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The Efficiency of Comparative Causation

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Under a rule of comparative causation, an accident loss is shared between a victim and a tortfeasor when the parties are either both negligent (as with comparative negligence) or when they are both non-negligent. When one or the other party is found solely negligent, the negligent party bears the entire accident loss. Comparative causation is the only tort regime that allows sharing of an accident loss between a non-negligent injurer and his non-negligent victim. By allowing the sharing of an accident loss in equilibrium, the comparative causation rule has efficiency and risk-allocation properties that are never observed under conventional negligence or strict liability regimes. With respect to efficiency, the comparative causation rule spreads activity level and R&D incentives between the parties, rather than concentrating them on one or the other party (the residual bearer). With respect to the allocation of risk, comparative causation avoids the all-or-nothing allocations of the residual loss that we observe under other legal rules. In doing so, comparative causation provides a mechanism of mutual insurance of victim and tortfeasor with a more equitable apportionment of the residual loss. In spite of these interesting attributes, the existing literature still falls short of establishing the compatibility of comparative causation with efficiency. In this paper, we show that loss sharing can be achieved while preserving optimal care incentives for both parties.

1. INTRODUCTION
The law and economics literature has devoted extensive attention to the different negligence and strict liability regimes, with a wide array of formal economic models having been used to analyze the effect of alternative liability rules on the parties’ incentives. In this literature it is shown that different liability regimes often produce similar incentives with respect to the parties’ levels of care. Traditional liability rules produce all-or-nothing allocations of the residual loss in equilibrium (the allocation of the loss when all parties adopt due care). For example, negligence and strict liability regimes, by choosing substantially different allocations of the residual loss,
produce substantially opposite incentives with respect to the parties’ activity levels and R&D incentives. Following Parisi and Fon (2004), in this paper we consider the incentive and risk-allocation properties of the rule of comparative causation. This rule is an elegant hybrid of negligence and causation-based strict liability, which allows loss-sharing in equilibrium. We consider a simple setting in which the allocation of residual loss between faultless parties is carried out on the basis of their contribution to the causation of an accident. If the spreading of the residual loss can be carried out without diluting the primary care incentives, comparative causation could induce an equilibrium in which both parties adopt due care, and it would possess a highly desirable property of inducing both parties to mitigate their activity levels with an equitable division of the accident loss when both parties are non-negligent. By inducing both parties to be vigilant with respect to care levels as well by mitigating their activity levels, this rule has the potentially unique virtue of being efficient as well as equitable. This is an effect that is not generated by any of the conventional rules based on negligence or strict liability.

Both negligence-based and strict-liability-based criteria of liability fail to provide a satisfactory rationale for the allocation of the residual loss between non-negligent parties. Under standard negligence-based liability rules, the victim bears the entire residual loss when – as is expected in equilibrium – the tortfeasor is not found negligent. On the contrary, under strict-liability rules, the tortfeasor bears the entire loss even when he undertook optimal precautions. These all-or-nothing allocations of the residual loss seem equally arbitrary from a justice point of view and may cause risk-allocation losses that could be avoided by allowing a distribution of the residual loss between non-negligent parties. The all-or-nothing approach in the allocation of the loss between non-negligent parties was criticized as early as 1625 by Dutch legal scholar and philosopher Hugo Grotius, who proposed a criterion of apportionment of liability between faultless parties, which he invoked as a corollary of the compensation principle. This criterion did not enjoy much acceptance by modern legal systems until recent years. In recent times, Guido Calabresi (1965) also criticized the fact that under existing liability rules, the entire accident loss is borne by just one party in equilibrium. As Calabresi observed, by doing this, negligence regimes only deter accidents that are caused through fault and ignore the value of deterring accidents that occur when no party is at fault. Calabresi suggested that the problem could be mitigated by dividing the residual loss of faultless accidents among the activities involved. As shown by Dari-Mattiacci (2005), the problem here
may simply be that some of these precautionary measures are not incorporated into the due care standard. Faultless accidents are those that should be expected when parties respond to incentives in equilibrium. The cost of faultless accidents can be viewed as an externality imposed on one party on the residual bearer. The externality arises due to the activity levels and other relevant issues that are not captured by the due care standards. Rather than allocating this externality entirely on victims (as it happens under negligence regimes) or tortfeasors (as it happens under strict liability regimes), Calabresi and Cooper (1996) explored the possible use of comparative causation criteria, tracing the spread of comparative causation rules in tort cases. They show that over the last 30 years US courts began favoring solutions based on comparative negligence over contributory negligence on equitable grounds and suggested that modern trends in case law favor the idea of an equitable apportionment of an accident loss also between faultless parties—an equitable apportionment that the criterion of comparative causation can deliver in equilibrium.\(^7\) The trend towards comparative causation is observed in areas that had typically been subjected to strict liability or negligence, and are driven by a desire to split the damages among faultless parties instead of allocating the entire burden of the loss on one or the other party.\(^8\)

The spreading of the residual loss between victim and tortfeasor may be desirable on both efficiency and risk-allocation grounds. With respect to efficiency, we will show that the spreading of the residual loss between the parties leads both parties to mitigate their activity levels and to invest in R&D to reduce the riskiness of their activities. These are incentives that are generally concentrated only on one party (the residual bearer). With respect to the allocation of risk, comparative causation avoids the all-or-nothing allocations of the residual loss that we observe under other legal rules. In doing so, comparative causation provides a mechanism of mutual insurance between victim and tortfeasor and a more equitable apportionment of the residual loss. According to Honoré (1997), an apportionment of liability in which parties bear an accident loss proportional to their causal contribution to the accident loss is consistent with principles of equity and social insurance, which might require loss spreading between faultless parties. The comparative causation rule, by inducing a loss sharing that shields both parties from the risk of facing the entire loss in equilibrium, could be viewed as an instrument of social insurance through tort law.\(^9\) In this respect, the rule pursues a function that is generally regarded as falling outside the proper scope of tort policy, focused as it is on incentives rather than optimal
allocation of the risk. Risk-spreading solutions are generally viewed as incompatible with the other functions of tort law.10

In the more recent literature, Parisi and Fon (2004) have developed an economic model to identify the virtues and limits of causation-based systems of liability, considering how comparative causation would perform when applied as a general and sole basis of liability, in the absence of other liability rules (what the authors call “pure comparative causation”), and later extended the analysis to the case of a joint application of the principle within a negligence system (what the authors call “comparative causation under negligence”). The authors have studied the issue in a general framework that allows the parties to choose care levels as well as activity levels. The authors established that, contrary to intuition, the spreading of the residual loss in equilibrium does not necessarily undermine the parties’ optimal care incentives. The authors, however, fell short of establishing the incentive compatibility of comparative causation. In their view, a dilution of incentives under the rule could therefore be possible under certain circumstances.11

Kahan (1989), Van Wijck and Winters (2001), Singh (2007a), Feldman and Singh (2009), and Schweizer (2009) have also studied different versions of ‘causation-based liability.’ The rules considered by these authors, however, are quite different from the rule of comparative causation considered in this paper. Moreover, analysis in these studies is restricted to only care levels: activity levels are assumed to be constant. Singh (2007b) has shown that the rule of comparative causation under negligence is consistent with economic efficiency. However, the claim is restricted to constant activity level accidents, hence omitting the analysis of this rule in the more general and relevant case where parties can also choose their activity levels.

