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Compensating Wage Differentials for Workplace Accidents: Evidence for Union and Nonunion Workers in the UK

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Abstract

This article measures compensating wage differentials for job risks for union and nonunion workers. Job risk is made endogenous to avoid a selectivity bias arising if more able people choose safer jobs. We find that this adjustment has a considerable effect on the union group, raising their fatal risk premium above that of non-union workers. This implies that there is more variation in unmeasured ability in the unionized group, and that job risk is an inferior good. The fact that unionized workers are also found in safer jobs might therefore be attributable to their greater wealth, rather than to greater "knowledge" in the unionized plant. The estimated statistical value of a life is £8.8 million in 1990 prices for union workers, with nonunion workers about 20% lower.

Key words: Workplace accidents, compensating wage differentials, unions
JEL Subject Category: J28

Introduction

In this paper we use a new UK dataset on accidents at the workplace to estimate compensating wage differentials for job risks for workers in union and nonunion environments. The contrast between union and nonunion workplaces is important, since a connection is often made (as, for example, in the European Community Social Charter) between worker and participation and improved workplace safety (Addison and Siebert, 1991). In addition, unions are sometimes said to have better knowledge both of workplace risks, and of the preferences of inframarginal workers (Viscusi, 1979, p. 173). If this is the case, then special government policies will be required for the nonunion sector. As it is, in terms of UK law (the 1974 Health and Safety at Work Act), only workers in firms which recognize an independent trade union are able to demand a safety representative, who is empowered inter alia to inspect the workplace every three months or whenever there has been a major change or after a reportable accident. However, 60% of UK private sector workers work in establishments employing less than 100; the vast majority of these firms do not recognize unions and therefore have no safety representatives (Siebert, 1991, p. 200). Further, there has been a tendency over the past decade for union recognition to diminish, and for a rise in the proportion of establishments dealing with health and safety matters without consultation (the 1984 figure was 28%, the 1990 figure 44% (Millward et al., 1992, p. 161)). The question therefore arises as to whether anything further need be done to protect workers in nonunion plants.

UK empirical studies have all found that unionized workers receive *lower* compensating differentials than nonunion workers (Veljanovski, 1982; Marin and Psacharopoulos, 1982; and Sandy and Elliott, 1992). However, only the study by Sandy and Elliott has used data on individual workers' collective bargaining coverage (or union membership), rather than collective bargaining coverage in the respondent's industry. On the other hand, the majority of findings in the US indicate that unionized workers receive higher compensating wage differentials than nonunion workers (see for example Fairres, 1989; Gegax et al., 1991; Moore and Viscusi, 1990; and Viscus, 1979).

An important part of our procedure is to model individuals' choice of job risk. Our samples are self-selected, that is, individuals choose those jobs whose levels of risk suit them. In particular, if safety is a normal good, people with high (unobserved) ability, say, will have high earnings; they will also choose low risk (see below). This effect will tend to bias downwards OLS estimates of compensating wage differentials. However, with a two-stage of least-squares approach, we replace the risk actually chosen by an individual—a choice influenced by unmeasured ability—with risk predicted on the basis of an equation, only including measured characteristics.

The selection process could also be different in the union and nonunion sectors. This is because the personnel office in unionized firms is under greater pressure to recognise and reward ability so as to offset higher union pay, with the result that unionized workers have more unmeasured ability than their nonunion counterparts, ceteris paribus. Correctly measured, therefore, we might expect to find larger compensating wage differentials for unionized workers, combined with the choice of less risk, ceteris paribus. Our preferred model, which utilizes separate equations for union and nonunion workers and makes risk endogenous, in fact follows that of Moore and Viscusi (1990). As will be seen, our results with the UK dataset replicate and broadly confirm theirs.

The arrangement of the article is as follows. Section 1 develops the models. We present our data and estimation results in section 2. We discuss our results and offer some conclusions in the last section.

1. The models

1.1. Endogeneity of risk

Most studies of compensating wage differentials have utilized a hedonic wage equation with risk as an exogenous variable. However, workers will sort themselves into different jobs according to their tastes and abilities. It is likely that job risk is an inferior good (for a model predicting this, see Thaler and Rosen, 1976, p. 276). In this case, people with high (unobserved) ability will have high earnings and will choose low risk. If ability were measurable this would be no problem, but, since it is not, an OLS estimator of the coefficient of risk in an earnings equation will be biased downward according to the omitted variable formula, if there is a negative partial correlation between ability and job risk (see Hwang et al., 1992).

Problems caused by the omitted ability variable can be best seen in figure 1. There, three clouds of observations have been drawn, corresponding to three ability groups. If job risk is an inferior good, the more able will demand greater compensation for given job risk; their wage locus will therefore tend to be steeper than that for the less able, as drawn. The more able will also tend to be employed in less risky jobs. This will have the effect of displacing the cloud of observations for the more able to the left, as shown. For simplicity we assume, following Hwang et al. (1992), that all the clouds are situated on the same expansion path, from the zero safety origin. This means that more able individuals spend a greater proportion of their full wage, K_2, on buying safety,[1] and accordingly move towards the zero risk of death point, as is consistent with the Thaler/Rosen theory. Neglecting to allow for ability will lead to a downward biased line being estimated, as shown by the dashed line in the figure.

