Report to the Faculty Senate Council on Gender Pay Equity on Danforth Campus

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Summary of Findings and Discussion

The committee examined results of 2008-2009 salary data of tenured and tenure-track faculty on the Danforth Campus. Starting with the Arts & Sciences, a series of models were tested for each school—44 models for Arts & Sciences, 12 models for the Brown School, 8 models for Business, and 6 models each for Engineering, Design & Arts, and the Law School.

- In every model the gender coefficient was negative indicating that after controlling for discipline group, rank and experience level, women on average are paid less than men in all schools on the Danforth Campus.
- In the School of Law women earn between $5,544 and $6,484 less than their male counterparts (or 2.6 to 3.0% less using a log model).
- In the Sam Fox School of Design and Visual Arts, women earn between $3,149 and $6,897 less than men (or 3.2% to 7.0% less using a log model).
- In the Olin Business School, women earn $6,751 to $12,878 less than men (or 3.0% to 5.7% less using a log model).
- In the School of Engineering & Applied Science, women earn $507 to $3,838 less than their male counterparts (or 0.7% to 2.3% less using a log model).
- In the Brown School, women earn $4,730 to $6,455 less than their male counterparts. Among only social work faculty, the gap between men and women's salary ranges from $6,251 to $8,709 (or 4.2 to 6.7% less using a log model).
- In Arts & Sciences, women earn $3,072 to $3,979 less than men (or 1.5 to 2.0% less using a log model).

The following table summarizes the outcomes of regression of salary (dollar models) and log of salary (log models) on a series of independent variables including rank, discipline groups, Director/Department Chair, underrepresented minority, gender, years since degree, years at WU and squared terms of the last two variables by school.

Table 1. Results of regression models predicting salary and log of salary of tenured and tenure-track faculty by school on Danforth Campus, 2008-09

				Difference between female and male faculty salaries				
	Men	Women	Total N	Log Models % difference		Dollar models $ difference	Female Coeffic./std. error	Adj R^2 for 6 diff. models
Arts & Sciences	271	110	381	-1.5% to -2.0%		-$3,072 to -$3,979	-.65 to -1.02	.71 to .81
Business	47	10	57	-3.0% to -5.7%		-$6,751 to -$12,878	-1.14 to -1.34	.80 to .91
Engineering	73	8	81	-0.7% to -2.3%		-$507 to -$3,838	-.09 to -.57	.72 to .75
Fox School	23	14	37	-3.2% to -7.0%		-$3,149 to -$6,897	-1.11 to -1.73	.82 to .84
Law	25	20	45	-2.6% to -3.0%		-$5,544 to -$6,484	-.56 to -.60	.35 to .47
Brown School (Social work+ IPH)	17	15	32	-3.0% to -5.6%		-$4,730 to -$6,455	-.81 to -1.10	.83 to .90
Brown School (Social work only)	13	13	26	-4.2% to -6.7%		-$6,251 to -$8,709	-.1.26 to -1.53	.87 to .95

The type of statistical analysis described here cannot definitively explain the observed gender pay gap in faculty salaries. It is possible that some of the results may be influenced by the relatively small numbers of faculty in some schools, by one or a few "outliers" who may affect the results, or by the absence of variables that cannot be measured and controlled for. To the extent possible, the committee requested additional information and analyses to try to alleviate some of these types of concerns. Not all of those analyses are reported here, but they consistently reinforced the basic finding of this study—that women on average are paid less than men. On the other hand, these results do not tell us anything about the pay of individual faculty members. Many variables that cannot be captured by the data enter into salary-setting decisions. Some female faculty are paid more than their male colleagues of similar rank and experience; others are paid less. In the individual situation, the differences in pay may or may not result from legitimate performance-related characteristics. What this study captures, however, is a consistent pattern in which female faculty, on average, are paid less than male faculty. This pattern persists over time, across schools and across a variety of different statistical models.

It is also important to keep in mind that pay equity is only one aspect of addressing gender inequality. Issues of equal pay interact considerably with University practices regarding hiring, promotion and retention of faculty, as well as the recruitment and selection of faculty for leadership positions. Gendered decisions regarding recruitment or promotion could either cause or mask disparities in pay based on gender. For example, a statistical analysis that controlled for rank might show no difference in salary based on gender; however, that finding might be consistent with a pattern in which female faculty are not promoted at the same rate as male faculty. Conversely, increased hiring of women faculty will not necessarily take care of gender disparities in pay. The data reported here suggests that schools with higher proportion of women faculty do not necessarily show smaller gender differences in pay.

The committee believes that the persistent pattern of gender differences in pay revealed by this study warrants further close attention as part of an on-going examination of University practices relating to diversity and gender equality.

Report to the Faculty Senate Council on Gender Pay Equity on Danforth Campus

In January 2009, Andy Sobel, Chair of the Faculty Senate Council (FSC) appointed a committee to review and provide input to the pay equity study on the Danforth Campus. Seven faculty members from different schools served on the committee. This document reports the findings of pay-equity study to the FSC.

The pay-equity study was conducted by Lynn McCloskey, Assistant Provost and Tao Zhang, Research Analyst with feedback from committee members. Our committee met eleven times during the academic years 2008-09 and 2009-10. We began with a review of previous methodologies utilized at Washington University in the analysis of gender pay equity and spent a substantial amount of time advising McCloskey and her team on methodological development and assessment of results of new models. The committee did not have access to underlying salary data.

The first study assessing gender-pay equity at Washington University was conducted in 1986-87, and subsequent studies were implemented in 1989-90, 1997-98, and 1999-2000. These studies utilized ordinary least squares regression to predict the relationship between salary and gender controlling for discipline, years since terminal degree, years at Washington University, and in some models, variables to reflect three levels of rank (assistant, associate, and full professor) (See Appendices A, B and C for additional information about previous studies).

Our committee recommended six important changes to the earlier methodology:

1) Previous studies had used rank variables with three categories—assistant, associate and full professor. These studies had included Endowed Chairs in the Full Professor category. We recommended including a new variable, Endowed Chair to account for the differences in salaries between those who hold Endowed Chair and those who do not.
2) The committee recommended that an analysis should include a variable for underrepresented ethnic minorities[i] (URM) in the model.
3) We recommended running a model with and without Department Chair/Director/Associate Dean as a separate variable to account for additional stipends[ii] these individuals receive while serving in their roles.
4) In previous Gray Methodology studies, salaries were predicted based only on the male population. Our committee requested that a prediction model be based on both male and female and interpreted residuals and Z-scores (Z-scores are calculated by dividing the mean residuals by the standard error). Residuals provided difference in mean male and female salaries and Z-scores captured the magnitude of difference.
5) The residual method, however, assigned equal weight to male and female populations and the analysis presumed that there were equal number of males and females in the population. As there were fewer women faculty in every school (see Table 1), the committee also requested analyses with gender variable in the models and reviewed regression coefficients associated with gender.
6) Finally, although previous studies reported statistical significance of regression analyses, the current committee decided not to do so. It is appropriate to report statistical significance of

findings where the findings are based on a sample of a population. This study, however, is based on the entire population rather than a sample of faculty in each school, and so statistical significance is not relevant. Instead, the committee decided to report the magnitude of residuals, Z-scores, and regression coefficients associated with gender variable.

Current Analysis

The data consist of 458 male and 177 female tenured or tenure-track faculty on the Danforth Campus[iii] (see Table 2). As the salary for individual faculty at Washington University is determined separately by each school, separate analyses are conducted for each school.

Table 2. Faculty on the Danforth Campus by School and Gender (2008-2009)

School	**Men**	**Women**	**Total**
Arts & Sciences	271	110	381
School of Engineering & Applied Science	73	8	81
Olin Business School	47	10	57
School of Law	25	20	45
Sam Fox School of Design & Visual Arts	24	14	38
George Warren Brown School of Social Work	18	15	33
Total	**458**	**177**	**635**

Of the six schools on the Danforth campus, the committee began with a review of data from Arts & Sciences, the largest of the Danforth Campus schools with 381 tenured and tenure track faculty in the academic year 2008-2009.

