OCCUPATIONAL SAFETY AND HEALTH REGULATION:
ITS IMPACT AND POLICY ALTERNATIVES

W. Kip Viscusi

I. INTRODUCTION

A major feature of government initiatives begun in the 1970s was a concern with the quality of commodities traded in the market, especially with respect to quality components involving a risk to one's physical well-being. Product safety regulations, the control of the level and composition of food additives, and occupational health and safety regulation are chief among these efforts.

On a conceptual basis, the issues involved in each of these policy areas raise quite similar economic concerns. The principal justification for government intervention derives from the absence of perfect information on the part of the worker or consumer, the possession of superior information by either the government or the enterprise, the inadequacy of
market compensation for adverse outcomes, and similar factors common
to each form of regulatory activity.

The focus of this paper will be on occupational health and safety reg-
ulation. These efforts are particularly instructive because the underlying
conceptual analysis is well developed and there is substantial empirical
evidence available to enable one to assess the efficacy of market out-
comes and the impact of regulation.

Since the justification for intervention derives largely from a perception
that the market does not operate effectively, the discussion in Section II
begins with an overview of the nature of market performance. The market
mechanism that has received the greatest amount of attention since the
work of Adam Smith is the existence of compensating wage differentials
for hazards. Job risk premiums also are instructive in assessing the value
workers themselves implicitly place on death or injury. These magnitudes
can then be used to provide a frame of reference for assessing the
attractiveness of various regulations. Section III presents new empirical
evidence on the heterogeneity of these values of life and indicates their
relevance to policy design. These findings will be used in Section IV to
assess the financial incentives for safety created by OSHA. That discus-
sion will also discuss the extent of OSHA’s impact. The broader ramifi-
cations of the analysis are the subject of Section V.

II. THE MARKET CONTEXT

Before considering the impact of the regulation of job risks, I will first
consider the functioning of markets for potentially hazardous work. Mar-
et performance has been selected as the starting point for the analysis for
several reasons. First, an understanding of the market is important to
ascertaining whether or not the government should interfere with market
outcomes. At least implicitly, all motivations for government intervention
entail some inadequacy of the market. Second, examination of labor
behavior may provide insight into differences in the efficacy of market
allocations. For example, market mechanisms may be better equipped to
handle safety risks than health risks. Finally, the market is the setting in
which intervention will take place. Policies whose impact depends on the
actions of workers or enterprises will only be effective if economic incen-
tives are altered to produce the desired outcomes. Even policies whose
primary impact is viewed as being outside the market, such as a work-
men’s compensation system that assists injured workers, may affect
market behavior either through the nature of the program financing sys-
tem or by affecting the relative attractiveness of hazardous work.

The economic determinants of market outcomes are quite diverse,
including the scale of the enterprise, the presence of an effective labor
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union, and the accident-proneness of one’s coworkers. The discussion below will focus on two principal market mechanisms—compensating wage differentials and worker quitting generated by job risks. These aspects of market behavior are not only of substantial empirical importance but also are directly related to what may be the central issue for policy—the extent to which workers are incurring perceived risks voluntarily.

A. Compensating Wage Differentials

If workers perceive the risks they are facing and would rather be healthy than not, they will require additional compensation to work on a hazardous job. This classic compensating wage differential result was articulated by Adam Smith over two centuries ago:

The whole of the advantages and disadvantages of the different employments of labor and stock must, in the same neighborhood, be either perfectly equal or continually tending to equality. . . . The wages of labor vary with the ease or hardship, the cleanliness or dirtiness, the honorableness or dishonorableness of employment.

Although the theoretical basis of the theory is not controversial, there is considerable doubt that workers possess perfect job risk information, as is assumed in the compensating differential analysis. The most obvious informational shortcomings pertain to carcinogenic risks. For example, the tragic implications of shipyard workers’ exposure to asbestos during World War II have only become apparent recently due to the long time lags involved. The rapid proliferation of toxic and hazardous substances has far exceeded scientists’ capacity to assess the implications of various exposure levels. Moreover, even if the dose-response relationships were known, the concentrations of various toxic substances at the workplace are seldom known with precision either by the worker or the firm. These inadequacies are enhanced by problems associated with very small risks, which may pose information-processing difficulties for the individual and are also associated with small numbers of previous illnesses that can be used in forming one’s probabilistic beliefs.

Despite these shortcomings, workers appear to be widely informed of many risks they face. For a sample of almost 500 blue-collar workers analyzed in Viscusi (1979a), 52.2% of the individuals were aware of one or more hazards posed by the job. The particular risks cited corresponded closely to the types of risk one would expect for the particular job. For example, a construction worker cited inadequate shoring, while a plastic-products worker viewed slippery floors and footing as being the foremost hazard. In striking contrast with the popular belief that workers are ignorant of work conditions that do not involve safety risks posing visible
physical dangers, over forty percent of the risks cited were health hazards, such as excessive noise, dangerous exposures to dust, and exposure to communicable diseases.

