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Alternative Approaches to Valuing the Health Impacts of Accidents: Liability Law and Prospective Evaluations

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ALTERNATIVE APPROACHES TO VALUING THE HEALTH IMPACTS OF ACCIDENTS: LIABILITY LAW AND PROSPECTIVE EVALUATIONS*

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I

INTRODUCTION

The task of valuing accidental injuries and deaths is intrinsically difficult for two reasons. First, unlike standard consumer commodities, individual health is not traded explicitly on the market. It may be traded implicitly as with wage premiums for risky jobs, but these implicit prices must be estimated statistically. The second problem is that the value one places on any economic commodity depends on the welfare one can derive from it. Since adverse health effects influence the welfare one can obtain from any given level of income, the value of one's health status depends on the context in which such values are calculated. In particular, is one attempting to ascertain the amount a person would pay to prevent the loss of health, the amount he would like to be compensated under an insurance policy if he suffered such a decline in health, or the amount of compensation he would need after an adverse health effect to restore his level of welfare? The answer to each of these questions is quite different.

Since the manner in which the health value issue is posed plays a pivotal role in its determination, Section II addresses both the methodological underpinnings of valuing health impacts and the legal principles underlying accident compensation. Sections III and IV analyze the empirical evidence regarding prospective valuations of health risk prevention and *ex post* compensation for accidents. These health value estimates are quite different. Whether or not the observed disparities are inappropriate is unclear, but both the manner in which compensation issues should be structured and some empirical techniques for assessing the appropriate compensation levels can be reliably indicated.

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II

PRINCIPLES UNDERLYING COMPENSATION

A. Why Pay Compensation?

The rationale for compensating accident victims is much more complex than a simple desire to transfer income to individuals in financial need. If that were the objective, broadly based social insurance programs could be relied on to meet the income needs of all individuals requiring assistance. Accident compensation serves the dual role of making payments to those who are injured and imposing costs on the party responsible for the injury. The principal form of government-sponsored accident compensation, workers' compensation, which is merit rated for relatively large enterprises, also serves these dual roles.

Several economic objectives of accident compensation can be distinguished. First, the compensation system should induce efficient self-selection of participants in accident-generating activities. If compensation is overly generous, high-risk employees may accept hazardous jobs, for example, whereas ideally relatively safe employees should be matched to these positions. Similar concerns arise with respect to other accident participants, whether they be drivers of automobiles or producers of hazardous products. To provide incentives for individuals to engage in potentially risky endeavors on an efficient basis, the accident compensation system should induce people to engage in these hazardous activities either because they are relatively safe participants in such activities or because they have some other relative economic advantage in these pursuits.[1]

Once individuals choose the activities in which they would like to participate, the second objective of the compensation system should be to provide incentives for them to exercise care. It is this objective that has been the focus of most economic analyses of accidents.[2] The overall task is that of minimizing the total expected costs associated with accidents and accident prevention. In the case of product-related accidents, for example, the producer should have an incentive to produce safe products, and consumers should have incentives to use them safely.

These concerns are not, however, absolute. Added safety in the production of goods is only desirable if the value of improved safety exceeds the cost of such quality improvements. If the accident costs are comparatively low or if consumers can prevent accidents easily by increasing the caution with which they use products, increased safety attributes in products would not be warranted. Compensation systems should provide incentives for participants to exercise efficient degrees of care. By imposing a financial cost on the injurer, compensation increases the injurer's incentive to prevent accidents, but by compensating the victim, the compensation decreases the prospective accident victim's incentives to prevent acci-

1. More generally, the efficiency objective with regard to participation in accident-generating processes is to maximize the net surplus to society, that is, the benefits from accident-related activities less their expected accident costs.

2. *See generally,* G. CALABRESI, THE COSTS OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS (1970); Diamond, *Accident Law and Resources Allocation,* 5 BELL J. ECON. MGMT. SCI. 366 (1974); Shavell, *On Liability and Insurance,* 13 BELL J. ECON. MGMT. SCI. 120 (1982); Shavell, *Strict Liability vs. Negligence,* 9 J. LEGAL STUD. 1 (1980).

dents. When these adverse incentives problems are particularly severe, their influence can be limited by making compensation dependent on the degree of care exercised by the accident victim.

In situations of market-traded risks, such as unsafe jobs or unsafe products, market forces alone may generate efficient degrees of care.[3] If workers are fully cognizant of the risks they face and consumers are aware of all product-related risks, these incentives will be generated through market forces in terms of higher wages for risky jobs and lower prices for hazardous products. When risk perceptions are not accurate, compensation may serve a productive role in establishing efficient incentives for safety.[4] The safety incentive objective of compensation, consequently, is only relevant if the risks do not result from a voluntary market transaction, as in the case of automobile accidents, or if there are inadequacies in the markets in which the risks are traded.

A third objective of the accident compensation system is to serve an insurance function in situations in which individuals are risk-averse. Such insurance by its very nature must be *ex post,* that is, only individuals injured in accidents will be compensated. In contrast, much accident compensation transmitted through market forces is *ex ante*. Wage premiums for hazardous jobs and lower prices for risky products affect individuals irrespective of whether or not they are injured.

In principle, such *ex ante* compensation could be replaced through a system of insurance payments. However, if individuals underestimate their risk of injury, it will not be in a firm's financial self-interest to offer insurance since workers will undervalue this insurance compared to its actuarial cost. The cost of operating such insurance arrangements may also be quite high relative to the possible benefits. If accidents with a manufacturer's products were rewarded according to a predetermined payment schedule, the company would face a large number of claims, many of which might be suspect. Was the consumer using the product at the time of the accident? Did the product contribute to the accident? Did the consumer use the product in a safe manner? Since resolution of these issues will usually involve some third-party determination of the answers to such questions, the judicial system will ultimately be involved in many instances whether or not there is a formal insurance program. The rationale for insurance consequently may diminish to the extent that tort law promotes the same objectives.

