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Varying Injurer Costs of Care, Negligence, and Self-Selection

Standard economic models of negligence set a single standard of care to which all injurers must conform. When injurers differ in their costs of care, this leads to distortions in individual care choices. This paper derives the characteristics of a negligence rule that induces optimal care by all injurers by means of self-selection. The principal features of the rule are (1) the due standard is set at the optimal care of the lowest cost injurer, and (2) liability increases gradually rather than abruptly as care falls below this standard. The results are consistent with the gradation in liability under certain causation rules and under comparative negligence.

1. Introduction

The economic model of negligence, beginning with Brown (1973),¹ has generally focused on the case of a single injurer and a single efficient standard of care. In reality, of course, injurers have different optimal care levels arising from variation in their costs of care. (Specifically, optimal care decreases with the cost of care.) Actual negligence law nevertheless generally sets a single due care standard (the reasonable person standard) to which all injurers must conform. The argument is that the allocative savings from setting individualized standards would be more than offset by the cost of ascertaining individual costs of care, which are generally unobservable to the court.²

It does not follow from this argument, however, that actual liability rules make no provision for variation in injurer costs of care. It has been argued, for example, that certain causation rules (Schwartz, 1998) and comparative negligence (Rubinfeld, 1987) implicitly establish a range of care standards that allow injurers to sort themselves according to their costs of care. Because courts cannot observe these costs, however, such sorting necessarily involves self-selection. The purpose of this paper is to employ tools

from the literature on asymmetric information\textsuperscript{3} to examine the nature of this self-selection in detail, and to relate the results to actual legal doctrine.

The analysis begins by defining an Efficient Self-Selection Equilibrium, under which all injurers are induced to choose their individually-optimal care levels, even though the court cannot observe their types. It then shows that strict liability achieves this outcome, but a negligence rule with individualized due standards does not. Somewhat surprisingly, a simple negligence rule with a single due standard can achieve the efficient outcome, but only if the due standard is set at the optimal care level of the injurer with the lowest cost of care, and if all other injurers find the due standard to be so high that they choose to be negligent. Since this latter condition is unlikely to be satisfied in most settings, we derive the characteristics of a generalized negligence rule that can always achieve the efficient outcome. The most notable feature of such a rule is that it does not generally entail an abrupt drop in liability at the due care standard. Instead, liability declines gradually toward zero as care increases, a conclusion that mirrors the above interpretations of causation and comparative negligence.

2. The Model

The analysis employs a standard unilateral care accident model in which expected accident costs are given by

$$cx + p(x)D,$$ (1)

\textsuperscript{2} See Landes and Posner (1987, pp. 132-131), who argue that, in those cases where the cost of individualizing the standard is low, the court will do so.

\textsuperscript{3} See, for example, Mas-Coleil, Whinston, and Green (1995, Chapters 13 and 14), Cooper (1984), and Sappington (1983).
where $c$ is the injurer’s unit cost of care, $x$ is the amount of care, $p(x)$ is the probability of an accident ($p^<0, p^{''}>0$), and $D$ is the victim’s damages. Optimal care, $x^*$, therefore solves the first order condition

$$c + p'(x)D = 0,$$

from which it follows that $\frac{\partial x^*}{\partial c} < 0$. That is, injurers with higher costs of care should take less care.

Suppose in particular that there are $I$ injurers whose costs of care vary as follows:

$$c_1 > c_2 > \ldots > c_I,$$

which implies that

$$x_1^* < x_2^* < \ldots < x_I^*.$$

It is clear that a rule of strict liability achieves this outcome because all injurers expect to face the full damages from any accidents they cause. Thus, their private costs are identical to social costs.

The conclusion may be different, however, under negligence. If the court can observe each injurer’s cost of care and set the appropriate due standard, then all injurers will choose optimal care to avoid liability. But if the court cannot observe the $c_i$’s, or can only do so at high cost, then it must set a single due care standard, say $\overline{x}$. In this case, two sorts of inefficiencies will generally result (Landes and Posner, 1987). First, injurers with $x_i^*$ larger than $\overline{x}$ will just meet the due standard and will therefore take too little care. Second, injurers with $x_i^*$ less than but close to $\overline{x}$ will increase their care up to the due standard and take too much care. (Injurers with $x_i^*$ well below $\overline{x}$ will choose efficient care and will be found negligent by the court.)

