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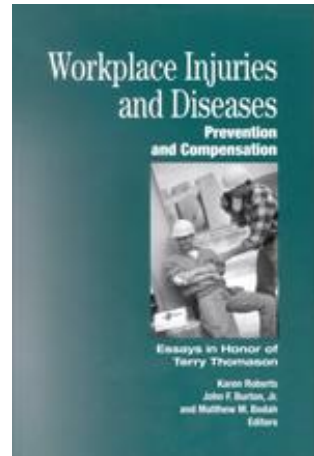
# How Can Behavioral Economics Inform Research on Workplace Injuries?

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# 9

## How Can Behavioral Economics Inform Research on Workplace Injuries?

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Over the last 30 years a number of theoretical and empirical advances have emerged in the study of how the risk of injury in the workplace influences labor market transactions. Economists have focused particular attention on mechanisms that compensate individuals for risk, primarily higher wages or workers' compensation benefits, and how these compensation mechanisms influence the level of workplace safety. These issues have not only been the focus of considerable attention by academics, but have also been applied to important public policy issues such as evaluating the benefits of safety programs and determining the optimal levels of workers' compensation benefits.

As with most applications of economic theory, however, a number of these results have relied on very specific assumptions about the ways in which individuals obtain and use information about risk. Information plays a critical role in economic theory. While economists have studied the role of information asymmetries in great detail, they have

paid less attention to how individual agents accumulate information and implement it in decision making. The standard economic model is one in which people process information perfectly, fully comprehending (and using) all information available to them. Gradually, however, economists have become increasingly interested in deviations from the perfect rationality model, particularly with regard to the processing of information about risk and uncertainty. We refer to the study of this issue broadly as *behavioral economics*.

For obvious reasons, the ability of individuals to accumulate and process information about risk is particularly important for economists studying occupational safety and health. If we fail to properly model the ways in which individuals perceive, value, and respond to risk, it is unlikely that we will be able to accurately predict behavioral responses to changes in the risk of workplace injuries. This has important implications not only for economic research, but also for policies designed to promote workplace safety.

The objective of this chapter is to both explore how past research in the economics of occupational safety has dealt with deviations from the perfect rationality model, and to ask how the standard predictions change when we incorporate some of the key results of behavioral economics. Economists since Adam Smith have recognized that deviations from the perfect rationality model would influence the way individuals respond to occupational risk. However, most recent studies use the basic framework from the standard perfect rationality model and study the effect of introducing a relatively small perturbation to the model, almost always by adding a subjective probability function that underestimates the true risk of occupational injuries. We attempt to incorporate some of the richer and more complex elements of behavioral economics into the analysis in the hopes of isolating some areas where current research might provide either misleading or incomplete conclusions about the role of occupational risk in employment and safety decisions.

Before proceeding we would like to note that this chapter is intended to be suggestive, and we do not presume to provide a comprehensive integration of behavioral economics with the economic analysis of workplace safety. Both fields are vast and complex, and we focus our attention on just a small sample of the possible set of issues. Nevertheless, we believe that the issues we focus on are important and illustrate both that occupational safety is a natural place to apply (at least some

of) the principles of behavioral economics, and that these principles can have a profound impact on our predictions.

We proceed as follows. In the next section we outline the standard model of occupational risk in an expected utility framework. We focus on two key issues from the economics literature: the existence of compensating wage differentials for job risk, and the relationship between workers' compensation benefits and workplace safety. Our discussion focuses on the derivation of the main results in the perfect rationality model and some of the empirical evidence. In the third section, we then review some basic principles of behavioral economics. Our goal with this section is to summarize some of the evidence on how individuals perceive, value, and respond to risk differently than in the standard economic model. In the fourth section we discuss the extent to which the behavioral model alters the predictions of the standard model. In the fifth section we discuss the possibility that employers might be subject to some of the same behavioral phenomena that affect workers, and we discuss how this could influence the predictions of the model. The sixth section then draws out some of the policy implications from our integrated model, and the final section concludes with recommendations for future research.

## **THE CLASSICAL APPROACH TO WORKERS' COMPENSATION**

In this section we outline some of the basic results that have been obtained from applying economic analysis to workplace safety. We focus our analysis on two central topics that have been studied in the literature: the existence of compensating wage differentials for job risk, and the relationship between the insurance for occupational injuries and the level of workplace safety. These topics are particularly useful for our purposes because they comprise many of the most important results in the field and, as we demonstrate later on, because they are sensitive to assumptions about how individuals perceive, value, and respond to risk.

## Compensating Wage Differentials for Job Risk

Adam Smith first introduced the concept of compensating differentials for job risks in *An Inquiry Into the Nature and Causes of the Wealth of Nations*. Smith (1937) argued that individuals faced with two identical jobs would, all other things equal, require more compensation to accept the job that involved a higher risk of personal injury or illness. Nearly 200 years later, Rosen (1974) formalized this intuitive notion and provided an empirical methodology to estimate the implicit “price” that workers charge for bearing the risk of injury on the job. Rosen’s work spawned a large literature dedicated to estimating this price using labor market data.

The intuition behind the empirical methodology is straightforward. Consider the empirical model relating individual wages to job characteristics:

$$(9.1) \quad w_i = \delta + X_i\beta + Z_i\zeta + \alpha q_i + \varepsilon_i ,$$

where  $w_i$  represents the wage offer  $w$  for worker  $i$ ,  $X$  represents a vector of individual characteristics such as age, gender or education,  $Z$  represents a vector of characteristics of individual  $i$ ’s job,  $q$  represents the probability of injury on the job and  $\varepsilon$  is a random, mean zero error term. Note that for simplicity we consider a single injury type here, but in practice the model has been extended to include vectors of both fatal and nonfatal risks.

For our purposes the chief parameter of interest in this regression equation is  $\alpha$ , which represents the compensating wage differential. Assuming that the parameter estimate of  $\alpha$  is well identified (generally that  $\alpha$  is uncorrelated with  $\varepsilon$ ), then we can literally interpret it as the marginal increase in wages an individual would require to make him or her indifferent to a marginal increase in job risk. This parameter is important, because in theory the price individuals charge to bear risk should be synonymous with their willingness to pay to reduce risk. The ability to estimate the willingness to pay to reduce risks is of critical importance for public policy, because this information is necessary if we wish to monetize the benefits of policies designed to increase safety. With the wealth of available data on individual wages, the estimation of compensating wage differentials for job risks has played a key role in

cost–benefit analysis for many environmental and health policies.