1. School of Arts and Sciences

Table 3 provides a summary of the Arts & Sciences faculty population included in this study[iv]. Of the 381 faculty included in the analyses, 110 are women and 271 are men. Sixty-nine percent of all women and 40% of all men faculty are assistant or associate professors. There are 332 Whites (not Hispanic), 25 Asians (not considered URM), and 24 URM (12 African American and 12 Hispanic or Latino) in Arts & Sciences.

Table 3. Arts & Sciences Tenured & Tenure Track Faculty, 2008-09

	Men	Women	Total
By Rank			
Assistant Professors	52	44	96
Associate Professors with Tenure	56	32	88
Full Professors	119	24	143
Full Professors, With Endowed Chairs	44	10	54
Total	271	110	381
Number of Faculty with Additional Role (with stipend)			
Faculty with Chair/Director Role	35	17	52
By Discipline Groups Used in Pay Analysis			
Natural Sciences, Math, Psychology	120	28	148
Anthropology and Political Science	38	12	50
Economics	23	2	25
English and History	30	19	49
Foreign Languages & Lit, Education, Other	60	49	109
Total	271	110	381
By Ethnicity			
African American	7	5	12
Hispanic, Native American	9	3	12
Underrepresented Minority Total	16	8	24
Asian	14	11	25
Non-Hispanic White, Other	241	91	332
Total	**271**	**110**	**381**

The analyses began with a replication of previous methodologies followed by an addition of three new variables not used in previous studies: Endowed Professorship, Underrepresented Ethnic Minorities (URM), and Department Chair/Director/Associate Dean. Also, for the current analysis, a prediction model based on both males and females is added. In the models summarized below, independent variables include five discipline categories[v], URM, three rank variables (assistant, associate, and full), Endowed Chair, Department Chair/Director/Associate Dean and four time variables: number of years since degree, number of years at Washington University, and the squared terms of the last two variables. The dependent variables are the total 9-month salary (including chair/director stipends adjusted to 9-month equivalent salary), and the natural log of total 9-month salary[vi]. Eight models are analyzed for each of the five methodological approaches with a total of 40 models (see appendix D: a summary page documenting 40 regression equations).

In addition to results from these 40 models, the committee reviewed results from four additional models: (1) two models including gender variable in addition to all other variables; and (2) two models that substituted a ratio time variable (years at WU divided by years since terminal degree) for the four time variables.

Tables 4 and 5 summarize the results from six strongest models (with adjusted R^2 ranging from .59 to .81). The models in Table 4 use a natural log of total 9-month salary as the dependent variable and the residuals reflect percent difference in salary between male and female faculty. For models in Table 5, the dependent variable is the total 9-month salary and the residuals reflect differences in salary in dollars. The first model in each Table reproduces the earlier Gray model using the 2008-09 data based on male faculty (see Models A & E)[vii]; in the second model, the two new variables Endowed Chair and URM are added but the model continues to use only male faculty data to predict salary (see Models B & F); the third model utilizes both male and female data to derive the prediction formula (see Models C & G); in the fourth model a separate variable, Department Chair/Director/Associate Dean is added to the third model (see Models D & H); in the fifth model gender variable is added to the fourth model (see Models D-2 and H-2); and finally, in the last model the four time variables from the previous model are replaced with a time ratio variable (Yrs at WU/Yrs since terminal degree) (see D-3 and H-3).

Table 4: Regression models predicting percent difference in salary (9-month), Arts & Sciences 2008-2009. N=381

Regression models			Residuals: average % difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)		
	Adj. R^2	Std error	Mean Female residual	Mean Male residual	Total difference between mean female and male residuals	z-scores for female	z-scores for male	Total difference in z-scores between men and women
Model A: Original Gray Residual Methodology, male only[1]	.67	2.32%	-0.59%	0	-0.59%	-0.25	0	-.25
Model B: Gray Residual Methodology modified by the addition of URM and Endowed Chair variables, male only[2]	.78	1.95%	-1.01%	0	-1.01%	-0.52	0	-0.52
Model C: Gray Residual Methodology modified to base prediction on both males and females[3]	.80	1.89%	-1.02%	0.38%	-1.40%	-.54	0.22	-.76
Model D: Same as Model C plus dept chair/director/associate dean variable[4]	.81	1.80%	-1.22%	0.50%	-1.72%	-.68	0.28	-.96
Models D-2 and D-3 used coefficient of gender variable to assess differences in salaries between men and women	Adj R^2	Std error	n.a.	n.a.	Difference indicated by female coefficient	Female coefficient divided by its standard error		
Model D-2: Same as Model D plus gender variable	.81	2.3%			-2.04%	-.89		
Model D-3: Same as Model D-2 except time ratio (yrs at WU/yrs since terminal degree) was substituted for 4 time variables	.80	2.3%			-1.50%	-.65		

[1] Model A: Dependent variable is the natural log of total 9-month salary. Independent variables include four discipline group, three rank levels (Assistant, Associate, and Full Professor), years since terminal degree, years since terminal degree squared, years at WU in tenure/tenure track appointment, and years at WU in tenure/tenure track appointment squared.

[2] Models B: Same as Model A except that it has two additional independent variables: Endowed Professorship and URM.

[3] Models C: Same as Model B except that the regression formula is derived from salary data for both men and women.

[4] Models D: Same as Model C except that the model has an additional predictor: Department Chair/Director/Associate Dean.

Table 5: Regression models predicting salary difference in dollars (9-month salary), Arts & Sciences 2008-2009.

	Gender variable not included							
Regression models[5]			Residuals: average $ difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)		
	Adj. R^2	Std error	Mean Female residual	Mean Male residual	Total difference in salary between men and women	z-scores for female	z-scores for male	Total difference in z-scores between men and women
Model E: Original Gray Residual Methodology, male only	.59	3,770	-1,130	0	-$1,130	-0.30	0	-0.30
Model F: Gray Residual Methodology modified by the addition of URM and Endowed Chair variables, male only	.73	3,165	-1,905	0	-$1,905	-0.60	0	-0.60
Model G: Residual Methodology modified to base prediction on both males and females	.72	3,015	-2,138	+868	-$3,006	-0.71	+0.29	-1.00
Model H: Same as Model F plus dept chair/director/associate dean variable	.73	2,931	-2,380	+966	-$3,346	-0.81	+0.33	-1.14
Models H-2 and H-3 used coefficient of gender variable to assess differences in salaries between men and women	**Adj R^2**	**Std error**	**n.a.**	**n.a.**	**Difference indicated by female coefficient**	**Female coefficient divided by its standard error**		
Model H-2: Same as Model H plus gender variable	.73	3,904			-$3,979	-1.02		
Model H-3: Same as Model H-2 except time ratio (yrs at WU/yrs since terminal degree) was substituted for 4 time variables	.71	3,955			-$3,072	-0.78		

The addition of two new variables (Endowed Chair and URM) increased the explanatory power of the regression model from 67% to 78% in the natural log models (Model A to Model B) and from 59% to 73% in the model using salary in dollars (Models E to Model F). Most of the increase in explanatory power came from inclusion of Endowed Professor as a separate variable (see Models B and F). The prediction equation based on both male and female increased the

[5] Regression models in this table are equivalent to the models in Table 4 except that the dependent variable is total 9-month salary in dollars.

Adjusted R^2 from .78 to .80 in the log model (see Model C) and decreased the Adjusted R^2 from .73 to .72 in the model using salary in dollars (Model G).

From the residual methodology using both male and female salaries and two new variables (Endowed Chair and URM) we find that, on average, female faculty earned 1.40% less in the log model ($2,979 less in the dollar model) than male faculty. This difference is larger than the results obtained from using earlier methodology where prediction is based only on male salaries showing a salary difference of -1.01% in the log model (-$1,905 in the dollar model). Also, standard errors[viii] are reduced when salaries of both male and female faculty are included.

