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Hedonic Analysis of PSU Faculty Salaries

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INTRODUCTION

The complex issue of faculty compensation has vital importance within the academic labor market. Salaries reflect institutional, interpersonal, organizational and labor market forces. Designing productive and equitable faculty salary structures is one of the most contentious challenges that American higher education institutions face (Bowen, 1986).

Increasingly, salary scales have been more responsive to market conditions, which has widened the salary disparities among academic disciplines within the university labor market. Upward pressure on the salary scales in some disciplines has been countered by a downward pull in others (Scott and Bereman, 1992). As a consequence, analyzing academic salary structure can generate friction among faculty and pose a threat to collegiality. The implications of not undertaking such an analysis, however, are much worse. In the absence of periodic appraisals, undesirable inequities can emerge, which pose a much more serious threat to the basic integrity of an institution.

Numerous approaches have been developed to assess salary structure. Approaches using multiple regression analysis include: the Salary Kit method (Scott, 1977); reverse regression (Birnbaum, 1985); and the compa-ratio analysis (Bereman and Scott, 1991). Other choices of methodology include paired-comparison approaches (Braskamp and Johnson, 1978; Scott and Bereman, 1992). This study estimates a hedonic salary model using a faculty salary database from Portland State University. Similar applications of the hedonic approach include works by Bellas (1993), Boudreau et al. (1997), Diamond (1986), Gordon et al. (1974), Hoffman (1976), and Ramsey (1979).

DATA

The sample from which the hedonic salary model will be estimated is comprised of 351 faculty on tenure-line instructional appointments at .90 FTE or greater during the 1994-95 academic year. The database developed for the analysis draws information from four main areas:

- Biographical
- Publications
- Citations
- Salary

Biographical Information

The 1994-1995 Portland State University Bulletin provided information on rank, experience (years since the receipt of terminal degree), seniority (years at PSU), college and school appointment, and gender.

Publication Information

The reference guide, *Books in Print*, was used to identify books published by PSU faculty. Information on journal articles was obtained through a search of the UNCOVER database. This database consists of titles and abstracts from periodicals maintained by subscribers to the Colorado Alliance of Research Libraries (CARL). It covers over 13,000 periodicals and extends from 1988 to the present.

Citation Information

Data on citations from 1988 to 1993 were collected from the Social Science Citation Index and the Science Citation Index.

Salary Information

The list of instructional faculty and salary data was obtained from the Office of Institutional Research and Planning by Professor James Strathman. Professor Strathman entered the salary data once all other information had been recorded. The names of faculty were not matched to salaries during any of the analysis. Thus the student authors of this report were not able to identify the salary of any given faculty member.

DESCRIPTION OF THE DATA

The first step in the analysis presents a descriptive picture of the data. While there are a number of different ways this presentation can be organized, it was decided to begin by describing patterns defined by major administrative divisions (i.e., colleges and schools). These patterns are summarized in Table 1.

More than half the faculty in the data set are appointed to departments and programs in the College of Liberal Arts and Sciences (CLAS); appointments in the remaining units range from 16 faculty in the School of Social Work (SSW) to 37 in the School of Business Administration. The average salary in 1994-95 was \$48,200. Salary averages were substantially higher in the schools of Business (SBA; \$64,800) and Engineering (EAS; \$57,800) and substantially lower in the School of Fine and Performing Arts (FPA; \$40,200), which generally reflects conditions in the academic labor markets in these respective areas.

Overall, almost half the faculty hold the rank of professor, while one-third are at the associate level and one-fifth are at the rank of assistant. The School of Education (ED), the College of Urban and Public Affairs (UPA) and SSW are noteworthy for their relatively small proportion of professors. The distribution by rank in part reflects the dynamics of program development and hirings. Programs that have grown relatively faster in recent

years, such as those in EAS and the School of Education (ED), have larger proportions of assistant professors.

Nearly 70 percent of the PSU instructional faculty are men, and the concentration is relatively greater in EAS (.92) and SBA (.76) and relatively less in ED (.45), SSW (.50) and UPA (.54).

Table 1
Characteristics of PSU Instructional Faculty
 (Standard Deviations in Parentheses)

