

Salary Equity Study
Office of Institutional Research and Effectiveness
August 3, 2007

INTRODUCTION

As part of the ongoing Advance grant program, Virginia Tech conducts salary equity studies on a regular basis to determine sources of variation in faculty salaries. This year's equity study, conducted by the Office of Institutional Research and Effectiveness, analyzed salary data from June 2007. In light of a recent report written by the taskforce on race and the institution, considerable attention was paid to race/ethnicity as a factor in explaining variation in salaries. As in the past, the analysis was completed using the Paychecks¹ methodology of using multiple regression techniques in which factors that are expected to affect pay are analyzed for their ability to explain variation in salaries. This report is a summary of findings of this study of factors affecting differences in faculty salary for tenured and tenure-track instructional faculty at Virginia Tech.

The report proceeds with an explanation of the variables considered in the analysis, a description of the population involved in the study, a summary of the models generated in the analysis, an interpretation of the results, and some known short-comings of the report dealing with data quality issues.

FACTORS

In the Paychecks methodology, several variables are identified as likely predictors of faculty salary. Other, more difficult to measure, factors that are likely to have a substantial amount of influence on salary differences, such as individual job performance, are omitted from the analysis. However, given the large sample size, differences in these other factors are likely to average out and thus, the following subset of factors was considered: gender, minority status, academic unit, academic rank category, time in rank (the length of time the faculty member held that particular rank), tenure status, US citizenship status, time at Virginia Tech (length of time since the faculty member's most recent hire date), and experience prior to joining VT (calculated as the length of time between the date a faculty member was awarded his/her highest degree and that faculty member's most recent hire date at Virginia Tech). These factors were used to build a model for predicting academic year (nine-month) salary.

¹ Haignere, L. 2002. Paychecks: A guide to Conducting Salary-Equity Studies for Higher Education Faculty. Washington, D.C.: American Association of University Professors.

POPULATION

One thousand three hundred forty-seven tenured and tenure-track instructional faculty, including those on research appointments, were included in the analysis. Faculty members were classified into one of four academic rank categories (assistant professor, associate professor, professor, Eminent Scholars). Nearly all Eminent Scholars held the rank of full professor. A few faculty members holding the Eminent Scholars designation had not yet been promoted to full professor, so there may be some minimal amount of noise in these data.

There was little change in the male/female distribution of faculty members from the 2005 study. In the 2007 study 24.4% of the population were female and 75.6% were male (Table 1). This compares with 23.7% female and 76.3% male in 2005. Likewise, the distribution of the study population over academic rank changed little since 2005, but there was a slight increase in junior faculty. Roughly 22.6% of the population held the rank of assistant professor; 34.7% were associate professors; and 33.9% were categorized as professors, with another 8.8% of faculty falling into the Eminent Scholars category. The distribution for 2005 was 20.5% assistant professors, 35.6% associate professors, 34.8% professors and 9.1% Eminent Scholars. While 48.7% of the men in the population were considered either professors or Eminent Scholars, only 24.0% of the women in the population fell into these categories.

Slightly less than three-quarters of the population had been awarded tenure at Virginia Tech with the remaining members of the population considered non-tenured, tenure-track faculty (Table 1). Seventy-eight percent of the men and 61% of the women in the population had been awarded tenure. These data reflect the increase in junior faculty mentioned above.

Nearly 80% of the 2007 population was white compared to 81% of the 2005 population (Table 1). This was consistent for men and women. Asian-Americans accounted for 9.5% of the population; African-Americans comprised 3%; and non-resident aliens accounted for 5%.² The remaining 2% of faculty were of other ethnicities. Roughly 85% of the 2007 population held US citizenship while nearly 90% of the 2005 population held US citizenship.

Distribution across faculty ranks appeared to vary a bit by race/ethnicity (Table 2). While no discernable pattern seemed to emerge for faculty from minority populations, the larger proportions of minority hires who were hired at the assistant professor level within the last three years compared to the corresponding figures for Caucasian faculty suggest that recent recruitment efforts may be succeeding at increasing the diversity of Virginia Tech faculty.

² Asian-Americans and African-Americans may include people who are resident aliens as well as those who hold US citizenship.

As in the earlier studies, women in the 2007 study, on average, had earned their highest degrees more recently than the men in the study (Table 3). The average length of time since earning their highest degrees for the female faculty was 13 years. For the male faculty, the average was 20 years. Not surprisingly, then, the average length of time at Virginia Tech was longer for men (16 years) than for women (10 years).

At the lower academic ranks, male and female faculty members have similar patterns in terms of time in rank (Table 4). Thirty-one percent of female assistant professors have spent 3 or more years as assistant professors compared with 35% of male assistant professors. At the associate professor level, 64% of female associate professors having spent 3 or more years at this rank compared to 70% of male associate professors. The major differences occur at the professor rank. A moderately larger portion of the female professors have been awarded the rank of professor within the last 6 years (43%) than male professors. Only 32% of male professors have been awarded the rank of professor within the last 6 years.

The average salary for the 1347 faculty members in the study was \$88,041. At first glance, salaries for female faculty members appeared to lag behind those for male faculty members in the same academic rank and with the same amount of time in rank (Table 5). However, these summary statistics do not take into account differences in academic unit.³ It is the purpose of this study to determine if there is *systemic* gender bias in salaries at Virginia Tech, and thus the data were further analyzed.

³ For example, the Electrical Engineering faculty would most likely earn higher salaries than the English faculty regardless of the gender composition of either faculty.

