APPLICATION OF MULTIVARIATE REGRESSION TO STUDIES OF SALARY DIFFERENCES BETWEEN MEN AND WOMEN FACULTY

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SUMMARY

Women who are employed receive lower salaries, on the average, than men. We investigate to what extent the differences in faculty salaries can be explained by relatively objective factors, such as lack of the Ph.D. and differences in performance, and to what extent they appear to be the result of discrimination. Using regression on more than 25 predictor variables, we estimate the salary of all faculty, of men faculty, and of women faculty in various types of universities and colleges and in various fields.

We find that the predictors that are important in determining salary are not always the same for men and women, but that both salaries are well predicted with a typical R of 0.8. When we compare the estimated salary of a man and a woman of the same abilities and performance, or when we compare the salary a woman actually gets with that predicted from the men's equation, we find that women tend to be underpaid by about $1500 annually, on the average, and often by much more. The amount of underpayment is more pronounced in the research universities, in the biological and physical sciences, and at the higher levels--just where salaries tend to be highest and women are scarce.

The apparent discrimination in faculty salary due to sex is strong and persists for every race. The Carnegie survey data indicate that the salary differential due to sex is much larger than that due to race.

1. INTRODUCTION

Women are underrepresented on the faculties of colleges and universities, and those women who are employed tend to be paid less well than the men at the same type of institution. The figures published by the Office of Education and by the National Education Association [1] show that the median salaries are between $1,000 and $4,000 lower for women than for men in similar institutions. The differences in median salaries tend to be larger in the more selective colleges and universities, just those where the salaries themselves tend to be higher. However, one must consider that fewer women have the doctorate, that women who are employed in academe have a different age distribution than men, and that they tend to be concentrated in certain fields. In this paper we estimate how much of the observed salary differentials can be explained by relatively objective factors such as highest degree held, differences in performance and in attributes, and to what extent they appear to be the result of sex discrimination. Do men and women of the same ability and performance receive different salaries, and if so, by how much?

The data available are from the large-scale national survey [2] made in 1969 by the Carnegie Commission on Higher Education in cooperation with the Office of Research of the American Council on Education. This survey included a comprehensive questionnaire returned by 60,028 faculty members located in 78 universities, 168 four-year colleges, and 57 two-year colleges. Astin and Bayer [3] used a linear regression equation with 32 predictor variables to compare the average salary a man would receive with the average for a woman having the same rank, background, and achievements. They included indicators of the type of institution and field among their predictor variables; they found that the average discrimination exceeds $1,000 in salary and one-fifth step in rank.

In an effort to get at the source of discrimination in more detail and also to obtain better estimators, we extended [4] the study of Astin and Bayer to investigate the salary differences of men and women for different types of institutions (as set out by the Carnegie Commission [4]) and different fields separately. We also included higher order interaction terms and an indicator of full-time versus part-time employment. Our analyses were based on the replies of all women sampled and a 25% random sample of the men. We used the salary intervals of varying width (averaging $3,000) adopted by the Carnegie

Table 1. COEFFICIENTS OF THE MULTILINEAR REGRESSION EQUATION FOR PREDICTING FACULTY SALARIES (IN $1,000)

Research Universities I - Biological and Physical Sciences - 1183 Men, 312 Women

	Men and Women	Men	Women	Variable
Const.	10.19	9.13	3.11	
1	-1.48**	---	---	Sex, 1 = male, 2 = female
2	.49***	.57**	.44*	Date of birth, 1 = 1908 or before to 9 = 1944 or later
3	.96*	.75	-.52	Marital status, 1 = never married, 2 = married or formerly married
4	1.16***	.74**	1.04*	No. of children, 1 = none to 4 = three or more
5	2.01***	2.23***	1.98***	Highest degree, 0 = BA or less, 1 = MA, 2 = doctorate
6	-.52***	-.59***	-.30*	Year of highest degree, 11 = 1928 or before to 21 = 1967 or later
7	.28	.24	.11	BA from a prestigious school, 0 = no, 1 = yes
8	-.31	-.24	-.86**	Graduate degree from a prestigious school, 0 = no, 1 = yes
9	.25	.31	.01	Support toward highest degree, 0 = none to 2 = TA/RA plus fellowship
10	---	---	---	Rank (variable omitted)
11	.75***	.86***	.46*	Years employed in academe, 1 = one or less to 8 = 30 or more
12	-.53***	-.59***	-.30*	Yrs empl'd in present inst'n, 1 = one or less to 8 = 30 or more
13	-.22⁻	-.30⁻	.07	Quality of present inst'n, 1 = high to 7 = low
14	1.29***	1.28***	1.25***	No. of articles, 1 = none to 6 = more than 20
15	.44***	.35*	.51⁻	No. of books, 1 = none to 4 = five or more
16	.19	.25	-.07	Assoc'n with a research institute, 1 = yes, 2 = no
17	.06	.01	.51*	No. of sources of research support, 0 to 6
18	.90***	.84***	1.07**	No. of sources of paid consulting, 0 to 6
19	-.31*	-.43**	.02	Research/teaching inclination, 1 = heavily research to 4 = heavily teaching
20	.63***	.68***	.30*	Administrative activity, 1 = none to 7 = 81 to 100 percent time
21	.00	-.03	-.04	Consulting, 1 = none to 7 = 81 to 100 percent time
22	-.28*	-.27⁻	-.45	Outside professional practice, 1 = none to 7 = 81 to 100 percent time
23	-.44***	-.51***	-.02	Hours taught per week, 1 = none to 9 = 21 or more
24	2.40***	2.48***	2.24***	Salary base, 1 = 9/10 months, 2 = 11/12 months
27	-.15***	-.15***	-.17***	Interaction: date of birth and number of articles
28	-.22	---	---	Interaction: sex and number of children
29	-.13**	-.11*	-.18*	Interaction: date of birth and number of children
30	.00	.31	.26	Interaction: sex, marital status, and age, 1 = male, never married, under 30 to 8 = female, married or formerly married, 30 years or older
31	-2.06***	-2.07***	-.96*	Part-time by Rule 5, 1 = full-time, 2 = part-time

⁻ Individual coefficient differs from zero at 0.10 significance (two-sided); * at 0.05; ** at 0.01; *** at 0.001.

