Discrimination and Efficiency Wages: Estimates of the Role of Efficiency Wages in Male/Female Wage Differentials

Michael D. Robinson and
Phanindra V. Wunnava

Recent work on efficiency wage models has increased our understanding of discrimination, as well as the operation of labor markets (Bulow and Summers [1986]; Bowles [1985]; and Akerlof [1984]). Bulow and Summers [1986] developed an efficiency wage model of labor markets that has direct implications for discrimination. They argued that the wage premia necessary to keep males and females from shirking differ because of relative quit rates. Discrimination results from the efforts of employers to limit the wage premia paid to females. In their work, no empirical tests of the hypothesis were presented.[1] We believe that directly testable hypotheses about sex discrimination can be derived from their model. This chapter will consider these issues and present the results of two empirical tests. We show that the average decrease in the earnings of each individual worker as the percentage of women in the workforce increases is more marked in large than in small plants. The second investigation reveals that for males there is a larger trade-off between supervision costs and wages than can be observed for females. These results indicate that some evidence exists that sex discrimination is in part the result of efficiency wages.[2]

I. THE NO-SHIRKING CONDITION AND DISCRIMINATION

Bulow and Summers [1986] derived the wage premia necessary to insure that primary-sector workers will not shirk under the assumption that workers maximize lifetime utility, dislike working, and may be fired for shirking in the primary sector. This premium is given by

(1) $$w_p - w_s = [ir/D] + [iqN/D(N-E)] ,$$

where w_p is the primary-sector wage, w_s is the market-clearing secondary-sector wage, i is the intensity of work effort, q is the quit rate, r is the discount rate, D is the probability that a shirker will be caught and dismissed, N is the size of the work force, and E is the size of the primary sector.[3] The wage premium, $w_p - w_s$, must be larger for workers that are less likely to be caught shirking. In addition, higher quit rates lead to higher premia. Here is the source of discrimination hypothesized by Bulow and Summers. Since women have lower labor-force attachment, they will require larger wage premia than men. Employers attempting to minimize wage costs will prefer to place men in primary-sector jobs and women in secondary-sector jobs, with the result of occupational segregation and wage differentials.

If the disutility of work is related to work effort, then we can obtain an expression from (1) that relates work effort to the wage differential, quit rate, and probability of being caught shirking:

(2) $$(w_p - w_s)/\{(r/D) + [qN/D(N-E)]\}.$$

Bulow and Summers assumed that supervision is fixed and therefore that a single wage premium is associated with a level of work effort. In different circumstances, the amount of supervision may vary, and, in fact, firms may be able to add supervision at some cost. This implies that a combination of wage premia and supervision will be associated with a given work effort.

A simple efficiency wage model can be developed by considering a competitive firm facing price P for output and wage w for labor. Output Q is a function of the number of workers L and the intensity i with which they work. Work intensity, given by (2), relates effort to wage premia and supervision. Work intensity is a function of two factors: the amount of supervision S (which determines D, the probability of being dismissed for shirking, and which is obtained at cost g) and the wage premium, $x = w_p - w_s$. These assumptions give the following simple system:

(3) $$\text{Profits} = PQ - (w + x)L - gS ,$$

(4) $$Q = f(L, i) ,$$

(5) $$i = g(x, S) .$$

The firm's problem is to maximize profits by selecting L, x, and S, the amount of labor, the wage premium, and the amount of supervision. The first-order conditions are as follows:

$$(6) \qquad Pf_L(L, i) = w + x,$$

$$(7) \qquad Pf_i(L, i)g_x(x, S) = L,$$

$$(8) \qquad Pf_i(L, i)g_S(x, S) = g.$$

Condition (6) sets the marginal cost of labor equal to the marginal productivity of labor (given work intensity), (7) sets the marginal cost of increasing work intensity equal to marginal benefits of increasing intensity, and (8) sets the marginal cost of supervision equal to the marginal benefit of supervision. From (7) and (8) the following condition can be derived:

$$(9) \qquad g_x(x, S)/L = g_S(x, S)/g.$$

This condition sets the marginal cost to marginal benefit ratio for supervision equal to that for work intensity.