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4 Differentiating (2) yields $\frac{\partial x^*}{\partial c} = -\frac{1}{p^{''}}D < 0$. 

In view of the large literature on the impact of imperfect information on market outcomes, it is not surprising that uncertainty by the court over individual injurer costs of care leads to this sort of inefficiency under a standard negligence rule. However, the fact that strict liability yields the first-best outcome without the need for the court to observe the $c_i$’s suggests that imperfect information need not result in inefficiencies in the current context. In what follows, we therefore examine in detail the conditions under which various liability rules, focusing especially on negligence, achieve the first best outcome when injurers vary in their costs of care but courts cannot condition liability on those costs. The latter restriction implies that liability rules must satisfy a self-selection requirement. That is, individual injurers must be free to choose the level of care and associated liability to minimize their private costs.

3. Liability Rules and Self-Selection

In this context, we define an Efficient Self-selection Equilibrium (ESSE) as consisting of the following properties:

\[ x_i = x_i^* \quad i = 1, \ldots, I, \]  
\[ L_i \in [0, D], \quad \forall i, \]  
\[ c_i x_i^* + p(x_i^*)L_i \leq c_j x_j^* + p(x_j^*)L_j \quad \forall i, j. \]

Property (i) says that all injurers choose their efficient levels of care. Property (ii) says that injurer $i$’s liability, defined to be $L_i$, is bounded below by zero and above by $D$, as is true of strict liability and all of the standard negligence rules. Finally, Property (iii)

5 The reason that the first-best outcome is possible here, in contrast to market settings, is that the party designing the “contract” (the court) is assumed to maximize social welfare rather than profit. Indeed, Sappington (1983) shows that the first-best outcome is attainable in his principal-agent context, but it is not implemented by the principal because it does not maximize profit.
defines the self-selection constraints, which require each injurer to choose the cost-minimizing combination of care and liability from among those “offered” by the court.

We begin the analysis by verifying that strict liability satisfies Properties (i)-(iii):

**Proposition 1:** Strict liability yields an ESSE.

**Proof:** By definition, \( L_i = D \) for all \( i \), which establishes Property (ii). As a result, each injurer chooses \( x_i^* \) by (2), which establishes Property (i). Cost minimization also implies that each injurer prefers his own cost-minimizing care level to that of any other injurer, or

\[
    c_i x_i^* + p(x_i^*) D \leq c_j x_j^* + p(x_j^*) D \quad \forall i, j.
\]

which satisfies self-selection (Property (iii)). Q.E.D.

We now turn to negligence rules. For our purposes, the defining feature of negligence is that there exists a due standard of care (possibly injurer-specific) such that \( L = 0 \) for those injurers who meet it, and \( L > 0 \) for those who do not. We first consider a negligence rule with individualized standards, where \( L_i \) is defined as follows:

\[
    L_i = \begin{cases} 
        0, & \text{if } x_i \geq x_i^* \\
        D, & \text{if } x_i < x_i^*.
    \end{cases} \quad \forall i
\]

Thus, each injurer faces a due standard equal to his or her optimal care level. As noted above, we have:

**Proposition 2:** A negligence rule with individualized standards as defined in (6) does not yield an ESSE.

**Proof:** Given (4) and (6), it is clear that \( c_i x_i^* + p(x_i^*) D < c_j x_j^* + p(x_j^*) D \) for all \( i > 1 \), which violates self-selection for all but the highest cost injurer. Q.E.D.
This result shows that all injurers have an incentive to claim to be the highest cost injurer because in so doing, they minimize the amount of care they need to take to avoid liability. Based on this logic, we can further state:

**Corollary:** Any negligence rule with more than one due standard of care cannot yield an ESSE.

We therefore restrict attention henceforth to single-standard rules. We first consider a simple negligence rule defined as follows:

\[
L_i = \begin{cases} 
0, & \text{if } x_i \geq \bar{x} \\
D & \text{if } x_i < \bar{x}.
\end{cases} \quad (7)
\]

Although we argued above that this rule will generally lead to an inefficient outcome because some injurers will take too little care while others will take too much, there are conditions under which it can yield the first-best outcome. These conditions are established in the next result:

**Proposition 3:** A simple negligence rule as defined in (7) yields an ESSE if and only if (a) $\bar{x} = x_i^*$, and (b) all injurers besides the lowest cost injurer (i.e., all $i<I$) find it optimal to violate the due standard.

