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Forgiving Overconfidence in Tort Law

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## Forgiving Overconfidence in Tort Law

**Abstract:** Overconfidence is an overestimation of one's own ability that is often associated with an underestimation of risks and inflated estimation of one's future success. Debiasing overconfidence through tort law is not an easy task. If people tend to believe that risks are less likely to materialize for themselves than for others, they inadequately react to legal threats and incentives. For example, overconfidence may lead to the assumption of excessive risks, undermining the deterrent effect of liability rules, even if parties are provided accurate information about statistical facts. In this paper, we build an economic model to consider the role of tort rules in debiasing overconfidence. We show a surprising and counterintuitive implication: the most effective way to correct overconfidence in tort law may be to forgive it, rather than penalize it through liability.

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*“Human beings tend to be optimistic. By itself this seems to be good news; but it can lead them to make big mistakes.”*

Cass Sunstein

Psychological research shows that there is systematic overconfidence in risk judgments. Overconfidence creates a distinctive problem for legal policymakers: even factually informed people tend to think that risks are less risky to materialize for themselves than for others (Sunstein, 2000).<sup>1</sup> Behavioral law and economics scholars have addressed the issue of overconfidence, considering the possible role of law in

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<sup>1</sup> Sunstein (2000) considers overconfidence and the role of law in debiasing this judgment error, considering the special challenges posed by the fact that the vast majority of people believe that they are less likely than other people to be subject to automobile accidents, infection from AIDS, heart attacks, asthma, and many other health risks, even though they do not lack statistical information about these risks in general.

restraining or correcting this judgment error.<sup>2</sup> If people tend to believe that risks are less likely to materialize for themselves than for others, they inadequately react to legal threats and incentives such as liability rules, even if they are provided accurate information about statistical facts. Previous scholars have considered the relevance of overconfidence and optimistic bias in a number of areas of law, showing some surprising implications. In this paper, we consider the role of tort rules in debiasing overconfidence, unveiling another surprising and counterintuitive implication. The most effective way to correct overconfidence in tort law could well be to forgive it, rather than to penalize it through liability.

This paper is structured as follows. In Section 1, we provide a brief introduction to the issue of overconfidence with reference to the psychological and behavioral literature and review the previous work in law and economics considering the role of law in debiasing overconfidence. In Section 2, we consider alternative legal strategies to correct overconfidence problems in tort law. We contrast the use of threat strategies (threatening liability when overconfidence leads to an accident) and forgiveness strategies (forego liability when the accident is solely caused by a biased perception of risk). In Section 3, we build a simple model of bilateral care to describe the effects of a bias in the perception of the probability of harm and consider the effect of overconfidence on parties' incentives. In Section 4, we compare the alternative threat and forgiveness strategies in reducing the cost of accidents due to overconfidence, considering that government investment in information usually fails to guarantee full debiasing of agents. Under each liability rule we characterize the care and activity levels chosen by injurer and victim in the presence of overconfidence and we rank each combination of rule/strategy according to the efficiency level that it will induce. The model highlights the role of tort law and the optimal design of liability rules for

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<sup>2</sup> A growing body of law and economics literature focuses on the departures of human behavior from full rationality and attempt to explain the positive and normative implications of bounded rationality in the formulation of legal policy. Sunstein (1997) and Jolls, Sunstein, and Thaler (1998) points out the need of a more accurate understanding of behavior and individual choice in legal context, in order to take into account the shortcomings in human behavior when structuring the law. Jolls and Sunstein (2006) discuss the idea of “debiasing through law”, instead of “debiasing law”, i.e. to insulate legal outcomes from the effects of boundedly rational behavior. Debiasing through law is instead aimed at developing legal strategies attempting to reduce or eliminate boundedly rational behavior. Jolls and Sunstein provide a general description of debiasing through law with application to many areas, as consumer safety law, corporate law and property law.

correcting overconfidence biases. We identify the effectiveness of alternative legal strategies under alternative liability rules, unveiling an interesting paradox: legal forgiveness of overconfidence may be a valuable second-best solution, when debiasing through information and threat strategies proves ineffective. The most effective way to correct overconfidence in tort law may well be to forgive it, rather than to penalize it through liability.

## 1. Overconfidence and Unrealistic Optimism

Overconfidence is an overestimation of one's own ability that is often associated with an underestimation of risks and inflated estimation of one's future success. Overconfidence is one of the two biases that result from what psychologists know as optimism bias.<sup>3</sup> Optimism bias is known to psychologists as one of the most widespread psychologically-generated biases in human judgment that affects people's subjective estimates of the likelihood of future events, and causes them to overestimate the likelihood of positive or desirable events and to underestimate the likelihood of negative or undesirable events (Colman, 2001). Optimism bias was reported by psychologists starting from the early twentieth-century (Lund, 1925; and Cantril 1938) and rigorously studied and documented by the US psychologist Neil David Weinstein, who gave it the name of "unrealistic optimism" in a 1980 article published in the *Journal of Personality and Social Psychology*.<sup>4</sup>

Several subsequent psychological studies confirm the stylized fact that people exhibit an unrealistic optimism bias (see the survey of the literature in Wenglert and Rosén, 2000).<sup>5</sup> An interesting example of overconfidence for the purpose of this

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<sup>3</sup> There are two forms of judgment bias that follow from unrealistic optimism: overconfidence bias which implies an overestimation of one's own ability, and self-serving bias which is a tendency to evaluate evidence or make judgments in a way that benefits oneself (Muren, 2004).