Court-determined accident compensation serves this insurance function by transferring resources to the injured party. With fully efficient risk spreading, all accident-related income losses will be averted except in those cases where the accident lowers the benefit the injured party derives from additional resources, as in the case of a fatal accident. Although it is usually appropriate to assume that the victim is more risk-averse than the party responsible for the accident, particularly when the injurer is a large firm, this assumption is not always appropriate. If an

3. For a discussion of the conditions under which this result will occur, see W.K. VISCUSI, RISK BY CHOICE: REGULATING HEALTH AND SAFETY IN THE WORKPLACE 38-42 (1983).

4. For an analysis of the job safety situation, see *id.* at 87-92. For a discussion of the product safety case, see Spence, *Consumer Misconceptions, Product Failure and Producer Liability,* 44 REV. ECON. STUD. 561 (1977).

indigent driver's car hits a limousine, transferring resources from the less affluent driver to the more affluent driver will not serve an insurance function on balance since the poor driver will value the risk of being forced to pay compensation more than the affluent driver values the chance of being compensated. In such situations, compensation may be desirable, but not because it promotes insurance.

A final possible objective of compensation is to promote redistribution of wealth. Most matters of equity and fairness are already subsumed into the previously discussed objectives. If the accident victim is paid sufficient compensation to induce the party causing the accident to exercise an efficient degree of care, there will already be a substantial transfer of resources. Although one could advocate the use of accident compensation to promote society's broader social welfare concerns, these matters can be handled more effectively with existing government transfer programs.

The legal requirements for receiving accident compensation reflect concerns which are not too dissimilar from economic efficiency considerations. For concreteness, I will focus primarily on the criteria applied in products liability cases. Although these criteria are not structured in the same manner as economic objectives, they are not necessarily incompatible with them.

Under one theory of products liability, a seller of a defective product "is liable for negligence in the manufacture or sale of any product which may reasonably be expected to be capable of inflicting substantial harm if it is defective."[5] The legal standard of negligence hinges on both the accident losses and the costs of preventing the accident. More specifically, under the formula defined by Judge Learned Hand,[6] the defendant is guilty of negligence if his cost of preventing the accident is less than the expected accident costs (that is, probability of an accident multiplied by the size of the loss).[7] This criterion prevents some inefficient accident prevention since large prevention expenses need not be incurred to avoid small accident losses.

The Hand formula does not ensure that the defendant will not be burdened with the task of accident prevention in situations in which the victim could have prevented the accident at lower cost. However, these situations are addressed by the doctrine of contributory negligence under which the victim is barred from recovery unless he has exercised the care of a "reasonable man." In states in which there is a comparative negligence standard, the accident compensation is adjusted to take into account the victim's relative contribution to the accident. These legal principles establish incentives for accident prevention not unlike those that would be advocated on the basis of economic principles.

Accident compensation also may be awarded on the basis of a breach of warranty.[8] Generally, there is an implied assurance of safety whenever goods are offered for sale, although in some cases, express representations may have been made regarding the product's safety. Because of attempts to disavow such warran-

5. W. PROSSER, LAW OF TORTS 643 (4th ed. 1971).
6. United States v. Carroll Towing Co., 159 F.2d 169, 173 (2d Cir. 1947).
7. R. POSNER, ECONOMIC ANALYSIS OF LAW 122-25 (2d ed. 1977).
8. W. PROSSER, *supra* note 5, at 650-56.

ties (for example statements that the product is not warranted) and ambiguities raised by implied warranties, a strict liability criterion has also evolved whereby the seller is subject to absolute liability for physical harm from products not free of hazardous defects.[9] Although the strict liability rule places a much greater burden on the seller than does the negligence principle, both approaches can potentially lead to economically efficient accident compensation.[10] The primary difference is that the distribution of resources is different, with accident victims benefiting more often from a strict liability rule than a negligence rule.

An extreme variant on the strict liability approach is that taken under the workers' compensation system. Employers are responsible for accident costs irrespective of whether or not they created unreasonably dangerous conditions or whether the worker's action was the sole contributing cause of the accident.[11] Such increased coverage should be accompanied by reduced benefits, which is a bias borne out by actual payment levels.

B. The Form of Compensation

The manner in which individuals are compensated for accidents varies both in terms of the timing of the payments and the type of compensation. In the case of market-traded risks that individuals believe they face, the compensation is *ex ante.* If there are wage premiums for hazardous jobs or lower prices for risky products, these premiums represent financial gains to all individuals potentially exposed to the risk, not simply compensation of individuals who are injured. If people are fully cognizant of the risks they face, this compensation will be sufficient to make them indifferent to whether or not they must incur the risk.[12]

Accident compensation may also be *ex post.* Judicial awards for accident victims are inherently *ex post,* and market-provided insurance for workers in hazardous jobs serves a similar function. If individuals are risk-neutral and if the accident does not affect the welfare benefits they can derive from income (as with one's death), they will be indifferent between whether they are compensated before the accident or after the fact. So long as the certain *ex ante* premium is the same as the expected payment in the event of an accident (that is, the probability of an accident multiplied by the size of the award), the form of the payment is not consequential.

The costs of arranging for compensation may be quite different. Making payments only to accident victims, rather than providing *ex ante* compensation eliminates the task of identifying all individuals who incurred the risk. This factor is particularly important in the case of judicially determined awards. Moreover, if accident victims seeking payments from injurers could only sue to obtain the value

9. *Id.* at 656-58.

10. *See* Shavell, *supra* note 2. These results are based on very strong and restrictive assumptions, including: all parties are risk-neutral; all parties accurately assess accident probabilities; and there are no legal costs, delays, or uncertainties in obtaining a liability settlement.

11. Small firms for which merit rating is weak do not bear these accident costs, however, since their premiums are based on an industry-wide average.

12. Strict indifference applies only to the marginal individual. Some inframarginal consumers and workers may be compensated by more than is needed to make them willing to bear the risk.

of the *ex ante* compensation that would have made them indifferent to incurring the risk, their incentives to incur the legal fees required in such cases would be diminished. As a consequence, there would be relatively few awards for accident losses, and these would be comparatively small. The net effect would be that the product liability award would be so modest that they would not provide effective incentives for safety.

