Analysis of Gender Differences in Salary at The University of Montana, AY 2005-2006

Richard Barrett, Professor Emeritus
Department of Economics
University of Montana

December 21, 2007

Report to the President
University of Montana

ATTACHMENT B

Table 1
Means of Selected Salary Determining
Characteristics; by Gender: UM Faculty, 2005-06.

Variable	Full Sample (n=433)	Males (n=272)	Females (n=161)
FY FTE salary	$59,857	$62,323	$55,690
Percent full prof.	44.1%	52.6%	29.8%
Percent assoc prof.	29.3%	25.4%	36.0%
Percent asist. prof.	26.5%	22.0%	34.2%
Regional average salary by disicipline	$75,717	$76,859	$73,781
Regional average salary by rank and disicipline	$78,328	$82,050	$72.041
Merits raises received	1.74	2.05	1.23
Inversion adjustments received	0.33	0.40	0.26
Years at asst. prof. and above	12.7	14.4	9.6
Percent minority	8.4%	6.3%	11.8%

It should be noted that the analysis proceeds from the assumption that gender discrimination can operate in either direction, i.e. either against, or in favor of, women, and the fact that women on average earn less than men creates no presumption that if discrimination is found, it will be against women. If this seems counter-intuitive, Table 2 provides a simple numerical illustration of a hypothetical case in which average salaries of women are less than those of men but there is gender discrimination in favor of women. For simplicity, in this example there are only two determinants of salary: rank and sex. For non-discriminatory reasons, men are more concentrated in the upper ranks than women, but for discriminatory reasons, at every rank women earn more than men.[5]

While the regression analyses presented here *can* measure the effect on salary of gender, while controlling for gender differences in other relevant characteristics (e.g. differences in rank), it *cannot* determine whether the differential possession of those other characteristics is itself discriminatory. To do the latter, it would be necessary to have independent evidence regarding gender differences in the qualifications needed to attain a particular characteristic (promotion to full professor, say) and compare that evidence to gender differences in the actual attainment of the characteristic (in this example, full professorship). Unfortunately, no such independent evidence

[5] The numbers listed in Table 2 for men and women at each rank and for average salary by rank are roughly representative of the University of Montana. Average salaries by sex and rank are entirely hypothetical.

2. Methodology and Model Specification

In this analysis it is assumed that there is a process by which salaries are determined at the University and that this process can be represented with an earnings function. This function relates the AY FTE salary, S, earned by an individual to a variety of individual characteristics, C. While the function might take a variety of forms, the simple log-linear form assumed here is

(1) $\ln S = b_0 + b_1C_1 + b_2C_2 + \ldots\ldots + b_nC_n + u$

where lnS is the natural log of FTE salary and there are n characteristics believed to affect lnS. With this specification, the coefficient b_i measures the percent change in salary resulting from a one unit change in C_i, while holding all other characteristics constant; u is a random disturbance term with an expected value of zero and constant variance. The numerical values of b_i are estimated using regression analysis.

Any characteristic, C_i may be one which an individual either does or does not have (being female, for example). In such a case, C_i is represented by a dummy variable which equals 1 for those having the characteristic and 0 for those who don't. To a reasonable approximation, b_i in this instance measures the percent difference in salary associated with having, rather than not having, the characteristic in question. If we create a dummy variable called "SEX1", and set it equal to 1 for women and 0 for men, then b_{SEX1} represents the percent change in salary associated with being female rather than male, with all other characteristics held constant; b_{SEX1} is therefore interpreted as a measure the salary gap attributable to discrimination.[7]

It is important to understand, however, that even if there were no discrimination occurring at all, meaning that the *true* value of b_{sex1} is zero, the *estimated* value of this coefficient is unlikely to be zero[8]; this implies that the true values of the coefficients are estimated with uncertainty and that the estimated coefficients must be evaluated for to statistical significance. If the estimated value of b_{SEX1} is statistically significant, we can with high confidence *reject* the hypothesis that there is no discrimination and that the true value of b_{SEX1} is zero. If the estimated value of b_{SEX1} is statistically insignificant, we cannot reject the hypothesis of no discrimination; on the contrary it is quite possible that there is no discrimination present and that the estimated non-zero value of b_{SEX1} we observe results from random noise in the data.

