Workers' Compensation and Workplace Safety

Some Lessons from Economic Theory

Richard B. Victor, Linda R. Cohen, Charles E. Phelps
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1982
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Foreword

One recurring theme of public policy analysis is the examination of simply stated "obvious" propositions to see whether they stand up under hard scrutiny as well as they do in everyday conversation. One such proposition is the widely shared assumption that increases in the benefits provided to injured employees covered by state Workers' Compensation programs will always increase their employers' incentives to invest more in worker safety. This presumed relationship has been an important and largely unquestioned factor in innumerable public and private decisions regarding Workers' Compensation policy. Few analysts have attempted to address whether it is an absolute truth, insensitive to circumstance, or whether its validity varies with the particular conditions under which the question is posed. The authors of this publication take a theoretical, rather than an empirical, approach to the issue. A companion report provides an empirical analysis of these issues: R-2979-ICJ, Workers' Compensation and Workplace Safety: The Nature of Employer Financial Incentives, by R. B. Victor.

Assuming that corporate decisions on safety investment are made on grounds of purely financial advantage, the authors seek to establish what standard principles of economic theory would lead one to expect a rational manager to do in the context of varying assumptions about the way in which the firm provides for its Workers' Compensation liability, and the context (e.g., the other applicable public benefit and regulatory programs) in which this provision is made. The authors' analytic vehicle is a hypothetical firm of a specified size and operating within a particular state. In showing the rational decision calculus that would seem likely to be employed by the management of such a firm, the researchers are able to trace the interactions among the factors that management's concern for profit maximization would probably lead them to take into account in reaching corporate decisions affecting the level of investment in safety.

The results may surprise those who assume a simple, one-way relationship between benefit increases and safety incentives. Since this
work does not report the results of observation of actual corporate behavior, the authors' conclusions do not prove that the real world is more complex than the simple proposition assumes. But they do suggest that economic theory provides no basis for expecting that the proposition will always be true, either absolutely or to the same degree, regardless of differing modes of Workers' Compensation coverage and/or the context in which that coverage is provided. And, the work results in a set of hypotheses about the relationships among the variables likely to be weighed by corporate management in making such decisions which offers both a rich agenda for proof or disproof through empirical research and a theoretical framework for fitting each product of such empirical investigation into a broader pattern of knowledge.

Thus, though the analytic approach used here is theoretical, the results underlie the factual analysis of major issues in Workers' Compensation undertaken by the Institute for Civil Justice. The present effort provides the intellectual underpinnings that guide later choices of targets for empirical research and details the basic logic employed in thinking through the problem and in addressing it empirically.

Gustave H. Shubert
Director, The Institute for Civil Justice
Summary

By imposing some of the costs of employees' injuries on the employer, the Workers' Compensation (WC) system provides financial incentives for the employer to prevent injuries and diseases in the workplace. This report uses the tools of economic theory to analyze how firms can be expected to respond to these financial incentives. The report focuses on a statement that is usually assumed to be true and is repeated as conventional wisdom by many policymakers and the researchers who advise them: Increasing Workers' Compensation benefits induces a firm to increase safety. This common wisdom, coupled with a concern about the adequacy of WC incentives, has engendered a host of proposals for enhancing WC incentives and reducing workplace injuries. These proposals include raising benefit levels, mandating deductibles for insured firms, imposing an additional "injury tax," limiting the federal tax deductibility of WC costs, and extending experience rating.

Our research suggests that although the common wisdom has a strong theoretical basis in many cases, it does not have it in all cases, and the empirical evidence fails to provide much support for it. Our analysis explores the conditions under which increasing WC benefits may enhance, diminish, or leave unaffected employers' investments in safety.

SCOPE OF THE REPORT

This report presents the results of a theoretical analysis of how we would expect WC financial incentives to influence the safety decisions of rational, profit-maximizing firms. It does not report on how firms are actually observed to behave. That is the subject of ongoing work.

The analysis does not address every factor influencing a firm's risk-management decisions nor every type of firm or hazard. Abstracting
from the complexity of the real world makes it possible to focus attention on important principles and aspects of behavior that complexity might otherwise obscure. The analysis is also limited to employers’ safety decisions because the WC system—rightly or wrongly—assigns primary responsibility for prevention to the employer, although it is recognized that safety is a joint employer-employee undertaking and that changes in the WC system may influence employees’ behavior as well as the employer’s.

Our economic models assume that firms are rational profit-maximizers—that the decision to invest in prevention is an economic one like any other economic decision. This does not imply that we believe economic factors alone determine prevention decisions. Many noneconomic factors may play important roles. Nevertheless we concentrate on economic factors here because they are likely to be important and operate in predictable ways, whereas noneconomic factors, although they may be important, are less measurable and may be less predictable. We have consistently heard from safety professionals that the way to persuade a firm to increase prevention is to show that it increases net profits. That is the guiding assumption of our analysis.

This analysis leads to a series of propositions about employer behavior that, while often stated boldly, should be interpreted in a limited way. We typically offer conclusions as ceteris paribus—or "all other things held equal"—statements. For example, where we might conclude that a large, experience rated firm will invest more in safety than a self-insured firm, the appropriate interpretation contrasts two firms that are otherwise identical in all material characteristics—size, industry, location, employee mix, management attitude, information, and the like.

**CONCEPTUAL FRAMEWORK**

The firm makes safety decisions in light of the costs and benefits of additional prevention. The benefits are the savings that accrue to the firm by avoiding injuries. WC savings are only one component of the firm’s prevention benefits. Others include reduced OSHA (Occupational Safety and Health Act) penalties and compensating wage differentials (wage premiums paid for hazardous work), profits lost from downtime and damaged equipment, and recruitment and training necessitated by workplace injuries. In making these decisions, the firm takes into account uncertainty about the likelihood of injury, the probability that WC claims will be filed and paid, and the chances of an OSHA inspection. The value placed on costs and benefits of injury
prevention is influenced by the firm's attitude toward risk, its ability to shift injury costs (to the consumer or others), and when the costs are incurred and the benefits accrue (present value comparison).

CONCLUSIONS: SELF-INSURED FIRMS

We begin with a simplified base case; then we introduce a number of complicating factors.

For self-insured firms, we assume in the simplest case that:

- The firm is risk-neutral.
- Its only costs of injuries are WC costs; it pays no compensating wage differentials or other direct costs.
- It does not move its operations in response to a change in WC laws.
- Workers are risk-neutral; they always follow safe practices; and their behavior is unaffected by benefit levels.
- The firm is seeking to prevent a single type of common traumatic injury that can occur in the current year from a specific workplace cause.
- Prevention is undertaken with a safety input that has a one-year life; its efficacy is uncertain, and its price is stable from year to year.
- All claims are successfully brought; liability is strict; and compensation is limited.

Two general propositions emerge. First, increasing WC financial incentives will increase safety—the conventional wisdom. Second, there are diminishing safety returns to successive increases in these financial incentives. From a national perspective, this means that WC increases will produce the greatest safety gains in states with the lowest WC incentives, ceteris paribus.

But these general conclusions do not always hold. Several factors may dilute, negate, or even reverse the effect of WC incentives on employer prevention actions. One such factor is the compensating wage differential (CWD)—a wage premium paid to employees for hazardous work, which compensates them for the uncompensated portion of the risk they encounter. If the employer were obligated to compensate an injured worker for all pecuniary and nonpecuniary losses, there would be no uncompensated risk and the CWD would be zero. The more the employer's liability falls short of full compensation, the greater the CWD. If the CWD fully reflects the uncompensated risk, an increase in the WC benefits both increases the WC incentives and
decreases the CWD. The effects are exactly offsetting. Thus, increases in WC yield no change in safety. Where the CWD exists but does not fully reflect the risk, increasing WC will improve safety, but not as much as where no CWD exists.

Employee failure to follow safe practices dilutes the effects of the WC incentives facing employers. The more often that employees ignore safe practices (e.g., wearing safety glasses), the smaller are the employer’s incentives to invest in prevention. Thus, employee failure to follow safe practices not only leads to more injuries in its own right, but may reduce the employer’s incentives to take certain precautions.

The financial incentives for injury prevention exceed those for disease prevention, for four principal reasons. (1) Disease claims are less likely to be brought, and often less likely to be successful, than those for injury. (2) Many disease claims accrue many years after prevention costs are incurred, whereas injury claims are brought more currently. When the rate of growth of benefits is less than the interest rate, which it typically is, there is less incentive to prevent diseases than to prevent injuries. (3) The efficacy of injury prevention is typically well understood, whereas the efficacy of many courses of disease prevention is often uncertain. In the face of uncertainty about the returns to disease prevention, the firm will discount its potential returns accordingly. (4) Disease hazards may be unrecognized; where so, the WC system will have no effect on prevention.

Personal protective equipment and engineering controls are two often substitutable approaches to occupational injury and disease prevention. Personal protection equipment (e.g., a respirator) is worn by a single employee for protection against a hazard. Engineering controls abate the hazard at its source (for example, a ventilation system) and typically protect multiple employees. Until recently, OSHA has preferred engineering controls, but many hotly debate the preferred strategy for abatement. WC financial incentives may differ sharply with regard to these two abatement approaches.

We find that increasing WC financial incentives always increases investments in safety when personal protective equipment is used, but does not always do so for engineering controls. Under certain circumstances, higher WC incentives may even lead firms using engineering controls to reduce investments in safety, particularly firms in very hazardous, very competitive industries. A striking implication is that OSHA’s insistence on mandating engineering controls instead of personal protective equipment may weaken, neutralize, or even reverse the traditional WC incentives for prevention, possibly leaving the workplace more hazardous than it would be with lower WC benefit levels. This situation is likely to occur when WC costs are a relatively
large share of a firm’s total labor costs, or where the firm’s demand for labor is relatively responsive (elastic) to changes in hourly labor costs. Inflation may defeat the conventional wisdom about WC and safety. If the prices of safety devices and equipment rise faster than WC benefit levels, WC prevention incentives will decline. We examined what happened during the 1978-1981 period. Increases in medical costs have helped increase real WC incentives. Tying permanent partial and temporary total benefits to the state average weekly wage to create automatic annual benefit adjustments has helped keep incentives even with inflation. Major reforms that have dramatically increased benefits have increased real incentives. Incentives for safety have been eroded in most states that only periodically adjust temporary total and permanent partial benefits.

Since it is often difficult to prove precisely what caused a disability, several approaches have emerged to holding employers responsible for compensating workers whose disability is arguably the result of both personal and workplace causes. In some states, any nexus with employment is sufficient to trigger full WC liability. Recently, North Carolina adopted a rule that apportions liability in byssinosis cases according to the relative importance of the personal and workplace causes. Other states exclude “ordinary diseases of life” from compensation—implicitly presuming dominant personal causes. Each approach has different implications for employer prevention incentives.

Our base case assumes that the firm is risk-neutral; that is, that it weights each possible consequence of a hazard by the probability of its occurrence. In fact, firms may not be risk-neutral, but risk-averse; that is, they place greater weight on more serious, although less likely, consequences. Because the benefits of prevention are higher for a risk-averse firm than for a risk-neutral firm, the former will invest more to avoid losses, especially larger losses.

Information about the existence and nature of hazards, as well as the appropriate courses of prevention, is necessary to make decisions on safety. The cost of this information is one of the costs of prevention, and the more costly the information is, the lower the firm’s investments in prevention will be. The WC system and OSHA may play critical roles by providing financial incentives for firms to support research, provide information, and conduct inspections. The resulting economies of scale in producing information lower the cost of information and may decrease the uncertainty about the consequences of a hazard and effective courses of prevention. Where the employer has underestimated the risk, this interaction encourages remedial action.
CONCLUSIONS: INSURED FIRMS

WC financial incentives for insured firms influence employers' prevention decisions in generally the same manner as for self-insured firms, but differ in regard to the size of insured incentives, the effect of insurance loss limitations on incentives, and the interaction of insurance and compensating wage differentials.

WC insurance may enhance or dilute employers' prevention incentives. The size of insured incentives depends principally upon the characteristics of the firm, the WC system in its state of residence, and its insurance arrangement, particularly merit rating and dividend plans.

Under the experience rating formula, the prevention incentive increases with the extent of experience rating, a common form of merit rating, which rises with firm size, hazardousness of the industry, and wage level of the firm, and declines with the size of the loss prevented. Despite the impressions left by the National Commission on State Workmen's Compensation Laws in their 1972 report (and others), firms need not have more than a thousand employees to have significant WC prevention incentives. An insured firm in a hazardous, high-paying California industry, such as sawmills, will have greater WC prevention incentives than a much larger self-insured firm, if it has 25 or more employees.