Numerous empirical studies have used Rosen's approach to estimate  $\alpha$ , beginning with Thaler and Rosen (1976). In general, the empirical results have shown evidence of a compensating wage differential for fatal injury risk, but only mixed evidence of a wage differential for nonfatal injury risk (Viscusi 1993). A number of explanations have been posited for why the estimated differentials for nonfatal risks are difficult to estimate. From an empirical standpoint, the general problem is that the parameter of interest  $\alpha$  might be negatively correlated with the error term  $\varepsilon$ , which causes a negative bias in estimates of  $\alpha$ . The primary reasons for this suspected correlation presented in the literature are a confounding effect of workers' compensation benefits, selection bias, and measurement error.

A failure to include workers' compensation benefits in the vector  $Z$  could bias  $\alpha$  toward zero because these benefits reduce the expected cost of injuries, so workers with higher benefits demand a lower compensating wage differential. To eliminate this bias, a number of studies have included a measure of workers' compensation benefits and have increased the size of the estimated compensating wage differential (Viscusi 1993).

Selection bias can result because the level of job risk may be a choice variable for the worker. Individuals with a greater tolerance for risk might be more willing to accept employment at a risky job, a tendency that would bias the compensating differential downward. Brown (1980) used a fixed-effects estimator to control for this selection and found little evidence of compensating differentials for job risk. Garen (1988) used an instrumental variables approach and found evidence of relatively large compensating differentials. Measurement error is one possible explanation for why Brown (1980) found no evidence of compensating differentials. Black and Kniesner (2003) found evidence of significant, nontrivial measurement error in published job-risk variables that was correlated with other observable variables, making it impossible to consistently estimate compensating differentials with ordinary least squares.

These are all plausible explanations as to why it is difficult to estimate compensating wage differentials for nonfatal, or even fatal, job risks. However, each of these can be overcome given the appropriate econometric technique and the availability of instrumental variables.

Later, when we discuss compensating wage differentials in the context of behavioral economics, we will see how certain elements of the behavioral model will call into question our ability to obtain estimates that are meaningful for policy analysis.

### **Optimal Workers' Compensation Benefits and Safety Incentives**

In the United States, the primary relief for workers injured on the job comes from workers' compensation. One of the key features of workers' compensation is that it offers only partial compensation for workplace injuries. Whereas an individual with a valid cause of action suing for damages in the tort system would be eligible to recover full economic losses as well as noneconomic losses (pain and suffering), workers' compensation provides only partial replacement for lost income and no compensation for noneconomic losses. On the other hand, because individuals can recover damages regardless of whether or not there was negligence, compensation occurs with much greater frequency than it would in the tort system.

A common justification for the use of partial coverage in workers' compensation is the potential impact of benefits on safety incentives. One facet of this argument supposes that individual workers have the ability to take precautions that reduce the risk of injury but are unobservable (or unverifiable) to employers. If workers can control the level of risk they face, and if safety precautions involve some cost, then no-fault insurance will give workers the incentives to take fewer precautions and thereby reduce the overall level of safety. By only providing partial income replacement, workers' compensation benefits reduce any disincentive by workers to take care.<sup>1</sup> It may also reduce employer efforts to oppose reporting of legitimate claims, because such efforts would yield greater savings (Chelius and Kavanaugh 1988; Azaroff, Levenstein, and Wegman 2002). Note that there are other dimensions of this problem that may be mitigated by partial insurance coverage that might have little or no direct impact on actual safety levels, such as fraudulent claiming or extending injury duration past the true recovery period. In addition, workers' compensation may lead employers to reduce safety precautions if they are imperfectly experience rated or if workers do not demand the "optimal" level of precautions (Rea 1981; Smith 1992).

Worker safety precautions are not the only mechanism through which workers' compensation can influence the risk of occupational illnesses or injuries. A natural argument against removing occupational injuries from the tort system and restricting compensation is that it will reduce the incentives of employers to invest in safety precautions that reduce the frequency and/or severity of occupational injuries. Workers' compensation provides incentives for employers to improve safety, as fewer and less severe injuries will result in lower benefit payments (and correspondingly, lower workers' compensation insurance premiums).

The effect of workers' compensation benefits on workplace safety is the subject of debate in the literature. Studies such as Krueger (1990) and Ruser (1993) generally find evidence in support of the notion that higher workers' compensation benefits lead to higher injury rates (for a review of the literature see Butler 1994). Less evidence has been found to support the claim that firms respond to incentives to improve workplace safety (see Roberts 2005). Later in this chapter, we explore how behavioral economics changes our predictions about the relationship between workers' compensation and workplace safety, and ask if it offers any guidelines for public policy.

## THE BEHAVIORAL APPROACH TO RISK AND UNCERTAINTY

In this section we briefly review how behavioral scientists have thought about decision making under uncertainty, with a particular eye for the decision elements relevant for the study of occupational safety. We focus much of our discussion, at least in a broad sense, on the work of Kahneman and Tversky, which has exposed some critical assumptions that have led economists traditionally to mischaracterize human behavior (Rabin 2003). Specifically, we utilize the framework of *prospect theory*, introduced in Kahneman and Tversky (1979).

One of the most important contributions of behavioral economics is to demonstrate that people make *predictable* judgment errors when faced with uncertainty (Rabin 2003).<sup>2</sup> Individuals frequently employ rule-based, decision making techniques when they cannot calculate the costs and benefits of a choice. People may lack the time or the analytic skills necessary for the evaluation. For some, the dearth of cru-



cial information regarding the choice, such as objective probabilities and outcome values, hinders the rational decision-making process. For others, the dizzying array of information simply overwhelms. The frequent practice of substituting heuristics, or cognitive rules of thumb, for structured analysis helps to explain why normative theory tends to fall short of reality. It also demonstrates the importance of considering the bounds to human rational decision making.

Prospect theory provides a systematic methodology for reconciling individual decision making with some of these errors. As a descriptive theory of choice, prospect theory illustrates decision making under risk as a selection among particular gambles or prospects. It distinguishes between two stages of the decision making process: an editing phase in which an individual organizes the problem into a choice between changes in wealth (or utility), and a choice phase in which the individual chooses whichever outcome has the highest value. In this section we discuss how individuals might “edit” the problems associated with job risk. In particular, we focus on three aspects of the problem where this editing is of key importance: the perception of risk, the valuation of risk, and the response to risk. In the next section we then consider how these edited problems produce results that are different from the classical model.

Before moving on, we identify some subtle differences in what we mean by “risk” in these three aspects of individual behavior. When we discuss how individuals perceive risks we are generally referring to their perception of the probability of an injury or illness occurring. When discussing how individuals value risk we are talking more about the magnitude of the loss in utility individuals face if an injury or illness occurs. Finally, when we discuss how individuals respond to risk we refer to the behavior of individuals in response to the probability of an injury, the size of the loss, or, most often, the expected value of the loss.