---

[7] If bSEX1 is negative, the discrimination is against women. If it is positive, the discrimination is against men.

[8] By way of an analogy, suppose there is no reason whatsoever to think that UM and MSU students differ in their normal daily caloric intake. Even so, if we measured the caloric intakes of the two student bodies on a particular day, we would not expect them to be exactly identical.

years of service at the University and JNRSEX1, which equals 1 for women with 9 or fewer years of service.. The coefficient on SEX1 (b_{SEX1}) measures the percentage difference in the average salaries of all women and all men; the coefficients on SENSEX1 and JNRSEX1. ($b_{SENSEX1}$ and $b_{JNRSEX1}$) measure, respectively, the percentage difference in the average salaries of women with more than 9 and less than 10 years of experience, and all men. The reason for differentiating the effect of gender by years of service is that in 1997 women received a remedy payment for past gender discrimination; it seems unlikely that discrimination could reassert itself among the women who were entitled to that remedy and were still on the faculty 9 years later. Discrimination could, however, influence the salaries of women who did not receive that payment, mainly through its possible impact on starting salaries.[13]

3. Data and Sample

Data on University faculty used in the estimation of earnings functions reported below was provided by the University's Office of Planning, Budgeting and Analysis.[14] Regional average salaries by rank and discipline were derived from annual surveys conducted by Oklahoma State University.

The data used to estimate the earnings functions reported below, and to calculate the statistics reported in Tables 1 and 3, pertain to tenure track faculty in the UFA bargaining unit on the main University campus at the rank of assistant professor and above. Individuals with faculty status who are excluded from the sample are thus members of the Law School and COT faculties, individuals with non-tenurable appointments, and those assigned to administrative duties (deans, provosts, etc.). The reason for excluding these individuals is that the processes by which their salaries are set are typically different from the process applicable to individuals included in the sample. The later process is largely defined by compensation and promotion provisions of the collective bargaining contract. A small number of individuals were also excluded due to missing data.

Table A1 in the Appendix provides the names and definitions of the explanatory variables [i.e. the C_i terms on the right hand side of equation (1), above] used in the various estimations of the earnings function reported in the following section and in the appendix. Table A2 provides summary statistics for these variables.

---

[13] Again, this discrimination could work in favor of younger women. In the last ten years the University has made a concerted effort to hire more women, which could have placed them at an advantage in the negotiation of starting salaries.

[14] . I wish to acknowledge the invaluable assistance of Will Innes of that office in providing, perfecting and interpreting this data.

Table 3

Coefficients on Gender Variables;
Various Earnings Functions Specifications

Model	Specification		b_{sex1}		$b_{jnrsex1}$		$b_{sensex1}$	
	Years	Gender	Est.	p	Est.	p	Est.	p
1	total	all women	-.023*	.066				
2	by rank	all women	-.015	.201				
3	total	women by years			-.019	.249	-.027	.107
4	by rank	women by years			-.033**	.043	.003	.867

*Estimated coefficient statistically different from zero at at least the 10 percent confidence level.
**Estimated coefficient statistically different from zero at at least the 5 percent confidence level.

percent more than men; the significance of this estimate, however, is extremely low.

4.2 Analysis of Outliers.

The results reported in Table 3 suggest the presence of gender discrimination against women in salary setting, and although the statistical evidence is somewhat weak, the hypothesis that there is no discrimination at all cannot be confidently rejected. As a result of this finding, a search for outliers was undertaken. A faculty member was considered to be an outlier if there was a large difference between his or her actual salary and the salary that the earnings function would predict for that person, given his or her characteristics. Outliers, in other words, are people who do not quite "fit the mold" of the faculty in general.

The identification of outliers can be helpful in two ways. First, they may reveal cases in which data was mis-recorded. This was not the case for any of the outliers identified here. Second, a listing of outliers may reveal that many or all of them share some common characteristic which has an impact on their salaries but which was not previously included as an explanatory variable in the earnings function. When such a characteristic is identified, it is appropriate to re-estimate the earnings function including a variable representing the characteristic.