A final advantage of *ex post* compensation is that it serves an insurance function which risk-averse individuals will value. If such insurance could be purchased in the market on an actuarially fair basis, legally provided *ex post* compensation would yield no additional insurance benefit, and people would simply purchase the insurance directly. Such opportunities are limited both by problems of adverse selection (only the bad risks would join) and adverse incentives (the insurance award may alter the incentive to have an accident). If a textile mill worker were able to purchase insurance that paid him $1 million if he developed brown lung disease, his incentive to take care (for example, decrease his cigarette consumption which affects the lung capacity loss associated with cotton dust exposures) would be diminished.

A potential shortcoming of all forms of *ex post* compensation is that to make such awards on a meaningful basis one must be able to monitor the outcome. Was the product use related to the accident? Was the product defective in any way? Did the accident victim exercise reasonable care? These matters raise many practical difficulties for common accident situations such as automobile accidents, but may pose insurmountable problems for illnesses, such as cancer, that have long gestation periods and multiple causes.

Finally, the form of payment may vary in terms of the nature of the compensation. Although *ex ante* compensation is financial (higher wages and lower product costs), as is much *ex post* compensation, in some instances compensation is in the form of services. Medical care and rehabilitative services are chief among these. Since individuals would never prefer services to equivalent cash compensation that they could spend as they wished, the reason the compensation takes this form must derive from some potential advantage which this mode of compensation offers. Individuals not in need of care will place a relatively low value on such services. As a result, providing services rather than cash compensation may serve an informational role by distinguishing the existence and severity of ailments.

C. Choosing the Level of Compensation

The level of compensation will be determined by market forces in the case of market-traded risks. This discussion will focus on the job safety case. The product safety analysis is quite similar. Before discussing the particular level of compensation, some notation must be introduced. Let p be the probability of an accident, and $w(p)$ represent the schedule of annual earnings for jobs posing a risk p. The derivative of the wage schedule, dw/dp, is the rate of change in annual earnings with respect to an increase in the risk. In this situation, dw/dp for the job the worker selects represents the implicit value of the accident. This magnitude in

turn hinges on worker attitudes toward risk.[13] If p represents the fatal accident probability, dw/dp represents the implicit value of life. For situations in which p represents the nonfatal accident probability, dw/dp represents the implicit value of an injury.

This implicit value terminology is somewhat misleading since dw/dp does not represent the amount the worker would require to accept certain death or injury. Rather, it reflects the worker's rate of trade-off between risk and dollars for very small risks. A worker who values his life at $1 million will require $100 to accept a one in 10,000 chance of death, but for very large risks, such as those involving certain death, he would require much more than $1 million.[14] Suppose, however, that there is a group of 10,000 individuals with identical attitudes toward risk-money trade-offs. If one of these people will be killed, then overall these individuals would accept one certain, but randomly inflicted, death if they were compensated $100 each.

Nonmarket compensation concepts pose fewer problems of interpretation, but require the use of some additional notation. Let Y^1 represent the individual's total income if he is not involved in an accident, and let Y^2 represent his income if he is involved in an accident. If the accident imposes a financial loss, the size of this loss is equal to $Y^1 - Y^2$.

Irrespective of whether there is any financial loss, the accident may affect the individual's welfare through an impact on his health. Let $U^1(x)$ represent his utility from consumption x (equal to his income Y^1) when he is healthy, and let $U^2(x)$ represent his utility from consumption x (equal to his income Y^2) after the accident. If there is no adverse health effect, $U^1(x)$ and $U^2(x)$ are identical for any constant consumption level x. If there is an adverse health impact (possibly death), $U^1(x) > U^2(x)$. The individual would rather be healthy than not. Moreover, for any given level of consumption, it is usually assumed that the marginal utility of consumption is greater when the consumer is healthy, $U^1_x > U^2_x$.[15] Although this assumption is more speculative, it seems quite reasonable for disabling ailments and for fatalities, in which case U^2 becomes the bequest function.

Finally, let Z denote the actual compensation paid after an injury. The level of Z that should be chosen depends in large part on what one is trying to accomplish. If the compensation is intended to serve a punitive function, to deter intentional torts or criminal acts, it will be much higher than if its role is purely

13. More specifically, let Y^0 represent initial assets, x represent consumption (equal to $Y^0 + w(p)$), U^1 represent utility when healthy, and U^2 represent utility when injured or dead, where $U^1(x) > U^2(x)$; $U^1_x > U^2_x$ and $U^1_{xx}, U^2_{xx} \leq 0$. Then one can show that

$$\frac{dw}{dp} = \frac{U^1 - U^2}{(1-p)U^1_x + pU^2_x} = \frac{\textit{Difference in Welfare when Healthy or Injured}}{\textit{Expected Marginal Utility of Compensation}}$$

14. The source of this difference is the role of wealth effects. If, for example, a worker were compensated for successive increases in the risk, he would become richer as the risk increased for preferences of the type usually assumed. *See* W.K. VISCUSI, *supra* note 3, at 45-53.

15. It is also assumed that the consumer is not risk-loving. *See supra* note 13.

compensatory. The focus of this discussion will be restricted to nonpunitive settlements.

The first compensation concept is to provide sufficient compensation Z to restore the accident victim to his pre-accident level of welfare, so that

$$U^2 (Y^2 + Z) = U^1 (Y^1).$$

If the accident losses are purely financial,

(1) $$Z = Y^1 - Y^2.$$

When there is some additional adverse health effect, the cost of making the accident victim whole is some

$$Z > Y^1 - Y^2.$$

Although this principle has some appeal, it will generally lead to inefficiently large levels of compensation. If an individual is killed and U^2 represents his bequest, how much must his bequest be increased to make him indifferent between living and dying? This sum presumably will be huge, particularly if he has no heirs. Serious disabilities and illnesses would also command substantial compensation.

