USING INTERNAL MARKET RATIOS
TO DETECT GENDER DIFFERENCES IN FACULTY SALARIES

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Discipline and market are two related factors that are frequently used in the evaluation of faculty salary equity at colleges and universities (Balzer, et al., 1996; Haignere, 2002; Luna, 2007; Moore, 1992). Although it is assumed that the variation of market factors should be responsible for explaining differences in faculty salaries, this assumption has not been tested yet (Bellas, 1994). In general, salary differences across disciplines are considered as market neutral by AAUP and CUPA (Bellas, 1997; Haignere, 2002). The observed differences in faculty salaries at large are not considered a result of gender discrimination, but rather the effect of market factors; specifically, the supply of qualified faculty relative to the demand for their work and service by employers (Bellas, 1997; Semelroth, 1978; Waldauer, 1984).

For decades, market factors have had great impact on differentiation of faculty salaries across disciplines at colleges and universities. Since the 1980s, differences in faculty salaries across disciplines have increased, especially in disciplines related to Business/Economics and Engineering. According to *the Annual Report on the Economic Status of the Profession* published by AAUP (1980-2010), using assistant professors and the discipline of English as reference groups, the proportions of average salaries in Education, Fine Arts, Foreign Languages, Communications, and Philosophy have decreased since 1980-81 (Figure 1). However, the proportion of average salaries in Business and Economics related programs has increased from

124% in 1980-81 to 187% in 2009-10, representing a 51 percent increase over the time. As a result, faculty who have taught in fields with lower market values have suffered "pay penalty." These observed differences cannot be totally explained by variances in individual characteristics (e.g., gender, race, and highest degree), professional maturity (e.g., rank and years of experience), and performance.

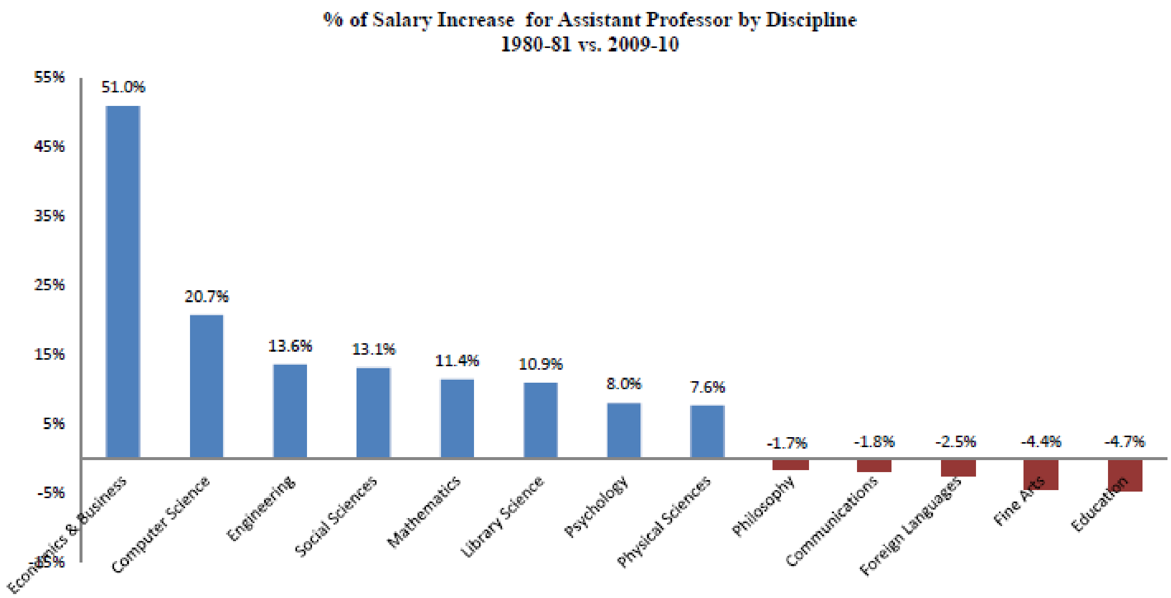

Figure 1: Percentage of Salary Change by Discipline (1980-81 vs. 2009-10)

Bellas (1994) points out that in higher education, the unequal job opportunities between male and female faculty at the entry-level position have continued, resulting in more female faculty concentrated in disciplines with relatively lower market values, such as English, Foreign Languages, Education, and Fine Arts (Barbezat, 1991; Braskmp, Muffo, & Langston, 1978; Howard, Snyder, & McLaughlin, 1993; Raymond, Sesnowitz & Williams, 1988; Semelroth, 1987). Consequently, the increase in differentiation of market values across disciplines has further exaggerated salary differences between male and female faculty at colleges and universities.

