OPTIMAL LIABILITY WHEN THE
INJURER'S INFORMATION ABOUT
THE VICTIM'S LOSS IS IMPERFECT

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About the Victim's Loss is Imperfect

ABSTRACT

A central result in the economic theory of liability is
that, if an injurer's liability equals the victim's loss,
then either the rule of strict liability or the rule of
negligence can induce the injurer to behave properly.
However, for this result to hold, the injurer must know
the victim's loss __before__ the injurer decides whether to
engage in the harmful activity and, _a fortiori_, before any
harm has occurred. This paper reevaluates the rules of
strict liability and negligence when the injurer's
information is imperfect. Two questions are addressed:
Under each rule, should the level of liability imposed on
the injurer still equal the victim's loss? Are the rules
of strict liability and negligence still equally
desirable? With respect to the first question, it is
demonstrated that the optimal level of liability generally
is __not__ equal to the victim's loss. With respect to the
second question, it is shown that if the injurer's
liability equals the victim's loss, then the two rules are
equivalent, but if liability is set optimally under each
rule, then strict liability generally induces the injurer
to behave in a more appropriate way.

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1. Introduction

A central result in the economic theory of liability is that, if an injurer's liability equals the victim's loss, then either the rule of strict liability or the rule of negligence can induce the injurer to behave properly. [1] To see why, suppose that injurers differ in terms of their gains from engaging in some harmful activity, and that they all know what the victim's loss will be if they do engage in the activity. Under the rule of strict liability, an injurer would have to compensate the victim for the loss, so that only those injurers whose gains exceed the victim's loss will engage in the activity. Under the rule of negligence, an injurer would have to compensate the victim only if the injurer is negligent--that is, only if his gain is less than the victim's loss. Again, only those injurers whose gains exceed the victim's loss will engage in the activity. Thus, either remedy can induce injurers to behave in a socially appropriate way. [2]

Note that the preceding argument requires a strong assumption about the injurers' information: each injurer must know the victim's loss _before_ he decides whether to engage in the harmful activity and, _a fortiori_, before any harm has occurred. While it is reasonable to assume that injurers have some information about what the harm would be, it is not realistic to assume that this information is always accurate. For example, even if a schedule of the losses that would be caused by various types of driving accidents were regularly published in newspapers or disseminated in other ways, it is clearly implausible to assume that drivers would remember every detail.

This paper reevaluates the rules of strict liability and negligence when the injurers' information about the victim's loss is imperfect. Two questions are addressed: _Under each rule, should the level of liability imposed on an_

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injurer still equal the victim's loss? Are the rules of strict liability and negligence still equally desirable? [3]

With respect to the first question, it will be demonstrated that the optimal level of liability generally is not equal to the victim's loss. Whether the optimal level of liability is above or below the loss depends on the social desirability of the activity--that is, on whether the average gain of injurers is less than or greater than the victim's loss.

To see why this is so, suppose that the court makes the injurer liable exactly for the victim's loss, which will be referred to as compensatory damages. [4] Consider the effects of this policy under the rule of strict liability. If an injurer's estimate of the loss is less than the true loss, that injurer might be underdeterred--that is, he might engage in the activity even though his gain is less than the victim's loss. But if an injurer's estimate of the loss is above the true loss, that injurer might be overdeterred--he might not engage in the activity even though his gain exceeds the victim's loss. Thus, using compensatory damages leads to two possible errors.

Suppose, instead of using compensatory damages, the court adjusts compensatory damages upward by some amount. Assuming that injurers consequently raise their estimates of their liability, this adjustment decreases the number of injurers who will be underdeterred but increases the number who will be overdeterred. If the gains of most injurers are below the victim's loss--that is, if the activity is socially undesirable--then the imposition of additional damages results in a net social benefit. Conversely, if the activity is socially desirable, then it is optimal to impose less than compensatory damages on injurers since the benefit from reducing

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overdeterrence is more important than the detriment from increasing underdeterrence.