These risk perceptions were also strongly correlated with objective measures of the hazard. The first column in Table 1 lists the BLS injury frequency rate interval for the worker's industry. Since the risks posed by particular jobs within an industry are not likely to be identical to the average risk in the industry, there is likely to be some discrepancy between the objective risk measure and the workers' own perceptions. Column 3 of the table lists the fraction of workers in each risk group who view their jobs as hazardous in some respect. There is a strong correlation between the industry risk level and the workers' own perceptions. The slight discrepancies that do exist are not implausible, in view of the heterogeneity of jobs within an industry and the small sample of workers in many of the categories. Although this evidence does not imply that worker perceptions are accurate, there does appear to be a substantial awareness of many risks which is correlated with the actual industry risk level.

If workers are cognizant of differences in the risk level for various jobs, the positions perceived as being more risky will command a wage premium. In some instances, this premium is specified precisely in labor-market contracts. For example, elephant handlers at the Philadelphia Zoo receive an extra $1000 annually because "elephants will work only with people they like, and if they don't like them, the handlers face extra risk" (New York Times, July 3, 1979, p. D1).

In the usual instance, hazard premiums are not specified with precision. Instead, job hazards are a component of the job evaluation system, which assigns each job an overall rating that determines the rate class in which the job falls. The implicit risk premium in this situation can be ascertained using conventional statistical techniques.

<table>
<thead>
<tr>
<th>BLS Injury Rate (IR)</th>
<th>Fraction in the Sample</th>
<th>Fraction Facing Job Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ≤ IR &lt; 5</td>
<td>.50</td>
<td>.24</td>
</tr>
<tr>
<td>5 ≤ IR &lt; 10</td>
<td>.18</td>
<td>.43</td>
</tr>
<tr>
<td>10 ≤ IR &lt; 15</td>
<td>.08</td>
<td>.47</td>
</tr>
<tr>
<td>15 ≤ IR &lt; 20</td>
<td>.08</td>
<td>.53</td>
</tr>
<tr>
<td>20 ≤ IR &lt; 25</td>
<td>.06</td>
<td>.68</td>
</tr>
<tr>
<td>25 ≤ IR &lt; 30</td>
<td>.07</td>
<td>.66</td>
</tr>
<tr>
<td>30 ≤ IR</td>
<td>.04</td>
<td>.71</td>
</tr>
</tbody>
</table>

Source. Based on Viscusi (1979a).
The first successful effort along these lines was that of Thaler and Rosen (1976), who analyzed the wage premiums for incremental occupational death risks. Their analysis of workers in very risky jobs—with an annual death risk of 1/1000—indicated that workers received wage premiums associated with an implicit value of life of $400,000 in 1978 prices. The wage premiums for a more representative sample of workers facing death risks of 1/10,000 annually reported in Viscusi (1979a) yield an implicit value of life of $2.3 million.

These results are not inconsistent. One would expect that the self-selection process leading to match ups of workers and jobs would link workers requiring the lowest wage premium per unit of risk to the most hazardous positions. The value of life results presented in Section III are consistent with this view, as they represent the first successful empirical attempt to estimate explicitly the heterogeneity of the value of life within a particular sample of workers.

Workers also receive premiums for nonfatal accidents. For the BLS injury measure used prior to OSHA, the wage premiums for nonfatal risks were associated with an implicit value of $17,000 in 1978 dollars. Moreover, it is also instructive that the overall hazard pay estimates were roughly $700 (in 1978 prices), where the amount for the subjective risk perception variable was not statistically distinguishable from premiums obtained with objective risk measures.

Although the total premium per worker is relatively modest, the aggregate value of risk premiums for the economy is quite substantial. In 1978 there were 5.66 million worker injuries and 4,590 deaths to workers in the private sector. Using Section III’s average value of life figure of $4.2 million and the average injury value figure of $22,000, one finds that the total risk premiums for the economy are $125 billion. These estimates will be compared with the financial incentives created by OSHA in Section IV.

B. Job Hazards and Worker Quitting

Even if workers are not aware of the risks associated with a job before they begin employment, there is often the opportunity for learning about the risk through one’s on-the-job experiences. One can observe injuries to oneself and one’s coworkers, the level of noise, the work pace, the safety training procedures, and the care taken by one’s coworkers. These sources of information can be employed by the worker in forming his conditional assessment of the risks posed by the job.

The model underlying this job choice process is one of adaptive worker behavior in which workers experiment with jobs whose properties are not fully understood and quit if their experiences are sufficiently unfavorable. On an empirical basis, the risk-quit relation is quite powerful. Workers who view their jobs as exposing them to dangerous and unhealthy condi-
tions are twice as likely to be very likely to seek an alternative job as those who do not. Results from a variety of data sets indicate that job hazards lead to increased search by workers, greater quit rates, and shorter periods of employment at the enterprise. Indeed, as much as one-third of all manufacturing quits may be attributable to job risks. The quit mechanism and compensating wage differentials are complementary processes in which the attractiveness of the job is continually reassessed by the worker and, if the wage premium for the risk is insufficient, he will leave his position.