### **How Do Individuals Perceive Risks?**

In this section we are interested in the ways in which individuals perceive risks to health. Perhaps the most important question is whether or not individuals perceive risks accurately, i.e., does an individual’s subjective assessment about the likelihood of some adverse event oc-

curing equal the “true” likelihood on average. Evidence supports the notion that individuals do not perceive risk accurately, and has led behaviorists to identify a number of cognitive biases that disturb an individual’s information processing about risk. Below we discuss three of these biases that we feel are most relevant to the study of occupational risk: the availability bias, the optimism bias and the accumulation bias. We review the empirical evidence on each of these biases as they pertain to the workplace if such evidence is sufficiently available, and to health risks more generally if it is not.

### **The availability bias**

Biased predictive judgments and subjective probabilities frequently result from the common use of the *availability bias*. Humans tend to judge the likelihood of an event by its ease of recall: we tend to disproportionately weigh *salient* and *memorable* events even when better sources of information exist (Rabin 2003). To illustrate, consider the fact that a substantial number of people have avoided flying since the 9-11 terrorism attacks but continue to drive at high speeds on the nation’s highways, where physical injury is far more likely to occur. Additionally, we observe that people tend to be overly influenced by friends’ remarkable mishaps with certain car brands, ignoring the empirical evidence readily available from publications such as *Consumer Reports* (Rabin 2003). Tversky and Kahneman (1974) further illustrate this phenomenon as follows:

The subjective assessment of probability resembles the subjective assessment of physical quantities such as distance or size. These judgments are all based on data of limited validity, which are processed according to heuristic rules. For example, the apparent distance of an object is determined in part by its clarity. The more sharply the object is seen, the closer it appears to be. This rule has some validity, because in any given scene the more distant objects are seen less sharply than nearer objects. However, the reliance on this rule leads to systematic errors in the estimation of distance. Specifically, distances are often overestimated when visibility is poor because the contours of objects are blurred. On the other hand, distances are underestimated when visibility is good because the objects are seen sharply. Thus, the reliance on clarity as an indication of distance leads to common biases. Such biases are also found in the intuitive judgment of probability.

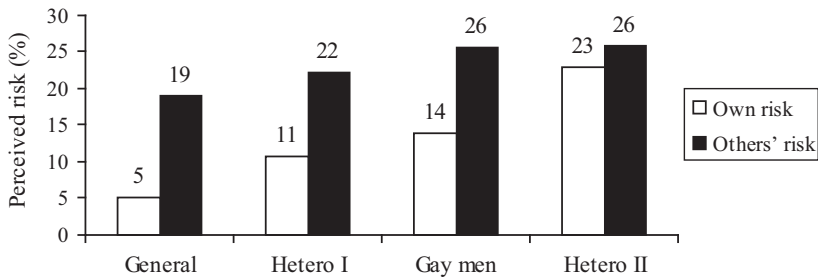
While some workers demonstrate a fairly accurate perception of risk (for example, see Ostberg 1980; Singleton, Hicks, and Hirsch 1981), empirical studies provide some evidence of workers' reliance on availability for occupational risk perceptions. For instance, in his survey of 915 workers on eight Norwegian oil rig platforms, Rundmo (1992) found that people most frequently perceived risk in connection with disasters and major accidents rather than with their routine tasks. This result also indicates the "flipside" of the availability bias—that workers may grow accustomed to their frequent and routine occupational dangers. In so doing, these risks may lose their "remarkableness" and are then underestimated as being "normal."

Organizational behavior scholars have provided us with substantial evidence of workers in familiar, highly risky work situations who underestimate their risk levels in comparison to workers in unknown situations with comparable risk profiles (Mearns and Flin 1996). For example, Zimolong (1985) found that workers in the construction industry typically overestimate the risks involved in tasks that they perform infrequently or do not understand fully, while commonly underestimating the risks involved in performing their routine tasks. In a subsequent study, Zimolong (1991) found that railway shunters, who are responsible for coupling and uncoupling train cars, overestimate the risks for tasks that have a reputation for being dangerous and underestimate the risks involved with routine activities. Rundmo (1992) found similar results in his work concerning Norwegian oil rig personnel; workers frequently perceived risk in connection with disasters and major accidents rather than in their common work responsibilities.

### **The optimism bias**

Another form of bias that has commonly been demonstrated in perception of risk is the *optimism bias*. The optimism bias simply states that people tend to underestimate their own injury risk compared to the average risk. Health behavior researchers have found that people generally think that they are less vulnerable to adverse health outcomes than the rest of the population. Specific examples appear frequently in the AIDS risk perception literature.

One such study focused on people's comparative AIDS risk assessments (van der Velde, van der Pligt, and Hooykaas 1994). The researchers surveyed four groups in Amsterdam, listed roughly in the order of

**Figure 9.1 Mean Scores of AIDS Risk Perceptions, Own versus Others**

SOURCE: van der Velde, van der Pligt and Hooykaas (1994).

their increasing risk of contracting AIDS: a nationally representative sample ( $n = 437$ ), heterosexuals with multiple private sex partners ( $n = 241$ ), homosexual men with multiple sex partners ( $n = 147$ ), and heterosexuals with multiple prostitution partners ( $n = 493$ ). They asked the participants to assess their personal risk (i.e., the likelihood that the subject himself or herself becomes infected) and average risk (i.e., the likelihood that a random person in their age group becomes infected). They found that people with more objective risk factors perceive themselves to be at greater risk. However, the subjects rated their personal risk substantially lower than that of others and were extremely optimistic about their own chances of avoiding the virus (see Figure 9.1).

A similar form of the optimism bias appears in workplace-related health risks. The more direct experience workers have with occupational hazards without adverse outcomes, the more confident they are in their ability to control the risk (Weyman, Clarke, and Cox 2003). For instance, a study of mine bunker operations reported that there was a “widespread faith in their ability to respond to dangerous incidents” (Rushworth et al. 1986). It thus appears that there is a kind of “Lake Wobegon” effect: when it comes to evaluating one’s own ability to avoid adverse health outcomes, everyone feels above average.

### **The accumulation bias**

Other inaccurate risk perceptions result from the tendency of humans to form incomplete problem representations. Researchers have

observed that people do tend to learn about risks in ways that change their original assessments of risk. In a study concerning 130 manufacturing workers, Cree and Kelloway (1997) found that accident history as well as perceptions of others' commitment to health and safety were predictive of workers' risk assessments. They also found these risk perceptions related to the workers' willingness to participate and turnover intentions. However, their risk perceptions may still fall short of the real level of exposure occurring in their workplace because of the *accumulation bias*.

People have the tendency to perceive risks "in isolation" rather than as a sequence of similar decisions or one that accumulates over a lifetime (Linville, Fischer, and Fischhoff 1993). Researchers have found that people typically do not perceive a difference between the likelihood of injury occurring when a risky action is taken once versus the likelihood that ensues through multiple exposures. For example, people may understand that the chance of being injured in a car accident is about 1 in 10,000 each time they drive. However, they typically fail to realize that this statement is equivalent to a 33 percent probability of being in an injurious accident at least once during their lifetime (Slovic, Fischhoff, and Lichtenstein 1978).

