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Causation, Economic Efficiency and the Law of Torts

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Abstract

In standard models dealing with liability rules, generally, the proportion of accident loss a party is required to bear does not depend upon the 'causation' - the extent to which the care or lack of care on the part of the party contributed to the loss. As a matter of legal doctrine, this specification of the liability rules is said to be incorrect. The efficiency analysis incorporating the causation requirement of law of Torts, whenever undertaken, is largely restricted *only* to the rule of negligence. One of the aims of this paper is to provide an efficiency characterization of the *entire* class of liability rules when the `causation' requirement of the law is taken into account. We demonstrate that the contradiction between causation doctrine of the law, on the one hand, and economic efficiency, on the other, is not as wide and intense as it is believed to be.

***Keywords*:** Causation in law, liability rules, total social costs, efficient liability rules, causation-liability, Nash equilibrium.

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1. Introduction

A liability rule typically determines the proportions as to which parties to an accident will bear the loss, as a function of the levels of care taken by the parties. Generally, in the standard models dealing with liability rules, the proportion of accident loss a party is required to bear does not depend upon the 'causation' - the extent to which the care or lack of care on the part of the party contributed to the loss. For example, under the rule of negligence if the care level of the injurer is just below the due level of care, the injurer is required to bear the entire loss in the event of an accident even when the victim takes no care at all. Similarly, under the rule of strict liability with defense of contributory negligence, if the victim's care level falls just short of the due level, he will bear all the loss in the event of an accident, irrespective of the level of care taken by the injurer. As a matter of legal doctrine, this specification of liability rules is said to be incorrect (Grady, 1983, 88, 89; Kahan, 1989; Wright 1985a, b , 87). One basic feature of operating legal systems is that for a party to be held liable for accident loss the party must be shown to have acted negligently and its action must be a necessary and proximate cause of the loss - the causation requirement.[1] (Keeton, 1963, sec 14; Becht and Miller, 1961; Kahan, 1989; Honoré, 1983; Shavell, 1987, ch 5; and Wright 1985 a,b, 87).

It has been argued that under a liability rule, say the rule of negligence, the doctrinal notion of liability has two requirements; (i) an injurer is liable only when he has been negligent, that is, his level of care was less than the legally required due level of care, and (ii) a negligent injurer is liable for *only* that loss which can be attributed to his negligence.[2] An illuminating analysis by Kahan

[1]The rule of strict liability as an exception does not employ negligence criterion.

[2]See Grady (1983, 88, 89), Kahan (1989), and Keeton *et al*(1984), Wright, (1987).

(1989) shows that the causation based liability induces injurers to take efficient care under the rule of negligence. The efficiency analysis incorporating the causation requirement of the law of torts, whenever undertaken, is largely restricted *only* to the rule of negligence. One of the aims of this paper is to provide an efficiency characterization of the *entire* class of liability rules when the 'causation' requirement of the law is taken into account.

The economic analysis of liability rules is not free of contentions. Controversies are particularly sharp over the causation requirement of the law of torts. One of the most central and debatable issues around the concept of causation is the issue of the magnitude of the injurers' liability. Economic analysis of liability rules has been undertaken in Brown (1973), Diamond (1974), Polinsky (1980, 89), Landes and Posner (1980, 87), Shavell (1987), Miceli (1997), Cooter and Ulen (1998), Dari Mattiacci (2002), and Jain and Singh (2002), among others. This work argues that in order to induce injurers to take efficient care, a negligent injurer (particularly when the victim was not negligent) should be made liable for the entire loss suffered by the victim (Arlen, 2000; Jain and Singh, 2002). Legal scholars, on the contrary, have argued that negligent injurers are liable for only the loss that can be attributed to their negligence, that is, the loss of which they are cause-in-fact. In particular, an injurer is not liable for the loss that would have occurred even if he were nonnegligent (Kahan, 1989; Grady, 1983, 88, 89; Honoré, 1983; Wright, 1985a, b, 1987).

Yet another controversial issue relates to the question, ' When should an injurer be considered as the 'cause' of the harm suffered by the victim?' Economic analysis of causation has been under taken in Calabresi (1970), Landes and Posner (1983, 87), Shavell (1987), Miceli (1996, 97), among others. The basic proposition emerging from this work is that a party's action can raise or reduce the risk of harm, and therefore is a cause of the prospective harm (Cooter, 1987; Burrows, 1999; Ben-Shahar, 2000). In this work inefficient (negligent) behaviour is considered as the cause of harm, and hence a reason for invoking liability. Further, it is argued that, liability cannot be determined on the basis of 'causation' as both the injurer and the victim are necessary causes for any harm to occur. Therefore, in these studies the term 'cause' does not have any meaning beyond economic (in)efficiency.

Taking an altogether different perspective, legal scholars have argued that assignment of liability on the basis of efficiency criterion defeats the very purpose of the law of torts in general and, in particular, the doctrine of 'causation'. Since, the main purpose of the law of Torts is stated to be 'corrective justice' - which in turn is founded on the causation doctrine - it is claimed, an enquiry in causation has no room for efficiency (Honoré, 1983; Hart and Honoré, 1985, p. lxvii-lxxvii; Wright, 1985a, b, 1987). In important contributions by Marks (1994) and Burrows (1999) while criticizing economic modeling of causation, it has been argued that such modeling, apart from being incompatible with the actual proceedings in courts, does not make any meaningful contribution towards the understanding of economic implications of the causation requirement of the law of Torts. The apparent contradiction in the above-mentioned approaches to causation has led protagonists from both the streams to conclude that the doctrinal requirement of 'causation' serves goals other than that of efficiency (Epstein, 1973, 87; Cooter 1987; Ben-Shahar, 2000). We demonstrate that the apparent contradiction between the causation doctrine of the law, on the one hand, and economic efficiency, on the other, is not as wide and intense as it is believed to be.

A liability rule may specify the due care levels for both the parties, for only the injurer, for only the victim, or for neither party.[3] The causation doctrine can be extended to the negligence of the victim, whenever a liability rule specifies the due level of care for the victim (Dari Mattiacci, 2002). This would mean that when the victim is negligent under the rule of strict liability with defense, he will be liable for *only* that loss which can be attributed to his negligence.

Other factors remaining the same, the choice of care level by the injurer in general will have different implications for the *actual* loss (that will materialize in the event of accident) and the *expected* loss.[4] The important question that arises is whether the injurer should be considered as the 'cause' of the actual loss or the expected loss when both of which can be attributed to his act. Economic analysis that incorporates the causation requirement whenever undertaken takes the expected loss into account. We show that when the injurer is negligent and the victim is not, necessary condition for any liability rule to be efficient is to require the injurer to bear at least that fraction of the *expected* accident loss that can be attributed to his negligence.