An analogous argument for adjusting compensatory damages can be made under the negligence rule. The main difference results from the fact that, under this rule, the injurer expects to be liable only if his gain is less than his estimate of the victim's loss. For reasons that will be explained below, this difference implies that upward adjustments to compensatory damages will not affect injurer behavior, while downward adjustments will have the same effects as under strict liability. Consequently, if the activity is socially desirable, it is optimal under the negligence rule to impose less than compensatory damages on injurers.

The second question--regarding the relative desirability of strict liability and negligence--will be answered in two contexts, depending on whether the court uses compensatory damages or optimally adjusts compensatory damages.

If compensatory damages are used, then the two rules are equivalent. The reasoning behind this result is essentially the same as in the opening paragraph--both rules will lead an injurer to engage in the activity if and only if his gain exceeds his estimate of the victim's loss.

However, if the court optimally adjusts compensatory damages under each rule, then strict liability generally is preferred to negligence. The explanation of this result follows from the earlier observation that, under the negligence rule, upward adjustments to compensatory damages have no effect, while downward adjustments have the same effects as under strict liability. Thus, if it is optimal to adjust compensatory damages downward under strict liability, negligence can do as well. But if it is optimal to

adjust damages upward, strict liability is superior to negligence. Stated somewhat differently, if the activity is socially desirable, then strict liability and negligence, with damages less than compensatory damages, are equally good; but if the activity is socially undesirable, then strict liability should be used and damages should exceed compensatory damages.

The paper is organized as follows. Section 2 analyzes strict liability in a general model. Section 3 illustrates the results of section 2 in an example. Section 4 compares strict liability and negligence. Section 5 contains some concluding remarks.

2. Strict Liability in the General Case

There are many potential injurers, each of whom obtains some gain from engaging in the harmful activity. In addition, there is a fixed loss that will result if an injurer engages in the activity. [5] Under strict liability, an injurer will engage in the activity if his gain exceeds his estimate of the sum of the victim's loss and the adjustment to compensatory damages. It is assumed that the injurer has a point estimate of the victim's loss, but knows the adjustment to compensatory damages exactly. [6]

Social welfare is taken to be the sum of the gains to injurers (conditional on their engaging in the activity) less the losses to victims. The court's problem is to choose an adjustment to compensatory damages that maximizes social welfare (as well as--see section 4 below--to choose whether to use strict liability or negligence). In solving this problem, the court is assumed to know the victim's loss, the distribution of the injurers' gains, and the distribution of the injurers' estimates of the victim's loss.

The following notation will be used in the general case:

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g   gain of an injurer

f(g)   density of gains across injurers $(0 \leq g_1 \leq g \leq g_2)$

l   loss of victim

l'   estimate of victim's loss

h(l')   density of loss estimates across injurers
                $(0 < l_1 \leq l' \leq l_2)$ [7]

d   adjustment to compensatory damages (optimal adjustment is d*)

W(d)   social welfare

The population will be normalized so that the total number of potential injurers is unity.

Consider the behavior of an injurer whose gain is g and whose loss estimate is l'. That injurer will engage in the activity if and only if g exceeds l'+d, or, equivalently, if l' < g-d. [8] Therefore, the fraction of injurers with gain g who will engage in the activity is H(g-d), where H(.) is the cumulative distribution of h(.). Note that, since l_1 is the lowest value of l', no injurers with gains less than l_1+d will engage in the activity; similarly, all injurers with gains greater than l_2+d will engage in the activity.

Social welfare can now be expressed as: [9]

$$(1) \quad W(d) = \int_{l_1+d}^{l_2+d} H(g-d)f(g)(g-1)dg \; + \; \int_{l_2+d}^{g_2} f(g)(g-1)dg.$$

The first term represents the gains less the losses of injurers whose gains are between l_1+d and l_2+d, only some of whom will engage in the activity (those with sufficiently low loss estimates). The second term represents the gains less the losses of injurers whose gains exceed l_2+d, all of whom will engage in the activity.