Although the quit mechanism is an important market response to imperfect information, it does not eliminate the problems associated with inadequacies in workers’ information. For many risks, such as those pertaining to irreversible health outcomes, the process of learning about the risk through one’s experiences may be quite costly. Whether or not adaptive quit responses are possible, it can be shown that workers confronting a sequence of job risk lotteries will display a systematic preference for jobs that are dimly understood, for any particular initial risk level. When coupled with a model of enterprise decisions, this behavior will lead to a bias toward new technologies that are not fully understood as well as an inefficiently high level of risk and an inadequate level of compensation provided to injured workers.4 In short, the adaptive quit response to job risks augments the other market response to risk but does not eliminate the potential problems arising from imperfect information.

C. Market Failure and the Motivation for Intervention

Much of the pressure for government intervention derives from the lack of a belief in a systematic market. Although labor markets do not function perfectly, the outcomes observed are not entirely capricious. It will be shown below that in many respects the allocations by the market have been more effective than OSHA in promoting health and safety.

Although there is substantial evidence of compensating wage differentials, quit rates, and other risk-related impacts, several shortcomings of the market can be identified. First, workers may have biased perceptions of the risk that they face. Although it is often alleged that workers systematically underestimate the risks they face, the direction of any bias is unclear. The limited empirical evidence that is available indicates that there are substantial risk perceptions and wage premiums for risks. Moreover, on a theoretical basis if there are investments made by the enterprise in monitorable work-place characteristics or risk-related forms of compensation, these signals of potential hazards will lead to unbiased risk perceptions in a signaling equilibrium. In short, in the absence of any empirical support, the economic underpinnings of the biased perception arguments appear to require further support.
Second, even if workers’ priors are unbiased, the imperfect nature of worker information combines with the potential for learning to produce the adaptive behavior discussed above. The resulting market outcomes will be associated with too great a level of risk and too little ex post compensation for injuries, as compared with the perfect information case.

Third, insurance markets have widely discussed imperfections, principally those pertaining to adverse selection and economies of scale in insuring large employee groups. The state workmen’s compensation programs can be viewed as a response to these shortcomings. Unfortunately, the merit rating incorporated in this system for relatively small firms is quite weak, as the premiums depend on the average industry risk rather than the firm-specific rate. For these enterprises, workmen’s compensation may, in effect, subsidize accidents, potentially reducing worker welfare.

The fourth shortcoming of the market is that the altruistic concerns of society at large are not reflected in employment decisions. Individual health is accorded special treatment through a variety of government policies because of the strength of these altruistic concerns. In view of the substantial values the workers themselves place on their own well-being, it is unclear whether these altruistic elements are of great relative importance.

Moreover, even if the altruistic concerns reflected substantial magnitudes, interfering with free choices by workers because taxpayers or policymakers may have a different rate of trade-off of risk for dollars is at best a controversial undertaking. It can be shown that as one’s wealth increases, the wage premium one will require to incur a given risk will rise. Consequently, poorer workers will accept hazardous jobs that others may consider abhorrent, not because of irrational behavior or imperfect information, but because their lower income status has enhanced the attractiveness of boosting one’s income in this manner. Whether society at large has a right to impose a quite different set of risk preferences on workers by regulating the types of jobs available is an ethical issue that is not easily resolved.

Finally, job risks create pecuniary externalities for society to the extent that the costs of social insurance programs are boosted by worker deaths, illnesses, and injuries. It should be noted that this argument for intervention is only persuasive if the justification for these other government programs is also sound.

III. HETEROGENEITY IN THE VALUE OF LIFE

A crucial input to assessing the desirability of any policy that influences individual health is a valuation of the lives extended and injuries that are prevented. For many purposes, it suffices to establish a metric by which
one can put different health impacts on comparable terms. For example, suppose that individuals place a $1 million value on their lives and a $10,000 value on injuries. If lives are treated as roughly 100 times as valuable as injuries, it will be possible to perform cost-effectiveness analysis of government programs by noting that different efforts cost $X per equivalent health improvement unit. These summary measures are often instructive in eliminating clearly inefficient efforts and in targeting expenditures in areas that are most effective in promoting health, for any given level of expenditures.

While helpful, relative valuation figures such as these do not eliminate the need for a definitive objective index. So long as public funds are in limited supply and have a nonzero value to taxpayers, decisions must be made regarding the appropriate scale of the health-enhancing effort. A second class of considerations requiring such valuation pertains to the heterogeneity of the lives affected. Should, for example, a larger value be placed on the lives of individuals incurring the risk of nuclear power involuntarily or on coal miners who are cognizant of the risk they are facing and who receive additional wage premiums for those risks?

The discussion here will focus on results that represent the first successful empirical effort to ascertain the heterogeneity of individual values of life. These new estimates were obtained from an analysis of the wage premiums received for risks by a sample of almost 4,000 full-time workers. Further details on the University of Michigan Panel Study of Income Dynamics data set and a description of the underlying empirical framework is provided in the Appendix.

