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Longitudinal Analysis of Salary Discrimination in Higher Education

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Abstract

Legal and statistical issues associated with the use of multiple regression models in faculty discrimination cases in higher education are presented in this paper. Faculty salary models as a function of gender, rank, tenure status, race, academic discipline, and age variables are analyzed in a longitudinal study covering three years (1982-84) at the University of Northern Colorado (UNC). Declining student enrollment during the period saw the size of the faculty drop from a high of 492 in 1982 to a low of 380 in 1984. Results of the exploratory data analysis indicate declining roles for gender, race and age variables in explaining salary differences. While the contribution of academic discipline variables in the regression models was statistically significant, results seem consistent with institutional salary policies which were in effect at each point in time.

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Introduction

Given the increasing frequency of litigation on matters of discrimination with regard to salaries in higher education, the courts are faced with statistical evidence that support and refute claims of discrimination at an ever increasing magnitude and complexity. The claims of discrimination are made on the basis of race, gender and age factors.

Within the past ten years, multiple regression techniques have become popular in litigation on discrimination. Two recent articles support the use of multiple regression techniques in judicial studies of race and sex discrimination, (Finkelstein, 1980; Fisher, 1980). Both researchers identify several concerns which must be addressed.

Finkelstein discusses the problems associated with the use of "tainted" variables. Predictor variables specified to reflect productivity are often affected by discriminatory practice themselves. For example, when using the variables of tenure status and rank to predict salaries, discrimination might also be present in tenure and promotion decisions (Finkelstein, 1980), thus the inclusion of the "tainted" variables may serve to mask salary discrimination if it exists.

Fisher (1980) discusses the assumptions underlying multiple regression analysis and points out the problems associated with multicollinearity and the "shotgun" approach to analyze the data. Too often, the analysis is performed with an overprescription of

independent variables in an attempt to discover what may be related to the criterion variable. When many variables are included, the risk of multicollinearity is increased. As a result, the magnitude and even the sign of the coefficients in the model may be affected. Fisher warns against the "shotgun" approach. He advises the experimenter to select carefully the variables to be used and develop a rationale for inclusion which can be defended.

Recently, studies have appeared which use other statistical techniques such as canonical correlation and multiple discriminant analysis, Carter, et al. (1983). Carter applies these techniques to analyze salary equity at the University of Wisconsin at Superior for two successive years, 1981-82 and 1982-83.

The two techniques used by Carter provide an alternative to address some of the concerns expressed by Finkelstein with regard to violation of assumptions in the multiple linear regression models. Specifically, the concern about "tainted" variables can be addressed by using canonical correlation and multiple discriminant analysis. These techniques assist the experimenter in determining whether or not the variables of tenure status and rank are affected by the variables of race, age or gender. If this analysis confirms the variables in question are not "tainted", then the multiple regression model can make use of the variables to improve the fit. If, however, the analysis reveals the variables are "tainted", the regression model will exclude

those variables in the model. In addition, the very fact that the variables are discovered to be tainted is important information which may be used to resolve discriminatory practices.

All three statistical procedures, multiple regression, canonical correlation, and discriminant analysis, are used in this longitudinal study of salary practices at the University of Northern Colorado (UNC). Data on all full-time faculty members at UNC for the academic years 1982-83, 1983-84, and 1984-85 are analyzed to determine the existence of salary discrimination on the basis of race, age or sex. The items collected on each faculty member include: salary, rank, tenure status, highest degree, years employed at UNC, years in each rank, years at UNC before obtaining tenure, years with the doctorate, discipline, sex, race and age.

The longitudinal data allows for an analysis of changes in salary practices as they are affected by changes in University policies. This paper relates University policy changes which occurred during the three-year period to the changes in the existence and/or extent of discrimination in UNC salaries.

The paper is subdivided into four major sections: multiple regression analysis of salaries for the three years, canonical correlation on rank and tenure status versus qualification, experience and discrimination variables, multiple discriminant analysis to determine classifications and misclassifications with regard to rank and tenure status, and a contextual analysis which

compares the UNC policy changes to the state of salary patterns at UNC during the three-year period.

Variables included in the statistical analyses of salary discrimination at UNC for the years 1982-83 through 1984-85 are presented in Table 1. Before proceeding with the statistical analyses several precautions were taken to insure the internal validity of the study. First, patterns of discrimination among the predictor variables themselves were examined using discriminant analysis and canonical correlation techniques. That is to say, relationships between university status variables (e.g., tenure status, rank, rate of promotion) and the discrimination variables were carefully examined before they were included in the regression models as predictor variables. If university status variables are tainted they should be removed. Second, collinearity diagnostics were obtained on the predictor variables. Although our primary interest is in the use of R^2 values, interpretation of the regression coefficients themselves is also of interest. It can be shown that the presence of collinearity can affect both the sign and magnitude of the regression coefficients (Pedhazur, 1982). Detection of collinearity among the predictor variables would require us to re-think the specification of our model.

Inspection of the collinearity diagnostics from the regression procedure of the Statistical Analysis System (1982)

indicated that the variables Longevity and Years with Doctorate were the primary sources of collinearity. Inasmuch as these variables were selected to contribute unique information to the model, the preliminary analyses indicate that these variables were already adequately represented by other predictors. Our solution to the problem was to delete Longevity and Years with the Doctorate from the set of predictor variables.

In the sections that follow, results form the canonical correlation and discriminant analyses designed to detect patterns of discrimination among the set of predictor variables are reported.

