

# North Carolina State University Report on the University Wide Salary-Equity Study

Submitted by Haignere, Inc.  
July, 2001

## EXECUTIVE SUMMARY

As the result of a competitive bid process, the North Carolina State University (NCSU) Office for Equal Opportunity retained Haignere, Inc. to conduct university wide data analyses so as to diagnose whether or not systemic gender and race faculty salary differences exist. NCSU has conducted similar annual faculty salary-equity studies since 1982.

The database used for this study includes the 1581 full-time faculty members at NCSU in the fall of 2000. This population differs from the populations studied in previous salary equity studies because of the addition of two groups: faculty members with an administrative title below department head and distinguished, named and titled faculty members. University Planning and Analysis compiled the study's database with assistance from the Office of the Provost.

### **Assessing the Potential for Variables to Mask or Suppress Salary Inequities**

Even a cursory review of the methodological literature concerning the assessment of gender bias in faculty salaries reveals substantial discussion of what variables should and should not be included. This discussion revolves around "tainted variables." Tainted variables are those that are likely to have discrimination embedded in them and, thus, mask or suppress gender effects. For example, if height were included in a salary disparity analysis where gender bias exists, the shortness of female faculty relative to male faculty could explain much of the gender differences in salaries.

We estimated whether or not the variables Rank, Tenure, Administrative Title, and Rank Modifiers may act to suppress findings of salary bias using frequency tables displaying the representation of white men relative to women and minorities. The results cannot be interpreted to demonstrate bias because frequency tables do not control for other variables. For example, low representation of women in the full professor rank could indicate a glass ceiling at the full professor level, or it could merely reflect "time in the pipeline." The objective of the frequency table analyses is to establish whether or not it is necessary to systematically vary a variable's inclusion in the analyses so as to estimate whether or not it is functioning as a suppressor variable. To the degree that the university can address the under representation of women and minorities in the categories examined some of the complexity of diagnosing systemic gender and race salary differences can be minimized.

The frequency tables indicate that women, including minority women are disproportionately visiting and less likely to be in research positions. Women do not hold distinguished professor rank modifiers in the proportions that men do. Women are less likely to be in tenure-track lines than are men even when controlled for degree level. Minorities are less likely to hold below department head administrative positions.

Concerning rank, minorities and women are less likely to have made it into the full professor rank. White women are less likely than minority men to be full professors and minority

women much less likely to be full professors than any other race/gender category. Even though women and minorities predominate in the visiting ranks, only one (1.4%) white woman holds a senior rank visiting appointment. By comparison ten white males (17%) hold senior rank visiting positions. Over two-thirds of the women and minorities in the visiting ranks are lecturers compared to half of the white males.

The results of the frequency-distribution analyses indicate that disproportional representation exists in the awarding of rank, non-tenure track positions and rank modifiers. Thus, it is feasible that these variables mask gender and/or race disparity when included in the regression analyses of salaries. The classic dilemma regarding potential confounding variables is that excluding them may overestimate disparity while including them may underestimate disparity. We address this dilemma by systematically excluding each potentially tainted variable with the exception of rank. Rank is included in all analyses. Even if there is considerable evidence of bias in current rank, we recommend the conservative approach of including Rank in the analyses. Having done so, however, it is important to remember that the results probably underestimate the amount of disparity that exists in salaries.

### **Diagnosis – Do systemic race and gender salary disparities exist?**

The university wide analyses indicate that there is reason to be concerned about both gender and race salary disparities. When we subset the NCSU faculty population so as to eliminate all potential suppressor variable effects by studying only tenure track faculty who do not have rank modifiers, the results indicate roughly \$1000 annual salary disparity between women faculty and comparable white males. For minority males there is a disparity in the neighborhood of \$2000 between them and comparable white males. These amounts are roughly equal to the midrange of the disparities indicated when we systematically vary the potentially tainted variables included in the regression analyses for the whole NCSU faculty population. In our opinion these are substantial salary disparities that need to be addressed. We suggest a group/systemic approach to remedy based on the greater consistency of this approach with the multiple regression statistical methods, ease of application and greater fairness to both high and low performing women and minorities.

### **NCSU Context**

NCSU has an impressive history of doing salary equity studies annually. These studies have emphasized college level analyses and used the white-male equation approach. Little attention has been paid in the past to the university level analyses. It remains to be seen whether the university level analyses will be used differently this year. If it is determined that salary adjustments will be made based on the university level analyses, it may be important to focus further on the variations in the results of the different regression models.

Conducting college level analyses should pose few problems at the four largest NCSU colleges: Agriculture and Life Science, Humanities and Social Science, Engineering and Physical and Mathematical Sciences. At the College of Veterinary Medicine and the remaining five of the NCSU colleges the small number of faculty may lead to methodological complexities. The general rule of five cases (faculty members) per independent/predictor variable should be respected. At the smaller colleges, respecting this limit can mean combining or eliminating some variables. White-male analyses may be particularly problematic for these smaller colleges. Not only are there many fewer faculty members in white-male analyses but calculating the average residuals for the women and minorities requires excluding any women and minorities for whom there is no white-male match.

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## I. INTRODUCTION

As the result of a competitive bid process initiated by a request for proposal for a salary equity study, the North Carolina State University (NCSU) Office for Equal Opportunity retained Haignere, Inc. to conduct university wide data analyses so as to diagnose whether or not systemic gender and race faculty salary differences exist. Lois Haignere has experience conducting similar analyses for over 30 other higher education institutions and is the primary author of the 133-page volume *Pay Checks: A Guide to Achieving Salary Equity in Higher Education*.

NCSU has conducted annual faculty salary-equity studies since 1982. A primary purpose of these studies has been to assess salaries for any gender and race disparities. Retaining Haignere, Inc. to conduct this year's university wide study provided for the review of the statistical models and personnel data so as to provide a state-of-the-art research design for the salary equity analyses. The regression analyses approaches are expanded and the variables used in the analyses are assessed for their potential to mask bias in salaries. The examination of the potential for variables to confound the results involves estimating the impact of hiring promotion and other institutional processes on the distribution and advancement of women and minorities.

## II. THE POPULATION STUDIED

NCSU is the largest institution in the 16-campus University of North Carolina system. NCSU is classified as category I, a doctoral level institution.<sup>1</sup> Having served North Carolina for over 100 years, some current NCSU institutional directions include partnerships with peer institutions, public schools, the government, business and industry. NCSU has over 21,900 students in 177 undergraduate degree programs and over 6,600 graduate students in 294 graduate degree programs. It houses 10 colleges: Agriculture and Life Sciences, Design, Education, Engineering, Humanities and Social Sciences, Management, Natural Resources, Physical and Mathematical Sciences, Textiles and Veterinary Medicine. For the number of faculty members studied in each of these colleges see Figure 1 below.

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<sup>1</sup> Annual Report on the Economic Status of the Profession, *Academe*, American Association of University Professors

*Figure 1*  
*Population by college*

College	Faculty
Agriculture and Life Sciences	408
Design	33
Education	61
Engineering	236
Humanities and Social Sciences	317
Management	74
Natural Resources	72
Physical and Mathematical Sciences	193
Student Affairs*	31
Textiles	41
Veterinary Medicine	115
Total	1581

\*Although not a college, Student Affairs houses the physical education faculty members that are included in this study.

