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Predicting the Annual Salaries of Construction Educators using Multiple Regression

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The development of a mathematical model to predict the annual salaries of construction educators is presented. A review of the literature identified a number of factors that are hypothesized to affect the annual salary of construction educators; academic qualifications, longevity, academic rank, parent college of the department, region in which the institution is located and gender. The responses from the annual ASC Faculty Salary Survey were used to develop a multiple regression model that predicts the annual 9-month salary of a construction educator. The stepwise selection method was used to select seven independent qualitative or dummy variables to include in the model. The model developed does not have a very high predictive efficacy as only 51 percent of the variation in the dependent variable (annual 9-month salary) is explained by the variation in the selected independent variables. The variables selected for the model includes levels of academic rank, academic qualifications, region in which the institution is located and parent college of the department. Independent variables representing longevity and gender were not included in the model.

Key Words: Construction Educators, Salaries, Regression, Predictive Models

Introduction

How much should I be earning? It is a question that most of us ask, but very few of us receive a satisfactory answer, particularly those of us who teach in institutions of higher learning. Studies on salary compensation are of interest to both academicians and administrators. There exists a wide body of literature on faculty salary levels in institutions of higher learning. One of the basic tenets of market economy is that income should be distributed according to contribution, and none takes greater pride in rewarding people for merit alone than academicians. Some studies seek to explain the difference in salary levels in terms of performance and contributions. The purpose of this study is to identify whether there are other factors that affect faculty compensation, particularly those engaged in teaching in the member schools of the Associated Schools of Construction.

Literature indicates that apart from scholarly productivity, longevity makes a substantial contribution to faculty salaries (Ferber, 1974; Monks & Robinson, 2001). Studies suggest that when adequate measures of past mobility are controlled for, the evidence of a positive correlation between income and seniority of academic faculty is overwhelming.

There is a large dissatisfaction with the salary equity of women faculty in some universities. Findings by Bellas et al. (2001) show that a sizable gap between men's and women's salaries exists after controlling for academic qualifications. The study indicates that women's scarcity in higher-level faculty positions contributes to their slower promotion rates, which in turn depresses their salary growth rates.

Faculty salaries also differ across the disciplines. A study by Cox (2001) shows that average earnings by law professors, at both public and private universities, are the highest among all disciplines. Similar findings are reported by an earlier study by Schneider (1999). Construction science is taught in schools ranging from architecture to business to technology in different universities. It is likely that the school in which they are employed may affect the salaries of the faculty in the department of construction.

Most of the studies on faculty salary include academic rank as an endogenous factor for prediction of salaries. Webster (1995) reports that while salary of a full professor differs from that of faculty in other ranks, the associate and assistant professor ranks have no statistically significant relationship with salary. He suggests that the outcome may be due to the effect of salary compression.

In view of the evidence provided by the results of the studies conducted in other disciplines, it is hypothesized that faculty salary in schools of construction that are members of the Associated Schools of Construction are affected by the following factors:

- Academic qualifications
- Longevity
- Academic rank
- Parent college of the department
- Region in which the institution is located
- Gender

Method

Study Population

The study population consists of all faculty that teach at institutions that are members of the Associated Schools of Construction (ASC). The ASC web site identifies that there are 585 ASC Faculty.

Data Collection

During the fall of 2001 ASC faculty were sent email messages inviting them to take part in the survey. The initial invitation was sent out on the 11 October and follow up messages were sent on 18 & 28 October. The messages invited faculty members to visit the ASC web site and complete an on-line survey. A screen capture from the web site showing the on-line survey form is shown in figure 1. By November 16, 2001, 200 of the 585 ASC Faculty had responded, a response rate of 34.2 percent. From the 200 respondents, 21 selected not to participate leaving 181 Faculty completing the survey. Of the 181 Faculty completing the survey, 5 Faculty did not supply a full-time annual salary figure and were therefore not used in constructing the statistical model. Permission was sought and obtained from the ASC to use the database for the purposes of this study. The ASC board had previously voted to allow any program or faculty to have access

to Data within the ASC Database. The data provided has been cleaned so that it is not proprietary and does not identify any particular individual.