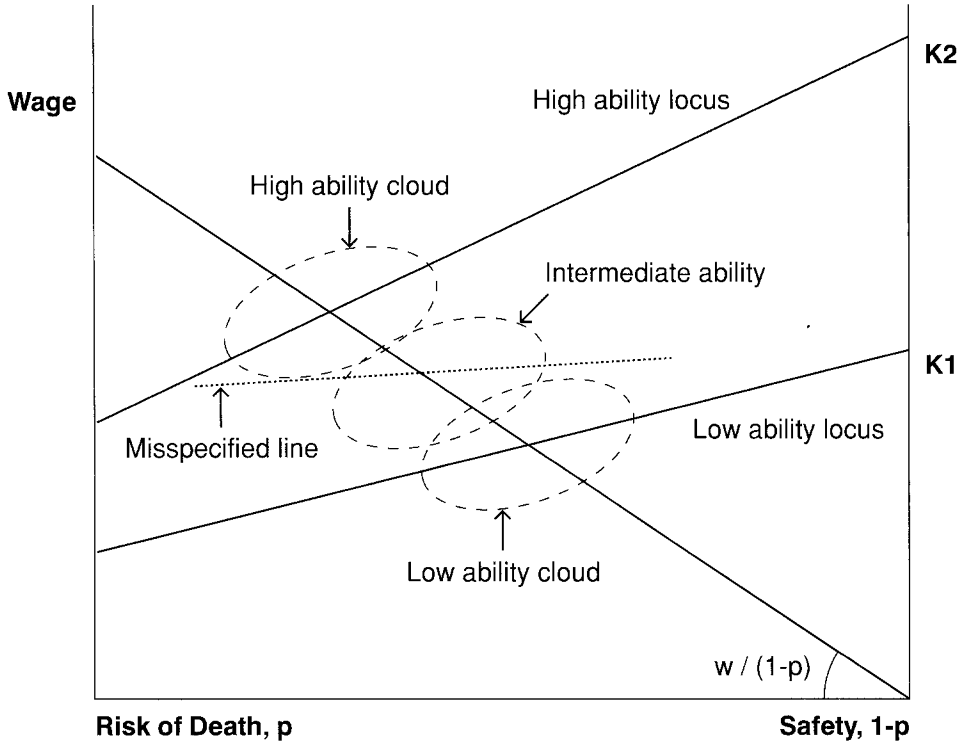

Figure 1. Effect of Omitting Ability.

To address such omitted variable bias an instrumental equation for job risk is required:

$$p = b_0 + b_1'x + b_2'z + \eta \qquad (1)$$

where p is job risk, x is a vector of variables determining job risk and also determining pay, z is a vector of variables determining risk but not pay, and η is a disturbance term.

An equation such as (1) also helps to instrument out measurement error in the risk variable (this is emphasised by Moore and Viscusi, 1990, p. 17). In practice therefore it is possible that changes in the risk coefficient when the instrumental equation is used have to do with measurement error rather than endogeneity due to unobserved ability. However, as will be seen, we obtain different results for the union and nonunion groups, with endogeneity of the risk variable having more impact for the union group. Since the same risk variable is used for both groups, we are inclined to think that equation (1) is doing more than simply instrument out measurement error, and is picking up the greater variation in unobserved ability of union workers.

The difficulty of course lies in finding appropriate z variables. Below we use, as is conventional, measures of nonlabor income such as the wife's socioeconomic grouping. Admittedly, to the extent that there is sortative mating, for example, the wealth of the wife will be correlated with the ability of the husband. However there need not be a high correlation, so our correction will lessen the bias. Moreover, the emphasis in the article is on comparison between union and nonunion workers, so we hope to detect the direction—if not the magnitude—of differences between the two groups.

In practice we will have two such equations, one for fatal, the other for serious workplace injuries. We use 2SLS, incorporating predicted p in the wage equation(s), since it can be shown (Garen, 1988) that where the choice variable, p, is continuous, 2SLS is analogous to the Heckman procedure used to correct for sample selection bias in simultaneous probit models, where the selectivity variable is binary. In the hedonic wage equation the coefficient of predicted risk will pick up the effect of omitted ability to a lesser extent than if OLS were used, and should therefore be less biased downwards. In practice this method depends upon the validity of our instruments, z, and so we perform sensitivity tests.

1.2. Endogeneity and union membership

Our dataset allows us to make the distinction between union and nonunion workers, and also between workers who are affected by collective bargaining (that is, who have a union for their type of work in their workplace) and those who are not. It might be thought that the latter distinction is more relevant, given the public goods nature of working conditions: if there is a union in the firm, and if there is collective bargaining or at least consultation, this will affect the working conditions of most workers in the firm, whatever their union status. In practice we attempt to make the distinction sharper, by comparing those who are both covered and union members, with those who are neither covered nor union members. We present these results alongside those based on the conventional union/non-union distinction.