The estimates were obtained by regressing the worker’s wage (or its logarithm) on a variety of variables pertaining to the worker’s job and his personal characteristics. The two risk measures used were the BLS lost workday injury and illness rate for the worker’s industry and the average fatality rate for the industry. The workers in the sample faced an average annual lost workday injury rate of .032 and an average annual death risk of $1.04 \times 10^{-4}$.

If individuals differ in the values they place on injuries and death, those who require the lowest wage premium per unit of risk will tend to be concentrated in the most hazardous jobs. To capture the heterogeneity in risk premiums arising from this self-selection process, the square of each of these risk measures was included in the regression equations so that any nonlinearities could be assessed.

In all of the equations considered, there was no evidence that the wage premiums/unit of risk for nonfatal worker injuries differed across the sample. Using the wage premiums estimated and the associated risk levels, one can assess the implicit value that workers receive for injuries. The results for the wage equation reported on the top line of Table 2 were
Table 2. Implicit Values of Death and Injury with Constant Valuations

<table>
<thead>
<tr>
<th>Implicit Values</th>
<th>Amount in 1978 Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Nonfatal Injury</td>
<td></td>
</tr>
<tr>
<td>Wage Equation</td>
<td>$21.7 \times 10^3</td>
</tr>
<tr>
<td>Log Wage Equation</td>
<td>$24.3 \times 10^{3.31}</td>
</tr>
<tr>
<td>Value of Death</td>
<td></td>
</tr>
<tr>
<td>Wage Equation</td>
<td>$4.16 \times 10^6</td>
</tr>
<tr>
<td>Log Wage Equation</td>
<td>$3.20 \times 10^{6.41}</td>
</tr>
</tbody>
</table>

Note.

a. Estimates for this specification were evaluated at the mean variable levels for the sample.

obtained in the following manner. The workers in the sample received an annual hazard premium for lost work-day accidents of $694. Since the average risk level was only $0.032, the average compensation for each accident was $694/0.032, or $21,700.

No individual worker would necessarily accept the certainty of an accident for this amount since the implicit value attached to an injury will usually vary depending on the level of the risk. However, a group of thirty-two workers including an average of one who will be injured will receive an average total risk pay of $21,700 to compensate them for the additional risk incurred.

The implicit value of injuries obtained from the semilogarithmic specification of the earnings equation was calculated similarly and was $24,300. The range of injury values implied by these results is $22,000–$24,000. These estimates are not too dissimilar from the $17,000 values (in 1978 prices) reported in Viscusi (1979a) for a different sample of workers. Moreover, the risk premiums were estimated for different risk measures, as the BLS injury rate in the earlier study pertained to nonfatal disabling injuries reported on a voluntary basis, while the lost workday injuries were reported on a mandatory basis by all firms. Thus, there was a slight change in the injury rate definition and a major change in reporting procedures.

The implicit value of life estimates obtained when only the linear form of the death risk variable was included in the equation ranged from three to four million, as indicated in the bottom of Table 2. For the earlier BLS death risk variable and a different sample of workers analyzed in Viscusi (1979a), the implicit value of life estimates ranged from $2.1–$2.6 million for the equation comparable to those estimated here. Due to the greater measurement error involved in the earlier, voluntary reporting technique, one would expect the estimates in the previous study to be biased down-
ward so that the minor differences in the results may not be of great consequence.

The primary matter of interest here is the heterogeneity in the value of life obtained when nonlinear death risk variables are included. The findings in Table 3 indicate the variation in these values, where the different quartile risk levels pertain to the entire private sector rather than the particular sample analyzed. It is especially striking that the majority of workers in the low-risk occupations place a similar value on their lives of $8 million for the linear specification and $5 million for the semilogarithmic wage equation. Indeed, the first and third quartile value of life estimates differ by only two to three percent.

The big discrepancy arises for workers in the high-risk jobs as their $3 million value of life estimates are much lower than those for workers in slightly less risky jobs. A value of life estimate of $400,000 (in 1978 prices) was obtained by Thaler and Rosen (1976) for a sample of workers facing an annual death risk of $11 \times 10^{-4}$, or twice the risk of the highest average industry risk level considered here. Although the estimates in this study cannot be extrapolated reliably to such high levels of risk, the sharp decline in the value of life at high risk levels is consistent with the types of pattern found here. In short, the findings suggest that if all individuals in society were ranked in terms of the value placed on their lives, the value of life would rise quite rapidly as one considered people beyond the low valuation group and then approach a constant level that is considerably larger than the values in the lower end of the range.

These estimates have implications for policy evaluation since individuals' own valuation of policy outcomes is a useful starting point for assessing government programs. The use of these value estimates in a public expenditure analysis raises a variety of issues, such as distributational considerations and society's concern with individual health that are explored elsewhere and are not readily resolved (Zeckhauser and Nichols, 1979; Schelling, 1968; Viscusi, 1978).