<sup>4</sup> Weinstein (1980) asked students to estimate the likelihoods of various events happening to them and showed that they rated their chances of experiencing positive (negative) events significantly above (below) the average for their peers.

<sup>5</sup> Economic experiments confirm the existence of optimism and related overconfidence bias. Forsythe, Rietz and Ross (1999) find experimental evidence of the human tendency to overestimate the probability of desirable events. Babcock, Loewenstein, Issacharoff & Camerer (1995) found evidence of a self-serving bias in an experiment where subjects were given roles as plaintiffs and defendants in a

paper is the finding by Svenson (1981) where most survey respondents see themselves as better and more competent drivers than average. Overconfidence appears to be robust with respect to a variety of accident risks (see, among others, Sunstein, 1997 and Jolls, 1998).<sup>6</sup> Studies on traffic accidents show that people's assessment of accident risks faced by others is fairly accurate (Lichtenstein et al. 1978) and at the same time people tend to be unrealistically optimistic about themselves, i.e. they systematically underestimate the likelihood that they will cause an accident (see Svenson 1981; Svenson, Frischhoff, and MacGregor 1985; Finn and Bragg 1986; Matthews and Moran 1986; DeJoy 1989; McKenna, Stanier and Lewis 1991; Guppy 1992).<sup>7</sup>

The optimism bias has been studied in the law and economics literature. Posner (2003) develops a positive economic model to study the effect of optimism for rare events in the case of unilateral accident, i.e. for low probability accidents. Agents know the probability of an accident when it is above some threshold but set accident probabilities to zero if it is below the threshold. Posner shows that under both strict liability and negligence, agents take inefficient level of care (either too much or too little) for sufficiently high levels of optimism and take optimal care for sufficiently low levels of optimism. Posner additionally shows that the difference on the effect on activity levels between strict liability and negligence rule tends to disappear in case of optimism, due to the fact that the optimistic agent treats the rare events as a zero-probability event.

A number of papers studies tort law models in non-expected utility framework. Specifically, Eide (2007) analyzes the basic tort law model under rank-dependent

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legal dispute over a claim for damages. Kaplan and Ruffle (2001) argue that strategic behavior may affect the measure of these biases.

<sup>6</sup> Empirical evidence suggests that optimism bias affects not only the perception of risky events, but it affects other choices, such as litigation choices. It has been shown that lawyers and litigants are systematically optimistic with respect to the outcome at trial. Bar-Gill (2006) studies the persistence of optimism bias in litigation using a setting of evolutionary game theory. The adaptive force of optimism is linked to its instrumental value in the pre-trial bargaining: optimistic lawyers can credibly threaten to resort to costly litigation, and are therefore more successful in extracting bargaining surplus from settlements.

<sup>7</sup> Interestingly, a pessimism bias is instead exhibited with respect to the risk of accidents that are either salient, catastrophic or technological in nature (see Sunstein 1997; Jolls 1998; Jolls, Sunstein, and Thaler 1998; see also Slovic, Frischhoff, and Lichtenstein 1982; Viscusi and Magat 1987; Viscusi 1992).

expected utility theory developed by Quiggin (1982 and 1993). Bigus (2006) analyzes the basic tort law model using Kahneman and Tversky's (1979) prospect theory. Teitelbaum (2007) develops a tort model based on Choquet's (1954) expected utility. In all these models inefficient levels of cares may be undertaken depending on the slope of the probability function under both strict liability and negligence. Teitelbaum finds that the injurer's level of care decreases (increases) with ambiguity if he is optimistic (pessimistic) and decreases (increases) with his degree of optimism (pessimism). The results suggest that negligence is more robust to ambiguity and, therefore, may be superior to strict liability in unilateral accident cases.<sup>8</sup>

In the following, we develop a model to highlight the role of overconfidence bias in tort law and use these results to formulate some normative corollaries for the optimal design of liability rules. We build a simple model of bilateral care as in Shavell (1987)<sup>9</sup> to describe the effects of a bias in the perception of the probability of harm, identifying the effectiveness of alternative legal strategies under alternative liability rules. In this section we consider the role of "threat strategies" (imposing liability when accidents are due to a biased perception of risk) and "forgiveness strategies" (foregoing liability when accidents are due to a biased perceptions of risk) in order to reduce the cost of accidents due to overconfidence. These two strategies are considered in combination with "information strategies," according to which the government aims at debiasing (at least partially) the parties' perceptions of risk by providing a better knowledge of the statistical probability of harm. We unveil an interesting paradox: legal forgiveness of overconfidence may be a valuable second-best solution, when debiasing through information and threat strategies proves ineffective.

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<sup>8</sup> From a different non-behavioral perspective other law and economics scholars have dealt with the issue of court errors and the effect of misperception and errors on expected liability and due care. Among others, Dari-Mattiacci (2005) shows that errors may distort care incentives in different ways, depending on whether they occur under rules (when a regulator defines due care and courts set the amount of damages) or standards (when courts set both damages and due care on a case-by-case basis). The two regimes differ in their capacity to insulate the effects of errors. Under rules, errors in determining damages and in setting due care occur independently of each other, while, under standards, an error in damages may trigger a corresponding error in due care.

