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ASSESSING GENDER DIFFERENCES IN DEVELOPERS: A PRELIMINARY INVESTIGATION

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Abstract

Previous studies have indicated that discriminatory practices exist in the Information Technology profession. This paper compares the current salaries and skill sets of women developers to their male counterparts. Following a number of previous studies, we take an economic perspective in examining potential discriminatory practices. We fit the human capital model based on economic theory to provide a quantitative assessment of the salary differences attributed to gender for developers. Our preliminary results indicate that women developers are paid less than their male counterparts.

Keywords: IS staffing, personnel, gender differences, discrimination, human capital model

Introduction

Gender differences exist in the workplace, including the Information Technology (IT) area. In an earlier study, Truman and Baroudi (1994) found that the mean salary for women senior IT managers was considerably lower than males even when controlling for job level, age, education, and work experience. They concluded this is "a problem suggestive of discriminatory practices". Panteli, Stack, and Ramsay (1999) reported that women were under-represented in all areas of the IT industry and cited several studies that indicate the IT culture is a "masculine, engineering type, computing culture". More recently, a special issue of the *Communications of the ACM* (July 2001) focused on issues regarding the global IT work force. One key issue that emerged was the under-representation of women, minorities, and older workers in the IT work force (Arnold and Niederman 2001). von Hellens and Nielsen (2001) discussed attracting women to the IT profession in Australia. Trauth (2001) focused on two work force challenges for Ireland relating to gender and socio-economic class.

Gender discrimination in the workplace can be divided in two types: access and treatment (Levitin, Quinn, and Staines 1971). Access discrimination occurs when members of a certain gender are not hired into certain jobs because of policies and procedures (written or unwritten) that bar or discourage their recruitment. Recent census data (Statistical Abstract of the United States 2001) suggests the presence of access discrimination. Currently, females constitute 50.1% of all Financial Managers (up from 38.6% in 1983), 56.7% of all Accountants and Auditors (up from 38.7% in 1983), and 61.8% of all Personnel and Labor Relations Managers (up from 43.9% in 1983). On the other hand, females currently constitute only 29.2% of the Computer Systems Analysts and Scientists (up from 27.8% in 1983). Treatment discrimination occurs when qualified members of a certain gender receive lower salaries, lower status, or lower positions than comparable members of the opposite sex (Levitin, et al. 1971). Economists take the position that some part of the gender gap in earnings or occupations is due to average group differences in productivity-linked characteristics (a human capital gap) and some part is due to average group differences in treatment (a discrimination gap). Gaps that can be explained by human capital differences make it easier to assert that labor markets function in a nondiscriminatory manner (Darity and Mason 1998).

The purpose of this paper is to compare the current salaries of women developers with their male counterparts. We fit the human capital model based on economic theory to provide a quantitative assessment of the salary differences attributed to gender. While the human capital model quantifies the salary differences based on gender, it also controls for the effects of different amounts of technical experience and different levels of education that developers possess.

In the next section, the human capital model, which we employ to assess potential gender discrimination, and its theoretical rationale, the human capital theory, are detailed. Following this, the nature of our survey is discussed. Then, the results for the human capital model are presented. The paper ends with some concluding remarks.

Human Capital Theory

The dominant economic theory of wage determination is the human capital theory (Berndt 1991). Its roots date as far back as the 18th century writings of Adam Smith (Smith 1937) on equalizing or compensating for differences in wages paid to workers based on amenities and risks in the workplace.

The human capital implications of education are a well-known and straightforward extension of Smith's idea of equalizing differences (Berndt 1991). More educated workers are expected to be more productive than their less educated counterparts and thus are more likely to command higher wages. This also provides an economic explanation as to why a person will forego earnings and incur additional expenses to undertake an education.

For the most part, the econometric literature on wage determination has been based on regression models of the following form: the natural logarithm of earnings is a function of a measure of schooling, a measure of experience, possibly other factors, and a random disturbance term. Early work by Roy (1950) related earnings distributions to the distributions of the underlying abilities (such as intelligence, physical strength, etc.).

Later work by Mincer (1974) showed the regression equation for wages is linear in education but quadratic in experience. That is:

$$\log Y_i = \log Y_0 + \beta_1 S_i + \beta_2 X_i + \beta_3 X_i^2 + u_i \qquad (1)$$

where Y_i is the wages for the i-th worker; Y_0 is the intercept term in the regression model which determines the base rate without education or experience; β_1 is the rate of return for education; S_i is the highest grade attended (in years) for the i-th worker (for example, 16 years indicates a bachelor's degree); X_i is the years of experience for the i-th worker; β_2 and β_3 are coefficients that assess the rate of return on experience; and u_i is the random disturbance associated with the i-th worker. Based on human capital theory, the wages function is concave in experience because as experience increases, earnings cannot increase indefinitely. That is, a maximum wage can be reached. Thus, estimates of β_2 should be positive while estimates of β_3 should be negative. In assessing and testing differences between two or more disjoint subsets (such as male and female) using the same econometric regression model, Chow (1960) is credited with developing a test of coefficient equality between the two subsets by fitting the regression model to each of the two subsets and the entire or pooled set of data.

Survey Details

The results presented here are based on a voluntary web-based survey of IT workers that was conducted by dice.com, an on-line placement company. This survey can be found at the company's web site at **http://www.dice.com**. In the period from June 7, 2000, to April 13, 2001, 22,488 **full-time** (data for contract workers was not included) USA IT workers correctly completed the survey on-line. In the on-line survey, a respondent could select from 38 different job titles. For developers, we combined 4 job title categories -- Developer: Applications, Developer: Client/Server, Developer: Database, and Software Engineers. This resulted in a sample of 4,172 (18.6% of the overall respondents) which was used in this analysis.