Under retrospective rating, another form of merit rating, WC financial incentives contain two components: current and future premium savings. The immediate savings depend upon firm size, the hazardousness of the industry, the loss prevented, and the retro plan selected. The future savings depend upon the same factors influencing the experience rated savings as well as upon the retro plan chosen. While it is difficult to generalize about the size of these incentives, a few generalizations follow:

For small losses, retro incentives exceed self-insured incentives for all but the smallest firms by 20 to 75 percent or more. For medium-sized losses, retro incentives will be larger for more hazardous industries and higher-paying and larger firms. For very large losses, retro incentives are typically less than self-insured incentives for all but the larger higher-paying firms in hazardous industries.

Two types of dividend arrangements are common: flat rate and sliding scale. Under a flat rate dividend plan, the insurer pays a stated percentage of the premium as a dividend to every policyholder regardless of loss experience. Under sliding scale plans, insurers pay higher dividend rates to (1) employers with better loss records and (2) larger policyholders.
Flat rate dividends decrease net insurance costs but add nothing to the incentives for prevention. Sliding scale dividends also decrease net insurance costs but, being tied to safety records, enhance prevention incentives. This effect will increase with the size of the firm, hazardousness of the firm and industry, and average level of wages paid, and must be added to the premiums saved through the various insurance rating plans to define a complete picture of insured WC prevention incentives.

Various limitations on losses or premiums limit the incentives for prevention that would otherwise arise from the WC insurance arrangement. Rating bodies limit the size of any single loss that is included in adjusting the experience modification factor. Under experience rating, these limits vary from state to state—for example, they are $87,000 in California, $43,000 in Georgia, and $135,000 in Oregon. Under a retrospective rating plan, the insured may elect an analogous maximum on individual losses. In both cases, prevention of losses in excess of this maximum loss yields the same prevention benefits as preventing the maximum loss. These loss limitations reduce WC incentives for preventing larger losses. The effects of loss limits are greater for risk-averse firms.

We argued above that an increase in WC benefits may merely produce an offsetting reduction in compensating wage differentials (CWD)—with no net effect on safety. However, increases in WC benefits for insured firms may interact with the CWD to produce a somewhat different result: enhanced prevention incentives for larger firms, but diminished incentives for smaller firms.
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This research would not have been possible without the assistance of a large number of individuals in the insurance industry who took the time and interest to help us understand the procedures and subtleties in both insurance rate-making and loss prevention activities. We especially want to thank John Worrall, Tom McDermott, and their colleagues at the National Council for Compensation Insurance; Robert Meyer at the California Workers’ Compensation Insurance Rating Bureau; John Eavenson, John Dane, and their colleagues at Liberty Mutual Insurance; Thomas F. Conneely, Timothy Phillips, and their colleagues at Industrial Indemnity; and Paul Wise and his staff at the Alliance of American Insurers.

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Chapter 1

INTRODUCTION

Workplace injuries and diseases impose a drain on our industrial society's resources through lost lives, lost productivity, lost income, litigation and medical expenses, and emotional distress. Effective public and private policies for preventing occupational injuries and diseases\(^1\) might yield bountiful fruit by reducing injuries without imposing undue costs on those responsible for prevention.

Society has taken three policy approaches to that end. The first relies on market forces. Even absent any government intervention to impose penalties or compensation costs, both firms and employees find injuries to be costly and therefore both take precautions to reduce workplace injuries.

Because many people believe that market forces provide inadequate incentives for precautions, federal and state governments have intervened with two policy instruments to enhance prevention incentives. One is the Occupational Safety and Health Act of 1970, establishing a comprehensive federal (and state) program of direct regulation and enforcement, whereby Congress sought "to assure safe and healthful working conditions for working men and women." The second is the array of Workers' Compensation (WC) systems that states established in the early part of this century. These systems typically require employers to provide certain but limited compensation for employees who suffer work-related injuries and diseases.

By imposing some of the costs of employees' injuries on the employer, the WC system provides incentives for the employer to prevent injuries; and by providing only partial compensation to employees, it gives them incentives for prevention as well. These incentives supplement any free market incentives.

In its 1972 report, the National Commission on State Workmen's Compensation Laws stated emphatically that "The encouragement of safety is one of the basic objectives of a modern workers' compensation system."

\(^1\)Unless the context suggests otherwise, hereafter we use the word "injury" to mean "injury and disease"; similarly, "safety" means "health and safety."
program." Others have echoed this view. The WC system encourages safety primarily through financial incentives. According to the National Commission, "Proper allocation of the costs of work-related injuries and diseases . . . can provide a powerful economic incentive for safety programs." Yet the Commission also notes the difficulty of demonstrating that these financial incentives actually increase safety in the workplace.

This report uses the tools of economic theory to analyze how we would expect firms to respond to the WC financial incentives. Policy-makers have often expressed concerns about the adequacy of the prevention incentives arising out of the WC system. Researchers studying WC often repeat these concerns. In view of these concerns, the various study panels considered a variety of reforms intended to enhance WC prevention incentives, including raising WC benefits. This report examines the conditions under which increased WC benefits will yield increased employer investments in prevention.

Our analysis suggests that there is often, but not always, good theoretical reason to expect increased benefits to induce employers to invest more in prevention. In analyzing the firm's response to WC financial incentives, this report identifies conditions under which employer prevention actions are enhanced, diminished, or unaffected by increased WC benefits.

WHY STUDY WORKERS' COMPENSATION FINANCIAL INCENTIVES AND SAFETY?

Several reasons suggest that further study of the effect of WC financial incentives should bear fruit. First, many reform proposals assume a relationship between WC and employers' decisions about prevention. Moreover, they assume that these incentives are inadequate and that enhanced incentives would substantially reduce injuries. Yet the evidence on these issues is unpersuasive. Finally, the challenge of

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2Report of the National Commission (1972), p. 87; other objectives include broad coverage, income protection, adequate medical care and rehabilitation services, and effective delivery system.


5Ibid., p. 96.


7Chelius (1977); Russell (1974).


9Others have identified conditions under which increasing WC benefits leads to less than the expected increase in prevention actions. See Viscusi (1980a), for example.
occupationally related diseases has stimulated a special set of proposals that may have implications for employers' decisions about workplace health.

Reform Proposals

Numerous reform proposals, advanced or adopted, assume a relationship between WC incentives and firms' safety decisions. Some of these proposals, such as the benefit and coverage increases urged by the National Commission and subsequently adopted by many states, assumed that increasing WC benefits always leads firms to increase investments in safety. That reasoning was offered as a partial justification for the increases proposed by the National Commission. Its report asserted that "if an inadequate proportion of lost remuneration is replaced by income benefits, then the stimulus to safety will be inadequate." More recently, the Interdepartmental Workers' Compensation Task Force and the Interagency Task Force on Workplace Safety and Health offered these arguments in their assessments of the case for further WC benefit increases.

Other reform proposals share the common belief that the availability of WC insurance tends to diminish the employer's willingness to invest in prevention. The Interagency Task Force report (erroneously) concludes that "A firm which self-insures for workers' compensation pays all its injury costs and has the maximum incentive for prevention" (emphasis added). As a consequence, the Task Force considered several proposals to enhance the "deficient" incentives arising out of WC insurance arrangements. These included extending experience rating to smaller firms, mandating deductibles for all firms, limiting the federal tax deductibility of WC insurance premiums, and imposing a separate injury tax on employers. While concluding that all would have a desirable effect on employers' decisions about prevention, it rejected, on unrelated grounds, all but the tax deductibility measure.

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10Hereafter "incentives" is used to mean "financial incentives facing the employer" unless the context suggests otherwise.
11We neither endorse nor oppose any of these proposals in this report. We raise them as examples of where careful examination of WC incentives and their effect on employers' safety decisions may aid in the evaluation of reform proposals.
14Ibid., p. IV-8; the National Commission report echoes this view.
Occupational Diseases

The "occupational disease problem" presents a major challenge to the WC system. Several proposals have been made to compensate victims of these diseases outside of the traditional WC system. Congress followed this path with "black lung." Others propose separate schemes for other diseases or for all diseases. Depending on the proposal, employers, employees, the federal government, or some combination of the above would finance these compensation funds. As with WC, the financing method chosen for disease compensation funds may significantly influence the willingness of employers and employees to reduce the risks of these diseases—hence the ultimate cost of the compensation program.

Existing Evidence

Despite the reliance of policymakers on the assumed relationship between WC and WC-like financial incentives and prevention, the evidence produced by the research community appears unpersuasive. Empirical research has examined the relationship between WC benefits and both injury rates and duration of disability. Researchers argue that an increase in WC benefits may have two simultaneous countervailing effects. On one hand, it induces employers to invest more in prevention, with a consequent decline in injury rates. On the other hand, benefit increases move workers to be less careful, report more injuries, press more claims, or remain away from work longer, with a consequent rise in injury rates or duration of disability. The research has not disentangled the two effects. If the former effect dominates, the observed relationship between WC and injury rates will be negative; if the latter dominates, the relationship will be positive.

Most of the empirical work to date finds a positive relationship between WC benefits and injury rates, but the results are not very convincing. In a study for the National Commission, Chelius (1973) examined injury rates in more than 2600 establishments in 17 manufacturing industries in 15 states. He analyzed the effect of higher WC benefits on the general injury frequency rate, serious injury frequency rate, and severity of injury. He found a positive relationship with re-

\[1^6\] There is a great deal of disagreement over what constitutes an occupational disease. However one chooses to define such a disease (and we take no position here), the policy debate rages on and reforms are being proposed. The analysis in this report is not intended to address the question "What is an occupational disease?"; rather it seeks to advance our understanding of the likely effects of different proposed reforms on employers' prevention actions.
spect to the former but no effect on either the frequency of serious
injuries or the severity of injury. From this one might conclude that
either the WC has no effect on employers' safety decisions or that the
employee effect dominates. However, an important anomaly in the
results leads us to reject both inferences. Instead we question the
credibility of the results themselves. The only difference between the
general injury and serious injury frequency rates is the inclusion in
the former of minor injuries with only 1 to 3 lost workdays. The
significance of the former results but not the latter suggests that
higher WC benefits lead workers to be more careless (or report more
injuries) with respect to only these minor injuries. Yet these injuries
are specifically not covered by WC benefits. Thus, Chelius' results
suggest that in response to higher WC benefits, workers exercise less
care (or increase reporting) only where WC is not applicable.

Butler (1982) examined injury rates in 15 South Carolina manufac-
turing industries over a 32-year period. He looked at the relationship
between injury rates and WC benefits for four classes of injuries: tem-
porary total disability, permanent partial disability and permanent
total disability, and death. While most of the time he found higher
WC benefits associated with higher injury rates, the statistical signifi-
cance of his results was mixed. Again, we might be tempted to infer,
as Butler did, that the employee effect dominates—except for an
anomaly in the results. Butler found that a 1 percent increase in WC
benefits raised the minor injury rate by only 0.13 percent, but raised
the incidence of workplace deaths by nearly nine times that. Could the
lure of increased WC benefits actually induce workers to sacrifice
their lives rather than merely their fingertips?

What may account for the persistent finding that higher WC bene-
fits are associated with higher injury rates? Several possibilities de-
serve mention. First, it is possible that the employee effect does
dominate, although the studies cited are not persuasive, given the
anomalous results described above. Second, the estimating equations
may not be properly specified. The relationships being analyzed in
these studies are complex; the data available for important variables
are often unmeasurable or measured with large error; and the many
simultaneities often make causation difficult to sort out. An alterna-
tive explanation is that high injury rates might cause high WC bene-
fits—not the reverse. In states where hazardous employments are
concentrated, workers are more likely to prefer higher WC benefits,

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17Chelius has found this pattern of results in several other studies. See Chelius,
1974 (frequency rate: positive; severity: no effect); Chelius, 1977 (frequency rate: posi-
tive); Chelius, 1982 (frequency rate: positive; severity: no effect).
may be better organized, and may be more able to effect their WC preferences through the political process.

Not all studies find that increasing WC benefits increases injury rates. In recent work, Chelius (1982a) examines manufacturing industries in 36 states for 1972-75. He finds that higher WC benefits increase the injury frequency rate, but decrease the severity rate. Chelius and Smith (forthcoming) examine injury rates in manufacturing industries to assess the effect of experience rating. They find no significant differential effect of higher WC benefits on injury rates of smaller and larger firms.

Finally, Smith (1974) finds that employers do in fact respond to increased injury costs. While not looking specifically at WC costs, he estimates that a 1 percent increase in injury costs leads to a 0.15 to 0.30 percent decline in injury rates.