Alternatively, social welfare can be written as the first-best level of

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social welfare less the sum of the social losses due to underdeterrence and

overdeterrence: [10]

$$W(d) = \int_1^{g_2} f(g)(g-1)dg$$

(2)

$$- \left(- \int_{l_1+d}^{1} H(g-d)f(g)(g-1)dg + \int_1^{l_2 \pm d} [1-H(g-d)]f(g)(g-1)dg \right).$$

The first term represents the level of social welfare that would result if

injurers were to engage in the activity if and only if their gains exceed the

victim's loss. The second term (the first term in braces) represents the

social loss due to some injurers actually engaging in the activity when their

gains are less than the victim's loss. And the third term represents the

social loss due to some injurers not engaging in the activity when their gains

exceed the victim's loss.

It is apparent from (2) that a policy of awarding compensatory damages (d

= 0) will not lead to the first-best level of social welfare since both of the

terms in braces will be positive. In other words, some injurers will be

underdeterred and others overdeterred. It is not clear, however, whether it

is desirable to raise or lower the level of liability, since raising liability

will reduce underdeterrence but increase overdeterrence, and lowering

liability will have the opposite effects.

Assuming that W(.) is a strictly concave function of d, and that d* is an

interior optimum, the sign of the optimal adjustment to compensatory damages

is determined by the sign of W'(d) evaluated at d = 0. From (2), this

condition can be expressed as:

$$(3) \quad d* \begin{array}{c} > \\ = \\ < \end{array} 0 \quad \text{as} \quad - \int_{l_1}^{1} h(g)f(g)(g-1)dg \begin{array}{c} > \\ = \\ < \end{array} \int_1^{l_2} h(g)f(g)(g-1)dg.$$

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The first integral in (3) is the marginal reduction in the social loss due to underdeterrence as d is raised, starting at d = 0; the second integral is the corresponding increase in the social loss due to overdeterrence. Therefore, whether compensatory damages should be adjusted upwards or downwards (or not at all) depends on the relative importance of underdeterrence and overdeterrence.

Since there is no reason to believe that the two integrals in (3) are equal, it is generally not optimal under strict liability to use compensatory damages without adjustment. However, unless some additional assumptions about the form of $h(.)$ and/or $f(.)$ are made, not much can be said about when the adjustment should be positive or negative.

Several alternative assumptions are sufficient to determine the sign of $d*$ from (3). Suppose, for example, that the distribution of the injurers' loss estimates, $h(.)$, is uniform. Then, without assuming anything about the distribution of gains across injurers, $f(.)$, condition (3) can be expressed as:

$$d* \overset{>}{\underset{<}{=}} 0 \quad \text{as} \quad \bar{g} \overset{<}{\underset{>}{=}} 1,$$

(4)

$$\text{where} \quad \bar{g} = [\int_{l_1}^{l_2} g f(g) dg] / [\int_{l_1}^{l_2} f(g) dg].$$

In other words, if the injurers' activity is socially undesirable--their average gain is less than the victim's loss--then compensatory damages should be adjusted upward, while if the activity is socially desirable, compensatory damages should be adjusted downward. (To be precise, it is the average gain of injurers conditional on their gains being within the range of the loss estimates--between l_1 and l_2--that is relevant.)

Another interesting special case is when the distribution of the injurers' loss estimates, h(.), is symmetrical around the true loss. Then, if the distribution of the injurers' gains, f(.), falls monotonically, the activity is socially undesirable, and (3) implies that d* > 0. If, alternatively, f(.) were to rise monotonically, the activity would become socially desirable and (3) would imply that d* < 0.