<sup>9</sup> The model is based on Shavell (1987), with one main difference: the expected loss is written as the product of a given loss  $L$  and the probability of an accident, as in Brown (1973).

## 2. Alternative Legal Strategies to Correct Overconfidence

According to empirical and experimental evidence, the knowledge about statistical incidence of overconfidence only has a limited effect on the belief about one's own overconfidence bias. Hence, we evaluate threat and forgiveness strategies considering that government investment in information usually fails to guarantee full debiasing of agents. We consider the effect of alternative liability rules under both threat and forgiveness regimes in correcting the inefficiency in care and activity levels caused by overconfidence biases. Under each liability rule we characterize the care and activity levels chosen by injurer and victim in the presence of overconfidence and we rank each combination of rule/strategy according to the efficiency level that it will induce. We assume that parties (tortfeasor and victim) are risk neutral, rational and utility maximizing.

The tortfeasor carries out an activity, with a value equal to  $V_T(w)$ , where  $w$  denotes the injurer's activity level. We assume that the value of the activity increases with the activity level in the relevant range,  $V_w > 0$ , at a decreasing rate,  $V_{ww} < 0$ . Likewise, the victim carries out an activity, with a value equal to  $V_V(z)$ , where  $z$  denotes the victim's activity level. Assume that  $V_V(z)$  has similar properties to the injurer's benefit function: the value of the victim's activity increases with the activity level in the relevant range,  $V_z > 0$ , at a decreasing rate,  $V_{zz} < 0$ .

The activity of the tortfeasor may cause harm. The tortfeasor can invest in precautions to reduce the probability of such harm. Denote with  $x$  the tortfeasor's level of precaution per unit of activity  $w$ , where  $x \in [0, \infty)$ . Likewise, the victim bears the harm but is able to reduce the probability of its occurrence with her own precautions. Denote with  $y$  the victim's level of precaution per unit of activity  $z$ , where  $y \in [0, \infty)$ . With a level of tortfeasor's precaution  $x$  and a level of victim's precaution  $y$ , damage occurs with probability  $p(x, y)$ , where  $p(x, y) \in (0, 1)$ . We assume bilateral precautions, such that the probability of the environmental damage is effectively controlled by the tortfeasor's and victim's level of precautions. Increasing

care is costly to the injurer and leads to decreasing benefits, hence assume that the tortfeasor's precautions decrease the probability of an environmental damage,  $p_x < 0$ , at a decreasing rate,  $p_{xx} > 0$ , for all  $w$ <sup>10</sup>. Similarly, the victim can decrease harm likelihood through precaution,  $p_y < 0$ , at a decreasing rate,  $p_{yy} > 0$ , for all  $z$ . Hence, increasing care is always costly to the victim, and in the relevant range an increase in activity level increases the victim's benefit. In case damage occurs, it creates an (exogenous) loss denoted by  $L$ ,<sup>11</sup> where  $L > 0$ . Let  $p(x, y)L$  be the expected damages per unit of activity where levels of care reduce expected accident costs at a diminishing rate, and the levels of care taken by the two parties are substitutes, i.e.  $p_{xy} < 0$ . Total expected damages are assumed to be  $wzp(x, y)L$ <sup>12</sup>.

The lawmaker cannot intervene directly by taking precautions on its own in order to reduce the accident risk. However it can affect the tortfeasor's and victim's level of precautions and activity by recurring to alternative strategies. We consider alternative strategies to address overconfidence in tort law: Information Strategies, Threat Strategies and Forgiveness Strategies. Most systems undertake *information strategies*, according to which the policymaker provides statistical information about riskiness of activities, likelihood of cognitive lapses (e.g., falling asleep while driving, etc.) in order to contrast the overconfidence bias. However, debiasing through information is costly and partially ineffective: knowledge of the statistical incidence of overconfidence only minimally affects the belief about one's own overconfidence bias. Hence governmental investments in information give only small returns in accident reduction. Most legal systems utilize information strategy in combination with a *threat strategy*, according to which a prospective tortfeasor faces a threat of liability if an accident occurs under such circumstances due to an optimism bias.

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<sup>10</sup> The signs of the second order derivatives in the model follow the literature (see, e.g. Shavell, 1987; Landes and Posner, 1987; and Miceli 1997). In general, it is assumed that the second order sufficient conditions hold for our problems.

<sup>11</sup> As it is standard in the literature, we are assuming that the injurer can only affect the probability of the harm, but not its magnitude. This assumption simplifies the model without loss of generality. As shown by Dari Mattiacci and De Geest (2005), the impact of insolvency on the incentives to take precaution is not qualitatively changed when the magnitude of the harm is endogenous.

<sup>12</sup> Since increasing care  $x$  decreases  $p(x, y)$ ,  $|wzp_x(x, y)L|$  can be interpreted as the (social) marginal benefit of an increased level of care  $x$ .



Threat strategies construe overconfidence errors as negligence (i.e. if the tortfeasor falls short of adopting the level of care of a fully rational/unbiased agent, liability is imposed).