Union and nonunion workers (or covered and non-covered workers) face different wage structures, estimation of which suffers from a selectivity bias due to workers' choice of union membership being nonrandom. We address this problem by using Heckman's correction based on the inverse Mills ratio $\lambda(t) = -f(t)/F(t)$, where f is the standard normal density function, F is the cumulated normal, and $t = \gamma' y$ is calculated from a probit function using the vector of variables, y, to explain union membership (or bargaining coverage).

Our wage equations therefore become:

$$\begin{aligned} \ln w_u &= \alpha_{01} + \alpha_{11}p + \alpha'_{21}x + k_1\lambda_1(t) + \epsilon_u \\ \ln w_n &= \alpha_{02} + \alpha_{12}p + \alpha'_{22}x + k_2\lambda_2(-t) + \epsilon_n \end{aligned} \quad (2)$$

where w_u, w_n are union and nonunion wages, ϵ_u, ϵ_n are corresponding error terms, k_1 is $\text{cov}(\epsilon_u, \nu)$ and k_2 is $\text{cov}(\epsilon_n, \nu)$, ν being the error term from the union membership equation. Our full model consists of equations (2), the risk equation (1), and the probit equation for union membership. We also present a model with the same structure, but based on the distinction between covered and noncovered workers.

In the following section, we first estimate wage equations such as (2), making the union selectivity correction (or coverage selectivity correction, as appropriate), but assuming risk to be exogenous. We then show the results of allowing risk to be endogenous, and discuss some sensitivity tests for our choice of x and z variables.

2. Data and estimation

The base dataset used here is the 1983 General Household Survey (GHS), which contains specific union membership and union coverage information for individual workers. (1983 is the only year in which the GHS collected data on union membership.) We merge these data with fatal (PFI) and nonfatal (PSI) accident rate data based on unpublished records supplied by the Health and Safety Executive (HSE).[2] The accident records relate to fatal and serious injuries (off work for more than three days) as reported by law to the HSE for the years 1986-88. We take the average number of accidents for the three-year period. Earlier accident data, contemporaneous with the 1983 GHS, were not available cross-classified by industry and occupation. Although the time gap between the individual and the accident information might introduce additional error into the risk variable, we do not think this is a serious problem, since accident rates, particularly fatalities, do not change quickly over time within given occupation-industry cells—hence the practice of averaging several years of data together to give a better representation of risks facing workers (see, for example, Moore and Viscusi, 1990, p. 73).

Although the data were classified by quite detailed occupation (99 groups following the special coding of the HSE) and also by industry (10 broad groups according to the

1980 Standard Industrial Classification (SIC)), we had to aggregate into 15 occupational groupings (using the 1980 version of Key Occupations for Statistical Purposes) in order to be compatible with our source of individual information, the 1983 GHS. With the cross-classification by industry, we thus have data on 150 occupation-industry cells (the procedure is thus similar to Dillingham, 1985). To obtain the number of employees in each industry—occupation cell, the denominator of the accident rate, we used cell numbers from the GHS. Since the GHS is the main UK nationally representative sample it gives the best estimate of the distribution of workers across industries and occupations. We then scaled the sample numbers up to national level using estimates of nationwide employment by industry. The resulting fatal accident risk variable has a mean of about 0.04 per 1000 full-time workers, as shown in table 1 below. This is somewhat lower than fatal accident risks evident in most US datasets, but is comparable to the BLS fatality rate of 0.05 per 1000 as used by Moore and Viscusi (1990, table 2.1).

These accident data should be quite accurate with regard to fatal injury rates, since the method of averaging over three years will help pick up rare events. The data are less satisfactory with respect to nonfatal injury rates, since serious accidents are lumped together with non-serious, and there are likely to be reporting and moral hazard problems associated with the less serious injuries. However we feel it is worthwhile reporting results using these data, so as to provide a benchmark for future research using different injury measures.

To reduce errors of measurement of risk facing individual workers, we restrict our samples to male manual (head of household) workers who work over 20 hours a week. The dependent variable used for our estimation is the logarithm of after tax weekly earnings (the 1983 GHS does not give an hourly wage rate).[3]

The other variables used in the initial specification of the wage equation are: age upon leaving full-time education; three dummies for the highest qualification attained (this improves the education measure); years of work experience and its square; months of tenure and its square; weekly overtime hours worked; number of dependent children; and dummies for whether a union member (or whether there is a union in the firm), married, whether a member of a firm's pension scheme, employment sector (Sect = 1 for the private sector), establishment size, and region (North, South, and Scotland/Wales). The means and standard deviations of these variables are given in table 1.

We first estimate wage functions by OLS, and then adjust for sample selectivity (see Greene, 1992, chapter 45) while treating job risk as exogenous. Two distinctions are made: between union and nonunion members, and between covered/union and noncovered/non-union workers. These results are reported in panels (A) and (B) of table 2. To save space we show only the risk and, where appropriate, the lambda coefficients. We also interact the risk variables with the education, experience, and tenure variables. These results are presented in panel (C) of table 2. (The probit selection equation is given in Appendix table 1.)