Table 1. Basic demographics of the study's population compared with the 2005 study population

	All				Women				Men			
	Number in Population		Percentage of Population		Women in Population		Percentage of Women		Men in Population		Percentage of Men	
	2007	2005	2007	2005	2007	2005	2007	2005	2007	2005	2007	2005
Gender												
Men	1018	996	75.6	76.3								
Women	329	310	24.4	23.7								
Total	1347	1306	100.0	100.0								
Academic Rank												
Assistant Professor	304	268	22.6	20.5	118	107	35.9	34.5	186	161	18.3	16.2
Associate Professor	468	465	34.7	35.6	132	129	40.1	41.6	336	336	33.0	33.7
Professor	457	454	33.9	34.8	72	66	21.9	21.3	385	389	37.8	39.0
Eminent Scholars	118	119	8.8	9.1	7	8	2.1	2.6	111	110	10.9	11.1
Total	1347	1306	100.0	100.0	329	310	100.0	100.0	1018	996	100.0	100.0
Tenure Status												
Non-tenured, tenure-track	353	301	26.2	23.0	128	113	38.9	36.5	225	188	22.1	18.9
Tenured	994	1005	73.8	77.0	201	197	61.1	63.5	793	808	77.9	81.1
Total	1347	1306	100.0	100.0	329	310	100.0	100.0	1018	996	100.0	100.0
Ethnicity												
White	1072	1053	79.6	80.6	262	250	79.6	80.6	810	803	79.6	80.6
Asian-American	128	111	9.5	8.5	19	15	5.8	4.8	109	96	10.7	9.6
African-American	44	44	3.3	3.4	18	17	5.5	5.5	26	27	2.6	2.7
Non-Resident Alien	70	68	5.2	5.2	22	20	6.7	6.5	48	48	4.7	4.8
Other	33	30	2.4	2.3	8	8	2.4	2.6	25	22	2.4	2.2
Total	1347	1306	100.0	100.0	329	310	100.0	100.0	1018	996	100.0	100.0
Citizenship Status												
US Citizen	1149	1145	85.3	87.7	279	277	84.8	89.4	870	868	85.5	87.1
Non-US Citizen	198	161	14.7	12.3	50	33	15.2	10.6	148	128	14.5	12.9
Total	1347	1306	100.0	100.0	329	310	100.0	100.0	1018	996	100.0	100.0

Table 2. Distribution of faculty rank by race/ethnicity

Rank	Time in Rank	American Indian/ Alaskan Native	Asian/Pacific Islander	Black	Caucasian	Hispanic
Assistant Professor	< 3 yrs	.	43	12	140	7
	3-6 yrs	.	16	4	63	7
	> 6 yrs	.	1	1	9	1
	Rank total	0	60	17	212	15
Associate Professor	< 3 yrs	1	21	7	117	4
	3-6 yrs	3	11	3	63	1
	> 6 yrs	1	11	9	211	5
	Rank total	5	43	19	391	10
Full Professor	< 3 yrs	1	12	4	70	.
	3-6 yrs	.	8	1	59	.
	> 6 yrs	.	15	3	279	5
	Rank total	1	35	8	408	5
Eminent Scholar	< 3 yrs	.	2	.	10	.
	3-6 yrs	.	1	.	8	.
	> 6 yrs	.	16	2	78	1
	Rank total	0	19	2	96	1
All		6	157	46	1107	31

Table 3. Descriptive measures for experiential variables by gender.

	Women				Men			
	Number ^a		Average number of years		Number ^a		Average number of years	
	2007	2005	2007	2005	2007	2005	2007	2005
Time since Earning Highest Degree	321	266	13.3	13.2	1004	971	20.0	19.9
Time at VT	329	266	10.4	10.6	1018	972	15.9	15.8

^aNumber of observations used in calculation of mean; degree data were missing for some faculty members

Table 4. Distribution of rank and time in rank by gender

Rank	Time in Rank	Women		Men	
		Number*	Percentage**	Number*	Percentage**
Assistant Professor	Less than 3 years	81	69%	121	65%
	At least 3 years, but less than 6 years	31	26%	59	32%
	6 years or more	6	5%	6	3%
	Total	118	100%	186	100%
Associate Professor	Less than 3 years	48	36%	102	30%
	At least 3 years, but less than 6 years	26	20%	55	16%
	6 years or more	58	44%	179	53%
	Total	132	100%	336	100%
Professor	Less than 3 years	20	28%	67	17%
	At least 3 years, but less than 6 years	11	15%	57	15%
	6 years or more	41	57%	261	68%
	Total	72	100%	384	100%
Eminent Scholars	Less than 3 years			12	11%
	At least 3 years, but less than 6 years	1	14%	8	7%
	6 years or more	6	86%	91	82%
	Total	7	100%	111	100%

* Number in population

** Percentage of the total number of faculty members of the designated gender within the designated rank

Table 5. Average salaries by rank, time in rank, and gender

Rank	Time in Rank	Women		Men	
		Number*	Average Salary**	Number*	Average Salary**
Assistant Professor	Less than 3 years	81	\$65,407	121	\$66,169
	At least 3 years, but less than 6 years	31	\$65,886	59	\$71,629
	6 years or more	6	\$64,499	6	\$66,245
	Total	118	\$65,487	186	\$67,903
Associate Professor	Less than 3 years	48	\$73,789	102	\$79,090
	At least 3 years, but less than 6 years	26	\$79,500	55	\$82,013
	6 years or more	58	\$75,495	179	\$78,160
	Total	132	\$75,664	336	\$79,073
Professor	Less than 3 years	20	\$96,562	67	\$101,052
	At least 3 years, but less than 6 years	11	\$89,295	57	\$97,025
	6 years or more	41	\$92,925	261	\$98,658
	Total	72	\$93,380	385	\$98,833
Eminent Scholars	Less than 3 years	0		12	\$156,093
	At least 3 years, but less than 6 years	1	\$149,250	8	\$140,041
	6 years or more	6	\$115,766	91	\$143,584
	Total	7	\$120,550	111	\$144,681