In spite of the recent interest in comparative causation regimes, the existing literature has left open the fundamental question as to whether it is possible to share the loss in equilibrium without undermining optimal care incentives for both parties, in the general situation where both care levels and activity levels can be chosen by the parties. In this paper, we fill this gap in the literature by exploring the nature of the equilibrium outcome under the rule. We identify the exact conditions under which loss-spreading can be carried out without compromising primary care incentives. In a very general setting we show that the sharing of liability under rule of comparative causation does not dilute the parties’ incentives with respect of care levels. The paper is structured as follows. Section 2 introduces notations, assumptions and the framework of analysis. In the interest of brevity, we shall refer to the rule of comparative causation under negligence as
“comparative causation” with no further qualification. The analysis is carried out in a framework that follows Parisi and Fon (2004), assuming that care levels as well as activity levels of the parties affect the causation of an accident and the expected loss in the event of an accident. We extend our framework allowing for a very general form of the causation function. In Section 3, we study the issue of existence of equilibria under the rule of comparative causation. In Section 4, we analyze the efficiency properties of the rule. We show that the rule of comparative causation possesses some desirable properties. Since the residual loss is spread between the parties, activity level and R&D incentives are likewise spread between the parties, rather than being concentrated on one or the other party as in traditional negligence or strict liability regimes. Nonetheless, we show that in an equilibrium both parties will choose at least the due level of care. Therefore, comparative causation can fulfill a valuable mutual insurance function, without diluting the parties’ primary care incentives. The result holds in contexts with constant as well as variable activity levels. Section 5 concludes with remarks on the analysis in the paper.

2. A GENERAL MODEL OF COMPARATIVE CAUSATION

We will work in the framework introduced in Parisi and Fon (2004) (hereafter P&F). That is, we consider accidents resulting from the interaction of two parties who are strangers to each other or otherwise unable to allocate the risk of accidents between themselves contractually. Both parties are assumed to be rational and risk-neutral. Each party’s behavior potentially contributes to causing an accident. However, when an accident takes place, the entire loss falls on one party whom we call the victim; we refer to the other party as the injurer. The parties’ choice of activity levels as well as care levels affect the likelihood and causation of an accident. In the interest of generality, we allow a party’s contribution to causation of an accident to increase with his or her activity level and possibly to decrease with his or her care level. Parties’ individual contributions to causation of an accident are referred to as causal inputs. We allow courts to evaluate a party’s causal contribution to an accident loss with reference to his or her activity level and to possibly with reference to his or her care level. Causation of an accident depends on the causal inputs of the parties involved and courts can allocate the loss between two non-negligent parties on the basis of their causal contributions to the loss. The elements contributing to the overall social cost of accident are the...
cost of harm occasioned by an accident, the cost of care, and the cost of reducing the parties’ activity levels.

Following the notation in P&F, denote by:

- $x$: care level for the injurer,
- $y$: care level for the victim,
- $z$: activity level for the injurer,
- $u$: activity level for the victim,
- $X$: the care choice set for the injurer,
- $Y$: the care choice set for the victim,
- $Z$: the activity choice set for the injurer,
- $U$: the activity choice set for the victim,
- $w$: the benefit function for the injurer,
- $b$: the benefit function for the victim,
- $D$: expected loss per unit of activity, $D \geq 0$,
- $c^I$: the causal input of the injurer,
- $c^V$: the causal input of the victim,
- $C$: the total causation function,
- $s$: the injurer’s share in accident loss,
- $t$: the victim’s share in accident loss, such that $t = 1 - s$.

We make the following assumptions:

(A1): $w$ is a function of $z$ and $x$; $w = w(z,x)$. In particular, $w$ is a strictly increasing and concave function of $z$; and a strictly decreasing and weakly concave function of $x$ for all $z \in Z$. i.e., $w_z > 0$, $w_{zz} < 0$ with $\lim_{z \to \infty} w_z = 0$; and $w_x < 0$, $w_{xx} \leq 0$. Likewise,

(A2): $b$ is a function of $u$ and $y$; $b = b(u,y)$. $b_u > 0$, $b_{uu} < 0$ with $\lim_{u \to \infty} b_u = 0$; and $b_y < 0$, $b_{yy} \leq 0$.

(A3): $D$ is a function of $x$ and $y$; $D = D(x,y)$. $D \geq 0$. $D$ is a decreasing and convex function of care level of each party. That is, $D_x < 0$, $D_{xx} > 0$, $D_y < 0$, and $D_{yy} > 0$. Moreover, $D_{xy} > 0$, i.e., care taken by a party is a substitute for care taken by the other party. As $D$ is expected loss per unit of activity, for a given $z$ and $u$ the total expected loss will be $zuD(x,y)$.

(A4): $c^I$ is a function of $z$ and $x$; $c^I = c^I(z,x)$. such that $c^I_z > 0$, $c^I_{zz} > 0$, $c^I_x < 0$ and $c^I_{xx} > 0$.

(A5): $c^V$ is a function of $u$ and $y$; $c^V = c^V(u,y)$. such that $c^V_u > 0$, $c^V_{uu} > 0$, $c^V_y < 0$ and $c^V_{yy} > 0$.

(A6): $C$, the total causation function, is an increasing function of both $c^I$ and $c^V$; $C = C(c^I, c^V)$. Therefore, $C_z > 0$, $C_u > 0$, $C_x < 0$ and $C_y < 0$, etc. follow immediately.
(A7): Social benefits from the activity of a party are fully internalized by that party.

(A8): The social goal is to maximize the net social benefits from the activities of the parties; the net social benefits are equal to the total social benefits minus the total social costs of accident.

(A9): Benefit, cost, and causation functions are such that there is a unique set of values of \( z, u, x, \) and \( y \), denoted by \((z^*, x^*), (u^*, y^*)\) that is socially optimal. In other words, the net social benefits are maximized if the injurer chooses \( z^* \) as his activity level and \( x^* \) as his care level, and the victim chooses \( u^* \) as his activity level and \( y^* \) as his care level.

(A10): The legal due care standard for the injurer, wherever applicable (say under the rule of negligence), is set at \( x^* \). Similarly, the legal negligence standard of care for the victim, wherever applicable (say under the rule of strict liability with defense) is set at \( y^* \).

