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Workers' Compensation: Wage Effects, Benefit Inadequacies, and the Value of Health Losses

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WORKERS' COMPENSATION: WAGE EFFECTS, BENEFIT INADEQUACIES, AND THE VALUE OF HEALTH LOSSES

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Abstract—Using the 1977 Quality of Employment Survey in conjunction with BLS risk series and state workers' compensation benefit formulas, the authors assess the labor market implications of workers' compensation. Higher levels of workers' compensation benefits reduce wage levels, and controlling for workers' compensation raises estimates of compensating differentials for risk. The rate of trade-off between wages and workers' compensation suggests that benefit levels provide suboptimal levels of income insurance, abstracting from moral hazard considerations. The value of nonmonetary losses from job injuries (including pain and suffering and nonwork disability) is estimated to be $17,000–$26,000.

I. Introduction

ALTHOUGH there has been a decade of literature on empirical estimates of compensating differentials for job hazards,[1] it is only recently that analysts have begun to focus on the role of the workers' compensation system in affecting these differentials.[2] From a conceptual standpoint one would expect workers' compensation to play a significant role since the employer can compensate workers for job risks either through ex ante compensation (compensating wage differentials) or ex post compensation (such as workers' compensation benefits). The relative importance of the two forms of compensation depends on the degree to which workers wish to insure the income risks of job injury—a value that hinges on factors such as the degree of wage loss and the effect of the accident on the marginal utility of consumption.

One could omit workers' compensation from wage equations if there were uniformity in the benefit levels. There are, however, substantial variations both by state and according to the worker's wage level. For example, the usual formula for temporary and permanent total disabilities provides for two-thirds wage replacement with a benefit cap, so that lower paid workers effectively receive more benefits. The principal state differences are with respect to features such as benefit caps, benefit floors, and time limits for benefit payment.

In view of this variation, one would expect the level of workers' compensation to play an important role in analyses of the compensation package. Although research results to date are somewhat mixed, they suggest evidence of two types of influences. First, workers are willing to trade off additional wage compensation for higher workers' compensation benefits. Second, inclusion of a workers' compensation variable raises estimates of the trade-off between wages and job risks.

Thus far there has been no link between empirical issues of this type and the more policy-oriented themes in the workers' compensation literature. A continuing perceived need that has been in the forefront of job safety policy since *The Report of the National Commission on State Workmens' Compensation Laws* (1972) has been determination of the adequacy of existing workers' compensation benefit levels.[3] Nominal workers' compensation earnings replacement rates have traditionally been below 1.0 except for very low income workers whose wages are exceeded by a benefits floor. (Replacement rates taking into account the benefits' favorable tax status are higher.) Whether partial compensation is optimal is, however, more difficult to ascertain. If a job injury lowers the

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[1] See, for example, the studies by Brown (1980), Duncan and Holmlund (1983), Olson (1981), Smith (1976), Thaler and Rosen (1976), and Viscusi (1978, 1983). Also see the reviews by Bailey (1980), Rosen (1985), Smith (1979), and Viscusi (1983). The literature began with Adam Smith (1776).

[2] Recent empirical work includes studies by Arnould and Nichols (1983), Butler (1983), and Dorsey and Walzer (1983). Also see the broader perspectives by Chelius (1977), Darling-Hammond and Kniesner (1980), Ehrenberg (1985), and Oi (1973) as well as the volumes edited by Worrall (1983) and by Worrall and Appel (1985).

[3] This theme of inadequate benefits has continued to be emphasized in the more recent work by the former Chairman of the National Commission on State Workmens' Compensation Laws, John Burton. See particularly Burton (1978).

worker's marginal utility of consumption for any given consumption level, as is often assumed in the health literature, then less than full compensation is desirable.[4] A worker would not choose to equalize income levels in the healthy and injured states if the injury impaired his ability to derive utility from the expenditures. How far below 1.0 the optimal replacement rate should be and whether current replacement rates are optimal remain open issues.

Obtaining a general sense of whether workers' compensation benefits are adequate is particularly important since this wage benefit component is not the result of a voluntary market transaction. States set the benefit floors for different classes of injury so that it is not possible to infer that actual benefits are necessarily efficient. Firms cannot reduce the benefit levels, and the transactions costs involved in setting up a separate program to augment existing benefit levels may discourage efforts to overcome the shortcomings that arise from inadequate benefits.

The purposes of this paper are threefold. First, the theoretical framework we develop enables us to assess the economic implications of the trade-off between wages and workers' compensation. We explore this trade-off using data from the 1977 Quality of Employment Survey coupled with information on industry risk levels and state workers' compensation benefits. Second, we refine the empirical estimates of the effect of workers' compensation on wage levels and on compensating differentials for job risks. Our analysis differs from previous studies in that the workers' compensation variable is worker-specific rather than a state benefit average, and it incorporates the favorable tax status afforded benefits. In addition, the diversity of the risk measures and the set of other nonpecuniary characteristics included is broader than in earlier studies. In particular, we include an individual-specific measure of job hazards in a number of our estimated equations.

As a final product of this research we generate the first implicit values of the nonpecuniary aspects of job injuries that have ever been obtained. This general area of concern, often referred to as the cost of pain and suffering and nonwork disability, has thus far not been amenable to estimation.

[4] See Viscusi (1979, 1980).

We develop the theoretical framework for the subsequent analysis in section II. Section III provides an overview of the data and the empirical framework, which can be viewed as a straightforward extension of the compensating differential approach. In section IV we report our empirical results and explore their implications.

