Salary Equity Study
Office of Institutional Research and Effectiveness
August 3, 2010

INTRODUCTION

As part of the ongoing AdvanceVT 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 December 2009 to reflect a time frame similar to the previous studies. Considerable attention was paid to race/ethnicity as well as gender as factors in explaining variation in salaries. As in the past, the analysis was completed using the Paychecks[1] 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 Virginia Tech (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-nine tenured and tenure-track instructional faculty, including those on research appointments, were included in the analysis. Faculty members were classified into one of five academic rank categories (assistant professor, associate professor, associate professor Eminent Scholar, professor, professor Eminent Scholar).

The distribution of gender among the faculty reflects a slight shift towards more women faculty. In this study, 26.2% of the population were female while in the 2007 study 24.4% of the population were female and 23.7% of the 2005 population were women (Table 1). The distribution of the study population over academic rank has changed little over the last six years (Table 2). In 2009, roughly 24% of the population held the rank of assistant professor; 34% were associate professors, including six male associate professor Eminent Scholars; 34% were categorized as professors; and another 8% of faculty were identified as professor Eminent Scholars category. While 47.9% of the men in the population were either professors or professor Eminent Scholars, only 25.2% of the women in the population held these ranks. In addition, a larger number of women and a higher percentage of women hold the rank of assistant professor in the 2009 study than in the previous two studies. This suggests that efforts to recruit women may be working but efforts to retain women may not be entirely successful.

Table1. Change in gender distribution since 2005

	2005		2007		2009	
Men	996	(76.3%)	1018	(75.6%)	996	(73.8%)
Women	310	(23.7%)	329	(24.4%)	353	(26.2%)
Total	1306		1347		1349	

Table 2. Rank distribution

	2005			2007			2009		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Assistant Professor	161 (16.2%)	107 (34.5%)	268 (20.5%)	186 (18.3%)	118 (35.9%)	304 (22.6%)	185 (18.6%)	143 (40.5%)	328 (24.3%)
Associate Professor	336 (33.7%)	129 (41.6%)	465 (35.6%)	336 (33.0%)	132 (40.1%)	468 (34.7%)	328 (32.9%)	121 (34.3%)	449 (33.3%)
Professor	389 (39.1%)	66 (21.3%)	455 (34.8%)	385 (37.8%)	72 (21.9%)	457 (33.9%)	382 (38.4%)	78 (22.1%)	460 (34.1%)
Eminent Scholar*	110 (11.0%)	8 (2.6%)	118 (9.0%)	111 (10.9%)	7 (2.1%)	118 (8.8%)	101 (10.1%)	11 (3.1%)	112 (8.3%)
Total	996	310	1306	1018	329	1347	996	353	1349

*Includes Associate Professor Eminent Scholars and Professor Eminent Scholars

Nearly 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 3). Seventy-eight percent of the men and 57% of the women in the population have been awarded tenure.

Table 3. Tenure status of the population

	2005			2007			2009		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Tenured	808 (81.1%)	197 (63.5%)	1005 (77.0%)	793 (77.9%)	201 (61.1%)	994 (73.8%)	780 (78.3%)	202 (57.2%)	982 (72.8%)
Non-Tenured, Tenure-Track	188 (18.9%)	113 (36.5%)	301 (23.0%)	225 (22.1%)	128 (38.9%)	353 (26.2%)	216 (21.7%)	151 (42.8%)	367 (27.2%)
Total	996	310	1306	1018	329	1347	996	353	1349

Roughly 80% of the 2009 population self-identified as white. This is consistent with figures from the earlier studies -- 80% of the 2007 population and 81% of the 2005 population (Table 4). Faculty who self-identified as Asian accounted for 9.8% of the population; faculty who self-identified as Black or African-American comprised 3.6%; and non-resident aliens accounted for 4.9%. The remaining 2% of faculty were of other ethnicities. In addition, there has been a significant change in the proportion of faculty who are US citizens. Roughly 82% of the 2009 population held US citizenship while nearly 85% of the 2007 population and 88% of the 2005 population held US citizenship.