The main result of the paper shows that necessary and sufficient condition for

[3]The rules of negligence with defense of contributory negligence, rule of negligence, and rule of strict liability, for example, are respectively the rules with legally specified due care standards for both the victim and the injurer, for only the injurer, for only the victim, and for none.

[4]For example, suppose other things remaining the same, if the injurer takes care the loss in the event of accident will be just 6, and if he does not the loss will be 9. When the injurer does not take care, 'causation' based enquiry by a court might reveal that the injurer is the cause of harm of only 3 (9-6), as the harm of 6 would have occurred anyway. Now assume that the probability of accident also depends upon the level of care by the injurer and is 1/3 when he takes care and 2/3 when he doesn't. As other things are assumed to be constant, no care by the injurer means that he has caused expected loss of not 3 but 4 ($2/3 \times 9 - 1/3 \times 6$).

efficiency of a liability rule is that it satisfy the condition of 'causation liability'. The condition of *causation liability* requires that the liability rule be such that: When the victim is nonnegligent, if the injurer chooses to be negligent rather than nonnegligent his expected liability will be more than his expected liability if he were just nonnegligent by an amount that is at least [greater than or equal to] the entire increase in the expected accident loss caused by his negligence. Similary, for the victim. When one party is negligent and the other is not, if the negligent party is required to bear a liability that is less than the increase in the expected loss 'caused' by the party's negligence then this party will not internalize the consequences of its behaviour fully and, therefore, will not act efficiently. Therefore at least in one sense, rather than being contradictory, the causation requirement turns out to be a necessary element for the efficiency of liability rules.

Such a characterization of liability rules in addition to delineating the efficient liability rules from inefficient ones can serve a very important purpose. With the set of all possible efficient liability rules in hand one can look for a rule that serves the stated purpose of the law of torts, namely, that of corrective justice or maximum possible compensation to the victims in a more desirable manner. We will show that the rules that are efficient in the standard framework will still be efficient when under these rules liability of the negligent party is reduced but is compatible with requirement of 'causation'.

2. Framework of Analysis

We consider accidents resulting from the interaction of two strangers to each other parties. The parties are assumed to be risk-neutral. To start with, the entire loss falls on one party to be called the victim; the other party being the injurer. We denote by $c \geq 0$ the cost of care taken by the victim and by $d \geq 0$ the cost of care taken by the injurer. Costs of care are assumed to be strictly increasing functions of care levels. As a result, costs of care for a party will also represent the level of care for that party. Let $C = \{c \mid c \geq 0$ is the cost of some feasible level of care which can be taken by the victim$\}$. That is, C is the set of feasible care-levels which the victim can take. Similarly, let D be the set of feasible care-levels which the injurer can take, i.e., $D = \{d \mid d \geq 0$ is the cost of some feasible level of care which can be taken by the injurer $\}$. $0 \in C$ and $0 \in D$.

Let π be the probability of occurrence of accident and $H \geq 0$ the loss in case accident actually materializes. π and H are assumed to be functions of c and d; $\pi = \pi(c, d)$, $H = H(c, d)$. Let, L denote the expected loss due to accident. L is thus equal to πH and is a function of c and d; $L = L(c, d)$. Clearly, $L \geq 0$. We assume that L, whenever positive, is a decreasing function of care level of each party. That is, a larger care by either party, given the care level of the other party, results in lesser expected accident loss whenever $L > 0$. Decrease in L can take place because of decrease in H or π or both. Activity levels of both the parties are assumed to be given.[5]

Social goal is to minimize the total social costs of accident. Total social costs (TSC) of accident are the sum of costs of care taken by the two parties and the expected loss due to accident; $TSC = c + d + L(c, d)$. Total social costs thus depend on c and d. We make the standard assumption that C, D, and L are such that there exists a unique configuration of care levels, for the victim and the injurer, which is TSC minimizing. Denote this configuration by (c^*, d^*). Thus, (c^*, d^*) is the pair of care levels which is efficient from social point of view. As,

[5] As will be clear, this framework is very similar to the standard framework of economic analysis of liability rules.

total social costs attain their minimum at (c^*, d^*), for all $(c, d) \neq (c^*, d^*)$, we have $c + d + L(c, d) > c^* + d^* + L(c^*, d^*)$. In this background, an accident-context is characterized by specification of C, D, and L.

As mentioned above, generally, the proportion of accident loss a party is required to bear under a liability rule does not necessarily depend on the extent to which negligence on the part of this party contributed to the loss. As a matter of legal doctrine, this specification of liability rules is said to be incorrect. It is argued that under the rule of negligence, the doctrinal notion of liability requires that a negligent injurer is liable for *only* that loss which was caused by his negligence, and not for the entire loss as is the case in standard models. The causation doctrine can be extended for the negligence of the victim, whenever a liability rule specifies the due level of care for the victim. This would mean that when the victim is negligent under the rule of strict liability with defense, he is liable for *only* the loss which can be attributed to his negligence.

As discussed earlier, care by a party will generally affect not only the actual loss that will materialize in the event of accident but also the expected loss, and these two need not be the same. Because of its forward-looking nature in the causation-based economic analysis of liability rules, accident loss that is taken into account while determining the liability is the *expected* rather than the actual loss.[6]

A liability rule may specify the due care levels for both the parties, or for only one of them, or for none.[7] We assumme that the legal due care standard (level)

[6] See Kahan (1989), and Miceli (1997, pp 22-24), Shavell (1987, pp), Ben- Shahar (2000), and Schwartz (2000, pp 1031-33).

[7] See footnote 3.

for a party, wherever applicable, is set at a level appropriate for the objective of minimization of TSC. That is, if (c^*, d^*) is TSC minimizing configuration of care levels, then the legal due care standard for the injurer, wherever applicable (say under the rule of negligence), will be set at d^*. Similarly, the legal standard of care for the victim, wherever applicable (say under the rule of strict liability with defense), will be c^*. This standard assumption is very crucial for the efficiency of a liability rule.

Given the above specification of due care levels, $d \geq d^*$ would mean that the injurer is taking at least the due care and he will be called nonnegligent. $d < d^*$ would mean that he is taking less than the due care, i.e., he is negligent. When $d < d^*$, the injurer's proportion of nonnegligence and negligence will be d/d^* and $1-(d/d^*)$ respectively. When $d \geq d^*$, the injurer is not negligent and therefore his proportion of negligence is zero. Similarly, for the victim. It should, however, be noted that technically speaking, a party can be negligent only if the liability rule specifies the due level of care for this party. In this paper, whenever the liability rule does not specify the due level of care for a party, negligence[nonnegligence] of a party would mean that care taken by this party is less than[greater than or equal to] the efficient level of care for it.

A liability rule uniquely determines the proportions in which the victim and the injurer will bear the accident loss, as a function of the proportions of (non)negligence of the parties. As a matter of fact the liability rules decide on two issues. First, the party that will bear the residual accident loss - accident loss when both parties are nonnegligent. Second, the proportions in which the two parties will bear the accident loss when one or both of them are negligent.