It will be useful to provide an informal interpretation of the above assumptions. Assumption (A1) says that the injurer’s benefits from the activity increase (at a decreasing rate) with the level of the activity. However, care is costly, so his benefits decrease as he spends more and more on care. (A2) makes similar assumption about the victim. (A3) assumes that the accident loss decreases with an increase in care level by either party. Assumptions (A4) and (A5) capture the idea that parties’ choice of activity levels as well as care levels affect the causation of an accident. More specifically, a party’s contribution to causation of an accident, i.e., his or her causal input, increases with activity level and decreases with care level. Therefore, by increasing the activity level or reducing the care level, a party increases his or her contribution to the causing of an accident, i.e., makes the accident more likely, and vice-versa. Assumption (A6) says that total causation of an accident increases with the causal inputs of each party. Assumptions (A7)-(A10) are the standard assumptions made in the interest of simplicity and to facilitate comparison of our results with the existing literature. \(^{14}\)

It should be noted that the causation function, \( C \), in (A6) is more general than in P&F wherein only two separate forms of \( C(c'(z, x), c'(u, y)) \) are considered; namely when \( C(c'(z, x), c'(u, y)) = c'(z, x) \times c'(u, y) \), and when \( C(c'(z, x), c'(u, y)) = c'(z, x) + c'(u, y) \). The first formulation above corresponds to the case of causal complements while the second represents the case of causal substitutes. Although in some cases causal inputs affect causation of an accident additively (i.e., causal substitutes) or multiplicatively (i.e., causal complements), in real life situations the parties are likely to affect the

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causation of an accident in several different ways, and causation follows a more complex mix because of this (Parisi and Fon, 2004; Landes and Posner, 1983). Therefore, in this paper, we allow a general form of the causation function, subject to assumption (A6). The limiting cases of causal complements and causal substitutes can therefore be viewed as special cases of our general function \( C \). The relevant results for these special cases can be derived simply by substituting any of the two explicit forms in our general causation function.

As stated above, the social objective is to maximize the net social benefits from the activities. Therefore, the social optimization problem is given by:

\[
\max_{z, x, u, y} \left\{w(z, x) + b(u, y) - C(c^I(z, x), c^V(u, y))zuD(x, y)\right\}.
\]

In view of (A9), \((z^*, x^*), (u^*, y^*)\) uniquely solves this problem.

A liability rule sets due care standards for both parties. Also, depending on care and activity levels, it determines the shares in which accident loss is to be borne by the parties.

Formally, a liability rule can be considered as a rule or a mechanism that determines the proportions in which the victim and the injurer bear the accident loss, as a function of their care and activity levels. That is, given the choice of \( z \) and \( x \) made by the injurer and of \( u \) and \( y \) made by the victim, a liability rule uniquely determines the injurer’s share, \( s(z, x, u, y) \), and the victim’s share, \( t(z, x, u, y) \), of the accident loss. For example, under the rule of pure comparative causation:

\[
s(z, x, u, y) = \frac{c^I(z, x)}{c^I(z, x) + c^V(u, y)},
\]

and

\[
t(z, x, u, y) = \frac{c^V(u, y)}{c^I(z, x) + c^V(u, y)}.
\]

The choice of care and activity levels by a party depends on the liability rule in force, as well as on the care and activity levels chosen by the other party. For any given pair \((u, y)\) chosen by the victim, the prospective injurer being rational and risk-neutral will choose a pair \((z, x)\) that maximizes his expected payoff. In other words, given that \((u, y) \in U \times Y\) is chosen by the victim, the problem facing the injurer becomes
\[
\max_{z,x} \{ w(z,x) - s(z,x,u,y)C(c'(z,x), c'(u,y))zuD(x,y) \}.
\]

Likewise, given that \((z,x) \in Z \times X\) is chosen by the injurer, the problem facing the victim becomes

\[
\max_{u,y} \{ b(u,y) - t(z,x,u,y)C(c'(z,x), c'(u,y))zuD(x,y) \},
\]

where \(s(z,x,u,y)\) and \(t(z,x,u,y)\) are determined by the relevant liability rule, but are such that \(s + t = 1\).

Note that with the assumption that \(s + t = 1\) we have excluded the decoupling (with \(s + t > 1\)) as well as social insurance (with \(s + t < 1\)) arrangements. As we will see in the following, the assumption that \(s + t = 1\) has important efficiency implications. However, it is in keeping with the standard liability rules. Moreover, while a mechanism with \(s = t = 1\) can ensure efficiency with respect to care as well as activity levels, this and other such arrangements are difficult to implement. Since \(s = t = 1\) implies that the victim is not entitled to compensation, he has no incentive to report an accident. As a result, the injurer is likely to escape accident liability. Indeed, it is almost impossible to implement \(t = 1\) and \(s = 1\), simultaneously. (For a discussion on these issues, see Singh (2006)).

With this clarification, we are all set to introduce the rule of comparative causation. Under this rule, when a party is found solely negligent, he or she bears the entire accident loss. Accident loss is shared between the parties only in cases in which parties are either both negligent or both non-negligent. In such cases, the loss-sharing is done according to the criterion discussed above under the rule of pure comparative causation. Formally, under this rule, given that \((u,y) \in U \times Y\) is chosen by the victim, the problem faced by the injurer is given by the following:

\[
\max_{z,x} \begin{cases} 
  w(z,x) & \text{if } x \geq x' \text{ and } y < y'; \\
  w(z,x) - \frac{c'(z,x)}{c'(z,x) + c'(u,y)}C(c'(z,x), c'(u,y))zuD(x,y) & \text{if } x \geq x' \text{ and } y \geq y', \\
  w(z,x) - C(c'(z,x), c'(u,y))zuD(x,y) & \text{if } x < x' \text{ and } y \geq y', \\
  w(z,x) - C(c'(z,x), c'(u,y))zuD(x,y) & \text{if } x < x' \text{ and } y \geq y'.
\end{cases}
\]

Similarly, given that \((z,x) \in Z \times X\) is chosen by the injurer, the problem facing the victim is:

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max \((u,y)\) \begin{align*} b(u,y) & \quad \text{if } x < x^\ast \text{ and } y \geq y^\ast; \\
 & \quad b(u,y) - \frac{c'(y)}{c'(u)} C(c'(z,x), c'(u,y)) z u D(x,y) \quad \text{if } x \geq x^\ast \text{ and } y \geq y^\ast, \\
 & \quad \text{or } x < x^\ast \text{ and } y < y^\ast; \\
 & \quad b(u,y) - C(c'(z,x), c'(u,y)) z u D(x,y) \quad \text{if } x \geq x^\ast \text{ and } y < y^\ast. \end{align*}

Let an equilibrium under the rule be denoted by \(((\bar{z}, \bar{x}), (\bar{u}, \bar{y}))\).

3. EQUILIBRIA

In this section, we will study the nature of equilibria under the rule of comparative causation. We will demonstrate that under the rule of comparative causation no party would want to be negligent, since being diligent is a dominant strategy for each party. That is, in equilibrium, both parties will choose at least the due care levels.

Formally, we will find out how the values \(((\bar{z}, \bar{x}), (\bar{u}, \bar{y}))\) compare with the socially optimal profile of care and activity levels derived above, \(((z^\ast, x^\ast), (u^\ast, y^\ast))\). For the time being assume that under the rule at least one equilibrium exists. To start with, we explore the implications of the following property that is a common feature of negligence-based rules.