Survey. The present study differs from the last only in that the salary intervals were converted to dollars before any estimates were computed or comparisons made. Since we want the results in dollars, carrying out the computations in dollars avoids additional bias.

2. ESTIMATES OF SALARY

We find good estimates of faculty salary from a simple additive equation. The variables used are listed in Table 1 with three sets of coefficients estimated for a prediction equation for salary in thousands of dollars. The first set of coefficients shown corresponds to 28 predictor variables, of which 4 are interaction terms, and was estimated using the combined sample of men and women in the field of Biological and Physical Sciences of institutional type Research Universities I. The next set, obtained using only the men faculty, and the last set, using only the women, omit the 2 predictor variables that involve sex in such a way that they become redundant, thus retaining 26 predictor variables of which 3 are interaction terms. (Even though the last interaction term involves sex, it is not redundant and was retained as a measure of mobility.) We have used the same set of predictor variables for each combination of field, type, and sex. Since rank is tightly locked to salary in many institutions, it was not used as a predictor variable. Preliminary studies suggested that including rank would cloud the effects of other variables more suitably regarded as predictors.

Initially, stepwise regression was employed to aid in selecting predictor variables, and tests of linear hypotheses were performed for particular combinations of field and type so as to see what might be important in setting up the systematic analyses. For these initial investigations, versions of the programs LINWOOD [5] and BMD [6] were used. The main analyses were carried out with an adaptation of DANIEL, a local version of the LINWOOD program.

The asterisks following the estimated coefficients in Table 1, and in Table 2 below, indicate the predictor variables that are individually significant in determining faculty salaries in the specified field and type of institution. Since many of the predictor variables are presumably themselves collinear, the individual significance probabilities do not necessarily give a full picture of the importance of particular predictors. Nevertheless, they are of interest.

We note that when men and women are considered together, the variable sex is important and its coefficient is appreciable, - $1,480. Thus, when all other predictor variables are fixed, the predicted annual salaries for women are $1,480 less than those for men. However, because the predicting equations fit to the men and to the women separately differ very significantly, this joint equation should be discarded.

Examining the other two columns of coefficients, the set for men and that for women, we see that having higher degrees is very important for both sexes. Also important for both sexes is the number of articles published, the salary base, and the interaction term date of birth by number of articles. On the other hand, for some variables, the coefficients estimated for men are quite different from those estimated for women. The increase in salary with the period employed in academe is twice as much for men as for women (predictor No. 11), both men and women gain by changing institutions but men gain twice as much as women (No. 12), men also gain twice as much as women by administrative activity (No. 20), men who teach less are paid more but a woman's salary is unaffected by hours of teaching (No. 23), and men lose more than women by being employed part time (No. 31). (This last conclusion is uncertain because the survey did not ask whether employment was full time; we estimated [4] this from answers to other questions since it must be an influential variable in predicting salaries.)

The sets of coefficients for other fields and other types of institutions are shown in Table 2. On each page of the table we show the coefficients for various fields in an institutional type, starting with Research Universities I. There is considerable variation in the coefficients and loss of power with small samples. The general pattern persists with some exceptions: the number of books published (predictor variable No. 15) tends to be important in the field Humanities, especially for men, and books are more rewarding for men. Having children (No. 4) tends to decrease the salary of women if they are not in the sciences or when they

Table 2. COEFFICIENTS OF THE MULTILINEAR REGRESSION EQUATION FOR PREDICTING FACULTY SALARIES (IN $1,000) IN RESEARCH UNIVERSITIES I

Field:	Bio/Phys Sci.		Education		Fine Arts		Humanities		Soc. Sci.		New Professions	
Predictors Sex:	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Constant	9.13	3.11	9.49	16.47	24.49	11.26	11.36	12.89	16.98	9.44	18.99	9.57
2 Date of Birth	.57**	.44*	.03	-.12	-.04	-.11	.19	-.19*	.15	-.14	.04	-.05
3 Marital Status	.75	-.52	.31	-.37	.85	.25	.19	-.20	.38	-.72	.76	-.44
4 No. of Child.	.74**	1.04*	.61	.26	.88*	-.52	.60*	-.71*	1.04***	-.48	.49	-.26
5 Highest Degree	2.23***	1.98***	2.21***	1.89***	1.32***	1.78***	1.14***	.93***	1.30***	1.18**	1.42***	1.76***
6 Year of Degree	-.59***	-.30*	-.38**	-.37***	-.69***	-.24*	-.41***	-.02	-.59***	-.15	-.66***	-.19***
7 BA Prestigious	.24	.11	-.42	-.23	-.14	.15	-.18	.01	-.02	.13	.15	.45*
8 Graduate Prest.	-.24	-.86**	-.22	.36	.42	-.54	.68**	.21	-.27	.18	-.11	.03
9 Support	.31	.01	-.04	-.12	.00	-.11	.30-	.19	.15	-.22	.39-	.03
11 Years Academe	.86***	.46*	.28	.31**	.21	.36-	.74***	.35***	.77***	.71**	.11	.35***
12 Years Present	-.59***	-.30*	-.19	-.22-	-.11	-.14	-.34***	-.09	-.50***	-.32	-.34*	-.17*
13 Qual. Present	-.30-	.07	.04	.24	-.48	-.85**	.24	-.33*	.29	-.01	-.81**	-.18
14 No. Articles	1.28***	1.25***	.65*	.29-	.15	.42	.96***	.42*	1.19***	.31	.65**	.71***
15 No. Books	.35*	.51-	.32	-.06	.31	.21	1.01***	.64***	.12	.28	.64***	.09
16 Assoc.Research	.25	-.07	-.56	-.03	-.64	.26	-.29	-.46	-.30	-.18	-.36	-.10
17 No. Research	.01	.51*	.55**	.29	.11	.30	.08	.40*	-.02	.06	.02	.46***
18 No. Consulting	.84***	1.07**	.70***	.49***	.75**	.19	.27-	.44**	.45**	.21	.68***	.49***
19 Research/Teach	-.43**	.02	-.01	-.24	-.42-	-.03	-.27	-.16	-.49**	.23	-.21	.03
20 Administrative	.68***	.30*	.24*	.37***	.49***	.33-	.49***	.43***	.44***	.48**	.71***	.48***
21 Consulting	-.03	-.04	-.32	-.28*	-.24	.01	-.48**	-.06	.16	.15	-.37*	.02
22 Prof. Practice	-.27-	-.45	.31	-.09	-.37**	-.03	-.40*	-.47***	-.58**	-.03	-.78***	-.23*
23 Hours Taught	-.51***	-.02	-.35**	-.33***	-.21*	.08	-.36***	-.42***	-.51***	-.21	-.12	-.14***
24 Salary Base	2.48***	2.24***	2.87***	1.29***	1.14*	.71-	.96***	.02	2.11***	1.32**	2.71***	1.30***
27 Birth×No. Art.	-.15***	-.17***	-.07	-.03	.00	-.07	-.10***	-.01	-.11**	.03	-.05	-.07*
29 Birth×No.Child.	-.11*	-.18*	-.09	-.04	-.18*	.07	-.08-	.10-	-.14*	.07	-.08	.02
30 Sex×Mar.×Age	.31	.26	.22	-.07	-.07	-.14	.09	.00	-.15	.08	.08	.07
31 Part-time	-2.07***	-.96*	-.67	-1.61***	-2.57***	-.74	-1.12**	-1.87***	-1.50***	-.63	-1.72***	-.84***
No. Observations	1183	312	320	381	264	192	712	520	581	215	700	1029
No. Variables	26	26	26	26	26	26	26	26	26	26	26	26
Res'l d.f.	1156	285	293	354	237	165	685	493	554	188	673	1002
Multiple R-Squared	.67	.69	.67	.70	.68	.60	.75	.70	.71	.54	.58	.62
Res'l Mean Square	12.26	6.57	8.15	3.99	7.47	4.44	7.76	3.35	8.84	7.43	13.07	5.65
Mean Opp.Sex Res'l	3.47	-2.32	1.66	-1.07	2.28	-1.64	2.14	-1.29	2.91	-.94	2.29	-1.32
S.D. Opp.Sex Res'l	3.89	3.06	3.14	2.51	3.27	2.53	3.38	2.26	3.54	2.99	3.93	2.82