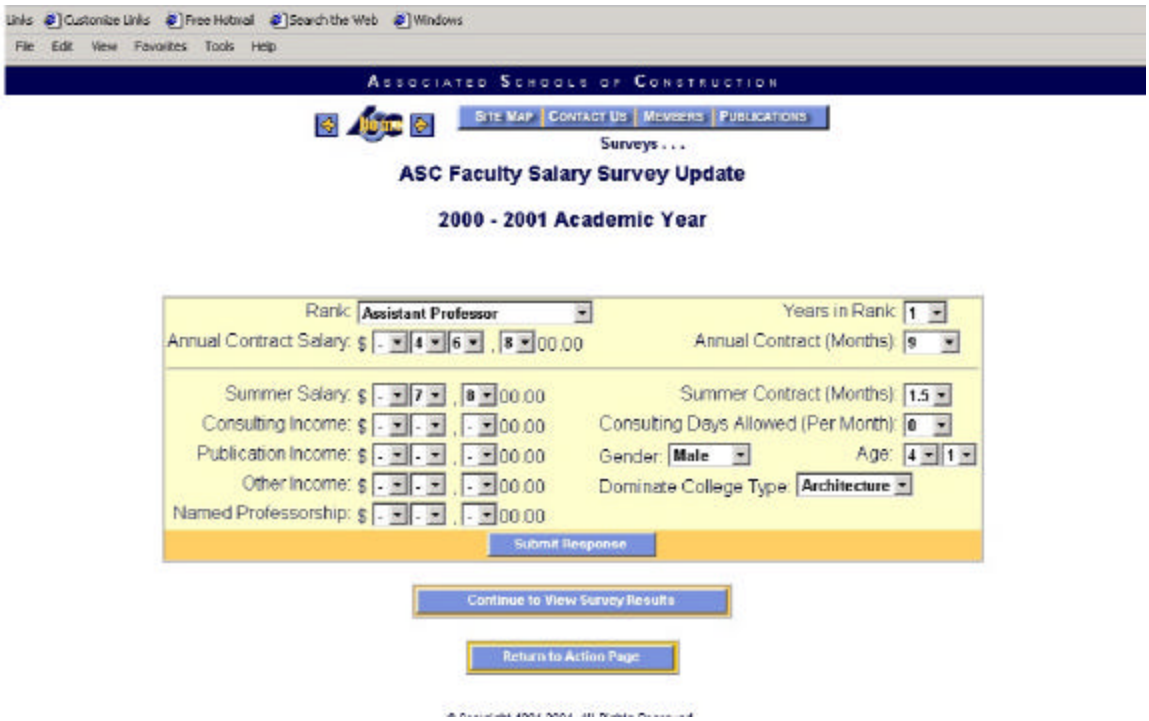

Figure 1: ASC Faculty Salary Survey Update form.

Variables of Interest

The dependent variable of interest is the annual contract salary of ASC faculty for a period of 9 months (ASC_9MO). Respondents submitted their annual contract salary and the annual contract period in months. Multiplying the annual contract salary by 9 and dividing it by the number of months of the annual contract calculated the dependent variable. The predictor or independent variables are of two types: quantitative and qualitative. The quantitative predictor variables are:

- Age of the faculty (AGE)
- Years in current rank (YRS_RANK).

The qualitative or dummy variables are used to represent further information about the faculty. The dummy variables cover the qualifications, rank, geographical region, college and gender of the faculty. A value of 1 is assigned if a faculty is a member of a particular qualification, rank, geographical region, college or gender group and a 0 if they are not. The qualitative or dummy variables are:

- Baccalaureate Degree (BS)
- Master of Science Degree (MS)
- Master of Arts Degree (MA)
- Law Doctorate (JD)
- Doctor of Education (DED)

- Doctor of Philosophy (PHD)
- Assistant Professor (ASST_PRO)
- Associate Professor (ASSO_PRO)
- Full Professor (FULL_PRO)
- Department Head or Chair (DEPT_HD)
- Senior Lecturer (SNR_LECT)
- Lecturer (LECTURER)
- Visiting/Adjunct Instructor (INSTRUCT)
- Graduate Teaching Assistant (GTA)
- Far West Region (FAR_WEST)
- Great Lakes Region (GT_LAKES)
- North Central (N_CENTRAL)
- North East Region (N_EAST)
- Rocky Mountain Region (ROCKY_MT)
- South Central Region (S_CENTRAL)
- South East Region (S_EAST)
- Architecture (ARCH)
- Business (BUSI)
- Engineering (ENGR)
- Technology (TECH)
- Other College (OTHER)
- Male (MALE)
- Female (FEMALE)

The names in brackets are the names assigned to the variables for use in the statistical software used for the analysis, SAS® for Windows® version 8.