**Property (P1):** A non-negligent party has no liability if the other party is negligent. That is, the entire accident loss is borne by the negligent party if the other party happens to be diligent.

First, we show that under a liability rule that satisfies property (P1), the parties cannot both be negligent in a Nash equilibrium (N.E.), no matter how the liability is assigned when both parties are negligent. In other words, in any Nash equilibrium, \(x < x^\ast \text{ and } y < y^\ast\) can never hold.

To see why, take any set of values, say \(((z, x), (u, y))\), such that \(x < x^\ast \text{ and } y < y^\ast\). Suppose, the injurer chooses \((z, x)\) and the victim chooses \((u, y)\). At \(((z, x), (u, y))\), let \(s(z,x,u,y)\) be the injurer’s share of loss, where \(0 \leq s(z,x,u,y) \leq 1\). So, \(t(z,x,u,y) = 1 - s(z,x,u,y)\). As a result, suppressing the arguments of \(s\) and \(t\), at \(((z, x), (u, y))\), the payoff of the victim is

\[b(u,y) - t C(c'(z,x), c'(u,y)) z u D(x,y).\]

On the other hand, given that \((z, x)\) is chosen by the injurer, if the victim instead chooses \((u^\ast, y^\ast)\), then the injurer will be solely negligent. In that case, in view of (P1), the injurer’s liability will be full and that of the victim will be
none. Therefore, given that \((z,x)\) is chosen by the injurer, if the victim chooses \((u^*,y^*)\), his payoff will be \(b(u^*,y^*)\).

Similarly, at \(((z,x),(u,y))\) the payoff of the injurer is

\[
w(z,x) - sC(c'(z,x),c'(u,y))zuD(x,y).
\]

But, given that \((u,y)\) is chosen by the victim, if the injurer chooses instead \((z^*,x^*)\), his payoff will be \(w(z^*,x^*)\). At \(((z,x),(u,y))\) if

\[
w(z^*,x^*) > w(z,x) - sC(c'(z,x),c'(u,y))zuD(x,y)
\]

holds, then a unilateral deviation by the injurer to \((z^*,x^*)\) is strictly preferable. In that case, \(((z,x),(u,y))\) cannot be a N.E. Thus, if \(((z,x),(u,y))\) is a N.E., then a unilateral deviation by the injurer to \((z^*,x^*)\) cannot be strictly preferable. Therefore, assume that

\[
w(z,x) - sC(c'(z,x),c'(u,y))zuD(x,y) \geq w(z^*,x^*). \tag{1}
\]

Since \(((z,x),(u,y)) \neq ((z^*,x^*),(u^*,y^*))\), by assumption, we know that

\[
w(z^*,x^*) + b(u^*,y^*) - C(c'(z^*,x^*),c'(u^*,y^*))z^*u^*D(x^*,y^*) \tag{2}
\]

\[
> w(z,x) + b(u,y) - C(c'(z,x),c'(u,y))zuD(x,y).
\]

Subtracting \(w(z^*,x^*)\) from the left-hand side and \(w(z,x) - sC(c'(z,x),c'(u,y))zuD(x,y)\) from the right-hand side of (2), in view of (1), we get

\[
b(u^*,y^*) > b(u,y) + C(c'(z^*,x^*),c'(u^*,y^*))z^*u^*D(x^*,y^*) - sC(c'(z,x),c'(u,y))zuD(x,y). \tag{3}
\]

Now, since by assumption \(C(c'(z^*,x^*),c'(u^*,y^*))z^*u^*D(x^*,y^*) \geq 0\), from (3) we have

\[
b(u^*,y^*) > b(u,y) - sC(c'(z,x),c'(u,y))zuD(x,y).
\]

That is, given that \((z,x)\) is chosen by the injurer, payoff of the victim is strictly greater if he chooses \((u^*,y^*)\) rather than \((u,y)\), i.e., the victim is better off adopting \((u^*,y^*)\) rather than \((u,y)\). Again, \(((z,x),(u,y))\) cannot be a N.E.

In other words, under a liability rule satisfying (P1), from any \(((z,x),(u,y))\)
such that $x < x^*$ & $y < y^*$, either the injurer will find unilaterally deviation to $(z^*, x^*)$ preferable, or the victim will find unilaterally deviation to $(u^*, y^*)$ preferable. Hence, we have the following result: If a liability rule satisfies property (P1), then

$$(\forall ((z,x),(u,y))[x < x^* & y < y^* \Rightarrow ((z,x),(u,y)) \text{cannot be a N.E.}]$$

It is interesting to note that all of the negligence criterion-based rules discussed in the literature (e.g., the rule of negligence, the rule of negligence with the defense of contributory negligence, the rule of strict liability with the defense of contributory negligence) satisfy property (P1). Therefore, under any of these rules there cannot be an equilibrium in which both the parties are negligent.

Now, let us return to the rule of comparative causation. Equilibrium under the rule is denoted by $((\bar{z}, \bar{x}), (\bar{u}, \bar{y}))$. As we stated earlier, we want to find out how $((\bar{z}, \bar{x}), (\bar{u}, \bar{y}))$ compares with the socially optimal profile of activity and care levels, i.e., with $((z^*, x^*), (u^*, y^*))$.

As it turns out, the rule of comparative causation satisfies Property (P1). Therefore, in equilibrium $\bar{x} < x^*$ and $\bar{y} < y^*$ can never hold, i.e., under the rule of comparative causation, there cannot be a N.E. in which both parties choose to be negligent with respect to care levels.

In fact, Property (P1) enables us to make further deductions about the behavior of the parties with respect to their choice of care levels. Suppose a liability rule satisfies Property (P1). When $x \geq x^*$ and $y < y^*$, the victim is solely negligent. In such an event, due to Property (P1), the injurer has no liability. So, for a given $z$ his payoff is $w(z,x)$. Note that $w(z,x)$ increases as care level $x$ decreases. Therefore, regardless of the $z$ chosen by him whenever $x > x^*$, the injurer can increase his payoff simply by reducing $x$ until he reaches $x^*$. This means that if the victim has chosen some $y$ such that $y < y^*$, the injurer is always better off adopting $x^*$ rather than any $x > x^*$, regardless of what $z$ is. As a result, any set of values $((z,x),(u,y))$, such that $x > x^* & y < y^*$, cannot be a N.E. Similarly, under a rule that satisfies Property (P1), a set of values $((z,x),(u,y))$, such that $x < x^* & y > y^*$, cannot be a N.E. In this case, the victim can increase his payoff by reducing $y$ until he reaches $y^*$. Therefore, in view of the fact that the rule of comparative causation satisfies property (P1), we have the following result for the rule: For all $((z,x),(u,y))$

$$[(x > x^* & y < y^*) \text{ or } (x < x^* & y > y^*)] \Rightarrow ((z,x),(u,y)) \text{ cannot be a N.E.}$$
In the following we will show that under the rule of comparative causation, in equilibrium no party would want to be negligent. For the ease of exposition, let

\[ z_p^* = \text{the activity level of the injurer that maximizes } w(z,x) \text{ when } x=x^*. \]
\[ u_v^* = \text{the activity level of the victim that maximizes } b(t,y) \text{ when } y=y^*. \]

That is, \( z_p^* \) is the optimum activity level for the injurer when he simply chooses \( x^* \) as care level but does not bear the accident costs at all. Likewise, for \( u_v^* \). It is easy to show that \( z_p^* > z^* \) and \( u_v^* > u^* \). That is, if the injurer can avoid liability by adopting due care \( x^* \) his activity level will be excessive. Similarly, the victim’s activity level will be excessive if he can avoid liability by adopting due care \( y^* \).