The evidence cited above, coupled with the assumed relationship between WC benefits and employer prevention actions, motivates the research reported on herein. This report seeks to provide policymakers and researchers with a clearer understanding of the likely effects of WC incentives on employers’ decisions about safety and health. Our analysis should aid policymakers in evaluating proposed reforms and researchers in conducting better empirical research on WC and safety.

SCOPE OF THE REPORT

This report examines the effect of WC financial incentives on employer safety decisions. We focus on employer decisions because WC (and OSHA) assign primary responsibility for safety to the employer. We recognize that safety is a joint employer-employee undertaking; that changes in the WC system may influence employees' behavior as well as the employer's; and that the employer's decisions about safety could well affect how employees act. However, because the problem of analyzing employers’ decisions is complex enough, we leave employee-employer interactions for analysis at another time.

We also analyze only the effect of WC financial incentives on the employer's decisions about prevention, although we are aware that nonfinancial factors may also be influential, such as management attitude, insurance loss control services, OSHA regulations, and internal safety organizations. Moreover, some financial incentives will arise from non-WC sources—the direct costs of injuries, OSHA penalties, and the like. We ignore these factors in this analysis—not because they are unimportant, but to better focus on WC financial incentives.
Finally, we are concerned with the effect of these incentives on employers’ safety decisions—not with the social optimality or desirability of the incentives or the resulting level of safety.

A NOTE ON METHODOLOGY

This report presents the results of a theoretical analysis of employer decisions about prevention. It examines how we would expect WC financial incentives to influence rational, profit-maximizing firms. It does not report observational data on such firms. That will be the subject of related econometric work currently in progress.

Any theoretical analysis must simplify reality. The analysis does not purport to address every factor influencing a firm’s prevention decision nor every type of firm or hazard. This willingness to abstract from the complexity of the real world allows us to focus attention on important principles and aspects of behavior that might otherwise be obscured by that complexity. Abstraction has costs, but if the principles used in constructing our theoretical models are well chosen, the inferences we draw from the models will usually provide useful, although imperfect, guidance to real world phenomena.

The analysis leads to a series of propositions about employer behavior which, while often stated boldly, should be interpreted in a limited way. We typically offer conclusions as ceteris paribus—or "all other things being equal"—statements. Thus, where we might conclude that a large, experience rated firm will invest more in safety than a self-insured firm, the appropriate interpretation contrasts two firms that are otherwise identical in all material characteristics—size, industry, location, employee mix, management attitude, information, etc.

Economic models contain a key assumption that firms are rational profit-maximizers that view the decision to invest in prevention as they would any other economic decision. This does not imply that we believe economic factors alone determine prevention decisions. Many noneconomic factors may play important roles, including public pressure and employee, union, and management attitudes. Our case studies examine the importance of these factors. Nevertheless, we concentrate on economic factors here because they are likely to be important and operate in predictable ways, while the other factors are less predictable and more difficult to measure. We have consistently heard from safety professionals that the way to persuade a firm to increase prevention is to show that it is profitable to do so. That assumption guides the theoretical analysis used here.
ORGANIZATION OF THE REPORT

Three chapters follow. Chapter 2 provides a general framework for analyzing the financial factors that influence employers’ prevention decisions. It helps place the WC incentives in a broader context and defines many concepts used in later chapters. Chapter 3 examines WC and safety in self-insured firms. Chapter 4 discusses the influence of WC incentives as transmitted by insurance on prevention decisions.
Chapter 2

WORKERS' COMPENSATION FINANCIAL INCENTIVES IN PERSPECTIVE:
AN ANALYTIC FRAMEWORK

Before examining the effects of WC financial incentives on employers' health and safety decisions, we present a general analytic framework. This framework has several purposes. First, it structures the problem for analysis, acknowledging that WC is only one of many financial factors that may influence risk-management decisions. Second, it defines for the reader several analytic concepts to be used in Chaps. 3 and 4. Finally, it provides an important part of the structure for the next phase of our research: a series of case studies of individual firms' workplace health and safety decisions.

To aid the exposition, we consider a hypothetical firm, the California Automated Tool Company (CATCO). CATCO is a medium-sized Los Angeles-based firm (500 employees) that manufactures machine tools. The injury rate in machine tool manufacturing is about average among manufacturing industries (see Table 2.1). CATCO exposes its workers to a full range of workplace hazards, among them contact with machinery, lifting, heat, noise, flying particles, and exposure to chemicals and dusts. A few of these chemicals and dusts are known to be harmful; several others have been suspected for many years of causing cancer or respiratory diseases, but the evidence is still fragmentary. One chemical, for which there are no adequate substitutes, has recently been rumored to be a carcinogen. For most of these substances, no evidence is available.

The firm has two plants, one in Los Angeles and the other in Northern California. CATCO self-insures, processing all WC claims in-house, and its general counsel's office handles all litigation-related activities for both WC claims and OSHA citations.

SIMPLE ANALYTICS OF PROFIT MAXIMIZATION

Our analysis maintains that a profit-maximizing firm like CATCO will invest in prevention up to the point where the costs exactly equal the benefits of an additional unit of prevention; that is, the marginal costs of prevention (MCP) equal the marginal benefits of prevention.
Table 2.1

INJURY RATE COMPARISONS AMONG INDUSTRIES

<table>
<thead>
<tr>
<th>Industry</th>
<th>Injury Rate</th>
<th>&quot;Lost Workday&quot; Injury Rate</th>
<th>Average Lost Workdays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine tools</td>
<td>14.6</td>
<td>5.1</td>
<td>78.9</td>
</tr>
<tr>
<td>All industries</td>
<td>9.5</td>
<td>4.3</td>
<td>67.7</td>
</tr>
<tr>
<td>All manufacturing</td>
<td>13.3</td>
<td>5.9</td>
<td>90.2</td>
</tr>
<tr>
<td>Sawmills</td>
<td>19.4</td>
<td>10.4</td>
<td>178.5</td>
</tr>
<tr>
<td>Banks</td>
<td>1.7</td>
<td>0.9</td>
<td>10.1</td>
</tr>
</tbody>
</table>


(MBP). In general, the total benefits of prevention will increase with additional units of prevention—but at a declining rate (see Fig. 2.1). This means that additional units of prevention are less and less effective in reducing injuries. The marginal benefits of prevention are given by the slope of the total benefits curve. The marginal benefits are generally positive, but decline with increasing safety inputs.

The total costs of prevention increase with additional units of prevention but typically at a constant rate (Fig. 2.2). Thus the marginal costs remain constant at all levels of prevention activity.

For each of its workplace hazards, CATCO will choose that level of prevention (S*) depicted by Fig. 2.3, where MCP equals MBP.

Factors that change the costs and benefits of precautions will change CATCO's prevention efforts. Changes in the benefits of prevention will influence investment in prevention in the same direction; that is, an increase in benefits increases investments (Fig. 2.4). Changes in the costs of prevention have the opposite effect, shifting the safety investment chosen from S1 to S2 in Fig. 2.5. That is, an

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1By prevention we mean prevention actions directed at a single specific hazard, e.g., an unguarded machine. Although a firm faces multiple hazards, for simplicity we assume that it faces only one. This is equivalent to assuming that prevention decisions are made about one hazard at a time—that is, that prevention decisions for different hazards are independent of one another.

2This is true unless the purchaser is sufficiently large that its additional purchases affect the price it must pay for safety inputs.
Fig. 2.1—Total and marginal benefits of prevention

Fig. 2.2—Total and marginal costs of prevention
Fig. 2.3—Selection of prevention level

Fig. 2.4—Effect of increased benefits on investment in safety inputs
increase in costs decreases investments. Many of these factors are discussed in the next section.

So far, we have spoken quite generally about the costs and benefits of prevention. We call the factors that influence the costs and benefits of safety the "determinants of safety" in the firm. We call the subset of financial factors the "financial determinants," of which WC is only one. We now set forth the financial determinants and how they might influence firms' decisions to invest in workplace safety.

**Costs of Prevention**

The costs of prevention take the form of either out-of-pocket expenditures or forgone production, hence forgone profits. Depending upon the course of prevention that CATCO pursues, its costs include one or more of the following:

- Cost of purchase, installation, operation, and maintenance of equipment (e.g., ventilation, machine guards);
• Cost of safety training, medical testing, and screening of employees;
• Cost of employee incentive programs;
• Forgone production from altering a production process to reduce risks (e.g., slowing assembly lines);
• Forgone profits from using a less efficient input mix (e.g., eliminating a useful but hazardous chemical input);
• Cost of information on hazards and precautions.

Benefits of Prevention

Injuries impose a variety of costs on a firm. CATCO attempts to avoid these costs by providing a safer workplace. The injury costs it avoids by prevention constitute the benefits of prevention. The most significant financial benefits of prevention include reductions in: 3

• WC costs and privately financed disability insurance costs
• OSHA noncompliance penalties
• Compensating wage differentials
• Damage to equipment and downtime
• Labor downtime, quit rates, and absenteeism
• Recruitment and training costs to replace disabled workers
• Administration and litigation costs in OSHA and WC

Workers' Compensation Costs. Some form of Workers' Compensation law covers 89 percent of all employees in the United States, 4 including all of CATCO's. These laws provide for limited but certain compensation for injured workers without regard to fault. To establish a claim, a worker only need prove the work-related cause of the injury and the extent of disability. While medical expenses are fully reimbursed, WC replaces only part of lost wages. While some compensation for permanent physical (and mental) impairment is provided, WC bars damages for other noneconomic losses (e.g., pain and suffering). Under California law, CATCO's employees would receive two-thirds of lost wages subject to a maximum of $175 per week. In addition, a worker who lost a hand, for example, would receive $21,770. California is a relatively low-benefit state. Maximum weekly benefits range from $98 in Mississippi to $859 in Alaska. The median state provides maximum weekly benefits of $216. By

3We ignore the potentially important noneconomic benefits of prevention—improved employee morale and labor relations, employer pride, etc.
comparison, injured employees at a CATCO competitor in Illinois (a high-benefit state) would receive two-thirds of lost wages up to a weekly maximum of $376.33 and a far more generous $71,503 for loss of a hand.⁶

Firms must pay these benefits to their injured employees. Some, like CATCO, self-insure; others purchase insurance from a state insurance fund or private insurance company. Preventing injuries will almost always reduce WC costs. As a self-insured firm, CATCO would save both the compensation payments and associated claims adjustment and, possibly, litigation expenses. For insured firms, all but the smallest will realize savings in current or future insurance costs ranging from a few dollars to more than several hundred thousand dollars, depending on the size of the firm, its industry and state, and the number and severity of the injuries prevented.⁶ Herein lies what we refer to as the WC financial incentive—the potential savings in WC costs as a result of preventing injuries and diseases.

**Employer-Financed Disability Insurance Costs.** CATCO provides all of its employees with both short- and long-term disability insurance protection. This provides the employee with the difference between his wage and the WC income replacement benefit. Since CATCO now self-insures, it reaps dollar-for-dollar savings from injury prevention. In its early years, it purchased this coverage from a private insurer. Even then, its insurance costs were influenced by its claims experience.

**OSHA Penalties.** Investing in prevention where required by statute or regulation may reduce a firm's exposure to OSHA noncompliance penalties and associated administrative and litigation costs. These penalties typically vary with the severity of the infraction and size of the firm. The average fine assessed for serious violations in California is $209. California OSHA also cites nonserious violations, but only 7 percent of these carry penalties, averaging $122.⁷ Federal enforcement of OSHA in all states produces similar figures (see Table 2.2). If OSHA inspectors found a serious violation at CATCO, the fine

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⁷The nature of these savings is described at length in Victor (1983), and portions are summarized in Chap. 4.

⁸California is regarded as an activist state from an OSHA enforcement perspective, yet North Carolina's OSHA, regarded as less activist, presents similar statistics. The average fine for a serious violation is $245; only 2 percent of nonserious violations carry fines, averaging $127. State Program Quarterly Evaluation Report CAL/OSHA Compliance, Consultation and Standards Activities, July 1981; Occupational Safety and Health Administration State Program Quarterly Evaluation Report—for the State of North Carolina, April 1981.
Table 2.2

FEDERAL OSHA PENALTIES, 1979

<table>
<thead>
<tr>
<th>Type of Violation</th>
<th>Penalty Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average penalty, serious violation</td>
<td>$340</td>
</tr>
<tr>
<td>% nonserious violations with penalties</td>
<td>3%</td>
</tr>
<tr>
<td>Average penalty, nonserious violation with penalty</td>
<td>$97</td>
</tr>
</tbody>
</table>

would likely exceed the state average ($209) since CATCO is much larger than the average firm. Avoiding this fine presents one, albeit small, incentive for prevention.