There is also a practical difficulty in determining the compensation needed to restore the individual to his pre-accident welfare level. In particular, what are the shapes of U^1 and U^2? These values are not unrelated to the implicit value of life obtained from estimates of risk premiums for market-traded risks,[16] but thus far no empirical tests have been devised to assess these values. Interview studies could potentially play a useful role, but individual responses to interviews are often not an accurate reflection of individual preferences. Accident victims certainly could not be asked since they would have an incentive to overstate their welfare loss.

These difficulties can be avoided by focusing on a more restrictive compensation concept whereby accident victims are compensated only for financial losses. (See equation 1.) The principal components of this loss are foregone wages and medical expenses. These magnitudes are comparatively easy to monitor, but they clearly provide too little compensation. Consider two situations in which there is a $20,000 financial loss. In one case there is no health impact, while in the other the accident victim is permanently disfigured. To provide for equal financial compensation in these cases is not efficient from an economic standpoint since it is desirable to establish a compensation mechanism that will create greater incentives to avoid accidents that impose more severe losses in welfare. Additionally, while ascertaining the size of the financial loss is often simpler than valuing pain and suffering, if these losses are not immediate, one must estimate the future earnings path with and without the accident to determine the present value of the drop in individual income. Section III will present illustrative estimates of this type.

A final accident concept is the level of compensation individuals would contract for *ex ante* if they could purchase insurance on an actuarially fair basis. This economic insurance approach yields a Z level such that the marginal utility of income is equalized in the accident and no-accident states, or

(2) $$U_x^1 (Y^1) = U_x^2 (Y^2 + Z).$$

16. *See id.*

If there are no adverse health effects and all losses are financial, this measure is tantamount to compensation for the monetary accident costs.

If there are adverse health effects, the marginal utility of income in the accident state will be lower for any given income level. For equation 2 to hold, $Y^2 + Z$ must be less than Y^1. Thus, the accident victim is not compensated by the amount that would restore his pre-accident welfare level since the incremental value of income is assumed to be lower in the post-accident state. The extent of the undercompensation cannot be determined without detailed information about individual preferences. By viewing compensation as a form of insurance that the accident victim would have liked to have purchased, the most that can be concluded is that full compensation to restore his level of welfare is not desirable.

The financial measure of health losses from accidents is most frequently used in determining compensation for wrongful death, perhaps in part because of its computational simplicity. The two most meaningful economic measures are quite different. The value of *ex ante* compensation represents the amount the individual would need to be paid to incur the risk of accident. This measure, in turn, can be used to establish an implicit value of life or injury. An alternative approach is to assess the compensation value individuals would place on the accident if they could insure themselves on an actuarially fair basis.

The difference in temporal perspective between the two measures is of substantive import because the value placed on financial compensation may be affected by the accident. Two conflicting influences are present. First, the desired compensation will be reduced if the marginal effect of income on welfare is lowered by the accident. One's death is an extreme case of such an event since the value of income to a healthy individual will exceed the benefit he receives from a bequest after his death. Second, if the accident reduces one's financial resources or greatly increases the value of out-of-pocket medical expenditures, the desirability of compensation will be enhanced. Although the net effect of these influences cannot be ascertained in general, by taking these factors into account one can at least establish appropriate criteria for compensation.

III

LABOR MARKET EVIDENCE

A. Implicit Value of Life

The principal focus of economic analyses of the value of life has been on *ex ante* values. Although there have been some early studies of life insurance payment levels,[17] these numbers did not reflect how much an individual valued his health, only how much he would choose to leave his heirs. Particularly when one is considering policy evaluations of programs that will prevent accidents, one is primarily interested in the *ex ante* valuations. For purposes of setting compensation levels, however, the choice of the value-of-life measure is less clear cut.

Although one could establish valuations of health by asking individuals what

17. Eisner and Strotz, *Flight Insurance and the Theory of Choice,* 69 J. POL. ECON. 355 (1961).

their risk-money trade-offs are, this interview approach has not proved particularly successful.[18] The principal difficulty is that interviews may not elicit accurate responses because respondents have no incentive to give thoughtful or honest answers.

As a result, the emphasis has been on analyzing the implicit trade-offs revealed in actual decisions. Each time we undertake a potentially hazardous act, we reveal information about the underlying risk-money trade-offs guiding our decision. Although evidence from any type of economic decision could potentially be instructive, primary attention has focused on the labor market, since we have the most extensive data for job risks and compensation for these hazards.

Since the time of Adam Smith, economists have observed that workers will demand a wage premium to incur additional perceived risks.[19] Although such wage-risk trade-offs should be expected, there is no reason to assume that they should be specified in labor market contracts, and they seldom are. Few contracts have explicit hazard pay provisions, since job hazards usually enter the wage determination process by affecting the rating assigned to a particular job, which in turn affects the wage rate.

To identify the premiums for risk one must rely on a statistical analysis of labor market outcomes isolating the risk-money trade-off and holding constant other factors that affect income. The standard approach is to specify an earnings equation where the worker's income depends on his personal characteristics, the nature of his job, work experience, job risk, and similar factors. More specifically, let w be annual earnings, x_i be a series of explanatory variables, p be the annual death risk, and q be the annual nonfatal injury risk. The coefficient γ_0 of p represents the implicit value of life ($\delta w/\delta p$, which is the analog of dw/dp for the case where there are multiple determinants of w), and γ_1 represents the implicit value of a nonfatal injury.[20] α is a constant term and the β_i's are coefficients that reflect the influence of explanatory variables x_i on earnings (for example, the impact of education on income). Then the general form of the earnings equation is

$$w = \alpha + \sum_{i=1}^{m} \beta_i x_i + \gamma_0 p + \gamma_1 q + u,$$

where u is a random error term.

A comprehensive model of this type would include the following explanatory variables: income-related personal characteristics (age, race, sex, marital status,

18. For an early interview study, see J. ACTON, EVALUATING PUBLIC PROGRAMS TO SAVE LIVES: THE CASE OF HEART ATTACKS (1973). For a critique of the interview approach, see W.K. VISCUSI, *supra* note 3, at 97.