Note that the analysis of strict liability in this section did not assume anything about whether there is a systematic bias in the injurers' estimates of the victim's loss--that is, whether the mean of l' equals l. Thus, even if the mean of l' equals l, compensatory damages generally are not optimal under strict liability. This point will be illustrated by the example in the next section.

3. Strict Liability in the Double-Discrete Example

The simplest version of the general model consists of having the injurers' gains and their estimates of the victim's loss each take on two values. This will be referred to as the double-discrete example. Let:

g_1, g_2 possible gains of injurers ($g_2 > g_1 > 0$)

q   fraction of injurers whose gains are g_1

1-e, 1+e   possible estimates of victim's loss (equally likely)

Since the average loss estimate equals the true loss, none of the results that follow are due to a systematic bias among injurers in estimating the victim's loss.

In order to have both some underdeterrence and some overdeterrence when compensatory damages are used in the double-discrete example, it is assumed that:

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(5) $$1-e < g_1 < 1 < g_2 < 1+e.$$

First consider strict liability with compensatory damages. Given (5), injurers whose gains are g_1 will engage in the activity if their estimate of the victim's loss is 1-e, but not if it is 1+e. Therefore, half the injurers with gains of g_1 will engage in the activity. Similarly, half of the injurers with gains of g_2 will engage in the activity--also those whose estimate of the victim's loss is 1-e. Thus, social welfare under strict liability with compensatory damages (d = 0) is:

(6) $$W(0) = .5q(g_1-1) + .5(1-q)(g_2-1).$$

It will be useful to compare this level of social welfare to the level of social welfare that would occur in the first-best outcome. In the first-best outcome, injurers would engage in the activity if and only if their gains exceed the victim's loss--that is, if their gains are g_2, but not if they are g_1 (see (5)). Relative to this outcome, using the rule of strict liability with compensatory damages causes two types of errors. The error of underdeterrence occurs when injurers with gains of g_1 think the victim's loss is 1-e. Compared to the first-best outcome, this error lowers social welfare by $-.5q(g_1-1)$. And the error of overdeterrence occurs when injurers with gains of g_2 think the victim's loss is 1+e. This error lowers social welfare by $.5(1-q)(g_2-1)$.

If compensatory damages are adjusted, then the appropriate expression for social welfare depends on whether the adjustment, d, is positive or negative. There are two relevant ranges to consider. [11]

In the first range, d is positive and high enough to eliminate the problem of underdeterrence that occurs with compensatory damages, but not so high as to worsen the problem of overdeterrence. Let d+ refer to any d in

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this range:

(7) $$0 < g_1 - (1-e) \le d < g_2 - (1-e).$$

Now, injurers whose gains are g_1 will not engage in the activity even if their estimate of the victim's loss is $1-e$, since $(1-e)+d \ge g_1$. The behavior of injurers whose gains are g_2 is unaffected; they will still engage in the activity if their estimate is $1-e$, and they will still not engage if their estimate is $1+e$. Therefore, social welfare will be:

(8) $$W(d+) = .5(1-q)(g_2-1).$$

Similarly, in the second range, d is negative and low enough to eliminate the problem of overdeterrence that occurs with compensatory damages, but not so low as to worsen the problem of underdeterrence. Let d- refer to any d in this range:

(9) $$g_1 - (1+e) \le d < g_2 - (1+e) < 0.$$

Now, injurers whose gains are g_2 will engage in the activity regardless of their loss estimate. And injurers whose gains are g_1 still will engage in the activity only if their estimate is $1-e$. Then social welfare will be:

(10) $$W(d-) = .5q(g_1-1) + (1-q)(g_2-1).$$

Since $g_1 < 1$ and $g_2 > 1$, it is immediately clear from comparing (6), (8), and (10) that both $W(d+)$ and $W(d-)$ exceed $W(0)$. In other words, under the rule of strict liability, it is never optimal in this example to use compensatory damages.