Our results suggest that legal forgiveness of overconfidence may be a valuable second-best solution, when debiasing through tort law cannot be effectively achieved. We consider the possible combined use of tort law remedies and *forgiveness strategies* in correcting judgment error. Forgiveness strategies do not construe overconfidence as per se negligence. When overconfidence is legally forgiven, a prospective tortfeasor does not face liability if he adopts reasonable care, in response to his subjective assessment of the probability of an accident – even if the subjective assessment of the risk was distorted by an optimism bias. Liability arises when the level of care falls short of the level of care that would be reasonable, given the tortfeasor’s subjective assessment of the risk.

In the following, we compare the effect of a threat and forgiveness strategies when used in combination with information strategy, showing the comparative advantage of each strategy in correcting the distortions caused by the overconfidence bias under different liability regimes. We illustrate the main results on the comparison between threat strategies versus forgiveness strategies in terms of information incentives, deterrence and moral hazard, and activity levels. The following propositions and corollaries outline the main results. Proofs of these propositions will be carried out for each liability regimes in Section 4.

### 2.1 *Information Incentives*

**Proposition 1A:** *Forgiveness Strategies [Threat Strategies] do not induce [induce] the parties to take into consideration the liability impact of their own overconfidence errors.*

**Proposition 1B:** *Forgiveness Strategies [Threat Strategies] induce [do not induce] the parties to take into consideration the other party’s overconfidence errors.*

In the case of debiasing, liability of overconfidence would be totally ineffective. Conversely forgiveness will induce parties to compensate for the overconfidence of the other party. In the intermediate case where parties are only partially debiased through information ( $\alpha > 0$ ) the choice between forgiveness and liability of overconfidence will depend on two countervailing effects. The first effect is given by the threat of liability of overconfidence, which will be only partially internalized by the parties. Internalization will increase with  $\alpha$ . The second effect is given by the compensation of other party's bias. The incentive to compensate for the other party's overconfidence will be undermined by the rule of liability for overconfidence.

## 2.2 *Deterrence and Moral Hazard*

**Proposition 2A:** *With Forgiveness Strategies [Threat Strategies], parties will not [will] be deterred by their own liability, and will not [will] adjust behavior accordingly.*

**Proposition 2B:** *With Forgiveness Strategies [Threat Strategies], parties will [will not] be induced to compensate the other party's overconfidence with their own care.*

**Corollary 1:** *With Forgiveness Strategies [Threat Strategies], parties will not [will] rely on the other party's liability, and will not [will] engage in moral hazard.*

When both tortfeasor and victim are similarly affected by an overconfidence bias (symmetric overconfidence), legal forgiveness of overconfidence will induce both parties to undertake precaution levels that approach the socially optimal level. Undershooting and overshooting are possible when asymmetries are introduced between the levels of overconfidence of tortfeasors and victims.

## 2.3 *Overconfidence and Activity Levels*

**Proposition 3:** *Legal forgiveness corrects the inefficient level of activity chosen by the "residually liable agent", restoring the second best efficient activity level.*

**Corollary 2:** *In cases of unilateral overconfidence, activity level is not corrected when the overconfident party is held residually liable.*

In Section 4, we shall prove these propositions and corollaries and build on these results to identify the optimal combination of liability rules and threat vs. forgiveness strategies to correct the incentive problems caused by overconfidence. We verify these results with respect to a number of alternative liability regimes.

### 3. Overconfidence: An Analytical Outlook

Overconfidence is a distortion of perception, resulting in an inflated estimation of one's future success. According to stylized fact, overconfidence is one of the most widespread psychologically-generated biases in human judgment. Behavioral law and economics scholars have given attention to the issue of overconfidence.

Let us indicate with  $p(x, y)$  the unbiased probability function of an accident to occur. Overconfidence induces an optimistic bias in the perception of the accident probability and is modeled as:

$$\underline{p}(x, y) < p(x, y)$$

For any level of care of tortfeasor and victim, the agent considers less likely an accident to occur with respect to the unbiased estimate of accident probability.

Additionally, the biased probability function obeys to the following relationship:

$$|\underline{p}_x(x, y)| < |p_x(x, y)|$$

This means that any additional level of care will cause a reduction in the probability of an accident loss lower for the overconfident than for the rational agent (either the tortfeasor or the victim).

#### 3.1 *The Role of Information in the Perception of Probability*

The government may invest in information, in order to correct (at least) partially the overconfidence bias affecting the tortfeasor and the victim. Information strategy consists in debiasing through information the probabilistic perception of the agent. In case the government delivers information to the public, each party corrects his own

estimation of the likelihood of the accident by a fraction  $\alpha$ , i.e. the probability estimation after information strategy becomes a weighted average of unbiased probability and overconfident assessment:

$$p^I = \alpha p + (1 - \alpha)\underline{p}$$

In case debiasing through information is perfect,  $\alpha = 1$  and the agent makes his optimal choices of care and activity based on unbiased estimate of probability. In case government makes no investment in information or information strategy are totally ineffective,  $\alpha = 0$  and the agent makes his optimal choices of care and activity on full biased estimate of probability. In case  $0 < \alpha < 1$ , debiasing through information is only partial and the agent makes his optimal choices of care and activity based on partially biased estimate of probability.