*includes  
"full time faculty"*

The database used for this study includes the population of 1581 full-time faculty members at NCSU in the fall of 2000 (See Figure 2). This population differs from the population studied in previous salary equity studies because of the addition of two groups: faculty members with an administrative title below department head and distinguished, named and titled faculty members. As is indicated by Figure 2, the bulk of the NCSU faculty population is in the assistant, associate and full professor ranks.

*Figure 2*  
*Population by rank, gender and race*

	White Male	Minority Male	White Female	Minority Female	Rank Totals
Full	510	61	65	5	641
Associate	290	46	82	17	435
Assistant	178	46	81	19	324
Instructor	6	0	13	1	20
Lecturer	65	8	77	11	161
Gender Totals	1049	161	318	53	1581

*what is  
"minority"*

### III. DATA SOURCES AND DATA CLEANING

University Planning and Analysis compiled the study's database with assistance from the Office of the Provost. A combination of the electronic personnel system census files, information from faculty administrators, and data from various hard copy files were used in creating and cleaning



the data.<sup>2</sup> When necessary the electronic information was checked against the hard copy files in the Office of the Provost, the Office of Academic Personnel and various deans' offices.<sup>3</sup> The deans were also instrumental in advising as to which administrative positions were below department head and, therefore, rightfully included in the study.<sup>4</sup>

Haignere Inc. conducted a series of tests for apparent data anomalies. Some examples of the anomalies investigated to make sure the data were clean were:

- Initial Rank is higher than Current Rank

- Years in Current Rank are greater than Years at NCSU

- Associate professor rank was awarded before Ph.D.

- Ph.D. was earned before 25 years of age

- More than 6 years at NCSU without tenure

- Current Rank is the same as Initial Rank, but Years at NCSU do not equal Years in Rank  
(We capitalize the names of variables to distinguish them.)

In many cases the existence of anomalies did not constitute incorrect data. For instance, there are faculty members who have been at NCSU more than six years without tenure because of movements in and out of tenure-track lines. There are even faculty members whose initial rank was higher than their current rank as those in non-tenure-track research and visiting ranks have moved to tenure track lines at lower ranks.

The major changes made to the database as a result of the data-cleaning process included updates of the educational level and the date the highest degree was achieved. Hire dates were also updated to reflect the date hired as a full time, as opposed to a part-time, faculty member. Some faculty members were found to have worked at NCSU, left employment at this institution, and been hired back at a later date. The appropriate hire date for the study was the most recent date of hire as long as the person had left the faculty at NCSU. Other data modifications included tenure dates, ranks, initial ranks, retirees and rank modifiers.

#### IV. STUDY DESIGN AND METHODS

##### **Assessing the Potential for Variables to Mask or Suppress Salary Inequities**

Even a cursory review of the methodological literature concerning the assessment of gender bias in faculty salaries reveals substantial discussion of what variables should and should not be included. This discussion revolves around "tainted variables." Tainted variables are those that are likely to have discrimination embedded in them and, thus, mask or suppress gender effects.

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<sup>2</sup> We thank Carol Gosselin, Applications Analyst Programmer, University Planning and Analysis, for her diligence in putting together the database and patient explanations of the details of the database and variables. We also thank Sharron Bouquin, Coordinator of Information and Technical Service, Office of the Provost, and her staff for her thorough investigation of the data inconsistencies. Ms. Gosselin and Ms. Bouquin responded quickly and effectively to our many emails for clarification during data cleaning and we are grateful for their assistance and good nature throughout.

<sup>3</sup> We thank Winnie Peoples, Administrative Assistant to the Dean of Education, Greta Johansen, Assistant to the Dean of Veterinary Medicine, John J. Grainger, Director of Electrical and Computer Engineering, and Charles Patch, Interim Department Head of Physical Education for their assistance in this process.

<sup>4</sup> We thank the following deans for their help in this process: James L. Oblinger, Marvin Malecha, Kathryn M. Moore, Nino A. Masnari, Margaret A. Zahn, Jon W. Bartley, Larry W. Tombaugh, Daniel L. Solomon, A. Blanton Godfrey, David Buchanan, and Oscar J. Fletcher.

do with and without rank

Scott (1977) speaks emphatically against the use of Rank in the assessment of gender bias in faculty salaries. Citing the example of women not being promoted at all or very rarely, she notes: "If rank is used as a predictor variable in such cases these women appear to be overpaid for their rank, whereas, in fact, their rank is frozen too low and they are actually underpaid (Scott 1977 p. 8)." On the other side of the issue, some studies have included rank because the wider academic community has difficulty accepting the results of an analysis that does not take rank into account. This difficulty is quite logical since the exclusion of rank can overestimate bias just as its inclusion can underestimate bias.

If you include a predictor variable that is biased, then some of the salary estimate that might properly be attributed to being female will instead show up as part of the biased or tainted variable's estimate. For example, if height were included in a salary disparity analysis where gender bias exists, the shortness of female faculty relative to male faculty could explain much of the gender differences in salaries. The salary disparity related to gender would be proportioned out by the regression analyses to both height and gender, masking the true magnitude of the gender bias. Fortunately, most higher education institutions do not consider height a legitimate compensable factor.

The research design for the NCSU study calls for the use of four variables that could mask or suppress gender findings: Rank, Tenure, Administrative Status and Rank Modifiers. Below we briefly discuss the potential for each of these variables to mask bias.

**Rank** - Several previous studies have examined gender bias in rank. Johnson et.al.(1987), using a statistical technique called discriminate function analysis, found Rank to incorporate bias. Weiller (1990) and Broder (1993) also found that females are less likely to be promoted than males. Long, Allison and McGinnis (1993) controlled for the prestige of Ph.D., department, citations of publications written by their graduate advisor or mentor, quantity of articles written in their current rank, quality of articles written in their current rank and citations of their published work. Holding these factors constant, they found that women were still less likely to be promoted than men and, when promoted, to be promoted more slowly than men.

**Tenure Track** - We know of no research reporting on gender bias relative to assignment to non-tenure v. tenure-track positions. However, studies specific to higher education reveal that department chairs, deans and members of faculty search committees prefer curricula vitae attached to male names over the same vitae attached to female names (Fidell 1970; Top 1991; Steinpreis, Anders, and Ritzke 1999). Studies of access to different ranks at initial hire indicate gender bias. In a study of department chair response to descriptions of candidates whose gender was systematically altered on otherwise identical descriptions, Fidell (1970) found that male names were, on average, 10 percent more likely to be judged as deserving appointment at the tenured level (associate and full professor) than the female names. Consistent with Fidell's findings, Haignere et. al. (1996) found evidence of gender bias in initial rank assignment. At the twelve SUNY institutions examined, women were consistently less likely than men with comparable education and experience to be initially appointed at senior ranks (associate or full professor).

**Administrative Titles** - Concerning appointment to administrative titles, Johnsrud and Heck (1994) and Haignere et.al. (1996) found that being appointed to an administrative title is much more common for male than female faculty. Such appointments commonly increase salaries due, in part, to the additional administrative responsibilities involved. However, if women faculty members are not able to access these additional responsibilities and the attached salary rewards their salaries and careers may suffer. This problem is compounded by the practice of not removing administrative salary increments when the faculty member steps down, creating a substantial pool of mostly male faculty members who have no current administrative responsibilities but who have higher salaries than their comparable faculty colleagues. Any percentage increments exacerbate this problem.

**Rank Modifiers** - Rank modifiers at NCSU include visiting, research, clinical and distinguished. They are called rank modifiers because they are in addition to rank. For example research and visiting modifiers can and are attached to every rank level from lecturer to full professor. We know of no studies that specifically investigate gender or race bias in the assignment of rank modifiers. As reflected in the studies of rank, tenure and administrative titles, it may be that women and minorities are over-represented in the less prestigious and non-tenure-track rank modifiers, while white males predominant in the more prestigious ones.

