Measuring Salary Equity for Women at University of Wyoming

Wendy Stock, Nicole Ballenger, Anne Alexander, and Lisa Muller[1]

March 2008

[1] The authors are, respectively, Professor and Co-Head, Department of Agricultural Economics and Economics, Montana State University; Professor of Agricultural and Applied Economics and Associate Vice President for Academic Affairs, University of Wyoming; Director of International Programs and Adjunct Assistant Professor, Department of Economics and Finance, University of Wyoming; and Research Scientist, Office of Institutional Analysis, University of Wyoming.

Abstract
Measuring Salary Equity for Women at University of Wyoming

Salary equity between the genders has been an issue of concern and action in the academe for some years now. Women academics at public doctoral universities on average earn 79 percent of men's salaries, and at the University of Wyoming (UW) women across all academic ranks earn 84.2 percent of their male counterparts' salaries. As at the national level, fewer women occupy positions of higher rank at UW.

This paper investigates the compensation differentials between women and men at UW using a snapshot of data from 2006. The results of three models, including a single-equation regression model, an interaction term model, and a multiple-equation Oaxaca decomposition model, are compared. These models are intended to examine whether systematic differences in salaries and returns to professional characteristics exist between men and women after controlling for seniority, discipline, and other appropriate and available factors, and to identify portions of gender pay gaps that are attributable to observable differences in characteristics and portions that are unexplained. In our single-equation regression model, we find that although there are statistically significant differences in the raw mean salaries for males and females, these differences disappear once other variables are included in the regression. In fact, the demographic characteristics that are statistically significantly in determining salaries, once other factors are controlled for, are age and U.S. citizenship. An interaction-term model shows that the estimated coefficients on the interaction variables are generally not statistically significant, so that we conclude that each gender is treated similarly in the salary allocation process. In the multiple-equation Oaxaca decomposition model, the decomposition estimates a positive differential treatment for females relative to males, with the implication that if males and females had equal returns to their characteristics, the pay gap between the two groups would be slightly *larger* than it actually is. One caution with respect to this interpretation however, is that the largest part of the difference in characteristics between males and females occurs in the rank variables. If males and females moved through the ranks at similar levels, the pay gap would be much smaller. Thus, we find that differences in the mean annual salaries of men and women largely disappear once other factors expected to influence salary are controlled for in a regression model. In addition, estimates of any differences in the *returns* to characteristics between genders are largely insignificant. One notable exception, however, is the much more negative return to non-tenure-track status relative to tenured status for females than for males.

INTRODUCTION

Salary equity between the genders has been an issue of concern and action in the academe for some years now. Differential salary treatment based on gender alone, as opposed to disciplinary or experience differences, continues to be the subject of legal action. For example, as recently as September of 2007 the EEOC filed an action against Adelphi University alleging it pays full-time female professors less than males with similar professional characteristics.

The AAUP's Faculty Gender Equity Indicators 2006 showed that, on average across all ranks (and not accounting for discipline), women academics at public doctoral universities earned nearly 79 percent of men's salaries. Tenured or tenure-track faculty members have smaller differentials – female assistant professors earn 91.6 percent of their male counterparts' salaries, associates earn 92.8 percent and full professors earn 91.6 percent. Female progression through the ranks is also of concern. Forty one percent of tenure track professors at public doctoral universities are female; only 26 percent of tenured professors are female.

Gender pay gaps at University of Wyoming (UW) are only slightly smaller than the national averages, according to the AAUP 2006 report. Women across all academic ranks earned 84.2 percent of their male counterparts' salaries. Full professors who were female earned 92.1 percent of the salaries of full professors who were male, while female associate professors earned 98.7 percent and assistant professors made 93.4 percent. Like at the national level, fewer women occupy positions of higher rank.

Salary levels of all UW faculty, women and men alike, in relation to the salaries of their peers nationally, have mirrored the highs and lows of the Wyoming state budget. The state budget, in turn, mirrors the "booms and busts" in energy market. In the early-1980s, Wyoming faculty salaries were among the highest for the nation's four-year public institutions of higher education. They ranked third in 1983 and 7th in 1986, according to data from the U.S. Department of Education, National Center for Education Statistics. Then, through more than a decade of soft energy prices, Wyoming faculty received salary raises in only a few years. By 1991 Wyoming faculty salaries ranked 26th; by 1996 they ranked 44nd; and they had fallen to 46th by 2001.