To assess the magnitude of difference between male and female residuals, the committee examined Z-scores. Z-scores are negative for women and positive for men in all models; the total difference in Z-scores between men and women ranged from -0.76 in the log model to -1.00 in the model using salary in dollars.

The difference in male and female salaries is more pronounced when Department Chair/Director/Associate Dean variable is added to the third model (See models D & H). On average, women earn 1.72% less in the log model ($3,346 less in the dollar model) than men. This model also has the lowest standard error and the highest explanatory power with an adjusted R^2 of .81 in log model and a .73 in the model using salary in dollars.

Inclusion of gender variable in the model widened the salary difference between men and women; on average, women earn 2.04% less in the log model ($3,979 less in the dollar model) less than men (see Model D-2 & H-2). When the four time variables (years since terminal degree, years here at WU and their squared terms) are substituted with a ratio time variable (years at WU divided by years since terminal degree), the salary difference between men and women is -1.50% in the log model (-$3,072 in the dollar model) (see Models D-3 and H-3).

A plot of mean female residuals from Tables 4 and 5 against their standard errors shows that women have negative residuals in each of the four models applied to the 2008-09 salary data from Arts & Sciences (see Table 6). Negative residuals for women are also consistent over-time (see Table 7). Female residual has been consistently negative over the history of pay equity studies of Arts & Sciences faculty (1986 to 2009) indicating gender difference in salary distribution.

Table 6. Difference between mean male and female residuals from 4 different models in percentage (Models A, B, C & D), 2008-09

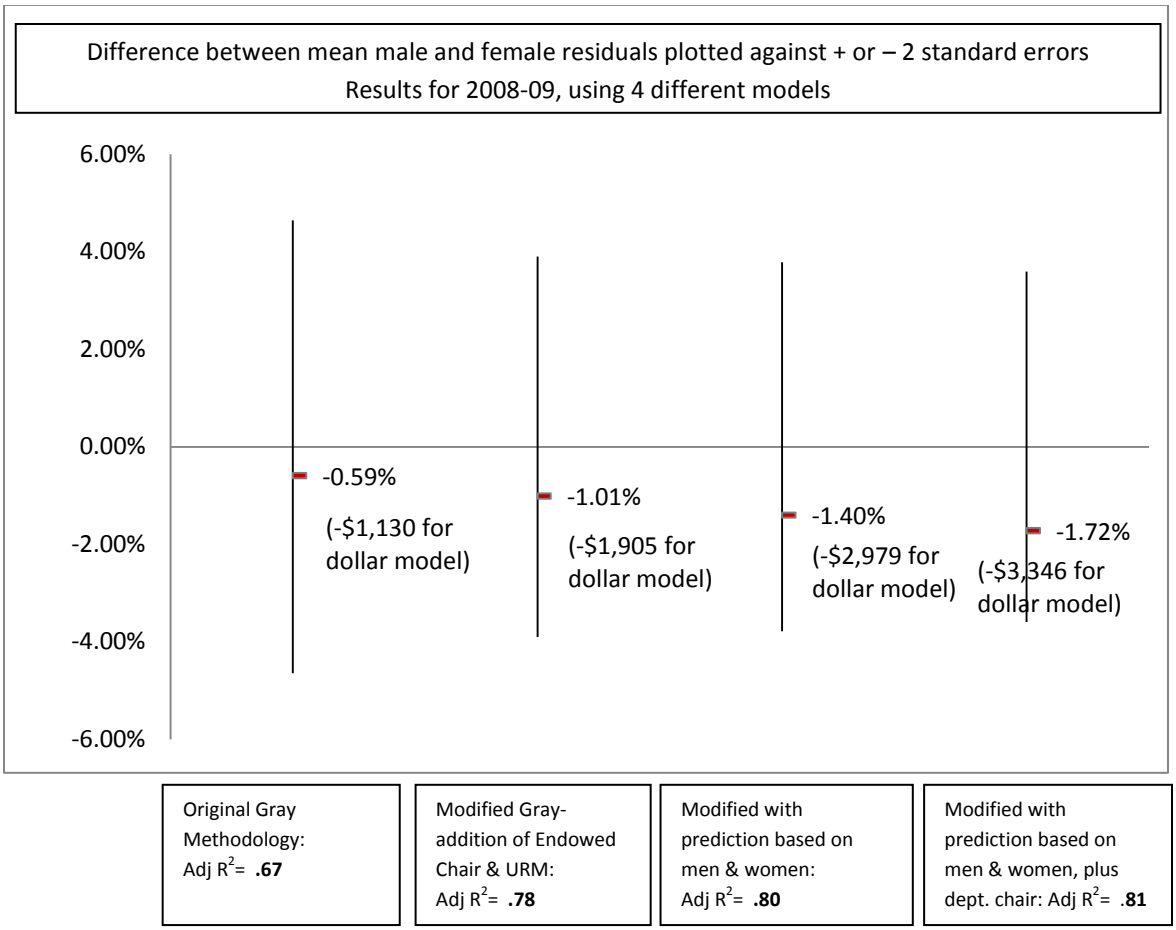
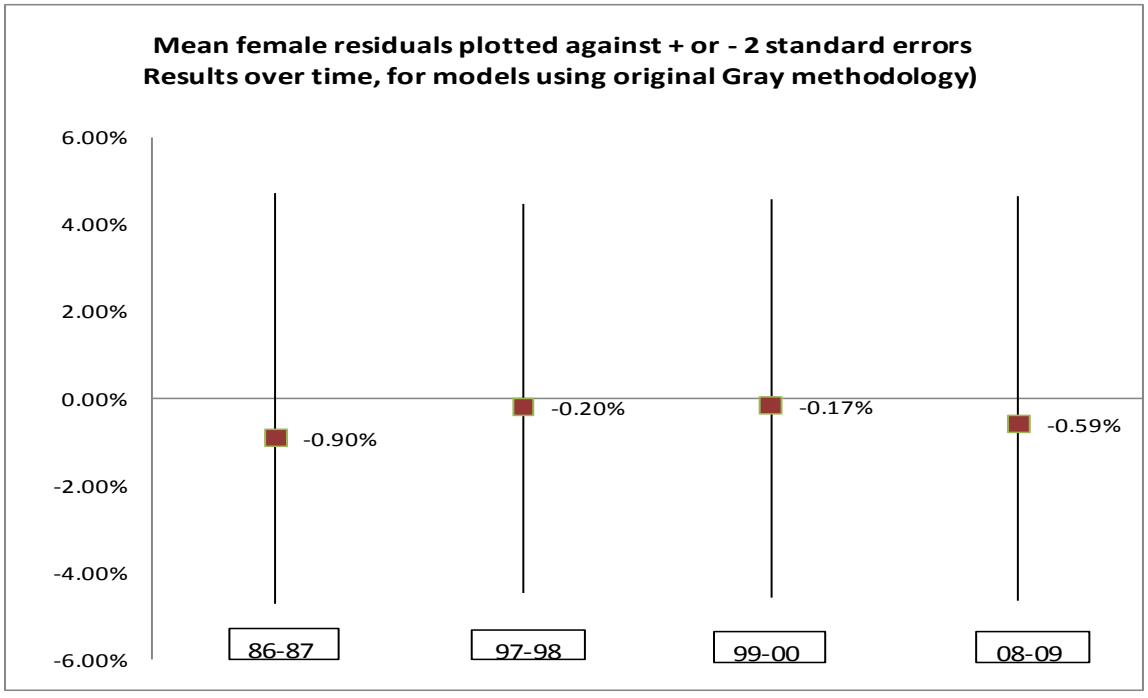


Table 7. A plot of log of salary mean-residuals against standard error, over time, 1986-2009



In sum, the analysis of Arts & Sciences 2008-09 salary data underscores difference in salaries of men and women after controlling for discipline, minority status, rank (assistant, associate, and full), Endowed Chair, and the four time variables--number of years since degree, number of years at Washington University, and the squared terms of the last two variables. Difference in salary between men and women faculty increases with the inclusion of Department Chair/Director/Associate Dean variable. The average difference between men and women's salary ranges from -$1,130 in the dollar model, Model E (or -0.59% in log model, Model A) using original Gray methodology to -$2,979 in the dollar model, Model G (or -1.40% in log model, Model C) based on both men and women with two new variables—Endowed Chair and URM. When we account for the position of a faculty as Department Chair/Director/Associate Dean, the difference between men and women's salary increases to -$3,346 in the dollar model, Model H (or -1.72% in log model, Model D). When gender is included as an independent variable, the salary difference between men and women widens to -$3,979 (Model H-2) (or -2.04% in log model, Model D-2).