Researchers have observed this tendency in a variety of psychology experiments related to health behaviors. Doyle (1997) found that people underestimate the cumulative risk of contraception use by failing to use the binomial probability model, where the probability of an unintended pregnancy is equal to 1 minus the probability of an intended pregnancy in one encounter raised to the number of sexual encounters. Likewise, Linville, Fischer, and Fischhoff (1993) found that peoples' risk estimates for being infected with AIDS in more than 10 encounters were far too small when considering the risk they perceived in one encounter. Their subjects' median risk perception of transmitting AIDS from a male to female when using a condom was 5 percent in one encounter, 10 percent in 10 encounters, and 20 percent in 100 encounters. If the subjects had appropriately applied the binomial probability model, they would have argued that the risk was 40.1 percent in 10 encounters and 99.4 percent in 100; these values differ with statistical significance.

## Summary

Here we have discussed three important biases about the ways in which people perceive risks. It is important to note that the biases are not mutually exclusive, and often work together. For instance, in the AIDS perception study by Linville, Fischer, and Fischhoff (1993) it was found that individuals underestimate lifetime risk given their own estimates of the risk from a single exposure. However, they found that individuals substantially *overestimated* both the single exposure risk and lifetime risk. This is easily explained by the availability bias; the risk of HIV infection is highly publicized and easy to recall, thus individuals tend to overestimate it. When taken in concert with the results of van der Velde, van der Pligt, and Hooykaas (1994), we can see how all three biases can be present with an individual's perception of a single risk to health.

These misperceptions can influence individual behavior and potentially lead to poor health decisions, including those precautions taken and protective equipment used to ensure occupational safety. For example, workers may neglect to wear a mask in a dusty warehouse because the risk of developing asthma from a single day of inhaling pollutants is relatively low. On the other hand, Linville, Fischer, and Fischhoff (1993) found that individuals overestimate the ability of condoms to protect them from a sexually transmitted disease. This suggests that in some cases individuals may place too much faith in protective technologies, and may avoid other kinds of precautions that are necessary to minimize the risk of injury.

## How Do Individuals Value Risks?

Prospect theory suggests that it is important not only to consider how individuals perceive risks, but also the ways individuals value risks. More precisely, it suggests that we should pay attention to the relative weights that individuals place on the gains and losses that are at stake. Standard economic theory predicts that people should value gains and losses symmetrically. In general, prospect theory suggests that this symmetry does not hold, particularly when the gains and losses are uncertain. If true, this might cause us to not only change our predictions about behavior, but to change the way we interpret observed behavior.

More specifically, individuals frequently display signs of *loss aversion*, suggesting that they dislike losses more than they like gains of equal magnitude (Kahneman and Tversky 1979; Tversky and Kahneman 1991). While there are many implications of loss aversion, for our purposes we can illustrate the key concepts with the following hypothetical scenario. Consider a risk averse individual who receives utility from some good  $y$  according to the function  $U(y)$ , where  $U$  is increasing and concave. Now suppose the individual faces two lotteries: one (which we call A) in which she begins with  $y = 2,000$  and faces a gain of 1,000 with probability 0.25, and the other (called B) in which she begins with  $y = 3,000$  and faces a loss of 1,000 with probability 0.25. In this example the expected utility for the lottery A is equal to  $0.75U(2,000) + 0.25U(3,000)$  and the expected utility for lottery B is equal to  $0.75U(3,000) + 0.25U(2,000)$ . It is a simple enough matter to show that the gain in expected utility from beginning with 2,000 and participating in lottery A is equal to the loss in expected utility from participating in lottery B.<sup>3</sup> This is an important point, because expected utility theory implies that *the amount individuals would be willing to pay to participate in lottery A should be equal to the amount they would pay to avoid lottery B*.

As we have stated, we would not expect this symmetry to hold under prospect theory. Prospect theory generally supposes that individuals evaluate changes based on gains and losses. Moreover, individuals evaluate these changes in welfare using a value function, which we denote  $V(\cdot)$ , that assigns a subjective value to a given gain or loss. Suppose we ignore the problems discussed in the previous section and assume that individuals perceive the probability of gain and loss accurately. If we let  $a = [U(3,000) - U(2,000)]$  and  $b = [U(2,000) - U(3,000)]$ , we can define the value of lottery A as  $V(a)$  and the value of lottery B as  $V(b)$ . Under expected utility theory, we would have  $V(a) = -V(b)$ , but under prospect theory we expect that  $V(a) < -V(b)$ . The subjective value that individuals place on a loss is greater than the value placed on an equivalent gain. Thus, we can say that *if individuals are loss averse, then the amount they would be willing to pay to participate in lottery A will be less than the amount they would pay to avoid lottery B*.

We should note that the concept of loss aversion is distinct from the concept of risk aversion, which is fundamental to the neoclassical theory of insurance demand. Risk aversion essentially states that

individuals dislike risk, and will require a premium to accept a lottery with an uncertain outcome but the same expected value as one with a certain outcome. Mathematically, risk aversion is incorporated under the standard model through the assumption that the utility function, represented by  $U(y)$  is concave (so the marginal utility of income increases at a decreasing rate). Although the two concepts sound similar, they refer to two very different behavioral phenomena. Simply put, an individual who is risk averse dislikes uncertainty, even uncertainty between two positive outcomes. Someone who is loss averse dislikes a shortfall, whether it occurs with certainty or not. In general, an individual can be loss averse and risk averse at the same time. However, an interesting implication of loss aversion pointed out by Kahneman and Tversky (1979) is that loss averse individuals will be risk loving with respect to avoiding losses (in other words, they will prefer an uncertain loss to a certain one with identical expected value).

There is a great deal of experimental evidence to support the existence of loss aversion in individuals (e.g., see Knetsch 1989; Kahneman, Knetsch, and Thaler 1990; and Bateman et al. 1997). Most of the studies we are aware of focus on actual consumption goods, and have not established whether or not individuals are averse to losses of health. Nevertheless, the evidence supporting loss aversion in empirical studies is certainly strong enough to suggest that it is a phenomenon worthy of further study in the context of job-related health risks. As we shall see later on, the possibility that individuals are averse to health losses will have substantial implications for the economic analysis of workplace safety.

### **How Do Individuals Respond to Risk?**

While the ways individuals perceive and value risks are important considerations for studying human behavior with regards to workplace injuries, in some sense they are both merely elements in the decision process that drives individual choices. McFadden (1999) defines a *cognitive process* as “the mental mechanism that defines the cognitive task and the role of perceptions, beliefs, attitudes preferences and motives in performing this task, to produce a *choice*.” Therefore, we can think of risk perception and the value placed on risky options as specific components in the larger problem of individual decision making.