Table 4. Race/ethnicity distribution

	2005			2007			2009		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
White	803 80.6%	250 80.6%	1053 80.6%	810 79.6%	262 79.6%	1072 79.6%	793 79.6%	283 80.2%	1076 79.8%
Asian	96 9.6%	15 4.8%	111 8.5%	109 10.7%	19 5.8%	128 9.5%	109 10.9%	23 6.5%	132 9.8%
Black or African-American	27 2.7%	17 5.5%	44 3.4%	26 2.6%	18 5.5%	44 3.3%	30 3.0%	18 5.1%	48 3.6%
Hispanics of any Race	19 1.9%	5 1.6%	24 1.8%	22 2.2%	5 1.5%	27 2.0%	2 0.2%	2 0.6%	4 0.3%
Native Hawaiian or Other Pacific Islander*							0 0.0%	0 0.0%	0 0.0%
Native American or Alaska Native	3 0.3%	3 1.0%	6 0.5%	3 0.3%	3 0.9%	6 0.4%	2 0.2%	3 0.8%	5 0.4%
Two or More Races*							0 0.0%	0 0.0%	0 0.0%
Not Reported	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	15 1.5%	3 0.8%	18 1.3%
Non-Resident Alien	48 4.8%	20 6.5%	68 5.2%	48 4.7%	22 6.7%	70 5.2%	45 4.5%	21 5.9%	66 4.9%
Total	996	310	1306	1018	329	1347	996	353	1349

*Categories were not used in 2005 and 2007

Distribution across faculty ranks appeared to vary a bit by race/ethnicity with minorities being more prevalent among the junior ranks (Table 5). The Eminent Scholars category is a notable exception to this statement with 20.5% of those with the Eminent Scholar title self-identifying as a minority. When looking at time in rank for assistant professors, there is a heavier concentration of minorities in the higher time in rank categories. Of those assistant professors who had been at the university for less than three years, 14.6% were minorities. Of those who had been at the university three to six years, 18.3% were minorities, and 22.7% of the assistant professors who had been at the university for nine years or more self-identified as minorities.

Table 5. Distribution of faculty rank by race/ethnicity

Rank	Time in Rank	American Indian or Alaska Native	Asian	Black or African American	White	Hispanics of Any Race	Non-resident Alien	Not Reported	Total
Assistant Professor	**< 3 yrs**	0	15	5	86	0	27	4	137
	3-6 yrs	0	20	9	105	2	31	2	169
	6-9 yrs	0	3	2	16	0	0	0	21
	9 yrs <=	0	0	0	1	0	0	0	1
	Rank total	0	38	16	208	2	58	6	328
Associate Professor	**< 3 yrs**	0	10	2	58	0	5	1	76
	3-6 yrs	0	16	8	106	0	1	2	133
	6-9 yrs	1	4	2	45	0	0	1	53
	9 yrs <=	2	8	7	167	1	0	2	187
	Rank total	3	38	19	376	1	6	6	449
Full Professor	**< 3 yrs**	1	7	2	43	0	1	1	56
	3-6 yrs	1	8	4	62	0	1	0	76
	6-9 yrs	0	7	2	54	0	0	0	63
	9 yrs <=	0	12	4	245	1	0	4	266
	Rank total	2	34	12	404	1	2	5	460
Eminent Scholar*	**< 3 yrs**	0	2	0	5	0	0	0	7
	3-6 yrs	0	5	0	9	0	0	0	14
	6-9 yrs	0	2	0	9	0	0	0	11
	9 yrs <=	0	13	1	65	0	0	1	80
	Rank total	0	22	1	88	0	0	1	112
All		5	132	48	1076	4	66	18	1349

*Includes Associate Professor Eminent Scholars and Professor Eminent Scholars

As in the earlier studies, women in the 2009 study, on average, had earned their highest degrees more recently than the men in the study (Table 6). The average length of time since earning their

highest degrees for the female faculty was 15 years. For the male faculty, the average was 22 years.

Table 6. Descriptive measures for experiential variables by gender.

	Average Number of Years since Earning Highest Degree					
	Women			Men		
Year of Study	2005	2007	2009	2005	2007	2009
Time since Earning Highest Degree	13.2	13.3	14.7	19.9	20.0	21.6

At the lower academic ranks, male and female faculty members have similar patterns in terms of time in rank (Table 7). Fifty-seven percent of female assistant professors have spent 3 or more years as assistant professors compared with 59% of male assistant professors. At the associate professor level, 83% of female associate professors having spent 3 or more years at this rank compared to 83% 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 (42%) than male professors. Only 26% of male professors have been awarded the rank of professor within the last 6 years.