Table 2 (cont.). COEFFICIENTS OF THE MULTILINEAR REGRESSION EQUATION FOR PREDICTING FACULTY SALARIES (IN $1,000) IN RESEARCH UNIVERSITIES II AND DOCTORAL-GRANTING UNIVERSITIES I AND II

Field:	Bio/Phys Sci.		Education		Fine Arts		Humanities		Soc. Sci.		New Professions	
Predictors Sex:	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Constant	12.35	2.48	10.88	10.97	5.18	10.56	8.27	6.30	16.37	6.21	8.38	5.69
2 Date of Birth	.15	.25	- .22	- .30**	.30	- .43**	-.08	.03	- .05	.10	-.18	-.08
3 Marital Status	- .31	-.42	- .21	- .15	-.21	.31	1.00*	-.65*	- .12	-1.36^{-}	2.42**	-.84*
4 No. of Child.	.86***	1.34*	.43	- .88^{-}	.43	- .45	.45^{-}	-.28	.37	-1.25*	.43	-.09
5 Highest Degree	1.95***	1.62***	1.19***	1.23***	-.27	1.49***	.80**	.89***	1.97***	1.16**	2.03***	1.97***
6 Year of Degree	- .46***	-.15	- .29*	.06	.26*	- .05	-.08	.01	- .48***	.16	-.33**	-.04
7 BA Prestigious	.36	.40	.55	.14	.38	.98^{-}	.34	.27	- .70*	.11	-.58	.20
8 Graduate Prest.	.36^{-}	.19	.24	.08	.44	- .44	.59**	.27	.33	.32	.88**	-.14
9 Support	.14	-.07	.19	.27^{-}	.01	.23	-.04	.08	.36^{-}	-.34	.08	.01
11 Years Academe	.67***	.44*	- .06	.22*	.64***	.30	.98***	.27**	.53***	.80***	.16	.30***
12 Years Present	- .52***	-.24	- .07	- .06	-.08	- .06	-.38***	.11	-.61***	-.73***	-.10	-.03
13 Qual. Present	.01	.04	.17	- .12	-.05	- .64^{-}	-.05	.08	-.02	-.22	-.44^{-}	.06
14 No. Articles	.82***	1.04***	1.13***	.46*	.22	.14	.58***	1.38***	.52*	.94**	.64**	.24^{-}
15 No. Books	.49***	.85*	.59**	.08	.33	- .08	.63***	.04	.24	.08	.08	.41**
16 Assoc.Research	.13	.01	.16	- .55*	-.87	- .54	.49	.71^{-}	-.19	-.23	-.17	.30
17 No. Research	.01	.11	- .11	.29	.40	.92*	.03	.07	.11	.17	-.18	.39**
18 No. Consulting	.56***	.28	.43***	.18	.40^{-}	.38	.33^{-}	.41*	.21	.31	.86***	.64***
19 Research/Teach	- .32*	-.13	- .33	- .09	.13	.23	-.25	-.27*	.10	-.25	-.04	.02
20 Administrative	.65***	.58***	.32***	.17*	.52***	.36*	.30***	.39***	.44***	.45**	.72***	.39***
21 Consulting	.23	.09	- .21	- .11	-.24	.00	-.24	-.22**	-.09	.24	.12	-.04
22 Prof. Practice	- .58***	-.22	- .53**	- .34**	-.19	.03	.12	-.11	-.11	-.34	-.34*	-.38***
23 Hours Taught	- .32***	-.11	- .16^{-}	- .22***	-.10	.00	-.59***	-.16*	-.63***	-.14	.09	-.09*
24 Salary Base	1.86***	1.86***	2.97***	1.09***	1.68***	.71	.95***	.20	3.08***	.42	1.66***	1.33***
27 Birth×No. Art.	- .08**	-.09^{-}	- .13**	- .01	.02	.00	-.04	-.20***	-.05	-.09	-.04	.02
29 Birth×No.Child.	- .10*	-.24*	- .03	.10	-.07	.09	-.06	.04	-.02	.22*	-.09	-.03
30 Sex×Mar.×Age	- .14	.10	.19	.03	.19	- .28	-.21	.07	-.11	.42*	-.29	.16*
31 Part-time	-1.24***	-.97^{-}	- .46	-1.19**	-1.64*	.48	-1.89***	-1.44***	-1.77***	-1.12*	-.35	-.60**
No. Observations	941	254	368	468	241	204	602	553	499	189	500	883
No. Variables	26	26	26	26	26	26	26	26	26	26	26	26
Res'l d.f.	914	227	341	441	214	177	575	526	472	162	473	856
Multiple R-Squared	.66	.63	.65	.53	.56	.48	.72	.59	.67	.54	.58	.61
Res'l Mean Square	7.54	5.86	6.56	5.05	6.45	5.33	6.29	2.94	7.04	6.33	8.77	4.60
Mean Opp.Sex Res'l	1.56	-.58	2.26	-1.44	.23	-1.45	2.13	-.26	2.97	-1.59	2.54	-.13
S.D. Opp.Sex Res'l	2.86	2.49	3.01	2.72	2.81	2.64	3.07	2.13	3.42	3.18	3.21	2.54