Hypothesis

The hypothesis is that the 9-month annual salary of ASC Faculty can be predicted using the following multiple regression model:

$$ASC\_9MO = ß_0 + ß_1AGE + ß_2YRS\_RANK + ß_3BS + ß_4MS + ß_5MA + ß_6JD + ß_7DED + ß_8PHD + ß_9ASST\_PRO + ß_{10}ASSO\_PRO + ß_{11}FULL\_PRO + ß_{12}DEPT\_HD + ß_{13}SNR\_LECT + ß_{14}LECTURER + ß_{15}INSTRUCT + ß_{16}GTA + ß_{17}FAR\_WEST + ß_{18}GT\_LAKES + ß_{19}N\_CENTRAL + ß_{20}N\_EAST + ß_{21}ROCKY\_MT + ß_{22}S\_CENTRAL + ß_{23}S\_EAST + ß_{24}ARCH + ß_{25}BUSI + ß_{26}ENGR + ß_{27}TECH + ß_{28}OTHER + ß_{29}MALE + ß_{30}FEMALE + e.$$

Analysis & Interpretation

Development of the Statistical Model

A multiple regression model was developed to express the relationship between the dependent variable and the independent variables. The regression model was developed using the three-step approach set down by Ott (1993) namely; selecting the independent variables, forming a suitable model and checking the model assumptions. The selection process identified those independent variables that caused the greatest variation in the dependent variable. The stepwise selection method was used to select the variables in the model. The significance level (P-value) for an independent variable to enter and remain in the model was set at 0.10.

Results of the Stepwise Selection Method

The results of the multiple regression analysis are set out in table 1. The F value is used to test whether there is a significant regression relation between the dependent variable and the independent variables. The high F value and low P value (<0.0001) show that there is a significant regression relation. This result in itself however does not mean that the model is suitable for predicting annual salaries. The R-Square value is the coefficient of determination and measures how well the regression fits. The R-Square value of 0.5140 shows that approximately 51 percent of the variation in the 9-month annual salary is explained by the variation in the selected independent variables.

Table 1

Results of the multiple regression procedure

		Analysis of Variance			
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	7	16914761271	2416394467	25.53	< 0.0001
Error	169	15994330969	94641012		
Corrected Total	176				
	Root MSE	9728	R-Square	0.5140	
	Dependent Mean	60792	Adj R-Sq	0.4939	
	Coeff Var	16.003			

The independent variables selected by the multiple regression process and their parameter estimates are set out in table 2. All variables selected for the model have a significance level of P < 0.10. All the variables selected were qualitative or dummy variables, therefore the parameter estimate is the amount in dollars that is added or subtracted to the intercept value.

Table 2

Parameter estimates for multiple regression model including 95 percent upper and lower confidence intervals

Parameter Estimates

Variable	**DF**	**Parameter**	**Standard Error**	**t Value**	**Pr > t ?**	**Standardized Estimate**

		Estimate				
Intercept	1	52605	1568	33.53	<0.0001	0
PHD	1	4927	1488	3.31	0.0011	0.18061
N_CENTRAL	1	-4765	2070	-2.30	0.0226	-0.12754
S_CENTRAL	1	-5927	2141	-2.78	0.0061	-0.15188
ASSO_PRO	1	7191	1834	3.92	0.0001	0.24156
FULL_PRO	1	20092	1844	10.89	<0.0001	0.65509
DEPT_HD	1	22322	3868	5.77	<0.0001	0.31905
TECH	1	-4561	1672	-2.73	0.0071	-0.14870

Figure 2 shows a chart showing predicted 9-month salary values with 95 percent confidence and prediction intervals and actual 9-month salary values for all 176 observations.

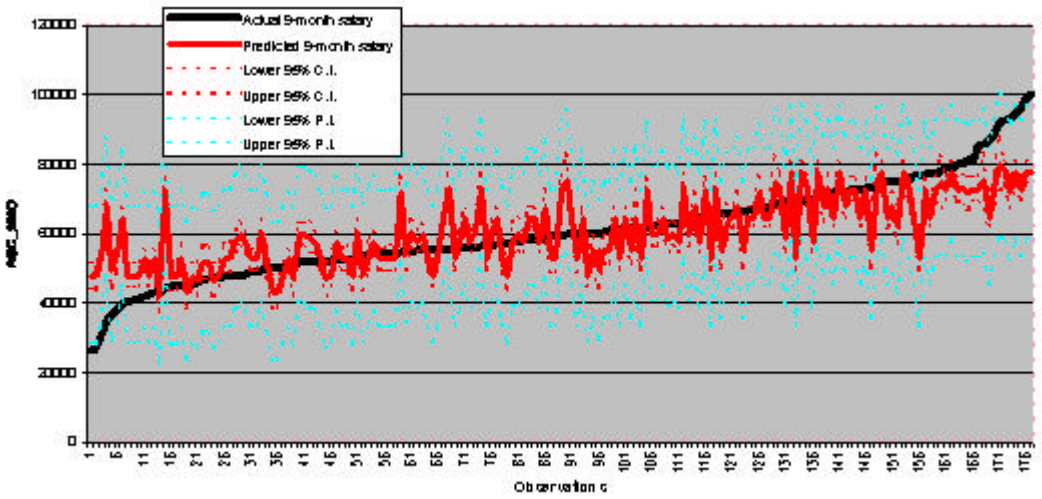

Figure 2: Chart showing predicted 9-month salary values and actual 9-month salary values