* Number in population

** Average *academic year* salary of faculty members of the designated gender within the designated rank

THE ANALYSIS

In standard salary equity study methodology, developing multiple models for predicting salaries is recommended.⁴ If the models produce similar results with respect to which variables have significant effects on salaries, then a certain measure of validity is afforded all of the models. In that vein, multiple models were developed for the Virginia Tech data. However, this discussion is focused on two particular models that were developed. The first model was developed using multiple regression to analyze the effects of academic unit, academic rank, gender, tenure status, US citizenship, ethnicity, time in rank, time at Virginia Tech, and experience prior to joining VT on

⁴ Haignere, L. 2002. *Paychecks: A guide to Conducting Salary-Equity Studies for Higher Education Faculty*. Washington, D.C.: American Association of University Professors. P. 43.

academic year salary. The second model also used multiple regression, but the factors of academic rank and time in rank were removed from the analysis.

Model 1 – Full Model

As outlined in the Paychecks methodology, a multiple regression model was developed with academic year salary as the predicted value (i.e., outcome variable). Academic unit was included in the model as a set of dummy or indicator variables with the statistics department being the “reference” unit or the academic unit to which all other academic units are compared. Ethnicity was also included as a set of 4 dummy variables with “white” being the reference ethnicity. Academic rank was indicated using 3 dummy variables; the rank of Eminent Scholar was the reference rank. Time in rank comprised 2 dummy variables with “less than 3 years” being the reference time in rank. Binary variables included gender (reference gender was male), tenure status (reference status was tenured), and US citizenship (reference citizenship was US). Using the SAS statistics package, a regression model was generated and the program's output is provided in appendix A. Nearly 80% of the variation in salaries was accounted for by the factors in the model (adjusted $R^2 = 0.78$). Factors that were significant in explaining the variation in salaries included academic unit ($p < 0.0001$), academic rank ($p < 0.0001$), time at VT ($p < 0.0262$), and experience prior to joining VT ($p < 0.0001$). Gender was *not* significant in explaining differences in salaries.

There were very few surprises in terms of the type of effect (positive or negative) that each of the significant factors had on salary. Time at Virginia Tech and experience prior to joining Virginia Tech, both had positive effects on salary. As expected, holding the rank of full professor, associate professor, or assistant professor had a negative effect on salary relative to the rank of Eminent Scholar. The magnitudes of the beta estimates increased as rank decreased suggesting that on average, assistant professors earn less than associate professors; associate professors earn less than professors; and, professors earn less than eminent scholars. Academic departments in the colleges of engineering and business tended to have positive beta estimates indicating that on average, those departments have higher salaries than statistics.

In brief, several variations of this model were developed. Based on previous years' work, a model (Model 1a) was developed rescaling the salaries using a logarithmic transformation of the academic year salary. This model produced results similar to those obtained using Model 1; eighty percent of the variation in transformed salary was explained by the model, compared to 78% of the variation in untransformed salary being explained by Model 1. Academic unit, academic rank and experience prior to VT were highly significant factors in the transformed

model ($p < 0.0001$ for each factor). Time at Virginia Tech was also fairly significant with a p-value of 0.0617.

A model that included quadratic terms for the experience prior to joining Virginia Tech factor and the time at Virginia Tech factor was developed to accommodate a possible non-linear relationship between experience and salary (Model 1b). The amount of variation explained by the model was only a minor increase over the amount of variation explained by the basic model (79% v 78%) even though the squares of time at Virginia Tech and experience prior to Virginia Tech produced significant effects ($p < 0.0001$ and $p = 0.0359$ respectively). Interestingly, this model also resulted in significant effects from tenure status ($p = 0.0008$) and years in rank (0.0018) as well as the variables that were significant in Model 1: academic unit ($p < 0.0001$), academic rank ($p < 0.0001$), time at VT ($p < 0.0001$) and experience prior to joining VT ($p = 0.0011$).

In addition, a model allowing for some interaction between the academic rank factor and the time in rank factor was developed (Model 1c). This model was developed because it was perceived that it was likely professors and Eminent Scholars who had been in rank for more than 6 years would receive larger and more frequent salary increases than assistant or associate professors who had been in rank for more than 6 years. Unlike previous years, the interaction effect was not significant. However, the pattern of significance of all other effects in the model was identical to the original model.

Once the R-squared measure was adjusted for the inclusion of additional variables, the amount of variation in salaries explained by each of these models was essentially the same as the amount of variation explained by the original model. Factors that were significant in the original model were also significant in the subsequent models. Therefore, the simpler, original model was considered appropriate for predicting 9-month/academic year salaries.

To confirm the lack of significance of ethnicity in the models, one additional model was developed with only the ethnicity dummy variables as independent variables. In this case, the amount of variation was less than 3% so it was determined that race/ethnicity was not a meaningful contributor to variation in salaries.

Model 2 – Reduced Model

While conducting a salary equity study at the Ann Arbor campus, investigators at the University of Michigan considered a set of factors similar to those used in the original Model 1 with a few variables regarding the types of appointments the various faculty members held and the relative

marketability of various fields of study. This model also differed from another model developed at the University of Michigan by omitting academic rank and time in rank as factors that might explain variation in salaries. If there is some difference in how women and men are assigned to an academic rank or if there is some difference in how quickly men and women are promoted to higher ranks, then the inclusion of the academic rank and time in rank factors might be masking part of the effect of gender in the model. While the additional factors used in the University of Michigan model were not added to this analysis, academic rank and time in rank were removed from Model 1 and the resulting model is called Model 2.