The results from the OLS union and nonunion wage functions in Panel A show that both groups receive significant positive wage compensation for fatal risk. However the figure appears considerably higher for nonunion workers (0.557) than union members (0.375). There is less of a difference for the nonfatal risk coefficient, though this is

Table 1. Means and SDs of the Main Variables*

Variables	Mean	SD	Meaning
log W (whole sample)	4.5412	0.3319	LOG NET WEEKLY EARNINGS
log W (union workers)	4.5712	0.2850	
log W (union and covered)	4.5737	0.2806	
log W (nonunion workers)	4.4835	0.4010	
log W (nonunion and uncovered)	4.4966	0.4342	
PFI (whole sample)	0.0379	0.0554	FATAL INJURY RATE (1/1,000 per year)
PFI (union workers)	0.0332	0.0495	
PFI (union and covered)	0.0331	0.0496	
PFI (nonunion workers)	0.0590	0.0738	
PFI (nonunion and uncovered)	0.0611	0.0759	
PSI (whole sample)	14.2459	10.0706	NON-FATAL INJURY RATE (1/1,000 per year)
PSI (union workers)	14.2477	9.9356	
PSI (union and covered)	14.2006	9.8574	
PSI (nonunion workers)	14.2761	10.5619	
PSI (nonunion and uncovered)	13.9102	10.4189	
Paidhrs (hours per week)	4.1892	6.4414	HOURS OVERTIME PER WEEK
Edlgag (years)	15.1270	1.9661	AGE LEFT SCHOOL
ED1	4.61%	0.2097	DUMMY IF THE HIGHEST QUALIFICATION IS FIRST DEGREE OR TEACHING OR HIGHER DEGREE
ED2	11.90%	0.3238	DUMMY IF THE HIGHEST QUALIFICATION IS NURSE OR GCE A LEVEL OR GCE O LEVEL.
Ed3	25.72%	0.4372	DUMMY IF THE HIGHEST QUALIFICATION IS ANY OTHER QUALIFICATION NOT IN ED2 AND ED3.
Expe (years)	27.1715	12.7692	YEARS OF WORK EXPERIENCE
Ten (months)	135.8518	120.6473	MONTHS IN PRESENT JOB
Dep	0.9796	1.0938	NUMBER OF CHILDREN UNDER 16 IN THE HOUSEHOLD
Unme	71.38%	0.4521	DUMMY IF UNION MEMBER
CB**	72.03%	0.4490	DUMMY IF UNION MEMBER COVERED BY COLLECTIVE BARGAINING
Married	91.10%	0.2848	DUMMY IF MARRIED
Pensyou	64.79%	0.4777	DUMMY IF BELONGING TO EMPLOYERS PRIVATE PENSION SCHEME
Sect	66%	0.4738	DUMMY FOR EMPLOYMENT SECTOR (1 = PRIVATE SECTOR)

Source: 1983 GHS and data from HSE.

*The estimation below also employs 4 firm size dummies, 3 regional dummies, 5 industry dummies, 10 regional and industry composition dummies, and 5 father's and wife's socioeconomic group dummies.

**This is the mean when we restrict our sample of workers to be either union members and covered by collective bargaining or nonunion members and not covered by collective bargaining.

Table 2. Coefficients on risk variables (risk exogenous)*

Dependent variable: log W (net weekly wage)				
(A) Model with union membership and risk exogenous				
Variables	Union	Nonunion	Union and covered	Nonunion and uncovered
PFI	0.3754 (2.350)	0.5568 (2.302)	0.3610 (2.265)	0.5231 (1.637)
PSI	0.0013 (1.598)	0.0023 (1.399)	0.0011 (1.372)	0.0028 (1.270)
(B) Model with union membership endogenous				
Variables	Union	Nonunion	Union and covered	Non-union uncovered
PFI	0.4716 (2.930)	0.7765 (3.090)	0.3781 (2.348)	0.7408 (2.245)
PSI	0.0011 (1.454)	0.0016 (0.993)	0.0011 (1.332)	0.0018 (0.787)
lambda	−0.0781 (2.905)	−0.1229 (3.169)	−0.0163 (0.594)	−0.1152 (2.387)
(C) Model with risk cross-products				
PFI	−4.3061 (1.307)	0.9061 (0.320)	−4.8805 (1.429)	1.6173 (0.464)
PFI × Edlgag	0.4121 (2.083)	0.1914 (1.311)	0.4229 (2.064)	0.1763 (1.023)
PFI × Ed1	1.3538 (1.087)	−1.5382 (0.860)	1.7061 (1.318)	−1.5906 (0.655)
PFI × Ed2	−0.2160 (0.288)	−0.3585 (0.504)	−0.1641 (0.212)	−0.9165 (1.015)
PFI × Ed3	−0.4947 (1.212)	−0.2332 (0.432)	−0.3899 (0.914)	0.1222 (0.171)
PFI × Expe	−0.0004 (0.021)	0.0083 (0.341)	0.0018 (0.082)	0.0078 (0.240)
PFI × Ten	−0.0030 (1.480)	−0.0088 (3.824)	−0.0024 (1.122)	−0.0118 (3.535)
PFI^2	−1.3566 (3.278)	−10.179 (2.277)	−1.350 (3.25)	−10.832 (1.878)
PSI cross-products	all insignificant	all insignificant	all insignificant	all insignificant
lambda	−0.1739 (4.050)	−0.1651 (2.750)	−0.0480 (1.088)	−0.1782 (2.282)
Sample size	1315	702	1292	514

*Numbers in the brackets are absolute values of *t*-statistics.
Note: other variables in equations are as in table 3.

insignificant for nonunion workers. The pattern is unchanged when we distinguish between covered and noncovered workers. Panel (B) gives the results after adjustment for sample selectivity. The difference between the PFI coefficient for union (or covered) workers and nonunion (noncovered) workers becomes even larger. Though none of these differences are significant at conventional levels, the difference in point estimates is notable.