**Proof:** See the Appendix.

The intuition for this result can be illustrated graphically as follows. First, use (1) to derive the slope of an iso-cost line for a type-$c$ injurer in $(L,x)$ space as follows:

\[
\frac{dL}{dx} = \frac{c + p'L}{-p}.
\]

This expression is positive when the injurer’s costs are decreasing $(c+pL<0)$ and negative when those costs are increasing $(c+pL>0)$. The curves are thus inverted U’s
with the peak at the point where the injurer’s costs are minimized. When \( L = D \), the peak therefore occurs at the socially optimal care level for each injurer type. Further, costs are decreasing as the curves shift down and to the left (i.e., toward lower values of \( x \) and \( L \)), and the peaks of the curves shift leftward. Finally, note that the curves satisfy the “single-crossing property” since

\[
\frac{\partial}{\partial c} \left( \frac{dL}{dx} \right) = \frac{-1}{p} < 0,
\]

which implies that the self-selection conditions for adjacent types of injurers are the only ones that need to be considered (Cooper, 1984).

Figure 1 graphs the iso-cost (IC) curves for three types of injurers, \( I-2 \), \( I-1 \), and \( I \), for the case where \( L_{I-2} = L_{I-1} = D \) and \( L_I = 0 \). The graph shows a situation where the conditions of Proposition 3 are met, so that the negligence rule in (7) yields an ESSE. Clearly, injurer \( I \), the injurer with the lowest cost of care, minimizes costs by meeting the due care standard. As for injurer \( I-1 \), he attains a lower iso-cost curve by choosing his own optimal care level and being found negligent (i.e., by choosing point \((D, x_{I-1}^*)\)) than by meeting the due standard (point \((0, x_I^*)\)). Likewise, all injurers with higher costs (for example, injurer \( I-2 \) in Figure 1) find it less costly to choose their individually optimal care levels rather than to meet the due standard.

In contrast, Figure 2 shows a situation where the conditions of Proposition 3 are not met, in which case the rule in (7) does not yield an ESSE. Note specifically that the self-selection requirement (Property (iii)) fails to hold for injurer \( I-1 \) because he attains lower costs by meeting the due standard, and hence taking too much care (indicated by the iso-cost curve labeled \( IC_{I-1} \)), as compared to choosing his own optimal care level and
being judged negligent (indicated by the curve IC_{t-1}). This situation reflects the second type of inefficiency described Landes and Posner (1987). (Their first type of inefficiency does not arise in the current setting precisely because the due standard is set at the optimal care level of the lowest cost injurer.)

When the situation in Figure 2 holds, an ESSE can only be achieved under negligence by modifying the rule in a particular way. Proposition 4 describes the general characteristics of such a rule.

**Proposition 4:** Any negligence rule that yields an ESSE has the following features:

(a) \( \bar{x} = x_1^* \);

(b) \( 0 < L_j \leq D \ \forall j < I \);

(c) The upper bound for the feasible range of \( L_i \) for any injurer is greater than the equilibrium liability of the injurer with the next-lowest cost (injurer \( i+1 \)), given \( L_{i+1} < D \);

(d) If \( L_j = D \) satisfies self-selection for any \( j \), then \( L_i = D \) also satisfies self-selection \( \forall i < j \) (i.e., for all higher cost injurers).