Again, multiple regression techniques were used to develop a model that predicts academic year salary. Once again, academic unit was included in the model as a set of dummy or indicator variables with the statistics department being the “reference” unit or the academic unit to which all other academic units are compared. Ethnicity was also included as a set of 4 dummy variables with “white” being the reference ethnicity. Binary variables included gender (reference gender was male), tenure status (reference status was tenured), and US citizenship (reference citizenship was US). As with Model 1, the SAS statistics package was used to generate a regression model and the program’s output is provided in appendix B.

Using the reduced list of factors, only 60% of the variation in salaries was accounted for by the factors in the model (adjusted $R^2 = 0.57$). Factors that were significant in explaining the variation in salaries included academic unit ($p < 0.0001$), time at VT ($p < 0.0001$), experience prior to joining VT ($p < 0.0001$), and tenure status ($p < 0.0001$). In this model ethnicity might be considered to have a significant effect on salaries as well ($p = 0.0810$). Again, gender was *not* significant in explaining differences in salaries.

Again, the model yielded few surprises in terms of the type of effect (positive or negative) that each of the significant factors had on salary. Time at Virginia Tech and experience prior to joining Virginia Tech, both had positive effects on salary. Not yet having earned tenure had a negative effect on salary. Academic unit had a significant effect on salary with the direction and magnitude of the effect being determined by how far above or below the average Statistics (the reference academic unit) salary the academic unit’s average salary fell. All but one of the engineering departments (Department of Engineering Education) had positive beta estimates and most had positive significant effects on salary relative to the statistics department. Having an ethnicity of Asian American⁵ had a positive effect on salary ($p = 0.0407$) as did having an “ethnicity” of non-resident alien ($p = 0.0869$). This is not surprising; 71% of Asian Americans in the population and

⁵ Including Resident Aliens

56% of non-resident aliens in the population are faculty members in one of the three colleges with the highest average salaries.

DATA QUALITY ISSUES

The time in rank factor was converted to a categorical variable with three possible levels: less than 3 years, at least 3 years but less than 6 years, and 6 or more years. This was due to the loss of data that occurred with the conversion from the IMS computer system to the Banner data management system. When a faculty member has a change in rank, the date of that change is recorded in the Banner system. However, during the conversion to Banner, changes in ranks that occurred prior to January 1, 1997, were recorded as January 1, 1997. Therefore, a person who achieved professor rank in 1996 fell into the same category as a person who achieved professor rank in 1986. Clearly information contained within these data was lost.

In addition, some academic units were not included in the analysis as individual academic units. Small academic units were either combined with other similar academic units or removed entirely from the analysis.

SUMMARY

Both models explained much of the variation in faculty salaries with adjusted R^2 values of 0.78 and 0.57. According to the Paychecks methodology, "most analyses of faculty salaries have adjusted R^2 values greater than .50, and values above .70 are common."⁶ Although Model 2 explained considerably less variation than Model 1, the model achieved an R^2 value over 0.50, and was considered adequate, at least as a starting point for the investigation. Importantly, gender effects on faculty salaries did not reach statistical significance despite several different statistical approaches to test gender as an individual effect and in interaction with other key factors like rank.

Women's compensation continues to appear to be less the issue at this juncture than female representation in tenure-track ranks. Progress is necessarily slow as the university is not seeking large-scale turnover among the faculty. However, it is important to note that the percentage of women in tenure-track or tenured positions has increased. Women have constituted about 21.5% of all full-time tenure-track/tenured faculty positions five years ago compared to 24.5% in fall 2006 with small increases each year over the previous year. As in previous studies, the challenge seems to be that women are still underrepresented in traditionally male dominated disciplines.

⁶ Haignere, L. 2002. Paychecks: A guide to Conducting Salary-Equity Studies for Higher Education Faculty. Washington, D.C.: American Association of University Professors. P. 6.

For example, in the college of engineering, only 12.5% of all full-time tenure-track/tenured faculty positions are held by women while 44.5% of the positions in the college of liberal arts and human sciences are held by women. Again, it should be noted that the figures show slight improvements over the last five years.

While women seem to be doing well at achieving parity with their male colleagues in pay, progress will continue to be slow in improving numbers of female faculty given the limited hiring opportunities that the college faces each year. As encouraging as current findings may be, they do suggest that the college should make efforts to ensure that parity in salary must now be combined with parity in opportunity.

Finally, race/ethnicity did not appear to contribute to explaining salary differences. In addition, the ethnic distribution of faculty at the assistant professor level is considerably more diverse than senior faculty. If the university is successful at retaining these recently hired faculty members, then over time, the senior ranks will become more diverse as well.