II. Conceptual Framework

The focus of the empirical analysis is on the trade-off between wages and workers' compensation in the total compensation package for hazardous jobs. For much the same reason that we observe positive compensating wage differentials for job risks and other unpleasant job attributes, we should observe negative wage differentials for beneficial aspects of the overall compensation package, such as workers' compensation. The purpose of this section is not to reiterate this basic result, which is a direct generalization of the work of Adam Smith, but rather to investigate the properties of the trade-off between wages and workers' compensation. In particular, what is the efficient rate of substitution between these two compensation components? The expression we derive for this trade-off provides the benchmark in the subsequent empirical work for ascertaining whether workers' compensation levels are appropriate.

The formulation of the model, which entails very few restrictive assumptions, parallels the health state utility function approach of Viscusi (1978). Suppose that there are two possible health states. In state 1 the worker is healthy and experiences utility $U^1(x)$ from any given consumption level x. In state 2 the worker experiences a job injury and has utility $U^2(x)$. For any given level of consumption, the worker would rather be healthy than not ($U^1(x) > U^2(x) > 0$), has a greater marginal utility of consumption when healthy than when injured ($U_x^1(x) > U_x^2(x) > 0$), and has a diminishing marginal utility of consumption ($U_{xx}^1, U_{xx}^2 < 0$).

Let p denote the risk of an on-the-job injury, that is, the probability that state 2 prevails. Similarly, $1 - p$ is the probability that the worker remains healthy. Let w_1 be the wage the worker is paid when he is healthy and w_2 be the level of workers' compensation when the worker is injured. For simplicity all other income the worker receives when injured, such as social security benefits, is subsumed into the functional form of $U^2(x)$.

As Worrall and Butler (1985) document, such supplementary benefits are a significant source of income support. While the level of such benefits affects the welfare of workers, there is no loss in generality in excluding them from the analysis by incorporating them into $U^2(x)$, provided that the assumptions above are satisfied. Unlike workers' compensation, social security benefits are not merit rated to any degree so that there is no trade-off between wages and benefits within the particular job contract. The benefit value does, however, have an indirect effect by raising the level of $U^2(x)$ and possibly altering its shape. The analysis below addresses the worker's welfare net of any such influences. Viewed somewhat differently, it addresses the adequacy of workers' compensation benefits, given the existence of these other social insurance programs.[5]

To facilitate the conceptual analysis, assume all disabilities are temporary and total. Unlike earlier analyses of workers' compensation, this model and the subsequent empirical analysis explicitly recognize its favorable tax status. There is a proportional tax rate t on wages w_1. We assume that the role of assets in affecting consumption is subsumed in the functional form of the utility functions, so that consumption levels in states 1 and 2 are $(1-t)w_1$ and w_2.

The focus here is on the rate of substitution between wages and workers' compensation for a worker at a job with risk p. Analytically, the initial part of the development follows Diamond (1977) and Viscusi (1980). The worker's expected utility is given by

$$(1-p)U^1((1-t)w_1) + pU^2(w_2) = G. \quad (1)$$

The rate of trade-off between wages and workers' compensation that maintains the worker's level of welfare is

$$\frac{dw_1}{dw_2} = \frac{-\partial G/\partial w_2}{\partial G/\partial w_1} = \frac{-pU_x^2}{(1-p)(1-t)U_x^1}. \quad (2)$$

[5] This discussion addresses a homogeneous class of injuries. If social security benefits vary by injury severity, the net effect is to raise the level of $U^2(x)$ for these more heavily compensated injuries. The empirical analysis will address whether there is any remaining benefits gap, where in effect the higher social security benefits can be viewed as making classes of injuries less severe.

If the job risk p equals zero then dw_1/dw_2 also equals zero. The existence of a trade-off between wages and workers' compensation consequently hinges on the existence of some risk that state 2 will prevail.

In a situation in which the tax rate is zero and there is workers' compensation insurance available on an actuarially fair basis, from Viscusi (1979) we have the result that income will be allocated across the two states so that U_x^1 equals U_x^2. In this perfect markets case, equation (2) reduces to

$$\frac{dw_1}{dw_2} = \frac{-p}{1-p}.$$

For the workers in the sample considered below, and using the lost workday case injury rate as the value of p, this condition implies a trade-off of -0.04. In effect, workers will sacrifice 4 cents of compensation (i.e., wages, fringes, etc.) when healthy for an additional 1 dollar in compensation when injured (i.e., workers' compensation) if there are no taxes and if insurance is available on an actuarially fair basis.

The manner in which these relationships are altered under the existing compensation system can be ascertained by assuming that the government has structured the compensation system optimally. Observed deviations from these conditions can then be used to determine whether compensation levels are appropriate and, if not, how they differ from the optimal amount.