Only 19.0% of the respondents to the survey were female. Since females now constitute 29.2% of the Computer Systems Analysts and Scientists in the USA, some concerns can be raised by the representation of the respondents of this survey. Two possible explanation on why the percentage of female survey (by an on-line placement company) respondents is low: (1) women conduct a job search with less intensity than men (Keith and McWilliams 1999) and (2) women are less likely to separate from an existing job (Kulik 2000). Further, the survey sample was not random since the respondents were self-selecting and voluntary which may introduce a bias towards younger workers (since the survey was on-line) and respondents actively seeking new employment (since the survey was placed on an on-line placement company's web site).

The respondents were categorized by (technical) experience level (6 categories), education (8 levels), and gender. For the first 2 experience level categories (less than 1 year and 1-2 years), females constituted 25.8% and 22.8% of the respondents. In contrast, for the last 4 experience level categories, females constituted only 17.8%, 16.9%, 15.8%, and 17.1% of the respondents. Males make statistically significantly more than their female counterparts at all experience levels except at Level 2 (1-2 years experience). Even at Level 2, the sample means show that males make, on average, $1,255 more than their female counterparts. Apparent gender differences are present but not as pronounced as was the case for experience. For 5 of the 8 education levels, the overall pattern of 81% male and 19% female is approximated – females range from 18.1% to 20.4%. However, for the 3 education levels that have the smallest overall representation, Military (1.8%), Doctoral Degree (1.6%), and Professional Degree (1.1%), males are found in substantially greater proportions – 96.0%, 88.6%, and 86.2%, respectively. Again, the differences in salary between males and females are quite dramatic and significant with the average difference ranging from $6,088 to $19,133.

Model Results

Berndt (1991) suggested that rather than using annual salaries, the hourly salary rate should be employed. Since the respondents also indicated the average number of hours worked per week, we fit the human capital model by taking the annual salary and dividing it by the estimated hours worked per year.

Table 1 presents the results for the human capital model. The Chow test indicates a significant difference between the male and female models with a p-equal to .0001 (note: p-values lower than .0001 will also be indicated with the .0001 value). The base coefficient for males is substantially higher than for females indicating that male developers have a substantial initial advantage in salary. However, females get a greater increase from education than their male counterparts which somewhat lessens the base impact. Females also appear to benefit more from experience than males. As expected, experience has a positive coefficient while Exp^2 has a negative coefficient.

In order to interpret better the log-linear nature of the human capital model, we computed expected salaries using values from the complete sample which yielded an average experience of 6.42 years and average education of 15.44 years. The "Typical Fit" indicates that women developers make 92% ($28.17 versus $30.59) of what their male counterparts make with the same amount of experience and education.

Table 1. Human Capital Model Results

Coefficient or Statistic of Interest	Overall	Males	Females
"Typical Fit"	30.27	30.59	28.17
Base	2.2916 ***	2.3964 ***	1.6899 ***
Education	0.0456 ***	0.0404 ***	0.0782 ***
Exp	0.0857 ***	0.0829 ***	0.0905 ***
Exp^2	-0.0033 ***	-0.0032 ***	-0.0034 ***
N (%)	4172	3,462 (83%)	710 (17%)
Sum of Squares	624.52	518.28	101.89
Adj. R^2	0.17	.16	.24
p-value	0.0001	.0001	.0001

F-statistic of Chow Test = 7.29 with a p-value = .0001
χ^2 statistic= 12.71 with a p-value = .0001
*** coefficient significantly different from 0 at .01 level

The highly significant results for the Chow test and the substantially larger base coefficient for males suggests that discrimination is present. Moreover, the difference in wages is not attributable to education or experience; in fact, females derive a greater incremental benefit from both education and experience. To investigate the representation of women in the developer jobs, the

χ^2 test for homogeneity was used. The results were highly significant indicating that women were under-represented in developer jobs and suggests the presence of access discrimination.

In evaluating the human capital model, some reservations must be expressed concerning its application (Berndt 1991): (1) "wage determination may reveal only a portion of the total compensation differentials among workers", (2) "it is often difficult to obtain accurate data on hours worked by salaried people", and (3) "the practicing econometrician in labor economics is typically forced to make use of data that are considerably less than ideal" (Berndt does add that "in spite of these serious measurements much has been learned concerning the determinants of wages").

Concluding Remarks

A major implication from our results is that woman's human capital accumulation benefits greatly from education (substantially more than their male counterparts). Firms should place a premium in educating and training female workers. In addition, female IT workers should be strongly encouraged to improve their skills through degree programs and professional development programs. This is especially important in the IT industry where technology changes very rapidly.

Despite some concerns about our sample and some reservations about the human capital model, we feel that our preliminary results indicate that for developers, women are **not** paid the same as men. Future research efforts should determine if other factors such as skill set and job type are responsible for these differences. The results of a forthcoming study by Dattero and Galup (2003) provide a possible explanation for some of the salary differences. Women have greater representation maintaining COBOL legacy systems rather than "engineering" new systems. In a similar vein, the slightly higher percentage of males (compared to the huge difference favoring males for Java or C++) knowing SQL and Oracle may indicate that women focus more on reporting functions for existing systems. Finally, among new IT workers, a significantly greater proportion of females report knowing HTML. While HTML may provide an entry point to an IT job, it may also stereotype an IT worker into less demanding (and lower paying) programming jobs.

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