Appendix A. SAS output for Model 1

Analysis for Untransformed AY Salary values
 All time variables entered as linear components
 Jun-07

The GLM Procedure

Class Level Information

Class	Levels	Values
DEPT	75	Accounting & Information Systems Aerospace and Ocean Engineering Agricultural & Applied Economics Agricultural & Extension Educati Alson H. Smith, Jr. AREC Animal and Poultry Sciences Apparel, Housing & Resource Mgt Architecture Art & Art History Biochemistry Biological Sciences Biological Systems Engineering Biomedical Engineering Biomedical Science Building Construction Business Information Technology COE Northern Virginia Division Chemical Engineering Chemistry Civil & Environmental Engineerin Collaborative Creative Tech (CCTAD) Communication Computer Science Crop & Soil Environmental Scienc Dairy Science Dept. of Engineering Education Dept. of Interdisciplinary Studi Eastern Shore AREC Economics Electrical and ComputerEngineeri Engineering Science & Mechanics English Entomology Finance, Insurance & Business La Fisheries and Wildlife Science Food Science and Technology Foreign Languages Forestry Geography Geosciences Hampton Roads AREC History Horticulture Hospitality and Tourism Human Development Human Nutrition, Foods & Exercis Industrial and Systems Engineeri Landscape Architecture Large Animal Clinical Sciences Management Marketing Materials Science & Engineering Mathematics Mechanical Engineering Mining and Minerals Engineering Music Myers-Lawson School of Construction Philosophy Physics Plant Pathology, Phys, & Weed Sc Political Science Psychology School of Education School of Pub & Internat Affairs Science and Technology in Societ Small Animal Clinical Sciences Sociology Southern Piedmont AREC Theatre Arts Tidewater AREC VT Inst for Metropolitan Res Virginia Seafood AREC Water Resources Research Center Wood Science & Forest Products Z Statistics
new_rank	4	1 Assistant Professor 2 Associate Professor 3 Full Professor 4 Eminent Scholar
GENDER	2	F M
minority	5	Asian Black NR Alien Other White
TENCODE	2	P T

years_rank_cat	3	1 -- > 6 yrs 2 -- 3-6 yrs 3 -- < 3 yrs
citizen2	2	N Y

Number of Observations Read	1347
Number of Observations Used	1347

Analysis for Untransformed AY Salary values

All time variables entered as linear components

&study_date

The GLM Procedure

Dependent Variable: AY_salary

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	88	8.19269E+11	9309876155	55.34	<.0001
Error	1258	2.11631E+11	168228137		
Corrected Total	1346	1.03E+12			

R-Square	Coeff Var	Root MSE	AY_salary Mean
0.794712	14.73212	12970.28	88040.81

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DEPT	74	1.99305E+11	2693315480	16.01	<.0001
new_rank	3	1.98132E+11	66044071904	392.59	<.0001
GENDER	1	516502.109	516502.109	0	0.9558
minority	4	472292137.9	118073034.5	0.7	0.5907
TENCODE	1	282684401.8	282684401.8	1.68	0.1951
citizen2	1	18085894.37	18085894.37	0.11	0.7431
years_rank_cat	2	2854014.165	1427007.082	0.01	0.9916
years_pre_vt	1	21838484706	21838484706	129.81	<.0001
years_at_vt	1	833726183.8	833726183.8	4.96	0.0262

Parameter	Estimate	Standard Error	t Value	Pr > t
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Intercept	129774.6689	B	4209.18062	30.83	<.0001
DEPT Accounting & Information Systems	36342.0456	B	4620.14909	7.87	<.0001
DEPT Aerospace and Ocean Engineering	8883.8936	B	4800.99146	1.85	0.0645
DEPT Agricultural & Applied Economics	-4748.0172	B	4738.87453	-1	0.3166
DEPT Agricultural & Extension Educati	-6884.9167	B	6131.13702	-1.12	0.2617
DEPT Alson H. Smith, Jr. AREC	-21639.6927	B	7435.7556	-2.91	0.0037
DEPT Animal and Poultry Sciences	-12104.7111	B	4521.26125	-2.68	0.0075
DEPT Apparel, Housing & Resource Mgt	-16558.7525	B	5275.54743	-3.14	0.0017
DEPT Architecture	-11985.7438	B	4128.76225	-2.9	0.0038
DEPT Art & Art History	-16900.5128	B	5142.17278	-3.29	0.001
DEPT Biochemistry	-7358.6855	B	4795.28695	-1.53	0.1251
DEPT Biological Sciences	-10472.0291	B	4174.90072	-2.51	0.0123
DEPT Biological Systems Engineering	1019.3316	B	4745.50725	0.21	0.83
DEPT Biomedical Engineering	11232.3075	B	6913.81035	1.62	0.1045
DEPT Biomedical Science	-4013.331	B	4281.49083	-0.94	0.3487
DEPT Building Construction	-7531.1175	B	5869.29765	-1.28	0.1997
DEPT Business Information Technology	21919.8146	B	4672.41656	4.69	<.0001
DEPT COE Northern Virginia Division	30252.0001	B	13577.57991	2.23	0.0261
DEPT Chemical Engineering	11549.2278	B	5219.45111	2.21	0.0271
DEPT Chemistry	-268.153	B	4338.24358	-0.06	0.9507
DEPT Civil & Environmental Engineerin	5811.2222	B	4147.71344	1.4	0.1614
DEPT Collaborative Creative Tech (CCTAD)	-19101.0456	B	13501.93102	-1.41	0.1574
DEPT Communication	-14973.5701	B	5111.94043	-2.93	0.0035
DEPT Computer Science	12078.4124	B	4186.65614	2.88	0.004