It is important to note that the mean female residual has been consistently negative in all analyses of tenured and tenure track faculty of Arts & Sciences performed over the last 20 years[ix]. Moreover, when identical methods of analysis are utilized, the current mean difference of -0.59% is larger than the -0.20% difference observed 10 years ago. (See Table 7) The improved methodology with the addition of three new variables and a prediction formula based on both men and women produces a larger mean female residual; the female residual increases from -0.59% in the original methodology to -1.22% in the current improved model (see Table 4, column 3).

Analysis of Olin Business, Engineering, Sam Fox, Law and Brown (Social Work) School on Danforth Campus

The methodologies developed in the study of Arts & Sciences are applied to the remaining five schools—Brown School (Social Work), Engineering, Business, Sam Fox, and Law—on the Danforth Campus. The sample populations are smaller[x] in these schools compared to Arts & Sciences. McCloskey's team consulted with each dean to define and construct school-specific disciplinary groups and ran a series of models to address school specific questions.

Results from six models (12 models for the Brown School) for each school—three using log of 9-month salary and three using salary in dollars are summarized below. The first pair of models (Model A in the tables that follow) utilized both male and female faculty to predict salaries, corresponding to Model D of Table 4 for Arts & Sciences. The second pair of models (Model B in the tables that follow) included a variable for gender, corresponding to Model D-2 of Table 4 for Arts & Sciences. The third pair of models (Model C in the tables that follow) is the same as Model B, except that a time ratio variable was substituted for the four time variables of the earlier models. (This last pair of models corresponds to Model D-3 of Table 4 for Arts & Sciences.

2. George Warren Brown School of Social Work (Brown School)

Analyses of the Brown School include 32 faculty members of which 15 (or 47%) are women and 17 (53%) are men (see Table 8). Among women faculty 67% are assistant and associate professors, whereas among men 41% hold similar ranks. Among male faculty, approximately 59% are full or endowed professors whereas among women, only 33% hold similar positions.

Table 8. Tenured & Tenure Track Faculty at the Brown School, 2008-09.

	Men	Women	Total
By Rank			
Assistant Professors	4	4	8
Associate Professors with Tenure	3	6	9
Full Professors	6	1	7
Full Professors, With Endowed Chairs	4	4	8
Total	17	15	32
Number of Faculty with Additional Role (with stipend)			
Faculty with Chair/Director Role	7	5	12
By Discipline Groups			
Public Health	4	2	6
Social Work	13	13	26
Total	17	15	32
By Ethnicity			
African American	1	2	3
Hispanic, Native American	2	0	2
Underrepresented Minority Total	3	2	5
Asian	2	3	5
Non-Hispanic White, Other	12	10	22
Total	**17**	**15**	**32**

Similar to Arts and Sciences, the dependent variable for the Brown School is salary in dollars or the natural log of salary. The models include the same set of variables as in Arts & Sciences analysis. As the Brown School now has Institute of Public Health (IPH) faculty, the committee reviewed regression results using two different populations—one with and one without IPH faculty. The relevant population was defined two different ways because the IPH faculty recently joined the Social Work school as a group, and it may be more appropriate to view salary setting as the result of two separate processes, rather than a single process in which discipline group differs. The results from the six models for each population are presented in Tables 9a and 9b. The first set of analyses (Table 9a) include both social work and IPH faculty (N=32; 17 men and 15 women) and control for the two discipline categories—social work and public health (see Table 9a). All 6 models have a very strong predictive power with an Adjusted R^2 ranging from .83 to .90.

Difference in salary between men and women faculty in the Brown School ranges from -3.01% to -5.63%. In dollar models, women in the Brown School earn $4,730 to $6,455 less than their male counterparts.

The second set of analyses excludes the IPH faculty from the population (N=26) (see Table 9b). When the analyses are limited to this smaller population, gender difference in salary widens even more. Women earn between 4.19% and 6.65% less than men. According to the dollar models, women earn $6,251 to $8,709 less than men.

The findings from the Brown School show a salary difference between men and women faculty in every analysis. The difference in salary between men and women widen when IPH faculty are excluded.

Table 9a: Regression models predicting salary in percent and in dollars, Brown School of Social Work, 2008-2009, (N=32).

Regression Models				Residuals: average % difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)	
Model A uses the Mean Residual Method to assess difference between men and women	Dependent variable	Adj R^2	Std error	Mean female residual	Mean male residual	Difference between mean female & male residuals	z-score for female	z-score for male
Model A: All original variables (includes 4 time variables) plus chair/director variable, based on men and women[6]	Natural log of 9-month salary	.90	3.26%	-1.60%	1.41%	-3.01%	-.49	.43
	9-month salary	.83	5,126	-$2,513	$2,217	-$4,730	-.49	.43
Models B & C use the Coefficient of Gender Variable to assess difference between men and women	Dependent variable	Adj R^2	Std error	n.a.	n.a.	Difference indicated by female coefficient	Female coefficient divided by std error	
Model B: All original variables (includes 4 time variables) plus chair/director and gender variables, based on men and women	Natural log of 9-month salary	.90	4.76%			-4.11%	-.86	
	9-month salary	.83	7,492			-$6,455	-.86	
Model C: Same as Model B, except time ratio (yrs here/yrs degree) is substituted for 4 time variables	Natural log of 9-month salary	.87	5.11%			-5.63%	-1.10	
	9-month salary	.83	7,491			-$6,046	-.81	

[6]Model A: Similar to Model D in Arts & Sciences. Dependent variable is log of 9-month salary or actual dollars. Independent variables include 3 rank variables (Assistant, Associate, and Full Professor), Endowed Chair, Department Chair/Director/Associate Dean, URM, two discipline groups (social work and Institute of Public Health), years since terminal degree, years at WU, and squared terms of the last two variables.

Table 9b: Regression models predicting salary in percent and in dollars, Brown School of Social Work, excluding Institute of Public Health (IPH) Faculty, 2008-2009, (N=26).

Regression Models				Residuals: average % difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)	
Model A uses the Mean Residual Method to assess difference between men and women	Dependent variable	Adj R^2	Std error	Mean female residual	Mean male residual	Difference between mean female & male residuals	z-score for female	z-score for male
Model A: All original variables (includes 4 time variables) plus chair/director variable, based on men and women[7]	Natural log of 9-month salary	.94	2.54%	-2.10%	2.10%	-4.19%	-.82	.82
	9-month salary	.91	3,945	-3,125	3,125	-$6,251	-.79	.79
Models B & C use the Coefficient of Gender Variable to assess difference between men and women	Dependent variable	Adj R^2	Std error	n.a.	n.a.	Difference indicated by female coefficient	Female coefficient divided by std error	
Model B: All original variables (includes 4 time variables) plus chair/director and gender variables, based on men and women	Natural log of 9-month salary	.95	3.64%			-5.57%	-1.53	
	9-month salary	.92	5,649			-$8,295	-1.47	
Model C: Same as Model B, except time ratio (yrs here/yrs degree) is substituted for 4 time variables	Natural log of 9-month salary	.92	4.54%			-6.65%	-1.46	
	9-month salary	.87	6,903			-$8,709	-1.26	

[7]Model A: Similar to Model D in Arts & Sciences. Dependent variable is log of 9-month salary or actual dollars. Independent variables include 3 rank variables (Assistant, Associate, and Full Professor), Endowed Chair, Department Chair/Director/Associate Dean, URM, years since terminal degree, years at WU, and squared terms of the last two variables.