19. The contribution of ADAM SMITH, WEALTH OF NATIONS (1937) has given rise to a series of recent analyses, including R. SMITH, THE OCCUPATIONAL SAFETY AND HEALTH ACT (1976); W.K. VISCUSI, EMPLOYMENT HAZARDS: AN INVESTIGATION OF LABOR MARKET PERFORMANCE (1979); Oi, *On the Economics of Industrial Safety,* 38 LAW & CONTEMP. PROBS. 669 (1974); Oi, *The Economics of Product Safety,* 4 BELL J. ECON. & MGMT. SCI. 3 (1973); and Thaler & Rosen, *The Value of Saving a Life: Evidence from the Labor Market,* in HOUSEHOLD PRODUCTION AND CONSUMPTION 265 (N. Terleckyj ed. 1975).

20. In some cases, the semilogarithmic form of the regression equation is estimated, that is, the natural logarithm of w is the dependent variable.

TABLE 1

SUMMARY OF LABOR MARKET STUDIES OF WAGE-RISK TRADEOFFS*

Investigator	Sample	Implicit Value of Life	Implicit Value of Nonfatal Injuries
Brown[a]	National Longitudinal Survey, 1967-1973	$1-$1.5 million	-
Leigh[b]	Panel Study of Income Dynamics, 1974	$3.8-$8.9 million**	$45,000-$56,000
	Quality of Employment Survey, 1977	$4.8-$8.4 million**	$38,000-$64,000
Marin & Psacharopoulos[c]	U.K. data, 1975	$1.8 million	-
Olson[d]	Current Population Survey, 1973	$7.4 million	-
Smith[e]	Current Population Survey, 1967	$7.5 million	-
	Current Population Survey, 1973	$3.3 million	-
Thaler & Rosen[f]	Survey of Economic Opportunity, 1967	$580,000	-
Viscusi[g]	Survey of Working Conditions, 1970-71	$2.9-$3.9 million	$23,000-$34,000
Viscusi[h]	Panel Study of Income Dynamics, 1976	$7-$11 million**	$32,000-$35,000

* All prices are in 1982 dollars.

** The results for the Leigh and Viscusi studies are evaluated at the mean risk level for the sample for models in which the heterogeneity in wage-risk trade offs was assessed.

Sources: a. Brown, *Equalizing Differences in the Labor Market,* 94 Q.J. ECON. 113 (1980).

b. Leigh, *Estimates of the Value of Accident Avoidance at the Job Depend on the Concavity of the Equalizing Differences Curve* to be published in Q. REV. ECON. BUS.

c. Marin & Psacharopoulos, *The Reward for Risk in the Labor Market: Evidence from the United Kingdom and a Reconciliation with Other Studies,* 90 J. POL. ECON. 827 (1982).

d. Olson, *An Analysis of Wage Differentials Received by Workers on Dangerous Jobs,* 16 J. HUM. RESOURCES 167 (1981).

e. R. SMITH, THE OCCUPATIONAL SAFETY AND HEALTH ACT (1976).

f. Thaler & Rosen, *The Value of Saving a Life: Evidence from the Labor Market,* in HOUSEHOLD PRODUCTION AND CONSUMPTION 265 (N. Terleckyj ed. 1975).

g. W.K. VISCUSI, EMPLOYMENT HAZARDS: AN INVESTIGATION OF LABOR MARKET PERFORMANCE (1979).

h. Viscusi, *Occupational Safety and Health Regulation: Its Impact and Policy Alternatives,* 2 RESEARCH IN PUB. POL'Y ANALYSIS AND MGMT. 281 (J. Crecine ed. 1981).

education, job experience, etc.) and job-related characteristics (unionization, industry, occupation, supervisory status, physical conditions, work speed). The inclusion of extensive nonpecuniary job characteristic variables is essential to ensure that the estimated values of γ_0 and γ_1 reflect premiums for risk rather than rewards for other unpleasant job attributes.

Such analyses of labor market incomes are summarized in Table 1, with the value-of-life estimates ranging from $500,000 to $7 million or more. Most of these analyses obtained estimates of the implicit value of fatal injuries alone. Only one of these studies included extensive variables pertaining to the risk level and nonpe-

cuniary characteristics of the worker's particular job, making it possible to better isolate the job risk premium.[21]

Two studies focused on very distinctive groups of workers. The paper by Marin and Psacharopoulos[22] considers British workers. To the extent that British workers have a lower level of wealth than U.S. workers, they should be expected to place a lower value on their lives, and therefore have quite different money-risk preferences than U.S. workers.[23] The actual pattern is broadly consistent with this hypothesis since the $2 million value of life of British workers is one of the lower estimates yet obtained.

The analysis by Thaler and Rosen[24] considers the risk preferences of workers in very high risk jobs—fatal accident rates on the order of 1/1000 annually, roughly ten times that of the average U.S. blue-collar worker. Since workers with the greatest willingness to bear risks should self-select themselves into these positions, one should expect to find lower implicit values of life for such workers than for workers in jobs with more representative risk levels. This is borne out in Table 1, since the Thaler and Rosen estimate of $580,000 sets the lower bound on the value-of-life range.

The possibility that this low estimate is attributable to differences in attitudes toward risk is not mere conjecture. The heterogeneity of wage-risk trade-offs has been explicitly estimated.[25] Although workers at the mean death risk level of 1/10,000 annually had much higher values of life than workers in the Thaler and Rosen study, workers in the high risk jobs were estimated to have values of life comparable to those in their study.

This heterogeneity is of practical consequence since the appropriate measure of the value of life depends on whose life we are valuing. Although some distinctions are easy to draw, such as the positive relationship between individual wealth and the implicit value of life, perhaps the most informative considerations pertain not to personal characteristics but to the revelation of one's money-risk trade-off through risk-taking actions. Individuals who incur large risks voluntarily should be accorded a value of life much lower than those who incurred the risk unknowingly. Since the implicit value of life varies by a factor of at least ten, consideration of the heterogeneity in the value of life is central to any assessment of the value of the risk.

The range of values for individual injuries is less broad. Viscusi's estimates of

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21. *See* W.K. VISCUSI, *supra* note 19. All other studies omit one or more categories of variables either because of the nature of the data set or because of an inability to estimate certain coefficients successfully.