DEPT Crop & Soil Environmental Scienc	-16777.3847	B	4484.48228	-3.74	0.0002
DEPT Dairy Science	-14801.4284	B	5122.27853	-2.89	0.0039
DEPT Dept. of Engineering Education	-7397.1718	B	4949.33734	-1.49	0.1353
DEPT Dept. of Interdisciplinary Studi	-15928.3346	B	4703.73135	-3.39	0.0007
DEPT Eastern Shore AREC	-10339.8901	B	8334.91995	-1.24	0.215
DEPT Economics	1442.6121	B	5342.48221	0.27	0.7872
DEPT Electrical and ComputerEngineeri	7547.4419	B	3929.50699	1.92	0.055
DEPT Engineering Science & Mechanics	10754.0152	B	4491.59247	2.39	0.0168
DEPT English	-16049.2471	B	4183.7427	-3.84	0.0001
DEPT Entomology	-16734.28	B	4933.30348	-3.39	0.0007
DEPT Finance, Insurance & Business La	31674.9846	B	4758.1094	6.66	<.0001
DEPT Fisheries and Wildlife Science	-8334.4278	B	5114.0395	-1.63	0.1034
DEPT Food Science and Technology	-8534.7737	B	5342.10516	-1.6	0.1104
DEPT Foreign Languages	-18555.2646	B	4801.46506	-3.86	0.0001
DEPT Forestry	-14948.6316	B	4541.32212	-3.29	0.001
DEPT Geography	-8143.7316	B	6112.18487	-1.33	0.183
DEPT Geosciences	2033.0426	B	4867.34504	0.42	0.6762
DEPT Hampton Roads AREC	-21894.4259	B	6408.82857	-3.42	0.0007
DEPT History	-15068.1673	B	4536.8492	-3.32	0.0009
DEPT Horticulture	-16058.8754	B	4927.92055	-3.26	0.0011
DEPT Hospitality and Tourism	6880.2562	B	5645.30728	1.22	0.2232
DEPT Human Development	-10931.5087	B	4589.36506	-2.38	0.0174
DEPT Human Nutrition, Foods & Exercis	-4289.004	B	4755.95439	-0.9	0.3673
DEPT Industrial and Systems Engineeri	8502.234	B	4575.92898	1.86	0.0634
DEPT Landscape Architecture	-9258.6473	B	5657.46614	-1.64	0.102
DEPT Large Animal Clinical Sciences	-712.5291	B	4741.7187	-0.15	0.8806

DEPT Management	19992.0876	B	4762.72132	4.2	<.0001
DEPT Marketing	33934.248	B	5230.07483	6.49	<.0001
DEPT Materials Science & Engineering	5205.1737	B	5024.39219	1.04	0.3004
DEPT Mathematics	-2681.3732	B	4116.40064	-0.65	0.5149
DEPT Mechanical Engineering	9628.5791	B	4193.74812	2.3	0.0218
DEPT Mining and Minerals Engineering	5780.5875	B	5881.07848	0.98	0.3258
DEPT Music	-18589.1256	B	4708.64999	-3.95	<.0001
DEPT Myers-Lawson School of Construction	11932.1864	B	13502.02398	0.88	0.377
DEPT Philosophy	-11035.7822	B	5227.30788	-2.11	0.035
DEPT Physics	-10950.6723	B	4504.85731	-2.43	0.0152
DEPT Plant Pathology, Phys, & Weed Sc	-15404.6826	B	5108.67838	-3.02	0.0026
DEPT Political Science	-12871.538	B	4936.15158	-2.61	0.0092
DEPT Psychology	-8800.5858	B	4657.28558	-1.89	0.059
DEPT School of Education	-6047.7176	B	3993.84767	-1.51	0.1302
DEPT School of Pub & Internat Affairs	-2462.8407	B	4354.19289	-0.57	0.5717
DEPT Science and Technology in Societ	-13805.0383	B	5487.7934	-2.52	0.012
DEPT Small Animal Clinical Sciences	-7048.4494	B	4596.11531	-1.53	0.1254
DEPT Sociology	-13696.687	B	4834.68341	-2.83	0.0047
DEPT Southern Piedmont AREC	-19095.3351	B	6844.27069	-2.79	0.0054
DEPT Theatre Arts	-23520.6424	B	5678.84945	-4.14	<.0001
DEPT Tidewater AREC	-14531.9226	B	6096.9343	-2.38	0.0173
DEPT VT Inst for Metropolitan Res	70319.754	B	13524.61156	5.2	<.0001
DEPT Virginia Seafood AREC	-13664.7933	B	13495.78501	-1.01	0.3115
DEPT Water Resources Research Center	-1900.7358	B	13509.60763	-0.14	0.8881
DEPT Wood Science & Forest Products	-9338.6144	B	5042.50045	-1.85	0.0643

DEPT Z Statistics	0	B	.	.	.
new_rank 1 Assistant Professor	-59047.9288	B	2739.60089	-21.55	<.0001
new_rank 2 Associate Professor	-54180.9677	B	1579.07226	-34.31	<.0001
new_rank 3 Full Professor	-36266.1444	B	1431.93123	-25.33	<.0001
new_rank 4 Eminent Scholar	0	B	.	.	.
GENDER F	-52.0028	B	938.51202	-0.06	0.9558
GENDER M	0	B	.	.	.
minority Asian	672.3594	B	1337.25919	0.5	0.6152
minority Black	1278.8014	B	2092.63775	0.61	0.5412
minority NR Alien	2676.4461	B	2108.64308	1.27	0.2046
minority Other	-1904.9439	B	2368.59776	-0.8	0.4214
minority White	0	B	.	.	.
TENCODE P	-2719.2575	B	2097.72583	-1.3	0.1951
TENCODE T	0	B	.	.	.
citizen2 N	-446.0086	B	1360.26204	-0.33	0.7431
citizen2 Y	0	B	.	.	.
years_rank_cat 1 -- > 6 yrs	160.5346	B	1289.09964	0.12	0.9009
years_rank_cat 2 -- 3-6 yrs	28.8329	B	1107.50667	0.03	0.9792
years_rank_cat 3 -- < 3 yrs	0	B	.	.	.
years_pre_vt	945.7207		83.00437	11.39	<.0001
years_at_vt	166.2345		74.67215	2.23	0.0262