Raises appropriated by the Wyoming Legislature during the current energy boom have begun to help reverse the "free fall" in UW salaries in relation to national averages. For example, between 2001 and 2007, full professor salaries at UW increased on average 5.5 percent a year in contrast to an increase of 3.7 percent at U.S. public doctoral-level universities. (Academe and UW Office of Institutional Analysis)

Raise monies offer an opportunity to advance faculty salaries generally but also to redress any salary inequities that may exist. *Raises administered in proportion to recent performance only, if they do not correct for inequities already in place, serve to perpetuate those inequities into the future and possibly even magnify them.* UW's Office of Academic Affairs requests the college deans to consider equity when formulating their raise recommendations—and, in fact, in conjunction with raises the Vice President for Academic Affairs reviews salaries of women and also faculty of color. However, such efforts have been by and large *ad hoc*, or based on "eyeballing" spreadsheets containing salary and other pertinent data. The purpose of this study is therefore to develop and implement a statistically rigorous approach to assessing faculty salary equity at the institution level. A methodological contribution of this study is the use of several alternative model specifications. By combining and comparing statistical results from the several models, we achieve a more robust assessment of salary differences.

BACKGROUND

University of Wyoming is one of the smaller U.S. land-grant universities, classified by the Carnegie Foundation as a high research-activity university. The majority of the students and almost all of the 617 tenured or tenure-track faculty members and 193 extended-term-track academic professionals[2] --counts as of fall 2007-- are located on the Laramie campus. UW's geographic location poses challenges to recruiting and retaining women faculty. The university is the area's principal employer and the city offers few alternative employment opportunities for those with advanced degrees, including partners of UW faculty. Laramie is located just 2-3

[2] Extended-term-track academic professionals include lecturers, research scientists, and extension educators who have undergone or are in the process of undergoing peer review for extended-term contract appointments of six years.

hours from Denver, Colorado, but likely seems too far "off the beaten track" for those who prefer an urban lifestyle, especially in winter when weather conditions make travel difficult. Laramie's population is also predominantly white, and exhibits less cultural and ethnic diversity than many university environments. Despite these characteristics, some meaningful progress has been made in increasing the numbers and percentages of women with academic appointments (see table 1).

It is important to ensure that salary inequities do not contribute to failure to advance the goal of increasing diversity at UW, including hiring and retaining women faculty. Indeed, salary differentials are likely the most easily remedied source of inequity. Other efforts to address equity concerns will ring hollow if compensation is not fundamentally fair.

PREVIOUS RESEARCH ON UNIVERSITY SALARY EQUITY

Research on university salary structures has been reviewed recently by Barbezat (2002). Such research dates back to the 1970s, partly in response to changes in the legal environment (including affirmative action) and partly as a result of a plateau in university pay structures during that period. Studies have generally found that female faculty members earn less than their male counterparts with similar measurable characteristics (Toutkoushian, 2003; Barbezat, 1991; Ransom and Megdal, 1993).

The literature identifies several ways to measure salary differences among demographic groups. For example, if there are two groups of workers (e.g., male and female), one could simply measure the difference between their average salaries:

$$(1) \qquad \Delta\bar{S} = \bar{S}_m - \bar{S}_f$$

Where $\bar{S}_m$ is the average wage of males in the study and $\bar{S}_f$ is the average wage of females in the study. There are several problems with this simple comparison, however, most importantly that simple differences in averages compare workers in different disciplines, with different educational levels, hours of work, and experience, and other factors generally thought to be legitimate determinants of salary.

Single Equation Models

Barbezat (2002) notes in her review, "by the end of the 1970s a consensus had developed regarding the use of multiple regression analysis as the preferred method of estimating pay equity" (p. 16). Rather than a comparison of mean salaries delineated only by gender, a better model compares wages of similar workers after adjusting the raw mean differential for differences in seniority, discipline, and other factors. Early institution-level studies of university pay structures tended to regress salary on faculty rank and other characteristics, with indicator variables for gender and race/ethnicity to capture differences in salary across those demographic groups. (See Appendix A for the mathematical specifications of the models.) In such models, the focus is on comparing salaries of faculty of similar rank, discipline, experience, tenure track status, and so forth.

Research on university salary structures includes extensive discussion regarding which characteristics are appropriate to include in regression estimates of salaries, since factors such as rank and tenure status may themselves result from unequal treatment across demographic groups (Becker and Toutkoushian, 2003). Hoffman (1976), for example, argues that regressions should not control for academic rank, since it may be endogenous. That is, unequal treatment may generate differences in promotion rates across demographic groups. Research that includes rank tends to find smaller gaps in pay by group, but it can be argued that its inclusion generates downward biased estimates of the "true" extent of salary inequity because the rank variable itself results from differential treatment across groups (McNabb and Wass, 1997; Barbezat, 1991; Riggs, et al, 1986). Alternatively, however, the exclusion of rank from salary estimates may introduce other biases because salary can legitimately increase with faculty promotions (Becker and Toutkoushian, 2003).

One approach to dealing with potential endogeneity of rank is to independently examine rank (and other potentially suspect variables like tenure status) for potential bias. For example, rank can be regressed on other factors, such as experience, seniority, discipline, and gender and/or race/ethnicity to identify whether rank appears significantly related to gender or race/ethnicity. If so, its inclusion in the model may be suspect and the model should be estimated both with and without rank to compare the consistency of the outcomes (Riggs, et al, 1986; Becker and Toutkoushian, 2003; McLaughlin and McLaughlin, 2003).