The difference between union and nonunion workers becomes more marked when we take into account the very different fatal accident probabilities of the two groups. As can be seen from table 1, the fatal accident probabilities are 0.059 for nonunion workers versus 0.033 for union workers. (A large difference in accident probabilities remains even when an extensive set of controls are used; see the PFI equation in Appendix table 2.) The chance of a fatal accident thus raises pay by 4.6% (= .777 × .059) on average for nonunion workers, but by only 1.6% (= .472 × .033) for union workers. This difference is significant, yet it would appear to put nonunion firms at too much of a cost disadvantage to be an equilibrium.

Before considering specifications in which accident risk is endogenous, a simpler approach based on interacting PFI with personal characteristics is worth considering. These results are shown in panel (C) of table 2. If risk is an inferior good we would expect more educated (that is, wealthier) individuals to demand higher compensating wage differentials. There appear to be strong effects of this type in the union sector, as shown by the significant positive coefficient on PFI × Edlgag. Moreover, we would expect more tenured workers to have been selected over time to better match their jobs, and therefore to demand less compensation for risk. This should show up in a negative interaction between PFI and Ten. Table 2 shows that there do exist such negative interactions, at least outside the union sector (where tenure effects are likely to be weakened by standard wage rate policies).

We next reestimate the wage equation using instruments to predict the job risk variables. We present these results in table 3. Corresponding specifications and results for the union membership and risk equations are listed in the Appendix.

The initial instruments we use for the risk variable(s), that is, vector z in equation (1), are measures of people's nonlabor income and opportunity to take a risky job. The following variables are used for nonlabor income: the household's total family income excluding the head's earnings; whether the head owns a house or rents privately (the excluded category being rents from the state); the wife's years of schooling and her qualifications; and the wife's socioeconomic group. We also include the father's job category, since this might influence the son's tastes[4] (and training) with respect to job choice. On a similar argument we constructed regional industrial composition variables giving the percentage employed in the individual's area in each of 10 industrial categories; in addition we include 5 dummies for the individual's broad industry (we did not use 10 industry dummies since these would have been too closely related to the risk variables, which are partially classified by industry).[5]

It can be argued that some of these variables, for example the industry dummies, should enter the wage equation in their own right. One way of assessing this would be to see if these variables were significant in the wage equation. We do this later. For the moment consider the results of this specification, which are given in table 3.

Table 3 indicates that, once risk is made endogenous, the fatal risk premium for union members is higher, not lower, than that for nonunion workers. A similar, somewhat stronger effect is apparent when comparing covered with noncovered workers. Taking these latter groups, the covered workers' coefficient for fatal risk (PFI) more than doubles when compared with the table 2 specification (0.864), while that for noncovered workers remains more or less unchanged (0.652). The implication here is that the unmeasured ability term is more important for choice of risk among the group of covered workers.[6]

Table 3 also shows that the coefficient for nonfatal risk (PSI) becomes small and insignificant for union workers, though it increases in size for the nonunion groups, once we make nonfatal risk endogenous. The low coefficient for union workers is a puzzle, although most studies give a similar result, with nonfatal risk having inconsequential

Table 3. Coefficients of wage functions with risk endogenous*

Dependent variable: log W				
Variables	Union	Nonunion	Union and covered	Nonunion and uncovered
Constant	4.2756 (84.666)	4.0345 (47.212)	4.1976 (84.792)	3.9928 (38.741)
$\hat{PFI}$[a]	0.9075 (2.102)	0.7329 (1.467)	0.8644 (2.105)	0.6523 (1.162)
$\hat{PSI}$[b]	0.0001 (0.029)	0.0079 (2.066)	−0.0003 (0.193)	0.0089 (1.869)
Edlgag	0.0124 (2.678)	0.0100 (1.336)	0.0123 (2.680)	0.0121 (1.344)
Ed1	0.2386 (6.826)	0.1556 (1.956)	0.2271 (6.452)	0.1754 (1.733)
Ed2	0.0625 (2.704)	0.1064 (2.219)	0.0681 (2.951)	0.0995 (1.653)
Ed3	0.0267 (1.584)	0.0393 (1.081)	0.0279 (1.665)	0.0715 (1.546)
Ten	0.0004 (1.709)	0.0014 (3.034)	0.0004 (1.858)	0.0014 (2.356)
Ten^2	−0.0000004 (0.838)	−0.000003 (2.515)	−0.0000004 (0.877)	−0.000003 (2.283)
Expe	0.0068 (2.283)	0.0079 (1.317)	0.0071 (2.383)	0.0080 (1.063)
Expe2	−0.0001 (2.429)	−0.0002 (1.685)	−0.0001 (2.479)	−0.0002 (1.271)
Paidhrs	0.0141 (11.607)	0.0118 (3.745)	0.0145 (12.203)	0.0113 (2.894)
Married	0.0456 (1.748)	0.082 (1.415)	0.0493 (1.890)	0.0851 (1.209)
Dep	0.0082 (1.028)	0.0046 (0.281)	0.0100 (1.260)	0.0020 (0.097)
Pensyou	−0.0174 (0.553)	−0.0128 (0.206)	0.0276 (0.876)	−0.0188 (0.197)
Sect	0.0475 (3.014)	0.1561 (2.630)	0.0409 (2.583)	0.1728 (1.621)
lambda	−0.0774 (1.862)	−0.0966 (1.560)	0.0248 (0.581)	−0.0958 (1.216)
Firm size and Region Dummies	included	included	included	included
Sample size	1353	709	1292	514