**Frequency Table Tests** – We use frequency tables to study whether or not Rank, Tenure, Administrative Status and Rank Modifiers are likely to be "tainted" variables. The results help us estimate whether or not these variables may act to suppress any findings of salary bias. These tables can also suggest whether there are hiring and promotional processes that create glass ceilings for minorities and women.

Frequency tables provide the distribution of men, women and minorities in the institutional categories of interest.<sup>5</sup> By calculating the percent of all white men in a category and comparing with the percent of women and minorities in that category you can estimate the equality of the distribution. Where the representation of white men is proportionately equal to the representation of women and minorities it is less likely that a variable can mask or suppress bias in salaries.

The weakness of frequency tables is that they do not control for other variables. For example, the greater length of their faculty careers may explain the commonly seen predominance of white males at the full professor rank. Although frequency tables are not amenable to controlling most variables, it is possible to base the proportions examined on relevant factors. For example, noting that almost all faculty members with administrative titles are in the senior ranks (associate or full professors), we examined the proportions of women and minorities in senior rank who receive administrative titles rather than the proportion of women and minorities in the total population.

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<sup>5</sup> There are more advanced statistical analyses that can be used to assess whether or not gender and race bias are embedded in categorical variables such as rank, tenure and rank modifiers. (See Chapter 4 of *Pay Checks*.) These approaches statistically control for other variables such as years of experience and degree. If white men predominate in a particular rank or rank modifier because they have many more years of experience this difference can be controlled by categorical modeling or event history analyses. The time and resources needed to do these additional statistical analyses were not available for this study.

Variables that are found to have unequal distributions of white men, women and minorities in the expected directions are labeled potentially tainted variable. This means that we systematically vary their inclusion in the analyses so as to estimate whether or not they are actually functioning as suppressor variables and, if so, the range of the potentially masked salary disparity. For example, if the frequency tables indicate that rank modifiers could act as a suppressor variable, we conduct analyses with and without the rank modifiers. If there is little or no increase in the amount of gender or race salary disparity indicated we could conclude that rank modifiers do not suppress bias. Having established this there would be no reason to drop this variable from subsequent analyses. If, however, there is an increase in the amount of salary disparity indicated you have a range between the amount of disparity indicated with the potential suppressing variable in the analysis and when the potential suppressing variable is left out of the analysis. The first may underestimate salary disparities, the second may overestimate disparities, but the limit of this range is established.

### **Testing for Disparities in Faculty Salaries**

Realizing the potential for gender bias in their faculty salaries, many institutions of higher education have done studies examining whether or not there are systemic salary differences indicating discrimination against women as a class. These studies are commonly conducted using multiple regression analysis with Salary as the dependent variable.<sup>6</sup>

Consistent with the long history of salary equity studies at NCSU and as widely recommended in the literature, we used a statistical technique called multiple regression to assess salary disparities university wide at NCSU. For those interested in understanding more of the specifics of this analytical approach we have attached Appendix A from *Pay Checks: A Guide to Achieving Salary Equity in Higher Education* (Haignere et. al. 1996) which provides an introduction to multiple regression as it is used to study equity in salaries. Recognizing that our audience has a wide range of mathematical knowledge we have attempted to make it understandable to those who are not familiar with statistical techniques. The uninitiated may want to scan it before reading further in this report. It may prove helpful in interpreting the results.

The use of multiple regression analysis with Salary as the dependent variable involves accounting for the variations in salaries with a set of control variables such as Years of Experience, Highest Degree and Discipline. Controlling for these variables, we examine the impact of the gender and race variables. If the correlation coefficient<sup>7</sup> for a particular gender/race variable, such as Minority Men, is negative, the salaries of those in this category are less, on average, than those of comparable white men.

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<sup>6</sup> Among other sites, such studies have been conducted at the University of Maine System, University of Maryland Baltimore College of Dental Surgery, University of Hawaii at Manoa, University of Wisconsin-Stout, Memorial University of Newfoundland, the University of Illinois at Urbana-Champaign, Queens University, the University of Rhode Island, University of Western Ontario, the University of Connecticut, Concordia University, the University of Maryland at College Park, Kansas State University, Simon Fraser University, the University of Nebraska at Omaha, Monroe Community College, the University of Wisconsin at Madison and 29 institutions at the State University of New York. For more specific information on these studies and the methodological approach used see J. Allen, 1984; Geetter, 1988; Gray, 1990; Gray and Scott, 1980; Johnson, Riggs and Downey, 1987; McLaughlin, Zirkes and Mahan, 1983; Ramsey, 1979; Schau and Heyward, 1987; Schrank, 1977, 1985, 1988; Scott, 1977; Muffo, Braskamp, Langston, 1979; Brittingham and Pezzullo et.al., 1979; Hurley, R. et.al., 1981; Finkler, Van Dyke and Klawnsky, 1989 and Haignere et.al, 1996.

<sup>7</sup> In the case of the white-male line approach, the residual.

The three types of multiple regression models used in reviewing NCSU salaries are the ones most commonly reported in the literature. Here we describe each approach along with its primary advantages and disadvantages. Since we use all three regression methods for the university wide salary equity analyses, understanding the basic differences between these approaches is helpful in understanding the results.

**Total Population Salary Analysis** - The first approach uses the total population of faculty in deriving the regression equation. Men and women, minorities and non-minorities are included in the analyses. The dependent variable is Annual Salary in actual dollars. Gender and race are accounted for by entering the dummy variables for each race/gender category, such as Female or Asian male, etc. An advantage of this model is that the regression coefficients (also called parameter estimates) can be directly and easily interpreted in real dollar amounts. For example, the coefficient for the variable Female is the average salary difference between females and the default category, white males. If the coefficient is -1000, females are paid \$1,000 less than white males with comparable predictor variable scores. If the dummy variable African American Male is entered, then the average salary difference between African American males and the default category, white males, is indicated by the coefficient for the African American Males variable. Appendix A explains in detail this regression approach.

The disadvantage of the total population model is that it assumes that every factor that influences white male salaries affects female and minority salaries at the same rate. As a result, some discriminatory differences could get averaged away. For example, if males are rewarded \$1,000 for having a Ph.D. and females are rewarded \$500, the total population regression analysis masks this inequity because it looks only at the average reward for Ph.D. A comparison of the computer outputs of the Total Population and White Male Population analyses can estimate the degree to which women and men are being paid differently. (See pages 63 and 64 of *Pay Checks*.) If a problem exists, one way to eliminate it is to use the "white- male population" approach.

**White-Male Population Salary Analysis** - The second approach, the "white male only" model, has been widely promoted because it solves the problem of masking different rates of pay. This is the regression approach that has been used in the previous NCSU studies. To apply this method, you calculate a regression equation using only the white male faculty. This "white male" equation is used to predict what the salaries for women and minorities would be if their career attributes were rewarded in the same way as those of white males. (See Appendix A for how to calculate a predicted salary using regression.) The difference between each woman/minority's predicted salary, based on the white male equation, and his/her actual salary is called that person's salary *residual*. The average residual for a gender/race category measures the difference between the actual salaries of those in the group and the statistical estimate of what they would have been paid if their race had been "white" and their gender "male." A negative average residual indicates that the actual salaries of faculty members in the category (for example, Minority Men) are lower than their predicted salaries based on how white males are paid. A positive average residual means that, on average, the actual salaries of those in the race/gender category are higher than their predicted salaries using the white male equation.