An application of a liability rule is characterized by the specification of C, D, L, and (c^*, d^*). Once C, D, L, and (c^*, d^*) have been specified, depending on the proportions of negligence of the victim and the injurer a liability rule uniquely determines the proportions in which they are to bear the loss H, in the event of accident. Formally, for a *given* application specified by C, D, L, and (c^*, d^*), a liability rule can be defined by a unique function f: $C \times D \mapsto [0,1]^2$ such that:[8]

$$f(c, d) = (x, y) = (x(c, d), y(c, d)),$$

where $x \geq 0$ [$y \geq 0$] is the proportion of H that will be borne by the victim [injurer] under the rule, and $x + y = 1$.

Remark 1: Since an application of a liability rule involves specification of C, D, L, and (c^*, d^*), a different specification of C, D, L, and (c^*, d^*) would mean a different application. Any change in C, or D, or L, or (c^*, d^*) would mean a different application. Let f define a liability rule for the application specified by C, D, L, and (c^*, d^*), and let g define the rule for the application specified by C_1, D_1, L_1, and (c_1^*, d_1^*). As the function defining the liability rule is application specific, f and g will be different, in general.

Further, a liability rule has the following attribute. Consider any C, D, L, and (c^*, d^*). Given any c opted by the victim, if the injurer increases his care level beyond d^*, the proportion in which injurer is required to bear the loss will exactly be the same as when he opted for d^*. That is, under a liability rule $d > d^*$ and $d = d^*$ are treated similarly, the injurer is nonnegligent and his proportions of

[8] Given C, D, L, and (c^*, d^*), since for every $c \in C$ and every $d \in D$ opted by the victim and the injurer, respectively, the liability rule uniquely determines the proportions in which the parties will bear the accident loss, the function f defining the liability rule for the given application is unique.

negligence and nonnegligence are 0 and 1 respectively. Similarly, given d opted by the injurer, if the victim increases his care level beyond c^*, the proportion in which victim is required to bear the loss will exactly be the same as when he opted for c^*. Therefore, if function f defines the liability rule for above C, D, L, and (c^*, d^*), then $\forall(c, d \geq d^*)[f(c, d^*) = f(c, d)]$ and $\forall(c \geq c^*, d)[f(c^*, d) = f(c, d)]$. In particular, if $f(c^*, d^*) = (x_1, y_1)$ then for all $c \geq c^*$ and $d \geq d^*$, $f(c, d) = (x_1, y_1)$. Also, when both parties are nonnegligent depending upon the rule in force, only the victim or only the injurer will bear the entire loss, i.e., $f(c \geq c^*, d \geq d^*) = (1, 0)$ or $(0, 1)$. As a matter of fact all the liability rules discussed in the literature satisfy these properties.

Suppose C, D, L, and (c^*, d^*) are given. Let function f define the relevant liability rule for this appliacation. When the victim and the injurer take care equal to $c' \leq c^*$ and $d' \leq d^*$, respectively, the associated expected loss is $L(c', d')$, but in the event of accident actual loss will be $H(c', d')$. On the other hand, if their respective care levels are c^* and d^*, the associated expected loss is $L(c^*, d^*)$, and in the event of accident the actual loss will be $H(c^*, d^*)$. Thus, $L(c', d') - L(c^*, d^*)$ and $H(c', d') - H(c^*, d^*)$ denote the increase in the expected and actual loss, respectively, due to the parties' negligence. Suppose to start with $c \geq c^*$ and $d = d^*$. Now, if the injurer opts for some $d' \leq d^*$, the increase in the expected loss that can be attributed *only* to the injurer's negligence is $L(c \geq c^*, d') - L(c \geq c^*, d^*)$. With c and d opted by the victim and injurer, respectively, if accident actually materializes the realized loss will be $H(c, d)$, and the court will require the injurer to bear $y(c, d)H(c, d)$. As, when accident takes place, the entire loss is suffred by the victim, $y(c, d)H(c, d)$ represents the liability payment to be made by the injurer to the victim.

Remark 2: Let $c < c^*$ or $d < d^*$ or both. $L(c, d) - L(c^*, d^*) = \pi(c, d)H(c, d) -$

$\pi(c^*, d^*)H(c^*, d^*) > \pi(c, d)[H(c, d) - H(c^*, d^*)]$, whenever $\pi(c, d) > \pi(c^*, d^*)$ and $L(c^*, d^*) > 0$.

Efficient Liability Rules:

A liability rule is said to be efficient for a given application, that is, for given C, D, L, and (c^*, d^*) iff it motivates both the parties to take efficient levels of care. Formally, a liability rule is efficient for given C, D, L, and (c^*, d^*), iff (c^*, d^*) is a unique Nash equilibrium (N.E.).[9] A liability rule is said to be *efficient* iff it is efficient for every possible application, i.e., iff for every possible choice of C, D, L, and (c^*, d^*), the rule is efficient.

3. Characterization of efficient liability rules

As mentioned above a liability rule uniquely determines the proportions in which the parties will bear accident loss in the event of accident, as a function of their proportions of (non)negligence. From the analysis above we also know that given any C, D, L, and (c^*, d^*), the injurer is said to be negligent only if $d < d^*$ and his proportion of negligence, say p, is given by $1 - (d/d^*)$. It is clear that for every $d < d^*$, p is uniquely determined, and there exists a unique $d < d^*$ corresponding to every $p > 0$. Similarly for the victim.

Take any C, D, L, and (c^*, d^*). Suppose a liability rule has the following attribute. When the victim is nonnegligent, i.e., $c \geq c^*$, if the injurer reduces his level of care from $d \geq d^*$ to any $d' < d^*$ (where his proportion of neg-

[9] A strategy profile (c', d') is said to be a N.E. iff given c' opted by the victim, d' is a best response from the view point of the injurer and vice-versa. The use of the notion of Nash equilibrium as prediction for equilibrium outcome is very common in the literature on liability rules.

ligence is positive), the *increase* in the injurer's expected liability is at least $[L(c \geq c^*, d') - L(c \geq c^*, d^*)]$, the increase in the expected loss caused by his negligence.[10] And, when the injurer is nonnegligent, i.e., $d \geq d^*$, if the victim reduces his level of care from $c \geq c^*$ to some $c' < c^*$ (where his proportion of negligence is positive), the increase in the victim's expected liability is at least $[L(c', d \geq d^*) - L(c^*, d \geq d^*)]$, the increase in the expected loss caused by his negligence. It is clear that under this liability rule, when the victim is nonnegligent, if the injurer reduces his care from a level where he is nonnegligent to a level where his proportion of negligence is positive, the *increase* in the injurer's expected liability is at least [greater than or equal to] the entire increase in the expected accident loss that is caused by his negligence. Similarly for the victim. Based on this discussion we define the following condition.