Economists generally rely on the principle of utility maximization as the cognitive process that drives behavior. Taking preferences as given, the economic model predicts that individual behavior can be well explained by a process by which individuals choose whatever allocation of resources provides them with the highest overall benefit. While there can be no question that the utility maximization model has proved extremely useful and provided countless valuable insights into human behavior over the years, it has been criticized by behaviorists as ignoring many other important principles that influence behavior. This criticism is an important one for our purposes, because even if we make the right assumptions about subjective probability and subjective value we may still find it difficult to predict behavior if individuals do not respond to risk as assumed in the standard economic model.

If individuals fail to (always) act as rational utility-maximizing agents, then what principles do we expect to govern the choices that they make? Prelec (1991) argues that individuals create decision rules to guide choices in cases where ordinary cost–benefit analysis is problematic. It is important to distinguish between these rules and the more common bounded rationality model. Prelec explicitly distinguishes rules that override cost–benefit analysis even when the analysis is relatively straightforward from the rules associated with bounded rationality, which are used exclusively when cost–benefit analysis is difficult and costly. For our purposes, bounded rationality would lead to similar results if the cost–benefit analyses associated with workplace safety decisions are sufficiently complicated.

Prelec suggests three cases in which cost–benefit analysis might fail. The first case is that of a *temporal mismatch*, whereby individuals have difficulty assessing the net gain or loss of a particular action when its cost(s) and benefit(s) are separated by a substantial period of time. The second refers to a *saliency mismatch*, in which one of the pair (i.e., either the costs or the benefits) is vivid and easy to understand or imagine while the other is vague or uncertain. The final case is that of a *scale mismatch*, in which either there is a large disparity between the costs and benefits or if one of them is only realized if the action is repeated many times. Prelec argues that cost–benefit analysis fails under each of these because it leads to an asymmetry in the weight assigned to either the cost or benefits associated with the action.<sup>4</sup>

Risks to health resulting from workplace injuries may be subject to any of the three mismatches that confound cost–benefit analysis. For example, determining the level of care to exert when using certain machinery that may pose a risk of loss of limb potentially suffers from the scale mismatch. The scale effect could arise because the cost of using a machine carefully is relatively small while the benefit of not suffering a loss of limb is large. Faced with the similar decision of whether or not to wear a seat belt, Prelec (1991) argues that individuals may develop a simple rule that governs use regardless of small permutations of the problem (such as whenever it rains or whenever driving on the highway).

The scale mismatch is only one example of how behavior related to workplace risks might be subject to these cost–benefit asymmetries. Repetitive stress disorders represent a set of common occupational injuries that may suffer from the temporal mismatch, given that they only develop over long periods of time. The saliency mismatch could arise in cases where workers felt financial pressure to take risk. Faced with the threat of job loss because of low productivity, for example, workers may take unsafe shortcuts or work too fast because the potential for job loss seems more “real” than the possibility of injury. These mismatches need not be mutually exclusive; decisions relating to activities that might involve exposure to toxic chemicals potentially may be subject to all three mismatches (the cost of injuries are likely to be delayed, of unknown severity, and probably occur only after multiple exposures).

In general, if individuals create rules that govern behavior with regard to workplace activities that influence the likelihood of workplace injuries, then these rules will have several implications for the predictions of the standard model laid out in the second section. We explore these implications in the following section.

## **INTEGRATING THE STANDARD MODEL AND THE BEHAVIORAL MODEL**

Here, we come back to the results of the standard model and examine how they are affected by the principles of behavioral economics. We follow the same outline as in the second section, focusing first on compensating wage differentials and then moving on to the optimal

workers' compensation benefits and levels of workplace safety. We consider how the results of the behavioral model affect both the theoretical predictions of the standard model and the empirical studies estimating these predictions.

### Compensating Wage Differentials for Job Risk

Generally speaking, integrating the principles of behavioral economics with the standard model has relatively little impact on the theory of compensating wage differentials. The standard model states that workers will require higher compensation to accept employment in occupations associated with increased risk of workplace injuries or illnesses, *ceteris paribus*. In the behavioral model, we need only refine this statement to say that individuals will require higher compensation to accept employment in occupations in which there is *perceived* to be a greater likelihood of an injury or illness.

The distinction between actual and perceived risks is an important one. The standard economic model predicts that individuals will respond to the actual level of risk. Economists interested in workplace safety have generally understood that individuals may not perceive risks accurately, however, and it is often assumed that individuals underestimate the risk of job injuries.<sup>5</sup> This assumption seems widely supported by the empirical evidence on the availability bias, optimism bias and accumulation bias discussed in the third section. Given that we expect workers to respond to the risks that they perceive, the size of the compensating wage differential they demand will be based upon the perceived risk as opposed to the actual risk. Importantly, as long as the perceived risk of injury is positively related to the actual risk, the compensating wage differential will still be positive.

As discussed in Viscusi (1993), if workers systematically underestimate the level of occupational risk, then they will demand a lower compensating wage differential. To see how this can matter empirically, consider Equation (9.1) on p. 222. In this setting the true job risk variable  $q$  serves as a proxy for the perceived job risk, and the estimated parameter  $\alpha$  represents the compensating wage differential multiplied by the correlation between the actual and perceived job risk. If workers underestimate the risk of job injury then the correlation between the

true and perceived levels of risk will be less than 1, implying a lower observed compensating wage differential.

The underestimation of risk may lead to a lower compensating wage differential than the standard model would predict, but loss aversion will tend to have the opposite effect. To see this, consider that, according to prospect theory, individuals choose between different options by comparing the gains and losses associated with each. In the case of choosing an occupation, this would suggest workers compare the “gain” of staying healthy and receiving wages against the “loss” of being injured and receiving workers’ compensation benefits.<sup>6</sup> If individuals are loss averse, they will place additional weight on the loss from being injured relative to the gain from staying healthy and receiving the compensating wage differential. This suggests that if individuals are loss averse they will require extra compensation to accept higher levels of perceived risk than what is predicted by the standard model.

While the predictions of the behavioral model are fairly benign from a theoretical standpoint, they are problematic for the purposes of estimation because they have opposite effects on the size of the differential. This makes it difficult to interpret differences in the estimated coefficient ( $\alpha$ ) for different kinds of risk. For instance, the fact that past studies have had relatively more success estimating positive compensating wage differentials for fatal risks than nonfatal risks is consistent with two behavioral explanations: 1) that individuals underestimate the risk of nonfatal injuries more than fatal injuries (which perhaps are overestimated), or 2) that the impact of loss aversion will be more severe with respect to fatal injuries than nonfatal ones (because clearly it makes sense to think of fatal injuries as involving a greater loss). While these explanations need not be mutually exclusive, they complicate matters by adding two more to the (already long) laundry list of items that potentially confound the estimation of compensating wage differentials.