Table 2 (cont.). COEFFICIENTS OF THE MULTILINEAR REGRESSION EQUATION FOR PREDICTING FACULTY SALARIES (IN $1,000) IN COMPREHENSIVE UNIVERSITIES AND COLLEGES I AND II

Field:	Bio/Phys Sci.		Education		Fine Arts		Humanities		Soc. Sci.	
Predictors Sex:	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Constant	11.08	5.59	18.55	6.75	16.58	8.74	18.71	10.63	21.04	7.57
2 Date of Birth	-.14	.02	-.30	.15	-.26	.30-	.01	.03	-.19	.21
3 Marital Status	.36	.42	.78	-.14	.72	-1.43-	.22	.25	1.12	-.44
4 No. of Child.	.06	-1.24	-.29	.45	-.49	-.62	1.81***	-.60	1.62*	-.74
5 Highest Degree	1.94***	1.26*	1.71***	2.21***	1.93**	.72-	.99**	1.55***	1.63**	1.50***
6 Year of Degree	-.22-	-.10	-.38**	-.08	-.25	-.13	-.40**	-.06	-.49*	-.16
7 BA Prestigious	-.43	.17	1.06	.63	1.10	.68	.25	.74-	-.08	-.35
8 Graduate Prest.	.61-	-.52	-.40	.50	.61	-.24	.06	.06	1.40*	.72
9 Support	.37	-.38	.24	.09	-.22	.16	.60**	.03	-.10	.15
11 Years Academe	.08	-.28	.36-	.28*	.45	.58*	-.00	.18	-.29	.24
12 Years Present	-.10	.63*	-.28	.11	-.05	.02	.38**	.44**	-.01	.36-
13 Qual. Present	-.75***	-.10	-.41**	-.41***	-.66**	-.17	-.35*	-.23*	-.70***	-.39*
14 No. Articles	1.57***	1.83***	.22	1.25***	-.08	.44	.15	1.01***	-.06	2.41***
15 No. Books	.75**	.30	.61-	.84**	.65-	2.04***	1.12***	.31	1.15**	.28
16 Assoc.Research	1.21*	1.54	-.89-	-.20	-.75	-.30	.06	-.89	-.18	.08
17 No. Research	-.47*	.54	.24	-.57	.38	1.79***	-.43	-.09	.25	.30
18 No. Consulting	.59*	-.66	.32	.25	.05	.54	.40	-.09	.37	-.12
19 Research/Teach	-.30	-.28	-.01	-.17	.02	.24	-.11	-.12	-.31	-.00
20 Administrative	.55***	1.13***	.29*	.22*	.70***	-.23	.00	.35**	.43*	.67***
21 Consulting	-.13	-.49	-.08	-.01	-.17	-.35*	-.50*	.14	.27	-.25
22 Prof. Practice	-.08	-.09	-.42-	-.28-	-.05	-.21	-.13	-.34-	-.29	-.25
23 Hours Taught	-.19-	-.28	-.23-	-.12	.13	-.15	-.68***	-.35**	-.57*	-.11
24 Salary Base	2.39***	2.03*	1.43**	1.51***	-.61	1.72***	.33	1.10***	.96	.54
27 BirthxNo. Art.	-.22***	-.19-	-.02	-.22**	.03	-.10	-.01	-.19***	.01	-.36***
29 BirthxNo.Child.	.03	.21	.07	-.13	.13	.05	-.26***	.10	-.26*	.14
30 SexxMar.xAge	-.31	.03	-.02	.07	-.39	.41*	-.07	-.01	-.01	.07
31 Part-time	-1.65**	-1.89*	-.76	-1.11*	-1.25	-2.56***	-1.80**	-1.75**	-1.20	-.99
No. Observations	253	124	194	303	123	153	238	347	177	139
No. Variables	26	26	26	26	26	26	26	26	26	26
Res'l d.f.	226	97	167	276	96	126	211	320	150	112
Multiple R-Squared	.75	.72	.65	.65	.61	.67	.69	.66	.64	.77
Res'l Mean Square	5.18	7.34	6.44	4.93	7.57	4.27	5.85	4.71	9.40	5.07
Mean Opp.Sex Res'l	.22	.43	1.36	-.28	1.98	1.31	.64	-.29	1.21	-.39
S.D. Opp.Sex Res'l	2.92	3.00	2.67	2.54	3.25	4.07	2.92	2.74	3.74	3.04

Table 2 (cont.). COEFFICIENTS OF THE MULTILINEAR REGRESSION EQUATION FOR PREDICTING FACULTY SALARIES (IN $1,000) IN LIBERAL ARTS COLLEGES I