Prediction Methods

McLaughlin and McLaughlin (2003) demonstrate the use of the single-equation model to compare individuals' actual salaries against the salaries that the regression model would predict, while excluding race/ethnicity and gender variables from the equation. Under this strategy, expected salary is computed for each individual, and residual values (that is, predicted minus actual values) calculated. Average residuals by various groups, including race/ethnicity, gender, or rank can also be computed in order to uncover systematic discrepancies. In the case that systematic discrepancies are not found, comparisons of individual salaries against their predicted salaries can be made to identify specific individuals earning below what would be expected based on the salary regression.

Multiple-Equation Models

Research that focuses on determining the sources of pay gaps by gender and race/ethnicity includes Oaxaca (1973, 1994), Blinder (1973), and Neumark (1988). These authors use two-equation models to generate estimators that separate gaps in pay by group into a portion that can be explained by observable differences in levels of *characteristics* by group (e.g., different disciplines or levels of educational attainment), and a portion deriving from differences in the *returns* to such characteristics, which may reflect discrimination, unobserved heterogeneity between the groups, or other unmeasured differences in pay.

In examining differences in pay by gender, for example, the Oaxaca decomposition estimates earnings models for men and women, including in the regression observable characteristics. The Oaxaca decomposition uses the result from each gender’s regression, allowing for different slopes and intercepts for females and males. The average salary for each gender from this set of regressions can be used to generate a difference in average salaries by simply finding the difference between the means. The Oaxaca decomposition separates the resulting wage differential into a portion that arises when men and women have different characteristics on average, and a portion attributable to differences in the respective returns to those characteristics for men and women.

In similar spirit, models that include interaction terms can also be used to investigate gender-based salary differences. An interaction term tests a multiplicative relationship between two independent variables in the regression, such as between a demographic variable and a non-demographic variables. The interaction term captures changing returns to an individual being, essentially, two things simultaneously. For example, a female finance professor may make more than either a female professor in another discipline with higher rank, experience, and so forth, or a male finance professor of similar rank, experience, etc. Thus, there are higher returns in pay to being simultaneously female and a finance professor, other things equal. In interaction term models, systematic differences in the returns to experience or other factors by gender, race/ethnicity, or age would be suggestive of areas of concern for salary adjustments.

DATA AND DESCRIPTIVE STATISTICS

Data for academic year 2006 were prepared by the UW Office of Institutional Analysis. They included the employment-related and demographic variables described in table 2. The discussion here focuses on differences between men and women in academic positions, although the study also considered salary differences between whites and people of color, between U.S. and non-U.S. citizens, and by age, and also evaluated these differences for employees in staff (non-academic) positions.[3] The descriptive statistics and complete model results by faculty and staff can be found on the UW website at: http://uwadmnweb.uwyo.edu/acadaffairs/equity/.

The overall mean salary among the academic personnel is $68,462. The mean for males is $72,171 and for females is $60,869, and the difference between the two is statistically significant at the 5 percent level in a

[3] Importantly, there is a small absolute number of faculty members in the non-white race/ethnicity categories. Among the academic personnel at the time of the analysis, 93 percent are white. The small number of observations in the separate race/ethnicity categories would generate numerous multicollinearity and missing categorical variable problems if they were included separately in the regressions. In order to keep the regression analysis tractable and meaningful, regressions that separate results by race/ethnicity include only two race categories, white and non-white.

two-tailed hypothesis test. Other statistically significant differences in mean variable values indicate that males have significantly more average years of seniority and years in rank than females, and are distributed among senior-ranked positions at higher rates than are females, all of which are associated with higher pay. A higher proportion of females are academic professionals (non-tenure track positions), while a higher proportion of males are tenured or tenure-track faculty. A smaller proportion of males have MA-level degrees, while a larger proportion has doctorate-level degrees than females. Additionally, it appears that females have a larger proportion of their jobs allocated to advising and professional development[4], and a smaller proportion of their jobs allocated to research than do males. Other differences, including distribution across colleges and across disciplines/departments, are insignificant.

SALARY MODELS ESTIMATED

Three primary estimation strategies were used, based on the data described in table 2:

1. Estimates of a single-equation regression model to establish whether or not systematic differences in salaries exist by gender, after controlling for seniority, discipline, and other appropriate and available factors.[5]
2. Estimates of an interaction-term model to capture any significant differences in the returns to professional employment characteristics by gender.
3. Estimates of the multiple-equation Oaxaca decomposition model to identify portions of gender pay gaps that are attributable to observable differences in professional characteristics and portions that are unexplained.

In addition, the models (1) and (2) were estimated with the rank variables excluded in order to explore the implications for the regression results of the likely possibility that the rank variables are endogenous.