*Numbers in the brackets are absolute values of t-statistics. Full results of equations are available on request.
[a]The estimated value of PFI from the risk equation.
[b]The estimated value of PSI from the risk equation.

effects on wages (see Veljanovski, 1982; Fairris, 1989; and Gegax et al., 1991). As noted above, we think the difficulty is that our nonfatal risk measure suffers from reporting error problems.

Our next step is to conduct a sensitivity test of the choice of z variables of equation (1). For this we allow the data to dictate, in a sense, which are the x and z variables. This is done by estimating a wage equation with all the variables in it, including the industry dummies (see Biddle and Zarkin, 1988, p. 663, for a similar procedure). Only variables which are significant at the 10% level or better are retained for use in the structural wage equations (2) (though we include the risk variables and the core human capital variables in any case). These are our x variables, and the rest are the z variables. The new specification is shown in table 4.

As can be seen from table 4, the new specification has a somewhat longer list of x variables than that of table 3, the set being slightly different for covered and non-covered groups. The coefficient for nonfatal risk tends to become negative and insignificant, which, while unsatisfactory, is probably to be expected given its fluctuating magnitudes in the other specifications. The coefficient on fatal risk in the new specification remains

Table 4. Coefficients of wage functions with risk endogenous—specification test*

Dependent variable: log *W*				
Variables	Union	Nonunion	Union and covered	Nonunion and uncovered
Constant	4.1445 (64.871)	4.2718 (44.105)	4.1101 (67.801)	4.2407 (34.969)
$\hat{PFI}$	0.8515 (1.215)	0.7709 (1.746)	0.5246 (0.904)	0.8158 (1.680)
$\hat{PSI}$	−0.0056 (0.782)	−0.0112 (1.734)	−0.0045 (0.695)	−0.0073 (0.772)
Edlgag	0.0080 (1.700)	0.0049 (0.725)	0.0082 (1.779)	0.0081 (1.005)
Ed1	0.2057 (6.013)	0.1650 (2.292)	0.1979 (5.794)	0.1963 (2.135)
Ed2	0.0396 (1.750)	0.0778 (1.792)	0.0415 (1.839)	0.0793 (1.457)
Ed3	0.0342 (2.075)	0.0342 (1.039)	0.0354 (2.141)	0.0735 (1.750)
Ten	0.0004 (1.917)	0.0014 (3.442)	0.0004 (1.752)	0.0014 (2.714)
Ten^2	−0.0000005 (1.081)	−0.000003 (2.720)	−0.0000004 (0.915)	−0.000003 (2.534)
Expe	0.0040 (1.408)	0.0100 (1.842)	0.0050 (1.772)	0.0091 (1.343)
Expe2	−0.0001 (1.602)	−0.0002 (2.375)	−0.0001 (1.887)	−0.0002 (1.610)
Paidhrs	0.0143 (12.546)	0.0113 (4.145)	0.0142 (12.643)	0.0113 (3.238)
Dep	0.0164 (2.133)		0.0178 (2.311)	
Sect	0.0388 (1.197)		0.0380 (1.297)	
Nlabinc	0.0002 (3.528)		0.0002 (3.141)	
Owner	0.0465 (3.062)	0.0959 (3.178)	0.0444 (2.986)	0.0882 (2.316)
Ncars	0.0584 (5.402)		0.0593 (5.574)	
Pseg3[a]		0.1403 (1.968)		0.1702 (1.948)
Wed2[b]		0.0742 (1.844)		0.1089 (2.175)
lambda	−0.0054 (0.196)	−0.0179 (0.508)	0.0302 (1.143)	−0.0326 (0.772)
Sample size	1353	709	1292	514

*Numbers in the brackets are absolute values of *t*-statistics

Note: Significant region, firm size, and industry dummies are also included in all equations.

[a]Dummy if father's socioeconomic group is non-manual worker.

[b]Dummy if wife's highest qualification corresponds to Ed2.

higher for union workers (0.851) than for nonunion (0.771). This interesting result survives therefore. However when the sample is split into covered and noncovered workers—and the approximately 200 workers who are covered but are nonunion are eliminated from the sample—the PFI coefficient for the covered group becomes lower (0.525) than that for the noncovered group (0.816). The contrast for covered and noncovered workers therefore seems sensitive to equation specification.