### Table 3. Heterogeneity in the Value of Life

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Annual Death Risk¹</th>
<th>Value of Life (Wage Equation)</th>
<th>Value of Life (Log Wage Equation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Quartile</td>
<td>.48 × 10⁻⁴</td>
<td>$8.05 \times 10^6$</td>
<td>$5.01 \times 10^6$</td>
</tr>
<tr>
<td>Second Quartile</td>
<td>.54 × 10⁻⁴</td>
<td>$7.99 \times 10^6$</td>
<td>$4.99 \times 10^6$</td>
</tr>
<tr>
<td>Third Quartile</td>
<td>.70 × 10⁻⁴</td>
<td>$7.85 \times 10^6$</td>
<td>$4.93 \times 10^6$</td>
</tr>
<tr>
<td>Fourth Quartile</td>
<td>6.18 × 10⁻⁴</td>
<td>$2.98 \times 10^6$</td>
<td>$2.82 \times 10^6$</td>
</tr>
<tr>
<td>Sample Mean</td>
<td>1.04 × 10⁻⁴</td>
<td>$7.56 \times 10^6$</td>
<td>$4.83 \times 10^6$</td>
</tr>
</tbody>
</table>

*Note.*

a. Risk levels for each quartile pertain to the upper boundary of the quartile.
Here I will focus on a representative instance in which the heterogeneity issue arises. Considerable attention has focused on the differing health risk of alternative energy policies, notably coal and nuclear power. In the case of coal, workers incur these risks, cognizant of the added danger to their lives. The widespread risks from a nuclear catastrophe are not targeted at specific population groups. As a consequence, the lives lost may be valued at more than twice the amount as coal miners. Put somewhat differently, these individuals would have been willing to pay considerably more for policies that would achieve a reduction in risk. When coupled with the important differences in risk compensation depending on whether the risk is incurred voluntarily, this result suggests that policymakers should be particularly concerned with risks spread over large segments of the population on an involuntary basis.

IV. THE EFFECT OF OSHA

A. Overview

The Occupational Safety and Health Administration (OSHA) began operation in 1971, with its principal function being the promulgation and enforcement of health and safety standards. The economic incentives provided for workplace health and safety are determined by the nature of the enforcement policy. Firms not in compliance with the standard risk an expected penalty.

The magnitude of these financial incentives is not particularly great. Consider the period of operation through 1975, which is the most recent year for which detailed data are available. There is less than a one in one hundred chance that any particular enterprise will be inspected in any given year. If inspected, the firm risks being cited for an average of 3.7 violations for which the average penalty per violation is $26. Overall, the expected annual penalty per establishment is only $1.52.

Even if the penalties are aggregated over the entire economy, they total only $10 million (in 1975)—an amount that is roughly one-tenth thousandth the size of the financial incentives provided by wage premiums for risk. Similar disparities are borne out in widely publicized OSHA interventions. After the cooling tower collapse in West Virginia that killed fifty-one workers, OSHA assessed $108,000 in penalties, or about $2,000 per life. In contrast, the implicit market value of a life reflected in wage premiums is over 1,000 times as large and, in this instance, probably even larger since unionized establishments such as the construction site are associated with larger risk premiums. This incident is also instructive since OSHA had inspected the work site prior to the accident and concluded that the guards to prevent tools falling from the scaffold
were inadequate. OSHA's emphasis on superficial hazards and its neglect of more fundamental risks is characteristic of the emphasis of the enforcement effort. Recent standards revisions suggest that more important health and safety concerns will receive increased emphasis.

B. A Review of OSHA's Impact

Since the advent of OSHA, the private-sector injury and illness incidence rate has dropped from 10.9 per 100 workers in 1972 to 9.4 per 100 workers in 1978. In view of the weak financial incentives for safety created by OSHA, one may attribute this decline to other economic factors. In an effort to assess the relative impact of OSHA, in Viscusi (1979b) I analyzed a pooled time series and cross section of industries from 1972 to 1975. This large sample included over eighty percent of all workers within OSHA's jurisdiction.

The two OSHA policy variables used were the average inspection rate per worker and the average OSHA penalties per worker in the industry. The contemporaneous values of these variables and all available lagged values were included to assess both current and deferred impacts of OSHA. There was no evidence of any direct or indirect effect of OSHA on the industry injury and illness rate, enterprise investments in health and safety, or planned enterprise investments in health and safety.

A principal determinant of the drop in accidents was an unexplained temporal decline from 1972 to 1973 that could not be accounted for by any of the variables reflecting the industry's technology or worker characteristics. The most likely cause of this drop is the nature of accident reporting. During the early years of OSHA operations, enterprises were overzealous in tallying accidents. After becoming accustomed to the new reporting procedures, fewer minor injuries were reported. This explanation is consistent with the greater relative decline in overall worker injuries and illnesses since the advent of OSHA as compared with the trends for death rates and lost workday injury rates, each of which is subject to less reporting error.

Other contributors to the temporal decline in accidents include a continuation in the drop in accidents throughout this century in response to increased worker wealth, which would diminish the attractiveness of working a hazardous job to boost one's income. There also may have been an enterprise response to OSHA due to misperceptions regarding the agency's enforcement effort or the presence of noncompliance costs (e.g., legal fees) that are measured imperfectly by either the inspection rate or average penalty levels.