Table 7. Distribution of faculty rank by gender

Rank	Time in Rank	Women		Men		Total
		Number	Percentage*	Number	Percentage*	
Assistant Professor	**< 3 yrs**	61	42.7%	76	41.1%	137
	3-6 yrs	67	46.9%	102	55.1%	169
	6-9 yrs	14	9.8%	7	3.8%	21
	9 yrs <=	1	0.7%	0	0.0%	1
	Rank total	143	100.0%	185	100.0%	328
Associate Professor	**< 3 yrs**	21	17.4%	55	16.8%	76
	3-6 yrs	44	36.4%	89	27.1%	133
	6-9 yrs	17	14.0%	36	11.0%	53
	9 yrs <=	39	32.2%	148	45.1%	187
	Rank total	121	100.0%	328	100.0%	449
Full Professor	**< 3 yrs**	15	19.2%	40	10.5%	56
	3-6 yrs	18	23.1%	58	15.2%	76
	6-9 yrs	10	12.8%	53	13.9%	63
	9 yrs <=	35	44.9%	231	60.5%	266
	Rank total	78	100.0%	382	100.0%	460
Eminent Scholar**	**< 3 yrs**	3	27.3%	4	4.0%	7
	3-6 yrs	1	9.1%	13	12.9%	14
	6-9 yrs	0	0.0%	11	10.9%	11
	9 yrs <=	7	63.6%	73	72.3%	80
	Rank total	11	100.0%	101	100.0%	112
All		353		996		1349

* Percentage of the total number of faculty members of the designated gender within the designated rank
**Includes Associate Professor Eminent Scholars and Professor Eminent Scholars

The average salary for the 1349 faculty members in the study was $92,084 with women averaging $80,296 and men averaging $96,261. 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 8). However, these summary statistics do not take into account differences in academic unit.[2] 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.

[2] 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 8. Salary averages

Rank	Time in Rank	Women		Men	
		Number	Average Salary	Number	Average Salary
Assistant Professor	**< 3 yrs**	61	$70,462	76	$73,066
	3-6 yrs	67	$68,721	102	$73,376
	6-9 yrs	14	$70,056	7	$64,142
	9 yrs <=	1	$90,491	0	
	Rank total	143	$69,746	185	$72,899
Associate Professor	**< 3 yrs**	21	$80,794	55	$83,477
	3-6 yrs	44	$76,899	89	$82,301
	6-9 yrs	17	$79,363	36	$82,744
	9 yrs <=	39	$75,437	148	$81,496
	Rank total	121	$77,450	328	$82,184
Full Professor	**< 3 yrs**	15	$92,413	40	$107,149
	3-6 yrs	18	$95,171	58	$111,628
	6-9 yrs	10	$94,545	53	$103,118
	9 yrs <=	35	$98,553	231	$104,743
	Rank total	78	$96,078	382	$105,815
Eminent Scholar*	**< 3 yrs**	3	$166,323	4	$158,135
	3-6 yrs	1	$157,050	13	$134,548
	6-9 yrs	0		11	$156,154
	9 yrs <=	7	$121,310	73	$149,495
	Rank total	11	$136,835	101	$148,638
All		353	$80,296	996	$96,261

**Includes Associate Professor Eminent Scholars and Professor Eminent Scholars
** 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.[3] 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 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

[3] 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.

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 6 dummy variables with "white" being the reference ethnicity. Academic rank was indicated using 4 dummy variables; the rank of Assistant Professor was the reference rank. Time in rank comprised 3 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. Over 70% of the variation in salaries was accounted for by the factors in the model (adjusted $R^2 = 0.72$). Factors that were significant in explaining the variation in salaries included academic unit ($p < 0.0001$), academic rank ($p < 0.0001$), 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. Experience prior to joining Virginia Tech had a positive effect on salary. As expected, holding the rank of full professor, associate professor, regardless of whether or not the designation of Eminent Scholar applied a positive effect on salary relative to the rank of assistant professor. The magnitudes of the beta estimates increased as rank increased suggesting that on average, associate professors earn more than assistant professors, and professors earn more than associate professors. All academic departments in the college of business had positive beta estimates indicating that on average, those departments have higher salaries than the statistics department. In most cases, the business salaries were notably higher on average with all but one of the beta estimates being over $30,000. While smaller in magnitude than the beta estimates for the departments within the college of business, beta estimates for departments in the college of engineering tended to be positive 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; seventy-six percent of the variation in transformed salary was explained by the model, compared to 72% of the variation in untransformed salary being explained by Model 1. As with Model 1, academic unit, academic rank and experience prior to VT were the significant factors in the transformed model ($p < 0.0001$ for each factor).