Whether compensatory damages should be adjusted upward or downward in the double-discrete example can be expressed as follows:

(11) $$W(d+) \underset{<}{\overset{>}{=}} W(d-) \quad \text{as} \quad -.5q(g_1-1) \underset{<}{\overset{>}{=}} .5(1-q)(g_2-1).$$

This result, which is the analogue to (3) in the general case, has the

following interpretation: An appropriate upward adjustment of compensatory damages can eliminate the error of underdeterrence, while an appropriate downward adjustment can eliminate the error of overdeterrence. [12] Which adjustment is most desirable depends on which error is more important to correct. It was shown previously that, relative to the first-best outcome, the welfare loss from underdeterrence is $-.5q(g_1-1)$, and the welfare loss from overdeterrence is $.5(1-q)(g_2-1)$. Thus, (11) states that compensatory damages should be adjusted upward if the welfare loss from underdeterrence exceeds the welfare loss from overdeterrence, and downward if the reverse is true.

It will be useful to provide another formulation of (11), which can be rewritten as:

$$(12) \quad W(d+) \quad \begin{array}{c} > \\ = \\ < \end{array} \quad W(d-) \quad \text{as} \quad \bar{g} \quad \begin{array}{c} < \\ = \\ > \end{array} \quad 1, \quad \text{where} \quad \bar{g} = qg_1 + (1-q)g_2.$$

This result corresponds to (4) in the general case and has the same interpretation: If the injurers' activity is socially undesirable (average gain less than victim's loss), then compensatory damages should be adjusted upward, while if the activity is socially desirable, compensatory damages should be adjusted downward. [13]

4. Strict Liability Versus Negligence

Under the negligence rule, an injurer will be found liable only if his gain is less than the victim's loss (in contrast to the strict liability rule, under which he would be liable regardless of his gain). Thus, for the court to be able to apply the negligence rule, it is necessary to assume that the court can determine an injurer's gain _after_ the injurer has engaged in the harmful activity. But it is still assumed that at the time the court chooses

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the adjustment to compensatory damages, it only knows the distribution of gains across injurers. [14]

If compensatory damages are used under both rules, it is easy see that strict liability and negligence are equivalent. Consider the behavior of an injurer whose gain is g and whose loss estimate is l'. If g is greater than l', that injurer will believe that he will not be found negligent under the negligence rule; therefore, he will engage in the harmful activity. The same behavior would result under strict liability. If g is less than l', the injurer will expect to be liable under the negligence rule and to have to pay l'; consequently, he will not engage in the activity. Again, the same behavior would result under strict liability. Thus, if damages are compensatory, both rules will lead an injurer to engage in the activity if and only if his gain exceeds his estimate of the victim's loss.

However, if damages are set optimally, then the strict liability rule generally is preferred to the negligence rule. To understand why, it is necessary to examine two cases--when the adjustment to compensatory damages is positive and negative.

First suppose that d is positive, and again consider an injurer whose gain is g and whose estimate of the loss is l'. It is easy to see that, under the negligence rule, the injurer will behave just as if compensatory damages were used. If g is greater than l', the injurer will believe that he will not be found negligent; therefore, he will engage in the harmful activity even though d is positive. And if g is less than l', the injurer will expect to be liable under the negligence rule and to have to pay l'+d; consequently, he will not engage in the activity regardless of whether d is zero or positive. Thus, if d is positive, injurers will behave under the negligence rule as if

compensatory damages were used.

Now suppose that d is negative. It will be shown that an injurer's behavior will be the same under negligence and strict liability. If g exceeds l', the injurer will engage in the harmful activity under the negligence rule since he will believe that he will not be found negligent. The same behavior would result under strict liability when d is negative. If g is less than l', the injurer will expect to be liable under the negligence rule and to have to pay l'+d; therefore, he will engage in the activity if and only if g > l'+d. Again, the same behavior would result under strict liability. Thus, if d is negative, the two rules are equivalent.