The difficulty with more substantive explanations such as these is that the mechanism of such influences is unclear. There has been no comparable temporal increase in enterprise investments in health and safety or
planned investments of this type. The empirical results are also unambiguous in suggesting that there is no evidence of a substantial influence of the enforcement variables on health and safety outcomes.

C. The Optimal OSHA Enforcement Level

The relatively weak expected penalties for noncompliance with OSHA standards have failed to create sufficiently strong financial incentives to have an observable impact on worker welfare. One’s immediate reaction is to suggest that the enforcement effort be expanded. This approach has two principal weaknesses. First, the present enforcement structure does not appear to be well suited to such a task. In addition, even if an effective structure could be devised, one would have to confront the more fundamental issue of whether the likely impact of this effort on market outcomes is likely to be beneficial.

Consider first the attractiveness of boosting the financial incentives for safety created by OSHA. A useful index of effectiveness is the level of enforcement activities that will provide the same financial incentives as the conservative estimates of market wage premiums discussed in Section II. For the present number of inspections and violations per inspection, OSHA could provide equivalent financial incentives by raising the average penalty per violation from $26 to $325,000. Punitive fines of this type would create substantial problems of legitimacy for the agency’s activities. Indeed, OSHA inspectors presently are reluctant to assess fines at more modest levels such as $500 because the inspectors reportedly do not have confidence in the appropriateness of the standards.

Instead of boosting the penalty level, one would raise the expected penalty amount by increasing the number of inspections. Assuming that this expansion would not raise the overall costs of coordinating the agency’s efforts, that inspections would yield the same number of violations per inspection, and that these inspections could be increased at the present average enforcement cost per inspection, OSHA penalties would be comparable to market wage premiums if the enforcement budget were increased by $1.1 trillion. Since this amount is almost ten times larger than the financial incentives that would be created by the penalties, one might wish to explore alternative uses of the enforcement budget. For example, direct tax subsidies for health and safety improvements would be a more effective policy tool.

If the present enforcement strategy were to be made more effective in some manner, it would be necessary to assess the desirability of its impact before concluding that the policy was sound. Throughout its brief history, OSHA has been widely criticized for subjecting enterprises to apparently misguided regulations, such as those pertaining to portable toilets for cowboys and the voluminous specifications for OSHA-approved ladders.
Although these criticisms have been somewhat overdrawn, there is a general consensus that the agency’s efforts are misdirected.

Table 4 provides a breakdown of OSHA violations. Perhaps the most striking aspect of these violations is the preponderance of safety-related violations and the consistency of the agency’s emphasis on particular hazard categories. Indeed, over one-fourth of all violations are for machinery and machine-guarding violations, while over two-thirds of all violations are in the following categories: machinery and machine guarding, electrical hazards, construction, powered platforms and walking-working surfaces, and compressed gas and hazardous materials. The preponderance of all violations are for readily monitorable safety hazards.

In contrast, health risks have received scant attention. Fewer than one percent of OSHA violations are for toxic and hazardous substances.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Powered Platforms and Walking-Working Surfaces</td>
<td>0.117</td>
<td>0.112</td>
<td>0.108</td>
<td>0.100</td>
</tr>
<tr>
<td>Means of Egress</td>
<td>0.041</td>
<td>0.046</td>
<td>0.049</td>
<td>0.047</td>
</tr>
<tr>
<td>Occupational Health and Environmental Control</td>
<td>0.017</td>
<td>0.013</td>
<td>0.011</td>
<td>0.012</td>
</tr>
<tr>
<td>Compressed Gas and Hazardous Materials</td>
<td>0.047</td>
<td>0.061</td>
<td>0.057</td>
<td>0.072</td>
</tr>
<tr>
<td>Personal Protective Equipment</td>
<td>0.020</td>
<td>0.020</td>
<td>0.022</td>
<td>0.012</td>
</tr>
<tr>
<td>General Environmental Controls</td>
<td>0.021</td>
<td>0.016</td>
<td>0.020</td>
<td>0.022</td>
</tr>
<tr>
<td>Medical and First Aid</td>
<td>0.005</td>
<td>0.012</td>
<td>0.012</td>
<td>0.009</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>0.053</td>
<td>0.067</td>
<td>0.072</td>
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<tr>
<td>Materials Handling and Storage</td>
<td>0.056</td>
<td>0.051</td>
<td>0.048</td>
<td>0.042</td>
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<tr>
<td>Machinery and Machine Guarding</td>
<td>0.241</td>
<td>0.230</td>
<td>0.220</td>
<td>0.225</td>
</tr>
<tr>
<td>Hand and Portable Power Tools</td>
<td>0.017</td>
<td>0.020</td>
<td>0.019</td>
<td>0.017</td>
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<td>Welding, Cutting, Brazing</td>
<td>0.039</td>
<td>0.035</td>
<td>0.032</td>
<td>0.028</td>
</tr>
<tr>
<td>Special Industries</td>
<td>0.025</td>
<td>0.008</td>
<td>0.006</td>
<td>0.009</td>
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<tr>
<td>Electrical</td>
<td>0.094</td>
<td>0.113</td>
<td>0.126</td>
<td>0.146</td>
</tr>
<tr>
<td>Toxic and Hazardous Substances</td>
<td>0.008</td>
<td>0.006</td>
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<td>0.006</td>
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<td>Procedures for State Inspections and Citations</td>
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<td>0.016</td>
<td>0.018</td>
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<td>Procedures for Reporting, Recording and Modifying Standards</td>
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<td>0.018</td>
<td>0.030</td>
<td>0.028</td>
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<td>Ship Building, etc.</td>
<td>0.010</td>
<td>0.005</td>
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<td>Longshoring</td>
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<td>0.001</td>
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<td>Miscellaneous</td>
<td>0.011</td>
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<td>0.000</td>
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<td>Total Violations</td>
<td>139,256</td>
<td>304,678</td>
<td>313,076</td>
<td>378,151</td>
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</tbody>
</table>