**Remark:** When a liability rule satisfies Property (P1), in the region of \( x \geq x^* \) and \( y < y^* \), the injurer’s payoff is \( w(z,x) \). But \( w(z,x) \) is uniquely maximized at \((z^*_p,x^*)\). Therefore, under a liability rule that satisfies Property (P1), when \( x \geq x^* \) and \( y < y^* \), a set of values \(((z,x),(u,y))\) can be a N.E. only if \((z,x)=(z^*_p,x^*)\); if \((z,x)\) is different from \((z^*_p,x^*)\), the injurer can increase his payoff by deviating to \((z^*_p,x^*)\). Clearly, such deviation should not be possible in an equilibrium. Similarly, under a rule satisfying Property (P1), a set of values \(((z,x),(u,y))\), where \( x < x^* \) and \( y \geq y^* \), can be a N.E. only if \((u,y)=(u^*_p,y^*)\).

Now we are ready to state and prove our main result about the nature of equilibria under comparative causation: A set of values \(((z,x),(u,y))\) can be a N.E. under the rule only if \( x \geq x^* \) and \( y \geq y^* \). Formally,

**Proposition 1:** Let \(((\tilde{z},\tilde{x}),(\tilde{u},\tilde{y}))\) be a N.E. under the rule of comparative causation. Then, \( \tilde{x} \geq x^* \) and \( \tilde{y} \geq y^* \).

The proposition says that under the rule of comparative causation, in equilibrium, care levels chosen by both the parties will at least be the due care levels. A formal proof is provided in the Appendix. The informal argument is as follows. In view of the above, a set of values \(((z,x),(u,y))\) cannot be a N.E. if \( x < x^* \) and \( y < y^* \), or if \( x > x^* \) and \( y < y^* \), or if \( x < x^* \) and \( y > y^* \). Therefore, to prove the claim, it is sufficient to show that under the rule, a set of values \(((z,x),(u,y))\), such that \( x = x^* \) and \( y < y^* \), or \( x < x^* \) and \( y = y^* \), cannot be a N.E.

When \( y=y^* \) and \( x < x^* \), the injurer is the solely negligent party. Therefore, the victim’s liability is zero. This means that the victim has strong incentives to engage in an excessive level of activity. The excessive activity on the part of the victim further increases the costs of accident,
and it is the injurer who bears the entire cost. Therefore, in order to
decrease the accident costs, a solely negligent injurer has incentive to
increase his care level. In addition, the excessive activity level of the
victim enhances the productivity of the injurer’s care, providing him with
additional incentives to take even greater care. Indeed, as the formal
argument shows, the injurer does not want to take care that is less than
\( x^* \). An analogous argument shows that a set of values \((z,x),(u,y)\),
where \( x=x^* \) and \( y<y^* \), cannot be a N.E. \( \Box \)

Therefore, we have proved that in equilibrium under the rule of
comparative causation the parties will choose at least the due care levels.
Moreover, under certain conditions it is possible to prove that there will be a
N.E. in the domain such that both parties take at least due care.\(^{21}\)
Unfortunately, without imposing more structure on the functional forms, we
cannot make a similar claim with respect to the equilibrium choice of activity
levels by parties.

4. THE VIRTUES OF COMPARATIVE CAUSATION

By now we know that the rule of comparative causation induces both parties
to be diligent. That is, under the rule, it is a dominant strategy for each party
to be diligent. In this section, we show that the rule of comparative causation
has some additional interesting effects on the parties’ activity levels that are
not observed under any other conventional liability rule. Under this rule,
both parties partially internalize the accident loss in equilibrium. Therefore,
the activity level incentives between the parties are spread, rather than being
concentrated on one or the other party. These effects may be desirable or
undesirable according to the circumstances of the case. Towards the end of
this section, we discuss the contexts in which these unique effects will be
desirable.

Let us start by anticipating that comparative causation, like all conventional
liability rules, is unable to create optimal care and activity level incentives for
both parties. That is, under the rule, the profile of efficient care and activity
levels for both parties is not an equilibrium. The following result confirms this.

**Proposition 2**: Under the rule of comparative causation, \((z^*,x^*),(u^*,y^*)\) is
not a N.E. \( \Box \)

A formal proof is provided in the Appendix. The rule of comparative
causation cannot create optimal care and activity level incentives for any
arbitrary form of causation function. This is an inevitable result, since under
comparative causation the residual loss is never borne by both parties in full.

However, it is interesting to note that, unlike any other known liability rule, both parties partially internalize the accident loss in equilibrium. This produces two important effects: (i) spreading of the activity level incentives between the parties, rather than concentrating them on one or the other party, and (ii) augmentation of the care incentives for both parties. This is due to the fact that, since both parties face a share of the accident loss in equilibrium, they have incentives to mitigate their liability exposure by decreasing their level of activity and increasing their care level.

To prove the latter portion of this claim, we can consider an example wherein activity levels are constant, and where parties can choose only care levels. Since accident contexts with constant activity levels are a special case of contexts with variable activity levels, this illustration will show the effect of the comparative causation rule on the parties' care incentives. Here is one such example.

Suppose activity levels are fixed at 1, i.e., suppose \( z = 1 = u \) are given. In such a context, \( c^I \) is a function of \( x \) only, and \( c^V \) is a function of \( y \) only. Moreover, the social optimization problem can be written as

\[
\min_{(x,y) \in \mathbb{X} \times \mathbb{Y}} \{ x + y + C(c^I(x), c^V(y))D(x,y) \}.
\]

Also, the rule of comparative causation can be defined as follows:

\[
x \geq x^* \& y \geq y^* \Rightarrow [s(x,y) = \frac{c^I(x)}{c^I(x) + c^V(y)} \& t(x,y) = \frac{c^V(y)}{c^I(x) + c^V(y)}];
\]

\[
x < x^* \& y < y^* \Rightarrow [s(x,y) = \frac{c^I(x)}{c^I(x) + c^V(y)} \& t(x,y) = \frac{c^V(y)}{c^I(x) + c^V(y)}];
\]

\[
x \geq x^* \& y < y^* \Rightarrow [s(x,y) = 0 \& t(x,y) = 1];
\]

\[
x < x^* \& y \geq y^* \Rightarrow [s(x,y) = 1 \& t(x,y) = 0].
\]

For further simplicity assume that \( D(x,y) \) is constant. So, we simply write it as \( D \). Also, let \( C(c^I(x), c^V(y)) = [c^I(x) + c^V(y)]^{\frac{1}{2}} \). In this simple setting, the social optimization problem can be rewritten as

\[
\min_{(x,y) \in \mathbb{X} \times \mathbb{Y}} \{ x + y + \sqrt{c^I(x) + c^V(y)} \cdot D \}.
\]

Therefore, \( x^* \) and \( y^* \) solve the following first order conditions:

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respectively.