In higher education, it has become increasingly more important to develop market factors to appropriately explain the variability of gender differences in the study of faculty salaries (Luna, 2007). Haignere (2002) stressed that at a particular institution, salary differences across disciplines should primarily reflect the result of internal salary policies, structure, and promotion aiming to reward faculty based on the quality and quantity of teaching, research, and service.

Many studies have used discipline/market factors to detect gender differences in faculty salaries. Some have used internal discipline/market factors to represent salary differences across disciplines (Braskamp & Johnson, 1978; Haignere, 2002; Reagan & Maynard, 1974). Others have contended that external market factors do affect departmental salary differences (Ballas, 1997; Bereman & Scott, 1991; Braskamp, Muffo & Langston, 1978; Raymond, Sesnowitz, & Williams, 1988). These studies have used the average salaries of newly hired assistant professors or disciplinary ratios obtained from national salary databases (e.g., AAUP or CUPA) to reflect pricing mechanism and competition at a specific discipline across institutions nationwide (Duncan, Krall, Maxcy, & Prus, 2004; Luna, 2007). However, the study conducted by Braskamp & Johnson concluded that the external market factors did affect salary differences across disciplines, but the relationship was not high when compared to the importance of internal market factors (1978).

In studying faculty salaries at a particular institution, it seems preferable to use internal market factors to represent salary differences across disciplines because only internal market factors can fully reflect the local salary structure within that institution (Haignere, 2002; Koch &

Chrizmar, 1996). The more accurate the market factors reflect the salary structure and practice at the institution, the more reliable is the measure of market influence on faculty salaries (Reagan & Maynard, 1974).

Regression Model

Many institutional researchers have used different approaches to code disciplinary variables in regression, which were used to determine whether gender differences in faculty salaries can be appropriately explained by market/disciplinary factors after controlling other predictor variables. However, there is still a debate in higher education on methods of coding market/disciplinary variables in regression analysis. Two commonly used approaches are the dummy model and the market model.

Dummy model. The dummy model is the most commonly used method, which creates a set of dummy disciplinary variables in order to explain salary differences across disciplines. The dummy model is represented by L. Haignere (2002) in *Paychecks: A Guide to Conducting Salary-Equity Studies for Higher Education Faculty* and strongly recommended by the American Association of University Professors (AAUP). In the dummy model, disciplinary variables are coded as dummy variables with one discipline serving as a default group. The goal is to minimize the number of disciplinary variables and maximize the statistical power in regression. Because faculty salaries at the entry level have fluctuated with changing market conditions and often resulted in a wide variation across disciplines, this approach may yield more reliable results (Baker, Gibbs, & Holmstrom, 1994; Reagan & Maynard, 1974).

The dummy model is the most conservative method to detect gender differences in faculty salaries (Yao, 2012). Haignere (2002) summarizes that this approach allows the regression to assign an appropriate value for each discipline based on faculty salaries paid in that discipline. The results can truly reflect the institution's salary rewarding structure and promotion in practice. However, the dummy approach should be used with caution because it produces a large number of degrees of freedom which may limit the statistical power, particularly in a medium and small-size institution (Luna, 2007). More important, with a large number of dummy variables used in regression, it may become more complicated to explain the statistical results to administrators and faculty who have less knowledge and experience in multivariate statistics (Yao, 2012).

Furthermore, Moore (1992) indicates that the dummy approach may not be proper to test gender differences in pay when a department has a very small number of faculty, or faculty in a department are not evenly distributed by gender. In practice, if a department has less than five faculty members, those faculty need to be grouped with another related discipline (Haignere, 2002). Moreover, since different disciplines tend to have different reward structures, using the dummy approach may not truly reflect the internal salary rewarding structure (Howard, Snyder, & McLaughlin, 1993).