Using (9), we can see one possible source of male/female wage differentials as viewed by Bulow and Summers. Goldin [1986] and Bulow and Summers [1986] argued that $g_x(x, S)$ is greater for males than for females.[4] That is, the marginal gains in work intensity from increasing wage premia will be larger for males than for females. This may arise because of females' lower level of commitment to the job. If females plan to leave the job more often than males, it may be harder to persuade them to provide more intensity with a wage premium.[5] This implies that males and females working at the same intensity will have different levels of supervision and wage premia. This is consistent with the finding by Ragan and Smith [1981] that the wage reductions associated with high quit rates are larger for males than for females. Males will have larger wage premia than females (at the same intensity). Second, employers may perceive females as being more docile and easy to manage than males. This implies that the cost of supervision will be higher for males than for females and again that the wage premia offered to males will be higher than those offered to females working at the same level of intensity.[6]

Whichever explanation is accepted, firms treat males and females differently. Females will receive more supervision and lower wage premia for the same work intensity. It would be quite difficult for firms to achieve this mix with males and females working side by side at the same jobs. Therefore we would expect that firms would devise two occupations: one with high supervision and low wage premia and a second with low supervision and high premia. By channeling males and females to the appropriate occupations (that is, occupational segregation), firms could achieve the desired mix of supervision and wage premium for all workers.[7]

It is worth noting at this point the difference between this approach toward discrimination and the standard human-capital approach. Here, while the male/female wage differential does depend in part on differences in characteristics between males and females, the wage differential is rooted in the way in which employers extract labor power from the workers and not in the differences themselves. Further, the differences between males and females assumed by this model are not productivity differences.

II. TESTABLE HYPOTHESES

This section develops and tests two hypotheses that are implied by the preceding analysis. First we consider the relationship between plant size and the gender of employees in wage determination. Then we consider the relationship between supervision and earnings for males and females.

IIA. Plant Size and Percent Female

It is well known that wages are inversely related to the percentage of the work force that is female in an industry. We argue that this result can be explained by the efficiency wage model of discrimination. Further, this effect should manifest itself more in large firms because of increased supervision costs. Assuming that the work effort of females is less responsive to wage premia than that of males, employers would be more likely to fill primary jobs, again characterized by high wage premia, with males. Since this is the case, we can use the percentage of the work force that is female as a measure of the relative probability that a worker in the industry is in fact a secondary worker.

Next consider the case of plant size. If monitoring costs are related to plant size, wages should be determined differently in different-size plants. Suppose that there are two plants, one with perfect monitoring and the second with expensive and inefficient monitoring. In the first plant, all

Table 3.1
Variables Used in Efficiency Wage Model of Discrimination

Variable	Description
Experience (prior to current job)	Worker's age less education and tenure plus five
Experience^2	Experience squared/100
Sex	= 1 if male, = 0 otherwise
White	= 1 if white, = 0 otherwise
Education	Years of education
Tenure	Years of tenure
Tenure^2	Tenure squared/100
Union	= 1 if in Union, = 0 otherwise
Part-time	= 1 if works less than 35 hours per week
Percent union	Percent union at the 2-digit industry level
Percent female	Percent female at the 2-digit industry level

Other Control Variables

Region	Dummies for the nine Census Bureau regions
Occupation	Eight occupation dummies
Industry	Nine one-digit SIC code industries

(Estimates for these dummies are not reported due to space considerations, but are available on request from the authors.)