Note that when \( x \geq x^* \) and \( y \geq y^* \), total costs of the injurer are given by

\[
x + \frac{c'(x)}{c(x) + c'(y)} \sqrt{c'(x) + c'(y)} \ D, \text{ i.e., } x + \frac{c'(x)}{\sqrt{c'(x) + c'(y)}} \ D.
\]

Now, suppose the injurer has chosen \( x^* \) and the victim has chosen \( y^* \). Given \( y^* \) chosen by the victim, consider a marginal increase in care from \( x^* \) by the injurer. At \( x^* \), the change in the total costs of the injurer caused by marginal increase in care is equal to

\[
1 + \frac{c'(x^*) D}{2 \sqrt{c'(x^*) + c'(y^*)}} - \frac{c'(x^*) c'(y^*) D}{2 [c'(x^*) + c'(y^*)]^{3/2}}, \text{ i.e., equal to}
\]

\[
\frac{c'(x^*)}{2 \sqrt{c'(x^*) + c'(y^*)}} \left[ 1 - \frac{c'(x^*)}{[c'(x^*) + c'(y^*)]} \right] D.
\]

However, note that \( c'(x) < 0 \), and \( C(c'(x), c'(y)) > 0 \) always. Moreover, \( c'(x^*) < [c'(x^*) + c'(y^*)] \). Therefore, we have

\[
\frac{c'(x^*)}{2 \sqrt{c'(x^*) + c'(y^*)}} \left[ 1 - \frac{c'(x^*)}{[c'(x^*) + c'(y^*)]} \right] D < 0.
\]

That is, the injurer can decrease his total costs by increasing his care level beyond \( x^* \). Hence, \((x^*, y^*)\) is not a N.E. under the rule. More specifically, the
rule of comparative causation may lead to excessive care levels. However, for variable activity levels this distortion can be avoided by allowing causation to be affected only by the parties’ activity levels, following the idea originally articulated by Calabresi and Cooper (1996). This would simply mean that courts and juries should examine the parties’ care levels only for the purpose of establishing their possible negligence. Once the parties’ negligence is excluded, the accident loss should be spread between the parties only by reference to their activity level, without revisiting their care level at this stage. From another perspective, the possible distortion of care incentives under comparative causation has potential to correct other imperfections in the tort system, such as the dilution of care incentives due to court errors or parties’ overconfidence bias, such as those considered by Luppi and Parisi (2009). Optimal care incentives can be preserved in all other cases by allowing the shares of causation to be apportioned exclusively on the basis of activity levels.

On the other hand, the effect of comparative causation on the parties’ activity level incentives is worthy of more attention. It is in this dimension that the virtues (and possible limits) of the criterion of comparative causation lie. Comparative causation leads both parties to face a share of the accident loss in equilibrium. This spreads the activity level incentives between them, such that both parties will face (partial) incentives to mitigate their liability exposure by decreasing their level of activity. This is an effect that, decoupling solutions apart, no standard liability rule can generate. The fact that the parties face only partial activity level incentives is inevitable since it is impossible to put the entire accident loss on both the parties at the same time. As a result, no standard liability rule can achieve the optimal activity levels for both parties. Moreover, the above-shown inefficiency of the rule of comparative causation for a constant activity level is attributable to the choice of the specific functional form of the causation function. For the standard cases of causal complements and causal substitutes, the rule is efficient when activity levels are constant (see Singh, 2007b).

This unveils some of the virtues and desirable properties of the rule of comparative causation. Proposition 1 shows that in an equilibrium under the rule, both the parties will always choose at least the due level of care. We have shown this for variable activity levels. It is easy to prove a similar claim for constant activity levels as well. This means that the rule creates incentives for both the parties to be diligent. Recall that when both the parties have opted for at least the due level of care, the accident loss is apportioned under this rule between the parties in proportion to their causal contributions. Therefore, this rule induces at least the efficient care by both the parties as

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well as equitable distribution of accident loss among them. It does so for contexts with constant as well as variable activity levels. The sharing of the accident loss between a non-negligent injurer and his non-negligent victim spreads activity level and R&D incentives between prospective tortfeasors and their victims. As a result, both parties have incentives to moderate their activity levels and increase R&D so as to reduce the expected accident loss. This is an effect that is never observed under the other negligence and strict liability-based regimes. It is this attribute of the rule of comparative causation that sets it apart.

5. CONCLUDING REMARKS

The principle of comparative causation has gained attention in the recent law and economics literature. The results of this paper have contributed to a better understanding of the effects of comparative causation on the parties’ care and activity level incentives. The analysis has been carried out in a very general framework. We have assumed that care levels as well as activity levels of the parties may affect the causation of the accident and the expected loss in the event of accident. Moreover, we have extended the conventional framework by adopting a very general causation function. Consistent with the existing literature, we have shown that comparative causation provides a mechanism of mutual insurance between victim and tortfeasor that can achieve an equitable apportionment of the residual loss, spreading activity level and R&D incentives between the parties. These results follow from the fact that comparative causation induces both parties to internalize a positive share of the social cost and benefits of their care and activity levels in equilibrium.

We have further established that the rule of comparative causation preserves the essential elements of the negligence regimes. Here, we have contributed to the existing literature by showing that the loss-sharing effect of comparative causation is compatible with optimal incentives. In spite of the mutual insurance effects of comparative causation, both parties will adopt a level of care that is at least as high as the due level of care. This is an interesting result, since conventional wisdom would instead suggest that mutual insurance and loss-spreading in equilibrium would lead to a dilution of the parties’ care incentives. Comparative causation can therefore achieve an equitable loss-sharing between non-negligent parties, without undermining the parties’ care incentives. We have proved this for contexts with constant as well as with variable activity levels. Furthermore, we have shown that
when causation can be affected by care levels, the rule can even generate an
overshooting effect, leading to the adoption of a care level that exceeds the
due level. This problem can be avoided by instructing courts and juries to
examine the parties’ care levels only for the purpose of establishing their
possible negligence. If negligence is excluded, the residual loss should be
spread between the parties only by reference to their activity level, without
revisiting their care level at this stage. On the contrary, the overshooting
effects of comparative causation may be instrumentally utilized to correct
other imperfections in the tort system, such as the possible dilution of care
incentives caused by courts’ or parties’ errors.