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 a minor increase over the amount of variation explained by the basic model (73% versus 72%) even though the squares of experience prior to Virginia Tech and time at Virginia Tech produced significant effects ($p = 0.0024$ and $p < 0.0001$ respectively). Interestingly, this model also resulted in significant effects from tenure status ($p = 0.0377$) as well as academic unit ($p < 0.0001$), academic rank ($p < 0.0001$), and time at VT ($p < 0.0001$).

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. Models with only gender or only gender and minority factors did little better in explaining variation in salaries with the adjusted R^2 values remaining below 6%.

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 6 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 55% of the variation in salaries was accounted for by the factors in the model. 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 ($p < 0.0001$), tenure status ($p < 0.0001$), citizenship ($p = 0.0498$) and ethnicity ($p = 0.0424$). 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 American[4] had a positive effect on salary ($p = 0.0015$) as did having an "ethnicity" of non-resident alien to a less extent ($p = 0.0727$). This is not surprising; 76% of Asian Americans in the population and 65% of non-resident aliens in the population are faculty members in the four colleges with the highest average salaries. Given this result, it is somewhat surprising, that citizenship has a significant effect that is negative when the faculty member is a non-citizen. This suggests that resident aliens may be paid significantly less than non-resident aliens.

DATA QUALITY ISSUES

The time in rank factor was converted to a categorical variable with four possible levels: less than three years, at least three years but less than six years, at least six years but less than nine years and nine 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

[4] Including Resident Aliens

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 0.72 and 0.55. Interestingly, these values, which indicate the amount of variation explained by the models, are lower than the adjusted R^2 values from the models in the 2007 study with the same variables. The 2007 study yielded 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."[5] 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 constituted about 21.6% of all full-time tenure-track/tenured faculty positions in 2002 compared to 27.2% in fall 2010 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. For example, in the college of engineering, only 12.6% of all full-time tenure-track/tenured faculty positions are held by women while 48.9% of the positions in the college of liberal arts and human sciences are held by women.

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

[5] 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.

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 be a negative factor in explaining salary differences. In addition, the ethnic distribution of faculty at the assistant professor level is 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

The GLM Procedure

Class Level Information

Class	Levels	Values
DEPT	64	AREC Accounting & Information Systems Aerospace and Ocean Engineering Agricultural & Applied Economics Agricultural & Extension Education Animal and Poultry Sciences Apparel, Housing and Resource Mgmt Architecture Art & Art History Biochemistry Biological Sciences Biological Systems Engineering Biomedical Engineering Biomedical Science Building Construction Business Information Technology Chemical Engineering Chemistry Civil & Environmental Engineering Communication Computer Science Crop & Soil Environmental Science Dairy Science Department of Religion and Culture Department of Theatre and Cinema Dept. of Engineering Education Economics Electrical and ComputerEngineering Engineering Science & Mechanics English Entomology Finance, Insurance & Business Law Fisheries and Wildlife Science Food Science and Technology For Resources & Environ Consrv Foreign Languages and Literatures Geography Geosciences History Horticulture Hospitality and Tourism Human Development Human Nutrition, Foods & Exercise Industrial and Systems Engineering Large Animal Clinical Sciences Management Marketing Materials Science & Engineering Mathematics Mechanical Engineering Mining and Minerals Engineering Music Philosophy Physics Plant Pathology, Phys, & Weed Sci. Political Science Psychology School of Education School of Pub & Internat Affairs Science and Technology in Society Small Animal Clinical Sciences Sociology Wood Science & Forest Products Z statistics
rank	5	1 Professor Eminent Scholar 2 Professor 3 Associate Professor Eminent Scholar 4 Associate Professor 5 Assistant Professor
gender	2	F M
minority	7	Am. Ind/Alaskan Asian Black Hispanic NR Alien Unknown White
tencode	2	P T
years_rank_cat	4	1 -- > 9 years 2 -- 6-9 years 3 -- 3-6 years 4 -- < 3 years
citizenship	2	N Y

Number of Observations Read	1349
Number of Observations Used	1349

Analysis for Untransformed AY Salary values

All time variables entered as linear components

paycheck model

The GLM Procedure

Dependent Variable: AY_salary

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	81	8.88592E+11	10970267638	43.69	<.0001
Error	1267	3.18116E+11	251078501.4		
Corrected Total	1348	1.21E+12			