OSHA citations, because they must be posted in the workplace, may impose other economic and noneconomic costs on the firm. Being labeled an unsafe employer by a government agency may impair employee relations, increase quit rates, or enhance compensating wage differentials (see below). Frequently, we have heard that these difficult-to-quantify costs easily exceed OSHA penalties and are far more instrumental in influencing firms to invest in prevention.

Compensating Wage Differentials. Since Adam Smith, economic theorists have recognized the possibility that firms must pay wage premiums called compensating wage differentials (CWDs) to compensate employees for the risks of hazardous employments. The assumption is that employees understand the nature and severity of the risks faced, and have alternative, less hazardous employment opportunities; if they do (and are not risk-seekers), they will not supply labor to the more hazardous firms unless offered CWDs.

CWDs are difficult to measure. CATCO probably pays a CWD that reflects the common, easily appreciated risks faced by its workers, but does not reflect the exposure to chemicals whose hazards are not easily understood. Experienced employees, intimately familiar with the risks, will likely demand a larger CWD than new hires who have yet to learn precisely how risky their jobs might be. CATCO's highly skilled workers should also receive a larger CWD because there is a greater demand for them and they have many alternative, less hazardous employment opportunities. CATCO's employees undoubtedly receive a higher CWD than bank employees, but less

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8Although if employees widely believe a hazard exists, even if not verifiable, a CWD will be necessary to attract adequate labor.

9Viscusi (1979) finds that new hires underestimate job hazards but learn on the job. One response to improved knowledge is quitting; if the CWD is inadequate to compensate for the correctly perceived risk.
than employees in more hazardous firms or industries (e.g., meat packing). CATCO also pays a higher CWD than its Michigan competitor, MATCO. Because of the auto industry's slump and the resulting massive unemployment in the Great Lakes region, few of MATCO's workers have other good job opportunities, and therefore cannot demand large wage premiums. The larger these CWDs (in the sense of dollars per unit of increased risk), the greater the incentive for prevention.

The size of these CWDs has been the subject of much debate and empirical analysis. Most studies find a statistically significant CWD related to the risk of death, but not related to the risk of injury. The estimated effects vary widely. At the lower end, Thaler and Rosen (1975) suggest that reducing the risk of death by 1 in 1000 would reduce the annual CWD per worker by $200 to $300. At the upper extreme, Veljanovski (1978) estimates the annual reduction to be as much as $2700. In between are Brown ($400 to $600) (1980), Viscusi ($1500) (1978), and Smith ($1500 and $2000 in separate studies) (1973, 1976).

By reducing the risks facing workers, firms may reduce the CWDs—hence labor costs.

Other Costs of Injuries. Injuries and diseases may impose many other costs on firms. Production is lost and repair costs incurred when machinery is damaged. Production is also lost when workers, especially highly skilled ones, are disabled. Employers must recruit and train replacement workers. By preventing injuries, firms save these costs. Thus, even in the absence of WC and OSHA, firms may have significant incentives for prevention.

Folklore estimates place these costs at up to 10 times compensation costs. Their importance, while difficult to estimate, depends upon the nature of the disability, the identity of the injured worker, technology of production, and the size of the firm. If one of CATCO's unskilled workers suffered a one-week disability, the company would replace him from the existing labor pool—at relatively little cost—using overtime or part-time workers, or by shifting someone from a less important job. CATCO would find it more difficult to replace a skilled worker internally, and the costs of lost production higher. As the disability lengthens, the need for permanent replacement grows, generating recruitment and training costs. These costs are also larger

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10See Smith (1979) and Brown (1980) for reviews and critiques of the empirical literature.
11Heinrich (1980) estimates these costs at four times compensation costs; Simonds and Grimaldi (1956) think they may be less. Others we have spoken with say up to 10 times higher.
for a skilled worker than an unskilled one, and larger for smaller firms with smaller, less flexible labor pools and higher recruitment costs.

Uncertainty about Benefits of Prevention

Uncertainty permeates the firm's calculus about prevention. Employers make prevention decisions before OSHA inspections or injuries occur. Such decisions must be based upon the firm's perceptions of what will occur—that is, the expected benefits of prevention. These include the benefits described above, discounted by the likelihood that specific events will occur. Of the factors listed above, only the CWD, based on employee expectations, escapes this discounting by the employer. The firm must take into account three principal uncertainties:

- The likelihood of an injury,
- The likelihood of a successful WC claim being brought, and
- The likelihood of an OSHA inspection.

Uncertain Injury. The employer discounts all of the costs of an injury—compensation, equipment and labor costs, etc.—by the probability that an injury will occur. Every hazard presents an array of possible consequences, ranging from no injury to death or permanent disability. Since each consequence has a certain probability of occurrence, there is an associated distribution of probabilities for the typical injury hazard (e.g., an unguarded machine). Figure 2.6 gives a typical example where the most likely event is "no injury," and increasingly severe injuries grow less and less likely.

The position and shape of this probability distribution vary from hazard to hazard. One can envision exposure to some chemical hazard that produces, on one hand, a traumatic but short-term disability and, on the other hand, a slowly developing permanently disabling respiratory ailment. For certain levels of exposure, its probability distribution might resemble Fig. 2.7.

One can also envision exposure to some other chemical or dust that has little effect on most workers but permanently disables some non-trivial number who have particular sensitivities to it. The relevant probability distribution would resemble Fig. 2.8.

For each hazard, an "average consequence" becomes the focal point for employers' prevention decisions.\(^\text{12}\) Figure 2.9 depicts this average consequence—the mean of the probability distribution (\(X\)). Each consequence has a certain cost associated with it, as delineated

\(^{12}\text{This assumes risk neutrality on the part of the firm.}\)
Fig. 2.6—Typical probability distribution for a hazard

Fig. 2.7—Probability distribution for injury from a hazard with both short-term and long-term effects
Fig. 2.8—Probability distribution for long-latency injury hazard

Fig. 2.9—The "average consequence" of a given hazard
above—WC costs, forgone production, etc.—but is reflected in the aggregate benefits of prevention.

Courses of prevention change the probability distribution. Some safety investments will uniformly reduce all risks of all consequences (Fig. 2.10a); others will primarily reduce the risks of more serious consequences (Fig. 2.10b); still others are aimed at higher frequency but less severe injuries (Fig. 2.10c).

In each case, prevention reduces the mean consequences and attendant costs of injuries. Firms compare these benefits with the costs of the proposed prevention action in determining investment in workplace health and safety.

CATCO, like many manufacturing firms, has a problem with back injuries. It is considering instituting a training program to reduce lifting injuries. Of its 500 employees, 20 are likely to suffer a disability requiring some absence from work. And typical of California firms, back injuries account for 24 percent of all WC claims involving lost time. In a normal year, CATCO employees will suffer five disabling back injuries. A typical back injury in California costs employers $24,000 in WC costs plus unmeasured non-WC costs. To advance the argument, let us say that these noncompensation costs equal the compensation costs ($24,000). Then the expected costs of back injuries for CATCO total $240,000 ($48,000 \times 5$ injuries). The training program under consideration would cost $2,000 for the materials and instruction and $7,600 for employee time during instruction ($9,600 total cost). CATCO would be willing to purchase this program if it would reduce the likelihood of injury (or mean consequences of injury) by 4 percent or more—a reduction of $9600 in expected injury costs ($240,000 \times 0.04$).

Uncertain Compensation. Not all work-related injuries and diseases result in WC claims, and not all claims are successful. The firm will further discount the expected benefits of prevention by these uncertainties. A lower likelihood of a successful claim being brought reduces investments in safety.

To illustrate this phenomenon, Fig. 2.11 depicts the total and marginal benefits of safety for three probabilities of a claim success. As the likelihood of success ($\gamma$) falls from certainty to 50 percent, safety investment falls from $S_1$ to $S_3$. The effect of uncertain compensation depends upon (1) how likely compensation is and (2) how large a share

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13The benefit curves in Fig. 2.1 are drawn by tracing how the mean consequences change with the addition of safety inputs ($S$).


Fig. 2.10—Effect of prevention actions on average consequences of a hazard
Fig. 2.11—Uncertain claims and safety incentives
of the benefits of prevention are the WC savings. Obviously, for more unlikely compensation, the firm discounts potential savings by a greater margin (see Fig. 2.11), and further reduces safety investments. A larger WC share of aggregate prevention benefits produces a greater effect on safety investment.

Why might workers not bring claims?\textsuperscript{16} This is not a very well-documented problem, and we will not pretend to provide a comprehensive answer. In fact, most workers probably bring most potential claims to the WC system. The overwhelming majority of claims arise from single-occurrence traumatic injuries. Because causation is clear, nearly all of these are likely to be brought.\textsuperscript{17}

By contrast, the high degree of uncertainty about causation means that workers will bring a smaller proportion of long-latency cumulative trauma and occupational disease claims.\textsuperscript{18} Thus, this discounting seems more important for long-latency claims and we can expect relatively less effective WC incentives here.

The factors influencing the decision to press a claim include the costs and benefits to the claimant, the ease or difficulty of entering the dispute resolution system, the uncertainty of outcome and the claimant's attitude toward risk, information about one's rights under the system, and availability of alternative, more efficacious, avenues of compensation (e.g., Social Security Disability Insurance). Anything that lowers the costs of bringing a claim will raise the probability it will be brought. Thus contingent fee arrangements, outreach activities of the WC agencies and unions, and the easy availability of legal representation all raise the likelihood of claims and, hence, the expected benefits of prevention and prevention itself.

Claims are more likely to be brought where the potential benefits to the claimant are greater. Larger claims are more likely to be brought than smaller claims. Pro-claimant liability rules and benefit schedules will also increase the likelihood of claims.

Even where claims are brought, doubt may surround both a finding of compensability or the amount of compensation. For most traumatic injuries involving no permanent partial impairment, both the fact and

\textsuperscript{16}Here we only consider bona fide work-related claims. Workers may bring claims for non-work-related injuries in hopes of obtaining WC settlements or possibly awards. These impose litigation and compensation costs on firms, but because workplace safety investments will not prevent them, they have no effect on investments in safety. One significant exception is where employer investments in employee health status reduce the likelihood of both work and non-work injuries (e.g., back injuries), reducing WC costs from both. We ignore this case.

\textsuperscript{17}Certainly the likelihood rises with the size of the claim, approaching certainty rapidly.

\textsuperscript{18}Barth (1981).
amount of weekly compensation and medical expenses are rarely disputed. For those involving a claim of permanent partial disability, valuation of the injury is often uncertain. The uncertainty about causation (hence compensability) increases for long-latency injury and disease claims. In both cases, the legal rules and practices of the relevant jurisdiction will determine the probabilities associated with different possible outcomes of the claim. The greater the likelihood and expected amount of compensation, the less the firms will discount the WC incentives for prevention.

**Uncertain OSHA Inspections.** A firm with a condition that violates OSHA standards must be prepared to pay a fine if caught. We have already seen that these fines are not very large; thus they are unlikely to provide much incentive to invest in safety. This incentive is further reduced as violators discount for the less-than-certain chance of being inspected and caught. Thus, if the average fine, if caught, is $200, but there is only a one-in-ten chance of being caught, a firm that seeks only to avoid fines would only come into full compliance in advance of being caught if it would cost no more than $20 ($200 \times 0.10) to do so.

**Valuing Costs and Benefits**

After discounting for these uncertainties, the value the firm attaches to the expected costs and benefits of prevention depends upon when the costs are incurred and benefits accrue, the firm’s attitude toward risks, and its ability to pass through costs.

**Present Value Comparison.** Where the prevention costs and benefits accrue in the current year, no adjustment is needed. Where they accrue in the future, the firm discounts them on the basis of their present value. The importance of this discounting rises where a safety investment has a useful life spanning more than one year. If it does, the firm equates the present value of prevention savings with investment costs. Of course, the present value falls as the interest rate rises.\(^{19}\) Discounting is also important for long-latency claims, where prevention expenditures must be made in each of, say, 20 years, but the benefits accrue only in the 20th year (when no claim arises).

**Risk Preference.** The way a firm values the costs and benefits of prevention also depends upon its attitude toward risk. Our discussions so far assume that the firm is “risk-neutral.”\(^{20}\) Two other possibilities

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\(^{19}\)Or other appropriate measure of the firm’s opportunity cost of funds.