3. School of Engineering & Applied Science, 2008-09

Eighty-one faculty from the School of Engineering & Applied Science are included in the current study of which eight (or approximately 10%) are women (see Table 10). One half of all women faculty are assistant professors compared to 18% of their male counterparts serving in the same rank.

Table 10. Tenured & Tenure Track Faculty at the School of Engineering & Applied Science, 2008-09

	Men	Women	Total
By Rank			
Assistant Professors	13	4	17
Associate Professors with Tenure	20	2	22
Full Professors	15	1	16
Full Professors, With Endowed Chairs	25	1	26
Total	73	8	81
Number of Faculty with Additional Role (with stipend)			
Faculty with Chair/Director Role	6	0	6
By Discipline Groups			
BME-BioMedical	14	1	15
CSE-Computer Sci & Engin	21	3	24
EECE-Energy, Envir & Chemical	12	2	14
ESE-Electrical & Systems	15	1	16
MASE-Mechanical, Aerospace & Structural	11	1	12
Total	73	8	81
By Ethnicity			
African American	0	0	0
Hispanic, Native American	0	0	0
Underrepresented Minority Total	0	0	0
Asian	22	3	25
Non-Hispanic White, Other	51	5	56
Total	**73**	**8**	**81**

Regression results from the six models are reported in a separate Table (see Table 11). Similar to Arts and Sciences, the dependent variable is salary in dollars or the natural log of salary. The models include a similar set of independent variables as in the analysis of the Arts & Sciences data. This school has five departments[xi] but it does not have any underrepresented ethnic minority on faculty. Thus, regression models for Engineering school do not control for the URM.

Model adjusted R^2 range from a low of .72 to .75. The difference in salary between men and women faculty ranges from -0.68% to -2.33%. The dollar models show that on average, women faculty in Engineering earn $507 to $3,838 less than their male counterparts.

Table 11: Regression models predicting salary in percent and in dollars, School of Engineering & Applied Science, 2008-09 (N=81)

Regression Models				Residuals: average % difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)	
Model A uses the Mean Residual Method to assess difference between men and women	Dependent variable	Adj R^2	Std error	Mean female residual	Mean male residual	Difference between mean female & male residuals	z-score for female	z-score for male
Model A: All original variables (includes 4 time variables) plus chair/director variable, based on men and women[8]	Natural log of total 9-mo salary	.75	2.24%	-.61%	.07%	-0.68%	-.27	.03
	Total 9-month salary	.74	2,613	-457	50	-$507	-.17	.02
Models B & C use the Coefficient of Gender Variable to assess difference between men and women	Dependent variable	Adj R^2	Std error	n.a.	n.a.	Difference indicated by female coefficient	Female coefficient divided by std error	
Model B: All original variables (includes 4 time variables) plus chair/director and gender variables, based on men and women	Natural log of total 9-mo salary	.75	5.24%			-0.79%	-0.15	
	Total 9-month salary	.74	6,728			-$595	-0.09	
Model C: Same as Model B, except time ratio (yrs here/yrs degree) is substituted for 4 time variables	Natural log of total 9-mo salary	.74	5.14%			-2.33%	-0.45	
	Total 9-month salary	.72	6,732			-$3,838	-0.57	

4. **Olin Business School**

Analyses of data from Olin Business School include 57 faculty members; of these 10 or approximately 18% are women. Eighty percent of these women hold assistant or associate professor's rank compared to 57% of male faculty in similar ranks. It has seven discipline groups (see Table 12).

[8]A: Similar to Model D in Arts & Sciences. Dependent variable is the log of 9-month salary or actual dollars. Independent variables include three rank variables (Assistant, Associate, Full Professor), Endowed Chair, Department Chair/Director/Associate Dean, five departments (Energy, Environmental and Chemical Engineering (EECE-Energy and environment); Mechanical, Aerospace, and Structural Engineering (MASE-Mtis); Electrical and Systems Engineering (ESE-Electrical); Biomedical Engineering (BME-BioMedical); Computer Science and Engineering (CSE-Computer Sci &)); years since terminal degree, years at WU, and squared terms of the last two variables.

Table 12. Tenured & Tenure Track Faculty, Olin Business School, 2008-09

	Men	Women	Total
By Rank			
Assistant Professors	20	5	25
Associate Professors without Tenure	1	1	2
Associate Professors with Tenure	6	2	8
Full Professors	6	1	7
Full Professors, With Endowed Chairs	14	1	15
Total	47	10	57
Number of Faculty with Additional Role (with stipend)			
Faculty with Chair/Director Role	7	0	7
By Discipline Groups			
Accounting	5	2	7
Economics	6	1	7
Finance	12	0	12
Marketing	8	2	10
Operations & Mfg Management	5	2	7
Organizational Behavior	6	2	8
Strategy	5	1	6
Total	47	10	57
By Ethnicity			
African American	0	0	0
Hispanic, Native American	2	0	2
Underrepresented Minority Total	2	0	2
Asian	12	4	16
Non-Hispanic White, Other	33	6	39
Total	**47**	**10**	**57**

Regression results of the six models are reported in Table 13. Similar to Arts and Sciences, the dependent variable is salary in dollars or the natural log of salary. The models include a similar set of independent variables as in the analysis of Arts & Sciences, except that the rank variables include untenured, tenured Associate and tenured Full Professor and that this school has seven discipline groups.

In addition to reviewing results of models with seven discipline groups based upon department configurations in the School of Business, the committee requested an analysis using only two discipline groups--accounting & finance and all others (see Model B2 in Table 13). When only two discipline groups were utilized the results were similar to the models with seven discipline groups. The committee was informed that the two discipline model has less "face value" for the dean for practical purposes and that from the administrative perspective, considering all seven disciplines is preferable. Nevertheless, the committee has reported results from both models with all seven disciplines and one with only two disciplines.

Model adjusted R^2 for the School of Business ranges from .80 to .91. Difference in salary between men and women faculty ranges from -3.00% to -5.69%. On average, women faculty earn from $6,751 to $12,878 less than their male counterparts.

Table 13: Regression models predicting salary in percent and dollars, Olin Business School, 2008-2009 (N=57)

Regression Models				Residuals: average % difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)	
Model A uses the Mean Residual Method to assess difference between men and women	Dependent variable	Adj R^2	Std error	Mean female residual	Mean male residual	Difference between mean female & male residuals	z-score for female	z-score for male
Model A: All original variables (includes 4 time variables) plus chair/director variable, based on men and women[9]	Natural log of total 9-mo salary	.91	2.27%	-2.48%	0.53%	-3.00%	-1.09	0.23
	Total 9-month salary	.90	5,174	-5,566	1,184	-$6,751	-1.08	0.23
Models B & C used the Coefficient of Gender Variable to assess difference between men and women	Dependent variable	Adj R^2	Std error	n.a.	n.a.	Disparity indicated by Female coefficient	Female coefficient divided by std error	
Model B1: All original variables (include 7 discipline categories, 4 time variables) plus chair/director and gender variables, based on men and women	Natural log of total 9-mo salary	.91	2.98%			-3.67%	-1.23	
	Total 9-month salary	.90	6,801			-$8,257	-1.21	
Model B2: Same as B1 except that 7 discipline categories are combined to two disciplines (accounting & finance=1; else =0)	Natural log of total 9-mo salary	.91	2.99%			-3.39%	-1.14	
	Total 9-month salary	.89	6,788			-$8,561	-1.27	
Model C: Same as Model B1, except time ratio (Yrs here/Yrs degree) was substituted for 4 time variables	Natural log of total 9-mo salary	.84	4.24%			-5.69%	-1.34	
	Total 9-month salary	.80	10,151			-$12,878	-1.27	

[9]A: Similar to Model D in Arts & Sciences. Dependent variable is the log of 9-month salary or salary in dollars. Independent variables include 3 rank variables (untenured, tenured Associate and tenured Full Professor), Endowed Chair, Department Chair/Director/Associate Dean, URM, 7 discipline [Economics, Finance, Accounting, Marketing, Ops. Management, Organizational Behavior, Strategy); years since terminal degree, years at WU, and squared terms of the last two variables.