[4] Professional development is a job category for academic professionals. It is somewhat analogous to the service component of a tenure-track position.
[5] The single-equation model was also used to generate a set of predicted values that could be compared with actual values in order to identify individual salary outliers.

REGRESSION RESULTS

Estimates of model (1) are presented in column 1 of Table 3. The dependent variable is the natural logarithm of each faculty member's annualized salary. This equation generates estimates of differences in log annual salary by demographic characteristic, seniority/experience, rank, employment class, tenure status, educational background, college, and job allocation variables. Also included in the table are the absolute values of t-statistics for each estimated coefficient (the "|t|" sub-columns). The regression explains 79 percent of the variation in log salary. The variables with estimated coefficients that are statistically significant at the 5-percent level (in two-tailed tests) are in bold and are discussed below.

Although there are statistically significant differences in the raw mean salaries for males and females, these differences disappear once other variables are included in the regression. In fact, the demographic characteristics that are statistically significantly in determining salaries, once other factors are controlled for, are age and U.S. citizenship. The estimates indicate that each additional year of age is associated with a 1.5 percent increase in predicted annual salary, and that U.S. citizen salaries are approximately 5 percent higher than non-citizen salaries once other factors are controlled in the regression.[6] The insignificant coefficient on the age-squared variable indicates that there do not appear to be statistically significant decreases in the rate of return to age.

The coefficients on the rank variables indicate that pay is significantly higher for those of higher rank. However, the negative coefficient estimate on the “seniority” variable (years from date of hire) indicates that, controlling for other variables in the model, an additional year of seniority is associated with an estimated 1.8 percent decrease in annual salary. This result is consistent with the salary compression common in academe and also, we believe, with the larger impact of Wyoming’s lean raise years in the 1990’s on today’s more senior faculty.

---

[6] As noted above, in semilogarithmic equations, coefficient estimates on continuous independent variables (e.g., age) are interpreted to indicate that a one-unit increase in the independent variable is associated with a 100* $\hat{\beta}$ increase in annual salary. The percentage value interpretations for estimated coefficients on binary variables in log-linear models are computed as 100[exp($\hat{\beta}$)-1], following Halvorsen and Palmquist (1980).

Those in non-tenure track positions have significantly lower salaries than those in tenure-track positions (although the salary differences are statistically insignificant when other factors are controlled for in the regression). Additionally, jobs with higher proportions allocated to research, professional development, and administration are estimated to have higher salaries in relation to those with higher proportions allocated to teaching. For example, each percentage point increase in the job allocation to research is estimated to be associated with a 15 percent higher expected salary relative to a job with a higher teaching allocation. The interpretation of this finding may not be straightforward. Some suggest teaching is valued less than research; others argue that those who have successful research as well as teaching careers have demonstrated their versatility as faculty members and deserve higher pay. However, if women are more likely to be assigned job duties or hold positions that are more heavily weighted toward teaching, then this finding may be a source of concern.

Regression with interactions by gender

Column 2 of table 3 present estimates of the interactive variables model, which expands the baseline single equation to include interactions of each independent variable with an indicator variable for gender (and also with indicator variables for race/ethnicity and age, although those results are not discussed here). As discussed above, the estimated coefficients on the interaction terms capture differences in the "returns" to the various independent variables by gender. Systematic differences in the returns to the underlying characteristics would not be expected to occur if each gender were treated similarly in the salary allocation process.

As shown in the table, the estimated coefficients on the *female * X* interaction variables are generally not statistically significant. The exception is an estimated smaller coefficient on the years in rank-squared variable, which might indicate that any positive return to years in rank tapers off more quickly for females than for males. However, the coefficient is small (indicating a -.1 percentage point change per year in the estimated return to years in rank) and is somewhat offset by a larger (although not statistically different) coefficient on the linear *years in rank* term for females than for males.

Regressions excluding rank variables

When the rank variables are excluded from the models the results are similar, but there are a few differences worthy of note. Gender still appears to be statistically insignificant in determining salary once other factors are controlled in the regression model. As before, the significant coefficients are associated with age and U.S. citizenship. The negative return to seniority still occurs, but is smaller (closer to zero)—a finding which would be expected if *seniority* and the excluded rank variables were positively correlated (making the estimated return biased upward toward zero in the regression that excludes rank). In the rank-excluded version of the interactions model there is a more negative and statistically significant impact on salary for jobs with higher allocations to advising, which would be consistent with those positions being negatively correlated with the rank variables (i.e., if those with higher advising allocations are not among the higher ranks). Additionally, although it appears that for males there is no statistically significant salary “penalty” for non-tenure track status, once other variables are controlled for, there is a statistically significant negative impact on the salaries of females in non-tenure track positions. In other words, there is a larger negative salary “penalty” to women in non-tenure track positions than to men.

Salary Decompositions

Table 4 presents estimates of the Oaxaca decomposition model, which separates the "raw" mean log salary differentials among males and females into portions that may be attributed to differences in characteristics among the groups (i.e., differences in mean values of the independent variables in the models above) and differences in returns to those characteristics by gender.