### 3.2 *Equilibrium Configuration under Overconfidence*

In presence of overconfidence inefficiency arises under all liability rules. Overconfidence distorts tortfeasor's and victim's optimal choices, by inducing a level of precaution lower than the socially optimal one, and a level of activity higher than the socially optimal one. The social welfare function is given by the sum of the value of activity of tortfeasor and victim net of the expected cost of harm and of precaution exerted by both parties:

$$S = V_T(w) + V_V(z) - wzp(x, y)L - wx - zy$$

where  $V_T(w)$  is the value of tortfeasor's activity,  $V_V(z)$  is the value of the victim,  $w$  is the tortfeasor's activity level and  $z$  is the victim's activity level. Denote  $L$  as the exogenous<sup>13</sup> gravity of the injury,  $x$  level of precaution exerted per unit of activity by the tortfeasor and  $y$  the level of precaution exerted per unit of activity by the victim.

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<sup>13</sup> Although tortfeasors and victims can in fact frequently reduce both the magnitude and the probability of the damage that they produce, as is standard in the literature, we are assuming that the tortfeasor and the victim can only affect the probability of the harm, but not its magnitude. This assumption simplifies the model without loss of generality. As shown by Dari-Mattiacci and De Geest (2005), the impact of insolvency on the incentives to take precaution is not qualitatively changed when the magnitude of the harm is endogenous.

In order to identify the socially optimal values of  $x$  and  $y$ , we can derive the first order conditions

$$-zp_x(x^*, y)L = 1 \quad (1)$$

$$-wp_y(x, y^*)L = 1 \quad (2)$$

Where the left-hand-side of (1) and (2) represent the marginal benefit of care (in terms of reduced probability of an accident loss) and where the right-hand-side represents the marginal cost of care, respectively for the tortfeasor and for the victim.

The optimal level of  $w$  and  $z$  satisfies the following first order conditions:

$$V_w = zp(x, y)L$$

$$V_z = wp(x, y)L$$

Idea: we introduce a bias in the perception of the probability  $p(x, y)$ .

Let  $x^{**}$  and  $w^{**}$  be the social optimum level of precaution and activity of the tortfeasor, and  $y^{**}$  and  $z^{**}$  be the social optimum level of precaution and activity of the victim.

#### **4. Threat vs. Forgiveness under Alternative Liability Regimes**

In this section, we compare the equilibrium levels of care and activity under the alternative threat and forgiveness strategies under a number of liability rules. Specifically, we will consider the comparative advantage of threat and forgiveness strategies in conjunction with (a) simple negligence; (b) negligence with contributory negligence; (c) negligence with comparative negligence; (d) strict liability; (e) strict liability with contributory negligence; (f) strict liability with comparative negligence. As it will be shown in Table 1 at the end of this section, forgiveness and threat strategies correct the inefficiency induced by overconfidence in quite different ways.

##### *4.1 Strict Liability*

Under strict liability, the tortfeasor must pay for all accident losses caused by his activity, independently of the level of care exercised. The objective function of the tortfeasor is:

$$\max_{(w,x)} F_T = V_T(w) - wzp^l(x,y)L - x$$

And of the victim is:

$$\max_{(z,y)} F_V = V_V(z) - y$$

We need to distinguish between threat strategy and forgiveness strategy. We denote with  $x^*$  the private optimum in case of no bias in the perception of the agents and  $\underline{x}^*$  the private optimum in case of overconfidence bias.

Under threat strategy, the equilibrium of the victim does not change: as in standard analysis, the victim will exert no care since he will be compensated in case of a loss:  $y^* = \underline{y}^* = 0$ . The same is true for the level of activity chosen by the victim, that will be higher than socially optimal, and chosen according to first order condition:  $V_z = 0$ , i.e.  $z^* = \underline{z}^* > z^{**}$ .

The tortfeasor has an objective function identical to social optimum. However, the overconfidence bias induces an inefficiency in the choice of care and activity. In presence of overconfidence, the tortfeasor will choose care and activity level according to the following first order conditions:

$$-zp_x^l(\underline{x}^*, 0)L = 1$$

$$V_w = zp^l(\underline{x}^*, 0)L$$

The tortfeasor will exert a lower care:  $\underline{x}^* < x^*$ . Symmetrically, the level of activity chosen by the tortfeasor is higher than socially optimal, i.e.  $\underline{w}^* > w^*$ .<sup>14</sup>.

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<sup>14</sup> In absence of overconfidence bias the private optimum level of care and activity  $x^*$  and  $w^*$  of the tortfeasor are socially optimal responses to the choice of the victim. Note, however, that  $x^*$  and  $w^*$  will not coincide with the social optimum level  $x^{**}$  and  $w^{**}$  due to excessive level of activity and zero care of the victim.

Under forgiveness strategy, the equilibrium choices of both the tortfeasor and the victim will not change. The reason is rather intuitive: the strategy of forgiving the fact that the tortfeasor exercises a level of care lower than the socially optimal plays no role under a strict liability rule since the tortfeasor will be held liable irrespective of the care level chosen by the tortfeasor.

#### 4.2 Simple Negligence

Under negligence rule the tortfeasor will be held liable for injury losses only if he was negligent, i.e. he exerted a level of care less than the level specified by courts, namely due care. If the tortfeasor exercised a level of care equal or higher than due care, he will not be considered liable of the accident losses caused by his activity. Analytically, the tortfeasor will compensate the victim only if the level of precaution exercised is lower than the socially optimal one,  $x^{**}$ .