Size Categories (for table 3.2 and for "supervisory" variable in table 3.3)

Large	More than 100 employees
Small	Less than 100 employees

Plant Size Dummies (for table 3.3)

Size 1	Less than 25 employees
Size 2	25-99 employees
Size 3	100-499 employees
Size 4	500-999 employees
Size 5	1,000 and over employees

Table 3.2
OLS Wage Regression Results: Effects of Plant Size and Percent Female on Earnings

	All Workers		Males Only	
Variable	Large	Small	Large	Small
Intercept	1.665**	1.438**	1.818**	1.54**
	(29.14)	(32.29)	(25.25)	(25.72)
Percent Female	-0.373**	-0.115**	-0.450**	-0.215**
	(-10.11)	(-3.39)	(-8.15)	(-3.84)
Education	0.050**	0.043**	0.052**	0.047**
	(22.58)	(22.34)	(18.13)	(18.16)
Experience	0.009**	0.014**	0.011**	0.020**
	(8.31)	(16.04)	(7.01)	(14.61)
Experience²	-0.017**	-0.028**	-0.016**	-0.038**
	(-5.44)	(-12.77)	(-3.46)	(-11.42)
Tenure	0.030**	0.029**	0.033**	0.029**
	(21.08)	(20.23)	(17.23)	(15.01)
Tenure²	-0.057**	-0.058**	-0.060**	-0.059**
	(-12.57)	(-12.10)	(-10.68)	(-9.21)
Union	0.056**	0.199**	0.040**	0.219**
	(5.21)	(15.52)	(2.78)	(13.64)
Percent Union#	-0.041	-0.085	-0.106	-0.051
	(-0.80)	(-1.22)	(-1.63)	(-0.57)
Part-time	-0.127**	-0.127**	-0.201**	-0.179**
	(-7.93)	(-12.56)	(-6.53)	(-9.98)
Sex	0.182**	0.223**		
	(17.21)	(22.11)		
White	0.086**	0.041**	0.112	0.080**
	(5.96)	(2.90)	(5.22)**	(3.79)
Observations (N)	6,214	10,756	3,474	5,720
R-squared (adj)	0.53	0.47	0.47	0.43
F-value	188.75	246.34	84.75	117.54
Standard error	0.339	0.404	0.348	0.417

Notes: The dependent variable is the natural log of hourly earnings. Estimates were obtained by ordinary least squares. T-statistics are in parentheses.
** Significant at the 5% level.
Industry, occupation, and regional dummy coefficient estimates are available on request.
The unexpected sign on this variable may be due to a high correlation between Percent Female and Percent Union.

workers would be paid competitive wages, there would be no need for occupational segregation, and there would be little difference between male and female wages. In this case, the presence or absence of female workers tells us nothing about the level of wages. In the second plant, we would expect to observe large wage premia in primary-sector jobs and a sharp delineation between the primary and secondary sectors. Since the male workers would be more heavily concentrated in the primary jobs, we would expect the percentage of the workers that are female to be extremely important in wage determination. A plant with high monitoring costs that employed primarily males would pay much higher wages than a similar plant employing females. Since we believe that monitoring costs increase with plant size (Calvo and Wellisz [1978]), small plants should have low monitoring costs and large plants high monitoring costs. This implies that only in large plants will the gender mix of the workers contain information about the market-sector characteristics of the jobs.

The May 1983 Current Population Survey supplement contains data on plant size and allows us to test our hypothesis. Wage equations were estimated for small and large establishments using data for private-sector nonagricultural employees and including a measure for percent female at the two-digit level of the Standard Industrial Classification code. The equations were estimated for all workers and for males only.

Table 3.1 lists the variables used in the analysis and table 3.2 reports the regression results. The human-capital variables and labor-force-status variables have their expected signs. As predicted, the negative effect of percent female is much greater in magnitude for large plants than for small plants.[8] This suggests that the effect of the percentage of females is more pronounced where monitoring costs are larger.

IIB. Supervision Costs and Wage Differentials

Equation 9 indicates that there should be a positive correlation between supervision costs and wage premia for the profit-maximizing firm (Leonard [1987]). If the efficiency wage model of discrimination is correct, this relationship should be quite different for males and females. All things equal, an increase in supervision costs should lead to a larger increase in male than in female wages, since it is hypothesized that males are more responsive to wage premia. This occurs because an increase in supervisory costs leads to a change in the mix of supervision and wage premia used in obtaining effort from male and female workers. For example, in the extreme case where females are totally unresponsive to wage premia, increasing supervision costs would lead to higher male wages, no change in female wages, and a reduction in female employment.