The log salary differential among males and females included in the regression sample totals 0.150. Using the Oaxaca decomposition, 0.159 of the differential is explained by or due to differences in the mean characteristics of the two groups, and the differences appear greatest in the rank, employment class, educational background, and college variables. Alternatively, -0.009 of the differential is explained by differences in the returns to those characteristics for the two groups. Thus, the Oaxaca decomposition implies that the difference in characteristics of males and females more than explains the salary gap between the two, and that differences in the returns to those characteristics actually narrow the gap (albeit by a very small amount). Put differently, the decomposition estimates a positive differential treatment for females relative to males, with the implication that if males and females had equal returns to their characteristics, the pay gap between the two groups would be slightly *larger* than it actually is. One caution with respect to this interpretation however, is that the largest part of the difference in characteristics between males and females occurs in the rank variables. If males and females moved through the ranks at similar levels, the pay gap would be much smaller. As noted above, a closer analysis of rank may be called for to examine whether there are differential returns to characteristics among males and females in the probability of attaining given levels of rank.

SUMMARY AND NEXT STEPS TOWARD EQUITY

Differences in the mean annual salaries of men and women largely disappear once other factors expected to influence salary are controlled for in a regression model. In addition, estimates of any differences in the *returns* to characteristics between genders are largely insignificant. One notable exception, however, is the much more negative return to non-tenure-track relative to tenured status for females than for males.

Oaxaca decompositions of the salary differentials imply that the vast majority of pay gaps between men and women arise due to differences in the average characteristics of the two groups, and that differentials in the returns to the characteristics of the groups actually serve to narrow rather than increase the gaps. One concern however, is that the primary source of the differences in the characteristics of the groups comes in the rank variables, which many researchers argue are potentially endogenous in salary regressions. An important next step is to investigate further the factors that determine advancement in rank and to ensure there are no barriers to advancement systematically associated with gender. At U.S. public doctoral universities, 41% of tenure track professors are female, while at UW this figure is 36% (AAUP 2006). In addition, the study suggests the need for a careful assessment of who ends up in non-tenure track positions, and why a non-tenure track position appears to be come with a larger salary penalty for women than for men. In contrast to the tenure-track positions, UW's academic professional lecturer employees are majority female (58%). Finally, when focused on concern with equity for women and people of color, it is important to not lose sight of other groups that may be affected differentially in salary allocations. This study suggests, for example, that attention may need to be paid to non-U.S. citizens when making salary raise allocations.

Administrators also need to be diligent in continuing informal annual assessments of salary equity and periodic re-estimations of the formal models, particularly in conjunction with the administration of raises. "Good" statistical results do not mean the job is done or even that all is well. Salary equity is only one dimension of equity considerations for women in academia. UW, like many universities, needs a better understanding of a range of factors that affect hiring, retention, success and satisfaction of women. Recently UW has taken the step of joining the Collaborative on Academic Careers in Higher Education (COACHE), a Harvard-based "collaboration of colleges and universities committed to gathering the **peer diagnostic and comparative data** academic administrators need to recruit, retain, and develop the cohort most critical to the long-term future of their institutions" (http://gseacademic.harvard.edu/~coache/info/mission.html).

REFERENCES

American Association of University Professors. (1982-1983 to 2006-2007). Academe, The Annual Report on the Economic Status of the Profession. March-April.

Barbezat, D.A. (1991). Updating estimates of male-female salary differentials in the academic labor market, *Economics Letters*, 36(2), 191-195.

Barbezat, D. A. (2002). History of pay equity studies, *New Directions for Institutional Research*, 115(Fall), 9-39.

Becker, G.S. & Chiswick, B. R. (1966). Education and the distribution of earnings, *American Economic Review*, 56(May), 358-369.

Becker, W. E. & Goodman, R. (1991). The semi-logarithmic earnings equation and its use in assessing salary discrimination in academe, *Economics of Education Review*, 10(4), 323-332.

Becker, W. E. & Toutkoushian, R.K. (2003). Measuring gender bias in the salaries of tenured faculty members, *New Directions for Institutional Research*, 117(Spring), 5-20.

Blinder, A. (1973). Wage discrimination: reduced form and structural estimates, *Journal of Human Resources*, 8(Fall), 436-455.

Borjas G. (2005). *Labor Economics, Third Edition*. New York: McGraw-Hill Irwin.

Curran. F. & Bach, N. (1996). *The University of Vermont: An Equity Study of Full-time Staff Pay*, Unpublished Paper, Office of Institutional Studies, University of Vermont.

Ferber, M.A. & Loeb, J.W. (2002). Issues in conducting an institutional salary-equity study, *New Directions for Institutional Research*, 115(Fall), 41-69.