Canonical Correlation Analysis

In an attempt to ferret out potential patterns of discrimination during the past three academic years at UNC, canonical correlational analytic methods were undertaken. Canonical Analysis (CA) is a method designed to study the relations between two sets of variables, a set of predictor variables and a set of criterion variables. The set of independent or predictor variables (PV) identified in this study consisted of all the discrimination variables which included gender, race, and age. On the other hand, the set of dependent or criterion variables (CV) could be classified as university status

Table 1

Variables Included in the Analysis of Salary Discrimination

Variable	Description
	Rank
V1	Assistant Professor
V2	Associate Professor
V2	Professor
	Longevity
V4	Years of Service
	Degree
V5	Master's
V6	Doctorate
	Tenure Status
V7	Yes=1, No=0
	Gender
V8	Male=1, Female=0
	Race
V9	Caucasian=1, Otherwise=0
V11	Black=1, Otherwise=0
V12	Hispanic=1, Otherwise=0 Else, Oriental, or Indian
	Time in Rank
V14	Years as Instructor
V15	Years as Assistant Professor
V16	Years as Associate Professor
V17	Years as Professor
	Time Since Receiving Doctorate
V18	Years with the Doctorate
	Time Before Receiving Tenure
V19	Years before Receiving Tenure
	Discipline
V20	School of Business=1, Otherwise=0
V21	Physical Sciences=1, Otherwise=0
V22	Social Sciences=1, Otherwise=0
V23	Humanities=1, Otherwise=0
V24	College of Performing & Visual Arts=1, Otherwise=0
V25	College of Health and Human Services=1, Otherwise=0 Else, College of Education .
V29	Age
V30	Salary

variables. These variables included tenure, academic rank, degree earned, years spent at each level, and school or college in which the faculty member was assigned. The set of discrimination or predictor variables numbered six whereas there were 17 university status or criterion variables. Thus, the maximum number of linear combinations or composites of predictor variables and criterion variables which could be tested for a significant correlation is six.

Each of the possible six canonical correlations (Canonical R) for each of the three academic year studied at UNC was tested for statistical significance by converting Wilks' Lambda to an approximate F. In Table 2 are presented the standardized weights for the set of predictors and set of criteria associated with the three significant canonical R-values using N = 492 observations of the 1982-83 study group. All three canonical R-values are significant beyond the 0.001 level and the three canonical R-values in descending order are .76, .42, and .38. The remaining three non-significant canonical R-values and corresponding standardized weights are not reported.

The results for the 1983-84 study are presented in Table 3. It should be observed that only two of the canonical R-values were statistically significant for N = 446 observations used in the

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onical Solution Using Standardized Weights for Significant Relationships for N = 492
ervations (1982-83)

dictor iables	Standardized Predictor Weights PV1	PV2	PV3	Criterion Variables	Standardized Criterion Weights CV1	CV2	CV3
ider	.32	-.19	.91	Tenure	.02	-.50	-.04
casian	.16	1.67	.43	Asst. Prof.	.29	-.10	.36
ck	.00	.59	.29	Assoc. Prof.	.45	-.20	.46
panic	.02	1.10	.54	Professor	.54	-.18	.54
ental	.03	.46	.04	Masters	-.16	3.53	-.08
	.88	-.07	-.43	Doctorate	-.18	3.69	.21
				Yrs. Instr.	.02	.03	-.31
				Yrs. Asst. Prof.	.27	.38	-.15
				Yrs. Assoc. Prof.	.36	.25	.02
				Yrs. Prof.	.62	-.00	-.43
				Business	.18	-.07	-.16
				Phys. Sci.	.06	.02	-.04
				Soc. Sci.	.09	.04	-.01
				Humanities	.10	.18	-.49
				PVA	.10	-.05	-.05
				HHS	.06	.02	-.78
				Education	.18	-.07	-.58
				Canonical R	.76*	.42*	.38***

*Wilks' Lambda Significant at 0.001 when converted to an approximate F.
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*Wilks' Lambda Significant at 0.001 when converted to an approximate F.

analysis. As is the case with Table 2 the standardized weights associated with the set of predictors and set of criteria are presented. The two significant canonical R-values are .77 and .43. Both are significant at 0.001 level.

In Table 4 results of the canonical analysis for the 1984-85 study are described for N = 380 observations. The decline in the number of observations over the three-year period is a function of declining enrollment at UNC. The first two canonical R-values (.73 and .40) are statistically significant at the 0.001 level and the corresponding standardized weights for the set of predictors and criteria are reported. The standardized weights and canonical R-values for the four non-significant relationships in 1984-85 are not presented.

Standardized canonical weights are often interpreted in a manner analogous to the interpretation of standardized regression weights in multiple linear regression. It is not surprising, therefore, to see some researchers use them as indices of the relative contribution or importance of the variables with which they are associated. Because of the multicollinearity associated

ble 3

onical Solution Using Standardized Weights for Significant Relationships for N = 446

ervations (1983-84)

dictor iables	Standardized Predictor Weights PV1	PV2	Criterion Variables	Standardized Criterion Weights CV1	CV2
der	.30	.94	Tenure	-.05	.23
casian	.19	.15	Asst. Prof.	.36	.96
ack	-.02	.32	Assoc. Prof.	.65	.98
spanic	.07	.41	Professor	.82	1.03
iental	.09	-.05	Masters	-.04	-.21
e	.90	-.37	Doctorate	-.12	-.05
			Yrs. Instr.	.04	-.37
			Yrs. Asst. Prof.	.27	-.40
			Yrs. Assoc. Prof.	.28	.00
			Yrs. Prof.	.64	-.43
			Business	.18	-.26
			Phys. Sci.	.03	-.05
			Soc. Sci.	.11	-.07
			Humanities	.11	-.39
			PVA	.09	-.12
			HHS	.08	-.71
			Education	.15	-.50
			Canonical R	.77*	.43**

*Wilks' Lambda Significant at 0.001 when converted to an approximate F.
**Wilks' Lambda Significant at 0.001 when converted to an approximate F.

