COMPARATIVE NEGLIGENCE AS A BUFFER AGAINST ERRONEUS STANDARDS

GIUSEPPE DARI-MATTIACCI
EVA S. HENDRIKS

University of Amsterdam

PRELIMINARY DRAFT - DO NOT CITE OR DISTRIBUTE

Abstract. Comparative negligence poses one of the longest-lasting puzzles in Law & Economics. Under standard assumptions, its performance is identical to other negligence rules, while its implementation is slightly more complex. So, why is it the most common rule? In order to answer the question why comparative negligence is so much more frequently used than its alternatives, scholars have explored several variations of the basic model. In a recent article, Bar-Gill and Ben-Shahar (2003) argue that the problem is still waiting for a general solution. In this paper, we advance a novel argument and show that comparative negligence can serve as a buffer against erroneous due-care standards.

Keywords: comparative negligence, legal errors, tort law and economics, economics of tort liability.
JLE code: K13.

The authors would like to thank Gerrit De Geest, Fernando Gomez and the participants in the European Association for Law and Economics 2009 Annual Meeting in Rome for insightful comments. G. Dari-Mattiacci gratefully acknowledges the financial support provided by the NWO grant 016.075.332.

1. Introduction

Comparative negligence poses one of the longest-lasting puzzles in Law & Economics. Under standard assumptions, its performance is identical to other negligence rules, while its implementation is slightly more complex, thus more costly. So, why is it the most common rule? In order to answer the question why comparative negligence is more frequently used than its alternatives (Curran, 1992), scholars have explored several variations of the basic model, particularly focusing on the role of errors and information. "This literature has gone through four major phases. In the first phase, contributory negligence was considered the efficient rule because it was believed to create efficient incentives for parties to adopt efficient care, mainly in a setting in which a least cost avoider was assumed to exist. In the second phase, it was shown that under perfect information both rules were equivalent from an efficiency perspective. However, once some of the assumptions were relaxed, the equivalence between both rules did not hold. Hence, in this third phase, the discussion has focused on the assumptions and the performance of both rules that seem to favor comparative negligence. Today, though, discussion on the relative efficiency properties is more parsimonious in terms of a global advantage, and skepticism prevails about deciding which rule is preferred" (Artigot and Gomez, 2009, p. 46). In a recent article, Bar-Gill and Ben-Shahar (2003) have reexamined existing explanations and questioned their general validity. According to their analysis, the puzzle of comparative negligence is yet to be solved.

Dari-Mattiacci and De Geest (2005) have recently tackled this puzzle anew in a law-enforcement model in which precaution by one party is enough to avoid the accident, choices are binary (violate or comply) and the enforcer is incompletely informed about the parties' precaution costs. Their analysis shows that comparative negligence has a filtering effect: it prevents violations that yield high social costs, but lets violations that yield low social costs occur. Rules that burden one party, such as simple or contributory negligence, also prevent some accidents while letting other accidents occur, but they do so at random, without any selection. Thus, comparative negligence can improve social welfare by filtering out the most harmful accidents.

In this paper, we take the analysis in a different direction and employ a standard tort model, in which both parties can prevent the accident by choosing a level of care from a continuum. We claim that comparative negligence can serve as a buffer against erroneous due-care standards. Our argument is grounded in the idea that all-or-nothing rules (simple and contributory negligence) employ a stick (the payment of damages), which is applied entirely to one party. In contrast, comparative negligence shares this stick between negligent parties. Dari-Mattiacci and De Geest (2010) show that all-or-nothing sticks can be used to extract more effort from noncooperative parties than the amount of the stick itself; that is, sticks have a multiplication effect. For instance, with a stick (damages) of \$100, one could extract an effort (precaution) of \$70 by each one of two parties, resulting in an inefficiently high level of accident prevention, since a reduction of \$100 in accident costs is generally not worth spending \$140 on prevention.

The multiplication effect works by implementing a "divide and conquer" mechanism. Imagine that an accidental loss of \$100 can be prevented if both parties spend \$70 on precaution; if either party fails to take precaution, then the accident occurs. Under a simple negligence rule (see Table 1), the injurer pays damages to the victim only if he is found negligent; otherwise, he pays no damages. This rule can be described as follows: the threat of damages is directed towards the injurer, who, faced with the choice between compliance ($70, the cost of precaution) and violation ($100, damages), chooses compliance. Then, the same stick is applied to the victim. Given that the injurer behaves nonnegligently, under the simple negligence rule the victim is entitled to no compensation and hence bears the accident loss. Faced with a choice similar to that of the injurer between taking precaution ($70) and bearing the accident loss ($100), the victim also takes precaution. The result is that both parties (inefficiently) take precaution, spending $140 in total in order to prevent an accidental loss of only $100. The outcome of this game is somewhat analogous (although not identical) to that of a prisoners' dilemma, where parties are forced into a Nash equilibrium (taking precautions) that is inferior to an alternative outcome (letting the accident occur).