In addition to the presence of tax rates, actual social insurance schemes have associated administrative costs so that under standard loading procedures with imperfect markets the schemes are not actuarially fair. Suppose that the degree of insurance loading is such that for each dollar of expected compensation in state 2 the insured worker must sacrifice $1 + a$ dollars of compensation in state 1. Furthermore, the worker must break even on an actuarial basis given this degree of loading. The total limit on expected reimbursement, including the administrative costs of insurance, is the worker's marginal product, z. For a competitive firm, the marginal worker's marginal product equals his expected wages and workers' compensation benefits plus an additional fee, apw_2, to cover the administrative costs of all benefits received. The actuarial constraint is consequently

$$(1-p)w_1 + (1+a)pw_2 - z = 0. \quad (3)$$

The optimal insurance scheme is obtained by maximizing the worker's expected utility subject to equation (3), or

$$\max_{w_1, w_2, \lambda} V = (1-p)U^1((1-t)w_1) + pU^2(w_2) - \lambda[(1-p)w_1 + (1+a)pw_2 - z],$$

which yields

$$\lambda = (1-t)U_x^1 = U_x^2/(1+a),$$

or

$$U_x^2 = (1-t)(1+a)U_x^1.^6 \tag{4}$$

The presence of taxes and deviations from actuarially fair rates lead to optimal levels of insurance that do not equate the marginal utility of income in two health states unless $(1-t)(1+a)$ equals one. An appropriate combination of tax rates and insurance loading could produce this outcome. If $(1-t)(1+a)$ exceeds one, as when tax rates are low and the degree of insurance loading is high, then the optimal marginal utility of consumption in state 2 will be greater than in state 1. To produce this higher marginal utility in state 2 one must decrease the level of consumption in state 2. This result is expected since shifting resources to state 2 is more costly in the presence of taxes and actuarially unfair insurance rates, leading to a lower level of state 2 consumption and a higher associated marginal utility. Similarly, if $(1-t)(1+a)$ is below 1, U_x^1 will exceed U_x^2.

The principal issue considered here is how, given optimal workers' compensation benefit conditions as characterized by equation (4), the trade-off between compensation in the two states is affected. Substituting the value of U_x^2 from equation (4) into equation (2), we have

$$\frac{dw_1}{dw_2} = \frac{-p(1-t)(1+a)U_x^1}{(1-p)(1-t)U_x^1} = \frac{-p(1+a)}{1-p}. \tag{5}$$

With current levels of insurance loading, beneficiaries receive approximately 80 cents of each dollar of insurance premiums, according to calculations based on the net earned premium valuation method in Burton and Krueger (forthcoming).[7] The average value of dw_1/dw_2 for both the risk level in our sample and for the typical manufacturing worker will consequently be -0.05. Workers should be willing to trade off 5 cents of wages per additional dollar of workers' compensation benefits.

If the level of workers' compensation benefits is suboptimal, as a variety of observers have suggested, then the observed rate of trade-off should exceed 5 cents per dollar. Similarly, if benefit levels are excessive, then the observed trade-off of wages that workers are willing to sacrifice for more workers' compensation will be below this level. In the subsequent empirical analysis we ascertain how estimated rates of compensation substitution compare with the reference point provided by equation (5).

It should be noted, however, that these tests for optimality pertain only to the private valuation by the worker. The analysis does not address the role of his neglect of the external altruistic concern of society in his own welfare when making his job choice. If, however, benefits are found to be too low, consideration of these altruistic interests will simply reinforce the result.

A factor that works in the opposite direction is that of the adverse incentives or moral hazard problems associated with insurance. If workers' compensation leads workers to be less careful in avoiding accidents, then the efficient level of insurance will be lower. As a result, observing that insurance is inadequate from the standpoint of meeting workers' financial insurance needs might not necessarily imply that the outcome is inefficient if there is a significant moral hazard problem. Other causes of an observed excess of the estimated rate over our optimal rate include the option value of risky jobs (Viscusi, 1979) and the value of leisure during injury-induced layoffs.

III. Empirical Formulation and Sample Characteristics

The Data Base

The data used to estimate the model are drawn from the 1977 Quality of Employment Survey (QES) in which respondents were asked about

[6] This result is derived in Viscusi (1979), who also cites related formulations in the medical insurance literature. It should be noted that this result only pertains to earnings replacement. Medical expenditures that may enhance the chance of returning to good health are an entirely different issue.

[7] Although their paper focuses on 1983, similar calculations by Burton for other years suggest that the ratio of losses incurred to the net cost to policy holders has been in the 0.80 range in recent years.

their 1976 employment experiences.[8] The subsample that we examine contains 485 observations, consisting of non-farm heads of households who were not self-employed and who worked at least twenty hours a week in the year of the survey. The 1977 QES and its two antecedents (e.g., the 1969–70 Survey of Working Conditions) are unique in the variety of individual-specific information provided about working conditions. It is also possible to match objective measures of workplace hazards to sample members based on their industry and to assign workers' compensation benefit levels to workers based on their state of residence. Finally, unlike its earlier counterparts, the 1972–73 QES and the 1969–70 Survey of Working Conditions, the hourly wage can be calculated in the 1977 QES. Thus, estimates of compensating wage differentials are not confounded by hours effects.

The two central variables in this study are the job risk and workers' compensation variables. We capture the health and safety risks to which the worker is exposed in three different ways. First, the survey includes subjective, individual-specific responses to a series of questions concerning exposure to job hazards. If a worker cited any health and safety risks of his job, the binary *DANGER* variable assumes a value of 1. The remaining two risk variables are based on the U.S. Bureau of Labor Statistics (1979) data on industrial injuries and illnesses, which are matched to workers by three-digit industry code. These two variables are *RISKLW* and *RISKTR*, and they represent the rates of lost workday cases and total recorded cases of injury and illness per 100 workers, respectively. It has long been observed that each of these measures is potentially affected by errors-in-variables bias. The paper by Moore and Viscusi (1985) explores this problem, however, and finds no evidence of a statistically significant measurement error bias, or evidence of endogeneity of the risk variable.