In some ways, the issues raised by the behavioral model pose greater challenges to obtaining meaningful compensating wage differential estimates than the standard criticisms. Measurement error and selection bias are statistical problems that can be addressed using standard econometric techniques, at least if the proper instrumental variables can be obtained. However, disentangling the estimated compensating wage differential from the impact of subjective evaluations of risk and loss

can only be accomplished by eliciting additional information from individuals.

While our discussion in this section has focused on wage differentials, disability benefits represent an alternate means of compensating individuals for bearing risk. So, if we broaden our perspective to think about the implications of the behavioral model on the total injury compensation available to workers, we obtain similar results. Viscusi and Moore (1987) model the trade-off that workers implicitly accept between wages and workers' compensation benefits as an increasing function of the level of risk. Individual behavior should be governed by perceived risk, so if workers underestimate the true level of risk then they will be willing to trade off less wages in return for benefits and thereby lower the optimal level of workers' compensation benefits. On the other hand, if individuals are loss averse then they will place a greater weight on the possibility of a loss, which will increase their willingness to trade off wages for benefits at any given level of perceived risk. Thus, elements of the behavioral model may lead to either a lower or higher optimal level of workers' compensation benefits when compared to the standard model.

### **Worker learning**

Before moving on to discuss the optimal workers' compensation policy, it is worth considering the possibility that individuals learn to overcome their subjective evaluations as they gain experience. Viscusi (1979) hypothesizes that workers may be poorly informed about the level of risk at the start of their careers, but gradually learn about the level of risk over time. This suggests that the differences between the perceived probability of injury and the true probability may diminish over time, with workers possibly becoming perfectly informed with sufficient experience. If workers become more informed about risks, i.e., if they underestimate risk less, then workers with longer tenure in riskier jobs will demand higher compensating differentials or quit. Various works broadly support this prediction, including Viscusi (1979) and Moore and Viscusi (1990).

Another possibility is that individuals become less loss averse over time, in the sense that their relative weights on gains and losses become equalized as they gain experience. In a recent paper, List (2003) finds experimental evidence that individuals with more experience in

the market for trading cards tend to exhibit little or no evidence of loss aversion while those with less experience do. If this result held more generally to the case of workplace injuries it would suggest that workers with longer tenure would place relatively less weight on the possible loss from injuries and therefore require less compensation.

Thus, the effect of worker learning is to mitigate the impact of the behavioral model on the estimation of compensating wage differentials over time. Unfortunately, we know far too little about just how much workers actually learn over time to say with any certainty that this is the case. While the results of List (2003) are provocative, it is not clear *ex ante* whether or not individuals could learn to overcome aversion to health “losses” from injuries the same way they overcome aversion to income losses from trading goods. Additionally, while workers may become more informed about injury risk with experience, the availability bias suggests that it is possible that as risks associated with familiar tasks become better understood, individuals may revise their risk perceptions downward. Even if individuals do become more informed over time and their subjective risk assessments and loss valuations become “better,” the pace of learning may differ. This suggests that experience might have a nonmonotonic effect on the compensating differential, further complicating our ability to make predictions. Ultimately, a great deal of work needs to be done before we can understand the ways in which individuals learn about risk in the workplace.

### **Safety Incentives**

The predictions of the behavioral model on the relationship between workers’ compensation benefits and safety incentives are varied and complex. Workers’ compensation benefits can affect the safety incentives of workers if, by reducing the financial burden of an accident, they make workers less cautious about avoiding accidents. Obviously loss aversion matters in this sense, because if individuals are loss averse then they will have more incentives to take care for a given level of benefits, but they may also be more responsive to a change in benefits. This suggests that under loss aversion, individuals may be more responsive to changes in benefits than predicted by the standard model.

When talking about compensating wage differentials and workers’ compensation benefits we focused on how individuals perceive the level

of risk, but when considering safety incentives it is important to consider how individuals perceive the way risks change as safety precautions change. Past studies such as Rea (1981) and Viscusi (1990) have generally assumed that the effect of precautions on perceived risk is directly related to the impact of precautions on actual risk. This suggests that if individuals underestimate the risk associated with workplace injuries, they will undervalue the marginal benefit of taking additional precautions. If this is so, then individuals will underinvest in safety for any given level of workers' compensation benefits. By extension, if benefits increase (decrease) then workers will generally respond by decreasing (increasing) precautions by more than what would be predicted in the standard model.

However, there are reasons to suspect that the relationship between safety precautions and perceived risk is not as straightforward as suggested in the literature. The optimism bias and the aforementioned results of Weyman, Clarke, and Cox (2003) and Rushworth et al. (1986) suggest that individuals may overestimate their ability to control risks. This suggests that for any given level of benefits individuals will tend to be more cautious than predicted by the standard model. This suggests a result opposite of the case discussed above; a change in workers' compensation benefits would have less of an impact on worker safety precautions than the standard model predicts.<sup>7</sup>

The implications of individual perceptions of risk on safety are not exclusive to the safety precautions taken by individual workers. As we discuss later on, it is plausible to suppose that employers, at least large corporations, are less subject to some of the behavioral criticisms than individual agents. Nevertheless, worker perceptions of risk may have an impact on employer safety measures. Rea (1981) demonstrates that if individuals underestimate risk they will demand too few safety measures from employers. On the other hand, if workers place too much faith in protective technologies, as Linville, Fischer, and Fischhoff (1993) showed individuals tend to do with condoms, they may demand supraoptimal safety measures from employers.

Note that these different effects of the behavioral model on the level of safety measures taken assume that precautions are set as the result of an implicit cost–benefit analysis made by workers, even if their subjective evaluations of probability and loss differ from the standard model. However, we discussed earlier how workplace injuries may suf-



fer from the kinds of cognitive mismatches that Prelec (1991) argues can confound cost–benefit analyses. If this is so, workers may respond by implementing decision rules that govern the level of safety precautions they take. If workers operate under decision rules such as “always wear safety goggles,” it is quite possible that relatively small changes in disability benefits will not be enough incentive to induce workers to change their safety precautions. Thus, in extreme cases the behavioral model may contend that there should be no relationship between safety levels and workers’ compensation benefits.<sup>8</sup>

### **DOES THE BEHAVIORAL MODEL APPLY TO EMPLOYERS?**

Until now, all of our discussion has focused on applying the models of behavioral economics to workers. One question we have not addressed, and to our knowledge has not been addressed in the literature, is whether or not employers behave as the perfectly rational, perfectly informed economic agents they are supposed to be in the standard model. In this section we provide a brief discussion of how the behavioral model could be applied to employers and how this would change our predictions.