Condition of Causation Liability (CL):

A liability rule is said to satisfy the condition of Causation Liability (CL) iff under such a rule; (i) when the victim is nonnegligent, for every positive proportion of the injurer's negligence his expected liability [at the corresponding level of care] is more than his expected liability when he were *just* nonnegligent by an amount that is *at least* the entire increase in the expected accident loss that is caused by his negligence, and (ii) when the injurer is nonnegligent, for every positive proportion of the victim's negligence his expected liability [at the corresponding level of care] is more than his expected liability when he were just nonnegligent by an amount that is at least the entire increase in the expected accident loss

[10] Suppose $c \geq c^*$, and initially the injurer was taking care $d'' > d^*$. Now, if the injurer opts for some $d' < d^*$ then the increase in the expected loss that can be attributed to the injurer's negligence is only $L(c \geq c^*, d') - L(c \geq c^*, d^*)$ and not the entire increase of $L(c \geq c^*, d') - L(c \geq c^*, d'')$. This is because of the fact that the injurer is negligent only when $d < d^*$ and not when $d < d''$ (when $d^* \leq d < d''$ the injurer is not negligent).

that is caused by his negligence.

Let C, D, L, and (c^*, d^*) be given. Under a liability rule satisfying condition CL, when the victim is nonnegligent, i.e., $c \geq c^*$, if the injurer reduces his level of care from $d \geq d^*$ to some $d' < d^*$, the *increase* in the injurer's expected liability is $[L(c \geq c^*, d') - L(c \geq c^*, d^*)] + \beta$ (where $\beta \geq 0$), at least the increase in the expected loss caused by his negligence.[11] Similarly, when the injurer is nonnegligent, i.e., $d \geq d^*$, if the victim reduces his level of care from $c \geq c^*$ to some $c' < c^*$, the increase in the victim's expected liability is $[L(c', d \geq d^*) - L(c^*, d \geq d^*)] + \theta$, $(\theta \geq 0)$ at least the increase in the expected loss caused by his negligence. It should be noted that, here, the 'increase' in expected liability of a party refers to the increase in expected liability of the party over and above this party's liability, if any, when it were just nonnegligent.

The expected costs of a party are the sum of the cost of care taken by it plus its expected liability. Suppose the function f defines a liability rule for the given application specified by C, D, L, and (c^*, d^*). Let, $f(c \geq c^*, d \geq d^*) = (x_1, y_1)$. Under f, when $c \geq c^*$ and $d \geq d^*$, the injurer's expected costs, therefore, will be; $d + y_1\pi(c, d)H(c, d)$ or $d + y_1L(c, d)$, where $y_1 = 0$ or 1. $y_1L(c, d)$ represents the expected liability payment to be made by the injurer to the victim. The victim's expected costs, therefore, will be: $c + L(c, d) - y_1L(c, d)$ or $c + x_1L(c, d)$, as $x_1 = 1 - y_1$. Now, suppose one party say the victim is nonnegligent and the other (the injurer) is negligent. When the rule satisfies condition CL and and $c \geq c^*$ and the injurer chooses $d' < d^*$, at d' the injurer's expected liability is more than his expected liability at d^* by an amount that is greater than equal to $L(c, d') - L(c, d^*)$. Therefore at d' his expected liability is sum of his expected

[11]This means that when $c \geq c^*$ and $d' < d^*$, if $f(c, d') = (x(c, d'), y(c, d'))$ then $y(c, d')$ is such that $y(c, d')L(c, d') - y_1L(c, d^*) \geq L(c, d') - L(c, d^*)$.

liability at d^*, i.e., $y_1 L(c, d^*)$, and the increase in his expected liability on account of his negligence, i.e., $L(c, d') - L(c, d^*) + \beta$, where $\beta \geq 0$. That is, at at d' the injurer expected costs are $d' + y_1 L(c, d^*) + L(c, d') - L(c, d^*) + \beta (\geq 0)$. In particular, if $f(c \geq c^*, d \geq d^*) = (x_1, y_1) = (1, 0)$, at d' the injurer's expected costs will be; $d' + L(c, d') - L(c, d^*) + \beta (\geq 0)$. On the other hand, if $(x_1, y_1) = (0, 1)$ at d' the his expected costs will be; $d' + L(c, d')$.

Remark 3: The value of a liability rule f when $c < c^* \& c < d^*$, also when $c \geq c^* \& d \geq d^*$ has no implications as far as the fulfillment or otherwise of condition CL is concerned.

From the discussion so far it should be noted that c^* [d^*] denotes the care level for the victim [injurer] which is commensurate with objective of the TSC minimization, and also the legal standard for the victim [injurer] wherever applicable. The following claim shows that in all accident contexts the victim's expected costs will be minimum if he opts for c^*, assuming that the injurer has chosen d^*, and *vice-versa*. Formally, we prove that (c^*, d^*) is a N.E.

Claim 1 *If a liability rule satisfies condition CL then for every possible choice of C, D, L, and* (c^*, d^*), (c^*, d^*) *is a Nash equilibrium.*

Proof: Suppose a liability rule satisfies condition CL. Take any arbitrary C, D, L, and (c^*, d^*). Suppose for this specification of C, D, L, and (c^*, d^*) the rule is defined by the function f. Let, $f(c \geq c^*, d \geq d^*) = (x_1, y_1)$, where $(x_1, y_1) = (1, 0)$ or $(0, 1)$. Let, $(x_1, y_1) = (1, 0)$. Suppose, the victim's care level is c^*. Now, if the injurer chooses a care level $d' \geq d^*$, his expected costs are $d' + y_1 L(c^*, d')$ or simply d', as $y_1 = 0$. Therefore, given c^* by the victim, the injurer will be worse-off choosing $d' (> d^*)$, rather than d^*. Next, consider a choice of $d' < d^*$ by the injurer. If he chooses d^* his expected costs are just d^*. When

$c = c^{*}\&d' < d^{*}$, the injurer is negligent and the victim is not, and the increase in the expected loss due to the injurer's negligence is $L(c^{*}, d') - L(c^{*}, d^{*})$. So, by condition CL, at d' the injurer's liability is more than his expected liability at d^{*} by $\beta(\geq 0) + L(c^{*}, d') - L(c^{*}, d^{*})$ - at least the expected loss caused by the injurer's negligence. As, the injurer's liability is zero when $d \geq d^{*}$, at d' his expected liability therefore is $\beta(\geq 0) + L(c^{*}, d') - L(c^{*}, d^{*})$. Thus, $c = c^{*}\&d' < d^{*}$ and condition CL imply that the injurer's expected costs are $d' + \beta + L(c^{*}, d') - L(c^{*}, d^{*})$, where $\beta \geq 0$. But, when $c = c^{*}$ choice of $d' < d^{*}$ rather than d^{*} can be rational for the injurer only if his expected costs of choosing $d'(< d^{*})$ are less than or equal to that of choosing d^{*}. That is, only if, $\beta + d' + L(c^{*}, d') - L(c^{*}, d^{*}) \leq d^{*}$. That is, only if $\beta + d' + L(c^{*}, d') \leq d^{*} + L(c^{*}, d^{*})$, i.e., only if $\beta + c^{*} + d' + L(c^{*}, d') \leq c^{*} + d^{*} + L(c^{*}, d^{*})$. But, this is a contradiction as $\beta(\geq 0)$, and $(c^{*}, d') \neq (c^{*}, d^{*}) \rightarrow c^{*} + d' + L(c^{*}, d) > c^{*} + d^{*} + L(c^{*}, d^{*})$, by assumption. Therefore, given c^{*} by the victim, d^{*} is a uniquely best response for the injurer.