\(^{20}\)Simply put, the firm is risk-neutral if it is indifferent about a gamble with even odds. For an interesting and (relatively) nontechnical discussion of risk preference, see Kahneman and Tversky (1982), pp. 160-173.
exist: risk aversion, or risk seeking. A risk-averse firm places more
weight on potential losses than on equivalent gains, and therefore
invests more to prevent losses than would a risk-neutral firm.
Risk-seekers exhibit the reverse behavior.

Ability to Shift Injury Costs. Usually, larger injury costs enhance
the incentive for prevention. But the ability to shift injury costs to the
consumer in the form of higher prices reduces prevention incentives.
That ability depends upon the "elasticities" of supply and demand for
the firm's product. The less elastic (price responsive) the demand, the
greater the ability to shift costs to the consumer. Demand is less elas-
tic where:

- Firms do not face much foreign or domestic competition,
- There are few good substitutes for the product, or
- All firms face the same injury costs.

The latter is especially important where a product is produced in
many states but purchased in a national market. A national "injury
tax" would affect all firms in the same way, making cost-shifting easi-
er. Under state WC laws, by contrast, firms in different states face
different injury costs. As a result, competing firms in states where
injury costs are unchanged will not raise their prices commensurately
with those of firms trying to pass on WC costs in a state with in-
creased injury costs. The latter firms could not pass through the in-
crease in WC costs as readily; hence, safety incentives would be
higher in that state.21

The more elastic the supply of the product, however, the greater the
ability to pass through WC costs.

The industry supply elasticity depends upon the firm's underlying
production technology, the elasticity of supply of productive inputs,
and the ease of entry into the industry. Where unit costs are relatively
constant, the supply is elastic; where unit costs are steeply increasing,
supply is relatively inelastic. Firms whose production technology
yields relatively constant unit costs across their range of operation
can better pass through WC costs, reducing prevention incentives.
Where productive inputs are elastically supplied, the firms can also
pass on a greater proportion of the WC costs. And where new firms
may readily enter the industry, industry supply is more elastic.

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21 This assumes no mobility or shifting of output to out-of-state plants.
SUMMARY

The firm makes safety decisions in light of the costs and benefits of additional prevention. The benefits of prevention are the costs of injuries avoided. WC savings are only one component of prevention benefits; others include reduced OSHA fines, CWDs, and profits lost from downtime, equipment damages, and recruitment and training costs necessitated by workplace injuries. In making these decisions, the firm takes into account uncertainty about the likelihood of injury, the prospect that Workers’ Compensation will be paid, and the chances of an OSHA inspection. The firm’s attitude toward risk, its ability to shift injury costs to consumers, and the time frame in which prevention costs must be incurred and benefits accrue, all influence the value placed on costs and benefits of injury prevention.
Chapter 3

EFFECT OF WORKERS’ COMPENSATION FINANCIAL INCENTIVES ON EMPLOYER SAFETY DECISIONS: SELF-INSURED FIRMS

In this chapter we examine the influence of WC financial incentives on a self-insured firm’s decisions to invest in additional workplace health and safety. (Chapter 4 examines firms who purchase insurance for most of their potential WC liability.) Real-world firms face complex decisions. We begin by analyzing a very simple case, and then discuss a number of complications.

THE BASE CASE

Consider the self-insured firm’s decisions about investments in health and safety in the simplest case where:¹

- The firm is risk-neutral and self-insured.
- Its only costs of injuries are WC costs; it pays no CWD and incurs no direct costs.
- It does not move its operations in response to a change in WC laws.
- Employees are risk-neutral and always follow safe practices, and their behavior is unaffected by WC benefit levels.
- The firm is seeking to prevent a single type of common traumatic injury (not long-latency injuries or diseases) that will occur in the current year from a single workplace cause.
- Prevention is undertaken with a safety input with a one-year useful life; its efficacy is certain; its price is stable from year to year.
- All claims are bona fide and successfully brought; claims are not contested.
- Liability is strict; compensation is limited.

¹In subsequent sections we relax many of these restrictions. Throughout we retain the restrictive assumption that employees are risk-neutral. In fact, employees are most likely risk-averse. When the interaction of employer and employee risk preferences are taken into account, some of our conclusions may be altered.
The firm’s profits depend upon its revenues, production costs, injury costs, and injury abatement costs. In maximizing profits, the firm chooses that level of safety where the marginal cost of prevention equals the marginal benefits of prevention. In the absence of OSHA fines and direct injury costs, the marginal benefits of prevention are the compensation costs avoided by investing in one additional unit of prevention. As general propositions, we conclude that (1) increasing WC financial incentives will increase prevention actions, and (2) the increment in safety investment diminishes with successive increases in WC financial incentives.\textsuperscript{2} Increasing the costs of WC raises the marginal benefits of prevention. This stimulates the firm to undertake additional, but previously uneconomic, investments in safety (to $S_2$) (see Fig. 3.1). As a general rule, larger increases in WC incentives produce greater safety investment and consequent reduction in workplace risk, other things equal.

\textbf{Fig. 3.1}—Increasing WC benefits increase safety investments

\textsuperscript{2}See the Appendix for formal proofs.
However, successive increases in WC financial incentives will typically yield progressively smaller increments in safety investment. This follows from the nature of the abatement technology we have (quite appropriately) assumed (see Fig. 3.2). Successive increases in safety produce smaller and smaller reductions in the likelihood of injury—hence in the benefits of prevention. In Fig. 3.2 the move from $S_1$ to $S_2$ is equal to the move from $S_3$ to $S_4$, but the prevention benefits from the first (AA') far exceed those from the second (BB').

![Diagram](image)

**Fig. 3.2**—Diminishing safety returns to WC benefit increases

From a national perspective, this means that the greatest gains in prevention from increases in WC incentives occur in the low-WC-incentive states, other things equal. (It also means that OSHA enforcement by way of deterrence is likely to be most effective in these same states, ceteris paribus.)

**CWD and WC Incentives**

The base case neglects the possibility that workers are paid a wage premium for the hazardousness of their work. Chapter 2 outlines the
conditions under which this might occur. Tight labor markets and well-appreciated risks create the necessary environment. The CWD will not compensate the worker for the entire expected risk, but only for the uncompensated portion of the risk. If the employer were obligated to compensate an injured worker for all pecuniary and non-pecuniary losses, no uncompensated risk would exist and the CWD would be zero. The more the employer’s liability falls short of full compensation, the greater the CWD.

An increase in WC benefits means a decrease in the CWD. Where the firm pays a perfect CWD, an increase in the WC incentive increases the marginal benefits of prevention, but is exactly offset by a decrease in the CWD incentive; on balance, increases in WC yield no change in safety investment in the presence of a perfect CWD (Fig. 3.3a). For a less than perfect CWD—that is, where workers do not fully appreciate risks or where labor market conditions reduce the full CWD—the change in the CWD will not entirely offset the increase in WC incentives (Fig. 3.3b). In this case, increasing WC will increase safety investments, but by less than where no CWD exists.

We would expect a greater effect of WC on safety investment where the CWD is imperfect or nonexistent. Chapter 2 listed those conditions: high-unemployment areas, unskilled workers, and new employees facing unfamiliar risks.

**Employee Work Practices and WC Incentives**

The base case assumes that employees always follow safe practices. This implies that the returns to abatement that the employer expects are always realized. In practice, employees may not always use goggles or earplugs or may remove machine guards, etc. These actions reduce the expected benefits of what we have called safety inputs (see Fig. 3.4). Formally stated, where $\gamma$ is the proportion of time the safety input is used, the benefits of investment in that input will be discounted by $1 - \gamma$. If all employees always wore their goggles, $\gamma$ would equal zero. Where the goggles are worn only a fraction $(\gamma)$ of the time, or by a fraction of the workers, failure to consistently use the goggles reduces the WC prevention benefits by $(1 - \gamma)$, and hence investment in safety from $S_i$ to $S_i'$. The more often employees ignore safe practices...

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3Fully reflects the uncompensated risk.
4For a formal proof, see the Appendix.
5The effect of WC incentives in the presence of a CWD depends upon the firm’s insurance arrangement. In Chap. 4, we analyze the case of an insured firm.
6$\gamma$ could also represent the proportion of employees wearing goggles. In general $\gamma$ represents the fraction of all exposure during which employees wear goggles.
Fig. 3.3a—Compensating wage differentials, WC benefits, and safety investment
(the lower is $\gamma$), the less employers will invest in prevention, resulting in a more hazardous workplace. If employees wear goggles only half the time, WC incentives would fall by 50 percent; that is, the employer would willingly spend only 50 percent as much on additional prevention. Thus, employee failure to follow safe practices not only leads to work injuries in its own right, but also reduces the employer’s incentives to take certain precautions.\footnote{From this it follows that if WC benefit-increases reduce the employees’ incentives to take care, they will also reduce, at the same time, employers’ incentives to increase safety investments.}

**Injury vs. Disease Prevention**

There are many reasons why the effects of WC on decisions about injury prevention may differ from those on disease prevention.\footnote{Here we use “injury” as shorthand for the traumatic, single-cause injury or disease that occurs during the next year, and “disease” as shorthand for the long-latency, repetitive exposure disease, or cumulative trauma.} On
balance, the financial incentives for injury prevention appear likely to exceed the incentives for disease prevention. We conclude this because:

- Under current law and practice, disease claims are less likely to be brought and less likely to be successful if brought, than the typical injury claim.
- Disease claims accrue many years after prevention costs must be incurred, while injury claims are brought much more contemporaneously.
- The efficacy of many courses of disease prevention is often uncertain, while the efficacy of prevention actions for injury hazards is typically well understood.
- Many disease hazards may not be fully recognized.

We examine each of these propositions in greater detail and trace out their implications for decisions about prevention.

It is commonly thought that workers bring a smaller percentage of successful disease claims than injury claims. The meager data on this issue indicate that few long-latency disease claims enter the WC system, although cumulative injury cases are becoming more abundant. A recent study by Barth (1981) indicates that only 29 percent of asbestos victims filed WC disability claims (36 percent of their survivors filed death claims) despite widespread media attention to asbestosis and an aggressive outreach campaign by the asbestos workers union. By contrast, it is believed that the preponderance of all traumatic injury claims are brought.

The base case assumes that workers successfully bring all claims. Where the likelihood of bringing a successful claim for a work-related disability is less than a certainty, the WC incentive to abate the hazard is reduced proportionately. In terms of our model, the firm will equate MCS and MBS, but will discount the potential WC savings (prevention benefits) according to the likelihood of a successful claim (8). The lower is that likelihood, the greater the reduction in safety investment (see Fig. 3.5). Where the likelihood of a successful claim approaches 0.3 to 0.4 (as in Barth's study of asbestos victims), firms receive WC financial incentives for disease prevention only 30 to 40 percent of those for the prevention of an injury that entails an identical disability.

Why might disease claims not be brought or succeed? Several reasons have been suggested:

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9 Most of the small number of disease cases in the system are the result of traumatic occurrences rather than long-latency manifestations.
Fig. 3.5—Likelihood of a successful claim and safety investments

- Workers are not aware of the cause and work-relatedness of their disability;
- Workers are not aware of their rights to compensation;
- Workers are afraid of the legal system;
- Claimants have to carry an intimidating burden of proof in disease cases.

Policy actions that change any of these conditions, hence the likelihood of an action, will have safety implications.

Injury prevention incentives may also exceed disease prevention incentives because the savings from the latter occur in the distant future while the savings from the former accrue in the next year or so. Consider a traumatic injury hazard, where the most likely injury is a permanent total disability sometime during the next year. To simplify the discussion, assume that the disabled worker receives, as compensation, a lump sum payment equal to the present value of all compensation owed. Call this V. If this injury were certain to occur, the firm
would willingly pay up to V dollars to prevent it. Now consider an occupational disease hazard that could be prevented by a one-time expenditure today. This hazard, if unabated, will give rise to an identical permanent total disability claim, but 30 years from now. During that period, the statutory benefit levels paid to disabled workers can be expected to grow—hence, the potential prevention savings will grow. At the same time, future benefit dollars are worth less to the firm than current prevention dollars—the savings must be discounted. How the incentive for disease prevention (V_d) compares with the incentive for injury prevention (V_i) depends upon the relationship between the rate of growth in benefits (b) and the interest rate (r) over the time period of latency (n):

\[ V_d = V_i[(1 + b)^n/(1 + r)^n]. \]

Where the rate of growth of benefits is less than the interest rate, disease prevention incentives fall short of injury prevention incentives.