The second variable of interest is the measure of workers' compensation benefits. The measure we constructed took into account not only the favorable tax status of workers' compensation benefits but also the manner in which the benefit formulas pertained to the particular individual rathei than to the average worker. This is especially important because benefit caps lead to a lower replacement rate for more affluent workers, while benefit floors can dramatically increase replacement rates for low wage workers. To appreciate the difference between replacement rates estimated for average workers and those used here, one need only consider the ranges of rates derived in both cases. If the replacement rate across states is analyzed for the average workers in the sample, one finds that it varies between about 40% and 105%, while at the individual level the replacement rate goes from 18% to as high as 200%. It is also noteworthy that the mean replacement rate across all individuals in the sample increases from 0.55 to 0.83 when taxes are considered.

The worker-specific replacement rates including recognition of tax factors differ from those in the literature in differing degrees. Dorsey and Walzer (1983) use an industry and state-specific rate based on insurance premiums that is then matched to workers using Census industry codes. Butler (1983) uses two measures, each at the industry level. The first is actual benefits paid for death, temporary total disability, and other injury categories that are included as regressors in a pooled time series–cross section regression of industry average wages on human capital, injury and death rates, actual benefits, and other variables. His second measure is the industry average replacement rate for each year, which corresponds more closely to expected benefits and is consequently better suited to the theoretical model. Arnould and Nichols (1983) use state gross replacement rates from the *Compendium on Workmen's Compensation* (Rosenblum,1973) matched to workers in the 1970 census 1/10,000 sample. Finally, Ruser (1985) uses an individual-specific measure similar to ours, but he does not include the effect of tax status on the replacement rate.

Each of these measures yields mixed results. Compensating differentials are often insignificant, and sometimes wrong-signed. Likewise, the workers' compensation effects are usually weak. Dorsey and Walzer, in fact, find a positive relationship between wages and workers' compensation in the union portion of their sample. This finding is not replicated by Ruser. Note also that insurance premiums should be positively related to accident rates and are less likely to reflect the negative effect of ex ante insurance on wages.

[8] There were major changes in the workers' compensation benefit formulas in the 1970s so that, to the extent that there is a lag in the wage adjustment, the full equilibrium effects of the revisions may not be apparent. The results consequently may understate the equilibrium wage response to higher benefits.

Each of the previous studies attempts to identify an additive effect of workers' compensation on wages, and in some instances an interactive effect with job risks as well. In the purely additive models, workers' compensation variables usually have the expected negative signs, and are sometimes significant. The addition of higher-order terms consistently results in a dilution of this result. The interactive effects are usually negative, but are seldom significantly different from zero.

This previous research, although suggestive, appears to suffer from two principal shortcomings. First, as shown in section II above, workers' compensation affects wages only at positive risk levels, thus making an interactive model theoretically appropriate. Second, most of the aforementioned studies measure individual insurance levels with substantial error.

The replacement rate variable to be used in the subsequent analysis—*WORKCOMP*—is similar to that used by Topel (1984) to measure unemployment insurance benefits. Unfortunately, there is no single benefits measure that is ideal. States have often complex benefit formulas that provide for lump sum benefits and benefits depending on the duration of the disability. The waiting periods for these benefits may vary, and there are differences in the benefit structure according to the degree and type of disability, or whether a fatality was involved.

The approach we adopted was to base our benefits variable on the benefit formulas for temporary total disability by state.[9] This benefit category accounts for three-fourths of all claims and one-fifth of all cash benefits.[10] The formulas for permanent total disability are almost identical, except that the duration of these benefits is greater. Similarly, the large claims category of permanent partial disability benefits is positively correlated with temporary total disability.[11] Ideally, one might wish to obtain actuarial valuation of expected benefit levels by state, but such calculations are a substantial research task for which we did not have access to the pertinent data. Because of the positive correlation among benefit categories, we will use the temporary total benefit formulas as a proxy for state differences in workers' compensation benefit levels.

Where it was appropriate to do so, we adjusted the benefit levels using information on the survey respondents' marital status and number of dependents, and entered the resulting benefit figure as the numerator in the replacement ratio R_i:

$$R_i = \frac{b_i}{w_i(1 - t_i)}.$$

Since benefits are not taxed, the tax rate does not appear in the numerator of the expression for R_i. The denominator in R_i is the after-tax wage, $w_i(1 - t_i)$, where w_i is the weekly wage and t_i the marginal tax rate. We used the earnings, hours, and weeks worked information in the QES to calculate a wage variable. In computing the tax rate, we assume that all workers took the standard deduction, with the number of exemptions based on the reported number of dependents.[12]

Unlike previous measures of workers' compensation replacement rates, the value of R_i is individual-specific and includes the effects of taxes. As a result, it more closely measures the actual rate workers use in making their decisions. As noted by Topel for the analogous unemployment compensation situation, observable determinants of w_i and t_i render R_i endogenous. To correct for this endogeneity, we regress R_i on a vector of characteristics (Z_i) and state dummy variables.[13] The variable *WORKCOMP*, which is the predicted value of R_i, serves as the exogenous measure of the replacement ratio.

A detailed list of variable definitions appears in table 1, and table 2 summarizes the means and standard deviations. The dependent variable in the subsequent analysis is the worker's hourly wage (*WAGE*) or its natural logarithm. Each equation also includes a set of variables pertaining

[9] U.S. Chamber of Commerce (1976).

[10] See Price (1984).