Now, suppose that the injurer is choosing d^{*}. If the victim opts for $c' \geq c^{*}$, his expected liability is $L(c', d^{*})$, as $f(c \geq c^{*}, d^{*}) = (1, 0)$. So, injurer's expected costs are $c' + L(c', d^{*})$, if he chooses $c' > c^{*}$. On the other hand, if he chooses $c' < c^{*}$, under f his expected liability is $L(c^{*}, d^{*})$ [his expected liability when he were just nonnegligent] plus $L(c', d^{*}) - L(c^{*}, d^{*})$,[12] on account of his negligence as the rule satisfies condition CL. Therefore, when $c' < c^{*}$, his expected costs are $c' + L(c', d^{*})$. That is, for $c' \neq c^{*}$ the victim's expected costs are $c' + L(c', d^{*})$. But, if he opts for c^{*} his expected costs are $c^{*} + L(c^{*}, d^{*})$. So, when $d = d^{*}$ choice of $c' \neq c^{*}$ can be made by him only if $c' + L(c', d^{*}) \leq c^{*} + L(c^{*}, d^{*})$, i.e., only if $c' + d^{*} + L(c', d^{*}) \leq c^{*} + d^{*} + L(c^{*}, d^{*})$, a contradiction. Therefore, given d^{*} by

[12] In this case, as all of the expected liability is borne by the victim and again it is the victim who bears the loss initially when accident takes place, $\beta = 0$.

the injurer, c^* is a unique best response for the victim. Clearly, (c^*, d^*) is a N.E. Similarly, when $f(c \geq c^*, d \geq d^*) = (0, 1)$ it can easily be checked that (c^*, d^*) is a N.E.•

Intuitive outlines of the argument of Claim 1 are as follows. Suppose a liability rule satisfies condition CL. Suppose, when both the parties are nonnegligent, the rule holds the victim to be liable, i.e., does not entitle him to any compensation in the event of accident. Now, assume that the victim is choosing c^*. As injurer can avoid liability simply by choosing d^* he will be worse-off opting any $d > d^*$. And, if he opts for any $d < d^*$, because of CL, he will have to bear at least the resulting increase in expected loss. As (c^*, d^*) is TSC minimizing, when injurer reduces his care to some $d < d^*$, the resulting increase in the expected accident loss (and which he will be required to bear) will be greater than the reduction in the cost of care, otherwise (c^*, d^*) will not be TSC minimizing. This means, the increase in his liability will be greater than the gains to him in terms of lower cost of care. Hence, given c^* opted by the victim, the injurer stands to loose by opting a level of care other than d^*. That is, d^* is a unique best response by the injurer for c^* opted by the victim.

Similarly, given d^* opted by the injurer, since (c^*, d^*) is uniquely TSC minimizing if the victim decreases his care level below c^*, due to condition CL, increase in his expected liability (over and above his liability at c^*) will be greater than the benefits he will draw from the reduction in the cost of care. If he opts $c > c^*$, he still will bear all the loss and (as (c^*, d^*) is TSC minimizing) gains to him in the form of reduced expected accident loss will be less than the increase in cost of care. Therefore, it will be in his own interest to take c^* rather than $c > c^*$. Thus, c^* is a unique best response by the victim for d^* opted by the injurer. So, c^* and

d^* are the mutually best responses for the victim and the injurer respectively. Hence, (c^*, d^*) is a N.E.

When the liability rule is such that it holds the injurer liable when both the parties are nonnegligent, an analogous argument shows that (c^*, d^*) is a N.E.

Claim 2 *If a liability rule satisfies condition CL then for every possible choice of C, D, L and (c^*, d^*), (c^*, d^*) is a unique Nash equilibrium.*

For proof see Appendix. Informally the argument can be put as follows. Suppose a liability rule satisfies condition CL. Assume that under the rule when both the parties are nonnegligent in event of accident the victim will bear the entire loss. When the injurer is nonnegligent, i.e., when $d \geq d^*$ under this rule the victim will bear the entire loss irrespective of his level of care. When $c \geq c^*$ this follows from the assumption that when both the parties are nonnegligent in event of accident the victim will bear the entire loss. And when $c < c^*$, the victim is negligent and in view of CL he will also bear the additional loss caused by his negligence. Thus, whenever $d \geq d^*$, expected liability of the injurer is zero and his expected costs are just d. Clearly, whenever $d > d^*$, injurer can reduce his costs by opting d^* rather than $d > d^*$.

Now suppose $(\bar{c}, \bar{d})$ is a N.E. That is, given $\bar{c}$ opted by the victim, $\bar{d}$ is a best response for the injurer, and *vice-versa*. In view of above, under the rule irrespective of the value of $\bar{c}$, $\bar{d} > d^*$ can not be a best response for the injurer. That is, $(\bar{c}, \bar{d} > d^*)$ can not be a N.E. Thus, $(\bar{c}, \bar{d})$ is a N.E. implies $\bar{d} \leq d^*$. When $\bar{d} = d^*$, from Claim 1 we know that c^* is a unique best response for the victim. So, $(\bar{c} \neq c^*, \bar{d} = d^*) \neq (c^*, d^*)$ and therefore can not be a N.E. Finally, when $\bar{d} < d^*$, through a series of steps (as is shown in the proof) it can be shown that regardless of the value of $\bar{c}$, $(\bar{c}, \bar{d})$ can not be a N.E. Thus, $(\bar{c}, \bar{d}) \neq (c^*, d^*)$ can not be a N.E. Or, (c^*, d^*) is a unique N.E. Analogous argument shows that if the rule is such that when both the parties are nonnegligent in event of accident the injurer will bear the entire loss. (c^*, d^*) is a unique N.E.