3. Discussion and conclusions

We have found that, in almost all specifications, there are significant compensating wage differentials for fatal accident risk for both unionized and nonunionized male manual worker groups. Not allowing for endogeneity of union membership, and of risk, seems to bias downwards the estimates of the compensating wage differential. This result is the same as that found by Moore and Viscusi using US data (1990, p. 118), and acts to confirm their approach. The bias is apparently greater for the unionized groups. Measurement of the downward bias is, however, sensitive to the choice of instruments. In fact the imprecision of our instrumental variables estimates is such that the Hausman test never supports the hypothesis of endogeneity, even though our point estimate of the coefficient on PFI for the unionized group more than doubles (from 0.375 to 0.908) when comparing OLS with instrumental variables estimates.

However, while our estimates cannot prove that unionized workers receive greater compensating wage differentials, the possibility that they do is supported by the fact that there are lower fatal injury rates in the unionized sector. As table 1 shows, the fatal injury rate for union workers on average is 0.033, compared to an average for nonunion workers of 0.059.[7] This implies that a competitive process is at work, since if one group of workers values safety more than another group, the sum of worker and firm surplus will be maximized by negotiating more safety for that group (assuming transactions costs are not prohibitive). The lower injury rates of unionized workers would then chime in with our indications that their marginal compensating differential is somewhat higher, once allowance has been made for their greater variation in ability.

It is interesting to assess the implications of our results for the statistical value of a life. The Thaler and Rosen formula is:

$$1000\bar{w}\ {}^{\partial w}/\partial p, \text{ where } \bar{w} \text{ is the mean value of earnings}$$

Taking a figure of 0.908 as the coefficient for PFI for unionized workers from table 3, and using average earnings (£94), gives a figure of about £4.4 million ($= 0.908 \times 94 \times 52 \times 1000$) in 1983 prices, or £8.8 million in 1990 prices. For nonunion workers the corresponding figure is about 20% lower (i.e., £3.6 million $= 0.733 \times 94 \times 52 \times 1000$). There is of course a considerable degree of uncertainty surrounding these estimates, but we do obtain similar high figures using other UK workplace fatality risk datasets.[8]

A question raised by our results is why endogeneity assumptions make more difference to estimates of compensating wage differentials for fatal risk for unionized/covered workers than to nonunion/uncovered workers. The result presumably hinges on differences in unmeasured heterogeneity, or what we have called unmeasured "ability," as between union and nonunion groups. As inspection of figure 1 reveals, the greater variation in ability in the union sector would show up as a bigger distance between the K1 and K2 lines in that sector.

The pattern of high and variable ability in the union sector and a low level of fatal injuries, coupled with the opposite amongst nonunion workers, implies a cost-minimizing adaptive process on the part of firms in response to union power. We can think of unionization as bringing with it a variable wage increase (dependent upon the situation of union and firm), which is then matched by appropriate efforts on the part of the personnel office to select more able workers and to match pay to effort. Unionized workers are on average more able, and more able workers require greater safety, so both sides benefit by negotiating safer working conditions. The safety representative is in a sense endogenous here. If he were not required by law, he would be established in the firm simply because this saves so much money. On the other hand, among nonunion workers, pay and ability is lower, the demand for safe jobs is lower (workers would rather have the money), and the two parties make different adaptive moves bringing about a greater level of accidents. Special policies are not required to protect the workers in nonunion plants, to recur to the point we raised at the outset, since the higher levels of nonunion accidents need not be due to worse communication or less "knowledge" in the non-union plant, but rather to worker and firm choices.

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Appendix

Table 1. Probit estimates of the union membership models*

	Dependent variable	
Variables	Unme	CB
Edlgag	−0.0178 (0.910)	−0.0313 (2.329)
Ed1	0.0353 (0.204)	0.0910 (0.431)
Ed2	0.0134 (0.121)	0.0191 (0.147)
Ed3	−0.0392 (0.476)	−0.0578 (0.604)
Expe	−0.0003 (0.022)	−0.0083 (0.567)
Expe2	−0.0001 (0.288)	0.0002 (0.656)
Ten	0.0015 (1.570)	0.0021 (1.808)
Ten^2	−0.000003 (1.135)	−0.000004 (1.467)
Paidhrs	0.0198 (3.341)	0.0174 (2.553)
Married	−0.1000 (0.810)	−0.0841 (0.607)
Dep	0.0264 (0.703)	0.0147 (0.331)
Pensyou	1.1610 (15.112)	1.3963 (15.614)
Sect	−0.1775 (1.730)	−0.2962 (2.445)
Firm size dummies	included	included
Region and industry dummies	included	included
Log likelihood for normal	−844.01	−607.66

*Numbers in brackets are absolute values of *t*-statistics.