Field:	Bio/Phys Sci.		Education		Fine Arts		Humanities		Soc. Sci.	
Predictors Sex:	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Constant	.35	6.17	10.13	4.78	11.89	11.01	19.81	15.43	8.04	13.03
2 Date of Birth	-.33	-.03	-1.22	.00	-.14	-.21	.06	-.13	.02	-.21
3 Marital Status	.62	-.40	4.02	-.33	-.34	-.55	1.25	-.19	1.55	-1.54-
4 No. of Child.	-.38	-.05	.23	-.53	.47	-.66	1.25**	.41	-.05	-1.45-
5 Highest Degree	.65	1.87***	-.44	.90*	.43	.12	.98**	.91***	.17	.36
6 Year of Degree	.52**	.11	.43	-.04	-.16	.13	-.61***	-.14	-.17	.20
7 BA Prestigious	-.07	-.80	3.12*	1.59**	1.74-	.81	.13	-.13	-.14	.26
8 Graduate Prest.	-.20	-.12	.58	.34	1.12	.40	.63-	-.21	.39	.45
9 Support	.42	.30	.76	.53*	.30	.06	-.11	.34-	.06	.52
11 Years Academe	.80***	.18	.20	.42*	.11	.23	.20	.60***	.69-	.07
12 Years Present	-.01	.56*	.04	-.26	.55	.05	.16	-.10	-.50	.00
13 Qual. Present	-.75**	-.48	-.54	.00	.40	-.46	-.81**	-.81***	-.60	-.70-
14 No. Articles	1.65***	.07	-1.00	.44	1.37-	.42	.28	.83***	.93-	.97-
15 No. Books	.18	1.27*	-.82	-.19	1.45*	.21	.83***	.02	.95*	.87
16 Assoc.Research	-1.16	-1.38	-2.56	1.46	-2.29	1.03	-1.47-	-.96	.40	-.42
17 No. Research	-.03	-.25	2.34	-.77	1.23*	-.15	-.07	.15	.54	-.01
18 No. Consulting	.70*	2.22***	-1.23-	.38	-.21	.43	.28	1.20*	-.02	.37
19 Research/Teach	-.19	.33	.04	.54	.49	-.17	-.17	.21	.71-	.07
20 Administrative	.15	.63**	-.20	.59***	-.32	.62*	.58***	.60***	.76**	.44-
21 Consulting	.24	-.17	.79	-.02	.21	-.21	-.17	-.34*	.01	-.14
22 Prof. Practice	.48-	-.99*	-.86	-.04	.69-	-.02	-.31	-.02	-.40	.30
23 Hours Taught	-.33**	.11	-.42	-.24*	-.63**	-.27	-.10	-.16	-.35	-.14
24 Salary Base	1.39**	-1.04*	3.06*	-.37	-1.48-	-.57	.55-	.58*	.65	-1.22*
27 BirthxNo. Art.	-.21***	-.02	.35	.00	-.28*	.04	-.02	-.12*	-.09	-.15
29 BirthxNo.Child.	.06	-.06	-.08	.06	-.16	.00	-.17*	-.06	.09	.19
30 SexxMar.xAge	.29	.17	.06	.17	.52	.15	-.16	-.26-	-.17	.26
31 Part-time	-.61	-.88	-.76	-1.76**	-.03	-2.02*	-.18	-1.65***	-1.59-	-1.82**
No. Observations	156	140	47	108	54	93	221	292	127	81
No. Variables	26	26	26	26	26	26	26	26	26	26
Res'l d.f.	129	113	20	81	27	66	194	265	100	54
Multiple R-Squared	.76	.75	.82	.75	.86	.67	.77	.69	.58	.78
Res'l Mean Square	3.82	4.86	5.18	2.44	3.55	4.35	4.65	4.13	7.81	2.25
Mean Opp. Sex Res'l	1.67	-1.68	2.17	-.67	1.97	-3.47	.23	.10	3.04	-.09
S.D. Opp. Sex Res'l	2.86	3.08	3.03	3.94	3.03	3.39	2.46	2.57	3.34	2.20

Table 2 (concl.). COEFFICIENTS OF THE MULTILINEAR REGRESSION EQUATION FOR PREDICTING FACULTY SALARIES (IN $1,000) IN LIBERAL ARTS COLLEGES II AND TWO-YEAR COLLEGES

Field:	Bio/Phys Sci.		Education		Fine Arts		Humanities		Soc. Sci.		New Professions	
Predictors Sex:	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Constant	-.90	5.37	9.56	2.80	-.79	3.83	-3.74	1.22	8.61	-4.49	17.41	-1.03
2 Date of Birth	-.11	.03	.30	.04	-.02	.43**	.33	.12	-.01	-.11	.36	-.09
3 Marital Status	.07	.20	1.44	-.06	-.80	-1.12	-.23	-.24	.15	.25	-2.85	-.04
4 No. of Child.	.54	3.03***	.56	.21	1.23	-.57	1.23**	.35	-.35	.03	.91	-.43
5 Highest Degree	.85*	.83	1.20	.08	1.88*	1.42**	.94**	1.04***	1.46*	.30	2.69**	.84*
6 Year of Degree	.15	-.02	-.20	-.03	.15	-.12	-.03	-.01	-.37	.43*	-.27	.03
7 BA prestigious	.58	1.37	.17	1.30*	-1.18	.13	.49	1.00**	-.57	-.36	-.50	1.09*
8 Graduate Prest.	.40	-.41	-.37	-.04	.19	-.44	.68	.52*	-.66	.26	-.248	.07
9 Support	.11	-.51	-.17	.74**	-.02	-.30	.05	.35*	.97*	.22	-.71	.27
11 Years Academe	.63***	.41	.69*	.29	.12	.30	.43*	.36**	.63	.45	.31	-.04
12 Years Present	-.09	-.26	-.55	-.04	.31	.32	.18	.11	-.17	.19	-.12	.27
13 Qual. Present	.41	.16	.38	1.08***	1.20*	.03	.59*	.49**	.95*	.61	-1.32	1.35***
14 No. Articles	-.24	.96*	-.28	.15	-.81	.76	.06	.17	1.19	.22	4.36	-.03
15 No. Books	.25	-.96	1.06*	-.33	.04	.18	.71*	.23	-.21	-.16	-1.28	.18
16 Assoc. Research	.17	-.31	-.65	-1.11	-1.32	-.56	1.36	.46	-1.59	1.27	2.77	-.53
17 No. Research	-.18	-.18	-1.46	-.56	1.59	.16	.45	.03	-.27	2.03*	.40	1.37*
18 No. Consulting	.19	2.01**	.45	.29	-.46	-.22	.52	.46	.40	.52	.36	-.36
19 Research/Teach	.33	-.27	-.31	.41	.34	.48	.28	.23	.12	.19	-.31	-.31
20 Administrative	.46***	.29	-.18	.06	.39	.26	.35*	.21*	.66*	.24	.19	.35**
21 Consulting	-.35	-.25	-.35	-.20	-.35	-.19	.13	-.11	-.57	.02	-1.59	-.07
22 Prof. Practice	-.52**	-.79*	-.02	-.36*	-.23	-.05	-.31	-.18	.03	-.65*	-.71	-.21
23 Hours Taught	-.07	.19	-.07	-.09	-.27	-.10	-.06	-.04	-.11	-.53*	.15	.02
24 Salary Base	.51	.13	1.08	.14	1.05	.13	-.17	-.05	1.34	.23	1.39	.52
27 Birth×No. Art.	.09	-.02	.04	.10	.27	-.19	.00	-.02	-.20	.05	-.53	.03
29 Birth×No.Child.	-.04	-.47***	-.11	-.17	-.13	.08	-.19*	-.08	.04	-.14	-.06	-.02
30 Sex×Mar.×Age	.26	-.20	-.17	.17	.21	.45*	.30	.09	.08	.27	.36	.29
31 Part-time	-.40	-.27	-1.88*	-.29	-.96	-.58	-1.37*	-1.38***	-.83	-1.60	-1.29	-.34
No. Observations	250	180	88	207	93	139	241	469	112	124	47	223
No. Variables	26	26	26	26	26	26	26	26	26	26	26	26
Res'l d.f.	223	153	61	180	66	112	214	442	85	97	20	196
Multiple R-Squared	.46	.36	.52	.32	.43	.48	.45	.39	.63	.48	.73	.42
Res'l Mean Sqyare	4.72	7.22	5.37	6.02	7.02	3.94	5.94	4.64	7.61	8.01	7.81	4.62
Mean Opp.Sex Res'l	-.06	-1.34	2.61	-.42	3.32	-1.99	1.39	-1.61	2.35	-1.65	2.61	-2.96
S.D. Opp.Sex Res'l	3.00	3.10	2.68	3.00	2.83	2.38	2.45	2.28	3.33	3.46	3.83	4.03