Whether these peculiar features of the comparative causation regimes are
desirable in real life contexts depends on a variety of factors. The findings of
this paper will hopefully serve as a basis for future research, and for a
systematic assessment of the overall performance of the comparative
causation rule, in consideration of the parameters of the accident problem.

APPENDIX

PROOF OF PROPOSITION 1:

First of all, note that the assumption that \((z^*, x^*), (u^*, y^*)\) uniquely solves the social optimization problem implies the following:

\((z^*, x^*)\) uniquely solves:

\[
\max_{z, x} \{ w(z, x) - C(z, x) \cdot [C'(z, x), C''(u^*, y^*)]_{z} + D(x, y^*) \}.
\]

That is, \(z^*\) and \(x^*\) respectively and simultaneously solve (7) and (8).

\[
w_z(z, x) = [C(z, x), C'(z, x), C''(u^*, y^*)]_{z} + D(x, y^*) \quad (7)
\]

\[
w_x(z, x) = [C(z, x), C'(z, x), C''(u^*, y^*)]_{x} + D(x, y^*) \quad (8)
\]

More specifically, \(z^*\) solves (9):

\[
w_z(z^*, x^*) = [C(z^*, x^*), C'(z^*, x^*), C''(u^*, y^*)]_{z} + D(x^*, y^*) \quad (9)
\]

Similarly, \((u^*, y^*)\) uniquely solves

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\[ \max_{x,y} \{b(u,y) - C(c'(z^*, x^*), c''(u,y))z^*uD(x^*, y^*)\}. \]

That is, \( u^* \) and \( y^* \) simultaneously solve (10) and (11).

\[ b_*(u,y) = [C_*(c'(z^*, x^*), c''(u,y))u + C(c'(z^*, x^*), c''(u,y))]z^*D(x^*, y^*). \]

\[ b_(u,y) = [C_*(c'(z^*, x^*), c''(u,y))D(x^*, y^*) + C(c'(z^*, x^*), c''(u,y))]z^*u. \]

Also note that, in view of the arguments made in the text, it is sufficient to show that under the rule a set of values \((z,x), (u,y)\) such that \( x = x^* \) and \( y < y^* \), or \( x < x^* \) and \( y = y^* \) cannot be a N.E.

For the sake of argument, let us assume the contrary. That is, assume that a set of values \((z,x), (u,y)\), where \( x < x^* \) and \( y = y^* \), is a N.E. In view of the Remark made in the text, the set of values \((z,x), (u,y)\), such that \( x < x^* \) and \( y \geq y^* \), can be a N.E. only if \( y = y^* \) and \( u = u^*_y \). Therefore, the set of values \((z,x), (u,y)\), such that \( x < x^* \) and \( y \geq y^* \), can be a N.E. only if \((z,x), (u,y)\) = \((z,x), (u^*_y, y^*)\).

Now, let \((u^*_y, y^*)\) be chosen by the victim. Since at \( x < x^* \) the injurer is solely negligent, under the rule the injurer is fully liable. Therefore, when it is given that the victim has chosen \((u^*_y, y^*)\), in the region wherein \( x < x^* \), the injurer’s optimization problem is

\[ \max_{x,z} \{w(z,x) - C(c'(z,x), c''(u^*_y, y^*))zu^*_yD(x,y^*)\}. \]

In particular, when \( x < x^* \), the optimum \( z \) will solve

\[ w_1(z,x) = [C_1(c'(z,x), c''(u^*_y, y^*))z + C(c'(z,x), c''(u^*_y, y^*))u^*_yD(x,y^*)]. \]

and simultaneously, the optimum \( x \) will solve

\[ w_1(z,x) = [C_1(c'(z,x), c''(u^*_y, y^*))D(x,y^*) + C(c'(z,x), c''(u^*_y, y^*))D(x,y^*)]u^*_y. \]

Denote the solutions to (12) and (13) by \( \hat{z} \) and \( \hat{x} \), respectively. Now
compare (12) and (13) with (7) and (8). In view of our assumptions and the facts that \( u^*_p > u^* \) and \( y = y^* \), the envelope theorem gives us \( \hat{z} < z^* \) and \( \hat{x} > x^* \). In particular, given that \( (u^*_p, y^*) \) is chosen by the victim, no \( x < x^* \) can be a best response for the injurer. As a result, a set of values \( ((z, x), (u, y)) \), where \( x < x^* \) and \( y = y^* \), cannot be a N.E.

An analogous argument shows that a set of values \( ((z, x), (u, y)) \), where \( x = x^* \) and \( y < y^* \), cannot be a N.E. □

**PROOF OF PROPOSITION 2:**
To see why a set of values \( ((z^*, x^*), (u^*, y^*)) \) cannot be a N.E. under the rule of comparative causation, assume that under the rule there is an equilibrium in which the injurer has chosen \( x^* \) and the victim has chosen \( (u^*, y^*) \); otherwise, nothing is left to prove. Now, since both parties take due care, the choice of optimum \( z \) for the injurer will solve

\[
\max \left\{ w(z, x^*) - \frac{c'(z, x^*)}{c'(z, x^*) + c'(u^*, y^*)} C(c'(z, x^*), c'(u^*, y^*))zu'D(x^*, y^*) \right\},
\]

i.e., optimum \( z \) will solve

\[
w_z(z, x^*) = \frac{c'(z, x^*)}{c'(z, x^*) + c'(u^*, y^*)} \left[ C(c'(z, x^*), c'(u^*, y^*))z + C(c'(z, x^*), c'(u^*, y^*))u'D(x^*, y^*) \right] + \frac{c'(z, x^*)c'(u^*, y^*)}{[c'(z, x^*) + c'(u^*, y^*)]^2} C(c'(z, x^*), c'(u^*, y^*))zu'D(x^*, y^*).
\]

A comparison of (9) and (14) shows that in general \( z^* \) is not a solution of (14), since \( \frac{c'(z, x^*)}{c'(z, x^*) + c'(u^*, y^*)} \neq 1 \). Therefore, the rule cannot attain the efficient care and activity levels as an equilibrium outcome.

**Endnotes**

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1. For example, see Polinsky (1989), Landes and Posner (1987), Shavell (1987), Miceli (1997), Jain and Singh (2002), etc.

2. The victim bears the residual loss under all rules that use negligence as the criterion to

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impose primary liability (simple negligence, negligence with a defense of contributory
negligence, and negligence with a defense of comparative negligence). The injurer instead
bears the entire residual loss under all rules that use strict liability as the basis for the
primary liability (strict liability, strict liability with a defense of contributory negligence,
and strict liability with a defense of comparative negligence).

rules. The first rule is what the authors call the rule of pure comparative causation. Under this
rule, parties bear accident loss in shares that are proportional to their causal contribution
to the accident loss, regardless of whether they were at fault or not, at the time of the
accident. It is shown that under this rule, since each party bears only a fraction of the
accident loss, there is an incentive for the parties to choose less than the socially optimal
care levels and more than the socially optimal activity levels. That is, the rule of pure
comparative causation induces neither efficient care levels nor efficient activity levels. The
second rule considered by Parisi and Fon (2004) is called the rule of comparative causation
under negligence. This rule mixes the essential features of traditional negligence
criterion-based rules and that of the rule of pure comparative causation. Under this new
rule, a solely negligent party bears the entire accident loss. However, the accident loss is
shared between the parties when both parties are negligent or when both are
non-negligent. In such cases, loss-sharing is done as under the rule of pure comparative
causation. In this paper we concentrate on the study of the rule of comparative causation
under negligence. In the interest of brevity, we shall refer to it simply as “comparative
causation.”