Ferber, M.A. & Westmiller, A. (1976). Sex and race differences in nonacademic wages on a university campus, *The Journal of Human Resources*, 11(3), 366-373.

Gordon, N. & Morton,T. (1976). The staff salary structure of a large urban university, *Journal of Human Resources*, 11(3), 366-373.

Halvorsen, R., & Palmquist, R. (1980). The interpretation of dummy variables in semi-logarithmic equations. *American Economic Review*, 70(June), 474-75.

Hoffman E. (1976). Faculty salaries: Is there discrimination by sex, race, and discipline? Additional evidence. *American Economic Review*, 66(1), 196-198.

Looker, E. (1993). Gender issues in university: The university as employer of academic and nonacademic women and men. *Canadian Journal of Higher Education*, 23(2), 19-43.

McLaughlin, G.W. & McLaughlin, J.S. (2003). Conducting a salary-equity study: A consultant's view, *New Directions for Institutional Research*, 117(Spring), 97-114.

McNabb, R. & Wass, V. (1997). Male-female salary differentials in British universities. *Oxford Economic Papers*, 49(3), 328-343.

Mincer, J. (1958). Investment in human capital and personal income distribution, *Journal of Political Economy*, 66(August), 281-302.

Mincer, J. (1974). *Schooling, experience, and earnings*. New York: Columbia University.

Neumark, D. (1988). Employers' discriminatory behavior and the estimation of wage discrimination. *Journal of Human Resources*, 23(3), 279-295.

Oaxaca, R. L. (1973).Male-famale wage differentials in urban labor markets, *International Economic Review*, 14(October),693-709.

Oaxaca, R. L. (1994). On discrimination and the decomposition of wage differentials, *Journal of Econometrics*, 61(March), 5-21.

Riggs, M., Downey, R, McIntyre, P. & Hoyt, D. (1986). Using discriminant analysis to predict faculty rank, *Research in Higher Education*, 25(4), 365-376.

Ransom, M. & Megdal, S. (1993). Sex differences in the academic labor market in the affirmative action era, *Economics of Education Review*, 12(1), 21-43.

Toutkoushian, R.K. (2003). Addressing gender equity in nonfaculty salaries, *New Directions for Institutional Research*, 117(Spring), 9-68.

West, M.S., & Curtis, J.W. (2006). AAUP Faculty Gender Equity Indicators 2006. 20-34.

Appendix A – Technical Explanation of Previous Research

Single Equation Models

In the main text, it is noted that in multiple regression models, wages of similar workers are compared after adjusting the raw mean differential for differences in seniority, discipline, and other factors. If the focus is on differences in earnings by gender, for example, a typical early salary study would use a regression of the form

$$\text{(A)} \qquad ln(S_i) = \beta_0 + \alpha M_i + \sum_{j=1}^{k} \beta_j X_{ij} + e_i$$

Where $ln(S_i)$ denotes the natural logarithm of salary[7] for individual i, M_i is a binary variable identifying males, and X_{ij} is a vector of characteristics related to salary (experience, educational attainment, discipline, tenure-track status, etc.). In this specification, the coefficients in β_j capture estimated differences in S that are associated with differences in the characteristics in X. For example, if X_j is equal to years of experience, $(100*\beta_j)$ measures the percent change in salary per year of experience.

The variable α in this specification captures differences in salary among males and females, after controlling for differences in characteristics in X. In particular, $100(e^{\alpha} -1)$ gives the estimated percent difference in S for males relative to females (Halvorsen and Palmquist, 1980).

Multiple-Equation Models

In examining differences in pay by gender, the Oaxaca decomposition estimates earnings models for men and women, including in the regression observable characteristics. The decomposition uses the result from Ordinary Least Squares that, if $\bar{X}_m$ ($\bar{X}_f$) represents the mean characteristics of males (females) then their average salaries can be written as:

[7] The log-linear model is widely used to estimate salaries, as it allows for compounding of earnings over time (as would occur with percentage raises), and for non-linear returns to factors included in X_{ij}. See, for example, Becker and Chiswick (1966), Mincer (1958, 1974) for early presentations, Borjas (2005, p. 14) for a standard textbook presentation, and Ferber and Loeb (2002), Becker and Goodman (1991) for presentations in the context of university-equity studies. For completeness, regressions using a linear specification were also estimated. The results were qualitatively similar to those in the log-linear model.

$$\text{(B)} \qquad \bar{S}_m = \alpha_m + \beta_m \bar{X}_m \text{ and } \bar{S}_f = \alpha_f + \beta_f \bar{X}_f .$$

This generates a difference in average salaries that can be computed as:

$$\text{(C)} \qquad \Delta\bar{S} = \bar{S}_m - \bar{S}_f = \alpha_m + \beta_m \bar{X}_m - \alpha_f - \beta_f \bar{X}_f .$$