Table 4

Canonical Solution Using Standardized Weights for Significant Relationships for N = 38(Observations (1984-85)

Predictor Variables	Standardized Predictor Weights PV1	PV2	Criterion Variables	Standardized Criterion Weights CV1	CV2
Gender	.25	.94	Tenure	-.06.	.46
Caucasian	.18	-.08	Asst. Prof.	.39	.55
Black	-.06	.15	Assoc. Prof.	.68	.30
Hispanic	.05	.27	Professor	.73	.49
Oriental	.07	-.16	Masters	-.21	-.72
Age	.92	-.28	Doctorate	-.30	-.51
			Yrs. Instr.	.11	-.50
			Yrs. Asst. Prof.	.26	-.42
			Yrs. Assoc. Prof.	.36	.03
			Yrs. Prof.	.80	-.53
			Business	.09	-.12
			Phys. Sci.	.03	.04
			Soc. Sci.	.08	.05
			Humanities	.04	-.29
			PVA	.03	.02
			HHS	-.02	-.54
			Education	.10	-.38
			Canonical R	.73*	.40**

*Wilks' Lambda Significant at 0.001 when converted to an approximate F.
**Wilks' Lambda Significant at 0.001 when converted to an approximate F.

with the set of predictors as well as the set of criteria, the standardized canonical weights suffer from the same shortcomings as those of standardized regression coefficients. Not only the signs but the magnitude of the weights can be misleading. These limitations appeared with the results presented in Tables 2, 3, and 4. For these reasons, the investigators used structure coefficients for the purpose of interpreting and explaining the results of CA. For a further discussion of this point, see Cooley & Lohnes (1976); Thorndike & Weiss (1973).

In Tables 5, 6, and 7 are presented the corresponding structure coefficients or loadings associated with the significant canonical correlations found in the three-year study at UNC. A structure coefficient or loading in CA is the correlation of a specific variable and a canonical variate. For example, in Table 5, we see that the age variable correlates .94 with the first predictor variate (PV1). In other words, the square of .94 changed to a percent indicates that 88.36% of the variance in the linear composite of the predicator variables (discrimination variables) can be explained by the age variable.

A rule of thumb is suggested by Pedhazur (1982) that structure coefficients $\geq$ .30 be considered as meaningful or useful in explaining significant canonical correlations. In Table

Table 5

Structure Loadings for Significant Canonical Correlations for N = 492 Observations (

Predictor Variables	Structure Loadings Predictor Variables PV1	PV2	PV3	Criterion Variables	Structure Criterion Var CV1	Loa CV2
Gender	.44	-.30	.81	Tenure	.65	-.10
Caucasian	.20	.59	-.11	Asst. Prof.	-.52	.08
Black	-.03	.03	.08	Assoc. Prof.	-.12	.04
Hispanic	-.12	.05	.28	Professor	.71	-.07
Oriental	-.03	-.30	-.08	Masters	-.31	.10
Age	.94	.01	-.28	Doctorate	.33	.11
				Yrs. Instr.	-.08	-.08
				Yrs. Asst. Prof.	.28	.23
				Yrs. Assoc. Prof.	.69	.09
				Yrs. Prof.	.78	-.07
				Business	-.11	-.09
				Phys. Sci.	.16	.05
				Soc. Sci.	-.00	.07
				Humanities	-.00	.07
				PVA	-.00	-.11
				HHS	-.21	.08
				Education	.07	-.05

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ucture Loadings for Significant Canonical Correlations for N = 446 Observations (1983-84)

dictor iables	Structure Loadings Predictor Variables PV1	PV2	Criterion Variables	Structure Loadings Criterion Variables CV1	CV2
der	.41	.84	Tenure	.53	.00
casian	.17	-.18	Asst. Prof.	-.43	-.00
ck	-.05	.10	Assoc. Prof.	-.09	.05
panic	-.12	.26	Professor	.57	.02
ental	-.00	-.06	Masters	-.26	-.15
	.93	-.25	Doctorate	.27	.15
			Yrs. Instr.	-.05	-.19
			Yrs. Asst. Prof.	.22	-.11
			Yrs. Assoc. Prof.	.46	.04
			Yrs. Prof.	.61	-.00
			Business	-.13	.00
			Phys. Sci.	.11	.09
			Soc. Sci.	.04	.13
			Humanities	-.01	-.06
			PVA	-.01	.08
			HHS	-.10	-.25
			Education	.05	-.05

Table 7

Structure Loadings for Significant Canonical Correlations for N = 380 Observations (19