Note.

a. Figures calculated by the author using unpublished OSHA computer printouts generated for this study.
FY 1976, there were over eight times as many violations for improperly completed forms as for this important health category. The same monitoring difficulties impeding worker choices may also affect OSHA inspectors who forego time-consuming tests for health risks and instead concentrate on readily monitorable risks. Since over forty percent of the risk cited by workers in the SWC sample discussed in Section II were health risks, such as noise and noxious fumes, the market may be more effective than OSHA in dealing with the class of hazards generally linked with the most severe market failure.

V. TOWARD AN EFFECTIVE POLICY

A more effective strategy for improving market outcomes could be developed by abandoning the present reliance on the health and safety standard approach. The proposal sketched below is intended to be suggestive of a policy that provides incentives for health and safety, while also not undermining the desirable properties of market outcomes. The overlap of portions of this proposal with those of other economic analysts, such as Smith (1976) and Zeckhauser and Nichols (1979), is to be expected since their underlying analyses of the functioning of the market differ in terms of emphasis, but in many important respects are quite similar.

The class of hazards that can be handled rather effectively without an unwieldy policy implementation effort is safety risks. Most safety hazards and some health risks generate readily monitorable outcomes—worker injuries and illnesses. Better merit rating of workmen’s compensation benefits is essential or society will, in effect, be subsidizing worker injuries. By perhaps coupling the workmen’s compensation premiums with a modest injury tax, additional incentives for safety could be created without a costly network of inspectors.

It is often alleged that this approach would discriminate unfairly against small firms. However, merit rating of penalties is not tantamount to self-insurance. Each firm would be placed in a rate class based on its injury frequency rate, its size, and the industry type. The resulting penalties should not be exceedingly great since the market is relatively effective in handling these types of risk. Extraordinarily large penalties that threaten the viability of many small firms would result only if the extent of the intervention greatly exceeded the magnitude warranted by the degree of market failure in this area.

For health risks, the policy problem is more fundamental. Workers’ ignorance of the implications of many health risks is often shared in a lesser degree by policymakers. For example, it is difficult to monitor the concentrations of all potentially hazardous substances at the workplace.
Moreover, even if the concentrations are known, the link between exposure levels and the probability of different health outcomes is generally unclear. An essential prerequisite for an effective policy is more precise research that will distinguish different degrees of risk rather than concluding that a substance is potentially carcinogenic or hazardous in some respect.

Noise, noxious fumes, and other health-related environmental characteristics could be influenced by a variable penalty schedule in which firms incurred different penalties based on the levels of exposure and the number of affected workers. There would be a range of penalty levels rather than a critical standard level below which a penalty was assessed.

By permitting firms to incur the penalty and let the hazard remain rather than forcing firms to eliminate violations by imposing increasingly large fines for firms that persist in not complying with a rigid standard, the policy can create a decentralized mechanism by which the firm can choose whether the costs of improved health and safety exceed the benefits, where these costs are reflected in the reduction in expenditures for the firm dictated by the fine structure and the market outcomes.

The efficacy of OSHA inspectors could be enhanced if the health hazard exposure tax system was carried out on a self-assessed basis. The firm would assess its own penalties and pay the appropriate amount to the government. OSHA inspectors could then be used in a role similar to that of IRS auditors in which they investigated some firms at random and used information supplied by workers as well as information regarding the widespread incidence of illnesses to direct the inspections more selectively.

A final component of the policy might be to provide risk information to workers so that they can make more informed choices. Although too much information may not be processed in a meaningful fashion, experimentation with different types of information provision would be an innovative and potentially effective addition to any policy mix. For example, the employer could be required to inform the worker of the fatal and nonfatal injury and illness rate, the particular risk faced in the worker’s job, the relation of these risks to personal characteristics and activities (e.g., smoking), and the relative risk compared to other enterprises in the community.