By adding and subtracting the term ($\beta_m \bar{X}_f$) from this equation, one can then decompose the wage differential into a portion that arises if men and women have different characteristics (X) on average and a portion attributable to differences in the respective returns to those characteristics for men and women:

$$\text{(D)} \qquad \Delta\bar{S} = (\alpha_m - \alpha_f) + (\beta_m - \beta_f)\, \bar{X}_f + \beta_m\, (\bar{X}_m - \bar{X}_f)$$

The term $\beta_m\, (\bar{X}_m - \bar{X}_f)$ captures the difference in average earnings that arises from differences in the average levels of *X* among the two groups. The terms $(\alpha_m - \alpha_f) + (\beta_m - \beta_f)\, \bar{X}_f$ arise if men and women are treated differently either at the intercept $(\alpha_m - \alpha_f)$ and/or if the returns to the characteristics in *X* are different for men than for women $(\beta_m - \beta_f)$.

In similar spirit, models that include interaction terms between demographic and other variables can also be estimated:

$$\text{(E)} \qquad ln(S_i) = \beta_0 + \alpha M_i + \sum_{j=1}^{k} \beta_j X_{ij} + \sum_{j=1}^{k} \theta_j \left(X_{ij} * M_i \right) + e_i$$

In this model, the θ terms capture differences in the "returns" to characteristics in *X*. Systematic differences in the returns to experience or other factors by race/ethnicity, gender, or age would be suggestive of areas of concern for salary adjustments. Equation (E) is particularly valuable for estimating potential differential returns by age, since its continuous nature precludes an Oaxaca decomposition of salary differentials without ad hoc assumptions about the appropriate age groupings to compare against one another.

TABLES

Table 1. Full-Time Instructional Female Faculty at the University of Wyoming: 1994-95 to 2007-08

	1994-95		1998-99		2002-03		2007-08	
Female	% of Rank	N	% of Rank	N	% of Rank	N	% of Rank	N
Professor	8%	21	12%	27	14%	31	18%	40
Associate Professor	21%	32	29%	51	35%	56	35%	60
Assistant Professor	40%	62	34%	42	33%	46	43%	70
Instructor*	38%	3	50%	2	50%	2	33%	1
**Lecturer ** **	61%	39	69%	54	61%	60	54%	74

*Instructor includes tenure-track appointees who have not yet completed their terminal degree requirements.
** Lecturer includes extended term track academic professional lecturers and supplemental faculty.

Source: Office of Institutional Analysis files and "Academe" March-April Issues 1993-2007

Table 2. Faculty Data for Regression Models: Variable Descriptions

Variable Name	Variable Description
Pay Characteristics	
Salary(S)	Annual Salary (AY value) ▪ values for individuals with FY appointments are adjusted by 9/11 ▪ values for individuals on sabbatical are adjusted by 1.67 ▪ values for individuals with <1 FTE are adjusted by 1/FTE
FTE	FTE value, salaries for those with <1 FTE will be adjusted reflect corresponding value for FTE = 1
FY employee	= 1 for FY employees = 0 for AY employees
Demographics	
Male(M)	= 1 for males = 0 for females
Asian Black/African American Hispanic/Latino	Mutually exclusive race/ethnicity categorical variables: = 1 for Asian = 1 for Black/African American = 1 for Hispanic/Latino

White Other race	= 1 for White = 1 for other/not-specified/or <5 observations in category (e.g., American Indian/Alaska Native)
Age	Elapsed years from date of birth to 7/1/2006
US Citizen	= 1 for U.S. citizens = 0 for other citizenship

Seniority and Experience	
Years experience	Elapsed years from date degree issued to 7/1/2006
Years seniority	Elapsed years from date of hire into benefited position to 7/1/2006
Years in rank	Elapsed years from date or last rank change to 7/1/2006
Rank Variables	
  Assistant Associate Full/senior Distinguished professor/chair Dept. Head Asst./Assoc. Dean/Director Dean/Director Other	Mutually Exclusive Rank categories: = 1 for assistant professor/librarian, Asst. ETT = 1 for associate professor/librarian, Assoc. ETT = 1 for professor/librarian, Sr. ETT = 1 for distinguished professor, Wold Chair, centennial distinguished professor = 1 for department head/chair = 1 for asst. or assoc. dean or director = 1 for dean or director = 1 for president, vice president, associate vice president *As noted in the text, these variables will be excluded from some specifications.
Employment Class	
  Administrator Academic Professional Faculty	Mutually exclusive Employment Class categories: = 1 for administrators = 1 for academic professionals = 1 for faculty
Tenure Status	
  Non-tenure-track Tenure-track Tenured	Mutually exclusive Tenure Status categories: = 1 for non-tenure track appointments = 1 for tenure-track appointments = 1 for tenured appointments
Educational Background	
  Doctorate Professional	Mutually exclusive degree accomplishment categories: =1 for doctorate-level degree (PHD,EDD) =1 for professional degree (MD, DVM, JD)