Costs $\binom{I}{V}$	Injurer negligent	Injurer nonnegligent
Victim negligent	100 0	70 100
Victim nonnegligent	100 70	70 70

Table 1. An example under the simple negligence rule

The multiplication effect can be countered by rules that share the stick between the parties. Consider the same setting with a comparative negligence rule (see Table 2), under which a negligent injurer fully compensates the victim if the victim is nonnegligent but only pays 50% of the damages if the victim is also negligent. Each party faces a choice between taking precaution and paying 50% of the damages (half of the stick), that is, a choice between $70 and $50. In this case, a new equilibrium arises where both parties violate the rule and the accident (efficiently) occurs. This equilibrium is better for the parties than the equilibrium is which they comply and, hence, can be seen as a focal point.

Costs $\binom{I}{V}$	Injurer negligent	Injurer nonnegligent
Victim negligent	50 50	70 100
Victim nonnegligent	100 70	70 70

Table 2. An example under the comparative negligence rule.

We exploit the multiplication effect of sticks in order to explain that, if the due-care standards are erroneously set, comparative negligence induces the parties to violate them and choose levels of precautions that advance social welfare more often than simple or contributory negligence. There are two previous contributions that are particularly close to ours. Cooter and Ulen (1986) analyze the functioning of tort liability under evidentiary uncertainty, when parties cannot accurately predict whether the court will find them negligent. Evidentiary uncertainty induces parties to alter their levels of precaution. Cooter and Ulen find that, when parties are symmetrical in their abilities to take precautions, comparative negligence is to be preferred because it generates moderate distortions by both parties, while simple and contributory negligence cause large distortions for one party and small distortions for the other. Bar-Gill and Ben-Shahar (2003) emphasize that this result relies on the hypothesis that moderate distortions are preferable to large ones, which needs not be true in general. In addition, they show that moderate distortions could also be obtained by all-or-nothing rules. Our analysis differs from Cooter and Ulen's analysis in that we do not make any assumptions about the size and effect of distortions in the care levels; moreover, we consider biased but certain standards, rather than uncertain standards as Cooter and Ulen do.

Rubinfeld (1987) analyzes a setting in which there is heterogeneity among parties with respect to their costs of care, which cannot be directly observed in court. He finds it optimal for the court to set very high standards—in order to induce parties to be negligent—and employ comparative negligence—in order to induce parties to self-select with respect to their costs of care. The mechanism works because the parties can make small adjustments in their share in liability by taking more or less care. In contrast, under simple or comparative negligence, liability jumps discontinuously from zero to full liability and adjustments in caretaking are not fine-tuned. Bar-Gill and Ben-Shahar (2003) build on Rubinfeld's analysis and show that information revelation mechanisms can be constructed in response to a broader set of problems and that they can be implemented in all negligence rules, not only under comparative negligence, by appropriately setting the due-care standards. Hence, information revelation provides no validation for a preference for comparative negligence. In our model, due-care levels are erroneous not because there is heterogeneity in the population of injurers and victims, but rather because the regulator makes a mistake in identifying the socially optimal levels. Therefore, while in the analyses by Rubinfeld, Bar-Gill and Ben-Shahar the regulator can choose both the standards of negligence and the type of negligence rule, in our setting the (erroneous) standards of negligence are taken as given. In a sense, in our setting the regulator believes these standards to be correct while in Rubinfeld's setting the regulator knows the standards are correct only on average and can alter them.

This paper in structured as follows. In Section 2, we present a formal model, describing the full set of negligence rules and strict liability rules (with defense of negligence), and provide the standard efficiency-equivalence result under optimally set standards. Then, in Section 3, we analyze the behavior of injurers and victims under erroneous standards and prove three results. We first show, in Section 3.1, that negligence is efficient in equilibrium: any deviation from the due-care standards that emerges in equilibrium under any rule is efficient from the social welfare point of view because it yields less social costs of accidents than would occur if the parties abided by due care. Second, in Section 3.2 we show that comparative negligence is the rule that most frequently induces efficient negligence. Finally, in Section 3.3, we show that the commonly used rule that shares damages according to the parties' respective negligence always induces noncompliance whenever such an equilibrium exists. In Section 4, we conclude, emphasizing the implications of our results.