| | Total | CLAS | ED | EAS | FPA | SBA | SSW | UPA |
|------------|--------------------|-------------------|-------------------|--------------------|-------------------|-------------------|--------------------|-------------------|
| N | 351 | 181 | 29 | 36 | 26 | 37 | 16 | 26 |
| Salary | 48,205 (11,435) | 45,443 (9,031) | 43,733 (8,343) | 57,838 (10,563) | 40,234 (5,998) | 64,810 (9,744) | 46,906 (10,286) | 44,975 (9,487) |
| Professor | .46 | .50 | .34 | .42 | .62 | .49 | .37 | .35 |
| Associate | .32 | .32 | .28 | .31 | .19 | .32 | .37 | .42 |
| Assistant | .22 | .18 | .38 | .28 | .19 | .19 | .25 | .23 |
| Male | .69 | .71 | .45 | .92 | .62 | .76 | .50 | .54 |
| Seniority | 13.98 (9.73) | 16.43 (10.46) | 9.10 (6.58) | 11.22 (8.99) | 13.73 (7.66) | 11.76 (8.06) | 11.37 (9.87) | 12.35 (8.85) |
| Experience | 16.91 (9.49) | 18.72 (9.70) | 13.52 (8.95) | 14.28 (9.40) | 18.46 (9.17) | 15.41 (9.36) | 12.63 (7.18) | 15.15 (8.09) |
| Articles | 1.33 (2.23) | 1.08 (1.54) | 1.55 (1.62) | 1.50 (4.02) | .46 (1.45) | 1.62 (2.14) | 2.75 (3.59) | 2.12 (2.67) |
| Books | .34 (.93) | .30 (.81) | .34 (.67) | .17 (.45) | .19 (.40) | .35 (.75) | .69 (1.35) | .85 (1.87) |
| Citations | 7.24 (16.02) | 6.80 (13.85) | 8.03 (19.48) | 10.58 (15.37) | .08 (.39) | 9.35 (25.95) | 11.38 (20.40) | 3.81 (8.75) |

On average faculty have held their appointments at PSU for 14 years. Appointments in ED are the most recent (9.1 years) while those in CLAS are the longest-standing (16.4), reflecting the development dynamics discussed above. The experience variable measures the number of years between the receipt of a terminal degree and the 1994-95 academic years. The difference between this and the seniority variable represents professional experience of instructional faculty earned prior to appointment at PSU. Overall, prior experience averages about three years, and is relatively greater for faculty in FPA, ED, and SBA, and relatively less for faculty in SSW.

Publication activity is represented by the production of journal articles and books. The typical faculty member published 1.3 articles between 1988 and 1993, while the likelihood of a faculty member having a book in print was .34. Publication activity was greatest in SSW and UPA and least in FPA. In the case of FPA it should be remembered that publications are not as relevant an indicator of scholarly activity as they are for the other schools and colleges.

Citations proxy the quality of publications. They indicate that other scholars have benefited from someone's work sufficiently that they note it in their own research. On average, faculty received seven citations between 1988 and 1993, with those who were most cited being from SSW, EAS, and SBA.

It is noteworthy that the standard deviations of the publication and citation variables are quite large relative to the mean values. This indicates that publication activity and citations are concentrated among a relatively small number of faculty. For example, it was observed that 163 of the 351 instructional faculty had not published a journal article between 1988 and 1993, and 161 did not receive any citations during the same period.

MODEL SPECIFICATION

The relevant literature suggests that the determinants of faculty salaries include factors reflecting experience, academic discipline or field, and scholarly productivity and recognition. Because studies of faculty salary structure are often-times concerned with equity issues, models also seek to determine whether differentials exist with respect to gender, race, and ethnicity. The hedonic model of PSU faculty salaries seeks to analyze all of these factors, with the exception of race and ethnicity, which could not be determined from the information available to the research team. The model to be estimated is defined as follows:

$\ln \text{Salary} = f(\text{Associate, Professor, Male, ED, EAS, SBA, UPA, SSW, FPA, Cites, Cites}^2, \text{Articles, Articles}^2, \text{Books}), \text{ where}$

$\ln \text{Salary} =$ The natural log of the 1994-95 academic year salary;

$\text{Associate} =$ A dummy variable equaling 1 if the faculty member holds the rank of Associate Professor, and 0 otherwise;

$\text{Professor} =$ A dummy variable equaling 1 if the faculty member holds the rank of Professor, and 0 otherwise;

$\text{Male} =$ A dummy variable equaling 1 if the faculty member is a man, and 0 otherwise;

$\text{ED} =$ A dummy variable equaling 1 if the faculty member's appointment is in the School of Education, and 0 otherwise;

$\text{EAS} =$ A dummy variable equaling 1 if the faculty member's appointment is in the School of Engineering and Applied Science, and 0 otherwise;

$\text{SBA} =$ A dummy variable equaling 1 if the faculty member's appointment is in the School of Business Administration, and 0 otherwise;

$\text{UPA} =$ A dummy variable equaling 1 if the faculty member's appointment is in the College of Urban and Public Affairs, and 0 otherwise;

$\text{SSW} =$ A dummy variable equaling 1 if the faculty member's appointment is in the School of Social Work, and 0 otherwise;

- FPA = A dummy variable equaling 1 if the faculty member's appointment is in the School of Fine and Performing Arts, and 0 otherwise;
- Cites = The number of citations the faculty member's published works received between 1988 and 1993;
- Cites² = The number of citations squared;
- Articles = The number of published articles between 1988 and 1993, as reported by UNCOVER;
- Articles² = The number of articles squared;
- Books = The number of books written or edited by the faculty member, as reported in Books In Print.