**Proof:** See the Appendix.

As noted above, any negligence rule that yields an ESSE must set the due standard at the efficient care level of the lowest cost injurer, for otherwise, injurers with optimal care levels above the due standard will just meet the standard and take too little care. However, it cannot generally be the case that all injurers with higher costs will face \( L_j = D \) if they violate the due standard. To see why, return to Figure 2, which shows the case where setting \( L_{t-1} = D \) is not consistent with self-selection by the injurer with the next-to-lowest cost. In order to restore self-selection, \( L_{t-1} \) has to be lowered so that the
injurer’s costs from choosing the point \((L_{I-1}, x_{I-1}^*)\) are no greater than meeting the due standard and avoiding all liability. In order to satisfy that requirement, \(L_{I-1}\) must not exceed the upper bound labeled \(L_{I-1}^U\) in the graph. When \(L_{I-1}^U < D\), as is true for the case shown in Figure 2, injurers who fail to meet the due standard but choose a high enough level of care will face *partial* liability. At the same time, \(L_{I-1}\) cannot be lowered so much that the injurer with the lowest cost prefers the point \((L_{I-1}, x_{I-1}^*)\) to meeting the due standard. To satisfy this requirement, \(L_{I-1}\) can be no lower than the point labeled \(L_{I-1}^L\) in the graph, which is strictly positive. Thus, \([L_{I-1}^L, L_{I-1}^U]\) defines the feasible range for \(L_{I-1}\).

A similar procedure defines the feasible ranges for \(L_{I-2}, L_{I-3}, \ldots\). Note that, in contrast to market settings, there is no need here for the self-selection constraints to be binding in any particular way. Thus, there is some freedom in setting the \(L_i^s\). Nevertheless, the fact that the upper bound is increasing as optimal care decreases establishes a monotonicity in the maximum liability that is consistent with self-selection. This implies that at some point, \(D\) will fall in the feasible range if costs become sufficiently large. For this and all higher cost injurers, \(L_j = D\) (full liability) is consistent with self-selection. It should be apparent that the rule in (7) is a special case of the general rule described in Proposition 4, where \(L_j = D\) satisfies self-selection for all but the lowest cost injurer.

**4. Interpretation of the Results**

The generalized negligence rule described in Proposition 4 differs from the conventional negligence rule in (7) in that it does not entail a dramatic drop in liability from \(D\) to zero at the due standard. Instead, liability decreases gradually with \(x\) until it reaches zero at the optimal care level for the lowest cost injurer. Mathematically, this
was necessitated by the self-selection requirement in order to prevent injurers from
distorting their care choices near the due standard (i.e., to avoid the inefficiencies
identified by Landes and Posner (1987)). As a matter of law, the question is whether this
gradation in liability leading up to the due standard is descriptive of actual liability rules.
The answer is yes, both under a certain standard of causation, and under the rule of
comparative negligence.

    Regarding causation, Grady (1983) and Kahan (1989) have argued that the
definition of negligence in (7) is not reflective of actual tort law in that it ignores the role
of causation in determining liability. In fact, injurers who violate the due standard of care
are not held liable for all of the victim’s losses, only those that are caused by the injurer’s
negligence. For example, suppose that a train traveling above the speed limit collides
with a car stalled at a crossing, killing the driver. Despite its negligence, the railroad will
not be held liable for the damages if the court determines that it could not have avoided
hitting the car by traveling at a safe speed. The logic is that, if the train could not have
avoided the accident by taking due care, then its negligence was not the legal cause of the
accident.7

    In terms of the economic model of negligence, the effect of this limitation on
liability is to eliminate the discontinuity in damages at the due care standard. In other
words, the injurer’s liability increases gradually rather than abruptly as his care level falls
below the due standard, a result that is consistent with the generalized negligence rule
described in Proposition 4. Thus, one way to interpret the causation requirement under
negligence is as a way to allow injurers with differing costs of care to sort themselves out

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according to their individually-optimal care levels, rather than forcing them to bunch at the single due care standard.\footnote{Schwartz (1998) makes a similar argument.}

Rubinfeld (1987) has advanced a similar interpretation of the rule of comparative negligence. In contrast to simple negligence, comparative negligence apportions liability between the injurer and victim according to their degrees of relative fault. Like causation, this has the effect of gradually increasing each party’s expected liability as his or her care falls below the due standard, holding the other party’s care fixed. As a consequence, Rubinfeld (1987, p. 393) concludes that

…the comparative negligence rule allows both injurers and victims to adjust their levels of care based on their knowledge about their own costs of care, while a [simple] negligence rule requires all individuals to choose the same level of care. Of course, this is exactly the intuition behind the modified negligence rule described in Proposition 4.

5. Conclusion

It is often argued that negligence rules are costlier to implement than strict liability because negligence requires the court to establish a due standard of care, and then to compare the injurer’s actual care to it. Administrative costs would be even higher if courts sought to individualize standards based on differences in injurer costs of care. By setting a single standard for all injurers (the reasonable person standard), courts therefore save on administrative costs, but in so doing, they create a distortion in the care choices of injurers around the due standard.