Predictor Variables	Structure Loadings Predictor Variables PV1	PV2	Criterion Variables	Structure Loadir Criterion Variat CV1	C
Gender	.35	.87	Tenure	.64	
Caucasian	.20	-.24	Asst. Prof.	-.59	-
Black	-.06	.06	Assoc. Prof.	-.14	-
Hispanic	-.14	.29	Professor	.69	
Oriental	-.02	-.07	Masters	-.19	-
Age	.94	-.19	Doctorate	.19	
			Yrs. Instr.	-.06	-
			Yrs. Asst. Prof.	.13	-
			Yrs. Assoc. Prof.	.41	
			Yrs. Prof.	.59	
			Business	-.14	
			Phys. Sci.	.14	
			Soc. Sci.	.04	
			Humanities	-.01	-
			PVA	-.05	
			HHS	-.14	-
			Education	.05	-

ble 8

ful Structure Coefficients (Loadings) in Explaining Relationships between Significantly related Canonical Variates[1]

Discrimination Variables	1982-83 (N = 492) PV1	PV2	PV3	1983-84 (N = 446) PV1	PV2	1984 (N = 380) PV1	PV2
nder	*+	*-	*+	*+	*+	*+	*+
ucasian		*+					
lack							
spanic							
ientai		*-					
ge	*+			*+		*+	

University Status Variables	1982-83 (N = 492) CV1	CV2	CV3	1983-84 (N = 446) CV1	CV2	1984 (N = 380) CV1	CV2
enure	*+			*+		*+	
sst. Prof.	*-			*-		*-	
ssoc. Prof.							
rofessor	*+			*+		*+	
asters	*-		*-				
octorate	*+		*+				
rs. Instr.			*-				
rs. Asst. Prof.							
rs. Assoc. Prof.	*+			*+		*+	
rs. Prof.	*+			*+		*+	
usiness							
hys. Sci							
oc. Sci.			*+				
umanities							
/A							
HS			*-				
ducation							
anonical R	.76	.42	.38	.77	.43	.73	.40

[1]Structure coefficients $\geq$ .30 were considered as meaningful (Pehhazur's criterion). A "*+" represents a positive coefficient $\geq$ .30 and a "*-" refers to a negative structure loading $\geq$ .30.

8 the structure coefficients which are $\geq$ .30 are starred as positive or negative depending on the sign of the structure coefficient. The purpose of this table is to present the results for the three consecutive years at UNC in such a way that the significant canonical R-values might be interpreted in terms of the set of predictors and the set of criteria.

In reviewing the starred variables in Table 8 it can be seen that the linear combination of predictor variables in the first canonical R for each of the three years has a positive structure loading on gender and age. Thus, PV1 might be conceptualized as a factor representing older males. If we focus on the corresponding set of university status variables (CV1) for the three years we see positive loadings on tenure, professor, years associate professor, years full professor and a negative loading on assistant professor. For 1982-83 only we see a negative loading on masters and a positive loading on doctorate. The loadings on the criterion variate for all three years suggest that CV1 reflects the factor of an experienced professional--one with tenure, higher academic rank, and more experience at the associate or full professor level. It is interesting to note that degree status (criterion set) seems unrelated to age and gender (predictor set) in the last two years of study. As one

investigates the pattern that relates the predictor variate with the criterion variate in the second canonical R and in the case of 1982-83 the third canonical R, the picture becomes less clear. In 1982-83, the positive and negative loadings in PV2 suggest a factor of female Caucasian in the predictor variate whereas no significant loading was detected in the criterion variable set (CV1). From a discrimination claims point of view this might be interpreted as a positive finding. The discrimination factor in PV2 (female Caucasian) seems related to university status factor variables in no systematic way. Similarly, the PV2 seems to be a gender factor for both 1983-84 and 1984-85 but is unrelated to any university status variable in CV2 for both years. In 1982-83 a third significant canonical R was found. PV3 in this year seems to reflect a gender factor and this factor seems to show that males tended to have the doctorate, were not instructors, were social science faculty and not HHS faculty members. This gender university status pattern for 1982-83 did not show up in subsequent analyses for both 1983-84 and 1984-85 and should be considered another positive finding from a discrimination claims point of view. Finally, it should be observed that race as a discrimination variable did not exhibit a high loading in each of the three years. Race seems unrelated to the linear composite of university-status variables.

In Table 9 are presented the percent of the variance in the linear composite of the university-status variables (criterion

Table 9

Percent of Variance in Set of University Status Variables Linear Composite Explained by Discrimination Variables[1]

Discrimination Variables	1982-83 (N = 492) CV1	CV2	CV3	1983-84 (N = 446) CV1	CV2	1984-1985 CV1	C
Gender	11.36	13.10	22.83	10.41	23.55	6.74	19
Caucasian	2.39	8.95	9.13	1.79	2.45	2.22	3
Black	0.06	0.08	0.18	0.19	0.38	0.25	0
Hispanic	0.95	1.01	2.17	0.97	2.25	1.17	2
Oriental	0.09	1.78	1.88	0.00	0.08	0.04	0
Age	51.74	51.75	52.94	52.45	53.65	48.66	49
Canonical R	.76	.42	.38	.77	.43	.73	

[1]Only criterion variable linear composites are presented which are associated with canonical R-values which are significant beyond the 0.001 level.

variate) that can be explained by each of the six discrimination (predictor) variables for the significant canonical R-values found. Results in this table seem to confirm that age was the dominant variable over the three years--it explained about 50% of the variance in each of the criterion variates. Gender appeared to be a much less significant factor as the percent of variance for each criterion variate explained ranged from about 7% to a high of 24%. Race as a factor was not significant as the percent of variance of the criterion variate it was able to explain ranged from a low of 0% to a high of 9%.

In summary, the results of CA seem positive from the issue of discrimination claims in higher education. While the older-male relationship with the professional-experience factor was detected in the three-year analysis, the relationship has historical roots and is less pronounced today. No other gender or race factors were found to be linked in any systematic way to any university-status factors.