R-Square	Coeff Var	Root MSE	AY_Salary Mean
0.736377	17.20769	15845.46	92083.58

Source	DF	Type III SS	Mean Square	F Value	Pr > F
dept	63	2.32957E+11	3697723507	14.73	<.0001
rank	4	1.94755E+11	48688748149	193.92	<.0001
gender	1	629221957.2	629221957.2	2.51	0.1137
minority	6	1701867835	283644639.2	1.13	0.3426
tencode	1	51897379.39	51897379.39	0.21	0.6494
Citizenship	1	348942562.8	348942562.8	1.39	0.2387
Years_rank_cat	3	58511231.84	19503743.95	0.08	0.9721
years_pre_vt	1	22140924141	22140924141	88.18	<.0001
years_at_vt	1	498794873.8	498794873.8	1.99	0.1589

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	72980.39088	B	5197.964242	14.04	<.0001
dept AREC	-19445.21133	B	5257.877172	-3.7	0.0002
dept Accounting & Information Systems	39750.67697	B	5465.667967	7.27	<.0001
dept Aerospace and Ocean Engineering	10680.70119	B	5649.696776	1.89	0.0589
dept Agricultural & Applied Economics	-5364.26104	B	5341.016538	-1	0.3154
dept Agricultural & Extension Education	-13902.13958	B	6770.825436	-2.05	0.0403
dept Animal and Poultry Sciences	-3218.91435	B	5463.483122	-0.59	0.5559
dept Apparel, Housing and Resource Mgmt	-16886.00398	B	5991.107256	-2.82	0.0049
dept Architecture	-8396.48497	B	4684.947559	-1.79	0.0733
dept Art & Art History	-15633.93339	B	6071.476075	-2.57	0.0101
dept Biochemistry	-8202.5648	B	5584.803341	-1.47	0.1422
dept Biological Sciences	-11985.24233	B	4908.78483	-2.44	0.0148
dept Biological Systems Engineering	1685.4334	B	5531.94464	0.3	0.7607
dept Biomedical Engineering	16883.04568	B	7764.48079	2.17	0.0299
dept Biomedical Science	-1168.59085	B	5092.886133	-0.23	0.8186
dept Building Construction	-2948.03107	B	7282.543152	-0.4	0.6857
dept Business Information Technology	31392.10459	B	5459.482841	5.75	<.0001
dept Chemical Engineering	13583.81263	B	6075.961489	2.24	0.0255
dept Chemistry	1164.49434	B	5106.834732	0.23	0.8197
dept Civil & Environmental Engineering	7975.59128	B	4834.784883	1.65	0.0993
dept Communication	-12802.74027	B	6499.547458	-1.97	0.0491
dept Computer Science	10649.77912	B	4912.577473	2.17	0.0304
dept Crop & Soil Environmental Science	-15044.84429	B	5357.27049	-2.81	0.0051
dept Dairy Science	-9608.84193	B	6180.627263	-1.55	0.1203
dept Department of Religion and Culture	-14129.30488	B	6335.818136	-2.23	0.0259
dept Department of Theatre and Cinema	-21152.9321	B	6047.607053	-3.5	0.0005
dept Dept. of Engineering Education	-1145.82867	B	6059.403506	-0.19	0.85
dept Economics	3874.073	B	6022.676494	0.64	0.5202