Claim 3 *If a liability rule is efficient for every possible choice of C, D, L and* (c^*, d^*)*, then it satisfies the condition CL*

For proof see Appendix. Claim 3 says that if a liability rule violates condition CL then it can not be efficient in all accident contexts. Violation of condition CL by a liability rule means that: (I) When the victim is nonnegligent, for some positive proportion of the injurer's negligence the difference between his expected liability at the corresponding level of care and his his expected liability if he were just nonnegligent is *less* than the increase in the expected loss due to his negligence. Or, (II) When the injurer is nonnegligent, for some positive proportion of the victim's negligence the difference between his expected liability at the corresponding level of care and his expected liability if he were just nonnegligent is *less* than the increase in the expected loss due to his negligence.
Suppose (I) holds. This means that under the liability rule when the injurer reduces his level of care he will bear only a part of the resulting increase in the expected accident loss. But, the entire benefit of the reduction in cost of care will accrue to him. Therefore, the injurer will not fully internalize the consequences of his action and in at least some accident contexts (as is shown in the proof) it will be better for him to not to take efficient care. Similarly, when (II) holds, in at least some accident contexts the victim will find it advantageous to take less than the efficient care.

More specifically, under a liability rule if one party is nonnegligent and the other chooses to be negligent, and consequent increase in the negligent party' expected liability is less than the increase in the expected loss caused by his negligence, then such a rule can not be efficient in all accident contexts.

Remark 4: When $c = c^*$ if the injurer reduces his care from d^* to some d, consequent increase in the expected accident loss is $L(c^*, d) - L(c^*, d^*)$. On the other hand, increase in the actual loss will be $H(c^*, d) - H(c^*, d^*)$. From Claim 3 we know that for a liability rule to be efficient, when injurer reduces his care from d^* to $d < d^*$, the increase in his expected liability should at least be $L(c^*, d) - L(c^*, d^*)$. But, if the liability is based on the actual loss caused by the injurer, in the event of accident, court will require him to bear $H(c^*, d) - H(c^*, d^*)$, so his expected liability will increase only by $\pi(c^*, d)[H(c^*, d) - H(c^*, d^*)]$. In view of Remark 2 whenever probability of accident decreases with the increase in the care levels, i.e., whenever $\pi(c^*, d) > \pi(c^*, d^*)$ and $L(c^*, d^*) > 0$, $L(c^*, d) - L(c^*, d^*) > \pi(c^*, d)[H(c^*, d) - H(c^*, d^*)]$. That is, the increase in the injurer's liability will be less than the increase in the expected accident loss caused by his negligence. In view of Claim 3 this would mean that no liability rule will be efficient in all accident contexts.

When negligent injurers are liable only for the expected loss that can be attributed to their negligence, let us assume that courts make lower biased errors - on an average they under-estimate the harm suffered by the victim. Under a liability rule if the victim is nonnegligent and the injurer reduces his care from a level where he is nonnegligent to a level where he is negligent, lower biased court errors would mean that the increase in negligent injurer's expected liability will be less than the consequent increase in expected loss caused by his negligence. This, in view of Claim 3 and also Remark 3 implies that the rule under consideration, and for that matter any other liability rule, cannot be efficient in all accident contexts when court errors are lower biased.[13]

[13]Kahan (1989) has shown that when courts make lower biased errors and negligent injurers are liable only for the expected loss that can be attributed to their negligence, the rule of

The following theorem shows that the condition CL is both necessary and sufficient for any liability rule to be efficient in all accident contexts.

Theorem 1 *A liability rule is efficient for every possible choice of C, D, L and* (c^*, d^*)*, iff, it satisfies condition Causation Liability.*

Proof: If a liability rule satisfies the condition CL then by Propositions 1 and 2, for every possible choice of C, D and L, (c^*, d^*) is the unique N.E. That is, the rule is efficient for every application. And, if the rule is efficient for every possible choice of C, D, L and (c^*, d^*), then Proposition 3 establishes that it satisfies the condition CL. •

Remark 5: In view of Theorem 1 and Remark 2, how a liability rule assigns liability when both the parties are negligent or when both are nonnegligent, has no implications for the efficiency of the rule.

The rule of negligence can be defined as: $d \geq d^* \rightarrow x = 1 (y = 0)$, and $d < d^* \rightarrow x = 0 (y = 1)$. In particular, under the rule when injurer is negligent and the victim is not the injurer will be liable, and when victim is negligent and injurer is not the victim will be liable. Further, the liability is for the entire loss (Condition CL requires liability equal to or greater than the loss attributable to negligence). Thus, the rule of negligence satisfies condition CL and therefore is efficient.[14] Similarly, it can be checked that all the rules that are shown to be

negligence is not efficient.

[14] Kahan (1989) and Miceli (1997, p. 22-24) have shown that under the rule of negligence if a negligent injurer is required to bear only the expected loss that is caused by his negligence and not the entire expected loss (a requirement consistent with condition CL), then the rule is efficient.

efficient in the literature on liability rules such as the rules of negligence with defense, comparative negligence, and strict liability with defense, satisfy condition CL and are efficient for every possible choice of C, D, L and (c^*, d^*). Moreover it should be noted that instead of full liability (as is the case in standard modeling of these rules) if the liability is restricted to the causation liability as explained in the definition of condition CL, all these rules will still be efficient. The rules of no liability and strict liability, on the other hand, do not satisfy condition CL and cannot be efficient for every possible choice of C, D, L and (c^*, d^*).

Consider a liability rule such that the residual loss when both the parties are nonnegligent - is borne by the injurer. In view of Theorem 1, the rule will be efficient for every possible choice of C, D, L and (c^*, d^*) if under it whenever the victim is negligent and the injurer is not, the victim bears the expected loss caused by his negligence. And, whenever the injurer is negligent and the victim is not, increase in the injurer's liability is equal to the expected loss caused by his negligence. Now, consider the rule of strict liability with defense. Under this rule, also the residual loss is borne by the injurer, i.e., $c \geq c^* \& d \geq d^* \rightarrow x = 0$ $(y = 1)$. Further, the rule of strict liability with defense has two requirements: (1) A negligent victim will bear the loss even when the injurer was negligent. (2) Negligent victim will bear the entire loss. But, in the light our discussion, both of these requirements are unnecessary. The rule of strict liability with defense will still be efficient even if under it the scope of liability of the victim is further reduced [or of that of injurer's liability increased] in the following sense; (i) it makes the victim liable if and only if the victim was negligent and the injurer was not, and (ii) it makes a negligent victim liable for only the loss that can be attributed to his negligence.

4. Concluding remarks

The standard economic analysis of liability rules shows that the liability rules which are based on negligence or due care criterion are efficient. A liability rule may have negligence or due care criterion only for the injurer (say the rule of negligence), or only for the victim (say the rule of strict liability with defense), or both (say the rule of negligence with defense). All these rules are shown to be efficient when both parties can affect the risk and/or magnitude of accident loss. All these negligence based rules, as they are modeled in the standard analyses, have the following common attribute: When one party is negligent and the other is not, the negligent party will bear the *entire* loss in the event of accident. In particular, under the rule of negligence when the injurer reduces his care from a level where he is nonnegligent to a level where he is negligent, he becomes liable for the entire loss. Same thing holds for the victim under the rule of strict liability with defense of contributory negligence.