[11] These correlations are reported in unpublished work by John Burton and Alan Krueger. Using a sample of 31 states, Burton and Krueger have found that the logarithm of temporary total disability benefits has a correlation coefficient of 0.58 with the logarithm of permanent total disability benefits, 0.64 with the logarithm of fatality benefits, and 0.38 with permanent partial benefits. Their research effort takes into account benefit maximums, minimums, replacement rates, and durations. In contrast, our measure abstracts from duration but is otherwise an accurate measure of both temporary total disability and permanent total disability.

[12] Tax rates are from Commerce Clearing House, Inc. (1976a, b).

[13] The variables Z_i include the number of dependents, a marital status dummy variable, and all exogenous variables in the wage equation.

TABLE 1.—VARIABLE DEFINITIONS

WAGE	Computed hourly after-tax wage measure.
FEMALE	Sex dummy variable (d.v.): 1 if female, 0 otherwise.
BLACK	Race d.v.: 1 if worker is black, 0 otherwise.
HEALTH	Severity of health limitation d.v.: 1 if limiting physical or nervous condition has created either sizable or great problems in working on or in getting jobs, 0 otherwise.
EXPER	Experience variable: Years worked for pay since age 16.
*EDLT*12	Education d.v.: 1 if worker did not finish high school, 0 otherwise.
*EDEQ*12	Education d.v.: 1 if worker finished high school, 0 otherwise.
EDSC	Education d.v.: 1 if worker has some college education, 0 otherwise.
EDCP	Education d.v.: 1 if worker has at least a college degree, 0 otherwise.
MTAX	Marginal tax rate.
DANGER	Hazardous working conditions d.v.: 1 if worker answered "yes" to "does your job at any time expose you to what you feel are physical dangers or unhealthy conditions," 0 otherwise.
RISKLW	BLS industry hazard variable: annual rate of injuries and illnesses involving lost workdays.
RISKTR	BLS industry hazard variable: total annual rate of injuries and illnesses.
WORKCOMP	Workers' compensation replacement rate: Benefit level/($WAGE(1 - MTAX)$).
FAST	Work pace d.v.: 1 if job requires worker to work very fast a lot, 0 otherwise.
NODEC	Absence of worker decisions on job d.v.: 1 if it is not at all true that the worker makes a lot of decisions on the job, 0 otherwise.
OVERT	Overtime work d.v.: 1 if worker works overtime often, 0 otherwise.
SECURE	Job security d.v.: 1 if it is very true that the worker's job security is good: 0 otherwise.
SIZE	Firm size: Midpoints assigned to intervals for number of workers at the firm (hundreds of workers).
SUPER	Super d.v.: 1 if worker supervises anyone as part of his job, 0 otherwise.
TRAIN	Training program d.v.: 1 if employer makes available a training program to improve worker skills, 0 otherwise.
UNION	Union status d.v.: 1 if worker belongs to a union or employee's association, 0 otherwise.
NEAST	Northeast region d.v.: 1 if worker lives in northeastern United States, 0 otherwise.
SOUTH	Southern region d.v.: 1 if worker lives in southeastern U.S., 0 otherwise.
NCENT	North Central region d.v.: 1 if worker lives in north central U.S., 0 otherwise.
WEST	Western region d.v.: 1 if worker lives in western U.S., 0 otherwise.
URBAN	Urban area d.v.: 1 if worker lives in a major SMSA, 0 otherwise.
PROF	Professional and technical d.v.: 1 if worker reports occupation as professional or technical, 0 otherwise.
MGR	Manager and administrator d.v.: 1 if worker reports occupation as manager or administrator, 0 otherwise.
SALES	Sales d.v.: 1 if worker reports occupation as sales, 0 otherwise.
CLERK	Clerical d.v.: 1 if worker reports occupation as clerical, 0 otherwise.
CRAFT	Craftsmen and foremen d.v.: 1 if worker reports occupation as craftsman or foreman, 0 otherwise.
OPER	Operative d.v.: 1 if worker reports occupation as non-transport operative, 0 otherwise.
TRANS	Transport operative d.v.: 1 if worker reports occupation as transport equipment operative, 0 otherwise.
UNSK	Unskilled d.v.: 1 if worker reports occupation as unskilled laborer, 0 otherwise.
SERVE	Service d.v.: 1 if worker reports occupation as private household services, 0 otherwise.

to the worker's personal characteristics, such as the worker's sex (*FEMALE* dummy variable—d.v.), race (*BLACK* d.v.), presence of health impairments (*HEALTH* d.v.), years of work experience since the age of 16 (*EXPER*), and whether the worker has less than 12 years of schooling (*EDLT*12 d.v.), exactly 12 years (*EDEQ*12 d.v), some college (*EDSC* d.v.), or has completed at least a college degree (*EDCP* d.v.).

Pertinent job characteristics include the worker's marginal tax rate (*MTAX*), which was used in constructing the *WORKCOMP* variable, the subjective risk assessment variable (*DANGER* d.v.), the lost workday accident rate (*RISKLW*), the total recorded injury and illness rate (*RISKTR*), the predicted value of the workers' compensation replacement rate (*WORKCOMP*), whether the job requires the worker to work fast (*FAST* d.v.), whether the job permits the worker to make decisions (*NODEC* d.v), whether the worker works overtime often (*OVERT* d.v.), whether the worker has good job security (*SECURE* d.v.), the number of employees at the workplace (*SIZE*), whether the worker is a supervisor (*SUPER* d.v.), whether the employer offers a training program (*TRAIN* d.v.), and whether the worker is a union member (*UNION* d.v.). Occupation dummy variables (*PROF*, *MGR*, *SALES*, *CLERK*, *CRAFT*, *OPER*, *TRANS*, *UNSK*, *SERVE*) were entered to control for unobservable occupation-specific characteristics. The particular set of nonpecuniary rewards variables that was selected closely followed the group utilized in the earnings equations for the earlier Survey of Working Conditions results reported in Viscusi (1978).