Discriminant Analysis

To investigate further the possibility of discrimination patterns in tenure and promotion decisions, a statistical technique known as discriminant analysis (DA) was applied to data for the academic years 1982-83, 1983-84 and 1984-85. The DA

method analyzes one variable such as tenure status by comparing it with a group of variables called independent variables or predictors. Since the tenure status variable is a binary variable, DA determines a set of weights which maximizes the criterion for group membership, called the discriminant function. This function serves as the basis for attempts to "classify" each faculty member into one of the two original groupings, tenured or nontenured. Two linear combinations of the independent variables are formed to "characterize" group membership.

After the linear combinations are determined, the values of the predictors for each individual are used to calculate discriminant scores which will indicate which of the two groups the individual's profile most closely resemble. This measure is given by posterior probabilities of group membership. After the analysis is completed for all individuals, those observations which are misclassified can be analyzed for inequities or other irregularities.

For the three academic years of interest, DA was conducted using the five variables tenure status, professor rank, associate professor, assistant professor, and instructor as the criterion variables individually. The predictors were age, gender, race, highest degree, years in rank, and discipline. Tables 10 through 12 present the linear discriminant function for each criterion variable and the resulting classifications and misclassifications for the three years.

Table 10

Discriminant Function (1982-83)

	Criteria Variable									
	Tenure		Professor		Associate		Assistant		Instructor	
Predictors	0	1	0	1	0	1	0	1	0	1
Constant	-311.99	-320.77	-313.52	-320.55	-313.56	-313.96	-315.04	-313.09	-320.36	-304.05
Doctorate	62.64	69.01	62.52	63.93	62.25	64.99	63.50	61.21	68.87	58.13
Gender	9.41	10.06	9.43	9.82	9.37	9.55	9.42	9.33	10.50	8.66
Caucasian	33.16	29.49	33.37	33.44	33.38	32.22	32.44	34.19	33.51	33.25
Black	30.93	26.91	31.12	30.98	31.16	30.13	30.12	32.07	31.72	30.77
Hispanic	32.07	27.86	32.31	32.43	32.31	31.46	31.33	33.17	33.71	31.39
Oriental	37.38	36.95	37.63	39.16	37.16	35.74	35.56	38.17	38.38	38.78
Yrs.Instr.	.40	.85	.39	.46	.37	.45	.44	.31	.48	.31
Master	-.33	.32	62.83	61.67	62.96	65.53	63.44	62.60	67.18	60.35
Yrs.Asst.	-1.26	-.63	-.38	-.44	-.37	-.31	-.44	-.30	-.02	-.59
Yrs. Assoc.	-.46	-.24	-1.24	-.90	-1.30	-1.00	-.91	-1.65	-1.24	-1.34
Yrs. Prof	494.66	493.76	-.37	.32	-.46	-.83	-.42	-.52	-.52	-.44
Business	491.53	492.14	494.90	496.21	494.72	494.02	494.64	494.76	495.27	494.35
Phys. Sci.	493.54	494.35	491.82	493.91	491.52	490.54	491.82	491.21	491.13	491.74
Soc.Sci.	496.05	497.16	493.49	493.45	493.50	493.23	493.21	493.76	493.72	493.36
Humanities	63.23	67.62	496.07	496.58	495.99	495.93	496.02	495.96	496.65	495.58
PVA	493.92	494.91	494.09	495.57	493.87	493.39	493.91	493.82	494.99	493.15
HHS	496.53	496.58	496.74	498.09	496.56	494.93	495.99	497.83	496.17	496.76
Education	492.88	493.01	493.03	494.02	492.89	492.85	492.85	493.09	493.10	492.73
Age	.88	.93	.89	.92	.88	.90	.89	.87	.96	.83

Discriminant Function (1983-84)

Criterion Variable

	Tenure		Professor		Associate		Assistant		Instructor	
Predictors	0	1	0	1	0	1	0	1	0	1
Constant	-428.52	-436.40	-431.07	-443.23	-430.27	-435.56	-436.00	-428.38	-439.13	-418.89
Doctorate	227.82	225.97	228.46	230.37	228.24	230.51	227.24	227.64	240.55	221.68
Gender	5.67	6.57	5.96	6.44	5.81	5.99	5.32	5.76	8.44	4.52
Caucasian	153.16	155.11	153.97	155.41	153.99	156.46	159.22	153.37	150.98	154.44
Black	149.88	151.09	149.40	147.99	150.81	153.92	153.29	150.02	150.04	149.99
Hispanic	152.39	155.77	153.20	154.33	153.44	156.23	157.96	152.74	152.27	152.93
Oriental	147.91	153.57	149.91	153.29	149.44	153.19	158.08	148.50	145.66	149.75
Yrs.Instr.	-.31	.52	-.24	-.27	-.18	0.00	.04	-.23	-.28	-.20
Master	226.30	222.13	225.68	225.17	226.28	227.77	223.55	225.88	235.62	221.40
Yrs.Asst.	-.18	.61	-.10	-.12	-.09	-.07	-.27	-.10	.37	-.32
Yrs. Assoc.	-1.54	-.67	-1.35	-1.10	-1.33	-.86	-.56	-1.45	-1.42	-1.47
Yrs. Prof	-.54	-.20	-.12	.77	-.63	-1.09	-.36	-.51	-.60	-.47
Business	451.57	451.05	452.55	454.96	451.15	449.72	451.52	451.52	451.61	451.48
Phys. Sci.	445.88	446.83	447.28	450.34	445.60	444.17	446.09	445.98	445.23	446.32
Soc.Sci.	445.90	447.34	446.73	448.34	445.74	444.62	445.72	446.04	446.25	445.94
Humanities	454.85	454.89	455.68	457.61	454.50	453.12	453.79	454.85	456.66	454.03
PVA	449.49	451.57	450.82	453.45	449.58	449.14	450.39	449.69	452.01	448.62
HHS	453.42	453.78	454.68	457.53	452.82	450.36	452.44	453.45	453.33	453.52
Education	445.71	446.51	446.83	449.26	445.44	444.88	445.69	445.79	446.39	445.51
Age	.82	.85	.84	.90	.83	.85	.86	.82	.92	.78