dept Electrical and ComputerEngineering	8300.8116	B	4591.799435	1.81	0.0709
dept Engineering Science & Mechanics	10905.88011	B	5155.244222	2.12	0.0346
dept English	-12889.39028	B	4854.427608	-2.66	0.008
dept Entomology	-18808.61545	B	6057.447044	-3.11	0.0019
dept Finance, Insurance & Business Law	41040.96345	B	5549.980076	7.39	<.0001
dept Fisheries and Wildlife Science	-7829.32263	B	5843.826558	-1.34	0.1806
dept Food Science and Technology	-368.75357	B	6527.271837	-0.06	0.955
dept For Resources & Environ Consrv	-11465.55862	B	5307.043324	-2.16	0.0309
dept Foreign Languages and Literatures	-17510.36297	B	5396.569077	-3.24	0.0012
dept Geography	-7061.16634	B	7303.846207	-0.97	0.3338
dept Geosciences	202.87014	B	5671.265939	0.04	0.9715
dept History	-13264.44359	B	5377.801627	-2.47	0.0138
dept Horticulture	-16955.69064	B	6169.32988	-2.75	0.0061
dept Hospitality and Tourism	9700.63783	B	6985.330972	1.39	0.1652
dept Human Development	-6528.78629	B	5457.549948	-1.2	0.2318
dept Human Nutrition, Foods & Exercise	-403.40511	B	5701.315906	-0.07	0.9436
dept Industrial and Systems Engineering	7450.08313	B	5228.973762	1.42	0.1545
dept Large Animal Clinical Sciences	-2775.31551	B	5597.094948	-0.5	0.6201
dept Management	32791.10494	B	5616.280249	5.84	<.0001
dept Marketing	39154.49425	B	6072.786173	6.45	<.0001
dept Materials Science & Engineering	7492.08487	B	6109.555183	1.23	0.2203
dept Mathematics	-5651.8594	B	4828.613544	-1.17	0.242
dept Mechanical Engineering	9308.49671	B	4742.639759	1.96	0.0499
dept Mining and Minerals Engineering	13160.23844	B	7322.252627	1.8	0.0725
dept Music	-20120.60958	B	5550.072146	-3.63	0.0003
dept Philosophy	-14516.22632	B	6963.696522	-2.08	0.0373
dept Physics	-10538.52444	B	5189.541473	-2.03	0.0425
dept Plant Pathology, Phys, & Weed Sci.	-13808.81174	B	5725.668976	-2.41	0.016
dept Political Science	-8839.59529	B	5564.987752	-1.59	0.1124
dept Psychology	-4830.07809	B	5436.134318	-0.89	0.3744
dept School of Education	-8160.44708	B	4659.672375	-1.75	0.0801
dept School of Pub & Internat Affairs	-1718.92921	B	5063.500675	-0.34	0.7343

dept Science and Technology in Society	-16748.11883	B	6354.421111	-2.64	0.0085
dept Small Animal Clinical Sciences	-3511.72256	B	5453.843666	-0.64	0.5198
dept Sociology	-14989.56767	B	5338.089735	-2.81	0.0051
dept Wood Science & Forest Products	-15693.99456	B	6060.617942	-2.59	0.0097
dept Z statistics	0	B	.	.	.
rank 1 Professor Eminent Scholar	57891.80186	B	3593.677441	16.11	<.0001
rank 2 Professor	26264.35651	B	3227.901527	8.14	<.0001
rank 3 Associate Professor Eminent Scholar	18814.56613	B	7456.255471	2.52	0.0117
rank 4 Associate Professor	4314.57791	B	2896.240666	1.49	0.1365
rank 5 Assistant Professor	0	B	.	.	.
gender F	-1788.17963	B	1129.572141	-1.58	0.1137
gender M	0	B	.	.	.
minority Am. Ind/Alaskan	-8703.70731	B	7256.608435	-1.2	0.2306
minority Asian	1790.69319	B	1612.096024	1.11	0.2669
minority Black	2797.3236	B	2441.184369	1.15	0.2521
minority Hispanic	7244.48605	B	8107.203078	0.89	0.3717
minority NR Alien	3863.72674	B	2488.684032	1.55	0.1208
minority Unknown	-1972.67935	B	3893.791578	-0.51	0.6125
minority White	0	B	.	.	.
tencode P	-1282.59816	B	2821.127162	-0.45	0.6494
tencode T	0	B	.	.	.
Citizenship N	-1757.29351	B	1490.637683	-1.18	0.2387
Citizenship Y	0	B	.	.	.
Years_rank_cat 1 -- > 9 years	263.56989	B	1883.528816	0.14	0.8887
Years_rank_cat 2 -- 6-9 years	-509.13548	B	1760.685703	-0.29	0.7725
Years_rank_cat 3 -- 3-6 years	-242.86931	B	1289.230438	-0.19	0.8506
Years_rank_cat 4 -- < 3 years	0	B	.	.	.
years_pre_vt	926.87432		98.702406	9.39	<.0001
years_at_vt	131.53085		93.319284	1.41	0.1589

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 AY Salary values Dec 2009
All time variables entered as linear components
University of Michigan model 1