4. For criticisms of economic modeling of liability rules on various grounds including the
continuity caused by the ‘all-or-nothing’ allocation of liability, see Grady (1989), Kahan
(1989), Marks (1994), Burrows (1999), and Wright (1987). In addition to the problematic
continuity, it is argued that negligence rules are either inapplicable or unsatisfactory in
cases where multiple causation is involved or where fault is not easy to establish
(Strassfeld, 1992).

5. Parisi and Fon (2005) have traced an intellectual history of the principle of comparative
causation, considering some applications of the rule in historical and contemporary
societies. The authors note that, despite its lineage in legal history, limited attention has
been devoted among law and economics scholars to the efficiency properties of
causation-based allocations of liability.

6. Calabresi (1965) considers the example of a walker, a bicyclist and an automobile that are
involved in a three-party accident, suggesting that the costs could be divided amongst
these three activities on the basis of their causal contribution to the accident. This would
imply assigning greater liability to activities that are statistically or empirically more likely
to increase the probability or severity of an accident.

7. Calabresi and Cooper (1996:877) observe that “The integration of non-fault notions into
the splitting analysis under comparative negligence could ultimately lead us to compare
non-fault with non-fault-comparative-non-negligence, if you will. That is, there may be
situations in which neither side was negligent, but each side could have done something to
avoid the loss and did not. In these situations, too, we might want to split the loss. But we 
are, in fact, nowhere near ready to do that yet, across the board. And so where neither side 
is at fault, we still remain subject to all-or-nothing rules. In the absence of defendant fault, 
innocent plaintiffs bear the whole loss in most areas, while in so-called non-fault liability 
areas, defendants bear the entire loss where neither party is at fault.”

8. In the United States, the rule of comparative causation has been used in a handful of fairly 
recent cases in which the traditional criteria of liability failed to offer a viable standard of 
adjudication. As shown by Parisi and Fon (2005), these occasional applications of the 
comparative causation rule have been met with mixed support by commentators (see, e.g., 
Grimley, 2000). Some scholars have, however, endorsed the use of comparative causation 
in conjunction with negligence standards for the allocation of the residual loss, such as the 
rule considered in this paper. The residual application of comparative causation, for the 
apportionment of an accident loss is for example endorsed by Strassfeld (1992), when 
other traditional criteria of liability have already exhausted their incentive function. 
According to this view, when the standard of liability leaves no commensurable faults to 
compare (such as when neither party is at fault), courts should apportion the loss on the 
basis of causal weight (Strassfeld, 1992:949). As various studies have revealed, a growing 
number of foreign jurisdictions in many countries, including France, Germany, and Japan, 
have used causation-based apportionments of liability, with the endorsement of academic 
commentators (see, e.g., Yoshihsa (1999), Grimley (2000) and Yu (2000)). For a more 
extensive legal discussion of the applications of the comparative causation rules in U.S. 
and foreign jurisdictions, see Parisi and Fon (2005).

9. Proportional loss sharing also takes place under the rule of comparative negligence. 
However, under this rule, loss sharing takes place only when both parties are negligent, 
not when both parties are non-negligent. For an analysis of this rule, see Schwartz (1978), 
For a critical review of some of these works, see Liao and White (2002), and Bar-Gill and 
Ben-Shahar (2003).

10. The conventional wisdom in the literature views insurance as foreign to the proper goals 
of tort law, given that any insurance through tort law would at least partially dilute the 
incentives towards optimal precaution (see, e.g., Shavell, 2000). As discussed in Parisi and 
Fon (2004), the implications and potential reach of this paradigm of liability are extensive. 
Several all-or-nothing criteria of liability might be reconsidered for more nuanced 
solutions. For example, as noted by Calabresi and Cooper (1996) adopting a rule of 
comparative causation might transform the use of proximate cause because a party’s 
behavior, even though remote in time, may still have provided a causal contribution to the 
loss. Likewise, under joint and several liability a negligent co-defendant could be forced to 
pay the entire judgment. However, as Calabresi and Cooper (1996:880-881) point out, 
with comparative causation, statistical causation could be used to apportion the loss 
between co-defendants.

11. Parisi and Fon (2004) have established that the rule of comparative causation, by allowing 
non-negligent parties to share an accident loss in equilibrium, spreads activity level and 
R&D incentives between the parties. As is remarked by the authors, this rule brings in an

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element of equity and reduces the magnitude of ‘jumps’ in liability of both parties. Under this rule, as a party reduces his care from being non-negligent to become negligent, his liability increases from partial-liability to full-liability and vice-versa; not from zero-liability to full-liability and vice-versa.

12. Apart from the principle of comparative causation, the nature of causal relation and its efficiency properties also warrants further research. As far as the formalization of individual inputs to the causation of an accident is concerned, the focus of the mainstream has been on only two forms of the causal relationship, namely, the cases of causal substitutes and causal complements. In the first case, the causal inputs of the parties are assumed to affect the causation of an accident additively, while in the latter they are assumed to do so multiplicatively. However, as the literature suggests, the causal inputs of the parties can affect the total causation in several and complex ways including the above two. Therefore, there is need to allow for more general forms of total causation function.

13. As is well known, decoupling solutions aside, no liability rule can put the entire accident loss on both the parties simultaneously, and therefore no liability rule can achieve optimal activity level and R&D incentives for both parties simultaneously.

14. For some implications of the violation of assumptions (A9) and (A10), see Jain and Singh (2002), Kim (2004) and Singh (2004). In addition, Jain and Singh (2002), Kim (2004) and Singh (2003) consider the possibilities of there being more than one socially optimal profile of care levels. Singh (2004), on the other hand, examines the implications when the due care standards are different from what is required by economic efficiency.


16. This formulation of the social optimization problem is as in P&F. Second-order conditions are assumed to be fulfilled.

17. It should be noted that in the standard literature these shares depend only on the care levels of the parties involved. Here, we have assumed causation of an accident to depend on care as well as activity levels, and we are concerned with comparative causation liability which requires loss sharing based on individual causal contributions. Therefore, in the present framework these shares depend on care as well as activity levels.


20. As explained above, this rule corresponds to the rule of comparative causation discussed in Parisi and Fon (2004) under the name of “comparative causation under negligence.”

21. The existence of Nash equilibria follows from a result in game theory. For details, see Singh (2006).

22. For more on the efficiency of ‘comparative causation’ when activity levels are constant, see Singh (2007a).
References


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