22. Marin & Psacharopoulos, *The Reward for Risk in the Labor Market: Evidence from the United Kingdom and a Reconciliation with Other Studies,* 90 J. POL. ECON. 827 (1982).

23. These wealth effects are demonstrated on both theoretical and empirical grounds in W.K. VISCUSI, *supra* note 19. W.K. VISCUSI, *supra* note 3, presents an extensive empirical discussion of the consistency of the wealth effect with observed accident trends for various types of accidents (e.g., automobile accidents), both over time and across states.

24. Thaler & Rosen, *supra* note 19.

25. Viscusi, *Occupational Safety and Health Regulation: Its Impact and Policy Alternatives,* 2 RESEARCH IN PUB. POL'Y ANALYSIS AND MGMT. 281 (J. Crecine ed. 1981). Similar results were obtained in a replication of that analysis by Leigh, *Estimates of the Value of Accident Avoidance at the Job Depend on the Concavity of the Equalizing Differences Curve, forthcoming in* Q. REV. ECON. & BUS., who used similar data but a different set of explanatory variables.

the value of a typical job injury are in the $20,000 to $30,000 range.[26] Using comparable survey data, Leigh obtained somewhat higher estimates,[27] a difference that is possibly attributable to the fact that his analysis may not have isolated job risk premiums per se since he did not include a detailed set of other nonpecuniary characteristics in his analysis. The observed differences are not, however, very stark compared with the disparity in the value of life estimates.[28]

Making the transition from money-risk trade-offs for small risks to the values individuals would place on health impairments *ex post* is not simple. Three types of adjustments are needed. First, individuals will need to be compensated at a higher rate (for example, will have a higher implicit value of life) for large risks such as certain injury.[29] Second, if the accident lowers one's income it will be desirable to increase the post-accident compensation. Finally, if the accident lowers the incremental welfare one can derive from additional resources, the optimal level of compensation will be reduced.

B. Comparison with Financial Loss

The earnings equations used to calculate the wage-risk trade-offs can also be employed to assess the financial losses associated with various health effects, providing a useful comparison with measures traditionally adopted in the judicial process. For concreteness, this discussion will focus on the results obtained by Viscusi using the University of Michigan Survey of Working Conditions.[30]

In the case of a worker's death, all earnings throughout the rest of his career would be lost, which, for a forty year-old blue-collar worker who retires at age sixty-two, consists of roughly twenty-three years of earnings.[31] Although the mean earnings of the workers in the sample are $17,600 (1982 prices) it is not appropriate to simply multiply this figure by twenty-three to obtain lifetime earnings. Two adjustments must be made. First, the earnings growth over the life cycle must be taken into account using the parameters of earnings equation.[32] Second, one must discount these earnings to obtain a measure of the present value of earnings loss. Although there is a general consensus among economists about the need to discount, the choice of the discount rate is more problematic. There also is a legal consensus about the need to discount, although one state (Pennsylvania) does not permit discounting in such cases. A 10% discount rate is the value mandated by the Office of Management and Budget for use in all federal policy analyses, but a lower figure is probably more representative of the current real (inflation-adjusted)

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26. Viscusi, *supra* note 25.
27. Leigh, *supra* note 25.
28. There are other differences besides my inclusion of a more extensive set of nonpecuniary rewards variables. For example, the sample of occupations differed, as did the survey years. In addition, the injury rate variable for my study using the Survey of Working Conditions was defined much differently.
29. This result hinges on the role of wealth effects discussed in Section II.
30. W.K. VISCUSI, *supra* note 19.
31. Ideally, one should also take into account mortality rates and heterogeneity in retirement dates.
32. More specifically, the coefficients of the age and $(age)^2$ variables must be taken into account. The full set of coefficients appears in W.K. VISCUSI, *supra* note 19, at Table 15.2, equation 1 for the EARNG specification, that is, the equation with annual earnings as the dependent variable rather than its natural logarithm.

return on riskless capital investments. Below is a sensitivity analysis of the results using interest rates of 5% and 10%.

The present value of lifetime earnings is considerably smaller than the implicit value of life, irrespective of the discount rate used. At a 5% discount rate, the present value of lifetime earnings is $250,000 and at a 10% rate the present value is $170,000. In contrast, the mean implicit value of life for the sample is $3.5 million.

A potentially more instructive measure of the value of life is the value per discounted life year. That index adjusts for the differing length of individual life and provides a quantity-adjusted measure of health effects. Since one may wish to value the lives of individuals other than those with the age levels of those surveyed by the Survey of Working Conditions, such a measure enables one to extrapolate the existing value-of-life measures to a variety of alternative contexts. Using measures of earnings loss, the value of each life year is $15,000 using a 5% interest rate and $18,000 using a 10% interest rate. Using the implicit value-of-life estimate, rather than wage loss, produces estimates of $214,000 with a 5% interest rate and $363,000 with a 10% interest rate.[33]

Finally, the earnings equation can be used to obtain estimates of the earnings loss attributable to health impairments. For workers who have a health impairment that limits their ability to work, the annual loss averaged over all such impairments is $513. Throughout their future work career, however, the loss is much greater—$7000 at a 5% discount rate and $5000 at a 10% discount rate. These estimates understate the average earnings loss due to disabilities, since individuals who are no longer able to work are not captured in the sample.

What is particularly striking about all of these results is the wide gap between the financial loss from adverse health conditions and workers' implicit willingness to avoid these conditions. Since the figures differ by an order of magnitude, the empirical evidence suggests that the earnings loss from accidents comprises but a small portion of the individual welfare loss. The dominant impact is the pain, suffering, and shortened lifespan associated with accidents.

IV

PRODUCT LIABILITY AWARDS AND WORKERS' COMPENSATION

The *ex post* compensation provided to accident victims is based primarily on financial loss measures and is typically well below the observed implicit willingness-to-pay values. In the case of workers' compensation, the magnitude of the awards is determined by the provisions of state workers' compensation laws, and for product liability these awards are determined by out-of-court settlements or are set by the courts on an individual case basis. These categories are by no means exhaustive. Car accident awards, for example, are also pertinent. The objective here is not to survey all forms of compensation but to assess the most salient differences between individual risk-money trade offs and accident compensation.