The GLM Procedure

Class Level Information

Class	Levels	Values
dept	64	AREC Accounting & Information Systems Aerospace and Ocean Engineering Agricultural & Applied Economics Agricultural & Extension Education Animal and Poultry Sciences Apparel, Housing and Resource Mgmt Architecture Art & Art History Biochemistry Biological Sciences Biological Systems Engineering Biomedical Engineering Biomedical Science Building Construction Business Information Technology Chemical Engineering Chemistry Civil & Environmental Engineering Communication Computer Science Crop & Soil Environmental Science Dairy Science Department of Religion and Culture Department of Theatre and Cinema Dept. of Engineering Education Economics Electrical and ComputerEngineering Engineering Science & Mechanics English Entomology Finance, Insurance & Business Law Fisheries and Wildlife Science Food Science and Technology For Resources & Environ Consrv Foreign Languages and Literatures Geography Geosciences History Horticulture Hospitality and Tourism Human Development Human Nutrition, Foods & Exercise Industrial and Systems Engineering Large Animal Clinical Sciences Management Marketing Materials Science & Engineering Mathematics Mechanical Engineering Mining and Minerals Engineering Music Philosophy Physics Plant Pathology, Phys, & Weed Sci. Political Science Psychology School of Education School of Pub & Internat Affairs Science and Technology in Society Small Animal Clinical Sciences Sociology Wood Science & Forest Products Z statistics
gender	2	F M
minority	7	Am. Ind/Alaskan Asian Black Hispanic NR Alien Unknown White
tencode	2	P T
Citizenship	2	N Y

Number of Observations Read	1349
Number of Observations Used	1349

Analysis for AY Salary values Dec 2009
All time variables entered as linear components

University of Michigan model 1

The GLM Procedure

Dependent Variable: AY_salary

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	74	6.90012E+11	9324487074	22.99	<.0001
Error	1274	5.16696E+11	405569934.5		
Corrected Total	1348	1.21E+12			

R-Square	Coeff Var	Root MSE	AY_Salary Mean
0.571814	21.87009	20138.77	92083.58

Source	DF	Type III SS	Mean Square	F Value	Pr > F
dept	63	3.58137E+11	5684721312	14.02	<.0001
gender	1	1067768466	1067768466	2.63	0.1049
minority	6	5307245457	884540909.5	2.18	0.0424
tencode	1	6700461647	6700461647	16.52	<.0001
Citizenship	1	1563445303	1563445303	3.85	0.0498
years_pre_vt	1	1.01906E+11	1.01906E+11	251.27	<.0001
years_at_vt	1	62611906197	62611906197	154.38	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	72399.29544	B	5620.34894	12.88	<.0001
dept AREC	-21095.28578	B	6667.78252	-3.16	0.0016
dept Accounting & Information Systems	47685.70582	B	6789.42325	7.02	<.0001
dept Aerospace and Ocean Engineering	16571.26545	B	7160.33155	2.31	0.0208
dept Agricultural & Applied Economics	-1850.93186	B	6767.79313	-0.27	0.7845

dept Agricultural & Extension Education	-4921.36275	B	8587.0174	-0.57	0.5667
dept Animal and Poultry Sciences	-4023.6464	B	6923.32428	-0.58	0.5612
dept Apparel, Housing and Resource Mgmt	-13529.37909	B	7597.13893	-1.78	0.0752
dept Architecture	-10275.30116	B	5917.41258	-1.74	0.0827
dept Art & Art History	-13735.70851	B	7696.87049	-1.78	0.0746
dept Biochemistry	-14119.79793	B	7073.70854	-2	0.0461
dept Biological Sciences	-11558.57096	B	6218.54358	-1.86	0.0633
dept Biological Systems Engineering	-705.17096	B	7008.57358	-0.1	0.9199
dept Biomedical Engineering	25124.51444	B	9838.75502	2.55	0.0108
dept Biomedical Science	-5854.35199	B	6458.47896	-0.91	0.3649
dept Building Construction	4231.65022	B	9241.89271	0.46	0.6471
dept Business Information Technology	38739.45811	B	6907.4833	5.61	<.0001
dept Chemical Engineering	21095.15729	B	7688.9678	2.74	0.0062
dept Chemistry	2309.2908	B	6480.76672	0.36	0.7217
dept Civil & Environmental Engineering	14368.91619	B	6101.92925	2.35	0.0187
dept Communication	-14000.16785	B	8249.86251	-1.7	0.0899
dept Computer Science	9720.5823	B	6213.30076	1.56	0.118
dept Crop & Soil Environmental Science	-17290.94058	B	6787.69878	-2.55	0.011
dept Dairy Science	-9684.56911	B	7840.25173	-1.24	0.217
dept Department of Religion and Culture	-13410.16481	B	8045.51571	-1.67	0.0958
dept Department of Theatre and Cinema	-25712.29544	B	7670.68968	-3.35	0.0008
dept Dept. of Engineering Education	-6355.68943	B	7671.70612	-0.83	0.4076
dept Economics	6201.70173	B	7649.05493	0.81	0.4176
dept Electrical and ComputerEngineering	10785.48281	B	5809.35408	1.86	0.0636
dept Engineering Science & Mechanics	17647.8159	B	6517.91561	2.71	0.0069
dept English	-11262.44585	B	6153.68061	-1.83	0.0675
dept Entomology	-18840.96524	B	7682.06628	-2.45	0.0143
dept Finance, Insurance & Business Law	49948.81997	B	7019.13058	7.12	<.0001
dept Fisheries and Wildlife Science	-5618.86029	B	7411.50974	-0.76	0.4485
dept Food Science and Technology	-729.92338	B	8261.26033	-0.09	0.9296
dept For Resources & Environ Consrv	-3820.64881	B	6715.68153	-0.57	0.5695
dept Foreign Languages and Literatures	-18460.71539	B	6828.32241	-2.7	0.007
dept Geography	-5068.86185	B	9272.001	-0.55	0.5847