Masters Bachelors Other degree	=1 for Master's-level Degree (MA, MFA, MBA) =1 for Bachelor's-level Degree (BS, BA, BFA) =1 for other degree/not-specified
Field/Department	55 mutually exclusive binary category variables for field, based on department description
College	10 mutually exclusive binary category variables for college
Job Allocation	
Teaching Advising Research Service Cooperative extension Professional development Administration Other	Variables describing job appointment allocation in various categories (proportions)

Table 3. Regression Results: Dependent Variable: ln(salary)

	1			2				
	Academic personnel			**Males**			**Female Interaction**	
	dy/dx	|t|		dy/dx	|t|		dy/dx	|t|
Demographics								
Male	-0.003	0.25		-0.394	1.22		-	-
Asian	0.026	0.86		0.035	0.95		-0.046	0.67
Black/African American	0.008	0.13		0.022	0.31		0.001	0.01
Hispanic/Latino	0.030	1.00		0.066	1.94		-0.057	1.00
White	-	-		-	-		-	-
Other race or race not specified	0.007	0.26		0.017	0.57		-0.017	0.32
Age	**0.015**	2.52		**0.017**	2.27		-0.012	0.91
Age^2	0.000	2.14		0.000	2.02		0.000	1.01
U.S. Citizen	**0.050**	2.48		**0.069**	2.72		-0.073	1.66
Seniority and Experience								
Years experience	0.000	0.10		0.001	0.20		-0.003	0.64
Years experience^2	0.000	0.47		0.000	0.34		0.000	0.57
Years seniority	**-0.018**	4.89		**-0.017**	4.01		-0.007	0.92
Years seniority^2	**0.000**	4.18		**0.000**	2.96		0.000	2.08
Years in rank	0.007	1.97		0.004	0.81		0.014	1.81
Years in rank^2	0.000	1.12		0.000	0.30		**-0.001**	2.97

	1		2			
	Academic Personnel		Males		Female Interaction	
	dy/dx	|t|	dy/dx	|t|	dy/dx	|t|
Rank Variables						
Assistant	-	-	-	-	-	-
Associate	**0.099**	3.97	0.073	1.94	0.072	1.44
Full/Senior	**0.294**	10.20	**0.294**	7.68	0.000	0.00
Distinguished Professor	**0.498**	7.02	**0.499**	5.76	-0.103	0.88
Department Head	**0.185**	3.07	**0.223**	2.63	-0.095	0.95
Asst./Assoc. Dean/Director	**0.299**	3.81	**0.319**	3.05	-0.055	0.36
Dean/Director	**0.253**	3.40	**0.299**	3.08	-0.130	0.97
Other	0.145	0.98	0.012	0.12	0.205	0.95
Employment Class						
Academic Professional	**-0.207**	2.46	**-0.401**	2.92	0.214	1.29
Administrator	-	-	-	-	-	-
Faculty	**-0.136**	2.26	-0.085	1.02	-0.112	1.00
Tenure Status						
Non-Tenure-track	**-0.232**	3.68	0.007	0.06	-0.274	2.05
Tenure-track	-0.048	1.76	-0.061	1.56	0.015	0.28
Tenured	-	-	-	-	-	-
Educational Background						
Bachelor's-Level	-0.024	0.37	0.001	0.02	-0.083	0.59
Master's-Level	**-0.125**	4.71	**-0.122**	3.58	0.000	0.00
Doctorate-Level	-	-	-	-	-	-
Professional	0.028	0.69	0.009	0.17	0.034	0.40
College						
Other/NA	-0.085	1.37	-0.263	2.16	0.214	1.51
Academic Affairs	**-0.183**	2.93	**-0.207**	2.51	-0.002	0.02
Agriculture	-0.028	1.17	-0.010	0.36	-0.043	0.85
Arts & Sciences	-	-	-	-	-	-
Business	**0.296**	11.61	**0.286**	9.61	0.076	1.50
Education	-0.038	1.74	-0.067	2.04	0.058	1.36
Engineering	**0.213**	11.07	**0.213**	10.62	0.038	0.50
Health Sciences	**0.061**	2.55	0.060	1.67	-0.003	0.07
Law	**0.221**	3.81	**0.237**	3.15	-0.001	0.01
Outreach	**-0.124**	2.65	-0.166	1.99	0.067	0.63

Numbers in bold indicate coefficients statistically significant at the 5 percent level (two-tailed tests).

Table 4. Oaxaca Salary Decompositions

	1		
	Male – Female		
Overall differential:	0.150		
Differential due to:	**Characteristics**		**Coefficients**
Demographics	-0.004		0.313
Seniority and Experience	-0.012		0.019
Rank	0.057		-0.034
Employment Class	0.029		0.023
Tenure Status	0.002		0.080
Educational Background	0.021		0.000
College	0.054		-0.022
Job Allocation	0.011		0.005
Intercept	-		-0.394
Totals	0.159		-0.009