TABLE 3. CODED VALUES OF THE PREDICTOR VARIABLES FOR "TYPICAL" FACULTY MEMBER

Multipliers in the multilinear regression equation for predicting salaries.

Use corresponding number in parentheses for women. For predictor No. 6 (year of highest degree) in Biol/Physical Science, use 17 for faculty aged 40 years, use 15 for faculty aged 50 years.

	Type =	Research Univ. I		Res. Univ.II, Doc. - Grant. Univ. I, II		Comp. Coll., Univ. I, II		Lib. Arts Coll. I		Lib. Arts Coll. II, 2-Yr. Coll.	
	Age =	40	50	40	50	40	50	40	50	40	50
Predictors											
	Constant	1	1	1	1	1	1	1	1	1	1
2	Date of Birth	6	4	6	4	6	4	6	4	6	4
3	Marital Status	2	2	2	2	2	2	2	2	2	2
4	No. of Child.	3	3	3	3	3	3	3	3	3	3
5	Highest Degree	2	2	2	2	2	2	2	2	2	2
6	Yr. of Degree	18	16	18	16	18	16	18	16	18	16
7	BA Prestigious	1	1	1	1	1	1	1	1	1	1
8	Graduate Prest.	1	1	1	1	1	1	1	1	1	1
9	Support	1	1	1	1	1	1	1	1	1	1
11	Years Academe	4	6	4	6	4	6	4	6	4	6
12	Years Present	2	2	2	2	2	2	2	2	2	2
13	Qual. Present	1	1	3	3	2	2	1	1	3	3
14	No. Articles	4	5	2	2	1	1	4	4	1	1
15	No. Books	1	2	1	1	1	1	1	1	1	1
16	Assoc.Research	1	1	2	2	2	2	1	1	2	2
17	No. Research	1	1	0	0	0	0	1	1	0	0
18	No.Consulting	0	0	0	0	0	0	0	0	0	0
19	Research/Teach	2	2	3	3	4	4	2	2	4	4
20	Administrative	2	2	2	2	2	2	2	2	2	2
21	Consulting	2	2	2	2	2	2	2	2	2	2
22	Prof.Practice	1	1	1	1	1	1	1	1	1	1
23	Hours Taught	3	3	5	5	6	6	4	4	7	7
24	Salary Base	1	1	1	1	1	1	1	1	1	1
27	Birth×No. Art.	18	12	6	4	0	0	18	12	0	0
29	Birth×No.Child	6	4	6	4	6	4	6	4	6	4
30	Sex×Mar.×Age	4(8)	4(8)	4(8)	4(8)	4(8)	4(8)	4(8)	4(8)	4(8)	4(8)
31	Part-time/Full	1	1	1	1	1	1	1	1	1	1

are in less selective institutions.

We found that salaries are well predicted by the appropriate equation. Typical values of the multiple R^2 are above 0.6, or even 0.7, except for the last institutional type considered, a combination of Liberal Arts Colleges II and Two-year Colleges. Tests show these institutions to be somewhat heterogeneous, yet the sample sizes are too small for further subdivision. The value of R^2 tends to be smaller when the sample is small, which may be part of the reason the estimates for women often have smaller R^2 than the estimates for men in the same field and type. The standard deviation of an individual salary prediction is around $2,000 to $3,000 except for the Biological and Physical Sciences and the New Professions in the Research Universities I. Here, some men have considerably higher salaries than predicted.