Market model. Instead of using categorical variables to represent salary differences across disciplines, some studies transform categorical discipline variables into continuous variables or numerical ratios to reflect market influence on differentiation in faculty salaries. This approach attempts to explain gender differences in pay by assigning a market value or market ratio to each discipline and compare them using regression analysis.

The market ratio is defined as a ratio of the average salary for a specific discipline (numerator) divided by the average salary of all disciplines combined (denominator). Luna (2007) explains that the market ratio measures the relative strength of salaries between a particular discipline and disciplines as a whole. A market ratio below 1.0 indicates that the average salary in that discipline is being paid below the average salary of all disciplines combined. Conversely, a market ratio above 1.0 means that the average salary in that discipline is being paid above the average salary of all disciplines combined. In practice, market ratios that fluctuate from .95 to 1.05 are considered in the normal range.

The market approach has gained wide acceptance in higher education because of its flexibility and its convenience. Using market ratios generated from the CUPA national salary database in a study of faculty salaries, Luna (2007) concluded that the market ratio was the largest contributor to explain the variance of faculty salaries. This approach is more effective and efficient than the dummy model with less political and technical confusion (Luna, 2007). However, for a relatively small institution, using external market ratios to represent internal disciplines may produce a totally different salary rewarding structure, which would mask gender differences in pay. In addition, because gender is unevenly distributed across disciplines with more women are concentrated in fields with lower market values, the market ratio itself may be involved with gender discrimination in pay.

In summary, to select market ratios, some researchers prefer to use internal market values to replace dummy coded discipline variables in faculty salaries. They argue that salary differences should primarily reflect the result of internal salary policies, structure, and promotion. Others support using external market values to truly reflect the economic competition in a particular discipline across institutions of higher education. In this study, two different market ratios, including internal market ratios and external market ratios, were created to test which type of market ratios would be the better one to detect gender differences in faculty salaries.

Methods

Data were obtained from a unionized, four-year public institution in the northeastern region. The sample included 248 full-time faculty members. Among them, the distribution of faculty in current rank consisted of 13.7% full professors, 32.7% associate professors, 43.9% assistant professors, and 9.7% lecturers. The distribution of male and female faculty was 60.5% and 39.5%, respectively. Moreover, 18.1% were minority faculty.

In this study, three regression models (i.e., dummy model, external market model, and internal market model) were developed using three different types of disciplinary variables (dummy variables, internal market ratios, & external market ratios) in regression. The dummy model assigned a set of 19 disciplines as dummy variables, with one serving as the default group. The external market model converted 20 disciplinary variables into numerical ratios using the CUPA average salaries represented in each related discipline. The internal market model transformed 20 disciplinary variables into numerical ratios using the average salaries of each discipline at the given institution. Finally, multiple regression analyses were applied to test which model was the best one to properly explain gender differences in faculty salaries.

Variables used for assessing faculty salaries were selected based on strong determination on faculty salary rewards in the literature review and availability of data in the HR salary database at the given institution. Haignere (2002) warned that predictor variables should be carefully selected and evaluated. Some variables may be potentially tainted variables (e.g., rank & tenure status) which would mask gender difference in pay; some may produce redundant information (e.g., years in current rank and years of service at the institution) because the curvilinearity may occur and affect the time-related variable, particularly at unionized institutions (Haignere, 2002). In this study, the categorical regression analysis was applied to test whether assignment of current rank was biased. In addition, the quadratic term was used for the variable of years of service in order to solve the curvilinear issue.

The dependent variable was 9-10 month base salaries reported in October 2010 at the given institution. The predictor variables include the total number of years of service at the given institution, gender, race/ethnicity, highest degree earned, current rank, discipline, and market ratio. Disciplinary variables are coded into three different types (i.e., *k*-1 dummy variable, external market ratio, and internal market ratio).

Total number of *years of service.* This variable measures the professional maturity of an individual faculty member who has worked toward her/his profession. It assumes that the longer an individual faculty member has worked in her/his professional field, the higher she/he should be paid. To solve the issue of curvilinearity, the quadratic term was created and used in regression. The result showed that the quadratic term of the total number of years of service did not significantly contribute to the regression model and its unstandardized coefficient was very small; thus, it was deleted from the final model.