It is typical in economics to view employers, or firms more generally, as impersonal entities that are motivated solely by maximizing profits and share few of the behavioral nuances of individuals. For example, it is common to view employers as risk neutral while individual workers (or other agents) are typically assumed to be risk averse.<sup>9</sup> Likewise, models of occupational safety that incorporate risk misperceptions by individual workers typically assume that firms are fully informed about the true injury risk. There are a number of reasons that employers may behave more like the rational economic agents than individual workers. First, employers may have access to better data on the actual risk of injury to employees. Also, it is not clear the extent to which the personal nature or risk influences individual behavior, and it is possible that employers would have a more accurate perception of risk because it did not directly affect them.

On the other hand, there are reasons to suspect that employers may not perfectly fit the rational economic model. In general, large employers are probably most likely to be able to accurately predict the risk



of injury to an individual worker, simply because of the law of large numbers.<sup>10</sup> Small employers will simply not have enough observations to accurately formulate a probability. Even if employers as organizations understand the true risk of injury to workers, they are still driven by the decision making of individuals. It seems reasonable to suspect that individual managers might be poorly informed about the risk of injury to workers, or suffer similar cognitive biases about risk as those discussed above.

Another factor that might mitigate some of the impact of employers' risk misperceptions that will likely not be available to workers (even unionized ones) is the presence of insurance companies. Presumably, insurance companies have the knowledge and expertise to construct the most accurate estimates of the actual risk of injury for individuals. Thus, even if an employer does not place the appropriate marginal benefit on safety precautions, the insurance company could provide financial incentives for safety through discounts in workers' compensation premiums.<sup>11</sup>

However, there are other ways that investment in workplace safety might enter a firm's profit function than through premiums, such as the direct cost of investment, the impact of workplace safety on the expected marginal productivity of labor, and reductions in the compensating wage differential. Even if insurance companies can mitigate some of the impact of risk misperceptions, they likely won't have much effect on the wage negotiations between workers and employers unless they are able to communicate the appropriate risk levels. Also, the ability of insurance companies to convey accurate risk information will be less for smaller firms that are not perfectly experience rated. And finally, there are some risks for which even insurance companies likely have trouble assessing accurately, such as catastrophic risks. In these special cases, which involve extreme losses but have uncertain probability, employers and workers may over- or underreact in a similar fashion.

If employers as whole, or individual managers within firms, deviate from the perfectly rational model in ways that are similar to individual workers, then our model would predict different behavior for them as well. Consider the case of compensating wage differentials. If employers underestimate the risk of injury to individual workers, we might expect that this would make them less willing to negotiate compensating wage differentials. However, note that injuries will affect the expected

marginal productivity of labor, because injured workers are (at least temporarily) less productive than healthy ones. In this case, if employers underestimate the risk of injury it might lead them to *overestimate* the expected marginal productivity of labor (because more workers will be injured, and therefore be less productive, than expected by the employer). If employer misconceptions were positively correlated with the true injury risk, i.e., if they underestimated risk more in riskier jobs, this could lead to an upward bias of the compensating wage differential.<sup>12</sup>

Investment in workplace safety provisions will also be affected if employers deviate from the standard model. If employers underestimate the risk of injury, they may thereby underestimate the marginal benefit of safety measures. If this is the case, it will lead employers to underinvest in safety. On the other hand, suppose that employers overestimated their ability to influence workplace safety measures. This will lead employers to “oversupply” workplace safety, meaning they will invest beyond the point where the true marginal benefit equals marginal cost. However, if employers underestimate their ability to influence risk they will tend to undersupply workplace safety provisions. Ultimately, the equilibrium level of safety will be a complex function depending on both the employer’s and the employee’s perceptions of risk as well as other fundamentals of the model.<sup>13</sup>

## **POLICY IMPLICATIONS**

The discussion in the previous two sections focused on the implications of the behavioral model for research on the economics of workplace safety. However, just as this research has influenced public policy we believe that the issues we raise also have important policy implications. We focus our discussion on the two policy areas that are most closely related to our previous analysis: the use of compensating wage differentials to estimate the value of life, and policies designed to improve workplace safety.

### **Using Value-of-Life Estimates in Cost-Benefit Analysis**

Government policies and regulations can often reduce the risk of fatal and nonfatal injuries to individuals, but sometimes only at substan-

tial cost. In order to determine which policies are most cost-effective, it is necessary to have some estimate of the willingness to pay for a reduction in the level of risk. Compensating wage differential estimates can be used to provide an estimate of the “value-of-life,” allowing a computation of the expected benefit of increased safety in terms of a dollar amount. The use of value-of-life estimates to evaluate public policies began in the 1980s and has become more widespread since (Viscusi 1993).

Obviously these estimates are only useful to the extent that we are able to identify them well empirically, and as we have discussed there are numerous problems to doing so. The criticisms that come from the behavioral model are different, however, in that they do not question the validity of the empirical predictions as much as they question how to use the predictions. Specifically, while the behavioral model does predict that the size of the estimated compensating wage differential may be different than predicted by the standard model, this is not the same as saying that the estimated differential is biased. Indeed, if we ignore the measurement error and selection issues, the estimated relationship between wages and actual job risk should be well identified. The complication comes in interpreting the coefficient, because it will implicitly reflect the relationship between the actual risk and the individuals’ subjective risk perceptions and valuations. This is particularly troubling if the value-of-life estimate is used to assess the cost and benefits of some policy designed to reduce a risk that is subject to different cognitive biases than job-related risk (such as a plane crash, the risk of which individuals overestimate).

In some sense, the key impact of the behavioral model on the use of value of life estimates is to highlight the need for additional data. We simply do not know enough about the ways workers (or employers) perceive, value, or respond to risk. Survey and experimental data that elicited this information for job-related health and income risks would not only increase our understanding of many of these issues, it would allow us to generalize and improve the policy usefulness of value-of-life estimates based on labor market data.

## Promoting Safety in the Workplace

Workers' compensation is generally thought to provide employers and workers with financial incentives to improve safety. While this may be true, the behavioral model questions the effectiveness of both our ability to predict how strong the safety incentives are and whether or not they will have much effect at all. However, workers' compensation is certainly not the only public policy that deals with workplace safety. The federal Occupational Safety and Health Administration (OSHA) was founded in 1971 as a regulatory body to promote safer workplaces, and 24 states have their own health and safety plans that are approved and monitored by OSHA. Rather than rely (solely) on financial incentives, these organizations rely on traditional regulatory measures such as inspection and enforcement of safety programs.

However, it needs to be determined in light of the behavioral criticisms exactly what kinds of safety programs are most likely to be effective. Rea (1981) demonstrated that if individuals misperceive the risk of injuries they might respond to employer precautions in ways that mitigate the benefits of reduced risk. Moreover, if individual safety behavior is determined by rule-based decision making then it is difficult to predict how (if at all) individuals will respond not only to financial incentives but also to regulatory or programmatic incentives.