Finally, we included a set of regional dummy variables for whether the respondent lived in the Northeast (*NEAST* d.v.), in the South (*SOUTH*

TABLE 2.—SAMPLE MEANS AND STANDARD DEVIATIONS ($N = 485$)

Variable	Means	Standard Deviation
WAGE	7.676	3.779
FEMALE	0.162	0.369
BLACK	0.068	0.252
HEALTH	0.029	0.167
EXPER	20.901	12.078
*EDLT*12	0.191	0.393
*EDEQ*12	0.351	0.477
EDSC	0.226	0.419
EDCP	0.232	0.423
MTAX	0.264	0.095
DANGER	0.798	0.402
RISKLW	3.810	2.418
RISKTR	9.738	5.627
WORKCOMP	0.835	0.315
FAST	0.162	0.369
NODEC	0.016	0.127
OVERT	0.347	0.477
SECURE	0.427	0.495
SIZE	6.698	10.265
SUPER	0.351	0.478
TRAIN	0.511	0.500
UNION	0.341	0.474
NEAST	0.200	0.400
SOUTH	0.284	0.451
NCENT	0.337	0.473
WEST	0.179	0.384
URBAN	0.259	0.438
PROF	0.216	0.412
MGR	0.136	0.343
SALES	0.047	0.212
CLERK	0.092	0.290
CRAFT	0.219	0.414
OPER	0.127	0.334
TRANS	0.062	0.241
UNSK	0.046	0.209
SERVE	0.055	0.229

d.v.), in the North Central (*NCENT* d.v.), in the West (*WEST* d.v.), and in an urban area (*URBAN* d.v.). Detailed industry and occupation responses for each worker also made it possible to create pertinent job-related dummy variables and to merge the BLS risk data with the sample information at the three-digit industry level.[14] Overall, the sample was broadly representative of the working population.

The wage equations differ in three ways. First, the functional form of the dependent variable, which is theoretically arbitrary, is either *WAGE* or ln *WAGE*. The second distinction among the regressions is in the nature of the job hazard measure. As described above, there are three of these, *DANGER*, *RISKLW*, and *RISKTR*. Third, the manner in which the *WORKCOMP* variable enters varies, partly for purposes of comparison with previous research. We first omit *WORKCOMP* from the regressions, then enter it separately to provide a comparison with earlier research. Finally, the theoretically preferable interaction of *WORKCOMP* with the *RISK* variables is included. Not reported below are results from regressions in which the *WORKCOMP* variable is entered both interactively and additively. The additive term was never significant in any of these, while the interactive term performed well.

For example, the three ln *WAGE* equations for person i using $RISKLW_i$ as the hazard measure are[15]

$$\ln WAGE_i = \sum_k \beta_k X_{ik} + \gamma RISKLW_i + \epsilon_i, \quad (6)$$

$$\ln WAGE_i = \sum_k \beta_k X_{ik} + \gamma RISKLW_i + \mu WORKCOMP_i + \epsilon_i \quad (7)$$

and

$$\ln WAGE_i = \sum_k \beta_k X_{ik} + \gamma RISKLW_i + \delta RISKLW_i \times WORKCOMP_i + \epsilon_i. \quad (8)$$

Equation (6) corresponds to the usual hedonic wage regression that fails to account for insurance. Equation (7) is similar to those estimated by several other investigators. In Arnould and Nichols (1983), inclusion of the workers' compensation variable boosted the value of the risk coefficient by 12% and was associated with a statistically significant wage reduction, as expected. These modest effects may stem in part from their use of the death risk as a proxy for compensable job-related injuries, which is likely to be a less pertinent measure than the lost workday risk. Dorsey and Walzer (1983) adopted a similar formulation using BLS injury rate data and found a substantial positive effect on the job risk premium for nonunion workers and a negative effect for union workers.[16] Another approach that has appeared in papers by Ruser

[14] In only a few cases was it necessary to use two-digit risk measures.

[15] The variables X_{ik} are *EXPER*, $EXPER^2$, *FEMALE*, *BLACK*, *HEALTH*, *UNION*, education dummy variables, *FAST*, *NODEC*, *SECURE*, *SUPER*, *OVERT*, *TRAIN*, *SIZE*, *URBAN*, and region and occupation dummy variables.

[16] In our exploratory runs to be reported in a future study on unions we found an effect of workers' compensation for both union and nonunion subsamples of the QES.

(1985) and Butler (1983) is to include both a separate workers' compensation variable and one that has been interacted with the risk level, but their results are usually not statistically significant or have the wrong signs. It is worth noting that all previous research has omitted other workplace characteristics, a potential source of bias. Moreover, the individual-specific hazard variable *DANGER* has heretofore not been used in a study including workers' compensation.

IV. Compensating Differential Estimates

The focus of our empirical analysis is on a series of equations including different combinations of risk and workers' compensation variables. The basic structure of the wage equation is, however, unchanged. In table 3 we report detailed estimates for a representative ln *WAGE* equation with the *RISKLW* variable and the interaction of this risk variable with *WORKCOMP*. This specification is the most important, since it is the lost workday accident rate and its interaction with the workers' compensation variable that best reflect the impact of the workers' compensation system.