While the white male population model is theoretically better because it shows how females and minorities would be paid if they were white and male, in practice it is difficult to use (Haignere et. al. 1996, p 59-63; Gray 1993, p. 149; 1991, pp. 71-72). A problem occurs any time there are no white males in a category where there are women and minorities. With no white males as comparators it is impossible to derive an accurate predicted salary for these women and minorities. At NCSU the problem of no white male faculty does not exist for the university level analyses but surfaces in the college level analyses.

**The Natural Logarithm of Salary Analysis** - The third model uses the Natural Logarithm ( $\ln$ ) of Salary instead of actual Salary as the dependent variable. Taking the natural log of salary means that you are no longer studying dollar units and that the parameter estimates are no longer directly interpretable in dollars. They become proportions by which a salary is changed when an independent variable increases by one unit. As a general rule, if the parameter estimates are multiplied by 100, they become percentages. For example, if white males are the default group and the coefficient for Female is -0.0234, then the average female in the population is making 2.34 percent less than the average white male.

The principal impact of logging salaries is on the highest and lowest salaries. It lowers the highest salaries, bringing them closer to the mean and the rest of the distribution (Hodson 1985, p. 376), and minimizes their effect on the regression results. If there are extremely high paid individuals who make several times as much as most people in the salary analysis, logging salaries could be very important in reducing the impact of these individuals on the regression results. Logging also reduces the lowest salaries, pushing them further from the mean and the rest of the distribution.

The results of natural log analyses usually have a higher adjusted  $R^2$  than the actual salary analyses because the natural log salary transformation can create a more "normal," less skewed distribution. The price for this improvement in the distribution of the data is that the results are not as easy to explain and interpret. Gray (1991, p. 73) notes that the "log model generally allows us to get a better fit to the data, but at the sacrifice of simplicity."

Economists commonly use logs in studies of the general population or where the range from the highest to lowest salaries is substantial because they lessen the gap between the mean and the high end of the salary distribution. But the occupational/institutional context of faculty salaries commonly restricts their variations to a much narrower and less skewed range than in the general population. Observing this, Ferree and McQuillian (1998 p. 23) concluded "that converting salaries to logarithms offered more cost in loss of ready interpretability than it was worth." We recommend conducting log of salary analyses if the range between the highest and lowest salaries is greater than a factor of ten. For example, if the lowest salary is \$25,000 and the highest salary is \$300,000, you should conduct log analyses. This disparity is rare for faculty salary ranges. The range of salaries in the database for the university level NCSU salary analyses is from \$20,000 to \$168,842. Since the highest salary is less than ten times larger than the lowest salary, it is not necessary to conduct natural log analyses. However, we have conducted the natural log of salary analyses and provided the results.

As indicated above, we have applied all three of these regression approaches in conducting the NCSU university-wide salary equity analyses.

## V. RESULTS

### **Results Concerning Variables with the Potential to Mask or Suppress Salary Inequities**

The objective of this first section of results is merely to estimate whether or not the variables Rank, Tenure, Administrative Status and Rank Modifiers may act to suppress findings of salary bias. Where the representation of white men is proportionately equal to the representation of women and minorities it is less likely that a variable can mask or suppress bias in salaries. The results presented here cannot be interpreted to demonstrate bias in any of the variables examined because frequency tables do not control for other variables. The objective is to establish whether or not it is necessary to systematically vary a variable's inclusion in the analyses so as to estimate whether or not it is functioning as a suppressor variable.

#### *Administrative Status*

Women and minorities do not receive administrative titles in equal proportions to white males relative to their presence on faculty as a whole. Of the white male faculty 13 percent are below department head administrators. For minority males this figure is 6 percent, for white females, 9 percent and minority females, 2 percent. However, faculty members rarely receive administrative titles unless they are in a senior rank - associate or full professor.<sup>8</sup> When we consider only those who reach the "feeder pool" senior ranks we find that white women receive administrative titles in proportions roughly equal to white males. Racial minorities do not get administrative titles in proportion to their access to senior rank. Roughly 10% of male minorities have administrative titles. To be roughly equal to white males this proportion would have to be at least 15% (see figure 3), an increase of fifty percent. No minority females have below department head administrative titles.

We note, however, that a large proportion of the administrative positions is in the College of Agriculture and Life Sciences (CALS). Of the 166 senior-rank administrators at the university 96 are in CALS, most of these are extension specialists, coordinators and department extension leaders. When we drop CALS from the frequencies, the picture changes. There are only 7 women administrators outside of CALS, a lower percent (6.7) than both white and minority males (10.3 and 9.4). Thus, outside of the College of Agriculture and Life Sciences senior-rank women appear to receive disproportionately fewer administrative positions than either white or minority senior-rank males.

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<sup>8</sup> The only administrative faculty members who are assistant professors are in the College of Agriculture and Life Sciences and the College of Natural Resources. They are primarily extension specialists.

*Figure 3*  
*Below department-head administrators by race/gender category*  
*percentage of senior rank faculty*

	White Males			Minority Males			White Females			Minority Females		
	Adm. Title	Sr. Rank	%	Adm. Title	Sr. Rank	%	Adm. Title	Sr. Rank	%	Adm. Title	Sr. Rank	%
Total NCSU	126	800	15.8%	10	107	9.4%	22	147	15.0%	0	22	0%
Without CALS	54	533	10.3%	9	96	9.4%	7	105	6.7%	0	20	0%

To clarify how each percentage has been created: 15.8% = 126 white-male administrators/800 total senior-rank white male faculty

**Administrator Summary** – Since the analyses in this report are at the university level, our summary here disregards the findings regarding the proportions for administrators without CALS. For the university as a whole, senior-rank white women hold administrative titles in roughly the same proportions as senior rank white men. Senior rank minorities do not hold administrative positions in the same proportion as white men and none of the minority women at senior rank hold administrative positions. These results lead us to conclude that having an administrative title could act to mask race disparity in salaries.

### *Rank Modifiers*

NCSU utilizes four faculty rank modifiers: visiting, research, clinical and distinguished.<sup>9</sup> Due to the vast differences between these categories, we have chosen to investigate each modifier separately.

**Visiting** – Faculty members with the rank modifier of visiting are found exclusively within the non-tenure-track ranks. Women, including minority women, constitute a substantially higher percentage of those with a rank modifier of visiting than do males based on either their proportions within the non-tenure-track (NTT) ranks, or their proportions among NCSU faculty as a whole. By contrast, minority males are proportionately less likely than white males to be in these ranks. (See Figure 4.)

*Figure 4*  
*Visiting faculty by race/gender category*  
*as percentages of all faculty and non-tenure-track faculty*

	White Male			Minority Male			White Female			Minority Female		
	#	Total	%	#	Total	%	#	Total	%	#	Total	%
Faculty Totals	60	1049	5.7%	3	161	1.9%	70	318	22.0%	10	53	18.9%
NTT Totals	60	127	47.2%	3	17	17.7%	70	113	62.0%	10	17	58.8%

**Research** – Those with the rank modifier of research are divided into two categories based on whether or not they are on non-tenure track. Women, including minority women, are a

<sup>9</sup> Additional NCSU rank modifiers including adjunct, extension and librarian. But these rank modifiers are not used with the faculty population included in the salary equity study.

lower percentage of research non-tenure-track (NTT) research appointments than are males based on either their proportions within the NTT ranks or their proportions among NCSU faculty as a whole. (See Figure 5.) The number of faculty members in tenure-track (TT) research positions is too small to support conclusions. This is particularly true of gender conclusions since there are only two white women and no minority women in these ranks. (See Figure 6.)