Most of the outliers identified by the analysis in Models 1 to 4 were faculty members in the Mansfield Library. Of these cases, almost all were women with very few years of service, and all earned substantially less that would be predicted from the estimated earnings function for the faculty as a whole. Accordingly, Models 1 to 4 were re-estimated, including a variable, D1195, representing employment in the Mansfield Library. These regression results

5. Conclusions

The results presented in this report can perhaps best be described in the following way:

Over the past ten years, the University of Montana has made a significant effort to remedy pre-existing discrimination against women in the setting of salaries and to assure that such discrimination would not reassert itself. It is consequently reasonable to suppose that gender presently has no impact on salaries. The conclusion of this report is that there is no reliable statistical evidence that would justify rejecting this supposition. While women in the study year did, in fact, earn less than men, this was apparently due to differences in their disciplines and attainment of rank, seniority, merits and other determinants of salary.

As noted previously, this conclusion rests on the assumption that the procedures for awarding promotions and merit, market and inversion raises are themselves gender neutral. Whether or not that is true cannot be assessed from the data the University has available.

Likewise, this analysis does not require that to be considered non-discriminatory, the University must compensate for influences from the larger society and its educational and familial institutions that adversely impact women in the decisions they make regarding choice of discipline or career path.

References

The following are reports prepared for the campus community at the request of President George Dennison. Copies are available at his office.

Barrett, Richard. 1995. *An Analysis of Gender Differences in Salary at the University of Montana.*

_____. 1996. *Analysis of Remedies for Gender Discrimination in Salaries at the University of Montana.*

_____ and Krista Gebert. 1996. *Analysis of Gender Differences in Salary at the University of Montana: Addendum*

Singleton, Richard C. 1996. *Review of Richard Barrett's "An Analysis of Gender Differences in Salary at the University of Montana."* SRI Consulting, Menlo Park, CA

Table A1

Earnings Functions: Definition of Variables

Variable name	Definition
lnSAL	Natural log of AY FTE base salary
PRF	Dummy variable; = 1 for full professors, otherwise = 0.
ASC	Dummy variable; = 1 for associate professors, otherwise = 0.
DEVREFSL	Difference in dollars between the regional average salary for an individual's rank and discipline and the regional average salary for that rank for all disciplines.
PRFREF	Interaction variable; = devrefsl x prf
ASCREF	Interaction variable; = devrefsl x asc
MERITS	Total number of merit raises received
INVRSNS	Total number of inversion adjustments received
YRSPRF	Years in rank at full professor
YRSASC	Years in rank at associate professor
YRSAST	Years in rank at assistant professor
TOTYRS	Total years in rank of assistant professor and higher
ETHN	Dummy variable; = 1 for white; otherwise = 0.
PARTIM	Dummy variable; = 1 for part-time, otherwise = 0.
SEX1	Dummy variable; = 1 for women, otherwise = 0.
SENEX1	Dummy variable; = 1 for women with TOTYRS > 9, otherwise = 0.
JNRSEX1	Dummy variable; = 1 for women with TOTYRS <10, otherwise = 0.
D1196	Dummy variable; = 1 for faculty in Mansfield Library, otherwise = 0