Gender and race/ethnicity. It should be realized that many published studies include gender but exclude race/ethnicity because there are not a sufficient number of minority faculty to reliably estimate the salary differences using statistical techniques in regression analysis (Barbezat, 2002). But ignoring race/ethnicity may mask the gender differences in pay (Haignere, 2002). These two variables were coded as dummy variables, with male and white faculty serving as the reference groups.

*Current rank***.** Current rank is a strong determinant that reflects the institutional recognition of an individual faculty member's performance based on teaching, research, and service. Current ranks were categorized into four subgroups: full professors, associate professors, assistant professors, and lecturers and further coded as dummy variables, with the group of assistant professors serving as the reference group.

Some researchers are concerned that gender may be potentially tainted in assigning the current rank (Allard, 1984; Barbezat, 1991; Becker & Toutkoushian, 2003; Haignere & Eisenberg, 2002; Scott, 1977; Smart, 1991). To test whether assignment in the current rank was significantly different between male and female faculty, a categorical modeling analysis (i.e., multinomial modeling) was conducted. The result indicated that there was a potential bias when assigning female faculty from assistant professors to associate professors, with the odds ratio of 1.95. Even though the odds ratio was not statistically significant, it should be realized that using the current rank as a predictor variable may underestimate gender differences in pay.

Highest degree earned. This variable represents an individual's career investment in her/his profession. One dummy variable was coded, with the group of Ph.D. serving as the default group. In addition, Master of Fine Arts (MFA) was considered a terminal degree.

Discipline. This variable is used to reflect the market influence on differences in faculty salaries. It assumes that pay differences should be associated with different market values in disciplines, but should not attribute to either gender or race bias (Haignere & Lin, 2002). In this study, twenty disciplines were transformed into three different types of disciplinary variables, such as *k*-1 dummy variables, internal market ratios, and external market ratios.

Market ratio. This variable measures how well faculty at a particular discipline should be paid compared to all disciplines combined. The purpose is to reduce a large number of degrees of freedom and increase the statistical power in regression analysis. The formula is listed below:

$$\text{Market ratio} = \frac{\text{Average salary at a particular discipline}}{\text{Average salary of all disciplines combined}}$$

Table 1

Disciplinary Ranking Based on Market Ratios

Internal Market Ratios			External Market Ratios		
Ratio	Ranking	Department	Department	Ranking	CUPA Ratio
1.42	1	Business & Economics	Business & Economics	1	1.34
1.07	2	Mathematics	Biology	2	1.05
1.05	3	Chemistry	Sociology	3	1.02
1.02	4	Philosophy	Geography	4	1.02
1.02	5	Psychology	Anthropology	5	1.02
1.01	6	Education	Political Science	6	1.02
1.00	7	Human Ecology	Chemistry	7	1.01
0.99	8	Sociology	Physics	8	1.01
0.99	9	Geography	Earth Science	9	1.01
0.98	10	Biology	Psychology	10	1.00
0.97	11	Anthropology	Philosophy	11	0.98
0.97	12	History	Education	12	0.98
0.97	13	English	Communication	13	0.98
0.96	14	Music	Mathematics	14	0.97
0.95	15	Communications	History	15	0.97
0.95	16	Fine Arts	Human Ecology	16	0.94
0.95	17	Physics	Music	17	0.93
0.93	18	Earth Science	Fine Arts	18	0.93
0.92	19	Political Science	English	19	0.90
0.87	20	Foreign Languages	Foreign Language	20	0.92

Note.

1. A disciplinary ratio was calculated by using the average salary of a specific discipline divided by the average salary of all discipline combined at the given institution.

2. CUPA ratios were generated based on data obtained from College and University Professional Association for Human Resources (CUPA-HR, 2010).

In this study, two types of market ratios were developed (i.e., internal market ratios and external market ratios). The internal market ratio was calculated based on the average salaries of each discipline generated within the local institution. It reflects the local salary rewarding policies, structure, and promotion. The external market ratio was calculated based on the national average salaries by discipline published by CUPA in 2010. It takes into account the national comparability and competition of salaries at a particular discipline across institutions of higher education. Table 1 showed the discipline rankings based on market ratios generated from the local institution and the CUPA salary database.