In contrast, legal scholars have argued that this drastic change in liability is not part of the law of Torts. Our analysis shows that for economic efficiency this drastic change in liability is not necessary. Theorem 1 shows that necessary and sufficient condition for any liability rule to be efficient is that the rule be such that when one party is negligent and the other is not, then the negligent party will bears the fraction of loss that can be attributed to his negligence. The analysis shows that in at least one sense causation based liability is a necessary condition for any liability rule to be efficient. Imposition of the liability for the entire loss is not needed. The analysis shows that in at least one sense causation based liability is a necessary condition for any liability rule to be efficient. Furthermore, how a liability rule assigns liability when both the parties were not negligent or when both were negligent has no implications for the efficiency of the rule, and contradiction between the causation requirement of law and economic efficiency is not as pervasive as it is believed to be. Analysis, among other things, shows that the rule of strict liability with defense can be made more compensatory without any sacrifice of economic efficiency. However, when courts make lower-biased errors and the liability is based on causation no liability rule can be efficient.

Appendix

Proof of Claim 2:

Suppose a liability rule satisfies condition CL. Take any arbitrary C, D, L, and (c^*, d^*). Let the function f define the rule for this specification of C, D, L, and (c^*, d^*). Assume $(\forall c \geq c^*, \forall d \geq d^*)[f(c,d) = (x_1, y_1)]$. $(x_1, y_1) = (1,0)$ or $(0,1)$. Let $(x_1, y_1) = (1,0)$. $(\forall c \geq c^*, \forall d \geq d^*)[f(c,d) = (x_1, y_1) = (1,0)]$ implies that when $d \geq d^*$ and $c \geq c^*$, liability of the injurer is zero. And, when $d \geq d^*$ and $c < c^*$, $(x_1, y_1) = (1,0)$ and CL imply that the victim's liability is sum of $L(c^*, d \geq d^*)$ [his expected liability when he chooses c^* as $(x_1, y_1) = (1,0)$] and $L(c, d \geq d^*) - L(c^*, d \geq d^*)$, on account of his negligence. Thus, given $(x_1, y_1) = (1,0)$, when $d \geq d^*$ irrespective of the value of c, the injurer's expected liability is zero and the victim's expected liability is $L(c, d \geq d^*)$, i.e., the victim will bear all the expected loss and the injurer none. To prove uniqueness, suppose $(\bar{c}, \bar{d})$ is a N.E. Following three cases arise.

Case 1: $\bar{c} > c^*$: Suppose $\bar{d} > d^*$. When $\bar{c} > c^* \& \bar{d} > d^*$, $f(\bar{c}, \bar{d}) = (x_1, y_1) = (1,0)$ in view of the above implies that $(\bar{c}, \bar{d})$ can not be a N.E, as in this case injurer's expected liability is zero and he can lower his costs by opting d^* rather than $\bar{d} > d^*$. Now, suppose $\bar{d} = d^*$. From the proof of Claim 1 we know that c^* is a uniquely best response for the victim, given d^* opted by the injurer. Therefore,

$(\bar{c} > c^*, \bar{d} = d^*)$ can not be a N.E.

Finally, suppose $\bar{d} < d^*$. When $\bar{c} > c^* \& \bar{d} < d^*$, total expected loss is $L(\bar{c}, \bar{d})$. Condition CL, in view of $(x_1, y_1) = (1, 0)$, implies that the injurer's expected liability will at least be equal to the expected loss caused by his negligence. So, at $\bar{c} > c^* \& \bar{d} < d^*$ his expected liability is $L(\bar{c}, \bar{d}) - L(\bar{c}, d^*) + \beta (\geq 0)$, and the remaining expected loss of $L(\bar{c}, d^*) - \beta$ will be borne by the victim. Therefore, at $(\bar{c}, \bar{d})$, the expected costs of the injurer and the victim are; $\bar{d} + L(\bar{c}, \bar{d}) - L(\bar{c}, d^*) + \beta$, and $\bar{c} + L(\bar{c}, d^*) - \beta$, respectively. But, as explained in the beginning when $(x_1, y_1) = (1, 0)$, irrespective of the care level of the victim if the injurer opts for d^* his expected liability is zero and, therefore, his expected costs are just d^*. So, $(\bar{c}, \bar{d})$ is a N.E $\rightarrow$

$$\bar{d} + L(\bar{c}, \bar{d}) - L(\bar{c}, d^*) + \beta \leq d^* \tag{1}$$

Also, given $\bar{d}$ opted by the injurer, if the victim instead opts for c^* his expected liability will be $L(c^*, d^*) - \beta' (\geq 0)$, as CL and $\bar{d} < d^*$ imply that out of the total expected loss of $L(c^*, \bar{d})$, $L(c^*, \bar{d}) - L(c^*, d^*) + \beta' (\geq 0)$ will be borne by the injurer. Therefore, at c^* the victim's expected costs will be $c^* + L(c^*, d^*) - \beta'$. Now, $(\bar{c}, \bar{d})$ is a N.E., in particular, implies that given $\bar{d}$ opted by the injurer, expected costs of the victim when he opts for $\bar{c}$ are less than or equal to that of opting c^*, i.e.,

$$\bar{c} + L(\bar{c}, d^*) - \beta \leq c^* + L(c^*, d^*) - \beta' \tag{2}$$

Adding (1) and (2), $(\bar{c}, \bar{d})$ is a N.E $\rightarrow$
$\bar{c} + \bar{d} + L(\bar{c}, \bar{d}) \leq c^* + d^* + L(c^*, d^*) - \beta'$, or $\bar{c} + \bar{d} + L(\bar{c}, \bar{d}) \leq c^* + d^* + L(c^*, d^*)$, as $\beta' \geq 0$. Which is a contradiction, as $(\bar{c}, \bar{d}) \neq (c^*, d^*) \rightarrow \bar{c} + \bar{d} + L(\bar{c}, \bar{d}) > c^* + d^* + L(c^*, d^*)$, by assumption. Thus, we see that when $\bar{c} > c^*$ whether $\bar{d} \geq d^*$ or $\bar{d} < d^*$, $(\bar{c}, \bar{d})$ cannot be a N.E., i.e.,

$$\bar{c} > c^* \rightarrow (\bar{c}, \bar{d}) \quad cannot \quad be \quad N.E. \tag{3}$$

Case 2: $\bar{c} = c^*$: In this case from Claim 1 it is clear that given c^* opted by the victim, $d = d^*$ is a unique best response for the injurer. Therefore,

$$\bar{c} = c^* \ \& \bar{d} \neq d^* \rightarrow (\bar{c}, \bar{d}) \quad cannot \quad be \quad N.E. \tag{4}$$