Table 12

Discriminant Function (1984-85)

	Criterion Variable									
	Tenure		Professor		Associate		Assistant		Instructor	
Predictors	0	1	0	1	0	1	0	1	0	1
Constant	-366.12	-372.00	-368.21	-379.68	-367.77	-373.13	-379.33	-366.58	-369.82	-360.54
Doctorate	404.68	399.18	404.08	406.22	403.92	406.66	410.25	405.02	404.73	398.67
Gender	10.21	11.38	10.74	11.49	10.46	10.34	10.69	10.53	10.99	8.75
Caucasian	195.52	200.25	197.14	198.60	197.17	199.71	204.31	198.50	195.97	198.98
Black	190.90	196.38	193.25	196.32	192.43	193.51	198.55	193.74	191.95	193.10
Hispanic	195.23	201.73	197.11	198.10	197.32	199.96	203.63	198.43	196.54	197.63
Oriental	186.68	194.59	189.58	192.57	189.41	193.49	201.28	191.63	187.92	190.84
Yrs.Instr.	-1.07	-.28	-.89	-.91	-.85	-.68	-.39	-.76	-1.05	-.29
Master	402.94	395.57	401.16	401.13	401.55	403.40	404.57	401.99	401.48	400.11
Yrs.Asst.	.31	.98	.46	.45	.46	.41	.18	.40	.65	-.15
Yrs. Assoc.	-1.64	-.88	-1.39	-1.18	-1.36	-.89	-.27	-1.17	-1.43	-1.54
Yrs. Prof	-.87	-.48	-.44	.55	-.88	-1.39	-.50	-.71	-.82	-.62
Business	94.33	93.57	95.16	98.14	93.66	91.27	93.26	93.93	93.99	94.71
Phys. Sci.	93.58	94.54	95.32	99.78	93.26	90.57	93.66	93.76	94.22	92.40
Soc.Sci.	93.83	95.04	94.98	97.53	93.71	91.69	92.92	93.83	94.47	92.92
Humanities	111.50	111.47	112.44	115.24	111.05	108.86	109.61	111.04	112.52	107.98
PVA	100.22	102.36	101.87	105.22	100.42	98.91	100.69	100.72	101.98	96.45
HHS	101.81	102.10	103.06	106.58	101.11	97.37	98.96	101.17	101.67	102.60
Education	94.34	95.16	95.63	98.86	94.05	91.69	93.32	94.24	95.07	92.69
Age	.88	.88	.88	.88	.89	.94	.93	.90	.93	.74

Table 13

Classifications

82-83

TENURE

		TO 0	TO 1	T
FROM	0	100	6	106
	1	40	346	386
	T	140	352	492

PROF

		TO 0	TO 1	T
FROM	0	269	8	277
	1	22	193	215
	T	291	201	492

ASSOC

		TO 0	TO 1	T
FROM	0	254	84	338
	1	25	129	154
	T	279	213	492

ASST

		TO 0	TO 1	T
FROM	0	314	74	388
	1	3	101	104
	T	317	175	492

INSTR

		TO 0	TO 1	T
FROM	0	426	47	473
	1	1	18	19
	T	427	65	492

83-84

TENURE

		TO 0	TO 1	T
FROM	0	95	3	98
	1	21	327	348
	T	116	330	446

PROF

		TO 0	TO 1	T
FROM	0	252	1	253
	1	19	174	193
	T	271	175	446

ASSOC

		TO 0	TO 1	T
FROM	0	262	42	304
	1	21	121	142
	T	283	163	446

ASST

		TO 0	TO 1	T
FROM	0	295	50	351
	1	1	94	95
	T	296	150	446

INSTR

		TO 0	TO 1	T
FROM	0	398	32	430
	1	0	16	16
	T	398	48	446

84-85

TENURE

		TO 0	TO 1	T
FROM	0	70	2	7
	1	26	282	30
	T	96	284	38

PROF

		TO 0	TO 1	
FROM	0	208	0	2
	1	19	153	1
	T	227	153	

ASSOC

		TO 0	TO 1
FROM	0	228	28
	1	12	112
	T	240	140

ASST

		TO 0	TO 1
FROM	0	273	29
	1	1	77
	T	274	106

INSTR

		TO 0	TO 1
FROM	0	356	18
	1	0	6
	T	356	24

0 - indicates individual does not belong to class
1 - indicates individual does belong to class

FROM - is ACTUAL STATUS
TO - is PREDICTED STATUS

Table 14

R^2 Values for Full and Restricted Models for 1982-83 through 1984-85

	Academic Year		
Model	1982-83	1983-84	1984-85
Full Model (FM)	.8630 A	.8691 A	.9006 A
FM - Discrimination Set	.8510 B	.8616 B	.8990 A
FM - Gender	.8580 B	.8651 B	.8995 A
FM - Race	.8626 A	.8680 A	.9002 A
FM - Age	.8480 B	.8659 B	.9005 A

Note: R^2 values in a column with the same letter as the full model are not significantly different from each other. All P's $\leq$ .01.