A common element shared by this and the other policies is that the existence of important shortcomings of the market does not imply that many of the systematic aspects of the market are not beneficial or that economic behavior can be ignored for purposes of policy design. An effective policy will take advantage of the market rather than try to supersede it.
APPENDIX
STATISTICAL PROCEDURES

The implicit value of injuries and deaths were obtained from compensating wage differential equations estimated for the 1976 survey year of the University of Michigan Panel Study of Income Dynamics. The analysis was restricted to the 3,977 full-time workers in the sample, that is, those who worked at least thirty hours per week.

The principal dependent variable was the worker's wage (in cents) per hour, where this variable has a mean of 503 and a standard deviation of 225. Interpreted on an annual basis, assuming that individuals work forty hours per week and fifty weeks per year, one obtains an average earnings amount of $10,060 per year. The wage equation was estimated using both the wage rate (in cents per hour) and its natural logarithm as the dependent variable.

The principal explanatory variables were those pertaining to the risk of the worker's job. Using information pertaining to the worker's industry and published BLS data, injury risk variables were constructed for each worker in the sample. The fatal injury risk variable, Death, is the frequency of fatalities in the worker's industry, measured in terms of deaths per 1,000 full-time workers. To avoid measurement error problems arising from the small number of deaths in any particular year, the Death variable was constructed by averaging the industry death risk over the 1973 to 1976 period. The mean value of Death was .104, and its standard deviation was .108. On average, the workers in the sample faced an annual death risk of $1.04 \times 10^{-4}$. The square of this variable, Death × Death, was included in some equations in order to identify possible nonlinearities in the amount of compensation per unit of risk as the level of risk varied.

The nonfatal injury risk variable, Nonfatal, was the 1976 lost workday accident and illness injury and illness rate for the worker's industry, minus the fatality rate for the comparable period. The lost workday injury and illness rate avoids the measurement error problems associated with the total accident and illness rate. The broader injury and illness measure is subject to greater discretion in terms of reporting adverse outcomes since the criteria for determining whether an injury or illness is to be recorded is not clear-cut for the less severe cases. Moreover, the lost workday cases are more comparable in severity to the injury measure used in the pre-OSHA period, facilitating comparison with my earlier results.

The risk measure Nonfatal had a mean of 3.20 and a standard deviation of 1.74. Since Nonfatal was scaled in terms of the number of lost workday
accidents and illnesses per 100 full-time workers in the industry. Each worker in the sample faced an annual risk of about one in thirty-one that he would incur an injury or illness of this type.

The square of the Nonfatal variable was also included in a variety of specifications to test for possible nonlinearities in compensation for nonfatal risk. Since the resulting coefficients were consistently small in magnitude and not statistically significant (at the usual levels), this variable was not included in any of the results reported below.

Finally, each equation included twenty-three additional variables reflecting the worker’s personal characteristics (e.g., education, race, sex, and experience), job characteristics (e.g., coverage by a collective bargaining agreement and eight occupational dummy variables), and regional characteristics (e.g., the regional unemployment rate).

The principal regression coefficients of interest are summarized in Table A-1. All variants were estimated using both the wage and its natural logarithm as the dependent variables. The fit for each of the four equations reported was quite similar, with an \( R^2 \) value of .57 for all of them. The semilogarithmic specification has a stronger justification in terms of the human capital theory linkage between earnings and schooling, but no comparable relationship has yet been derived for job risk and earnings. Since more extensive discussion of these issues and similar, subsidiary aspects of related findings are reported in Viscusi (1979a), these details will not be reiterated here.

<table>
<thead>
<tr>
<th>Table A-1. Injury Risk Regression Results.</th>
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<tr>
<td><strong>Regression Results</strong></td>
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<td><strong>Wage Equation Results:</strong></td>
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<tr>
<td>Death</td>
</tr>
<tr>
<td>(26.10)</td>
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<tr>
<td>Death \times Death</td>
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<tr>
<td>(146.91)</td>
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<tr>
<td>Nonfatal</td>
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<tr>
<td>(1.78)</td>
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<td><strong>Log Wage Equation Results:</strong></td>
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<td>Death</td>
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<tr>
<td>(.054)</td>
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<tr>
<td>Death \times Death</td>
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<tr>
<td>(.303)</td>
</tr>
<tr>
<td>Nonfatal</td>
</tr>
<tr>
<td>(.004)</td>
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</table>
NOTES

1. These other mechanisms are discussed in detail in Viscusi (1979a).
3. The discussion in this section is based on Viscusi (1979a).
4. The discussion in this section is based on Viscusi (1979c).
5. Empirical and theoretical support of this phenomenon is provided in Viscusi (1979a).
6. The problem of pyramiding intervention is addressed by Zeckhauser and Nichols (1979).
7. The material in this section is based in part on Viscusi (1979b).
8. Other costs, such as legal fees and harm to the firm’s reputation, no doubt are also important, but these cannot be readily assessed.
9. The lost workday accident rate has increased, however, from 3.3 to 4.1 over that period.

REFERENCES