It is now easy to see why strict liability generally is superior to negligence when damages are set optimally. Suppose it is optimal under strict liability to adjust compensatory damages upward. Then strict liability clearly dominates negligence since every possible adjustment to compensatory damages under the negligence rule is equivalent to the strict liability rule with either no adjustment or a negative adjustment. Suppose, alternatively, that it is optimal under strict liability to adjust compensatory damages downward. Then strict liability and negligence are equally desirable (with the same downward adjustment under the negligence rule). In general, therefore, strict liability is preferable to negligence.

It will be useful to relate this discussion to activities characterized as socially desirable or socially undesirable (in the sense previously used). If the activity is socially desirable, then strict liability and negligence, with damages less than compensatory damages, are equally good; but if the activity is socially undesirable, then strict liability should be used and damages should exceed compensatory damages.

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5. Concluding Remarks

This section discusses several points related to the interpretation of the results and some extensions of the model.

(a) The results comparing strict liability to negligence may not carry over with a more realistic characterization of the negligence rule. Suppose, for example, that injurers are uncertain about what the standard of care is under the negligence rule, or that the courts make mistakes in observing the injurer's care. Then each injurer will anticipate being found liable with some probability and, presumably, this probability would fall as the injurer's care increases. In this framework, the analysis of the negligence rule could differ substantially from that presented here. Consider, for example, the effects of adjusting compensatory damages upward. In the model analyzed in this paper, such an adjustment had no effect. But in a model in which, under the negligence rule, injurers would be liable with some probability, there clearly would be some effects. Moreover, these effects could be quite beneficial precisely because the probability of liability declines with injurer care. For example, given any upward adjustment, injurers who take low care (and who might otherwise be underdeterred) will anticipate a greater increase in expected liability than injurers who take high care (and who might otherwise be overdeterred). [15]

(b) The result that it is generally optimal to adjust compensatory damages also could be affected in a significant way if the court, as well as the injurer, were assumed to have imperfect information about the victim's loss. For example, consider the rule of strict liability and suppose the court's imperfect information takes the same form as the injurers' imperfect

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information. In this framework, it can be shown that compensatory damages without adjustment are optimal. [16] Thus, a crucial assumption in the analysis in the paper is that the court has better information about the loss than the injurer. This assumption obviously is more realistic in some situations than others. For example, a court may deal with some types of harms--such as automobile accidents--repeatedly, whereas each injurer may only be involved with such harms infrequently, if ever.

(c) Notwithstanding the preceding two comments, the theory developed in this paper is broadly consistent with certain doctrines in American law. For example, one doctrine holds that activities classified as "ultrahazardous" or "abnormally dangerous" should be subject to the rule of strict liability rather than the rule of negligence. The analysis here is consistent with this principle since it was seen that strict liability is superior to negligence when the activity is socially undesirable. [17]

(d) The results of this paper can be applied, with some modification, to the use of taxes, fines, or standards to deal with externalities. The analysis of taxes and fines would be similar to the analysis of strict liability. If the party subject to the tax or the fine has imperfect information about its level, then that party may cause too much harm or too little harm as a result of the incorrect estimate of the tax or the fine. Depending on the relative importance of the two types of errors, it generally will be desirable to set the tax or the fine higher or lower than would be optimal if the party's information were perfect. The analysis of standards would be similar to the analysis of negligence since, if the standard is not complied with, the party subject to the standard often is punished by a financial penalty. It may be optimal to adjust the penalty (and possibly the

standard) if the party subject to the standard has imperfect information about the penalty (or the standard).

(e) Allowing for the injurer's information about the victim's loss to be imperfect has some important general implications for the theory of externalities. In the more commonly analyzed case in which injurers' information is assumed to be perfect, it is well known that if an injurer is made to pay for the victim's harm, then the socially desired behavior of the injurer will result. A corollary to this proposition is that the injurer's payment should not depend on whether he is engaging in a socially desirable or socially undesirable activity. For the reasons shown here, neither of these conclusions continues to hold if the injurer's information is imperfect.