dept Geosciences	4768.26775	B	7182.6999	0.66	0.5069
dept History	-17420.40527	B	6803.67032	-2.56	0.0106
dept Horticulture	-22321.9703	B	7817.76204	-2.86	0.0044
dept Hospitality and Tourism	10821.96764	B	8872.58414	1.22	0.2228
dept Human Development	-4224.98303	B	6922.6798	-0.61	0.5418
dept Human Nutrition, Foods & Exercise	-1873.32369	B	7206.42664	-0.26	0.7949
dept Industrial and Systems Engineering	14545.46352	B	6605.35378	2.2	0.0278
dept Large Animal Clinical Sciences	-2881.74723	B	7074.27698	-0.41	0.6838
dept Management	34413.78898	B	7077.45929	4.86	<.0001
dept Marketing	48741.97229	B	7685.51101	6.34	<.0001
dept Materials Science & Engineering	8536.80234	B	7689.14306	1.11	0.2671
dept Mathematics	-3648.55216	B	6123.02005	-0.6	0.5514
dept Mechanical Engineering	12860.99478	B	5968.88796	2.15	0.0314
dept Mining and Minerals Engineering	25752.11354	B	9257.00994	2.78	0.0055
dept Music	-30116.38533	B	7003.13302	-4.3	<.0001
dept Philosophy	-14251.30461	B	8836.78432	-1.61	0.1071
dept Physics	-13368.75776	B	6551.4022	-2.04	0.0415
dept Plant Pathology, Phys, & Weed Sci.	-16262.56332	B	7254.3331	-2.24	0.0251
dept Political Science	-8769.12564	B	7059.3139	-1.24	0.2144
dept Psychology	-8207.79183	B	6866.37701	-1.2	0.2322
dept School of Education	-10753.00839	B	5897.48562	-1.82	0.0685
dept School of Pub & Internat Affairs	-1887.63821	B	6409.00101	-0.29	0.7684
dept Science and Technology in Society	-18424.57221	B	8045.7294	-2.29	0.0222
dept Small Animal Clinical Sciences	-827.45342	B	6903.12401	-0.12	0.9046
dept Sociology	-15037.93516	B	6758.43861	-2.23	0.0263
dept Wood Science & Forest Products	-7502.75388	B	7656.37382	-0.98	0.3273
dept Z statistics	0	B	.	.	.
gender F	-2324.8138	B	1432.78988	-1.62	0.1049
gender M	0	B	.	.	.
minority Am. Ind/Alaskan	-7761.75733	B	9217.03959	-0.84	0.3999
minority Asian	6481.40665	B	2033.42211	3.19	0.0015
minority Black	1447.80482	B	3097.79903	0.47	0.6403
minority Hispanic	1923.12166	B	10292.25561	0.19	0.8518

minority NR Alien	5630.23881	B	3134.143	1.8	0.0727
minority Unknown	-2708.37522	B	4938.38073	-0.55	0.5835
minority White	0	B	.	.	.
tencode P	-7261.92419	B	1786.62013	-4.06	<.0001
tencode T	0	B	.	.	.
Citizenship N	-3707.57993	B	1888.34809	-1.96	0.0498
Citizenship Y	0	B	.	.	.
years_pre_vt	1746.37202		110.17186	15.85	<.0001
years_at_vt	917.13378		73.81372	12.42	<.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.