The dummy variables for academic rank are specified to capture the respective salary differentials for Associate Professors and Professors over Assistant Professors (which is the omitted category). Seniority or experience are also often specified, but the correspondence between these variables and rank at PSU is very close. Rank was chosen over experience or seniority because the university's collective bargaining agreement with the faculty stipulates that specific salary increments be linked to promotions. Boudreau et al. (1997) also found that faculty salary models that do not include rank are likely to suffer from specification bias.

Dummy variables are also specified for the schools and colleges in order to estimate salary differentials relative to CLAS, the omitted category. Gordon et al. (1974) found that, holding other factors constant, faculty in the areas of health, engineering and science received substantial salary premiums over faculty in other fields.

Citations and articles are both specified in linear and quadratic forms. This reflects the expectation of diminishing returns, as observed by Diamond (1986). If so, this would mean that the value of an additional citation or article would be greater for someone with, say, five than for someone with ten citations or articles. Diminishing returns will be exhibited if the parameter estimates on the linear and quadratic citation/publication terms are positive and negative, respectively. One would also expect to observe diminishing returns

from book publishing. However, a quadratic term was not included for books because the data showed that only 24 faculty had more than one book in print.

RESULTS

The hedonic salary model results are presented in Table 2. The general performance of the model is quite good, explaining 80 percent of the variance in faculty salaries, with nearly all of the variables being statistically significant and having the expected effect. The estimated coefficients are presented in the middle column of the table, and the right-hand column reports the associated percentage change in salary from a unit change in the variable. For the continuous variables the percentage salary effect is obtained by simply multiplying the estimated coefficient by 100. For the dummy variables in the model the percentage salary effect is calculated using the transformation suggested by Kennedy (1981). The discussion below focuses on the percentage effects rather than the estimated coefficients, and pays particular attention to those effects which were found to be statistically significant.

With regard to rank, it is estimated that Associate Professors earn a near-15% premium over Assistant Professors, while the premium for Professors is 42%. Controlling for variations in rank and scholarly activity, the model estimates that faculty in SBA are paid nearly 45% more than faculty in CLAS, while the premium for EAS faculty is 29%. At the other end, FPA faculty were estimated to earn 12% less than CLAS faculty. The estimated differentials for ED, UPA, and SSW faculty were not statistically significant.

The model estimates that the rank, organizational, and activity-controlled salaries of men are 1.5% greater than women at PSU, but this differential is not statistically significant. This is a noteworthy finding because nominally, male faculty were observed to earn 17% more than female faculty. The model indicates that this difference is attributable to the effects of rank (a relatively larger share of men are Professors), field (a relatively larger proportion of men in the academic fields paying a premium for faculty), and citations

(male faculty receiving more than twice the number of citations than female faculty). The implications of this result are discussed further in the concluding section.

Table 2
Hedonic Salary Model Estimates
 (Dep. Var. = ln Salary; t-scores in parentheses)

| Variable | Coefficient | Unit Salary Effect (%) |
|-----------------------|---------------------|-------------------------------|
| Constant | 10.45 (668.7) | |
| Associate | .138 (8.62) | 14.8 |
| Professor | .351 (22.10) | 42.0 |
| Male | .015 (1.14) | 1.5 |
| ED | .026 (1.19) | 2.6 |
| EAS | .258 (13.11) | 29.4 |
| SBA | .369 (19.16) | 44.6 |
| UPA | .026 (1.15) | 2.6 |
| SSW | .028 (1.00) | 2.8 |
| FPA | -.113 (-4.99) | -12.0 |
| Cites | .004 (4.93) | 0.4 |
| Cites ² | -.000041 (-4.45) | -0.0041 |
| Articles | .011 (2.22) | 1.1 |
| Articles ² | -.00022 (-.73) | -0.02 |
| Books | .002 (.30) | 0.2 |
| R ² | .80 | |
| SEE | 3.70 | |
| n | 351 | |

With respect to publication activity, the model estimates that production of books has no significant effect on salaries, while the production of articles does. In addition, citations are estimated to have a positive effect on salaries. As hypothesized, diminishing returns are found to pertain to the effect of citations on salaries. The coefficient for the quadratic article term is not significant, however, indicating constant returns from the publication of articles.