3. COMPARISON OF SALARIES OF MEN AND WOMEN

Given the attributes of any individual, including sex and field and type of institution, we can use the appropriate set of coefficients shown in Table 2 with the predictor variables listed in Table 1 to estimate the corresponding faculty salary. Examples are worked out for a faculty member aged about 40 years in 1969 and for one aged about 50 years. We selected attributes which might be "typical" for these ages in the specified type of institution, making as little change

Table 4. ESTIMATED SALARY (IN $1,000) OF "TYPICAL" FACULTY MEMBER BY SEX AND AGE FOR VARIOUS FIELDS AND TYPES OF INSTITUTIONS

Note ·less than 100 residual degrees of freedom, :less than 60, ::less than 30

	Field = B/Phy.Sci.		Educ.		Fine Arts		Human.		Soc. Sci.		New Prof's	
	Age = 40	50	40	50	40	50	40	50	40	50	40	50
Type	Sex											
Research Univ. I	M	15.6	20.1	13.1	16.0	15.5	18.2	13.5	18.1	15.8	20.5	14.5	17.7
	W	12.5	16.3	12.3	14.4	9.9	12.2	11.5	13.6	12.4	14.7	12.7	15.0
Research Univ. II, Doctoral-Granting Univ.I,II	M	13.8	16.1	12.1	13.3	11.3	12.7	12.1	14.6	12.2	14.4	13.1	14.7
	W	12.6	14.0	9.7	10.4	9.3	10.7	9.7	10.4	11.2	12.1	11.2	12.1
Comp.Univ. and Coll. I and II	M	11.0	11.9	12.4	14.3	12.5·	14.2·	11.8	13.1	13.3	14.6	-	-
	W	7.8·	7.0·	12.8	13.5	10.3	11.1	10.3	10.5	9.8	9.9	-	-
Liberal Arts Coll. I	M	12.6	15.0	23.6::	23.7::	15.4::	18.2::	14.5	16.4	12.1	14.2	-	-
	W	9.6	10.1	10.3·	11.1·	11.2·	11.6·	10.9	13.5	9.6:	10.3:	-	-
Lib. Arts Coll. II, 2-Yr.Coll.	M	12.1	13.4	12.8·	14.2·	11.0·	11.2·	13.0	13.6	10.5·	12.4·	12.6::	13.2::
	W	13.2	15.0	10.9	11.8	9.3	9.1	11.7	12.3	9.2·	9.8·	9.9	10.0

as possible in the individual. First, these attributes were coded using Table 1 (see Bayer [7] for more details) with the results as listed in Table 3. Once the values of the predictor variables were fixed, each was multiplied by the appropriate coefficient in Table 2. The sum of these cross-products is the estimated salary for the individual, as shown in Table 4. When the sample used to estimate the coefficients was small, the resulting estimated salary is less reliable; these cases are marked by colons.

In almost every category, the predicted salary for men is larger than that for women. The differentials tend to be larger in the Research Universities I; indeed, whenever the predicted salary for men is large, the salary differential between men and women tends to be large. Also, the increase in salary from age 40 to age 50 is much less for women than for men, almost without exception. We see that women who have exactly the same attributes as men, that is, the attributes shown in Table 3, tend to be paid a much lower annual salary. The striking differential persists at other age levels and with any reasonable choice of attributes, tending to be more pronounced for older women. Recalling the very good fit of the multilinear regression equations to the actual salary, as evidenced by the high R^2, we must conclude that there is sex discrimination in faculty salaries and that it is especially strong in Research Universities I and for older women.

Our study of salary differences between men and women is retrospective, utilizing salaries and prediction equations of faculty actually employed in 1969. Whatever discrimination there may be that prevents the employment of women as faculty is not observed in the Carnegie Survey. We have no information on those who are highly qualified, as judged by our predictor variables, but were not employed as faculty in 1969. Further, as pointed out by Astin and Bayer [3], for those who were employed, we utilize the observed value of the predictor variables. If there has been any discrimination against women that affects the predictor variables, such as discrimination in graduate school that

makes it more difficult for women to obtain the doctorate, these effects are not taken into account. We presume that there is some such discrimination against women, at least in some of the predictor variables. Hence our estimated salary differentials, showing women receiving less than men, have probably been underestimated.

4. COMPARISONS OF ACTUAL SALARY WITH THAT PREDICTED FROM THE EQUATION FOR THE OPPOSITE SEX

In the last section we compared the estimated salaries of men and women faculty who have the same specified attributes and found large salary differentials due to sex, indicating discrimination against women. It is also of interest to examine the actual salary differentials in the various fields and types of institutions. Since, as noted at the outset, men and women faculty do not have the same distribution of the attributes we used as predictor variables, the difference between the actual salary a woman receives minus the estimated salary for a man with the same attributes in the same field and type of institution is an indication of the salary discrimination against women in that field and type of institution. We study the distribution of the residual: actual salary minus the estimate from the opposite-sex equation.

This residual was computed for each individual in the sample. The last two lines of Table 2 show the mean and standard deviation of the opposite-sex residual, separately for men and women, for each combination of field and type of institution. In Biological and Physical Sciences in the Research Universities I, men are overpaid, as estimated from the women's equation, by $3,470 on the average. Further, women tend to be underpaid, as estimated from the men's equation, by $2,320 annually. For almost every combination of field by type, when judged by the multilinear regression equation for predicting salary of the opposite sex, men tend to be overpaid and women tend to be underpaid. Moreover, noting the standard deviation, we see that the mean opposite-sex residuals are significantly different for men versus women.

The distribution of these residuals is approximately normal, with the mean for men shifted to the positive, the mean for women shifted to the negative. The distributions are plotted for six cases in Figure 1. In the more selective institutions, the shift between men and women is very large, also some men have extremely large positive residuals, when their salary is compared with the prediction from the women's equation. More than 80% of the women there are underpaid as judged from predictions for men of the same attributes in the same case of field by type. Instead of finding half of the residuals above zero and half below (as happens when comparing actual salary with own-sex equation), we find that the 50% mark is at about -$2,000 and that 20% of the women are underpaid by $4,000 or more annually.

When we shift attention to less prestigious institutions, the sex differentials are smaller. Nevertheless, some differential persists. Admittedly, the determination of salary is complex and the results presented are statistical. But the differences found are entirely too large to be due to chance and reflect discrimination. Indeed, as noted above, because of the probable sex bias in the predictor variables, we are probably underestimating the bias in the salaries of women.

One might argue that any particular institution is "different" from those of its type. With a little effort, each institution can compute the residual difference between actual salary and that predicted from the coefficients in Table 2 for each member of its faculty, using first the appropriate sex equation and then the opposite-sex equation. Each institution can thus compute two residuals for each faculty member, actual salary minus prediction from own-sex equation, and actual salary minus prediction from opposite-sex equation. We have done this for each institution in the Carnegie Survey in order to check that the grouping into types was satisfactory. Our computations show that the results are not very different from one institution to another.