Table A3

Regression Results

Model 1

```
|_ols LNSAL   PRF ASC DEVREFSL PRFREF ASCREF MERITS  INVRSNS TOTYRS PARTIM SEX1
ethn

 REQUIRED MEMORY IS PAR=     180 CURRENT PAR=    2000
  OLS ESTIMATION
       433 OBSERVATIONS     DEPENDENT VARIABLE= LNSAL
 ...NOTE..SAMPLE RANGE SET TO:      1,     438

  R-SQUARE =    0.7312     R-SQUARE ADJUSTED =    0.7241
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.15049E-01
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.12268
 SUM OF SQUARED ERRORS-SSE=    6.3357
 MEAN OF DEPENDENT VARIABLE =    10.972
 LOG OF THE LIKELIHOOD FUNCTION =  300.211
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 421 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PRF	0.26300	0.2344E-01	11.22	0.000	0.480	0.5597	0.0106
ASC	0.10388	0.1751E-01	5.933	0.000	0.278	0.2027	0.0028
DEVREFSL	0.11260E-04	0.8911E-06	12.64	0.000	0.524	0.6192	-0.0046
PRFREF	-0.53838E-05	0.1134E-05	-4.746	0.000	-0.225	-0.2148	0.0015
ASCREF	-0.26681E-06	0.1287E-05	-0.2073	0.836	-0.010	-0.0074	0.0000
MERITS	0.36039E-01	0.3596E-02	10.02	0.000	0.439	0.3438	0.0057
INVRSNS	-0.11968E-01	0.6914E-02	-1.731	0.084	-0.084	-0.0484	-0.0004
TOTYRS	-0.86044E-03	0.1024E-02	-0.8400	0.401	-0.041	-0.0353	-0.0010
PARTIM	0.35815E-01	0.2389E-01	1.499	0.135	0.073	0.0384	0.0002
SEX1	-0.23432E-01	0.1271E-01	-1.844	0.066	-0.090	-0.0485	-0.0008
ETHN	-0.52751E-01	0.2184E-01	-2.416	0.016	-0.117	-0.0624	-0.0044
CONSTANT	10.866	0.2299E-01	472.6	0.000	0.999	0.0000	0.9903

Model 3

```
|_ols LNSAL   PRF ASC DEVREFSL PRFREF ASCREF MERITS  INVRSNS TOTYRS PARTIM
jnrsex1 SENSEX1 ethn

 REQUIRED MEMORY IS PAR=     184 CURRENT PAR=    2000
  OLS ESTIMATION
       433 OBSERVATIONS     DEPENDENT VARIABLE= LNSAL
...NOTE..SAMPLE RANGE SET TO:       1,     438

 R-SQUARE =    0.7312     R-SQUARE ADJUSTED =    0.7236
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.15081E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.12280
SUM OF SQUARED ERRORS-SSE=    6.3339
MEAN OF DEPENDENT VARIABLE =    10.972
LOG OF THE LIKELIHOOD FUNCTION =  300.274
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 420 DF	PARTIAL P-VALUE	STANDARDIZED CORR.	ELASTICITY COEFFICIENT	AT MEANS
PRF	0.26445	0.2383E-01	11.10	0.000	0.476	0.5628	0.0106
ASC	0.10500	0.1781E-01	5.895	0.000	0.276	0.2049	0.0028
DEVREFSL	0.11293E-04	0.8970E-06	12.59	0.000	0.523	0.6210	-0.0046
PRFREF	-0.54378E-05	0.1146E-05	-4.745	0.000	-0.226	-0.2169	0.0016
ASCREF	-0.28409E-06	0.1289E-05	-0.2203	0.826	-0.011	-0.0078	0.0000
MERITS	0.36008E-01	0.3601E-02	10.00	0.000	0.439	0.3435	0.0057
INVRSNS	-0.11818E-01	0.6935E-02	-1.704	0.089	-0.083	-0.0478	-0.0004
TOTYRS	-0.80685E-03	0.1037E-02	-0.7783	0.437	-0.038	-0.0331	-0.0009
PARTIM	0.36026E-01	0.2392E-01	1.506	0.133	0.073	0.0386	0.0002
JNRSEX1	-0.19531E-01	0.1691E-01	-1.155	0.249	-0.056	-0.0341	-0.0004
SENSEX1	-0.27340E-01	0.1693E-01	-1.615	0.107	-0.079	-0.0431	-0.0004
ETHN	-0.52721E-01	0.2186E-01	-2.412	0.016	-0.117	-0.0624	-0.0044
CONSTANT	10.864	0.2365E-01	459.3	0.000	0.999	0.0000	0.9901