2. Model

We consider accidents occurring between two wealth-maximizing, risk-neutral parties: a victim (V) and an injurer (I). Both the injurer and the victim can take care in order to reduce the expected harm. The injurer chooses a level $x \geq 0$ of expenditure in care; likewise, the victim chooses a level $y \geq 0$. The expected harm depends on both care levels and is expressed by $l(x, y) > 0$, which is assumed to be strictly convex in x and y.

2.1. **Liability Rules.**

Two standards of due care x^d and y^d are set by a regulator. Table 3 illustrates the possible allocations of the burden of liability depending on whether the injurer and the victim abide by the standards of due care.

	Injurer negligent	Injurer nonnegligent
Victim negligent	Victim, injurer, or damages are shared	Victim
Victim nonnegligent	Injurer	Victim or Injurer

TABLE 3. Who bears the harm under different liability rules.

Considering all possibilities gives six rules. We begin by examining the traditional negligence rules (simple negligence, contributory negligence and comparative negligence). If both parties abide by the due-care standard ($x \geq x^d$ and $y \geq y^d$), the victim bears the harm. If one party abides by the due-care standard, while the other is negligent, the negligent party bears the harm. That is, if the injurer takes $x \geq x^d$ and the victim takes $y < y^d$, then the victim bears the harm; vice versa, if the victim takes $y \geq y^d$ and the injurer takes $x < x^d$, then the injurer bears the harm. Finally, if neither party complies with due care ($x < x^d$ and $y < y^d$) the injurer pays a share $0 \leq \sigma \leq 1$ of the damages and the victim bears the remaining portion, $1 - \sigma$.

Note that the three versions of the negligence rule that we consider can be easily formalized within this framework. We have simple negligence if $\sigma = 1$: the injurer pays damages if he is negligent, irrespective of the behavior of the victim. We have contributory negligence in the opposite case of $\sigma = 0$: the injurer pays damages if negligent, but if the victim is also negligent the injurer's liability is waved. Finally, we have comparative negligence if $0 < \sigma < 1$, implying that if both parties are negligent, each of them bears a portion of the loss.

The same exercise can be repeated for strict liability rules with defense of negligence. There is only one difference with respect to the previous rules: If both parties abide by the due-care standard ($x \geq x^d$ and $y \geq y^d$), the injurer bears the harm. The other cases remain the same: a unilateral violation of the due care standard implies that the violator fully bears the harm, while if neither party complies with due care the harm is shared between the parties according to σ. As in the previous case, we can identify three rules. We have strict liability with defense of contributory negligence if $\sigma = 0$: the victim bears the harm if he is negligent, irrespective of the behavior of the victim. We have strict liability with defense of dual contributory negligence in the opposite case of $\sigma = 1$: the victim bears the harm if negligent, but if also the injurer is negligent, then he pays damages. Finally, we have strict liability rules with defense of comparative negligence if $0 < \sigma < 1$, implying that if both parties are negligent, each of them bears a portion of the loss.

In order to distinguish between the three negligence rules and the three strict liability rules, we introduce a parameter, $\vartheta = 0$ (for the negligence rules) or $\vartheta = 1$ (for strict liability rules), so that, when both parties abide by the due-care standard, the injurer pays a portion ϑ of the loss and the victim bears the remaining portion $1-\vartheta$. Table 4 shows the expected damages to be paid by the injurer and the victim, respectively, under all of the six rules. Table 5 illustrates the six liability rules on the basis of the parameters used. Under all rules, damages awarded to the victim are assumed to be perfectly compensatory, that is, equal to the harm suffered.

Expected cost $\binom{I}{V}$	$x < x^d$	$x \geq x^d$
$y < y^d$	$\sigma l(x,y) + x$ $(1-\sigma)l(x,y) + y$	x $l(x,y) + y$
$y \geq y^d$	$l(x,y) + x$ y	$\vartheta l(x,y) + x$ $(1-\vartheta)\, l(x,y) + y$

TABLE 4. The parties' expected costs

Liability rule	value of $\vartheta \in \{0,1\}$	value of $\sigma \in [0,1]$
Simple negligence	$\vartheta = 0$	$\sigma = 1$
Contributory negligence	$\vartheta = 0$	$\sigma = 0$
Comparative negligence	$\vartheta = 0$	$0 < \sigma < 1$
Strict liability with defense of contributory negligence	$\vartheta = 1$	$\sigma = 0$
Strict liability with defense of dual contributory negligence	$\vartheta = 1$	$\sigma = 1$
Strict liability with defense of comparative negligence	$\vartheta = 1$	$0 < \sigma < 1$