Note:

The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

Appendix B. SAS output for Model 1

Analysis for Untransformed AY Salary values
 All time variables entered as linear components
 University of Michigan model 1
 Jun-07

The GLM Procedure

Class Level Information

Class	Levels	Values
DEPT	75	Accounting & Information Systems Aerospace and Ocean Engineering Agricultural & Applied Economics Agricultural & Extension Educati Alson H. Smith, Jr. AREC Animal and Poultry Sciences Apparel, Housing & Resource Mgt Architecture Art & Art History Biochemistry Biological Sciences Biological Systems Engineering Biomedical Engineering Biomedical Science Building Construction Business Information Technology COE Northern Virginia Division Chemical Engineering Chemistry Civil & Environmental Engineerin Collaborative Creative Tech (CCTAD) Communication Computer Science Crop & Soil Environmental Scienc Dairy Science Dept. of Engineering Education Dept. of Interdisciplinary Studi Eastern Shore AREC Economics Electrical and ComputerEngineeri Engineering Science & Mechanics English Entomology Finance, Insurance & Business La Fisheries and Wildlife Science Food Science and Technology
		Foreign Languages Forestry Geography Geosciences Hampton Roads AREC History Horticulture Hospitality and Tourism Human Development Human Nutrition, Foods & Exercis Industrial and Systems Engineeri Landscape Architecture Large Animal Clinical Sciences Management Marketing Materials Science & Engineering Mathematics Mechanical Engineering Mining and Minerals Engineering Music Myers-Lawson School of Construction Philosophy Physics Plant Pathology, Phys, & Weed Sc Political Science Psychology School of Education School of Pub & Internat Affairs Science and Technology in Societ Small Animal Clinical Sciences Sociology Southern Piedmont AREC Theatre Arts Tidewater AREC VT Inst for Metropolitan Res Virginia Seafood AREC Water Resources Research Center Wood Science & Forest Products Z Statistics
GENDER	2	F M
minority	5	Asian Black NR Alien Other White
TENCODE	2	P T

citizen2	2	NY
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Number of Observations Read	1347
Number of Observations Used	1347

Analysis for Untransformed AY Salary values
 All time variables entered as linear components

University of Michigan model 1
 Jun-07

The GLM Procedure

Dependent Variable: AY_salary

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	83	6.18197E+11	7448150874	22.79	<.0001
Error	1263	4.12704E+11	326764509.5		
Corrected Total	1346	1.03E+12			

R-Square	Coeff Var	Root MSE	AY_salary Mean
0.599667	20.5321	18076.63	88040.81

Source	DF	Type III SS	Mean Square	F Value	Pr > F
DEPT	74	3.09375E+11	4180740044	12.79	<.0001
GENDER	1	409924433	409924433	1.25	0.2629
minority	4	2721013208	680253302	2.08	0.081
TENCODE	1	8131145088	8131145088	24.88	<.0001
citizen2	1	275210865.3	275210865.3	0.84	0.3589
years_pre_vt	1	97181651008	97181651008	297.41	<.0001
years_at_vt	1	61284689446	61284689446	187.55	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > t
Intercept	67937.80438	B	5288.45474	12.85	<.0001
DEPT Accounting & Information Systems	43708.59873	B	6402.64187	6.83	<.0001
DEPT Aerospace and Ocean Engineering	14932.42118	B	6680.8642	2.24	0.0256
DEPT Agricultural & Applied Economics	-741.28718	B	6600.73967	-0.11	0.9106

DEPT Agricultural & Extension Educati	4561.15604	B	8518.68053	0.54	0.5924
DEPT Alson H. Smith, Jr. AREC	-	B	10357.92924	-2.05	0.0405
	21239.76131				
DEPT Animal and Poultry Sciences	-8794.40236	B	6290.9692	-1.4	0.1624
DEPT Apparel, Housing & Resource Mgt	-9811.13556	B	7338.21657	-1.34	0.1815
DEPT Architecture	-	B	5733.97868	-2.17	0.03
	12456.92191				
DEPT Art & Art History	-	B	7145.29777	-1.84	0.0667
	13115.57947				
DEPT Biochemistry	-	B	6670.73794	-1.66	0.0964
	11097.50349				
DEPT Biological Sciences	-7547.12428	B	5803.3102	-1.3	0.1937
DEPT Biological Systems Engineering	5626.58787	B	6609.17025	0.85	0.3947
DEPT Biomedical Engineering	25700.0163	B	9600.69449	2.68	0.0075
DEPT Biomedical Science	-2702.78481	B	5950.08548	-0.45	0.6497
DEPT Building Construction	3564.4317	B	8149.26943	0.44	0.6619
DEPT Business Information Technology	36306.49955	B	6471.1112	5.61	<.0001
DEPT COE Northern Virginia Division	67256.62517	B	18840.73023	3.57	0.0004
DEPT Chemical Engineering	22673.31916	B	7250.18283	3.13	0.0018
DEPT Chemistry	2779.81528	B	6038.68167	0.46	0.6454
DEPT Civil & Environmental Engineerin	15663.37781	B	5754.76114	2.72	0.0066
DEPT Collaborative Creative Tech (CCTAD)	-	B	18804.28344	-0.75	0.4514
	14165.18295				
DEPT Communication	-9052.60741	B	7113.07477	-1.27	0.2034
DEPT Computer Science	14022.97902	B	5817.87462	2.41	0.0161
DEPT Crop & Soil Environmental Scienc	-	B	6237.92174	-2.12	0.0346
	13193.43501				
DEPT Dairy Science	-5868.06509	B	7114.99129	-0.82	0.4097
DEPT Dept. of Engineering Education	-6602.82061	B	6875.58802	-0.96	0.3371
DEPT Dept. of Interdisciplinary Studi	-12387.5508	B	6548.69486	-1.89	0.0588
DEPT Eastern Shore AREC	-9297.09788	B	11608.98186	-0.8	0.4234
DEPT Economics	7506.63913	B	7433.56799	1.01	0.3128
DEPT Electrical and ComputerEngineeri	13902.30721	B	5457.95219	2.55	0.011
DEPT Engineering Science & Mechanics	21869.81451	B	6231.10243	3.51	0.0005
DEPT English	-10284.8972	B	5815.80069	-1.77	0.0772
DEPT Entomology	-	B	6867.97133	-2.18	0.0296