As seen in the above tables, the number of misclassifications in all five analyses decrease from 1982-83 to 1984-85. Several policy changes within the institution provide possible explanations for this pattern. These relationships will be discussed in the section entitled Contextual Analysis.

Upon examination of the individual cases identified by DA as misclassified, the majority were explained by rational, nondiscriminatory factors or by historical factors due to evolving standards at UNC. For example, in the year 1984-85, UNC has 72 faculty members who are not tenured. The DA method indicates two of these individuals possess values for the predictors which more closely resemble the individuals who are tenured.

The first faculty member is a male who has a special seven year agreement with the Board of Trustees in lieu of tenure. The second faculty member is a male who is hired annually on state grant money through the Colorado State Vocational Education Program. Even though he has excellent credentials, he is on soft money and is therefore not tenured.

The majority of the 26 faculty members who are tenured but more closely resemble the nontenured group are faculty members who do not possess the doctorate. These faculty members were tenured in the period from 1965-1975 when the availability of qualified

faculty and the standards for obtaining tenure were quite different from the period since 1975.

Similar analyses were performed for the misclassifications for each rank. Few individual cases were identified which required further attention. In no instance was there any pattern of cases which would indicate systemic discrimination by the University on the basis of gender, age or race.

For 1984-85, the ranks of associate professor and assistant professor had a number of misclassifications from 0 to 1 (See Table 13). Upon further study, most of the misclassifications of this nature were situations in which a faculty member possessed a higher rank than the DA method predicted for the individual. The DA method consistently misclassified such individuals in all ranks for each year. These individuals had been promoted prior to 1976 when standards for promotion began to change at the institution.

This technique is an excellent tool for identifying general patterns as well as individual faculty members who may have been treated differentially. Certainly this method cannot be treated in isolation; however, it provides additional information to the institution in an attempt to correct whatever inequities which may exist. Both the canonical correlation and discriminant analyses show the variables of tenure status and rank are not "tainted" with respect to the discrimintation variables. Therefore, the variables of tenure status and rank may be used in the multiple regression analysis of salaries to improve the overall predictive efficiency.

Multiple Regression Analysis

Multiple regression (MR) analyses were performed to examine the relationship between salaries of full-time faculty and a set of discrimination variables, i.e., gender, race and age, for the years 1982-83 through 1984-85. Predictor vectors were coded for the MR analyses to reflect an individual's gender, race, age, qualifications, academic discipline, rank, tenure status, years spent in each rank and years before receiving tenure. Justification for including variables related to a faculty member's status within the institution was provided by the results of the canonical correlation analysis. Recall that there was no relationship between the academic status variables and the discrimination variables of gender and race. That is to say, no evidence was found that rank, tenure status, time in rank and time before receiving tenure were the result of discriminatory practices.

For each of the three years under consideration, salaries were regressed on the variables listed in Table 1 (the full model). Subsequently, salaries were regressed on a model containing all of the variables in the full model except for the set of discrimination variables: gender, race and age (the restricted model). Differences in R^2 values for the full and restricted models were tested by means of the F-distribution (Pedhazur, 1982). If the set of discrimination variables was found to account for a significant proportion of variance in

salaries, the variables were examined one at a time to identify the specific source(s) of discrimination. Diagnostics were also performed to determine if the collinearity assumption had been violated. R^2 values of the full and restricted models for each of the three years are presented in Table 14.

Results of the MR analyses for the 1982-83 year show that the full model accounted for 86% of the variance in faculty salaries, $F(22,469) = 133.93$, $p < .01$, while the restricted model accounted for 85% of the variability in salaries, $F(17,474) = 159.42$, $p < .01$. Although the difference in R^2 values for the two models was small, it was statistically significant, $F(5,469) = 8.21$, $p < .01$. Further analyses of the 1982-83 data found that gender, $F(1,469) = 17.11$, $p < .01$ and age, $F(1,469) = 51.35$, $p < .01$, accounted for a significant proportion of the variance in faculty salaries. There was a tendency for males to earn higher salaries than females and the relationship between age and salary was found to be positive. No evidence of discrimination on the basis of race was detected by the analysis, $F(3,469) < 1$.

A pattern similar to that found in 1982-83 emerged from the 1983-84 salary data. The squared multiple correlation coefficient for the full model was .87, $F(22,423) = 127.61$, $p < .01$, while the R^2 value of the restricted model was .86, $F(17,428) = 156.79$, $p < .01$. Again deleting the set of discrimination variables from the full model produced a statistically significant decrease in R^2, $F(5,423) = 4.83$, $p < .01$. Subsequent analyses show once again that

gender and age accounted for a significant proportion of the variance in salaries, $F(1,423) = 12.90$, $p < .01$; $F(1,423) = 10.32$, $p < .01$, respectively. The increment in the proportion of variance in salaries attributable to race was not significant, $F(3,423) = 1.18$.

Implementation of the new University salary model for 1984-85 virtually eliminated discrimination in salaries on the basis of gender, race or age. For the full model $R^2 = .90$ while the restricted model resulted in an $R^2 = .89$. The difference in R^2 values for the full and restricted models was not statistically significant, $F(5,357) = 1.14$, $p < .05$.