TABLE 5. The liability rules

2.2. **Social Optimum.** The total social cost is an aggregate of the costs for both parties. As is common in the literature, we take the social cost to be the sum of the costs of care and the expected damage. Thus, the socially optimal levels of care are those levels of x and y that minimize this sum. Let x^s and y^s denote the care levels that minimize the social cost of accidents:

$$S(x,y) = l(x,y) + x + y \tag{2.1}$$

Assuming that x^s and y^s are positive, these socially optimal care levels are implicitly defined by the following first order conditions (subscripts indicate derivatives):

$$l_x(x^s, y^s) = -1 \tag{2.2}$$

$$l_y(x^s, y^s) = -1 \tag{2.3}$$

Note that the sign of the cross-partial derivative $l_{xy}(x,y)$ indicates whether a party should optimally increase or reduce his care level in response to a change in the care by the other party. Assuming that $l_{xy}(x,y)$ does not change sign as x and y vary, we have three cases:

$l_{xy}(x,y) > 0$: The parties' precautions are substitutes: if a party decreases (increases) his care level, it is socially desirable that the other party increases (decreases) his care level; the marginal benefit of a party's care decreases in care by the other party;

$l_{xy}(x,y) = 0$: The parties' precautions are independent: a decrease (increase) in one party's care level does not change the level of care the other party should take; the marginal benefit of a party's care is constant;

$l_{xy}(x,y) < 0$: The parties' precautions are complements: if a party decreases (increases) his care level, it is socially desirable that the other party also decreases (increases) his care level; the marginal benefit of a party's care increases in the care by the other party.[1]

2.3. **Efficiency Equivalence.** If the regulator sets due care equal to the socially optimal levels ($x^d = x^s$ and $y^d = y^s$), the game has a unique Nash equilibrium, where both the injurer and the victim take due care ($x = x^d$ and $y = y^d$). Landes and Posner (1980, fn. 51) and Haddock and Curran (1985, sec. III) have demonstrated that this result holds under all of the six rules considered, that is, irrespective of the sharing σ and of the parameter ϑ. Rea (1987, prop 2) has shown that this result also holds true for $\sigma = \sigma(x,y)$, that is, a sharing of the loss which is endogenously determined by the levels of care chosen by the parties. It follows that all rules are equivalently efficient. For ease of exposition, in the next section we first examine an exogenously given σ and later extend the analysis to an endogenously determined $\sigma(x,y)$.

3. Analysis

We now consider a situation where the regulator erroneously sets due care too high or too low from a social welfare point of view. Due care can be erroneously set for different reasons. The regulator might inaccurately assess the relevant costs and benefits; the courts might be biased; or the parties might erroneously interpret the legal standard.

3.1. **Equilibrium Deviations from Due Care are Efficient.** If the due level of care is different from the socially optimal level, the parties might take levels of care $\left(x^* \neq x^d, y^* \neq y^d\right)$, which are privately optimal for the parties but different from the due-care levels. The first question that arises is whether such deviations from due care reduce the social cost of accidents or not. The following proposition shows that if the parties deviate in equilibrium from due-care levels, the resulting social cost of accidents is less than it would have been had they abided by the due-care standards.

The intuition behind this result is that negligence rules are such that the party who decides to deviate internalizes all costs and benefits of his decision and hence his decision to deviate must be socially advantageous. This result implies that negligence efficiently emerges in equilibrium (a result that echoes Grady, 1998) and, hence, should be somewhat encouraged, as we will see in the following section.

[1] The optimal levels of care satisfy $l_x(x^s,y^s) = -1$, thus we have $d(l_x(x^s,y^s)) = d(-1) = 0$, which implies $l_{xx}(x^s,y^s)\,dx^s + l_{xy}(x^s,y^s)\,dy^s = 0$ or $\frac{dx^s}{dy^s} = -\frac{l_{xy}(x^s,y^s)}{l_{xx}(x^s,y^s)}$, which proves the results above.