*Figure 5*  
*NTT Research faculty by race/gender category*  
*percentages based on all faculty and NTT faculty*

	White Male			Minority Male			White Female			Minority Female		
	#	Total	%	#	Total	%	#	Total	%	#	Total	%
Faculty Totals	26	1049	2.5%	8	161	5.0%	6	318	1.9%	1	53	1.9%
NTT Totals	26	127	20.5%	8	17	47.1%	6	113	5.3%	1	17	5.9%

*Figure 6*  
*TT Research faculty by race/gender category*  
*percentages based on all faculty and on TT faculty*

	White Male			Minority Male			White Female			Minority Female		
	#	Total	%	#	Total	%	#	Total	%	#	Total	%
Faculty Totals	7	1049	0.7%	4	161	2.5%	2	318	0.5%	0	53	0
TT Totals	7	922	0.8%	4	144	2.8%	2	205	1.0%	0	36	0

Clinical - Only eight-veterinarian non-tenure-track (NTT) faculty have clinical rank modifiers. Thus, we have used the College of Veterinary Medicine faculty and NTT faculty totals as the feeder pools. Women and minorities are more likely to be clinical than white males when faculty totals are used, and minorities are more likely to be clinical than whites when the NTT totals are used.

*Figure 7*  
*Clinical faculty by race/gender category as*  
*percentages of all veterinarian faculty and of NTT veterinarian faculty*

	White Male			Minority Male			White Female			Minority Female		
	#	Total	%	#	Total	%	#	Total	%	#	Total	%
Faculty Totals	2	71	2.8%	1	5	20.0%	3	32	9.4%	2	7	28.6%
NTT Totals	2	6	33.3%	1	2	50.0%	3	9	33.3%	2	3	66.7%

Distinguished – Although there is one associate professor with a rank modifier of distinguished, this rank modifier is primarily given to full professors. Therefore, we looked at the full-professor feeder pool as well as the tenure-track (TT) feeder pool to investigate the potential gender disparity in this category. Women are much less likely to be awarded a rank modifier of distinguished than men regardless of which population is used. Supporting the observation that the difference is one of gender, minority men are more similar to white men in

the percent distinguished, but no minority women receive this rank modifier. (See Figure 8.)

*Figure 8*  
*Distinguished faculty by race/gender category*  
*percentages of full professors and of all TT faculty*

	White Male			Minority Male			White Female			Minority Female		
	#	Total	%	#	Total	%	#	Total	%	#	Total	%
Full	55	499	11.0%	6	61	9.8%	2	64	3.1%	0	5	0%
TT Totals	56	922	6.1%	6	144	4.2%	2	205	1.0%	0	36	0%

Note: One white male is a distinguished associate professor, so he was left out of the first row's numbers since they only referred to full professors.

**Rank Modifiers Summary** – With the exception of the clinical rank modifier used only by the College of Veterinary Medicine, the differences regarding rank modifiers appear to be more related to gender than race. With regard to the visiting, research and distinguished rank modifiers, the minority male results are more similar to those of the white males than those of the minority females. There is a general pattern of women disproportionately having the rank modifier of visiting and being less likely to hold positions with research and distinguished rank modifiers. These results lead us to conclude that these rank modifiers could act to mask gender bias in salaries while the rank modifier of clinical could suppress race bias in salaries.

### *Tenured*

Tenure-track women and minorities who have received a senior rank tend to be equally likely to be tenured. Essentially almost all those who reach senior rank are tenured. This is not to say that tenure-track women and minorities are tenured in the same proportions as white males. They are not, but the greater proportion of women and minority assistant professors accounts for the difference. When we consider only those who reach senior ranks, we find that women and male minorities are only slightly less likely to be untenured.

*Figure 9*  
*Tenured faculty by race/gender category*  
*percentage of senior rank tenure-track faculty*

White Male			Minority Male			White Female			Minority Female		
#T	#TT	%T	#T	#TT	%T	#T	#TT	%T	#T	#TT	%T
767	781	98.2%	104	107	97.2%	141	146	96.6%	21	22	95.5%

#TT = Total number of faculty on tenure-track

#T = Total number of faculty tenured

**Tenured Summary** – Figure 9 indicates that of the senior-rank (associate and full professors) faculty, 98.2% of white males at NCSU are tenured. By comparison, 97.2% of minority males, 96.6% of white females, and 95.5% of minority females at NCSU are tenured. While the differences are in the expected direction, they are slight. These results lead us to conclude that being tenured is unlikely to mask gender or race bias in salaries.



### *Tenure-Track*

Women, including minority women, are less likely to hold tenure-track lines than are men. This is true whether we consider all faculty members or only those that have Ph.D. or equivalent degrees. However, when we look just at those who have a Ph.D. or equivalent degree, the gap between the proportion of women and men who hold tenure-track lines substantially decreases from a gap of 20 to 24 percentage points to a gap of 10 to 12 percentage points.

*Figure 10  
Tenure-track faculty by Ph.D. or equivalent and  
race/gender category*

	White Male			Minority Male			White Female			Minority Female		
	#TT	Total	%TT	#TT	Total	%TT	#TT	Total	%TT	#TT	Total	%TT
Faculty Totals	922	1049	88%	144	161	89%	205	318	64%	36	53	68%
Ph.D. Totals	889	960	93%	137	149	92%	197	243	81%	35	42	83%

**Track Summary** – Figure 10 indicates that, of the faculty with Ph.D. or equivalent degrees, 93% of white males and 92% of minority males are in tenure track positions, of white and minority females 81% and 83% respectively hold tenure track positions. We conclude that being on tenure track could mask gender bias in salaries.

### *Rank*

**Tenure-Track Ranks** - Minorities and women are less likely to have made it into the full professor rank with women even less likely than minority men to be full professors and minority women much less likely to be full professors than any other race/gender category. (See Figure 11.) By contrast, minorities and women are more likely to be in the associate and assistant professor ranks. The order of difference is the same as for the full professor category, with minority men's proportions being most similar to white males while white and minority women are progressively less similar to white males.

*Figure 11  
Tenure-track population by race/gender category and current rank*

Rank	Tenure-Track							
	White Male		Minority Male		White Female		Minority Female	
	#	%	#	%	#	%	#	%
Full	499	54.1%	61	42.4%	64	31.2%	5	13.9%
Associate	282	30.6%	46	31.9%	82	40.0%	17	47.2%
Assistant	141	15.3%	37	25.7%	59	28.8%	14	38.9%
Total TT	922	70.5%	144	11.0%	205	15.7%	36	2.8%

To clarify how each percentage has been created:

54.1% = 499 white male full professors / 922 white male tenure-track faculty

70.5% = 922 white male faculty / 1307 total tenure track-faculty

### Rank Modifier Ranks

*Those with little or no rank variation* - Out of 64 distinguished faculty, 63 are full professors. The one associate professor with a distinguished rank modifier is a white male. Among those with the clinical rank modifier there is no comparison across ranks. All eight of the College of Veterinary Medicine clinical faculty members are in the assistant professor rank.