Overall, the equation and its *WAGE* equation counterpart perform in the expected manner. There is a positive but diminishing effect of work experience on earnings. Workers in the college-educated group tend to earn more income, as do union members. Moreover, the performance of the explanatory variables such as union status is quite robust with respect to specification of the risk variables.

The focus of the analysis is on the various risk and workers' compensation measures. Results for the different combinations of risk and compensation variables utilized appear in table 4. In each case we first included a risk variable by itself, then with the interaction with the workers' compensation variable, and finally with a workers' compensation variable not interacted with the risk. Although we estimated eighteen equations in all, the principal patterns of influence were common across all of these variants. In 10 of 12 cases, inclusion of the workers' compensation variable boosted the statistical significance of the risk variable alone. Inclusion of workers' compensation (not interacted with job risk) had little effect on the risk variable coefficient. This was not the case for the interactive regressions 2, 5, and 8. Finally, the workers' compensation variable was con-

TABLE 3.—ESTIMATES OF ln *WAGE* EQUATIONS (*t*-ratios in parentheses)[a]

Independent Variable	Coefficient (*t*-ratio)
FEMALE	−0.230 (−4.545)
BLACK	−0.124 (−1.834)
HEALTH	−0.210 (−2.156)
EXPER	0.031 (5.576)
EXPERSQ	−0.001 (−4.773)
*EDLT*12	−0.098 (−2.028)
EDSC	−0.018 (−0.394)
EDCP	0.185 (3.314)
RISKLW	0.041 (2.946)
RISKLW × *WORKCOMP*	−0.031 (−2.079)
FAST	−0.068 (−1.549)
NODEC	0.140 (1.092)
OVERT	−0.042 (−1.208)
SECURE	0.085 (2.564)
SIZE	0.007 (3.931)
SUPER	0.069 (1.761)
TRAIN	0.049 (1.353)
UNION	0.160 (4.218)
NCENT	0.036 (0.761)
SOUTH	−0.013 (−0.275)
WEST	0.142 (2.614)
URBAN	0.182 (4.599)
PROF	0.210 (2.132)
MGR	0.236 (2.375)
SALES	0.201 (1.780)
CLERK	0.028 (0.283)
CRAFT	0.096 (1.073)
OPER	0.008 (0.094)
TRANS	0.005 (−0.052)
SERVE	−0.290 (−2.704)
$\bar{R}^2$	0.477

[a] Critical *t*-values are 1.64 (5% confidence level), and 1.96 (1% level) for one-tailed tests.

TABLE 4.—SUMMARY OF RISK AND WORKERS' COMPENSATION COEFFICIENTS (t-ratios in parentheses)[a]

Independent Variable	Equation Number								
	1	2	3	4	5	6	7	8	9
WAGE Equations									
RISKLW	0.099	0.282	0.101	—	—	—	—	—	—
	(1.528)	(2.319)	(1.599)						
RISKTR	—	—	—	0.037	0.113	0.038	—	—	—
				(1.310)	(2.249)	(1.353)			
DANGER	—	—	—	—	—	—	0.270	1.057	0.252
							(0.715)	(1.659)	(0.660)
RISKLW × *WORKCOMP*	—	−0.230	—	—	—	—	—	—	—
		(1.777)							
RISKTR × *WORKCOMP*	—	—	—	—	−0.096	—	—	—	—
					(−1.828)				
DANGER × *WORKCOMP*	—	—	—	—	—	—	—	−0.999	—
								(−1.534)	
WORKCOMP	—	—	−0.606	—	—	−0.610	—	—	−0.560
			(−1.075)			(−1.083)			(−0.993)
$\bar{R}^2$	0.374	0.374	0.372	0.373	0.411	0.371	0.372	0.371	0.369
ln *WAGE* Equations									
RISKLW	0.017	0.041	0.017	—	—	—	—	—	—
	(2.214)	(2.946)	(2.256)						
RISKTR	—	—	—	0.007	0.018	0.007			
				(2.017)	(2.945)	(2.064)			
DANGER	—	—	—	—	—	—	0.029	0.148	0.026
							(0.651)	(2.008)	(0.596)
RISKLW × *WORKCOMP*	—	−0.031	—	—	—	—	—	—	—
		(−2.079)							
RISKTR × *WORKCOMP*	—	—	—	—	−0.012	—	—	—	—
					(−2.188)				
DANGER × *WORKCOMP*	—	—	—	—	—	—	—	−0.153	—
								(−2.013)	
WORKCOMP	—	—	−0.080	—	—	−0.081	—	—	−0.074
			(−1.225)			(−1.241)			(−1.212)
$\bar{R}^2$	0.479	0.477	0.474	0.478	0.477	0.473	0.474	0.472	0.469

[a] Critical t-values are 1.65 (5% confidence level) and 1.96 (1% level) for one-tailed tests.

sistently negative and statistically significant in the interacted version.

The Implicit Value of Job Injuries

Although addition of the interactive *WORKCOMP* variable greatly boosts the coefficient on the job risk variable, after taking into account the role of both the risk and the interaction term there is not a large difference in the implicit value of job injuries when evaluated at current workers' compensation levels. The implicit value of a lost workday accident remains at $43,000 for the ln *WAGE* equation and rises from $32,000 to $36,000 for the *WAGE* equation upon inclusion of the interaction term.[17] Each of these is consistent with past estimates of the implicit value of injuries, as found in Viscusi (1979, 1983).