5. Sam Fox School of Design and Visual Arts

A total of 37 tenured and tenure-track faculty from the Sam Fox School of Design & Visual Arts are included in the analyses of which 14 or approximately 38% are women. There are two discipline categories—Architecture and Art (see Table 14). Among women 87% hold assistant or associate professor's position, whereas, among men approximately 57% hold similar rank.

Table 14. Tenured and Tenure Track Faculty, Sam Fox School of Design & Visual Arts, 2008-2009

	Men	Women	Total
By Rank			
Assistant Professors	4	5	9
Associate Professors with Tenure	9	7	16
Full Professors	7		7
Full Professors, With Endowed Chairs	3	2	5
Total	23	14	37
Number of Faculty with Additional Role (with stipend)			
Faculty with Chair/Director Role	2	1	3
By Discipline Groups			
Architecture	13	4	17
Art	10	10	20
Total	23	14	37
By Ethnicity			
African American	1	1	2
Hispanic, Native American	0	0	0
Underrepresented Minority Total	1	1	2
Asian	1	1	2
Non-Hispanic White, Other	21	12	33
Total	**23**	**14**	**37**

Regression results from the six models are reported in Table 15. Similar to Arts and Sciences, the dependent variable is salary in dollars or the natural log of salary. The models include a similar set of independent variables as in our analysis of Arts & Sciences.

Model adjusted R^2 ranges from .83 to .84. The difference in salary between men and women faculty ranges from -3.15% to -7.01%. On average, women faculty in the School of Design and Arts earn $3,149 to $6,897 less than their male counterparts.

Table 15: Regression models predicting salary and log of salary, Fox School, 2008-2009, (N=37).

Regression Models				Residuals: average % difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)	
Model A uses the Mean Residual Method to assess difference between men and women	Dependent variable	Adj R^2	Std error	Mean female residual	Mean male residual	Difference between mean female & male residuals	z-score for female	z-score for male
Model A: All original variables (includes 4 time variables) plus chair/director variable, based on men and women[10]	Natural log of total 9-mo salary	.83	3.11%	-1.96%	1.19%	-3.15%	-.63	0.38
	Total 9-month salary	.84	2,757	-1,958	1,192	-$3,149	-.71	0.43
Models B & C use the Coefficient of Gender Variable to assess difference between men and women	Dependent variable	Adj R^2	Std error	n.a.	n.a.	Difference indicated by female coefficient	Female coefficient divided by std error	
Model B: All original variables (includes 4 time variables) plus chair/director and gender variables, based on men and women	Natural log of total 9-mo salary	.83	4.55%			-5.04%	-1.11	
	Total 9-month salary	.84	4,086			-$5,036	-1.23	
Model C: Same as Model B, except time ratio (yrs here/yrs degree) is substituted for 4 time variables	Natural log of total 9-mo salary	.82	4.49%			-7.01%	-1.56	
	Total 9-month salary	.83	3,987			-$6,897	-1.73	

[10]A: Similar to Model D in Arts & Sciences. Dependent variable is the log of 9-month salary or salary in actual dollars. Independent variables includes three rank variables (Assistant, Associate, & Full Professor), Endowed Chair, Department Chair/Director/Associate Dean, URM, 2 discipline (Architecture & Art); years since terminal degree, years at WU, and squared terms of the last two variables.

6. School of Law

Of the 45 faculty, 20 (approximately 44%) are women. Discipline is not a variable in this analysis. At the School of Law, there are no assistant professors as the school grants associate professor's rank on initial hire.

Table 16. School of Law Tenured & Tenure Track Faculty, 2008-09

	Men	Women	Total
By Rank			
Assistant Professors			
Associate Professors (without Tenure)	3	2	5
Full Professors	11	10	21
Full Professors, With Endowed Chairs	11	8	19
Total	25	20	45
Number of Faculty with Additional Role (with stipend)			
Faculty with Chair/Director Role	5	5	10
By Ethnicity			
African American	1	2	3
Hispanic, Native American	0	0	0
Underrepresented Minority Total	1	2	3
Asian	1	1	2
Non-Hispanic White, Other	23	17	40
Total	**25**	**20**	**45**

Regression results from six models are reported in Table 17. Similar to Arts and Sciences, the dependent variable is salary in dollars or the natural log of salary. The model includes a similar set of independent variables as in analysis of Arts & Sciences except that it has no discipline variable and has only two ranks[xii].

Model adjusted R^2 ranged from .35 to .47. The difference in salary between men and women faculty ranges from -2.60% to -3.04%. Linear models show that, on average, women faculty in the School of Law earn $5,544 to $6,484 less than their male counterparts.

Table 17: Regression models predicting salary and log of salary, School of Law, 2008-09 (N=45)

Regression Models				Residuals: average % difference when actual salaries compared with predicted salaries			Z-scores (mean residual divided by corresponding standard error)	
Model A uses the Mean Residual Method to assess difference between men and women	Dependent variable	Adj R^2	Std error	Mean female residual	Mean male residual	Difference between mean female & male residuals	z-score for female	z-score for male
Model A: All original variables (includes 4 time variables) plus chair/director variable, based on men and women[11]	Natural log of total 9-mo salary	.45	4.28%	-1.44%	1.16%	-2.60%	-.34	.27
	Total 9-month salary	.37	9,246	-3,080	2,464	-$5,544	-.33	.27
Models B & C use the Coefficient of Gender Variable to assess difference between men and women	Dependent variable	Adj R^2	Std error	n.a.	n.a.	Difference indicated by female coefficient	Female coefficient divided by std error	
Model B: All original variables (includes 4 time variables) plus chair/director and gender variables, based on men and women	Natural log of total 9-mo salary	0.44	5.19%			-3.04%	-0.59	
	Total 9-month salary	0.35	11,246			-$6,484	-0.58	
Model C: Same as Model B, except time ratio (yrs here/yrs degree) is substituted for 4 time variables	Natural log of total 9-mo salary	0.47	4.80%			-2.89%	-0.60	
	Total 9-month salary	0.39	10,351			-$5,810	-0.56	

Conclusion

Given the current methodology, the predictive power of the model is strongest for the Brown School of Social Work and weakest for the Law School. The committee reviewed results of many other models. The fundamental findings from those analyses remain

[11]A: Similar to Model D in Arts & Sciences. Dependent variable is the log of 9-month salary. Independent variables include two rank variables (Associate, and Full Professor), Endowed Chair, Department Chair/Director/Associate Dean, URM; years since terminal degree, years at WU, and squared terms of the last two variables.

unchanged; they show that gender difference in salary is prevalent in all schools on Danforth Campus. Women earn less than men in every model examined.

Recommendation

The committee makes the following recommendations:

1. The university should conduct a gender pay-equity analysis with greater frequency than in the past. The most recent gender pay equity study at Washington University was conducted nine years ago, and the one before was a decade earlier. The persistence of a negative residual for women in Arts & Sciences is of concern. There is reason for continued scrutiny and careful attention to gender pay equity in Arts & Sciences. Analysis of the remaining five schools shows similar results. Given the persistent disparities in salaries by gender, we recommend that a pay equity study be conducted more frequently in the future, possibly every two years.
2. If a pay equity study is to be conducted on a regular basis, the committee recommends that any future committee consider some continuity with the work of previous committees so that we maintain institutional memory. To maintain this, the committee suggests that at least two to three committee members should be retained from a previous committee in the new committee.
3. We recommend continued improvements in the methodology in future studies. In particular, adjusted R^2 is the weakest for the Law School. Future studies should continue to improve predictive power of the models particularly for the School of Law.