In light of the independent variables selected using stepwise procedure, the salary prediction model can be rewritten as follows:

$$ASC\_9MO = ß_0 + ß_8PHD + ß_{10}ASSO\_PRO + ß_{11}FULL\_PRO + ß_{12}DEPT\_HD + ß_{19}N\_CENTRAL + ß_{22}S\_CENTRAL + ß_{27}TECH + e.$$

Discussion

The results show that faculty salary is correlated with one academic qualification variable, three of the faculty rank variables, two geographical region variables, and one college type variable. The regression model explains approximately 51 percent of the variation in the 9-month salary. This means that the predictive efficacy of the model is not very high. That is, nearly 50 percent of the variation in salary is unexplained by the model. This can be seen in figure 2. The model appears to predict 9-month salaries between the values of $45,000 and $80,000 quite well, as most of the actual 9-month salary values lie within the 95 percent confidence intervals. At the extreme ends of the salary scale the model is not so good at predicting salaries, although the

actual 9-month salary values lie within the 95 percent prediction intervals. There is some concern that some of the lower salary values may not be for full-time faculty members. If this were the case then it would be prudent to change the ASC Faculty Salary Survey Update form to allow a faculty member to enter the percentage of a full-time salary they receive. In fact, the literature indicates that studies on faculty salary are usually conducted using full-time effort criterion (Monk & Robinson, 2001;Webster; 1995). The Information Management and Testing Services (1996) at Baylor University defines a full-time faculty as a member of the instructional staff who is employed full-time and whose regular assignment is instruction, including those with released time for research.

The model only selected PHD from the qualification dummy variables and suggests that the possession of a PHD adds approximately $ 4927 to a faculty member's 9-month salary. Evidence in the literature provides support for this finding (Lamb & Moates, 1999; Webster, 1995).

Three faculty rank dummy variables were selected. This was expected as most promotions in academia result in salary increases. The model indicates the rank of Associate Professor would increase the 9-month salary by $ 7191, the rank of Full Professor by $ 20092, and the rank of Department Head by $ 22322. I t will be interesting to see in future studies whether these differences remain significant if a productivity measure is introduced in the model.

Only two of the seven geographical region dummy variables were selected. The model indicates that Faculty in the North Central and South Central regions would have their 9-month salaries reduced by $ 4765 and $ 5927, respectively. It will, however, be interesting to see whether these differences remain significant after adjusting for variations in taxes and cost of living across geographical locations.

The only college dummy variable selected was Technology. The model indicates that being a faculty member in a College of Technology would decrease their 9-month salary by $ 4561. There is some evidence in the literature in support of this finding. Schneider (1999) did a study on differences in salaries of university professors by disciplines in four-year institutions. The findings suggest that the average faculty salary in colleges of technology is significantly lower than that in colleges of architecture, business, and engineering.

The variables that were not selected are also of interest. Neither of the two quantitative independent variables, age and years in rank, was found to be statistically significant. Even though the general body of literature suggests that a correlation exists between salary compensation and these two variables, a study by Moore et al. (1998) provides evidence contrary to this belief. The researchers did not find any positive relationship between either longevity or seniority with faculty salary when the model took into account only these two independent variables. The variables, however, became significant when a quality-adjusted measure of research publications was introduced in the model. It will be worthwhile to introduce such a variable for future studies on ASC faculty salary.

The study did not provide any evidence of gender differences in salary, even though the literature indicates that women faculty earn less on average than their male counterparts (Bellas, et. al. 2001; Hamton, et. al. 2000). Bellas, et al. (2001), however, indicated in their study that this gap

maybe partially attributed to the concentration of women faculty in relatively low-paying disciplines. It might be a reason for gender not being a predictor of salaries for the faculty in construction schools.

Conclusions

The results indicate that the model as a whole accounts quite well for the behavior of the dependent variable, faculty salary in schools of construction that are members of ASC. This is evident from the high F-value of the model that is statistically significant at the 0.0001 level. The predictive efficacy of the model is not very high with an R^2 value of 0.51; but such values are not unusual in empirical studies related to social sciences. Faculty salary is found to be correlated with academic qualification variable Ph. D., faculty rank variables Associate Professor, Professor, and Department Head, geographical region variables North Central and South Central, and college type variable Technology. All these variables are statistically significant at the 0.05 level or less. The results did not provide evidence that salary level is affected by age or length of service in a rank of a faculty. It is also not affected by gender difference. However, in the light of preceding discussions, it recommended to include a quality-adjusted measure of publications and research by the faculty in pursuing future research on faculty salary.

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