In summary, evidence was found that males earned higher salaries than females from 1982-83 to 1983-84; however, the difference between male and female salaries was eliminated after the implementation of a new salary model. There was also a tendency for older faculty members to earn higher salaries than younger faculty members during the same period. Similarly, the relationship between age and salary was eliminated in 1984-85. There was no evidence of salary discrimination on the basis of race during any of the three years under consideration.

Contextual Analysis

Before discussing the results, a brief history of UNC is required in order to understand the context within which the results occurred. UNC is a former normal school which was founded in 1889. The institution evolved from the normal school to a teacher's college (1935), to a state college (1957), to a

university (1970) as have many other similar institutions in the country. However, UNC differed in one significant aspect. During the 1920-1940 period, UNC embarked on a unique path of offering many graduate programs particularly at the doctoral level. Instead of developing the programs from a solid base of bachelor degree programs to a broadly based masters degree program to the doctoral level, UNC jumped immediately to the doctoral level. This lack of breadth eventually caused serious problems of enrollment and quality of doctoral work in the late 1970's.

To further compound problems, the institution engaged in the practice of hiring its own graduates, particularly in the late 1950's and 1960's. These faculty members were tenured and promoted rapidly under standards which were less rigorous than those that exist now at UNC. Tenure was nearly automatic after three years of service and promotions were granted every four years. Thus a faculty member would normally become a tenured full professor after eight years of service. Many did not possess the credentials which would justify a similar rank or status at another institution of higher education. Thus the faculty member was "trapped" at UNC unless the faculty member was willing to take a lower rank at a different institution. All these factors resulted in an older faculty that was not mobile in the market place.

In addition, enrollment began to decline in 1977 and with one exception continued to decline in the 1980's. The institution's

enrollment has fallen from a peak of 11,770 in 1977-78 to 8,800 in 1984-85.

All these factors have led to numerous policy changes which are important to place the analysis in context. Prior to 1982-83, tenure and promotion decisions were made by a process which called for departmental recommendations to be passed to the council of deans who made a strong recommendation rarely overturned by the vice president or president. Little was known of the criteria or method of decision used by deans. Beginning in 1982-83, the council of deans was replaced by a committee of faculty members and the criteria for tenure and promotion were more stringent and clearly defined. This change was the final step in a movement towards higher tenure and promotion standards initiated in the late 1970's.

As a result, obtaining tenure and/or promotion is considerably more difficult now than at any time before. In fact there are numerous instances in which faculty members possess a rank for which they would no longer be qualified under the new policies. These tougher standards which have been used for faculty members hired since 1976 cause numerous misclassifications in the DA analysis presented in the previous section.

With the enrollment decline came the need to reduce staff, faculty and the budget. In 1982, the decline culminated in a major reduction in force which led to the termination of 47 faculty members, 38 of whom were tenured. From 1977-78 to

1984-85, the University lost 155 faculty positions or 24% of the faculty positions it employed in 1977-78. The faculty in 1984-85 is considerably younger than its counterpart which existed in 1982-83.

In 1983-84, the institution initiated an early retirement plan to encourage faculty members to retire. Forty-two (42) faculty members accepted the offer and retired at the conclusion of the 1983-84 academic year.

These two events, the reduction in force and the early retirement plan, help explain the dramatic improvement in the results of both the regression analysis and the discriminant analysis classification analysis over the three-year period. UNC lost approximately 90 of its older faculty members during this period and was able to hire a significant number of new faculty members. Thus a substantial change in the demographics of the remaining faculty has occurred. The improving pattern of rank and tenure classifications is to be expected as fewer faculty members who were tenured or promoted under past policies are employed at UNC.

Finally, in an effort to improve the salaries of its faculty and to correct individual inequities, UNC developed a new faculty salary model which was implemented for the 1984-85 year. This new model called for a survey of 29 peer institutions to be selected on the basis of similar role, mission, programs, enrollment and budget to that of UNC. At the same time the institution developed

a comprehensive evaluation system which was used to help determine salaries. Therefore, a faculty member's salary was determined by the rank, discipline, time in rank and the evaluation rating for the previous year.

This new salary model led to a substantial redistribution of salary dollars among the faculty. No salary was reduced; however, a number of faculty members had their salary frozen. In contrast, a number of faculty members received salary raises of between $6,000-$9,000 or an increase of 20% to 30%.

Any faculty member who received an unsatisfactory evaluation received no salary raise. There were approximately 20% of the faculty who fell into this category for 1984-85 salary determinations. Thus the salary patterns which had existed in 1982-83 and 1983-84 changed dramatically for 1984-85. The purpose for the change was two-fold as mentioned above: (a) to improve salaries of the faculty at UNC relative to peer institutions and (b) to base salary decisions on rational factors such as qualifications and evaluations rather than historical factors or inconsistent policies of the past.

The results of the regression analysis clearly demonstrate the success of the new salary model in neutralizing the gender factor in salaries. The effects of the reduction in force effective in 1983 and the early retirement plans effective in 1984 are clearly seen in the analysis of the age factor over the three years. These factors combined with the new salary model have

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produced a salary structure which has no indication of age dependency.

The race factor was not significant in any of the three years analyzed in this study. UNC has undergone significant changes both externally imposed and internally imposed. The statistical techniques used to assess the status of salaries and tenure and promotion decisions confirm the changes have improved the consistency of these decisions. When analyzed within the context of evolving institutional policies, these statistical tools can provide valuable insight into the status of decisions made with regard to salaries, tenure or promotion.

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