The Carnegie data were collected in 1969 and one might hope that salary differentials due to sex are less pronounced now. The American Council on Education repeated the faculty survey in 1972-73. The data are not yet available in detail but Bayer [8] has already published extensive summary information from the survey. It is evident that there has been

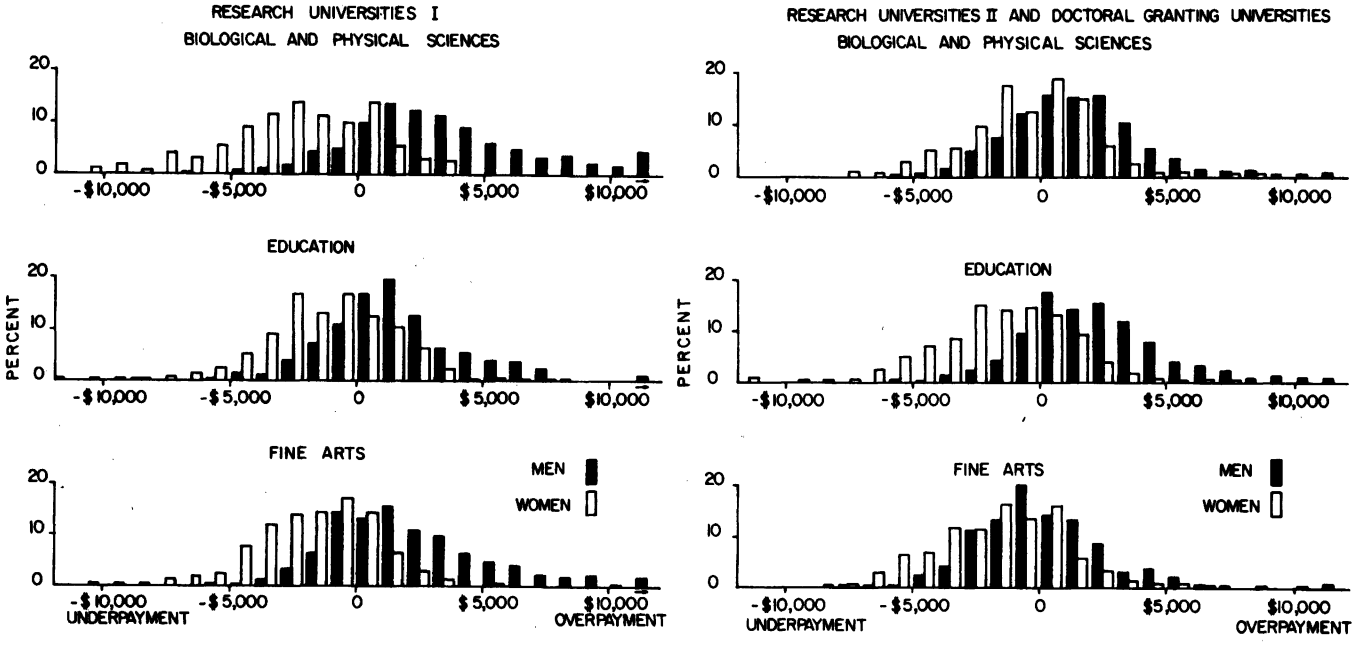

Fig. 1. Distribution of residual salary for men and women: difference between actual salary and that predicted from opposite-sex equation. Women tend to be underpaid compared with men of same ability and performance; men tend to be overpaid.

no appreciable change in the difference between the sexes.

5. DISCRIMINATION BY RACE AS WELL AS SEX

It is of interest to estimate the difference in faculty salary attributable to race as well as to sex. However, the numbers of nonwhite faculty in the Carnegie Survey are too small to allow a direct study by race, as was done for sex. But we can look at the residuals in salaries for each race separately. Do Black men tend to be underpaid when their actual salary is compared to the estimate computed from the equation for all men (and thus essentially for White men) in the same field and type of institution? Do Black women tend to be underpaid when their salary is estimated from the equation for all women in the same field and type? We can ask similar questions for Orientals and for Other races (Spanish surnames were not noted). Further, if we examine the distribution of residual salaries of Black men when their salary is estimated from the equation for all women, and similarly for other combinations of race and sex, we can determine whether race or sex is the more important in reducing salary.

For each combination of field and type of institution, we thus computed the salary residuals separately for each combination of race (White, Black, Oriental, and Other) with sex (men, women). The results are clear and consistent even with the irregularities to be expected from very small samples. There is a slight tendency for Black men to be underpaid when compared with the all men predictions; there is a slight tendency for Black women to be overpaid when compared with the all women predictions. Similar differentials appear for Orientals but more irregularly. But these differences are not significant. On the other hand, the differences due to sex persist and are strong; not only do White men tend to be overpaid as judged by the all-women prediction equations, so do Black men, so do Oriental men, and so do Other men, all by about the same mean amount. Conversely, as judged by the prediction equations for all men, women tend to be underpaid in almost every combination of field and type, no matter what race they may be.

The apparent discrimination in faculty salary due to sex is strong and persists for every race. Perhaps surprisingly, the apparent discrimination due to race is small; it is not significant. We are probably underestimating the discrimination due to race even more than we are underestimating that due to sex, considering the additional discrimination in the predictor variables such as access to graduate school or access to academe itself.

6. COMPARISON WITH OTHER STUDIES

There have been several studies of the salary differences between men and women faculty that consider the possibly different distribution of attributes and performance between the two groups. Most studies have concentrated on a single institution or a small group of universities and have restricted attention to a few departments. Insofar as their results overlap this paper; the agreement is good.

The initial results of an extensive study by Johnson and Stafford are reported [9] by Committee Z of the American Association of University Professors. The data used are taken from the 1964 and 1970 National Register collected by the National Science Foundation, so that disciplines in the humanities and professions are not included. Further, productivity is not measured. The preliminary results for five departments show percentage losses in salary of women consistent with our results; they note also that the salary differential increases sharply with increasing time from the Ph.D. They question whether the differential may in part be due to women's tendency to withdraw from the labor market during child-bearing years, something on which they do not have data. The facts are that highly educated women do not withdraw from the labor force more than men. The latest ACE survey found [8] that nearly one-fourth of all faculty had interrupted their professional careers more than one year and that, moreover, a greater percentage of men than women had done so. This is another indication that one should not try to blame salary differentials on unobserved variables.

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