Appendix A

Historical Analyses and Findings

1988 – An outside expert, Mary Gray, Professor of Mathematics and Statistics at American University, was hired to conduct an analysis of gender pay equity. She applied multiple regression analysis to develop a salary prediction equation based on the male population, then applied that formula to predict female salaries and examined the residual difference in predicted and actual female salaries. Gray concluded that the study of data for the 1986-87 academic year indicated a difference between pay for men and women and recommended across-the-board monetary compensation for women faculty.

1989-90 – A Senate Council Pay Equity Committee, chaired by Professor Martha Storandt, studied four years of Arts & Sciences salary data (86-87 thru 89-90). The analysis replicated the methodology developed by Professor Gray. The report, issued in April 1990, concluded that gender difference was real but not considered statistically significant for the most recent years. Also, that the magnitude of the difference had diminished in the last two years of the study.

1997-00 - A Senate Council Committee on Pay Equity originally chaired by Professor Jean Ensminger and succeeded by Professor Jody O'Sullivan, reviewed analysis of salary data for the 1999-2000 academic year, repeating the Gray methodology. The committee requested additional regression analyses using an alternate methodology (Blinder-Oaxaca[xiii]) and introducing gender interaction variables. Both methods yielded similar results, leading to the conclusion that gender was not a statistically significant predictor of salary for Arts & Sciences departments.

Also, to examine the effect of adding productivity variables as predictors, a pilot study for three Social Science Departments was undertaken. Data were collected for 49 productivity variables and incorporated into regression models predicting salary. In the pilot study of 3 departments, the female coefficient was positive indicating about +7% in the models that included the productivity variables, compared to about +4% when they were excluded. However, gender was not a statistically significant predictor in any of the 8 models examined.

The final report in April 2000 concluded that the results were consistent among all of the different methods applied, that women continued to have an average negative residual in the Gray methodology analysis but the difference was small. The report also concluded that the Pilot Study including productivity variables resulted in a similar conclusion and confirmed the results previously observed using the Gray and Oaxaca-Blinder methods.

Appendix B: Arts & Sciences – Gray Methodology

Arts & Sciences Tenure/Track Faculty Salary Analysis

Traditional methodology: model based on male population is applied to female population to predict female salaries
Variables include: discipline groups, years here, years since terminal degree, squared terms, rank dummy variables

Mean female residuals, standard errors and z-scores
Comparison of analyses for 1986-87, 1997-98 and 1999-2000

				1986-87				1997-98				1999-00			
model	sq terms	rank	log scale	R^2	standard error	difference: mean female residual	z-score	R^2	standard error	difference: mean female residual	z-score	R^2	standard error	difference: mean female residual	z-score
models with rank variable															
1	y	y	y	0.74	2.36%	-0.90%	-0.38	0.61	2.23%	-0.20%	-0.09	0.58	2.41%	0.11%	-0.05
2	y	y	n	0.63	995	-291	-0.29	0.51	1,826	-307	-0.17	0.47	2,334	-608	-0.26
5	n	y	y	0.74	2.31%	-1.12%	-0.48	0.61	2.19%	-0.18%	-0.08	0.57	2.38%	0.09%	0.04
6	n	y	n	0.63	956	-345	-0.36	0.51	1,780	-277	-0.16	0.45	2,251	-372	-0.17
models without rank variable															
3	y	n	y	0.62	2.71%	-3.38%	-1.25	0.47	2.69%	-2.84%	-1.06	0.45	2.93%	-0.89%	-0.30
4	y	n	n	0.53	1,164	-1313	-1.13	0.40	2,086	-1726	-0.82	0.38	2,673	-925	-0.35
7	n	n	y	0.58	2.92%	-5.83%	-2.00	0.43	2.82%	-4.93%	-1.75	0.38	3.11%	-3.96%	-1.27
8	n	n	n	0.52	1,193	-2095	-1.76	0.38	2,091	-2984	-1.43	0.32	2,671	-2957	-1.11

Note: All of the above models use the original discipline groups used in the initial Washington University study of 1986-87 data supervised by Mary Gray, Professor of Mathematics and Statistics at American University. The original selection of 11 aggregation groups appears to reflect a perception of national faculty characteristics in the 1980's.

Appendix C

Arts and Sciences Tenure/Track Faculty Salary Analysis 1999-2000

Traditional methodology: model based on male population is applied to female population to predict female salaries.
Variables include: discipline groups, years here, years since terminal degree, squared terms, rank dummy variables.

Comparison of two sets of models: using 5 discipline groups versus 11 discipline groups
Mean female residuals, standard errors and z_scores

				1999-00 using traditional discipline groups (11)				1999-00 using new discipline groups (5)			
model	sq terms	rank	log scale	R^2	standard error	difference: mean female residual	z-score	R^2	standard error	difference: mean female residual	z-score
models with rank variable											
1	y	y	y	0.58	2.41%	0.11%	-0.05	0.6	2.28%	-0.17%	-0.07
2	y	y	n	0.47	2,334	-608	-0.26	0.5	2,223	-253	-0.11
5	n	y	y	0.57	2.38%	0.09%	0.04	0.59	2.28%	-0.50%	-0.22
6	n	y	n	0.45	2251	-372	-0.17	0.48	2,171	-627	-0.29
models without rank variable											
3	y	n	y	0.45	2.93%	-0.89%	-0.3	0.48	2.79%	-0.91%	-0.33
4	y	n	n	0.38	2,673	-925	-0.35	0.41	2,551	-565	-0.22
7	n	n	y	0.38	3.11%	-3.96%	-1.27	0.4	3.01%	-4.29%	-1.42
8	n	n	n	0.32	2,671	-2957	-1.11	0.36	2,581	-3,010	-1.17

Original discipline groups:

- Math
- Biology
- Chemistry, Physics, Earth & Planetary Science
- Psychology
- Economics
- Education
- Anthropology, History, Philosophy, Political Science
- English
- ANELL, German, Romance Languages, Russian
- Classics, Comp Lit, AFAM, Art History, Wom Studies
- Performing Arts, Music

New discipline groups:

- Math, Biology, Chemistry, Physics, EPS, Psychology
- English, History
- Economics
- Anthropology, Political Science
- ANELL, German, Romance Languages, Russian, Classics, Comp Lit, Philosophy, Art History, Music, Performing Arts, AFAM, Wom Studies, Education

Note: the original discipline groups are those used in the initial Washington University study of 1986-87 data supervised by Mary Gray, Professor of Mathematics and Statistics at American University. The original selection of department groups appears to reflect a perception of national faculty characteristics in the 1980's. The purpose of introducing the new aggregation groups is twofold: (a) to reduce the number of discipline variables and thereby increase R square and (b) to recognize the character of Washington University Arts & Sciences departments as of 1999-2000.

Appendix D: A table documenting 40 regression equations

Original Gray methodology with prediction model based on men only

Traditional methodology: model based on male population is applied to female population to predict female salaries. The difference in predicted and actual female salaries is the residual. The average female residual and z-score are calculated to test for statistical significance. Generally, z-scores less than 2.00 support the null hypothesis (no gender bias). All 8 models include variables for discipline groups, years here, years since terminal degree. Rank is included in 4 models.