Three research questions were proposed: (1) which model would be the best fit in terms of adjusted R^2 and *F*-ratio, (2) which type of disciplinary variables (i.e., *k*-1 dummy, internal market ratio, external market ratio) would be better than the other two to properly explain gender differences in faculty salaries based on examining the unstandardized coefficient (*B*) and *t*-value of the gender variable, and (3) which type of market ratios largely contribute to explain salary differences.

Limitations

Even though the variable of current rank is one of the most accessible proxies for measuring professional maturity and productivities, omission of variables related to measuring faculty performances in teaching and research would affect the strength of explanation in regression analysis (Moore, 1992; Webster, 1995). In addition, three disciplines were removed because the numbers of faculty in each discipline were less than five. For fulfilling statistical requirements, these faculty members were grouped into other related disciplines.

Results

Three multiple regression models (i.e., dummy model, internal market model, & external market model) were developed and compared. The purpose is to test which model is the best to appropriately explain the gender differences in faculty salaries at the given institution. First, the adjusted R^2 and *F*-value generated from the three models were used to examine which model would be the best fit. Second, the unstandardized coefficients (*B*) and *t*-values of female were compared to see which model would be the best to properly detect gender differences in faculty salaries. In addition, to test which type of market ratios (i.e., internal market ratio vs. external market ratios) would be better to explain faculty salaries, standard errors, *t*-values and partial correlations generated from the three regression models were compared.

To avoid multicollinearity, values of variance inflation factors (VIFs), tolerance, and condition index produced by the three models were carefully examined. The issue of multicollinearity was not found.

Model Fit

The adjusted R^2 and *F*-value generated from the three models are used to compare which model would be the best than the other two to explain differences in faculty salaries. The percentage of adjusted R^2 is used to test the loss of predictive power. It measures how much variances in faculty salaries could be accounted for by the predictor variables. The *F*-ratio is used to assess the overall fit of the regression model (Field, 2009).

Table 2

Summary of the Three Regression Models (N = 248)

Model	R	R Square	Adjusted R Square	F	Sig. F
Internal Market Model	.845	.715	.705	74.83	.000
External Market Model	.817	.667	.656	59.79	.000
Dummy Model	.852	.727	.694	22.58	.000

Note. Significant Levels: *** $p < .001$, ** $p < .01$, * $p < .05$.

As shown in Table 2, it is clear that the internal market model produced the largest adjusted R^2 and the highest *F*-ratio, with adjusted R^2 =.705 and $F(8, 239) = 74.83$ ($p < .001$). The results provided strong evidence that the internal market model was better than the other two (i.e., dummy model and external market model) to explain the differences in faculty salaries.

Gender Differences in Faculty Salaries

To examine which model would be the best to properly detect gender differences in faculty salaries, the unstandardized coefficients (*B*) and *t*-values of female faculty were examined and compared among the three models.

Table 3

Unstandardized Coefficients and t-values of Female Faculty Generated from the Three Regression Models (N = 248)

	Unstandardized Coefficients	Standardized Coefficients		
	B	*β*	*t*	*Sig.*
Dummy Model	-470.0	-.023	-.59	.554
Internal Market Model	-364.9	-.015	-.41	.680
External Market Model	461.6	.018	.48	.631

Note. Significant Levels: *** $p < .001$, ** $p < .01$, * $p < .05$.

As shown in Table 3, although *t*-values of female faculty generated from the three models were very small and not statistically significant, it was apparent that the unstandardized coefficients of female faculty produced by the three models largely varied, ranging from -$470 to $462. The results showed that the unstandardized coefficient of female faculty produced by the internal market model was much closer to the one generated from the dummy model.

Market Ratios

To test which type of market ratios was better to explain faculty salaries using internal and external market ratios, standard errors, *t*-values and partial correlations were compared. As shown in Table 4, the internal market ratios obtained a higher *t*-value (t = 16.14, p < . 001) but a lower standardized error ($3,514) compared to the external market ratios. In addition, the partial correlation for the internal market ratios (partial r = .722) was much higher than the one associated with the external market ratios (partial r = .664), indicating that 72.2% of accounted variances in faculty salaries could be explained by the internal market ratios. As a result, the internal market ratio was the better one to explain differences in faculty salaries at the given institution.