The objective function of the tortfeasor is:

$$\max_{(w,x)} F^T = \begin{cases} V_T(w) - wzp(x,y)L - x & \text{if } x < x^{**} \\ V_T(w) - x & \text{if } x \geq x^{**} \end{cases}$$

and for the victim is:

$$\max_{(z,y)} F^V = \begin{cases} V_V(z) - y & \text{if } x < x^{**} \\ V_V(z) - wzp(x,y)L - y & \text{if } x \geq x^{**} \end{cases}$$

under the standard assumption of a level of due care chosen according to first order condition in (1).

Under threat strategy, the equilibrium in presence of a bias is a mirror image of strict liability case. Under the rule of simple negligence the tortfeasor will wish to take due care to avoid liability, i.e. the care level is chosen according to the following first order conditions:

$$-zp_x^I(\underline{x}^*, y)L = 1 \quad (3)$$

However, in presence of overconfidence, equation (3) yields a lower level of care with respect to socially optimal one, as established before, i.e.:

$$\underline{x}^* < x^{**}$$

As standard in the literature, the level of activity chosen by the tortfeasor will exceed the social optimum, and will be chosen according to first order condition:  $V_w = 0$ , i.e.  $\underline{w}^* > w^{**}$ . Because the tortfeasor has taken a due care level in his perception, the marginal cost of increasing the activity is only represented by the due care level and does not include the increase of expected accident losses.

The equilibrium of the victim changes drastically with respect to standard analysis: the victim realizes that the tortfeasor will be held liable by a court applying a threat strategy, while the tortfeasor fails to realize it. The victim will therefore exert no care since he will be compensated in case of a loss:  $y^* = \underline{y}^* = 0$ . In an analogous way, the level of activity chosen by the victim will be higher than socially optimal, and chosen according to first order condition:  $V_z = 0$ , i.e.  $z^* = \underline{z}^* > z^{**}$ .

Threat strategy to punish overconfidence do not correct two forms of inefficiency arising here: a lower level of care for both tortfeasor and victim and excessive activity level for both of them.

Under forgiveness strategy, the tortfeasor will not be held liable if he exercises a level of care according to (3), i.e. the social best response to the victim given the biased perception of the likelihood of the accident. The choice of care and activity of the tortfeasor will not change under forgiveness, while the equilibrium for the victim restores to the simple negligence case, i.e. the victim will choose care and activity level according to the following first order conditions:

$$-zp_y^I(x, \underline{y}^*)L = 1$$

$$V_z = wp^I(x, \underline{y}^*)L$$

Due to the presence of overconfidence, the care and activity level chosen by the victim will be respectively higher and lower with respect to the social efficient equilibrium of the victim, i.e.  $\underline{y}^* > y^{**}$  and  $\underline{z}^* < z^{**}$ , since now the victim compensate the lower level of care chosen by the tortfeasor due to the bias.



Forgiveness strategy restores efficiency in the choice of care and activity level for the victim (in the sense that the choice is the second best efficient given the choice of the tortfeasor), but does not correct fully the inefficiency in the levels of care (lower than the optimal ones due to bias for the tortfeasor) and the standard inefficiency in activity level of the tortfeasor (due to the functioning of the rule but not due to overconfidence).

#### 4.3 Negligence Rule with a Defense of Contributory Negligence

Under the negligence rule with the defense of contributory negligence, a tortfeasor is held liable for accident losses caused by his activity only if two conditions are met: the tortfeasor is negligent and exercises a level of care less than due care  $x < x^{**}$  and the victim is diligent, i.e.  $y \geq y^{**}$ .

The objective function for the tortfeasor is:

$$\max_{(w,x)} F^T = \begin{cases} V_T(w) - wzp(x,y)L - x & \text{if } x < x^{**} \text{ and } y \geq y^{**} \\ V_T(w) - x & \text{if } x < x^{**} \text{ and } y < y^{**} \text{ or if } x \geq x^{**} \end{cases}$$

and for the victim is:

$$\max_{(z,y)} F^V = \begin{cases} V_V(z) - y & \text{if } x < x^{**} \text{ and } y \geq y^{**} \\ V_V(z) - wzp(x,y)L - y & \text{if } x < x^{**} \text{ and } y < y^{**} \text{ or if } x \geq x^{**} \end{cases}$$

Under the rule of simple negligence with the defense of contributory negligence, the victim receives compensation only if he exercises due care to avoid liability, i.e. the care level is chosen according to the following first order conditions:

$$-wp_y^l(x, \underline{y}^*)L = 1 \quad (4)$$

However, in presence of overconfidence, equation (4) yields a lower level of care with respect to socially optimal one, as established before, i.e.:

$$\underline{y}^* < y^{**}$$

At the same time, the level of activity chosen by the victim will exceed the social optimum, and will be chosen according to first order condition:  $V_z = 0$ , i.e.  $\underline{z}^* > z^{**}$ .

Because the victim has taken a due care level in his perception, the marginal cost of increasing the activity is only represented by the due care level and does not include the increase of expected accident losses.

At the same time, the tortfeasor realizes that the victim will be held liable by a court applying a threat strategy, while the victim fails to realize it. The tortfeasor – knowing he will not pay compensation to the victim - will exert no care:  $\underline{x}^* = 0$ . In an analogous way, the level of activity chosen by the tortfeasor will be higher than socially optimal, and chosen according to first order condition:  $V_w = 0$ , i.e.  $\underline{w}^* > w^{**}$ .