				2008-09				2008-09 - GUE				2008-09 - GUEC			
				Orig - replicating historical analysis				URM & Endow Chr variables added				URM, Endow Chr & Chair/Dir added			
model	sq terms	rank	log scale	adj R^2	standard error	mean female residual	z-score	adj R^2	standard error	mean female residual	z-score	adj R^2	standard error	mean female residual	z-score
4 models with rank variable															
1	y	y	y	0.67	2.32%	-0.59%	-0.25	0.78	1.95%	-1.01%	-0.52	0.79	1.86%	-1.51%	-0.81
2	y	y	n	0.59	3,770	-1130	-0.30	0.73	3,165	-1,905	-0.60	0.74	3,070	-2,456	-0.80
5	n	y	y	0.67	2.33%	-0.68%	-0.29	0.78	1.96%	-1.07%	-0.54	0.79	1.87%	-1.67%	-0.89
6	n	y	n	0.58	3,724	-1437	-0.39	0.71	3,137	-2,237	-0.71	0.72	3,045	-2,929	-0.96
4 models without rank variable															
3	y	n	y	0.60	2.63%	-3.91%	-1.49	0.62	2.70%	-3.56%	-1.32	0.67	2.57%	-4.20%	-1.64
4	y	n	n	0.55	3,971	-4421	-1.11	0.56	4,050	-3,991	-0.99	0.58	3,928	-4,792	-1.22
7	n	n	y	0.54	2.77%	-4.24%	-1.53	0.55	2.81%	-3.92%	-1.40	0.63	2.63%	-4.64%	-1.76
8	n	n	n	0.51	3,988	-5323	-1.33	0.51	4,028	-4,918	-1.22	0.56	3,910	-5,808	-1.49

Variation of Gray methodology with prediction model based on both men & women

Prediction model based on combined male and female population is applied. The difference in predicted and actual salaries is the residual. The average female residual and z-score are calculated to test for statistical significance. Generally, z-scores less than 2.00 support the null hypothesis (no gender bias). All 8 models include variables for discipline groups, years here, years since terminal degree. Rank is included in 4 models.

				2008-09 - GMF combined male and female model						2008-09 - GMFC combined male & female model with Chair/Dir					
				URM variable is included in all models and Endow Chair variable included in the 4 models with rank.						URM and Chair/Dir variable is included in all models and Endow Chair variable included in the 4 models with rank.					
model	sq terms	rank	log scale	adj R^2	standard error	mean female residual	z-score	mean male residual	z-score	adj R^2	standard error	mean female residual	z-score	mean male residual	z-score
4 models with rank variable															
1	y	y	y	0.80	1.89%	-1.02%	-0.54	0.41%	0.22	0.81	1.80%	-1.22%	-0.68	0.49%	0.28
2	y	y	n	0.72	3,015	-2138	-0.71	868	0.29	0.73	2,931	-2,380	-0.81	966	0.33
5	n	y	y	0.79	1.91%	-1.13%	-0.59	0.46%	0.24	0.81	1.82%	-1.41%	-0.77	0.57%	0.31
6	n	y	n	0.72	3,026	-2361	-0.78	959	0.32	0.72	2,061	-2,704	-1.31	1,098	0.53
4 models without rank variable															
3	y	n	y	0.63	2.59%	-2.61%	-1.01	0.46%	0.18	0.67	2.48%	-2.80%	-1.13	1.14%	0.46
4	y	n	n	0.56	3,851	-3465	-0.90	1406	0.37	0.58	3,753	-3,714	-0.99	1,507	0.40
7	n	n	y	0.58	2.71%	-2.37%	-0.88	0.96%	0.36	0.63	2.56%	-2.72%	-1.06	1.10%	0.43
8	n	n	n	0.52	3,897	-3439	-0.88	1,396	0.36	0.56	3,788	-3,873	-1.02	1,572	0.42

[i] Although the definition of underrepresented ethnic minority (URM) depends on context, the Provost's Office at Washington University generally follows the convention used nationally for discussion of faculty in defining URM as the under-represented groups of African American, Hispanic or Latino, and Native American, Alaskan or Hawaiian. In aggregate, these are the groups most noticeably under-represented at U.S. research universities as a proportion of these groups in the U.S. population.

[ii] Chair/Director/Associate Dean status is different in nature from other such rank categories as Endowed Chair, Full, Associate, or Assistant professor, which is typically held permanently until promoted to a higher rank. These positions are often short term and come with the acceptance of an additional role of chair or director of a center. We have treated this as a separate category to account for a stipend that they receive in addition to their regular salary for their primary role of faculty. Before finalizing the model, the Committee also reviewed the results of Bayesian averaging analysis of various models; the posterior probability for the model with the Chair/director variable was .999 confirming that this was the most robust of all the different models.

[iii] Excluded from the analyses were 16 tenured faculty members (13 male and 3 female), including nine current or former deans. A total of seven tenured faculty from Arts & Sciences, three from Engineering, two each from the Brown School and the Fox School, one each from Business, and the Law School were excluded from regression analyses due to any one of the following reasons: current dean holding full-time administrative role, prior dean with salary influenced by recent service as a dean, percentage of a faculty's appointment in a school is less than 49%; faculty's role in a school was not equivalent to full-time faculty in year of study, a unique degree characteristic that places one individual in a competitive salary market different from any other person in that school and is an influential case.

[iv] The sample in Arts & Sciences includes two new faculty members with start dates of January 2009; all others are based on faculty appointment data as of November 1, 2008.

[v] Five Arts & Sciences discipline groups used in the regression models include: (1) Math, Biology, Chemistry, Physics, EPS, Psychology; (2) English, History; (3) Economics, (4) Anthropology, Political Science; (5) Foreign Languages, Classics, Philosophy, Education, Performing Arts.

[vi] Stipends paid for Dean of Academic Planning, Dean for Curriculum, McDonnell International Scholars Academy, ICARES Director and service on the Medical School Human Research Committee were excluded because these stipends were awarded for services beyond the Arts & Sciences faculty role. Chair/ director stipends are awarded as annual 12-month pay in Arts & Sciences and were adjusted to 9-month equivalency by applying a factor of 9/12. Two persons with one-semester interim chair/director stipends were adjusted to 9-month equivalency.

[vii] Model A & E: Similar to original Gray Residual Methodology. Dependent variable is the natural log of total 9-month salary or salary in dollars. Independent variables included five discipline groups, 3 rank levels (Assistant, Associate, and full Professor), years since terminal degree, years since terminal degree squared, years at WU in tenure/tenure track appointment, and years at WU in tenure/tenure track appointment squared. A formula based on these independent variables for men was applied to predict salaries for women; the difference between the predicted salary and the actual salary is the residual.

[viii] The following formula was utilized to calculate standard error for models C, D, G & H for Arts and Sciences and for model A for all other schools on Danforth Campus: Standard Error of (male mean residual - female mean residual) = square root of [(standard

deviation of male residuals squared /male n) + (standard deviation of female residuals squared /female n)]

[ix] An exception is the pilot study that includes productivity variables where the regression models indicate positive female residuals. In that study of 42 faculty members in three social science departments, the parameter estimates for females were positive

[x] Tabachnick and Fidell (1989) recommended using at least five cases for each independent variable in regression analysis. [Tabachnick, B. G., & Fidell, L. S. (1989). *Using multivariate statistics* (2nd ed.). Cambridge: Harper & Row.].

[xi] For the School of Engineering, the committee also requested an analysis using two discipline groups (BME-BioMedical=1 and everyone else=0) in addition to the five discipline groups based upon department configurations. When only two disciplines were utilized, Adjusted R-square dropped by about 8% suggesting that the five discipline groups accounts for more variation in the model Thus, the committee retained the original five-discipline version of the models.

[xii] In light of lower adjusted R-square for the Law School models compared to models for other schools, the committee requested Lynn's team to construct and add a new variable, lateral hire. Lateral hires were defined as cases where the person held a tenured or tenure track academic position at another law school before joining the faculty at WU. Lateral hire variable was created especially for the Law School. The addition of the lateral hire variable did not improve the R^2 or change the gender differences observed in the original models. Thus, the committee retained the original version of the models.

[xiii] Blinder, A. (1973). Wage discrimination, reduced form, and structural estimates. *Journal of Human Resources 8*, 436-55. Oaxaca, R. L. (1973). Male-female wage differences in urban labor markets. *International Economic Review 14*, 693-709.