The purpose of this paper was to show that there exists a class of negligence rules that can eliminate these distortions without the need for the court to observe individual
injurers’ costs of care. The key features of such a rule are: (1) the due standard (i.e., the level of care beyond which liability is zero) is set at the optimal care level of the lowest cost injurer; (2) liability is positive but less than full for injurers whose costs of care are slightly higher than the lowest cost injurer; and (3) liability is full for injurers with the highest costs of care. Although this rule does not entail an abrupt drop in liability (from full to zero) at the due care standard, a characteristic usually associated with negligence rules, it is consistent with the actual gradation of liability under certain causation rules as well as under comparative negligence. In this respect, the analysis provides a positive theory of what otherwise might appear to be redundant or unnecessary elements of tort law.

The analysis also bears on the choice between strict liability and negligence. While strict liability eliminates the need for courts to worry about distortions arising from varying injurer costs of care, it also removes any incentives for victims to take care in bilateral accident models. The results here strengthen the argument for negligence by showing that the distortions due to the unobservability of injurer costs are not as severe as the standard model suggests.
Appendix

Proof of Proposition 3: To prove (a), assume first that $\bar{x} < x_I^*$. Then the lowest cost injurer will choose $\bar{x}$ rather than $x_I^*$, which violates Property (i). Thus, set $\bar{x} = x_I^*$.

Now, by definition of $x_I^*$,

$$c_I x_I^* + p(x_I^*)D \leq c_I x_j^* + p(x_j^*)D \quad \forall j < I. \quad (A1)$$

It follows that

$$c_I x_I^* < c_I x_j^* + p(x_j^*)D \quad \forall j < I, \quad (A2)$$

which implies that the lowest cost injurer will meet the due standard, given $L_I = D \forall j < I$ as specified in (7). Now consider the injurer with the next-to-lowest cost (injurer $I-1$). This injurer must prefer to be negligent rather than to meet the due standard, for otherwise, he will take too much care. For injurer $I-1$ to choose to be negligent, it must be true that

$$c_{I-1} x_{I-1}^* + p(x_{I-1}^*)D \leq c_{I-1} \bar{x}, \quad (A3)$$

which therefore holds by hypothesis. We now show that, given (A3), all injurers with higher costs (i.e., all $j < I-1$) also prefer to be negligent. First, rearrange (A3) to get

$$p(x_{I-1}^*)D \leq c_{I-1}(\bar{x} - x_{I-1}^*).$$

Since $c_j > c_{I-1}$ for $j < I-1$ (and given $\bar{x} > x_{I-1}^*$), it follows that

$$p(x_{I-1}^*)D < c_j(\bar{x} - x_{I-1}^*),$$

or

$$c_j x_{I-1}^* + p(x_{I-1}^*)D < c_j \bar{x}. \quad (A4)$$

Finally, cost minimization implies

$$c_j x_j^* + p(x_j^*)D \leq c_j x_{I-1}^* + p(x_{I-1}^*)D \quad \forall j < I-1, \quad (A5)$$

which, together with (A4), implies

$$c_j x_j^* + p(x_j^*)D < c_j \bar{x}, \quad (A6)$$
thus proving that all $j < I - 1$ choose to be negligent. Q.E.D.

Proof of Proposition 4: Part (a) follows from Proposition 3. Given $L_I = 0$, the self-selection conditions for injurers $I$ and $I - 1$ imply

$$c_I x_I^* \leq c_I x_{I-1}^* + p(x_{I-1}*)L_{I-1}, \quad \text{(A7)}$$

and

$$c_{I-1} x_{I-1}^* + p(x_{I-1}*)L_{I-1} \leq c_{I-1} x_I^*. \quad \text{(A8)}$$

Together, these conditions imply

$$\frac{c_I (x_I^* - x_{I-1}^*)}{p(x_{I-1}^*)} \leq L_{I-1} \leq \frac{c_{I-1} (x_I^* - x_{I-1}^*)}{p(x_{I-1}^*)}. \quad \text{(A9)}$$