Threat strategy to punish overconfidence do not correct two forms of inefficiency arising here: a lower level of care for both tortfeasor and victim and excessive activity level for both of them.

Under forgiveness strategy, the victim will not be held liable if he exercises a level of care according to (4), i.e. the second best response to the tortfeasor under the biased perception of the likelihood of the accident. The choice of care and activity of the victim will not change under forgiveness, while the equilibrium for the tortfeasor restores to the one under negligence rule with the defense of contributory negligence, i.e. the tortfeasor will choose care and activity level according to the following first order conditions:

$$-zp'_x(\underline{x}^*, y)L = 1$$

$$V_w = zp'_w(\underline{x}^*, y)L$$

Due to the presence of overconfidence, the care and activity level chosen by the tortfeasor will be respectively higher and lower with respect to the second best efficient equilibrium of the victim in absence of the bias, i.e.  $\underline{x}^* > x^*$  and  $\underline{w}^* < w^*$  since now he needs to compensate the lower level of care of the victim. Forgiveness strategy restores efficiency in the choice of care and activity level for the tortfeasor (in the sense that the choice is the second best efficient given the choice of the victim), but does not correct fully the inefficiency in the levels of care (lower than the optimal

ones due to overconfidence bias) and the standard inefficiency in activity level of the victim (due to the functioning of the rule but not due to overconfidence).

#### 4.4 Negligence Rule with a Defense of Comparative Negligence

Under negligence rule with the defense of comparative negligence, the victim receives a share  $\alpha$  of compensation if the tortfeasor is negligent and the victim is diligent, i.e.  $x < x^{**}$  and  $y \geq y^{**}$ .

The objective function for the tortfeasor is:

$$\max_{(w,x)} F^T = \begin{cases} V_T(w) - wzp(x,y)L - x & \text{if } x < x^{**} \text{ and } y \geq y^{**} \\ V_T(w) - \alpha wzp(x,y)L - x & \text{if } x < x^{**} \text{ and } y < y^{**} \\ V_T(w) - x & \text{if } x \geq x^{**} \end{cases}$$

and for the victim is:

$$\max_{(z,y)} F^V = \begin{cases} V_V(z) - y & \text{if } x < x^{**} \text{ and } y \geq y^{**} \\ V_V(z) - (1 - \alpha)wzp(x,y)L - y & \text{if } x < x^{**} \text{ and } y < y^{**} \\ V_V(z) - wzp(x,y)L - y & \text{if } x \geq x^{**} \end{cases}$$

Under the rule of simple negligence with the defense of comparative negligence, in case of threat strategy, both the victim and the tortfeasor will wish to exercise due care to avoid liability, i.e. the care level is chosen according respectively to first order condition (3) and (4), yielding a lower level of care than social optimum for both of them, i.e.  $\underline{x}^* < x^{**}$  and  $\underline{y}^* < y^{**}$ . Since residual liability is on the victim and the tortfeasor does not realize his bias, the level of activity chosen by the tortfeasor will exceed the social optimum, and will be chosen according to first order condition:  $V_w = 0$ , i.e.  $\underline{w}^* > w^{**}$ . Symmetrically, the victim anticipates the mistake of the tortfeasor and under the anticipation he will be compensated the victim chooses a higher level of activity according to first order condition:  $V_z = 0$ , i.e.  $\underline{z}^* > z^{**}$ .

Under bias, forgiveness does not change the optimal behavior of tortfeasor (since he will not be held liable under the forgiveness strategy), i.e.  $\underline{x}^* < x^{**}$  and  $\underline{w}^* > w^{**}$ , while the victim corrects the choice of the activity level, as a second best efficient level in response of the tortfeasor's choice and overcompensate the lower level of care

of the tortfeasor by increasing his care level above the second best efficient level in absence of the bias, i.e.  $\underline{y}^* < y^*$ .

#### 4.5 *Strict Liability with a Defense of Contributory Negligence*

Under strict liability with the defense of contributory negligence, the victim receives compensation in all cases except if the victim is negligent, i.e.  $y < y^{**}$ .

The objective function for the tortfeasor is:

$$\max_{(w,x)} F^T = \begin{cases} V_T(w) - wzp(x,y)L - x & \text{if } y \geq y^{**} \\ V_T(w) - x & \text{if } y < y^{**} \end{cases}$$

and for the victim is:

$$\max_{(z,y)} F^V = \begin{cases} V_V(z) - y & \text{if } y \geq y^{**} \\ V_V(z) - wzp(x,y)L - y & \text{if } y < y^{**} \end{cases}$$

Under the rule of strict liability with the defense of contributory negligence, in case of threat strategy, the victim will wish to exercise due care to avoid liability, i.e. the care level is chosen according respectively to first order condition (4). Due to the overconfidence bias, however, the victim chooses a level of care lower than social optimum, i.e.  $\underline{y}^* < y^{**}$ . Because the victim does not realize her own mistake and feeling he will be compensated, the victim chooses a higher level of activity according to first order condition:  $V_z = 0$ , i.e.  $\underline{z}^* > z^{**}$ . The tortfeasor realizes victim's mistake due to bias and set a level of care equal to zero, i.e.  $z^* = 0$  and chooses a level of activity exceeding the social optimum, according to first order condition:  $V_w = 0$ , i.e.  $\underline{w}^* > w^{**}$ .