Model 1ML

```
|_ols LNSAL   PRF ASC DEVREFSL PRFREF ASCREF MERITS  INVRSNS TOTYRS PARTIM SEX1
d1195 ethn

 REQUIRED MEMORY IS PAR=      184 CURRENT PAR=     2000
  OLS ESTIMATION
       433 OBSERVATIONS      DEPENDENT VARIABLE= LNSAL
 ...NOTE..SAMPLE RANGE SET TO:       1,     438

  R-SQUARE =    0.7915      R-SQUARE ADJUSTED =    0.7856
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.11697E-01
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.10815
 SUM OF SQUARED ERRORS-SSE=    4.9128
 MEAN OF DEPENDENT VARIABLE =    10.972
 LOG OF THE LIKELIHOOD FUNCTION =  355.279
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 420 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PRF	0.23677	0.2080E-01	11.38	0.000	0.485	0.5039	0.0095
ASC	0.88043E-01	0.1550E-01	5.679	0.000	0.267	0.1718	0.0024
DEVREFSL	0.10955E-04	0.7861E-06	13.94	0.000	0.562	0.6024	-0.0044
PRFREF	-0.50552E-05	0.1001E-05	-5.052	0.000	-0.239	-0.2017	0.0014
ASCREF	-0.74298E-08	0.1135E-05	-0.6546E-02	0.995	0.000	-0.0002	0.0000
MERITS	0.35355E-01	0.3171E-02	11.15	0.000	0.478	0.3373	0.0056
INVRSNS	-0.14488E-01	0.6100E-02	-2.375	0.018	-0.115	-0.0586	-0.0005
TOTYRS	-0.21335E-03	0.9049E-03	-0.2358	0.814	-0.012	-0.0087	-0.0002
PARTIM	0.26178E-01	0.2108E-01	1.242	0.215	0.060	0.0281	0.0002
SEX1	-0.71900E-02	0.1130E-01	-0.6363	0.525	-0.031	-0.0149	-0.0002
D1195	-0.34510	0.3129E-01	-11.03	0.000	-0.474	-0.2524	-0.0009
ETHN	-0.35092E-01	0.1932E-01	-1.816	0.070	-0.088	-0.0415	-0.0029
CONSTANT	10.864	0.2027E-01	536.0	0.000	0.999	0.0000	0.9902

Model 3ML

```
|_ols LNSAL   PRF ASC DEVREFSL PRFREF ASCREF MERITS   INVRSNS TOTYRS PARTIM
jnrsex1 SENSEX1 d1195 ethn

 REQUIRED MEMORY IS PAR=     187 CURRENT PAR=    2000
  OLS ESTIMATION
       433 OBSERVATIONS     DEPENDENT VARIABLE= LNSAL
 ...NOTE..SAMPLE RANGE SET TO:       1,     438

  R-SQUARE =    0.7915     R-SQUARE ADJUSTED =    0.7851
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.11725E-01
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.10828
 SUM OF SQUARED ERRORS-SSE=   4.9127
 MEAN OF DEPENDENT VARIABLE =   10.972
 LOG OF THE LIKELIHOOD FUNCTION =  355.284
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 419 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PRF	0.23641	0.2117E-01	11.17	0.000	0.479	0.5031	0.0095
ASC	0.87764E-01	0.1578E-01	5.560	0.000	0.262	0.1713	0.0023
DEVREFSL	0.10947E-04	0.7915E-06	13.83	0.000	0.560	0.6020	-0.0044
PRFREF	-0.50418E-05	0.1011E-05	-4.986	0.000	-0.237	-0.2011	0.0014
ASCREF	-0.30961E-08	0.1137E-05	-0.2722E-02	0.998	0.000	-0.0001	0.0000
MERITS	0.35362E-01	0.3175E-02	11.14	0.000	0.478	0.3373	0.0056
INVRSNS	-0.14526E-01	0.6120E-02	-2.374	0.018	-0.115	-0.0588	-0.0005
TOTYRS	-0.22622E-03	0.9157E-03	-0.2471	0.805	-0.012	-0.0093	-0.0003
PARTIM	0.26123E-01	0.2111E-01	1.237	0.217	0.060	0.0280	0.0002
JNRSEX1	-0.81388E-02	0.1495E-01	-0.5444	0.586	-0.027	-0.0142	-0.0002
SENSEX1	-0.62264E-02	0.1505E-01	-0.4137	0.679	-0.020	-0.0098	-0.0001
D1195	-0.34524	0.3136E-01	-11.01	0.000	-0.474	-0.2525	-0.0009
ETHN	-0.35092E-01	0.1934E-01	-1.814	0.070	-0.088	-0.0415	-0.0029
CONSTANT	10.865	0.2086E-01	520.9	0.000	0.999	0.0000	0.9902