*Research Ranks* - The pattern of gender/race distribution in the research ranks can be seen without percentage figures because the numbers are small and the patterns are clear. In the non-tenure-track research ranks, white males hold senior rank positions; minorities and women do not. (See Figure 12.) Of the eleven minority and white males in tenure-track research ranks ten are at senior ranks, but so is one of the two white females in these ranks. The number of faculty members in tenure-track research positions is too small to support conclusions.

**Figure 12**  
*Research faculty by race/gender category, tenure status and current rank*

Rank	Research								Rank Totals
	Non-Tenure-Track				Tenure-Track				
	White Male	Minority Male	White Female	Minority Female	White Male	Minority Male	White Female	Minority Female	
Full	6	0	0	0	2	2	1	0	11
Associate	3	0	0	0	4	2	0	0	9
Assistant	17	7	6	1	1	0	1	0	33
Lecturer	0	1	0	0	0	0	0	0	1
Totals	26	8	6	1	7	4	2	0	54

*Visiting Ranks* - Out of 83 women and minorities with the rank modifier of visiting only one (1.2%) holds a senior rank. Out of the 60 white men with the rank modifier of visiting ten (17%) hold senior ranks. Over two-thirds of the women and minorities in the visiting ranks are in the lecturer rank compared to half of the white males. (See Figure 13)

**Figure 13**  
*Visiting faculty by race/gender category and current rank*

Rank	White Male		Minority Male		White Female		Minority Female	
	#	%	#	%	#	%	#	%
Full	5	8.3%	0	0%	1	1.4%	0	0%
Associate	5	8.3%	0	0%	0	0%	0	0%
Assistant	18	30.0%	1	33.3%	13	18.6%	2	20%
Instructor	2	3.3%	0	0%	8	11.4%	0	0%
Lecturer	30	50.0%	2	66.7%	48	68.6%	8	80.0%
Totals	60	100%	3	100%	70	100%	10	100%

### Instructor and Lecturer Ranks

Women, including minority women, are disproportionately in the non-tenure-track ranks of instructor and lecturer. Relative to the proportion of women on the faculty as a whole, 21 to 24 percent are in these two ranks. For white and minority men these figures are 5 and 6 percent. (See Figure 14.)

*Figure 14*  
*Lecturers and instructors by race/gender category*  
*percentage of total population*

Rank	White Male			Minority Male			White Female			Minority Female		
	#	Total	%	#	Total	%	#	Total	%	#	Total	%
Instructor	6	1049	0.6%	0	161	0%	13	318	4%	1	53	2%
Lecturer	65	1049	6%	8	161	5%	77	318	24%	11	53	21%

It is commonly believed that the lower proportion of women faculty holding Ph.D. degrees explains the higher proportion of women in the instructor and lecturer ranks. To assess this we looked at the proportion of women in these ranks relative to faculty members whose highest degrees are below Ph.D. Even when we take the highest degree level into account women make up much higher proportions of those in the ranks of instructor and lecturer. (See Figure 15.)

*Figure 15*  
*Below Ph.D. lecturers and instructors by race/gender category*  
*percentage of faculty with highest degree below Ph.D.*

Rank	White Male			Minority Male			White Female			Minority Female		
	#	Total	%	#	Total	%	#	Total	%	#	Total	%
Instructor	3	89	3%	0	12	0%	8	75	11%	1	11	9%
Lecturer	50	89	56%	5	12	42%	58	75	77%	8	11	73%

**Rank Summary** – Women, including minority women, are disproportionately at lower ranks whether we are examining the tenure-track ranks or the rank modifier and non-tenure track ranks. The minority male distribution across the ranks is more similar to that of white males than that of minority females. As with all of these frequency table examinations, the results could be explained by bias or by non-discriminatory factors. For example, the disproportionately low representation of women in the full professor tenure track rank and their predominance at the associate professor rank could indicate a glass ceiling at the full professor level, or it could merely reflect “time in the pipeline.” The consistency of the direction of the rank proportions, however, causes us to conclude that Rank could act to mask gender bias in salaries.

### *Implications for the Salary Analyses*

The results of the frequency-distributions analyses indicate that disproportional representation exists in the awarding of rank, non-tenure track positions and rank modifiers. Thus, it is feasible that these variables mask gender and or race disparity when included in the regression analyses of salaries. The classic dilemma regarding potentially tainted or confounding variables is that excluding them may overestimate disparity while including them may

underestimate disparity. We address this dilemma by systematically varying the inclusion of these variables as indicated in the next section.

## Salary Results

### *Predictor/independent variables*

The objective of multiple regression analyses for disparity in salaries is to assess whether or not salaries appear to include gender or race disparity once predictor variables that legitimately relate to salaries are controlled. Besides Gender and Race, the predictor/independent variables used for the NCSU analyses include Tenure Status, Rank, Administrative Title, Highest Degree, Years Between Highest Degree and NCSU Hire, Years in Current Rank, Years at NCSU Prior to Current Rank and College/Discipline.<sup>10</sup> While all of these variables can legitimately relate to salary, some may also have discrimination embedded in them that could mask or suppress race/gender effects.

As noted in the previous section, the results of the frequency distributions tainted variable analyses indicate that bias may exist in the awarding of rank, tenure track positions and rank modifiers.<sup>11</sup> Thus, these variables present us with the classic dilemma regarding potentially tainted variables: excluding them may overestimate salary disparity, including them may underestimate salary disparity. We address this dilemma by systematically excluding each potentially tainted variable with the exception of rank. Rank is included in all analyses. As is indicated in Chapter 4 of *Pay Checks*, even when there is considerable evidence of bias in current rank assignment, we recommend the conservative approach of including Rank in the analyses. Having done so, however, it is important to remember that the results probably underestimate the amount of disparity that exists in salaries. For those who would like to see the results with all of the potentially tainted variables excluded from the analyses, we have provided these results in Appendix C.

To indicate the results of systematically excluding the potentially tainted variables of Rank Modifiers and Tenure-Track, we begin by reporting the extreme of including all the potentially tainted variables in the analyses. Next we drop the Rank Modifiers. Dropping the Rank Modifiers provides balance for leaving ranks in the analyses. Regarding the visiting, clinical and research rank modifiers, leaving them out is consistent with the NCSU salary equity analyses done in previous years. However, with the addition of faculty with the rank modifier of distinguished to this year's data, leaving out rank modifiers also leaves out the distinguished distinction.

Finally, we drop the distinction between tenure-track and non-tenure-track assignments. It is important to note that the distinction of being tenured is not erased. Since there is little evidence of proportionately fewer senior rank women and minorities receiving tenure there is no basis for excluding the distinction of tenured. However, all those without tenure are

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<sup>10</sup> To test for the impact of receiving promotion in a year when State funding for higher education is low we conducted separate analyses of the population of faculty that have received a promotion subsequent to 1981. See Appendix B for the results.

<sup>11</sup> Having observed that minorities were less likely to hold administrative titles, we conducted an analysis of the effect of dropping this variable. The impact was to increase by \$50 the amount of bias indicated in salaries of minority males. There was essentially no impact on the salary bias indicated for women.

combined, meaning that the regression model cannot distinguish between those on tenure track but not yet tenured and those not on tenure track. This allows us to see the extent to which the greater proportional representation of women in non-tenure track lines could mask gender disparity in salaries.

The results provide a range from the amount of disparity indicated when tainted variables could be masking disparity, to the amount of disparity indicated when two of the three potentially tainted variables are not used and, therefore, could not be masking salary disparity.