Proposition 1. *If due care is too high or too low, any equilibrium in which one or both parties deviate ($x^* \neq x^d$ and/or $y^* \neq y^d$) yields less social cost than would result if both parties took due care: $S(x^*, y^*) \leq S\left(x^d, y^d\right)$.*

Proof. We consider two possible ways in which parties can deviate from due care: one could take less care than required (which qualifies as a violation of the standard and hence as negligent behavior) or one could take more care than required, which is a deviation from the due-care standard but does not qualify as a negligent violation. These two possibilities give rise to three kinds of equilibria.

1) Both parties are nonnegligent. Assume that $\left(x^* \geq x^d, y^* \geq y^d\right)$ is an equilibrium. Consider first the negligence rules ($\vartheta = 0$). The injurer has no incentives to take more care than the due level, since he does not bear the accident loss; thus, he takes $x^* = x^d$. The victim takes a level of care that minimizes $l\left(x^d, y\right) + y$; thus, if the victim chooses $y^* \geq y^d$ it must be the case that $l\left(x^d, y^*\right) + y^* \leq l\left(x^d, y^d\right) + y^d$. Adding x^d to both sides and substituting $x^* = x^d$ into the left-hand side, we obtain $S(x^*, y^*) \leq S\left(x^d, y^d\right)$. The same reasoning applies to strict liability rules ($\vartheta = 1$).

2) One party is negligent, while the other is nonnegligent. Assume that either $\left(x^* \geq x^d, y^* < y^d\right)$ or $\left(x^* < x^d, y^* \geq y^d\right)$ is an equilibrium. Consider the latter case, when the injurer is negligent: this outcome can only be an equilibrium if the injurer has no incentive to deviate, thus $l(x^*, y^*) + x^* \leq \vartheta l(x^d, y^*) + x^d$. Because $\vartheta \leq 1$, this inequality implies $l(x^*, y^*) + x^* \leq l(x^d, y^*) + x^d$; adding y^* on both sides, we have

$$l(x^*, y^*) + x^* + y^* \leq l(x^d, y^*) + x^d + y^*$$

It is easy to see that the nonnegligent party (the victim) has no incentives to take more than the due level of care, since he does not bear the accident loss; therefore, we can substitute $y^* = y^d$ into the right-hand side and obtain $S(x^*, y^*) \leq S\left(x^d, y^d\right)$. The same applies to the symmetric case in which the victim is negligent.

3) Both parties are negligent. Assume that $\left(x^* < x^d, y^* < y^d\right)$ is an equilibrium; this can only be the case if

$$\sigma l(x^*, y^*) + x^* \leq x^d \tag{3.1}$$

$$(1 - \sigma)\, l(x^*, y^*) + y^* \leq y^d \tag{3.2}$$

summing up, we have $l(x^*, y^*) + x^* + y^* \leq x^d + y^d$, which implies $S(x^*, y^*) < S\left(x^d, y^d\right)$. In all cases we have that if (x^*, y^*) is an equilibrium, then the total social cost is less than it would be if both parties took due care: $S(x^*, y^*) < S\left(x^d, y^d\right)$. □

Corollary 2. *If there are two equilibria, one in which both parties are nonnegligent, $\left(x^{**} \geq x^d, y^{**} \geq y^d\right)$, and one in which both parties are negligent, $\left(x^* < x^d, y^* < y^d\right)$, then the latter yields less social costs of accidents: $S(x^*, y^*) < S(x^{**}, y^{**})$.*

Proof. We have $l(x^*, y^*) + x^* + y^* \leq x^d + y^d \leq x^{**} + y^{**}$, where the first inequality comes from conditions (3.1) and (3.2), while the second inequality follows directly from the hypotheses of the corollary. This implies $S(x^*, y^*) < S(x^{**}, y^{**})$. □

The combination of Proposition 1 and Corollary 2 shows that whenever negligence emerges in equilibrium it is also desirable from a social point of view.

Corollary 3. *If the outcome in which both parties are nonnegligent is an equilibrium* $\left(x^{**} \geq x^d, y^{**} \geq y^d\right)$*, an outcome in which one party is negligent and the other is nonnegligent,* $\left(x^* = x^d, y^* < y^d\right)$ *or* $\left(x^* < x^d, y^* = y^d\right)$*, cannot be an equilibrium. Likewise if the outcome in which both parties are negligent is an equilibrium.*