In order to test this hypothesis, a measure of supervision costs had to be constructed; this measure could then be included in wage equations that were estimated using the data set described earlier (with the exception that part-time workers and nonwhites were included). Since data on the marginal cost of supervision would be impossible to obtain, estimates of average supervision costs were used. Average supervision costs in an industry are defined to be the dollars per hour per employee spent on supervision. Supervisors are defined as workers with three-digit occupations clearly identified as supervisory. The three-digit occupation codes make it relatively easy to identify supervisory workers in the industry. Because we believe that supervisory costs are much different in large and small plants, this measure was constructed separately for plants with more and those with less than 100 employees by two-digit industry SIC code. In order to construct the average cost measure, we first computed total supervisory costs per hour in the industry/plant size cell. This was simply the sum of the hourly wages of the supervisory workers. Total supervision costs per hour were then divided by the number of nonsupervisory workers in the industry to obtain average supervision costs per worker per hour. Clearly this measure represents a first approximation and the results should be taken in this light. It is also problematic to use an industry-level measure for supervisory costs that might better be constructed on the individual firm level.

The results from Table 3.3 indicate that there appears to be a correlation between wage premia and supervision costs. However, this relationship only holds for males. The relationship for females is not significant. In order to determine the importance of supervisory costs in total male/female wage differentials, we used a standard total differential decomposition, where the total differential can be expressed as:

$$TD = (b_m - b_f)X_f + b_m(X_m - X_f).$$

The first term on the right-hand side represents the unexplained differential and the second term the explained differential. Applying this technique reveals that 15 percent of the total male/female wage differential "is unexplained" by the different coefficients on supervision costs for males and females.[9] This tends to confirm the predictions made by the efficiency wage model of discrimination.[10]

Table 3.3
OLS Wage Regression Results: Effects of Supervision Cost on Earnings

Variable	Males Estimate	Females Estimate
Intercept	0.938	1.076**
	(23.68)	(20.86)
Average Supervision Cost†	0.082**	0.003
	(5.51)	(0.255)
Percent Female	–0.272**	–0.205**
	(–6.52)	(–5.81)
Education	0.045**	0.035**
	(21.83)	(15.44)
Experience	0.018**	0.007**
	(16.03)	(7.48)
Experience^2	–0.032**	-0.015**
	(–11.91)	(-6.02)
Tenure	0.029**	0.026**
	(19.58)	(16.58)
Tenure^2	–0.057**	–0.055**
	(–12.22)	(–9.70)
Union	0.143**	0.102**
	(12.26)	(7.41)
Percent Union#	–0.201**	–0.176**
	(3.42)	(2.22)
Part-Time	–0.174**	–0.074**
	(–11.37)	(–7.33)
White	0.0905**	0.014
	(5.69)	(1.05)
Observations (N)	8,241	7,420
R-squared (adj)	0.50	0.455
F-value	191.38	145.44
Standard error	0.40	0.36

Notes: The dependent variable is the natural log of earnings. Estimates were obtained by ordinary least squares.

T-statistics are in parentheses.

** Significant at the 5% level.

Industry, occupation, plant size, and regional dummy coefficient estimates are available on request.

† Average supervision cost is defined to be the dollars per hour spent on supervisory employees per nonsupervisory worker where supervisors are those workers in occupation codes 3-18, 303-306, 243, 413-414, 448, 456, 503, 613, 553-558, 633, 803, 843, 863. The measure was constructed by plant size (over and under 100 employees) for 40 two-digit industries. A descriptive table of the measure is available from the authors.

The unexpected sign on this variable may be due to a high correlation between Percent Female and Percent Union.