[17] All estimates are in 1984 dollars.

These estimates, however, do not take into account the depressing influence that workers' compensation has on the level of risk premiums. If workers' compensation benefits dropped to zero, the required wage premium would rise substantially because of the income risks workers would face. One measure of this increase is the increased implicit value of a job injury, which would rise to $96,000 for the wage equation and to $112,000 for its log wage counterpart. Similarly, full earnings replacement would lead to implicit values of injuries of $17,000 for the wage equation and $26,000 for the semilogarithmic form.

Although extrapolations of this nature are not as reliable as are estimates pertaining to current levels of compensation, the overall spirit of the results is clear. If there were no program providing earnings replacement to injured workers, the level of risk premiums would increase greatly. The reduction in risk premiums from additional increases in workers' compensation is much more modest.

The results for the full compensation case are of interest in their own right since they isolate the earnings risk from the health status risk associated with job injuries. The findings here imply that at least half of current implicit valuations of injuries represent implicit values of the nonmonetary aspects of injuries. In effect, the $17,000 and $26,000 estimates presented above represent the value of the nonmonetary health losses associated with accidents.

These results are the first estimates of nonpecuniary health impacts that have ever been obtained. These valuations pertain both to the value of pain and suffering and the more general welfare losses from what Burton (1983) has termed "nonwork disability." To the extent that analysts wish to place a value on these nonmonetary considerations for policy evaluation or in a judicial proceeding, these empirical estimates provide a beginning for the process of trying to assess these amounts, which in the past have been based entirely on speculation. At current compensation levels, about half of the compensation for injuries is for nonpecuniary consequences. If, however, there were no income replacement program, the relative importance of the health aspects would be far less.

Are Benefits Levels Optimal?

The fundamental and more immediate policy concern to which this paper is addressed is whether there is an adequate level of earnings replacement under the workers' compensation system. The results most pertinent to an assessment of the rate of substitution between wages and workers' compensation are in column 2 of table 4, which includes both *RISKLW* and the interaction of this variable with *WORKCOMP*. The lost workday accident rate is the risk variable that most closely corresponds to the probability of receiving workers' compensation benefits for temporary total disability or permanent total disability. Similarly, *WORKCOMP* is the appropriate measure of insurance.

The interaction term approach to assessing the role of workers' compensation is preferable because the expected value of workers' compensation coverage hinges on the risk level. Workers in completely safe jobs receive no benefits from the existence of such a compensation scheme. The expected benefits are the products of the risk level and benefits level, where in this case we use the replacement rate as the benefit variable. The interaction variable appears in columns 2, 5, and 8 of table 4.

The rate of substitution between wages and workers' compensation implied by these equations is quite substantial. Based on the empirical results, one can calculate how changes in the benefit formula affect the wage level. For both the *WAGE* and ln *WAGE* equations an additional 1 dollar in workers' compensation benefits leads to a 12 cent reduction in wages. In each case, the rate of substitution is more than twice the 5 cent per dollar trade-off one would expect given current rates of insurance loading and injury rates. Moreover, the 4 cent per dollar trade-off that would be optimal with actuarially fair insurance is even further below the observed trade-off rates.

Not only is there substitution between wages and worker's compensation, but workers are willing to sacrifice more wages when healthy than would be dictated by the added insurance costs. Taken at face value, these results imply that existing levels of workers' compensation benefits are suboptimal from the standpoint of insuring income levels. Such underprovision of benefits may nevertheless be efficient if moral hazard is an important concern. Recent evidence in Butler and Worrall (1983) suggests that the elasticity of injuries with respect to the level of benefits may be substantial. Their finding of a strong interstate correlation of workers' compensation benefits and reported injury rates is suggestive, but it has never been resolved whether this result is a reporting phenomenon or a reflection of an actual difference in injury rates.

Several other implications of the results are also noteworthy. First, we have calculated the benefit levels necessary to provide full insurance to equate the marginal utility when healthy and when injured and found that an increase of $111 from the weekly average of $266 would achieve this result. Second, and finally, it is not possible to calculate the benefit level necessary to reach the desired wage trade-off of 5 cents per dollar of benefits. This requires information on preferences, which is not available from hedonic wage equations such as we have estimated here.

V. Conclusion

The workers' compensation variable proved to be of fundamental importance in analyzing the structure of job risk compensation for workers in the Quality of Employment Survey. Higher levels of workers' compensation lead to a reduction in the base wage level that workers are paid. In addition, the size of the estimated risk-wage tradeoff is enhanced by inclusion of a workers' compensation variable, thus strengthening findings in the compensating differential literature. Overall, the strongest results were those for which the workers' compensation variable interacted with the job risk measure, as should be expected.

Two of the implications of the results extend to concerns of a much broader nature. First, the observed rate at which workers are willing to trade off base wage rates for higher levels of workers' compensation greatly exceeds the actuarial rate of trade-off, even taking into account administrative costs. These results suggest that benefit levels in 1976 were suboptimal, provided that one abstracts from moral hazard considerations.

Finally, the results suggest that a large portion of compensating differentials for job hazards is for the nonmonetary aspects of the potential loss. However, if there were no workers' compensation system the role of income losses would predominate. The estimate that job hazards have an associated health impact of $17,000 to $26,000 is the first estimate of the role of the nonmonetary costs of job risks. In this case it is clear that welfare implications of job risks extend well beyond their financial implications.

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