Benefits have medical and income replacement components. From 1978 to 1981, medical costs increased at an annual rate of 10 percent. In many states, total and partial disability benefit levels grow with the growth in wages (7 to 8 percent in recent years). Other states revise these benefit levels only periodically; benefit levels often lag the growth in wages (1 to 5 percent). The growth in benefit levels is the weighted average of medical and income replacement benefit growth—approximately 8 to 9 percent during the 1978-81 period for a typical state.\(^{11}\)

Typically, the interest rate exceeds the growth in benefits, so that incentives for injury prevention exceed those for disease prevention. In states like California, which adjust benefits irregularly, larger disparities appear than in states that automatically adjust benefit levels by tying them to the state's rate of wage growth. To provide some notion of the size of this disparity under different assumptions, Table 3.1 presents the ratio of disease to injury prevention incentives for different combinations of rates of benefit growth, interest, and latency periods. In those states that tie benefits growth to wage growth, even if all claims were brought, the disease prevention incentives might only be 34 to 70 percent of the injury prevention incentives. In states that only periodically adjust benefits, the incentives might be even smaller.

\(^{11}\)In California during the 1970s, medical costs were roughly 40 percent of all benefit payments. If this is typical, average benefit-level growth is: 0.4 (10%) + 0.6 (7%–8%) = 8.2%–8.8%.
Table 3.1

**Ratio of Disease Prevention to Injury Prevention Incentives: Illustrative Assumptions About Interest Rate and Benefit Growth**

<table>
<thead>
<tr>
<th>Annual Benefit Growth (b) and Interest Rate (r)</th>
<th>Latency Period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>b = 10%, r = 10%</td>
<td>1.00</td>
</tr>
<tr>
<td>b = 8%, r = 10%</td>
<td>0.83</td>
</tr>
<tr>
<td>b = 8%, r = 12%</td>
<td>0.70</td>
</tr>
<tr>
<td>b = 5%, r = 10%</td>
<td>0.63</td>
</tr>
</tbody>
</table>

WC financial incentives for injury and disease prevention might diverge for another reason. The efficacy of most courses of injury prevention is well understood and reasonably certain, producing clear returns to injury prevention. By contrast, the potential payoff for reducing exposure to many disease-producing substances is highly uncertain. What, for example, are the consequences associated with different levels of exposure to formaldehyde or benzene? Will reducing exposure by 50 percent reduce the likely consequences by 50 percent? Or more? Or less? For many substances, managers' “best guess” may be their best and only guidance.

In the face of this uncertainty about the returns to disease prevention, the firm will discount the potential returns accordingly. As with anything that reduces the expected benefits of prevention, this uncertainty dilutes disease prevention incentives more than it does injury prevention incentives, whose returns are more certain.

Finally, experience has shown that we are not always aware of the harmful effects of substances in the workplace. Where firms do not recognize a potential hazard, the WC system can have no effect on prevention.\(^{12}\)

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\(^{12}\)Although it may provide significant incentives for firms, trade associations, and insureds to engage in research on suspect substances.
Personal Protective Equipment vs. Engineering Controls

So far we have assumed a generic prevention technology, abstracting from the specific form that prevention actions may take. Now we consider two approaches to prevention that are often substitutable: personal protective equipment and engineering controls.\textsuperscript{13} Workers use the former devices (goggles, respirators, earplugs, etc.) for protection against an existing hazard. Engineering controls seek to abate the hazard at its source (e.g., noise enclosure or ventilation). Often these controls involve design modifications in equipment or in the workplace itself. A respirator protects a single worker; a ventilation system protects all exposed workers. Thus the prevention benefits from a unit of personal protective equipment come from the reduced risk to a single worker; those from a unit of engineering controls come from the reduced risks to the firm's entire exposed work force.

Many debate whether the preferred strategy should be reliance on personal protective equipment (PPE) or engineering controls (EC). During the Carter administration, OSHA actions strongly favored EC. Supporters argued that controls were more effective, did not rely on employee cooperation for their success, and, unlike PPE, did not introduce new hazards. Opponents cited the cost of EC and the paternalism implicit in forsaking PPE.

We find that WC financial incentives may produce quite different effects on the two approaches.\textsuperscript{14} Our analysis of PPE yields the traditional results: Except for the other limiting circumstances described herein, increasing WC financial incentives always increases investments in safety. However, this standard result sometimes fails for EC. In fact, higher WC incentives may lead certain firms using EC to reduce investments in safety.

Why might this surprising effect occur? The distinction drawn in a prior paragraph provides the key: The prevention benefits from a unit of PPE come from the reduced risk to a single worker; those from a unit of EC come from the reduced risks to the firm's entire exposed work force. In the profit-maximizing decision for PPE, the abatement

\textsuperscript{13}We use these labels as shorthand to distinguish between a safety input that protects a single worker and an input that protects multiple workers. Strictly speaking, personal protective equipment may on occasion be used by multiple workers—e.g., goggles that are used by workers on more than one shift; and engineering controls might be used on a machine to shield one worker. We use these terms "personal protective equipment and engineering controls" because the policy debate has been framed in these terms and because most typically the former benefits individual workers and the latter benefits groups of workers.

\textsuperscript{14}An explanation follows; for a formal proof, see the Appendix.
decision is made at the level of a single worker. That is, will buying a better grade of respirator be cost-justified? By contrast, the decision to invest in a higher-quality ventilation system depends on the aggregate benefits across all exposed workers.

Increasing WC costs increases the cost of labor. As with any cost increase, the firm will reduce its use of the now more expensive input—labor. Doing so, however, does not affect the safety cost-benefit trade-off for the remaining workers for PPE. The quality of individual safety devices is independent of the number of exposed workers.

This is not true for the cost-benefit trade-off for EC. If this firm did not adjust its use of labor when WC costs rose, an increase in WC costs would increase the benefits of prevention (Fig. 3.6), and safety investment would increase from $S_1$ to $S_2$. Now let the firm reduce its use of labor. If WC represents a small share of labor costs, an increase in WC will mean a small increase in labor costs, producing a small effect on the use of labor ($L$). If the wage elasticity of demand for labor is small, the same is true. In either case, when WC increases, employment decreases but only by a small amount; on balance, safety investment increases, as depicted in Fig. 3.6.

As shown, the employment adjustment lowers the benefits of safety investment, on account of the remaining workers, from $S_2$ to $S_3$. This occurs for EC, where the benefits of a unit of safety affect all exposed workers: Decreasing the number of workers decreases the benefits of prevention. Where the employment effect is small, safety investment increases, but only to $S_3$ instead of $S_2$. This does not occur for PPE, where the benefits of a unit of safety accrue only to one worker. Reducing the labor force does not change the benefits of safety for the remaining workers.

Now assume that the employment response is much larger—that WC represents a significant share of labor costs and/or that the demand for labor is very responsive (elastic) to changes in labor costs. Here, the increase in WC increases the benefits of safety, ignoring the employment response. Safety investment increases to $S_3$ in Fig. 3.7. However, the employment response may be large enough to drive the MBP below its original level. If so, on balance, safety investment falls (to $S_3$).\(^\text{15}\)

Strikingly, OSHA insistence on mandating EC instead of PPE may weaken, neutralize, or even reverse the traditional WC incentives for prevention—possibly leaving the workplace more hazardous than it was at lower WC costs. At first glance, this seems like an odd result. It will not occur in every case involving EC. However, it is more likely

\(^{15}\)Of course, if capital can be substituted for labor in production, the addition of modern capital equipment often improves safety in the workplace.
Fig. 3.6—Engineering controls, WC benefits, and safety investment (small employment effect)

to occur where WC costs are a relatively large share of total labor costs and/or where the firm's demand for labor is relatively responsive (relatively elastic) to changes in hourly labor costs. Formally stated, this effect will occur when CS > 1/θ, where CS = WC costs/total labor costs (which is the WC cost share), and θ = wage elasticity of demand for labor.

WC cost shares will vary from industry to industry and firm to firm. In general, the more hazardous the industry, the larger the cost share. For the "average" firm, WC manual insurance rates (for different industries) approximate these cost shares. For individual firms, CS = (ε × MR)/(100 + MR), where MR = manual rate and ε = experience modification factor. The manual rate should be adjusted to reflect the firm's claims experience relative to the average experience, using

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16 Although these rates probably overstate the cost share (1) for insured firms who receive dividends on their WC policies, and (2) slightly for self-insured firms who provide administrative services at lower cost than the rates provide.

17 ε is an index of the firm's injury experience relative to that of the average firm in the same industry or classification.
an "experience modification factor." In California these factors range from as little as 0.3 to more than 5.0.

Table 3.2 presents manual rates and approximate cost shares for selected industries in California. Each is presented for a firm of average claims experience ($\epsilon = 1$) and for one that is twice as hazardous as the average firm ($\epsilon = 2$).

Table 3.3 presents the values of WC cost share and demand elasticity necessary to get this contrary case. In almost every conceivable industry, the elasticity of demand must be large. For a lead manufacturer with twice the average injury experience, the contrary case will apply if the elasticity of demand for labor exceeds 2.5.

When is the elasticity of labor demand sufficiently large to produce this case? Unfortunately, econometric estimates are available at the aggregate level, but not industry or firm level, and are not useful for our purposes. We do know that the demand for labor is more elastic when:
Table 3.2

MANUAL INSURANCE RATES AND WC COST SHARES,
SELECTED INDUSTRIES

<table>
<thead>
<tr>
<th>Insurance Class Code</th>
<th>Industry</th>
<th>Manual Rate (% of Payroll)</th>
<th>Cost Share $\epsilon = 1$</th>
<th>Cost Share $\epsilon = 2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4567</td>
<td>Lead manufacturing</td>
<td>24.5</td>
<td>.197</td>
<td>.394</td>
</tr>
<tr>
<td>1803</td>
<td>Stone cutting</td>
<td>18.9</td>
<td>.174</td>
<td>.348</td>
</tr>
<tr>
<td>2797</td>
<td>Auto body manufacturing</td>
<td>11.6</td>
<td>.104</td>
<td>.208</td>
</tr>
<tr>
<td>2710</td>
<td>Sawmills</td>
<td>9.3</td>
<td>.085</td>
<td>.170</td>
</tr>
</tbody>
</table>

NOTE: Figures include only wages, not fringe benefits.

Table 3.3

CONDITIONS UNDER WHICH INCREASING WC BENEFITS REDUCES SAFETY INVESTMENT

<table>
<thead>
<tr>
<th>If the cost share is...</th>
<th>The demand elasticity must be at least:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>0.4</td>
<td>2.5</td>
</tr>
<tr>
<td>0.3</td>
<td>4</td>
</tr>
<tr>
<td>0.2</td>
<td>5</td>
</tr>
<tr>
<td>0.1</td>
<td>10</td>
</tr>
</tbody>
</table>

- Other inputs (e.g., capital) may be substituted for labor;
- Labor is not very productive (its output elasticity is small); and
- The demand for the product is relatively price elastic.

The last condition tells us the most empirically. The elasticity of demand for a firm's product is larger when that firm is in a very competitive industry. This competition may come from other domestic producers or from foreign firms. Firms producing steel, autos, and semiconductors are examples of firms facing a large elasticity of de-
mand for their products. We do not contend that these industries in
fact experience the contrary response to WC incentives; only that they
(and others like them) are good candidates. Moreover, the higher the
WC cost share, the better candidates they are.

There is another instance where the demand for labor might be
significantly affected by an increase in WC premiums. Consider a Cali-
ifornia firm in a very competitive industry, selling its product in a
national market and with its competitors scattered across the nation.
If all states raise WC costs by the same amount, and there is no for-
eign competition, some but not all of the increased costs can be shifted
to consumers by all firms. However, if only California raises WC costs,
the need to compete means that California firms cannot readily shift
costs, and the impact on the demand for labor would be relatively
large. As a result, under the right conditions, single-state increases, or
larger-than-average increases in WC benefits, might produce the kind
of cutback in employment that generates the contrary safety response.

Inflation and Safety

Normally, incentives for prevention increase as WC benefits in-
crease (Fig. 3.1). Since benefits often grew dramatically in the wake of
the National Commission Report (1972), one might expect that these
incentives—and safety investment—increased commensurately. How-
ever, this effect presumes that prices, especially the price of abate-
ment inputs, remain stable.

If prices rise faster than WC benefit levels, WC prevention incen-
tives will in fact decline (see Fig. 3.8). Increasing WC benefit levels by
X percent will increase safety investments in the base case from S1 to
S2. However, a larger than X percent increase in abatement input
prices will offset this increase, reducing safety investment below S1 to
S3.18

The impact of inflation on incentives depends upon the relative
rates of change of abatement prices and WC benefits. The price of
abatement inputs is tracked by the BLS in two producer price indices,
one for industrial safety equipment, the other for devices. Table 3.4
presents selected values.19 From June 1978 to December 1981, the
prices of devices and equipment rose at an annual rate of 6.6 and 7.6
percent, respectively. Where this exceeded the rate of growth in WC

18More generally stated, inflation erodes safety incentives—WC and otherwise—if
the price of abatement rises faster than the value of the benefits of abatement described
in Chap. 2. Inflation will affect each component differently.