Table 4

Unstandardized Coefficients of Market Ratios Generated from Internal and External Market Models (N = 248)

	Unstandardized Coefficients				Correlation
Discipline/Market Variable	*B*	*Std. Error*	*t*	*Sig.*	Partial
Internal Market Ratios	56722.56	3514.00	16.14	.000	.722
External Market Ratios	61870.01	4502.68	13.74	.000	.664

Note. Significant levels: *** p < .001, ** p < .01, * p < .05.

Conclusions

Salary differences across disciplines have been growing for decades at colleges and universities. Along with the high percentage of female faculty concentrated in disciplines with lower market values, gender equity continues to be an important issue in the study of faculty salaries. Previous studies of salary-equity have often examined relatively large datasets; however, these results cannot directly address conditions at individual institutions (Toutkoushian, 2002). Ferber and Loeb (2002) argued that even if gender differences in pay exist in higher education, the pay gap may not happen at a particular institution. Therefore, there is a continued need for studies on the issue of gender-equity in faculty salaries at institutional levels.

This study supports the premise that a single, continuous variable can be used to replace categorical discipline variables to explain variances in faculty salaries at a small-size public institution. Many studies have examined salary equity using relatively large datasets which allow applying sufficient degrees of freedom in multiple regression analyses (Haignere, 2002; Luna, 2007). However, for those relatively small institutions with few women and minority faculty members, it is difficult to run multiple regression analysis incorporated with large numbers of dummy coded disciplinary variables (Ferber & Loeb, 2002; Toutkoushian, 2002). Using market ratios to replace dummy coded disciplinary variables can properly solve this issue.

Secondly, this study demonstrates that the internal market ratio may serve as a better indicator to represent disciplinary differences in testing gender differences in faculty salaries because it truly reflects the local institution’s salary rewarding structure (Balzer et al., 1996; Braskamp, Muffo, & Langson, 1978; Reagan & Maynard, 1974; Raymond, Sesnowitz, & Williams, 1988).

Internal market ratios and external market ratios are highly related with each other but apparently reflect different salary rewarding structures. As shown in Table 1, it is clear that the salary structure developed based on the internal market ratios is ranked differently from the one created by the external market ratios. For example, the discipline of Mathematics ranks top second in salary rewarding structure at the given institution, with an internal market ratio of 1.07; while the national CUPA ratios showed that salary rewarding to faculty in Mathematics ranks 14 out of 20, with a market ratio as low as 0.97. Even the discipline of Business and Economics, which is ranked as the top paying discipline in both internal and external salary structures, the values of the market ratios appear to be different (1.42 vs. 1.34). Therefore, inclusion of external market ratios in salary studies should be carefully examined before uploading into the regression model.

Thirdly, there are no universal guidelines that can be used to determine how to conduct salary-equity studies. Although the AAUP has provided primary guidelines in *Paychecks* (Haignere, 2002) based on twelve case studies in the SUNY system, the use of dummy coded disciplinary variables to represent salary differences across disciplines have been viewed with skepticism. This approach may result in larger measurements of salary inequity (Toutkoushian, 2002). In this study, the unstandardized coefficients of female faculty generated by the dummy model and external market model were largely different (-$470 vs. $ 462), resulting in $932 difference in an absolute value. The same issue also occurred in Luna’s study using a large dataset collected from multiple institutions (2007, pp. 7-8). The results may lead to a controversial conclusion that the external market approach should be used with caution compared to using the internal market model at an individual institution.

In conclusion, market factors become major sources for testing gender differences in faculty salaries. Because female faculty tend to be concentrated in disciplines with lower market values, the market ratio itself may incorporate with gender discrimination (Bellas, 1997; Moore, 1992). Thus, inclusion of market ratios in examining faculty salaries may mask the potential gender discrimination in salary rewards. If a college is a leading institution with relatively competitive salaries paid to faculty, using the external market ratios may truly represent its mission and goals of recruiting and rewarding the best faculty. However, for most medium and small-size institutions with less competitive salaries rewarded to faculty, it is evident that the internal market ratios may be better than the external market ratios in predicting gender differences in faculty salaries.

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