	14960.36373				
DEPT Finance, Insurance & Business La	44569.67713	B		6596.02027	6.76 <.0001
DEPT Fisheries and Wildlife Science	-1358.13922	B		7105.23551	-0.19 0.8484
DEPT Food Science and Technology	-2249.15298	B		7432.10865	-0.3 0.7622
DEPT Foreign Languages	-	B		6662.76011	-2.7 0.0071
	17967.50104				
DEPT Forestry	-2671.02888	B		6294.22296	-0.42 0.6714
DEPT Geography	-2407.47364	B		8512.80399	-0.28 0.7774
DEPT Geosciences	7055.93522	B		6769.86045	1.04 0.2975
DEPT Hampton Roads AREC	-	B		8929.92406	-2.42 0.0156
	21616.05158				
DEPT History	-	B		6305.86699	-2.59 0.0097
	16331.68804				
DEPT Horticulture	-	B		6857.40249	-2.41 0.016
	16548.94158				
DEPT Hospitality and Tourism	11047.58119	B		7855.3188	1.41 0.1599
DEPT Human Development	-4476.23611	B		6388.46606	-0.7 0.4836
DEPT Human Nutrition, Foods & Exercis	-2678.28522	B		6613.82648	-0.4 0.6856
DEPT Industrial and Systems Engineeri	16889.26421	B		6343.93236	2.66 0.0079
DEPT Landscape Architecture	-	B		7871.22301	-1.41 0.1597
	11074.95028				
DEPT Large Animal Clinical Sciences	-1783.03992	B		6594.92691	-0.27 0.7869
DEPT Management	21616.69379	B		6596.72751	3.28 0.0011
DEPT Marketing	43674.23493	B		7275.33323	6 <.0001
DEPT Materials Science & Engineering	11074.43966	B		6978.07622	1.59 0.1128
DEPT Mathematics	2150.78979	B		5725.23131	0.38 0.7072
DEPT Mechanical Engineering	18865.15882	B		5824.32643	3.24 0.0012
DEPT Mining and Minerals Engineering	26150.68256	B		8129.49466	3.22 0.0013
DEPT Music	-	B		6531.14204	-3.66 0.0003
	23897.36455				
DEPT Myers-Lawson School of Construction	16082.3059	B		18803.01514	0.86 0.3925
DEPT Philosophy	-7224.241	B		7276.25627	-0.99 0.321
DEPT Physics	-	B		6262.92611	-1.9 0.0574
	11911.34423				
DEPT Plant Pathology, Phys, & Weed Sc	-	B		7115.95661	-2.26 0.0242
	16059.00992				

DEPT Political Science	-9044.56459	B	6870.49475	-1.32	0.1883
DEPT Psychology	-6684.63313	B	6460.76179	-1.03	0.301
DEPT School of Education	-5424.97622	B	5555.95217	-0.98	0.329
DEPT School of Pub & Internat Affairs	1284.22056	B	6054.20661	0.21	0.832
DEPT Science and Technology in Societ	-	B	7640.48704	-1.75	0.081
	13344.21354				
DEPT Small Animal Clinical Sciences	-1044.16233	B	6396.19888	-0.16	0.8703
DEPT Sociology	-	B	6730.8988	-2.28	0.0229
	15331.37631				
DEPT Southern Piedmont AREC	-	B	9535.01488	-1.8	0.0717
	17188.36429				
DEPT Theatre Arts	-	B	7863.15982	-4.15	<.0001
	32635.33388				
DEPT Tidewater AREC	-15085.0664	B	8483.79319	-1.78	0.0756
DEPT VT Inst for Metropolitan Res	73676.25558	B	18806.90966	3.92	<.0001
DEPT Virginia Seafood AREC	-4827.7023	B	18771.80088	-0.26	0.7971
DEPT Water Resources Research Center	10770.38877	B	18801.32446	0.57	0.5668
DEPT Wood Science & Forest Products	4198.89331	B	6994.10082	0.6	0.5484
DEPT Z Statistics	0	B	.	.	.
GENDER F	-1462.73331	B	1305.96244	-1.12	0.2629
GENDER M	0	B	.	.	.
minority Asian	3802.41805	B	1856.18519	2.05	0.0407
minority Black	599.46108	B	2914.11276	0.21	0.8371
minority NR Alien	4952.58655	B	2890.90158	1.71	0.0869
minority Other	-4328.12986	B	3294.14822	-1.31	0.1891
minority White	0	B	.	.	.
TENCODE P	-8076.69386	B	1619.10572	-4.99	<.0001
TENCODE T	0	B	.	.	.
citizen2 N	-1737.28499	B	1893.02226	-0.92	0.3589
citizen2 Y	0	B	.	.	.
years_pre_vt	1753.14453		101.65834	17.25	<.0001
years_at_vt	951.96277		69.51226	13.69	<.0001

Note:

The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