Proof. Assume that $(x^{**} \geq x^d, y^{**} \geq y^d)$ is an equilibrium and consider first negligence rules ($\vartheta = 0$). The injurer has no incentives to take more care than the due level, since he does not bear the accident loss; thus, he takes $x^{**} = x^d$. The victim takes a level of care that is greater than or equal to due care, $y^{**} \geq y^d$, and it must be the case that $l(x^d, y^{**}) + y^{**} \leq l(x^d, y) + y$ for all $y < y^d$. Thus, $(x^{**} = x^d, y^* < y^d)$ cannot be an equilibrium. Looking at the injurer, it must be the case that $x^d \leq l(x, y^{**}) + x \leq l(x, y^d) + x$, for $x < x^d$; thus $(x^* < x^d, y^* = y^d)$ cannot be an equilibrium. The same applies to strict liability rules ($\vartheta = 1$). A similar argument proves the second part of the corollary. □

3.2. **Comparative Negligence Stimulates Efficient Negligence.** Equilibrium deviations away from due care are always socially efficient. Thus, a rule that stimulates equilibrium deviations reduces the total social cost of accidents. The core of our argument is that comparative negligence is the rule that stimulates efficient deviations most frequently. We will examine several different cases and conclude that comparative negligence is either equivalent or superior to rules that burden one party only, such as simple negligence or contributory negligence.

Proposition 4. *Comparative negligence induces efficient negligence more frequently than alternative rules.*

Proof. The proof is articulated in the following two cases.

Case 1: Compliance is an equilibrium. If there is an equilibrium in which both parties take at least due care, then there cannot be a second equilibrium in which one party violates and the other complies (Corollary 3). This situation occurs for values of the due-care standards that are sufficiently close to the socially optimal levels. The only remaining possibility is a second equilibrium in which both parties are negligent $\left(x^* < x^d, y^* < y^d\right)$. Corollary 2 shows that if such an equilibrium exists then it is also desirable from a social point of view. Since the aggregate costs are lower than in the compliance equilibrium, one can argue that this equilibrium constitutes a focal point.

The levels of care taken by the parties when they are both negligent satisfy

$$
\begin{aligned}
l_x\left(x^*, y^*\right) &= -\frac{1}{\sigma} \\
l_y\left(x^*, y^*\right) &= -\frac{1}{(1-\sigma)}
\end{aligned}
$$

which implies that the chosen levels of care are functions of σ: $x^* = f^x(\sigma)$ and $y^* = f^y(\sigma)$. Moreover, an equilibrium where both parties are negligent emerges if and only if the conditions in (3.1) and (3.2) are simultaneously satisfied. Combining these two conditions, we obtain a range of possible values of σ that support the equilibrium, where the upper boundary is condition (3.1) rearranged and the lower boundary is condition (3.2) similarly rearranged:

$$
1 - \frac{y^d - y^*}{l(x^*, y^*)} \leq \sigma \leq \frac{x^d - x^*}{l(x^*, y^*)} \tag{3.3}
$$

An equilibrium in which both parties are negligent exists if and only if there is at least one value of σ that satisfies (3.3). Thus, the condition in (3.3) is necessary and sufficient for the existence of a noncompliance equilibrium. It follows that an optimal sharing rule is one that implements a sharing σ such that it falls within this range of values. It is easy to see that rules that always implement $\sigma = 0$, such as simple negligence, or $\sigma = 1$, such as contributory negligence, are less likely to fall within the range and hence often forgo the possibility to induce a socially desirable equilibrium. In contrast, comparative negligence can be designed in such a way as to implement an appropriate value of σ within the range. Generally, intermediate values of $\sigma \in (0, 1)$ can be expected to fall within the range more often than $\sigma = 0$ (contributory negligence) or $\sigma = 1$ (simple negligence).

Case 2: Compliance is not an equilibrium. In contrast with the previous section, here we consider the case in which compliance by both parties is not an equilibrium. This situation occurs for values of the due-care standards that are sufficiently greater than the socially optimal levels. We make a distinction between two subcases:

1) Negligence by Both Parties Cannot Be an Equilibrium. First we consider the case in which due care is such that the there is no σ that satisfies (3.3). Hence, there cannot be an equilibrium in which both parties are negligent, irrespective of the liability rule in force. Since the emergence of equilibria in which one party is negligent and the other is nonnegligent does not depend on the sharing between negligent parties, the choice between comparative negligence and other rules does not affect the social loss.

2) Negligence by Both Parties Could Be an Equilibrium. Here we consider the case in which due-care levels are such that there exists a σ that satisfies (3.3), so that negligence by both parties could be an equilibrium. By hypothesis, compliance by both parties is not an equilibrium. There remain two other possible equilibria: one in which the injurer is negligent while the victim is nonnegligent and another in which the injurer is nonnegligent while the victim is negligent. Which one of these three possible equilibria is desirable from society's point of view depends on the levels of x^d and y^d and on the characteristics of the expected harm $l(x, y)$, so that under different configurations a different rule could be desirable.