### *Race/gender categories*

After initial examinations of the results for seven (see Appendix D) race/gender categories we reduced the race/gender groups to females and minority males. These two groups are compared to the white-male reference group. Combining groups has several advantages. It increases the number of individuals in the categories being studied and provides continuity with the categories used in previous NCSU salary equity studies. Combining the minority women with white women is consistent with the institutional patterns displayed in the tainted variable frequency tables. These patterns suggest that minority women are more similar to white women than minority men.

Notably, reducing the race/gender categories actually slightly improves the adjusted  $R^2$  measures. This result indicates that consolidating the race/gender categories does not reduce the amount of variation in salaries that is accounted for by the regression procedure.

### *Findings – systematically dropping potentially tainted variables*

*Figure 16*  
*Regression results with all potentially tainted variables in the analyses*

Race/Gender	Number	Total Population Coefficient	Natural Log Coefficient*	White Male Line Residual
Females	371	-678	-436	-987
Minority Males	161	-1377	-925	-1671

\*These are the dollar equivalents of the natural log coefficients.

The results reported in figure 16 include all of the potentially tainted variables and could be considered a comparable extreme to leaving all the potentially tainted variables out of the analyses including rank. (See Appendix C.) The results provided on the above table can be interpreted as dollar measures indicating how a race/gender group compares with the white-male reference category. For example, the first number in the third column indicates the finding of the total population salary analyses that women faculty members earn \$678 less on average than white male faculty members do, when all of the variables in the analysis are held constant. The next column reports the finding of the total-population natural log analysis and shows less disparity with women faculty making \$436 dollars less on average than white males. The last column reports the result of the white male line analysis that indicates more disparity than the other two methods, \$987.



All coefficients are negative, indicating that, even with all the potentially tainted variables included, white males have higher salaries, on average, than minorities and women. This result is consistent across the three regression modeling approaches. The natural log of salary analysis shows less disparity than the salary analysis and the white-male analysis shows more for both women and minority men. All three regression models indicate more disparity for minority males than for females. The complete regression equations resulting from these analyses are provided in Appendix E.

*Figure 17*  
*Regression results without the rank modifier distinctions*

Race/Gender	Number	Total Population Coefficient	Natural Log Coefficient*	White Male Line Residual
Females	371	-882	-691	-1270
Minority Males	161	-1511	-1085	-1908

\*These are the dollar equivalents of the natural log coefficients.

When the potentially tainted Rank Modifier variables are left out of the analyses the amount of salary disparity indicated increases for both women and minority men. Again, the results indicate more disparity in the salaries of minority males than women. The relative magnitude of the findings are consistent with those reported in Figure 16 with the lowest disparity shown by the natural log analysis and the most disparity shown by the white-male line analysis. The complete regression equations for all three of these gender analyses of faculty salaries are provided in Appendix F.

*Figure 18*  
*Regression results without rank modifiers and the non-tenure track distinction*

Race/Gender	Number	Total Population Coefficient	Natural Log Coefficient*	White Male Line Residual
Females	371	-1093	-936	-1489
Minority Males	161	-1349	-897	-1785

\*These are the dollar equivalents of the natural log coefficients.

Figure 18 indicates that when the potentially tainted variable of non-tenure track is not included in the analysis the impact on the results for female faculty is different from that on the minority male faculty. The amount of disparity for minority males decreases for all three regression-modeling methods. The results for disparity in female faculty salaries are in the opposite direction with the amount of disparity increasing for all three methods. Again, the natural log of salary analysis shows less disparity than the salary analysis and the white-male analysis shows more. Two of the three regression models indicate more disparity for minority males than for females. The complete regression equations for all three of these gender analyses of faculty salaries are provided in Appendix G.

### *Findings – restricting the population to tenure-track faculty without rank modifiers*

To provide more information we decided to repeat the analyses on a restricted subset of the university population including only tenure-track faculty with no rank modifiers. This subgroup of NCSU faculty includes 1230 tenure-track faculty members with 237 females, 134 minority males and 859 white males. It is important to note that this subset contains proportionately fewer women than the total NCSU population. The reduction of white males from 1049 to 859 represents an 18% reduction. The reduction of minority men from 161 to 134 represents a 17% reduction. The reduction of women faculty from 371 to 237 represents a 36% reduction. Despite this disproportionate loss of women faculty, we decided to conduct these analyses to provide information on salaries without the confounding impact of non-tenure-track appointments and rank modifiers. The complete regression results for this analysis are provided in Appendix H.

*Figure 19*  
*Regression results for NCSU tenure-track faculty members who have no rank modifiers*

Race/Gender	Number	Total Population Coefficient	Natural Log Coefficient*	White Male Line Residual
Females	237	-958	-975	-1167
Minority Males	134	-2012	-1654	-2424

\*These are the dollar equivalents of the natural log coefficients.

When we compare the results shown on Figure 19 with those of Figures 17 and 18 we see that there is evidence of more salary disparity for minority males from all three analyses and more salary disparity for the females from the log of salary analyses. The white-male line analysis for females indicates less disparity than shown on Figures 17 and 18, while the total population results falls between the amounts shown on Figures 17 and 18.

## VI. DISCUSSION

### **Potentially Tainted Variables**

The tainted variable frequency table analyses indicate areas of disparity in the awarding of rank, tenure track positions and rank modifiers. In regards to rank modifiers, there is a general pattern of women, including minority women, being disproportionately visiting and less likely to be in research positions. Women do not hold distinguished professor rank modifiers in the proportions that men do. Women are less likely to be in tenure-track lines than are men even when controlled for degree level. Minorities are less likely to hold below department head administrative positions.

Concerning ranks, minorities and women are less likely to have made it into the full professor rank. White women are less likely than minority men to be full professors and minority women much less likely to be full professors than any other race/gender category. Even though women and minorities predominate in the visiting ranks, only one (1.4%) white woman holds a senior rank visiting appointment. By comparison, 17 percent of white males

hold senior rank visiting positions. (See Figure 13.) Over two-thirds of the women and minorities in the visiting ranks are lecturers compared to half of the white males.

As indicated above, the weakness of frequency tables is that they do not control for other variables. For example, the greater length of their faculty careers may explain the commonly seen predominance of white males at the full professor rank. There are more advanced statistical analyses that can be used to control for both continuous and categorical variables while studying gender and race bias in rank, tenure and rank modifiers. (See Chapter 4 of *Pay Checks*.) Here we have only used the uncontrolled frequency tables to allow us to predict which variables may mask gender or race disparity in salaries.

We were pleased to note that for the variable Tenured there was little difference between the white-male frequencies and those of women and minority males. For Administrative Title there was little gender difference. To the degree that the university can address the under representation of women and minorities in the categories examined, some of the complexity of diagnosing systemic gender and race differences can be minimized. When a variable is determined to be potentially tainted we are left with the dilemma that excluding them may overestimate disparity while including them may underestimate disparity. Although we address this dilemma by systematically varying the inclusion of these variables, we are left with a range of estimated salary disparity that complicates diagnosis.

### **The Results of the Three Regression Approaches**

There is no absolutely correct regression approach for studying salary inequities. The variables included and the type of model used have methodological impact. For this reason, we have tested three different models, assessed variables for potential taint and checked for individual outliers that might disproportionately impact the findings.

In Section IV – Study Design and Methods, we explain some of the differences in the three methods used. These differences help to explain how the three models vary. The total population models assume that every factor that influences white male salaries affects female and minority salaries at the same rate. Using the white male equation eliminates this constraint. Thus, the white male population model is theoretically better because it shows how females and minorities would be paid if they were white and male. The common drawback of the white-male equation, categories where there are no white males but are women and minorities, does not occur in these university wide NCSU analyses.