<u>Notes</u>

[1] See, for example, Brown (1973). He also considers the victim's behavior, which is an issue that will not be dealt with here.

[2] This conclusion may not be correct if injurers are risk averse, or if their "activity level" (e.g., amount of driving) as well as their "care" (e.g., speed) affects expected accident losses. These issues will not be considered here.

[3] Although these questions have not been addressed before in a model which emphasizes the imperfect information of the injurer, there are some closely related studies. Most of these studies focus on whether, under the rule of negligence, an injurer will meet the standard of care when the injurer has imperfect information about the negligence standard or when the court has imperfect information about the injurer's care. See, for example, Diamond (1974), Golding (1982), Grady (1983), and Craswell and Calfee (1986). Some attention also has been given to the optimal level of liability and the choice between strict liability and negligence when there is imperfect information. See, for example, Calabresi and Hirschoff (1972), Cooter (1982), and Landes and Posner (1983). Much of this literature recently has been synthesized and extended in Shavell (1987, esp. Chs. 4.C & 6.C).

[4] Although reference will be made throughout the paper to "the court,"

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this is meant in a generic sense to refer to whatever institution is responsible for choosing the level of liability (including a legislature or an administrative agency).

[5] In other words, there is no uncertainty about the likelihood or the magnitude of the loss. It will become clear that the results will generalize to a model in which both the probability and the magnitude of the loss may be uncertain.

[6] More realistically, one could assume that the injurer also has imperfect information about the adjustment to compensatory damages. This generalization would not affect the results of the paper (provided, as seems reasonable, that the average estimate of the adjustment is positively related to the actual adjustment).

[7] It is assumed for convenience that the density of loss estimates across injurers is independent of the density of gains across injurers.

[8] There is no loss of generality in assuming that the injurer will not engage in the activity when his gain equals the sum of the loss estimate and the damage adjustment.

[9] The following expression assumes that $g_1 < l_1$ and that $g_2 > l_2$. If these conditions do not hold, it will be obvious how the expression for social welfare is affected.

[10] It is straightforward to show from (1) that $W'(d) < 0$ if $d > 1-l_1$ and $W'(d) > 0$ if $d < 1-l_2$. Therefore, $l_1+d* < 1 < l_2+d*$, making the following decomposition of (1) well defined for the optimal value of d.

[11] It will become clear from the analysis below that d in one of these ranges dominates d outside of these ranges. Therefore, values of d outside of these ranges will not be considered.

[12] Given the assumptions of the double-discrete example, it is possible either to eliminate underdeterrence without worsening overdeterrence, or to eliminate overdeterrence without worsening underdeterrence. Of course, this will not be true in general.

[13] Richard Craswell has pointed out to me that the results in this section do not depend on the distribution of the injurers' estimates of the victim's loss. This observation does not, however, apply generally.

[14] The characterization of the negligence rule in this section is overly simplistic in several respects. For example, in practice the negligence rule imposes liability on an injurer with some probability that depends on the injurer's care; see comment (a) in section 5 below.

[15] In an earlier version of this paper, each injurer's information about the victim's loss was characterized as a probability distribution rather than as a point estimate. In that version, strict liability and negligence were not equivalent when compensatory damages were used (either rule could dominate), and negligence was superior to strict liability when damages were set optimally (essentially for the reason suggested in this comment).

[16] This result is implicit in Shavell (1987, Ch. 6.C).

[17] To be more precise, it is strict liability with compensatory damages optimally adjusted upward that is superior to negligence with optimal damages when the activity is socially undesirable. Unfortunately, there does not appear to be any evidence that indicates whether liability for ultrahazardous or abnormally dangerous activities generally exceeds compensatory damages. I am indebted to Richard Craswell for raising this point.

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