Consider for instance a situation is which the standard for the injurer is set at the socially optimal level, $x^d = x^s$, while the standard for the victim is too high, $y^d > y^s$. If the harm is such that $l_{xy}(x, y) = 0$ (a parties' socially optimal level of care does not depend on care taken by the other party), simple negligence induces both parties to take the socially optimal level of care. The resulting equilibrium is such that the injurer is nonnegligent while the victim is negligent but takes $y^* = y^s$, as he pays the full accident loss in addition to his cost of care. Comparative negligence might induce an inferior outcome. Consider now a different situation in which both due-care standards are too high and the harm is such that $l_{xy}(x, y) < 0$ (a parties' socially optimal level of care increases with care taken by the other party). In this case, simple and comparative negligence might induce equilibria in which both parties' care levels are greater than the social optimum, while comparative negligence might induce an equilibrium in which care by the parties is less than the socially optimal levels. Which one of these two equilibria is desirable depends on the characteristics of $l(x, y)$. In essence, which equilibrium emerges depends on the value of σ, but which equilibrium yields lower social costs depends on the characteristics of $l\,(x,y)$ and on the due-care standards set by the regulator. No rule is generally preferable over the others, a result in line with the analysis by Bar-Gill and Ben-Shahar (2003).

Summing up, in Case 1 (compliance is an equilibrium) comparative negligence performes better than other rules, while in Case 2 (compliance is not an equilibrium) the different rules cannot be generally compared. □

3.3. **Sharing the Loss According to the Parties' Negligence.** So far, we have considered a sharing rule σ that is exogenously determined and announced ex ante to the parties. Eeven though it is possible to determine the optimal exogenous sharing rule, in practice this is unlikely to happen. The problem with an exogenous σ is that a regulator who makes mistakes in determining the due-care standards cannot be expected to set the sharing of the accident loss in an optimal way, so that parties can efficiently deviate from the due-care standards (although, in general, some intermediate level of σ might still prove more efficient than simple or contributory negligence).

Most commonly, the apportionment of the loss is done ex post in court, on the basis of an (ex ante determined) balance of the parties' respective negligence. Therefore, the sharing is endogenous to the model: $\sigma = \sigma\,(x,y)$, with the natural assumptions that $\sigma_x\,(x,y) < 0$ and $\sigma_y\,(x,y) > 0$ (if a party raises his level of care, his share in the loss decreases). As we have already noted, the determination of the social optimum of section 2.2 and the efficiency equivalence result of section 2.3 also hold true with an endogenous sharing rule. Likewise, the analysis of section 3.1, which shows that deviations from due care are efficient when they arise in equilibrium, does not change with an endogenous sharing rule; thus, proposition 1 and corollaries 2 and 3 remain valid.

The analysis of section 3.2 can be easily adapted to an endogenous sharing rule by modifying the relevant range in (3.3) as follows:

$$1 - \frac{y^d - y^*}{l(x^*, y^*)} \leq \sigma(x^*, y^*) \leq \frac{x^d - x^*}{l(x^*, y^*)} \tag{3.4}$$

Proposition 4 implies that if an equilibrium (x^*, y^*) in which both parties violate the due-care standards exists and the resulting sigma falls in the range in (3.4), then comparative negligence is to be preferred to simple and comparative negligence. In turn, an equilibrium (x^*, y^*) exists if there are values of the parties' care $x^* \in \left[0, x^d\right)$ and $y^* \in \left[0, y^d\right)$, such that

$$\begin{aligned} x^* &= \arg\min\left[\sigma\,(x, y^*)\,l\,(x, y^*) + x\right] \\ y^* &= \arg\min\left[(1 - \sigma\,(x^*, y))\,l\,(x^*, y) + y\right] \end{aligned}$$

In this section, we examine the simplest and most intuitive endogenous comparative negligence rule, which shares the loss according to the parties' respective negligence:

$$\sigma^*\,(x,y) \equiv \frac{x^d - x}{(x^d - x) + (y^d - y)} \tag{3.5}$$

Proposition 5. *The simple sharing rule $\sigma^*\,(x^*, y^*)$ equal to the parties respective negligence is the only sharing rule that falls within the optimal range given in (3.4) whenever noncompliance by both parties is an equilibrium.*