Because the citation and article variables are specified in linear and quadratic form, their percentage effects on salaries vary with respect to their levels. Their percentage effects can be recovered by taking the appropriate salary derivative and multiplying it by one hundred. For citations, the derivative is as follows:

$$\delta \ln \text{ salary} / \delta \text{ citations} = [.004 - .000082 * \text{ Citations}] * 100$$

Table 3 reports the estimated marginal salary effect at zero, five, and ten citations and articles, calculated at the mean salary. The estimated values of a faculty member's first citation and article are \$192 and \$530, respectively. As the table shows, the marginal salary increases from another citation/article tend to decline relative to their initial contributions. By comparison, Diamond (1986) estimated the value of a first article from a sample of mathematicians from the University of California at Berkeley to be \$439, and the value of a first citation to be \$402. Diamond also reviewed four similar studies, and the PSU results are within the range of estimates he reported.

Table 3
Estimated Effect of An Additional Citation
or Article on PSU Salaries

| Level | Citation Effect | Article Effect |
|--------------|------------------------|-----------------------|
| 0 | \$192 | \$530 |
| 5 | 173 | 424 |
| 10 | 153 | 318 |

CONCLUSIONS

This report has analyzed factors influencing instructional faculty salary structure at Portland State University. The analysis shows that attributes associated with academic rank, field of specialization, publication activity and citation of one's work by other scholars have a significant influence on salaries. Several implications and more general issues are discussed below.

The analysis found that book publication did not have a significant effect on faculty salaries. One possible reason is that there are relatively few books published by the faculty. Also, it should be noted that book and article publication are important criteria considered in promotion and tenure decisions. Thus, the academic rank effects on salary are an indirect measure of the value of publication activity, among other things. Finally, books typically generate more citations than articles, suggesting that although book authors are not rewarded for publication, they are rewarded for the differential recognition that books receive through citations.

The analysis found no evidence of gender-specific salary differentials at PSU. The nominal differences that exist between the salaries of men and women can be attributable to differences in rank, field, and research effects. What can be concluded from this is that there is no direct evidence of gender-based pay discrimination. As Gunderson (1989)

points out, however, it is important to remember that gender-based differences in rank and research activity may themselves reflect discrimination in decisions on promotion¹ and tenure or in the editorial review process in publication.

Presently, the university is engaged in a general review of graduate education, with the intent of defining principles for future development as well as standards for program evaluation. This study's finding of economic returns to publications and citations relates to several key principles defined in the review of graduate education (Task Committee on Graduate Education, 1996). These principles emphasize that graduate education should be research-based and that incentives and rewards be used to promote further development of the university's research base.

Finally, the empirical model fits the salary data quite well, indicating that there is a logic to the system of faculty compensation at PSU. The model did not explain 20 percent of the variance in salaries, however. A careful literature review provides some reassurance against the possibility of the unexplained variation being due to specification error, leaving us relatively more confident that it reflects random error. One implication of error in this context are instances of observed faculty salaries being greater or less than what was predicted by the hedonic model. In some case the difference is fairly substantial. In the interest of equity, it would be desirable to assess instances where the disparities are large, and to consider whether such disparities are deserved.

FOOTNOTES

1. It is possible to assess gender-based differences in promotions using the data collected for the hedonic analysis of salaries. In this case we can estimate the likelihood of a faculty member holding the rank of professor as a function of seniority and scholarship, with the latter proxied by the number of articles and books published as well as citations of published work. School and college dummy variables need to be included to determine whether the likelihood of promotion varies among major organizational divisions of the university. Finally, a gender dummy variable is included.

The table below presents logit estimates of the likelihood that a faculty member will hold the rank of professor. This likelihood increases significantly with seniority; it is also significantly enhanced by published articles and citations. As with salaries, book publication is not estimated to contribute significantly to promotion. Significant differentials are not found among the colleges and schools, with the exception of FPA, where the likelihood is significantly greater. As mentioned earlier, the variables specified for scholarship are not very well suited to FPA, and it is hypothesized that with suitable proxies, the differential estimated for FPA would shrink.

The gender dummy variable is statistically significant, indicating that after controlling for the effects of seniority, publications and citations, men are more likely to hold the rank of professor than women at PSU. Specifically, men are estimated to be 72 percent more likely to hold the rank of professor, as calculated at the mean levels of attributes in the model.

Logit Model Estimates of Faculty Rank

(Dependent Variable = Probability that a faculty member is a professor; t-ratios in parentheses)

| Variable | Coefficient |
|----------------------------|--------------------|
| Constant | -4.16 (-8.06) |
| Seniority | .16 (8.69) |
| Male | 1.08 (3.29) |
| ED | .54 (1.05) |
| EAS | .22 (.44) |
| SBA | .60 (1.23) |
| UPA | -.27 (-.46) |
| SSW | -.52 (-.71) |
| FPA | 1.76 (3.31) |
| Citations | .04 (3.35) |
| Articles | .26 (3.04) |
| Books | .31 (1.52) |
| Log-likelihood (0) | -242.4 |
| Log-likelihood (β) | -159.8 |
| Likelihood Ratio (11 d.f.) | 165.1 |
| Maddala R ² | .34 |
| n | 351 |

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