The first inequality, which sets a lower bound on $L_{I-1}$, implies that $L_{I-1} > 0$, as required by part (b). The second inequality, which sets an upper bound, implies that $L_{I-1} < D$ if

$$\frac{c_{I-1} (x_I^* - x_{I-1}^*)}{p(x_{I-1}^*)} < D,$$

or if

$$c_{I-1} x_I^* < c_{I-1} x_{I-1}^* + p(x_{I-1}*)D, \quad \text{(A10)}$$

which says that injurer $I - 1$ would choose to meet the due standard if $L_{I-1} = D$ (the case shown in Figure 2). However, if the inequality in (A10) is reversed, $L_{I-1} = D$ is consistent with self-selection (the case in Figure 1). Similar reasoning applies to all $j < I - 1$.

To show that $L_i^U$ is decreasing in $x^*$, note that $L_i^U$ is defined by the self-selection constraint as follows:

$$c_i x_i^* + p(x_i^*)L_i^U = c_i x_{i+1}^* + p(x_{i+1}^*)L_{i+1}. \quad \text{(A11)}$$
That is, injurer $i$ is indifferent between choosing the bundle of care and liability intended for him and that intended for the injurer with the next-lowest cost (injurer $i+1$). We want to show that $L_i^U > L_{i+1}$ given that $L_{i+1}$ is consistent with an equilibrium and $L_{i+1} < D$. Some manipulation of (A11) yields

$$\frac{L_i^U - L_{i+1}}{x_i^* - x_{i+1}^*} = -(c_i + \frac{\Delta p}{\Delta x} L_{i+1})/p(x_i^*),$$

(A12)

where $\Delta p/\Delta x = (p(x_{i+1}^*) - p(x_i^*))/(x_{i+1}^* - x_i^*) < 0$. Note that the right-hand side of (A12) is the slope of the injurer’s iso-cost curve over the range from $x_i^*$ to $x_{i+1}^*$ (see (8)). This slope must be negative for $x \geq x_i^*$ since the injurer’s costs are increasing over this range (i.e., $c_i + (\Delta p/\Delta x)L_{i+1} > 0$) given $L_{i+1} < D$. Thus, the left-hand side of (A12) is negative, which implies that $L_i^U - L_{i+1} > 0$ given $x_i^* - x_{i+1}^* < 0$. This proves (c).

As for part (d), suppose that $L_j = D$ is consistent with self-selection for some $j < I$. It follows that

$$c_j x_j^* + p(x_j^*) D \leq c_i x_i^* + p(x_i^*) L_i$$

(A13)

for all $i > j$, where $L_i \leq D$. We now show that, given (A13), setting $L_k = D$ also satisfies self-selection for all $k < j$. Cost minimization implies that

$$c_k x_k^* + p(x_k^*) D \leq c_k x_k^* + p(x_k^*) D,$$

(A14)

which satisfies self-selection for all $k$ relative to $j$. We also need to verify self-selection of $k$ relative to $i$. We do this by supposing that injurer $k$ prefers $(x_i^*, L_i)$ to $(x_k^*, D)$ and then deriving a contradiction. Thus, assume

$$c_k x_i^* + p(x_i^*) L_i < c_k x_k^* + p(x_k^*) D.$$  

(A15)

Together, (A14) and (A15) imply
\[ c_k x_i^* + p(x_i^*) L_i < c_k x_j^* + p(x_j^*) D, \]

or

\[ c_k (x_i^* - x_j^*) < p(x_j^*) D - p(x_i^*) L_i, \]  \hspace{1cm} (A16)

where the left-hand side is positive given \( x_i^* < x_j^* \) (which is true by hypothesis). Thus, since \( c_j < c_k \) (also by hypothesis), we have

\[ c_j (x_i^* - x_j^*) < p(x_j^*) D - p(x_i^*) L_i, \]

which can be rearranged to yield

\[ c_j x_i^* + p(x_i^*) L_i < c_j x_j^* + p(x_j^*) D. \]  \hspace{1cm} (A17)

But this violates (A13), thus proving the assertion. Q.E.D.
References


Figure 1. The case where a negligence rule with a single due standard set at $x_I^*$ is an ESSE.
Figure 2. The case where a negligence rule with a single due standard set at $x_I^*$ is not an ESSE.