Proof. Assume that $\left(x^* < x^d, y^* < y^d\right)$ is an equilibrium. The range of values for $\sigma\left(x^*, y^*\right)$ in (3.4) is nonnegative if and only if

$$l(x^*, y^*) + x^* + y^* \leq x^d + y^d$$

Rearranging and multiplying both sides by $\left(x^d - x^*\right)$ we obtain

$$l(x^*, y^*)\left(x^d - x^*\right) \leq \left[\left(x^d - x^*\right) + \left(y^d - y^*\right)\right]\left(x^d - x^*\right)$$

or

$$\sigma^*\left(x^*, y^*\right) \equiv \frac{\left(x^d - x^*\right)}{\left(x^d - x^*\right) + \left(y^d - y^*\right)} \leq \frac{x^d - x^*}{l(x^*, y^*)}$$

which satisfies the upper boundary of the range in (3.4). By a similar exercise one can show that also the lower boundary is met. To see that this rule is unique consider the case in which both conditions (3.1) and (3.2) are binding. This implies

$$l(x^*, y^*) = \left(x^d - x^*\right) + \left(y^d - y^*\right)$$

It is easy to see that if a sharing $\acute{\sigma}$ satisfies (3.3), then we must have

$$1 - \frac{y^d - y^*}{l(x^*, y^*)} = \acute{\sigma}\left(x^*, y^*\right) = \frac{x^d - x^*}{l(x^*, y^*)}$$

which implies $\acute{\sigma}\left(x^*, y^*\right) = \sigma^*\left(x^*, y^*\right)$. □

4. Conclusion

In this paper, we have advanced a novel argument to explain why comparative negligence is such a frequently used rule. We have shown that comparative negligence can serve as a buffer against erroneous due-care standards, by more easily inducing violations when these are desirable from a social welfare point of view. In a sense, our analysis provides for an additional instantiation of the notion of efficient negligence developed by Grady (1998) in order to deal with unintended violations of the negligence standard. What distinguishes our analysis from previous literature is that we do not attempt to compare the social welfare resulting from the different rules in general but rather focus on those subset of situations in which comparative negligence makes a difference, because it induces parties who would otherwise be compliant to be (efficiently) negligent.

The core of our argument is that, if due-care standards are too high it is socially desirable that the parties violate such standards. Comparative negligence, with its low-powered incentives, is the rule that most often induces such efficient violations. However, there could be situations in which excessive due-care standards are socially desirable in the face of additional externalities, such as harm to third parties other than the victim. If this is the case, our conclusions should be reversed. Comparative negligence becomes undesirable under these circumstances precisely because it facilitates violations.

References

[1] Artigot i Golobardes, Mireia and Gómez Pomar, Fernando (2009), "Contributory and Compartive Negligence in the Law and Economics Literature," in M. Faure (ed.), *Tort Law and Economics*, in G. De Geest (ed.), *Encyclopedia of Law and Economics*, Cheltenham: Edward Elgar, 46-79.

[2] Bar-Gill, Oren and Omri Ben-Shahar (2003), "The Uneasy Case for Comparative Negligence," 5 *American Law and Economics Review*, 433-69.

[3] Cooter, Robert and Thomas Ulen (1986), "An Economic Case for Comparative Negligence," 61 *New York University Law Review*, 1067-1110.

[4] Curran, Christopher and David Haddock (1995), "An Economic Theory of Comparative Negligence," 14 *Journal of Legal Studies*, 49-72.

[5] Curran, Christopher (1992), "The Spread of the Comparative Negligence Rule in the United States," 12 *International Review of Law and Economics*, 317-32.

[6] Dari-Mattiacci, Giuseppe and Gerrit De Geest (2005), "The Filtering Effect of Sharing Rules," 34 *Journal of Legal Studies*, 207-37.

[7] Dari-Mattiacci, Giuseppe and Gerrit De Geest (2010), "Carrots, Sticks, and the Multiplication Effect," 26 *Journal of Law, Economics, and Organization*, forthcoming.

[8] Grady, Mark F. (1998), "Efficient Negligence," 87 *Georgetown Law Journal*, 397-420.

[9] Landes, William and Richard Posner (1980), "Joint and Multiple Tortfeasors: An Economic Analysis," 9 *Journal of Legal Studies*, 517-55.

[10] Rea, Samuel (1987), "The Economics of Comparative Negligence," 7 *International Review of Law and Economics,* 149-162.

[11] Rubinfield, Daniel (1987), "The Efficiency of Comparative Negligence," 2 *The Journal of Legal Studies*, 357-394.