Table 2. Estimates of the risk equations*

Variable	Dependent variable PFI (with Unme)	PSI (with Unme)	PFI (with CB)	PSI (with CB)
Constant	0.1037 (0.897)	27.529 (1.415)	0.0911 (0.755)	46.203 (2.255)
Edlgag	−0.1599 (2.485)	−0.2426 (2.240)	−0.0017 (2.517)	−0.2510 (2.255)
Ed1	−0.0070 (1.226)	−0.7315 (0.766)	−0.0046 (0.780)	−0.4299 (0.432)
Ed2	−0.0011 (0.317)	−0.7448 (1.222)	−0.0022 (0.580)	−0.8230 (1.306)
Ed3	−0.0007 (0.268)	0.2854 (0.639)	−0.0018 (0.676)	0.4493 (0.976)
Expe	−0.0007 (1.586)	−0.0679 (0.870)	−0.0002 (0.487)	−0.0327 (0.406)
Expe2	0.00001 (0.737)	0.0003 (0.238)	0.0000002 (0.030)	−0.0005 (0.366)
Ten	0.000005 (0.146)	−0.0009 (0.158)	0.0000007 (0.021)	0.0040 (0.715)
Ten^2	0.00000003 (0.364)	0.000006 (0.474)	0.00000001 (0.120)	−0.000002 (0.205)
Paidhrs	−0.0001 (0.260)	0.0037 (0.113)	0.00004 (0.210)	0.0103 (0.308)
Married	−0.0023 (0.455)	1.0911 (1.291)	−0.0022 (0.424)	1.1407 (1.310)
Dep	0.0015 (1.232)	−0.1925 (0.921)	0.0018 (1.394)	−0.3172 (1.464)
Pensyou	−0.0098 (3.207)	−0.7529 (1.463)	−0.0079 (2.467)	−0.5413 (0.991)
Sect	−0.0241 (7.981)	−4.7983 (9.451)	−0.0252 (8.219)	−4.3287 (8.331)
Unme	−0.0138 (4.364)	−0.4401 (0.829)		
CB			−0.0140 (3.793)	−0.0863 (0.138)
Nlabinc	−0.00001 (0.942)	−0.0011 (0.637)	−0.00001 (0.799)	−0.0028 (1.591)
Ownh	0.0016 (0.597)	0.4814 (1.088)	0.0015 (0.564)	0.1727 (0.381)
Privrent	0.0014 (0.212)	−0.3961 (0.359)	0.0126 (1.835)	0.2340 (0.201)
Ncars	0.0020 (1.101)	0.0786 (0.259)	0.0014 (0.773)	−0.0632 (0.203)
Nmoves	−0.0001 (0.794)	−0.0103 (0.603)	−0.0001 (1.392)	−0.0097 (0.548)
Wiflsch	−0.0002 (0.977)	−0.0456 (1.235)	−0.0005 (2.021)	−0.0390 (1.000)
Wed1	0.0114 (1.333)	1.5332 (1.062)	0.0128 (1.399)	1.1069 (0.716)
Wed2	−0.0034 (0.915)	−0.0177 (0.028)	−0.0029 (0.757)	−0.5035 (0.779)
Wed3	0.0032 (1.037)	−0.1442 (0.277)	0.0034 (1.089)	0.0746 (0.140)
Dummies for the wife's and father's socioeconomic group	included	included	included	included
Firm size and region dummies	included	included	included	included
Industry dummies	included	included	included	included
Sample size	2017	2017	1806	1806
Adjusted R^2	0.2959	0.2980	0.3259	0.3158

*Numbers in the brackets are absolute values of t-statistics.

Notes

1. Write the wage locus as $w = K - n(1 - p)$, where w = pecuniary wage, p = risk of death, K = full wage obtainable when $p = 1$, and n = price of safety. Then, if n rises with ability, along a linear expansion path w/K falls with ability.
2. We are grateful to Mr P. Thomas and Mrs K. Sloan of the Health and Safety Executive for providing these data.

3. We control for hours of paid overtime worked per week, but not for weekly hours worked, on the argument that the latter is endogenous. In fact, we find that models including the hours worked variable gave similar results for compensating wage differentials, presumably because our sample restrictions mean there is not much variation in hours.
4. As indicators of "lifestyle" were also included the number of cars in the household, and the number of moves the household has made in the last 5 years. These, however, were never important.
5. The aggregated groupings are as follows: 1 = SIC group 0 (agriculture), 2 = SIC groups 1 (energy and water supply) + 2 (extraction of minerals, and manufacture of metals, mineral products and chemicals), 3 = SIC group 3 (metal goods and vehicles) + 4 (other manufacturing) + 5 (construction), 4 = SIC groups 6 (distribution) + 8 (banking and finance) + 9 (other services, mainly government), 5 = SIC group 7 (transport and communication).
6. In a pooled equation (not shown) we also find a considerable increase in the coefficient on the fatal risk variable when risk is specified as endogenous. This result is similar to our findings when analyzing the 1973 General Household Survey (Siebert and Wei, 1992). It is also similar to the results of Biddle and Zarkin (1988).
7. This difference is reduced, but by no means eliminated, when we control for industry, area, firm size, and individual characteristics as shown in the risk equations in the appendix. In these equations the coefficient on Unme, or Cb, is approximately −0.01, indicating a 25% (= 0.01/0.038) lower probability of a fatal accident for unionized workers, ceteris paribus.
8. In 1990 prices, and taking the manual groups together, we obtain a figure of £5.3 million for the statistical value of a life using a 1972 occupational injury dataset (Siebert and Wei, 1992); research in progress using a 1990–92 industry level dataset gives a £9 million value (Wei and Siebert, 1993).

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