Case 3: $\bar{c} < c^*$: Let $\bar{d} \geq d^*$. As shown in the very begining when $(x_1, y_1) = (1, 0)$, $\bar{d} \geq d^*$ implies that the expected costs of the injurer are just $\bar{d}$. So, as in the Case 1, $(\bar{c} < c^*, \bar{d} > d^*)$ can not be a N.E. When $\bar{d} = d^*$ for the reason analogous to the one in Case 2, $(\bar{c} < c^*, \bar{d} = d^*)$ can not be a N.E. Finally, let $\bar{d} < d^*$. In this case it should be noted that the condition CL does not say any thing about the assignment of liability. In this case in the event of accident actual loss will be $H(\bar{c}, \bar{d})$ and the liability rule (function f) will assign some proportion, say y', $0 \leq y' \leq 1$, of this loss to the injurer. Therefore, the injurer will bear the expected liability equal to $y'\pi(\bar{c}, \bar{d})H(\bar{c}, \bar{d})$, or $y'L(\bar{c}, \bar{d})$. Remaining expected loss of $L(\bar{c}, \bar{d}) - y'L(\bar{c}, \bar{d})$ will be borne by the victim. Thus, at $(\bar{c}, \bar{d})$ expected costs of the injurer and the victim are $\bar{d} + y'L(\bar{c}, \bar{d})$ and $\bar{c} + L(\bar{c}, \bar{d}) - y'L(\bar{c}, \bar{d})$, respectively. On the other hand, given $\bar{d} < d^*$ by the injurer, if the victim opts for c^* his expected costs (as in the Case 1) are $c^* + L(c^*, d^*) - \beta (\geq 0)$. Also, as above, if the injurer opts for d^* his expected costs will be simply d^*. Now, in this case $(\bar{c}, \bar{d})$ is a N.E $\rightarrow$

$$\bar{c} + L(\bar{c}, \bar{d}) - y'L(\bar{c}, \bar{d}) \leq c^* + L(c^*, d^*) - \beta, \tag{5}$$

and

$$\bar{d} + y'L(\bar{c}, \bar{d}) \leq d^* \tag{6}$$

Adding (5) and (6) we get, $(\bar{c}, \bar{d})$ is a N.E. $\rightarrow$
$\bar{c} + \bar{d} + L(\bar{c}, \bar{d}) \leq c^* + d^* + L(c^*, d^*) - \beta$, or $\bar{c} + \bar{d} + L(\bar{c}, \bar{d}) \leq c^* + d^* + L(c^*, d^*)$, as $\beta \geq 0$. Which, again, is a contradiction. Therefore, when $\bar{c} < c^*$, whether $\bar{d} \geq d^*$ or $\bar{d} < d^*$, $(\bar{c}, \bar{d})$ cannot be a N.E., i.e.,

$$\bar{c} < c^* \rightarrow (\bar{c}, \bar{d}) \quad cannot \quad be \quad N.E. \tag{7}$$

Finally, (3), (4) and (7) imply that $(\bar{c}, \bar{d}) \neq (c^*, d^*)$ can not be a N.E. This, in view of Claim 1 implies that when $(\forall c \geq c^*, \forall d \geq d^*)[f(c,d) = (1,0)]$, (c^*, d^*) is a unique N.E. Similarly, it can be shown that when $(\forall c \geq c^*, \forall d \geq d^*)[f(c,d) = (0,1)]$, (c^*, d^*) is a unique N.E.•

Proof of Claim 3:

Suppose, there exits a liability rule such that the rule violates condition CL and is efficient for every possible choice of C, D, L, and (c^*, d^*). Now, the rule violates condition CL implies that: (I) When the victim is nonnegligent, for some positive proportion of the injurer's negligence the difference between his expected liability at the corresponding level of care and his expected liability when he is just nonnegligent is *less* than the increase in the expected loss due to his negligence. Or,

(II) When the injurer is nonnegligent, for some positive proportion of the victim's negligence the difference between his expected liability at the corresponding level of care and his expected liability when he is just nonnegligent is *less* than the increase in the expected loss due to his negligence.

Let, (I) hold. Let, when the victim is nonnegligent, for some positive proportion of the injurer's negligence, say p, the difference between the injurer's expected liability at the corresponding level of care and his expected liability when he is just nonnegligent is α times the increase in the expected loss due to his negligence, where $\alpha < 1$. Let $q = 1 - p$. As $0 < p \leq 1$, $q < 1$. Take $t > 0$. Clearly, $\alpha t < t$. Choose a positive number r such that $\alpha t < r < t$. Now consider the following specification of C, D, and L:

$C = \{0, c_0\}$, where $c_0 > 0$,

$D = \{0, qd_0,\ d_0\}$, where $d_0 = r/p$,

$L(0,0) = t + qd_0 + c_0 + \delta + \Delta$, where $\delta > 0$, and $\Delta \geq 0$,

$L(c_0, 0) = t + qd_0 + \Delta, \quad L(0, qd_0) = t + c_0 + \delta + \Delta,$

$L(0, d_0) = c_0 + \delta + \Delta, \quad L(c_0, qd_0) = t + \Delta, \quad L(c_0, d_0) = \Delta.$

Let, the function f define the rule for the above specification of C, D, and L. Clearly, (c_0, d_0) is the unique TSC minimizing configration for the above specification. Let $(c^*, d^*) = (c_0, d_0)$. $f(c^*, d^*) = (0,1)$ or $(1,0)$. Suppose, $f(c^*, d^*) = (0,1)$. Given c_0 opted by the victim, if the injurer opts for d_0 his expected liability is Δ and his expected costs are $d_0 + \Delta$. On the other hand, when (I) holds if he chooses qd_0, consequent increase in his liability is α times the increase in expected loss as a result of his negligence, i.e., $\alpha[L(c_0, qd_0) - L(c_0, d_0)] = \alpha t$. That is, at qd_0 his expected costs are $qd_0 + \alpha t + \Delta$. But, $qd_0 + \alpha t + \Delta < d_0 + \Delta$, as $\alpha t < d_0 - qd_0$. Therefore, expected cost of the injurer of choosing qd_0 are strictly less than that of choosing d_0. Thus, (c^*, d^*) is not a N.E. When $f(c^*, d^*) = (1,0)$, given c_0 opted by the victim, expected costs of injurer of choosing d_0 and qd_0 are d_0 and $qd_0 + \alpha t$, respectively. Again, as $qd_0 + \alpha t < d_0$, (c^*, d^*) is not a N.E. We have shown that (I) implies that there exist a specification of C, D, L and (c^*, d^*) such that the rule is not efficient.[15] When (II) holds, an analogous argument shows that the rule cannot efficient for every possible choice of C, D, L and (c^*, d^*). •

[15]From the proof it should be noted that: (i) we have not assumed any thing about the magnitude of α apart from assuming that $\alpha < 1$; (ii) in principle, one can construct infinitely many accident contexts wherein any liability rule violating CL will be inefficient.

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