33. These numbers were obtained by dividing the pertinent value-of-life measure by the discounted number of life years.

A. Product Liability Awards

No information is available on the appropriate level of compensation for product-related accidents in which no claim is filed. The data that are available pertain to successful product liability claims and consequently are biased toward the more serious accidents. One cannot obtain an unbiased perspective on the prevalence of accidents by considering product liability awards, but one can determine the relationship between the compensation paid and the magnitude of the economic loss.

The basis for product liability settlements is primarily the financial loss involved. This loss consists of wage loss (72% of the loss), medical expenses (22.5%), and other financial costs (5.5%).[34] Over half of all awards for property loss product liability claims equal the economic loss and only 23% of the awards are for more than the economic loss.[35] In contrast, although the magnitude of the financial loss is clearly important in bodily injury claims, it does not apear to be the sole consideration.[36] Bodily injury cases are much more likely to receive awards in excess of the loss than are property loss product liability claims. For bodily injury claims in which a liability award was made, 20% of the awards were

TABLE 2

AVERAGE PAYMENT BY ECONOMIC LOSS RANGE, FOR BODILY INJURY CASES*

Economic Loss Range	Number of Injured Parties	Average Payment	Average Economic Loss	Payment/Loss Ratio
$ 0	798	1,766	$ 0	NA
1-1,000	4,529	1,676	195	8.595
1,001-2,000	349	15,956	1,441	11.073
2,001-3,000	216	18,743	2,473	7.579
3,001-4,000	165	22,720	3,513	6.467
4,001-5,000	90	23,996	4,462	5.378
5,001-7,500	154	41,999	6,094	6.892
7,501-10,000	121	66,980	8,712	7.688
10,001-15,000	123	62,337	12,471	4.999
15,001-20,000	63	106,346	17,257	6.162
20,001-25,000	47	92,027	22,573	4.077
25,001-50,000	107	142,093	34,979	4.062
50,001-100,000	64	393,895	66,431	5.929
100,001-200,000	54	500,324	144,787	3.456
200,001-300,000	30	261,102	244,530	1.068
300,001-400,000	19	578,722	346,738	1.669
400,001-500,000	18	485,175	449,676	1.079
500,001-750,000	13	308,635	581,349	0.531
750,001-1,000,000	9	846,661	862,662	0.981
1,000,001-UP	10	389,208	2,593,242	0.154
Total	6,979	$ 24,129	$ 12,561	1.921

* All figures are in 1977 prices.

Source: INSURANCE SERVICES OFFICE, PRODUCT LIABILITY CLOSED CLAIMS SURVEY Table 5-7.

34. INSURANCE SERVICES OFFICE, PRODUCT LIABILITY CLOSED CLAIMS SURVEY 45 (1977).
35. *Id.*
36. *Id.*

for the exact amount of the financial loss, 70% were for more than the financial loss, and 10% were for less than the financial loss.

The extent of compensation varies with the size of the economic loss. As indicated in Table 2, most of the compensation in excess of the financial loss occurs in cases of accidents with small losses. Severe accidents with losses of $100,000 or more have a payment/loss ratio of .99, which suggests almost exact equivalence. The Alliance of American Insurers survey of large loss claims of similar magnitude yielded roughly comparable results, $1.22 in payments for each dollar of economic loss.[37]

The size of the payments is influenced not only by the financial loss, but by the particular liability theory that was used in the settlement.[38] Average awards under strict liability are highest—$38,258—which one might expect since the award is not adjusted to take into account the injurer's degree of responsibility in causing the accident, as in the case of comparative negligence. Under negligence liability and breach of warranty, the awards average considerably less, $23,081 and $18,786. What is perhaps most striking is that punitive damages are seldom assessed. Under 1% of all claims receive punitive damages, even though claimants request them quite often.[39]

The extent of compensation for various types of health impacts is summarized in Tables 3 and 4. The average payment for deaths is about $130,000, which is roughly comparable to the present value of earnings loss and is more than an order of magnitude smaller than most estimates of the value of life obtained in labor market studies. This disparity is not unreasonable, since the value a person places

TABLE 3

DISTRIBUTION OF PAYMENTS BY SEVERITY OF INJURY, BODILY INJURY CASES*

Severity of Injury	Percentage of Parties w/Payment	Average Payment	Percentage of Total Payments
Death	3.6%	$132,871	18.8%
Permanent Total Disability	3.0	255,378	29.9
Permanent Partial	2.3	157,238	14.2
Temporary Total	23.0	16,555	15.0
No Disability	68.2	8,258	22.2
Total	100.0%	$ 25,390	100.0%
Unknown	—	$ 42,325	—

* All figures are in 1977 prices.

Source: INSURANCE SERVICES OFFICE, PRODUCT LIABILITY CLOSED CLAIMS SURVEY Table 22-1, at 113.

37. ALLIANCE OF AMERICAN INSURERS, HIGHLIGHTS OF LARGE-LOSS PRODUCT LIABILITY CLAIMS at ii (1980).

38. INSURANCE SERVICES OFFICE, *supra* note 34, at 105.

39. In 18% of large-loss cases such a request is made. *See* ALLIANCE OF AMERICAN INSURERS, *supra* note 37, at i.

on his life in his efforts to preserve it is likely to be much larger than the bequest he would choose to leave his heirs.

Similarly, an individual would rationally choose to provide himself with more compensation after many nonfatal accidents than he would after death. The health impact categories associated with such awards include: permanent total disability, permanent partial disability, cancer, paraplegia, quadriplegia, and brain damage. These high compensation categories involve such large awards because of the sizable medical expenses associated with treatment of these health effects. If such expenditures significantly improve one's quality of life they will represent economically worthwhile allocations.