19The indices were initiated in June 1978.
Fig. 3.8—Inflation, WC benefits, and safety investment

Table 3.4

PRODUCER PRICE INDEX
(June 1978 = 100)

<table>
<thead>
<tr>
<th>Date</th>
<th>Safety Equipment</th>
<th>Safety Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 1978</td>
<td>102.9</td>
<td>103.7</td>
</tr>
<tr>
<td>Dec 1979</td>
<td>111.3</td>
<td>112.5</td>
</tr>
<tr>
<td>Dec 1980</td>
<td>117.8</td>
<td>120.6</td>
</tr>
<tr>
<td>Dec 1981</td>
<td>125.1</td>
<td>129.1</td>
</tr>
</tbody>
</table>

benefits, safety incentives eroded; where it was less, safety incentives were fortified.

Three types of WC benefits account for most of the WC safety incentives: medical, temporary total disability, and permanent partial disability. Medical care is among the fastest-rising components of the Consumer Price Index (CPI). From January 1978 to October 1981, a period of less than four years, the medical cost-of-living index rose nearly 45 percent—an annual rate of 10 percent. Although various cost-containment practices by WC agencies and insurers may have reduced the growth of WC medical costs below the economy-wide rate, the increase in medical costs undoubtedly outpaced the growth in abatement costs.

WC statutes often peg temporary total disability benefits at some fraction of a worker's wage, subject to some maximum. For those whose wages fall below the maximum, benefits grow with their wages. This growth rate can be approximated by the growth in the state average weekly wage (SAWW). From 1978 to 1981, the SAWW in most states grew by an annual rate of 7 to 8 percent—roughly the same as the growth in abatement costs.

For those workers constrained by the maximum, their benefits will, of course, increase as the maximum increases. States' maximums fall into two categories. Most states tie their maximums to the SAWW. Each year the maximum is automatically adjusted by the growth in the SAWW—7 to 8 percent annually from 1978 to 1981. Nine states currently adjust their maximums only by periodic legislative action. In six of those, the maximums grew by less than the maximums in states that make automatic adjustment (2.0 to 5.9 percent). More important, these maximums grew by less than the growth in abatement costs.

In response to the National Commission Report, many states switched their approach from periodic to automatic adjustment. Other states increased the benefit replacement rate.\(^{20}\) In both cases, the transition period produced a sharp increase in benefits. As a result, the growth of WC safety incentives in these states far outpaced the growth of abatement costs, so that real incentives increased as a result of the reforms.

Two types of permanent partial disability benefits are common. The first is determined by schedule—so much money for loss of an eye, leg, etc. The second is determined by often complex formulas and administrative practices. For the latter, it is difficult to estimate the growth in benefits. We only do so for scheduled injuries.

\(^{20}\)The percentage of pre-injury wages replaced by temporary total benefits.
Many states also tie permanent partial disability benefits to the SAWW. In these states, benefit levels increased in line with abatement costs, maintaining real WC safety incentives from 1978 to 1981. In a number of other states, reforms in the permanent partial schedules resulted in major benefit improvements. Washington State provides an example. While its temporary total benefits grew by an annual rate of 8 percent from 1978 to 1981, permanent partial benefit levels grew by 26 percent per year. As with the temporary total benefits, these large benefit enhancements stimulate real increases in WC safety incentives. In still other states, permanent partial benefits grew much more slowly than the SAWW. Five states did not adjust scheduled benefits at all from 1978 to 1981. In these states, inflation eroded the resulting WC safety incentives (rendering them nearly 1/3 less in 1981 than 1978).

In summary, inflation produced the following effects on WC safety incentives:

- Increases in medical costs have helped increase real WC incentives.
- Tying permanent partial and temporary total benefits to the SAWW has helped keep incentives even with inflation.
- Major reforms that have increased benefits have increased real incentives.
- In most states that adjust temporary total and permanent partial benefits only periodically, incentives have eroded.

Multiple Causation and WC Incentives

Ordinarily, compensation is due when disability results from a workplace cause. Occupational diseases and cumulative traumas present special problems for the WC system. In each, workplace causes may constitute only a partial—maybe not even a major—cause of disability. For example, the relationship between workplace exposures to various substances, smoking, and a larger number of diseases is well established; back injuries often result from the

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21 Alaska, Colorado, Missouri, New York, and North Dakota. Also California (hearing loss).

22 Often the issue of causation turns on epidemiological evidence. For example, if workers in plant X have twice the expected rate of lung cancer, a workplace cause is inferred. For any given worker, causation is not proved directly—only in a probabilistic sense. Since the disease may occur apart from workplace causes, the personal cause is also established in a probabilistic sense. The policy question is how to balance these two causes in a compensation system.
combined effects of work and personal activities as well as the normal aging process.

Since it is often difficult to prove precisely what caused the disability, several approaches have emerged, each holding employers responsible for compensating workers whose disability is arguably the result of both personal and workplace causes. In some states, any nexus with employment triggers full WC liability. We call this a "strict causation" approach, by analogy to strict liability. Recently, North Carolina adopted a rule that apportions liability in byssinosis cases according to the relative importance of the personal and workplace causes. Again, by analogy, we call this "comparative causation." Some other states exclude "ordinary diseases of life" from compensation—implicitly presuming dominant personal causes. We call this a "dominant causation" rule.

Each of these approaches to compensation leads to different employer prevention incentives. Under a strict causation rule, the employer has incentives to modify both his and the employee's conduct insofar as either contributes to the disability. Thus we should see employer prevention and screening programs for occupationally related diseases and back injuries. We should also see employers taking employee health status and personal habits (e.g., smoking) into account in hiring decisions.

Under a comparative causation rule, the employer is liable for compensation only in proportion to the importance of the workplace cause. Here the employer has incentives to modify only his behavior, not the employees'.

Under a dominant causation rule, the employer is liable only where the workplace cause is dominant. Under this rule, the employer has incentives to modify his and the employees' conduct for some classes of disabilities but not others; here we should see screening and prevention programs for disabilities with dominant workplace causes, but not for ordinary diseases of life.

Risk-Aversion and Safety

Up to now we have assumed that the firm is risk-neutral; that is, it weights each possible consequence by the probability of its occurrence. Risk-neutral firms take the mean consequence of injury ($\bar{X}$ in Fig. 3.9) as the focal point for safety investment decisions.

Risk-averse firms place greater weight on more serious, although less likely, consequences. The focal point for safety decisions is still

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23If synergies between the personal and workplace cause are charged in any part to the employer, the employer has incentives to modify the employee's conduct.
the weighted sum of the consequences. But because firms accord greater weight to the more severe losses, the focal point exceeds the mean consequence by some amount (δ). The size of δ depends on the degree of risk-aversion. The more risk-averse a firm is, the greater is δ.

How does risk-aversion affect safety decisions? Recall from Chap. 2 that the prevention-benefits curve under risk-neutrality flows from the mean consequence of injury. For a risk-averse firm, the benefits of safety are analogous; however, the mean consequence (\( \bar{X} \)) plus the risk premium (δ) determine the benefits of safety. A risk-averse firm perceives higher benefits from prevention than does a risk-neutral firm (Fig. 3.10); it therefore will invest more to avoid losses, ceteris paribus.\(^{24}\)

Risk-aversion will also influence the types of abatement strategies favored by firms. As compared with a risk-neutral firm, risk-averse

\(^{24}\)Risk-seeking is the opposite of risk-aversion. Its consequences are the reverse of risk-aversion.
firms will have a greater preference for abatement actions aimed at the most severe consequences.

**Information and Safety**

Information about the existence and nature of hazards, and about the appropriate courses of prevention, is a necessary input to prevention decisions. This information is costly, however. Trained personnel must inspect the workplace, identify hazardous conditions, and search out effective remedies; chemical substances must be monitored; medical and epidemiological research must be supported; etc.

The costs of information add to the costs of prevention. The more costly the information is, the less will the firm invest in prevention. Especially for disease hazards, individual firms may find information costs prohibitive. In this case (and for some injury hazards as well), both the WC system and OSHA may play critical roles. The WC system provides financial incentives for firms to come together, often
through trade associations, to support research, provide information, and conduct inspections. Insurance companies also receive incentives to produce this information for their insureds. The resulting economies of scale in producing information lowers the cost of information, hence prevention, to individual firms and enhances safety. OSHA may have analogous effects by providing free information to firms. Research sponsored by the National Institute for Occupational Safety and Health, the promulgation of regulations governing hazardous substances, OSHA's consultation services, where used, and unions' information efforts, all serve to call attention to hazards at little or no cost to employers.

SUMMARY

The common wisdom that WC benefit increases will increase safety investments sometimes fails. While generally true, we have described a number of reasonable circumstances under which an increase in WC benefits is likely to reduce or have no effect on employer investment in safety. These involve (1) relatively rapid inflation in safety input prices; (2) the presence of a significant compensating wage differential; and (3) hazard abatement using engineering controls rather than personal protective equipment by firms in hazardous industries where the demand for labor is very responsive to changing labor costs (e.g., firms that face significant foreign competition). The last circumstance means that with OSHA's preference for engineering controls over personal protective equipment in these industries, OSHA and the WC system work at cross-purposes.

WC financial incentives are likely to be more effective stimulants for prevention of occupational injuries than for prevention of diseases.
Chapter 4

EFFECT OF WORKERS’ COMPENSATION INSURANCE ON EMPLOYER SAFETY DECISIONS

Most of the results in Chap. 3 apply to insured and self-insured firms alike. The major differences for insured firms arise from:

- The size of insured incentives for prevention,
- The effect of insurance loss limitations on incentives, and
- The interaction of insurance and compensating wage differentials.

THE SIZE OF INSURED INCENTIVES:

Many assert that WC insurance dilutes the incentives for prevention. We have shown elsewhere that this is not necessarily true; more correctly, WC insurance may either enhance or diminish prevention incentives. Those incentives depend upon the nature of the merit rating and dividend plans used. Insurers use two types of merit rating plans: experience and retrospective rating.

Experience Rating

Under experience rating, the firm’s current loss experience affects its future premiums. The sensitivity of premiums to losses depends upon the statistical credibility of the firm’s loss experience. At one extreme, additional losses may have no effect on future premiums. At the other extreme, additional losses will be counted 100 percent in computing future premiums. In most cases, additional losses count to some extent, but not in their entirety. The larger are the firm’s actuarially determined expected losses, the more credible its experience and the greater the extent of experience rating.

The financial incentive facing experience rated firms is the present value of the future premiums saved as a result of prevention. Since

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premiums are based on losses incurred 2, 3, and 4 years previously, current prevention actions will be reflected in premiums 2 to 4 years hence.

Under the experience rating formula historically used by rate-making bodies, the prevention incentive increases with the extent of experience rating. We have shown elsewhere that the extent of experience rating rises with firm size, hazardousness of the industry, and wage level of the firm, and declines with the size of the loss prevented. Despite the impressions left by the National Commission (1972) and Russell (1974), firms need not employ more than a thousand workers to receive significant insured WC prevention incentives. An insured firm in a hazardous, high-paying California industry such as sawmills will have greater incentives than a larger self-insured firm if it has 25 or more employees.

Regardless of how WC affects safety in self-insured firms, experience rating may amplify or dilute the effect. Whether or not insurance enhances or diminishes the relative incentives depends upon the extent of experience rating. We have shown elsewhere (Victor, 1983) that some insured firms, not self-insured firms, have the maximum incentives for prevention. Where the insured firm is sufficiently large, high-paying, and/or in a hazardous industry, or the loss is sufficiently small, its prevention incentives may be 25 to 75 percent greater than those facing the otherwise identical self-insured firm. Of course, if the firm is sufficiently small, low-paying, and/or in a less hazardous industry, or where the loss is exceptionally large, incentives may be substantially less than self-insured prevention incentives. It is important to recognize that self-insured firms will not have the maximum incentives.

Retrospective Rating

In retrospective rating, current-period losses directly influence current insurance premiums. Prior to the insurance period, the insured and insurer agree on a retrospective rating plan. This plan prescribes minimum and maximum bounds on the premium. The actual premium, subject to these bounds, contains two components. The first, an insurance charge or basic premium, independent of actual current year losses, depends only on the minimum and maximum premiums agreed upon. The second, a loss-sensitive premium (Segment BC in Fig. 4.1), depends on losses and includes loss-adjustment expenses that are a stated proportion of losses (typically 11.5 percent). Thus, if aggregate losses do not exceed AB' in Fig. 4.1, the insured pays the minimum premium. If losses fall between AB' and AC', the firm pays
the basic premium plus losses and proportional loss-adjustment expenses. And if losses exceed AC', the firm pays only the stated maximum premium.