Concerning the natural log of salary analyses, we have eliminated the complexity of interpretation by providing a translation of the coefficients to dollars. The log results tend to show less salary disparity than the actual salary or white male equation analyses. As noted, logging salaries lowers the highest salaries bringing them closer to the mean and the rest of the distribution (Hodson 1985, p. 376) and minimizes their effect on the regression results. Thus, the impact of individuals who make several times as much as most people in the salary analysis is reduced. As indicated in Section IV, conducting log of salary analyses is recommended if the range between the highest and lowest salaries is greater than a factor of ten. The range of salary differences at NCSU is not of this magnitude (\$20,000 to \$168,842). Therefore, the

extreme salary differences usually addressed by logging salaries are not present at NCSU.

The pattern of the amount of salary disparity indicated is consistent across the three regression approaches. The white-male line analyses consistently provide the highest estimate of salary disparity (ranging from -987 to -1489 for Females and -1671 to -2425 for Minority Males). The total population salary analyses provide the intermediate amount of disparity indicated (ranging from -678 to -1093 for Female and -1377 to -2012 for Minority Males). The log salary analyses provide the lowest estimate of disparity, with the exception of the Females result in Figure 19 (ranging from -436 to -975 for Female and -957 to -1654 for Minority Males).

### **Suppressor Effects**

When rank modifiers are dropped from the analyses the indication of disparity increases for both the Females and Minority Males. More specific analyses indicate that the inclusion of the distinguished and visiting rank modifiers decreases the amount of disparity indicated for Female while the inclusion of distinguished and research rank modifiers decreases the amount of disparity indicated for Minority Males.

When the non-tenure-track distinction is eliminated from the analyses along with the rank modifiers, the coefficients for minority-male salaries become less negative. This result indicates that the non-tenure-track variable is not suppressing salary disparity findings for minority males. For women, the increases in salary disparity when we eliminate the non-tenure-track distinction support the hypothesized suppressor effects. These findings are consistent with the frequency table observations that minority men are represented in proportions similar to white men, while higher proportions of women, including minority women, are in non-tenure-track lines.

### **Population Subset - Tenure-track faculty with no rank modifiers (N=1230)**

Our analyses of the subset of tenure-track faculty without rank modifiers reinforced the findings from the total population analyses. The negative coefficients for females (see Figure 19) are at roughly the same magnitude as the analyses without rank modifier distinctions and without the non-tenure-track distinction (see Figures 17 and 18). More disparity is indicated in minority male salaries, from four to six hundred more than the results for the total population.

### **Diagnosis — Do systemic race and gender salary disparities exist?**

The university wide analyses indicate that there is reason to be concerned about both gender and race salary disparities. When we subset the NCSU faculty population so as to eliminate all potential suppressor variable effects by studying only tenure track faculty who do not have rank modifiers, the results indicate roughly \$1000 annual salary disparity between women faculty and comparable white males. For minority males there is a disparity in the neighborhood of \$2000 between them and comparable white males. These amounts are roughly equal to the midrange of the disparities indicated when we systematically vary the potentially tainted variables included in the regression analyses for the whole NCSU faculty population. In our opinion these are substantial salary disparities that need to be addressed.

### *Role of Statistical Significance*

In diagnosing salary disparities the question of statistical significance commonly arises. The significance levels of the salary coefficients are reported in the appendices. Most do not reach statistical significance. Significance levels are also called probability levels. This is a less misleading name because what is being measured is the probability of replicating the findings in another sample. Probability levels were developed for use with inferential statistics. Inferential statistics make inferences about a whole population based on a sample. As is true of most faculty salary studies, we are directly examining the entire faculty population at NCSU. If we took a random *sample* of faculty members and found a salary difference related to gender or race, we would use a significance test to estimate whether this finding was due to chance or whether we could expect the same difference if we selected another sample or examined the entire population.

In our opinion, recognizing the limited role of statistical significance when a population is being studied (See Chapter Six of *Pay Checks* for further discussion of the Significance of Significance) and therefore, looking at the substantive importance of the results is the appropriate approach. If eliminating salary discrepancies improves morale, recruitment, retention and fairness, asking if it is statistically significant is the wrong question.

We recommend that tests of statistical significance be used as one piece of information in weighing the importance of the results. The importance of any salary differences found should be weighed in light of the general pattern of the findings and should not be strictly a statistical decision. The NCSU regression results are robust. In no case is there a result that indicates that women or minority males are paid more than white-males. If the findings were reversed and every test showed that white-males were paid less than women and minorities there would be no question of the interpretation. We are accustomed to gender and race salary disparities that favor white males and, therefore, find it easy to shrug off the consequences. The absence of statistical significance should not be viewed as proof of the absence of bias. There is a pervasive pattern of negative coefficients and residuals for the Female and Minority Male variables.

### *NCSU Context and College Level Analysis*

NCSU has an impressive history of doing salary equity studies annually. These studies have emphasized college level analyses and used the white-male equation approach. Little attention has been paid in the past to the university level analyses. It remains to be seen whether the university level analyses will be used differently this year. If it is determined that salary adjustments will be made based on the university level analyses, it may be important to focus further on the variations in the results of the different regression models.

Conducting college level analyses should pose few problems at the four largest NCSU colleges: Agriculture and Life Science, Humanities and Social Science, Engineering and Physical and Mathematical Sciences. At the College of Veterinary Medicine and the remaining five of the NCSU colleges the small number of faculty may lead to methodological complexities. The general rule of five cases per independent/predictor variable should be respected. At the smaller colleges, respecting this limit usually means combining or eliminating some variables. White-male analyses may be particularly problematic for these



smaller colleges. Not only are there many fewer faculty members in white-male analyses but calculating the average residuals for the women and minorities requires excluding any women and minorities for whom there is no white-male match. For example, if there are no Below Ph.D. white male faculty, any woman or minority faculty member without a Ph.D. or equivalent degree could not be included in the calculation of the average female or minority salary residual.

### *Remedy*

Whether the university wide or college level results are used, it makes sense to consider a class-based remedy compatible with the multiple regression statistical method used in both the current and historical NCSU annual studies. Salary bias identified by multiple regression is by definition not individual, but pertains to the class or systemic differences (Gray and Scott 1980). Accordingly, it is controversial to base remedies on the individual-level predicted salaries provided by the multiple regression. Multiple regression results, like averages, indicate class, rather than individual differences. A class can be any group membership such as a rank, discipline, highest degree, gender, race or hiring cohort - but not an individual. If you assume that bias is individual not systemic, there is no reason to conduct a multiple regression analysis. Statistical methods do not adequately address the individual level. Even if they did, the data available for most salary analyses are not adequate or appropriate for suggesting remedies for individual cases of salary disparity.

Remedies that are distributed to all those in the affected group can be applied easily, efficiently, promptly and without prolonged attention to the issue. Any remedy that involves only those whose predicted salaries are below their actual salaries is misguided. When the regression coefficient for any group or class studied is negative, everyone in that group is, on average, paid less than everyone in the comparator/default group. For example, if the default rank is associate professor and the variable for assistant professor has a negative coefficient, this indicates that, on average, all assistant professors are paid less than associate professors. To assume that being an assistant professor affects only those who are paid below the associate professor line misuses this finding.

Some practical problems involved with applying remedies are explained in Appendix I along with a discussion of the underlying assumptions implicit in many of the debates over how to study and how to correct faculty salary disparities.