B. Workers' Compensation

The pattern displayed in workers' compensation payments is quite similar. This discussion will focus on the upper bounds of the benefit ranges specified by the state workers' compensation programs. Total disabilities and fatalities are both compensated at a rate of roughly two-thirds of workers' lost wages. The

TABLE 4

DISTRIBUTION OF PAYMENTS BY INJURY DIAGNOSIS, BODILY INJURY CASES*

Injury Diagnosis	Percentage of Parties w/Payment	Average Payment	Percentage of Total Payment
Amputation	2.6%	$112,988	11.2%
Asphyxiation	1.0	69,787	2.6
Bruise-Abrasion	3.8	5,165	0.8
Burn	7.6	78,786	23.5
Concussion	0.7	32,479	0.9
Dermatitis	2.1	1,468	0.1
Dislocation	0.3	32,120	0.4
Electrical Shock	0.3	31,728	0.4
Fracture	16.7	21,146	13.7
Laceration	14.5	11,240	6.4
Poisoning	16.1	1,102	0.7
Strain-Sprain	3.4	25,198	3.4
Disease-Respiratory	0.6	59,621	1.3
Disease-Cancer (Including Hodgkins Disease & Leukemia)	0.3	166,883	1.8
Disease-Other	0.9	17,414	0.6
Paraplegia	0.1	319,620	1.5
Quadriplegia	0.1	505,355	2.6
Brain Damage	0.8	357,482	10.5
Other	28.1	16,127	17.6
Total	100.0%	$ 25,680	100.0%
Unknown	—	$ 39,592	—

* All figures are in 1977 prices.

Source: INSURANCE SERVICES OFFICE, PRODUCT LIABILITY CLOSED CLAIMS SURVEY Table 25-1, at 116.

benefit caps for fatalities tend to be somewhat higher, but most states do not impose a benefit limit overall. They do, however, have maximum weekly benefit levels that are generally the same as the levels for total disabilities. The majority of states have maximum benefit limits of $300 or less per week and minimum fatality benefits of at least $50, implying an annual benefit range between $2,600 and $15,600. If one were to receive compensation at this level indefinitely (assuming no amount limit), the present value of this compensation would range from $26,000 to $156,000 when discounted using a 10% interest rate.

The typical payoff for fatal accidents will consequently be below $100,000. This amount should be below the typical product liability settlement for fatalities. Many fatal product accidents lead to unsuccessful claims or very small settlements, either because the causal relationship between a product defect and the accident

TABLE 5

INCOME BENEFIT RANGE UNDER WORKERS' COMPENSATION PAYMENTS, 1983

General Categories*	Low	High
Total disability	$16,470	$163,056
Fatality	$16,500	$250,000
Scheduled Injuries		
Arm at shoulder	$10,000	$125,460
Hand	8,675	102,510
Thumb	3,250	31,248
First finger	1,800	18,252
Second finger	1,350	15,624
Third finger	924	12,475
Fourth finger	600	11,475
Leg at hip	9,360	125,460
Foot	6,000	81,340
Great toe	1,200	19,960
Other toes	480	11,475
Eye	6,000	84,150
Hearing (one ear)	2,000	24,950
Hearing (both ears)	8,000	87,325

* Amounts pertain to maximum benefit limits.

Source: U.S. CHAMBER OF COMMERCE, ANALYSIS OF WORKERS' COMPENSATION LAWS (1983).

was not shown or because of contributory negligence, whereas the workers' compensation payment for fatalities is made irrespective of employee negligence.

As with product liability settlements, there are many severe injuries that may lead to higher income awards than would one's death. Loss of one's arm at the shoulder is one such category. There is, however, substantial similarity between the provisions for total disability awards and awards for fatalities.

V

SETTING APPROPRIATE LEVELS OF COMPENSATION

The accident value estimates that have been obtained span a broad range even for similar types of accidents. In the case of fatalities, workers' compensation payments are generally under $100,000, while product liability awards are somewhat higher. Each of these amounts is considerably below the implicit value workers attach to their lives, which ranges from about $500,000 to $7 million or more. A major source of the discrepancy between the liability awards and risk premium results is that neither the tort liability system nor workers' compensation places a substantial weight on the pain and suffering involved, in part because of the difficulty of quantifying this effect. A second difference is that one's attitude toward an accident after the fact will be quite different than before it has occurred. Compensation after one's death may benefit the victim very little except to the extent that he anticipated before he died that his survivors' income needs would be met. In contrast, extra money received before an accident will have a much greater incremental effect on one's welfare.

Before one can select the appropriate value of the health effects of accidents one must know the use to which the information will be put. Is the compensation intended to provide incentives for accident avoidance or to simply compensate the victims? Individuals may place a large value on preventing accidents, but might not place a great weight on the compensation they would receive after the accident, particularly if it is fatal. There should consequently be a disparity between the health values for purposes of prevention and compensation, but the extent of the optimal discrepancy is not clear. At present, the difference in the values used is at least an order of magnitude in the case of fatal accidents.

Although this undercompensation for accidents may represent an efficient transfer from the standpoint of insuring income losses from accidents, as the compensation level is reduced the costs imposed on injurers by accidents is also lowered. As the injurer's ultimate liability is reduced, these parties will no longer have an incentive to fully value the economic losses associated with the accident. As a result, the liability system will not provide adequate incentives for safety.[40] Increasing the level of compensation would boost the incentives for safety, but

40. In the case of perceived risks incurred in a voluntary market transaction (for example, the choice to work on a risky job), these incentives will be augmented by other market forces such as wage premiums for risks.

would provide more compensation than is desirable from the standpoint of insuring the financial costs of accidents.

There is, consequently, an inevitable trade-off between providing efficient incentives for accident avoidance behavior and meeting the income needs of accident victims in an efficient manner. Compensation for income loss alone is not appropriate since it completely ignores the objective of providing efficient incentives for accident avoidance. Similarly, using the value of life estimates that are pertinent to *ex ante* policies to save lives will result in inefficiently large compensation of accident victims. At present, the most that can be concluded is that some undercompensation for the welfare losses from accidents is desirable. Whether the present compensation levels are appropriate is a more difficult problem and an open empirical question.