The financial saving from prevention arising out of a retrospective rating plan contains two components: immediate and future. Current prevention activities produce immediate savings in the current premium, subject to the minimum (plus loss-adjustment expenses and taxes). The future savings arise because current loss prevention reduces future standard premiums by reducing the future experience modification factor. As prevention reduces the standard premium, it also reduces the basic retrospective premium. The future component is the present value of the reductions in future basic premiums.

The immediate savings depend upon firm size, the hazardousness of the industry, the loss prevented, and the retro plan selected. The future savings depend upon the same factors influencing the experience rated savings as well as the retro plan chosen. Although it is difficult to generalize about the size of these incentives, a few generalizations follow.

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2 Several retrospective rating plans are available in most states. Each combines minimum, maximum, and basic premiums.
For small losses, retro incentives exceed self-insured incentives for all but the smallest firms by 20 to 75 percent or more. For medium-sized losses, retro incentives will be larger in more hazardous industries and higher-paying and larger firms. For very large losses, retro incentives are typically less than self-insured incentives for all but the largest higher-paying firms in hazardous industries.

Dividends

Dividends paid by insurers to firms with good safety records often enhance the firms' incentives for prevention. Not all policies pay dividends, however, and not all dividends are tied to safety records.

Two types of dividend arrangements are common: flat rate and sliding scale. Under a flat rate dividend plan, the insurer pays a stated percentage of the premium as a dividend to every policyholder regardless of loss experience. Under sliding scale plans, insurers pay higher dividend rates to (1) employers with better loss records and (2) larger policyholders.

Flat rate dividends will reduce WC premiums but do not affect the incentives for prevention. Sliding scale dividends will also decrease premiums, but being tied to safety records, will enhance prevention incentives. This effect increases with the size of the firm, hazardousness of the firm and industry, and average level of wages paid.

The effect of sliding scale dividends must be included with the experience and retro rated insured incentives described above. Because dividend plans and payments vary so widely across time, insurers, and insureds, it is difficult to generalize about the magnitude of the effect on incentives. However, where insured exceed self-insured incentives, the gap will be even wider; where self-insured incentives are larger, dividends will at least reduce the difference.

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3Dividends cannot be promised to the insured; instead they are declared and paid after the close of the policy year. From the firm's point of view, these dividends are uncertain. Dividend payments by many insurers are extraordinarily predictable; for others they are variable. The more predictable the dividend, the greater the likely effect on prevention. If one insurer has paid a 5 percent dividend every year for a decade, while another has paid a 5 percent dividend 5 out of 10 years, the former (being more certain) will provide a greater stimulus for prevention. Even if the second company had paid a 10 percent dividend in each of those five years, a risk-averse firm would respond more to the first company's dividends.

4Meaning policyholders who pay larger premiums. Premiums are a function of firm size, wages paid, and hazardousness of the industry and firm.
INSURANCE LIMITATIONS AND FINANCIAL INCENTIVES

Various loss or premium limitations also limit the incentives for prevention that would otherwise arise from the WC insurance arrangement. Rating bodies limit the size of any single loss that is included in adjusting the experience modification factor. Under experience rating, these limits vary from state to state—for example, $87,000 in California, $43,000 in Georgia, and $135,000 in Oregon. Under a retrospective rating plan, the insured may elect an analogous maximum on individual losses. In both cases, prevention of losses that exceed the maximum yields prevention savings equivalent to preventing the maximum loss. These loss limitations reduce WC incentives for prevention, as shown in Fig. 4.1. AB is the probability distribution of actual losses. Without a loss limit, the focal point for a risk-neutral firm's prevention decision is \( \bar{X} \). Introducing a loss limit (at E) counts all losses greater than E as E. This shifts the probability distribution to ACD, reducing the mean to \( \bar{X}_L \). The reduced mean consequence of injury reduces the incentive for prevention.

A risk-averse firm suffers even greater reductions in incentives. Recall that such a firm gives greater weight to larger losses than does its risk-neutral counterpart. As a result, eliminating or reducing the possibility of (heavily weighted) very large losses magnifies the effect of loss limits on safety by shifting the value of the mean consequence by more than \( (\bar{X} - \bar{X}_L) \) in Fig. 4.2. The greater the degree of risk-aversion, the greater the difference will be.

INTERACTION OF INSURANCE AND COMPENSATING WAGE DIFFERENTIALS

We have discussed earlier how increases in WC benefits might have a reduced effect or no effect at all on a self-insured firm's safety decisions where workers receive compensating wage differentials for hazardous work. According to the argument, an increase in WC benefits may merely reduce the CWD—with a reduced effect on safety investment.

Under different insurance circumstances, increases in WC benefits may interact with the CWD to either enhance or diminish the incentives for prevention. Consider, at one extreme, a self-rated firm paying a perfect CWD. Increasing WC benefits by one dollar would reduce the marginal CWD but increase the WC incentive. These opposing effects are exactly offsetting for a self-insured firm. But as we have suggested
earlier in this chapter (and in Victor, 1983), the increase in the WC incentive for a self-rated firm may exceed that for a self-insured firm by as much as two times. Consequently, the increase in the WC benefits increases the WC incentive by an amount that exceeds the decline in the CWD. Hence, the net incentive to the firm increases, enhancing safety investment.

By contrast, consider a community-rated firm—one whose WC premium is unaffected by its loss experience. An increase in WC benefits will decrease the CWD, but leave the WC incentive unaffected (at zero). The net incentive for prevention declines as do safety investments.
MATHEMATICAL APPENDIX

BASE CASE MODEL

The firm maximizes profits, which consist of revenues net of production, compensation, and abatement costs:

\[
\pi = p \times Q(K, L) - w_L \times L - w_K \times K - w_s \times S \times L
- \beta \times \phi(S) \times L
\]  

(1)

where \( p \) = output price
\( Q \) = quantity produced
\( w_L \) = wages of labor
\( w_K \) = unit price of capital
\( w_s \) = unit price of safety inputs
\( L \) = number of workers
\( K \) = capital inputs
\( S \) = safety inputs (per worker)
\( \phi \) = probability of an injury occurring
\( \beta \) = Workers' Compensation benefit (e.g., $/week)

In Eq. (1), \( Q_K, Q_L > 0; Q_{KK}, Q_{LL} < 0; \phi_s < 0; \phi_{ss} > 0. \) First-order conditions are:

\[
\pi_L = p \times Q_L - w_L - w_s \times S - \beta \times \phi(S) = 0
\]

(2)

\[
\pi_s = -w_s - \beta \times \phi_s = 0
\]

(3)

\[
\pi_K = p \times Q_K - w_K = 0
\]

(4)

The second-order conditions for a regular maximum are satisfied.

INCREASING WORKERS’ COMPENSATION BENEFITS (\( \beta \))
INCREASES SAFETY

Totally differentiating the first-order conditions and solving by Cramer’s Rule:

\[
dS/d\beta = \phi_s/ - \beta \phi_{ss}
\]

(5)
Since $\phi_s < 0$ and $\phi_{ss} > 0$, $dS/d\beta$ is positive; hence, increasing WC benefits always increases safety ($S$).

**DIMINISHING RETURNS TO FURTHER WORKERS' COMPENSATION BENEFIT INCREASES**

Let

$$
\frac{dS}{d\beta} = \phi_s - \beta \phi_{ss} = f(S, \beta) \tag{6}
$$

$$
\frac{df}{d\beta} = \frac{\partial f}{\partial \beta} + \frac{\partial f}{\partial S} \frac{dS}{d\beta} \tag{7}
$$

Assuming third derivatives are zero,

$$
\frac{df}{d\beta} = \phi_s \phi_{ss} / \beta^2 \phi_{ss} + \phi_s / \beta^2 \phi_{ss} \tag{8}
$$

Since both terms are negative, $df/d\beta < 0$. This means that the increments in safety fall with successive WC increases.

**INCREASING WORKERS' COMPENSATION BENEFITS IS EXACTLY OFFSET BY DECREASES IN THE CWD**

Let wages ($w_L$) be an increasing function of the uncompensated risks faced by workers [$R = \phi(S) \times (\hat{\beta} - \beta)$],

where $R =$ uncompensated risk,

$\phi(S) =$ probability of injury,

$\hat{\beta} =$ worker’s valuation of injury (that is, full compensation),

$\beta =$ WC benefits, and

$\partial w_L/\partial R > 0$.

Further assume that output is produced with only labor. Then the first-order conditions become:

$$
\pi_L = p \times Q_L - w_L \times \phi(S) \times (\hat{\beta} - \beta) - \phi(S) \times \beta - w_s \times S = 0 \tag{9}
$$

$$
\pi_S = \partial w_L/\partial R \times (\hat{\beta} - \beta) \times \phi_s - \beta \times \phi_s - w_s = 0 \tag{10}
$$

Solving for $\phi(S)$ in Eq. (1),

$$
\phi(S) = [p \times Q_L - w_L - w_s \times S] / \beta \tag{11}
$$
Differentiating Eq. (11) with respect to \( S \), substituting in Eq. (10), and simplifying, yields:
\[
\frac{\partial w_L}{\partial R} \times (\hat{\beta} - \beta) + \beta = 1. 
\] (12)

The first term is the marginal compensating wage differential; the second is the marginal WC cost.

Differentiating with respect to \( \beta \) yields
\[
d(\frac{\partial w_L}{\partial R} \times (\hat{\beta} - \beta)) / d\beta = -\beta / d\beta = -1. 
\] (13)

Equation (13) says that a one-dollar change in the marginal WC cost will be exactly offset by a one-dollar change in the marginal CWD.

**PERSONAL PROTECTIVE EQUIPMENT VERSUS ENGINEERING CONTROLS**

Let profits be given by:
\[
\pi = p \times Q(K,L) - w_L \times L - w_K \times K - w_S \times S \times g(L) - \beta \times \phi(S) \times L, 
\] (14)

where \( g(L) \) = number of pieces of safety equipment needed to protect the exposed workers, \( S = \) quality of those inputs, and all other symbols are the same as in the base case. The expression \( g(L) \) is technologically determined, so that for personal protective equipment \( g(L) = L \); that is, for example, \( L \) goggles are needed for \( L \) exposed workers. For ventilation equipment, for example, \( g(L) = 1 \); that is, only one ventilation unit is needed to protect the exposed workers.

For the case of personal protection equipment, the first-order conditions are the same as in the base case and:
\[
dS/d\beta = -\phi_S / \beta \times \phi_{SS} > 0. 
\] (15)

For engineering controls, the first-order conditions are different:
\[
\pi_L = p \times Q_L - w_L - \beta \times \phi(S) = 0 
\] (16)
\[
\pi_K = p \times Q_K - w_K = 0 
\] (17)
\[
\pi_S = -w_S - \beta \times L \times \phi_S = 0 
\] (18)

Using Cramer’s Rule,
\[
dS/d\beta = p \times \phi_S \left[ p \times L \times (Q_{LL} \times Q_{KK} - Q_{LK})^2 + \beta \times \phi(S) \right. 
\times \frac{1}{\det A} 
\] (19)
where $A = -p \times L \times \phi_{ss} [Q_{LL} \times Q_{KK} - Q_{KL}^2] - \beta \times Q_{KK} \phi_s^2 < 0$. The sign of $dS/d\beta$ in this case is indeterminate, depending on the relative magnitudes of the two terms inside the brackets in the numerator. If the first is larger, $dS/d\beta > 0$ and WC increases safety. If the second is larger, the reverse is true.

Equation (19) has a more intuitive representation if we rearrange terms.

$$
\frac{dS}{d\beta} = -(p \times \phi_s) \times (p \times Q_L) \times Q_{KK}/|A| \\
\times \left[ -L/(p \times Q_L) \times (p \times Q_{LL} - (p \times Q_{KL}/Q_{KK}) \right] \\
- [\beta \times \phi(S)/(p \times Q_L)].
$$

The term inside the first bracket is merely the inverse of the elasticity of demand for labor where the price of labor is the full price—that is, the wage and WC costs per worker. By substituting Eq. (16) into the denominator of the second bracketed term, we see that it is the WC share of total labor costs. If the elasticity of demand for labor exceeds the WC cost share, $dS/d\beta < 0$ and the contrary effect occurs.
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