analysis proceeds with inspection of residual lists for each department-rank combination. In Table IV, residual lists are presented. These particular lists do not correspond to any real data but have been constructed to illustrate the type of patterns that occur with real data.



Table IV  
TYPICAL RESIDUAL LISTS

Department-Rank									
1		2		3		4		5	
Sex	Residual	Sex	Residual	Sex	Residual	Sex	Residual	Sex	Residual
F	-105	M	-110	F	-101	M	-106	F	-127
M	-37	M	-48	M	-67	M	-54	M	-95
M	-30	M	-24	M	-19	M	-34	M	-73
M	-25	M	-4	F	32	M	20	F	-53
M	6	M	3	M	36	M	26	M	-49
M	95	F	10	M	48	M	27	M	-23
M	95	M	22	M	72	M	53	M	-7
		M	45			F	68	M	-3
		M	106					F	15
								M	45
								M	57
								M	60
								F	79
								F	82
								M	92

Note that in all cases, the residuals add up to zero (there may be some small round-off errors.) Departments 1 and 3 should be asked to provide an explanation for the apparently underpaid females. In department 2, the pattern looks good while in department 4 some reverse discrimination may be present. The department 5 residuals, while not showing a particularly bad pattern, deserve some review.

We would like to point out that this methodology allows the administrators to look at all residuals, regardless of the sex of the individual.

## 7. SOME DIFFICULTIES

In this section some of the difficulties which arose in the course of this study are discussed. In many cases, these can only be resolved by individuals responsible for making and interpreting university policy.

(1) Monthly salary. The correspondence between monthly salaries for academic year and fiscal year employees should be carefully considered. At Purdue, a policy exists which states that an individual being switched from an academic year appointment (10 monthly checks) to a fiscal year appointment (12 monthly checks) should receive a 25% increase in salary. To account for this, monthly salaries for fiscal year personnel are multiplied by 0.96 for comparison purposes.

(2) Departments. In a large university with many schools, definitions of departments sometimes vary. Some arbitrary judgements may be necessary to determine appropriate groupings.

(3) Assignment of individuals to departments. In some cases, exceptions to the assignment rule based on the largest portion of salary paid may be necessary.

(4) Doctorate. This predictor variable should be interpreted to include all types of doctorate or equivalent in one category.

(5) Years in rank. Credit for service in the same rank at other institutions is appropriate in some cases.

(6) Vita variables. Choice of vita variables is influenced by what nondiscriminatory information is readily available.

(7) Articles, books and consulting. These may be difficult to define appropriately, e.g. in creative arts. In addition, the difficulty

of quantifying the quality of the work seems to be insurmountable. For these reasons, we have decided to rely solely on the Q variables as measures of merit.

(8) Q variables. The Q variables should be obtained from individuals not responsible for setting salaries. If discrimination is present, then seeking this information from the person determining salaries is at best questionable. Further analysis of some of our data indicates that there may be some nonlinear effects with these variables. Inclusion of quadratic terms should be considered.

## 8. CONCLUSIONS

The effectiveness of the procedures described in this paper ultimately depends on the use of the results by university administrators. Clearly, a sincere effort on the part of these individuals is required. With such an effort, we believe that responsible administrators can effectively use the data provided to diagnose and correct instances of sex discrimination in faculty salaries.

The methods presented in this paper, while devised for detecting sex discrimination, can also be effectively used to pinpoint possible cases of salary inequities for all faculty members.

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