III. CONCLUSION

This chapter contains the results from an empirical study designed to test the predictions of an efficiency wage model of discrimination. Bulow and Summers in their 1986 paper argued that discrimination against women stems from the need for employers to pay wage premia to workers to inhibit shirking. Since women have lower labor-force attachment than men, the wage premia that would have to be offered for a given level of supervision exceed those that would have to be offered to men. Because of this, occupational segregation occurs.

Given the relationship between plant size and supervision, two hypotheses were made based on this discrimination theory. Since large plants have higher supervision costs, managers there will more likely pay large wage premia and need to discriminate. Small plants with low supervision costs will more likely pay competitive wages to males and females. Our results indicate that in fact wage effects associated with the percentage of females are larger in large plants.

A second approach taken was to attempt to distinguish the unexplained wage differentials between males and females that were associated with variables that measure supervisory costs. Our results indicated that male wages were positively correlated with supervision costs, while there was no significant relationship between female wages and supervisory costs.

CHAPTER 3

We would like to thank Steven Shulman, Richard Cornwall, Alan Dillingham, and other participants of the Middlebury Conference for their valuable comments on an earlier draft of this chapter. The usual caveat applies.

1. Goldin [1986] presents evidence from manufacturing around 1890 on the relationship between monitoring costs and occupational segregation.

2. See the preceding chapter by William Darity for arguments confronting efficiency wage explanations of the existence of involuntary unemployment and discrimination.

3. Here we assume that the probability of a false positive detection of shirking is zero.

4. Note that the preceding chapter of this volume cites evidence by Bielby and Bielby [1988] that questions this distinction by sex in the relation between work effort and wage premia.

5. Meitzen [1986] and Viscusi [1980] examine sex differences in quit rates.

6. Of course, in equilibrium the cost of worker effort to the firm is the same for both males and females if one assumes diminishing marginal effects of supervision and wage premiums on effort. It is only the mix of wage premia and supervision that will vary between males and females, not the final cost to the firm.

7. This is not dissimilar to the explanation for sexual segregation given by William Bielby in chapter 5.

8. The difference between the coefficients of large and small plant sizes is statistically significant at the 1 percent level.

9. In order to compute this, we assume that the male coefficients are the nondiscriminatory coefficients. Thus the difference between the male and female coefficients times the mean supervision cost for females gives the unexplained

differential due to supervision cost coefficient differentials: (.0826 – .00373) x .702 = .0554. The total log differential between male and female wages in this sample is 0.376. Therefore, the unexplained differential due to supervision variable would be approximately .147 (= .0554/.376).

10. Note that equation 9 indicates that for profit maximization, firms will set the ratio of the marginal benefits of wage premia (in terms of effort) equal to the marginal benefits of supervision to the costs of supervision. Hence in general, we would expect that increasing supervision costs would lead to higher wage premia. If there is a difference between males and females in either their responsiveness to wage premia or to supervision, this trade-off will occur at different rates. Suppose in the extreme case that females are totally unresponsive to wage premia; then one would expect that increasing supervision costs would not lead to higher wages for females. Thus the coefficient of the supervisory variable in the wage regressions for males should be greater than that for females. The decomposition is just to give an idea of how important this difference is for the overall male/female wage differential.

Michael D. Robinson is an assistant professor of economics at Mount Holyoke College in South Hadley, Massachusetts 01075-1461. He taught at Middlebury College during 1987-88. He received a B.A. from Washington University in St. Louis and a Ph.D. from the University of Texas at Austin. His areas of research include labor economics and econometrics.

Phanindra V. Wunnava is an associate professor of economics at Middlebury College in Middlebury, Vermont 05753 and is also a research associate in economics at the State University of New York at Binghamton. He received Bachelor of Commerce and Master of Commerce degrees from Andhra University in India, a Doctor of Arts degree from the University of Miami, and a Ph.D. from the State University of New York at Binghamton. His main areas of interest are life-cycle union wage/benefit effects, firm size effects, gender discrimination, efficiency wage models, charitable contributions towards higher education, frontier estimation, and pooled cross-section time-series analysis.