One important way to improve safety, or at least to improve the efficiency of safety decisions, may be to provide information to workers.<sup>14</sup> We discussed above how experience and learning by individuals may allow them to overcome some of their cognitive biases about risk and act more like the rational economic agent. Of course, it often requires a substantial investment of time and effort to obtain and process information. If there are economies of scale in acquiring information then we might expect firms to have an advantage in this regard, which would make them a more efficient mechanism to collect and process the relevant data. More work needs to be done to say for sure, but it is possible that doing more to educate workers in risky positions, and perhaps the employers as well, would lead to more efficient long-run employment contracts between workers and employers.<sup>15</sup>

Even if information cannot fully overcome workers' or employers' biases, it may be helpful in other ways. Suppose worker safety precautions were governed by rules, but those rules were based on suboptimal

perceptions about risk. Thus, information may be able to help individuals switch to “better” rules that make them choose more efficient levels of precautions. All of this is highly speculative, but it does suggest that a better understanding of how individuals think about and respond to risk may allow us to come up with superior policies regarding workplace safety.

## CONCLUSIONS

In this chapter we have attempted to highlight some principles of behavioral economics and show how they can influence the economic analysis of occupational safety. Behavioral economics predicts that in some cases individuals will fail to perceive, value, or respond to risk as predicted in the standard economic model. We have shown that if the behavioral model holds it will at the very least greatly complicate the analysis of how individuals respond to the risk of workplace injuries, and in many cases the standard model might make misleading (if not actually false) predictions about behavior.

We fully acknowledge that our analysis raises many more questions than it answers. Economists generally make assumptions to simplify analysis, and the elements of behavioral economics we discuss add complication back to our model. Given this, it is probably not surprising that, when we consider the additional dimensions that might govern individual choices, we find that these dimensions often work in different directions and restrict our ability to make clear predictions. That said, in many cases the general predictions of standard economic model hold, particularly with regard to compensating wage differentials. The strongest effect of the behavioral model seems to be to change our interpretation of the results we find empirically, and often this interpretation cannot be made without more *a priori* information about how individuals actually perceive, value, or respond to risk.

Now we come to the place that many researchers arrive at—calling for more research. In this case, it should be clear to the reader that we indeed know very little. Work is needed to disentangle the various behavioral predictions about the ways people cope with the risk of injuries and illnesses at work. Specifically, we need information not only on how individuals perceive the risk of injury in various occupations

but how these perceptions change over time and in response to worker and employer safety precautions. We need information about how individuals value the risk of injury relative to the way they value wages and higher compensation, and we also need to see how this valuation changes over time. We need to learn how individuals respond to perceived risk, and how increased information changes those responses (if at all). This information is not readily available given current sources of data, but we feel that future experimental and observational studies that address these and related issues will greatly increase our ability to conduct research and inform meaningful policy pertaining to occupational safety.

### Notes

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1. It is worth noting that this argument is not necessary to justify the use of partial insurance coverage. Basic insurance theory tells us that the optimal level of insurance will equalize the marginal utility of income in the “good” and “bad” states. Viscusi and Moore (1987) and Viscusi and Evans (1990) argue that the marginal utility of income is lower for individuals with disabling injuries, possibly because working becomes more difficult when one is disabled, and so the optimal insurance contract provides less than full coverage of economic losses.
2. The distinction between predictable and unpredictable errors in judgment is important. If individuals make predictable errors, this suggests that they (might) behave in a way different than that predicted by the standard economic model. If, on the other hand, errors are random, then the economic model should predict behavior accurately *on average*.
3. The difference is equal in absolute value to  $0.25[U(3,000) - U(2,000)]$ .
4. Note that in many cases these mismatches are related to the subjective assignments of perception and value discussed previously. For example, the saliency mismatch is closely related to the availability bias, suggesting that individuals consistently place greater weight on situations or outcomes that are easily understood. Likewise, a failure to place the appropriate weight on costs (or benefits) that occur only after multiple actions is similar to the availability bias, in which individuals appreciate the cumulative risk resulting from multiple exposures.
5. In addition to suggesting the existence of compensating wage differentials, Adam Smith (1776) also proposed that individuals underestimate risk, noticing the relatively small number of individuals who purchased fire insurance. Spence (1977) provided a formal model of how the underestimation of risk can lead in-

dividuals to underinsure against the risk of product failure, and Diamond (1977) and Rea, Jr. (1981) examined how underestimating risk affects optimal workers' compensation insurance (which we discuss more later).

6. Presumably, the gain and loss is measured relative to some benchmark utility level that is received with certainty, i.e., the "reservation" utility level.
7. Note that we are implicitly assuming here that there is no fixed safety level that workers are trying to obtain. If workers are maximizing expected utility with respect to safety precautions then they will set the marginal benefit equal to the marginal cost, which will lead to more precautions taken if they perceive a higher marginal reduction in risk. If, on the other hand, workers are trying to attain some fixed level of (perceived) safety then overestimating the productivity of safety precautions could lead to reduced precautions, because they can achieve this perceived level with fewer precautions.
8. As mentioned before, empirical evidence has demonstrated a relationship between workers' compensation claims rates and workers' compensation benefits. However, as we cannot rule out the possibility that this relationship is driven either by fraud or simply the efficient response by individuals to some unobservable (to econometricians) costs of claim filing instead of some change in actual safety behavior, we cannot dismiss the possibility that actual workplace safety is unresponsive to benefit levels.
9. The assumption of risk-neutral firms is generally justified by the notion that shareholders drive the behavior of firms. If this is true and shareholders are able to perfectly diversify assets, they will desire the managers of firms to maximize expected profits. While this assumption of risk neutrality might be valid for large firms, the notion of perfectly diversified shareholders is probably less meaningful for small firms.
10. On the other hand, it is not clear why a large union would not have access to similar information, so it seems less likely that there would be a divergence between the risk perceptions of employers and organized labor.
11. In the long run, insurance premiums should be completely "passed on" to workers in a perfectly competitive market. If wages are sticky, however, there will be short run costs to premiums that will influence firm behavior.
12. Note that if workers underestimated risk in a similar fashion as employers, they would demand less of a compensating differential in the same occupations that firms would be willing to offer higher wages. Thus, the net effect on the compensating differential estimate would be ambiguous.
13. These other model primitives include such factors as the complementarity of worker and employer safety precautions and differences in utility and marginal utility of income in the injured and health states.
14. It is important to distinguish efforts to increase safety from efforts to make the level of safety more efficient. Some of the predictions of the standard model actually predict that there might be *too much* safety relative to the standard model. In this case, it could be efficient to make people less careful.
15. Of course, we recognize that it is difficult to communicate risk information so that it is perceived accurately.

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**Prevention and Compensation**

*Essays in Honor of Terry Thomason*

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Matthew M. Bodah  
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