Under bias, forgiveness does not change the optimal behavior of victim (since he will not be held liable under the forgiveness strategy), i.e.  $\underline{y}^* < y^{**}$  and  $\underline{z}^* > z^{**}$ . This implies that the tortfeasor realizes fully he will be held liable and corrects the choice of care to be second best efficient in response of the victim's choice, inducing an overcompensation of the lower level of care of the victim, thereby increasing his care level above the second best efficient level in absence of the bias, i.e.  $\underline{x}^* > x^*$ .

Symmetrically, the activity level chosen by the tortfeasor is second best efficient given the choice of the victim and taking into consideration the lower care,  $\underline{w}^* < w^*$ .

#### 4.6 *Strict Liability with a Defense of Comparative Negligence*

Under the defense of comparative negligence, the victim receives a share  $\alpha$  of the compensation if the tortfeasor is negligent and the victim is diligent, i.e.  $x < x^{**}$  and  $y \geq y^{**}$ .

The objective function for the tortfeasor is:

$$\max_{(w,x)} F^T = \begin{cases} V_T(w) - \alpha w z p(x,y) L - x & \text{if } x < x^{**} \text{ e } y < y^{**} \\ V_T(w) - w z p(x,y) L - x & \text{if } y \geq y^{**} \\ V_T(w) - x & \text{if } x \geq x^{**} \text{ and } y < y^{**} \end{cases}$$

And for the victim is:

$$\max_{(z,y)} F^V = \begin{cases} V_V(z) - (1 - \alpha) w z p(x,y) L - y & \text{if } x < x^{**} \text{ e } y < y^{**} \\ V_V(z) - y & \text{if } y \geq y^{**} \\ V_V(z) - w z p(x,y) L - y & \text{if } x \geq x^{**} \text{ and } y < y^{**} \end{cases}$$

Under the rule of strict liability with the defense of comparative negligence, in case of threat strategy, both the victim and the tortfeasor will wish to exercise due care to avoid liability, i.e. the care level is chosen according respectively to first order conditions (3) and (4). The equilibrium is analogous to the rule of simple negligence with the defense of comparative negligence, but here the residual liability is on the tortfeasor. Due to the overconfidence bias, however, both the victim and the tortfeasor choose a level of care lower than social optimum, i.e.  $\underline{y}^* < y^{**}$  and  $\underline{x}^* < x^{**}$ . Because the victim does not realize her own mistake and feeling he will be compensated, the victim chooses a higher level of activity according to first order condition:  $V_z = 0$ , i.e.  $\underline{z}^* > z^{**}$ . The tortfeasor realizes victim's mistake due to bias and set a level of care equal to zero, i.e.  $z^* = 0$  and chooses a level of activity exceeding the social optimum, according to first order condition:  $V_w = 0$ , i.e.  $\underline{w}^* > w^{**}$ .

Under bias, forgiveness does not change the optimal behavior of victim (since he will not be held liable under the forgiveness strategy), i.e.  $\underline{y}^* < y^{**}$  and  $\underline{z}^* > z^{**}$ . This

implies that the tortfeasor realizes fully he will be held liable and corrects the choice of care to be second best efficient in response of the victim's choice, inducing an overcompensation of the lower level of care of the victim, thereby increasing his care level above the second best efficient level in absence of the bias, i.e.  $\underline{x}^* > x^*$ . Symmetrically, the activity level chosen by the tortfeasor is second best efficient given the choice of the victim and taking into consideration the lower care,  $\underline{w}^* < w^*$ .

	CARE LEVELS				ACTIVITY LEVELS			
	Injurer (X)		Victim (Y)		Injurer (W)		Victim (Z)	
	T	F	T	F	T	F	T	F
<b>Simple Negligence</b>	$\underline{x}^* < x^{**}$	=	0	$\underline{y}^* > y^{**}$	$\frac{\underline{w}^*}{>w^{**}}$	=	$\underline{z}^* > z^{**}$	$\underline{z}^* < z^{**}$
<b>Contributory Negligence</b>	0	$\underline{x} < x^*$	$\underline{y} < y^*$	$\underline{y} < y^*$	$\underline{w} > w^*$	=	$\underline{z} > z^*$	$\underline{z} < z^*$
<b>Comparative Negligence</b>	$\underline{x} < x^*$	$\underline{x} < x^*$	$\underline{y} < y^*$	$\underline{y} < y^*$	$\underline{w} > w^*$	=	$\underline{z} > z^*$	$\underline{z} < z^*$
<b>Strict Liability</b>	$\underline{x} < x^*$	=	0	=	$\underline{w} > w^*$	=	$\underline{z} > z^*$	=
<b>SL + Contrib. Negligence</b>	0	$\underline{x} < x^*$	$\underline{y} < y^*$	$\underline{y} < y^*$	$\underline{w} > w^*$	=	$\underline{z} > z^*$	$\underline{z} < z^*$
<b>SL + Compar. Negligence</b>	$\underline{x} < x^*$	$\underline{x} < x^*$	$\underline{y} < y^*$	$\underline{y} > y^*$	$\underline{w} > w^*$	=	$\underline{z} > z^*$	$\underline{z} < z^*$

**Table 1:** *Threat vs. Forgiveness Strategies*

## 5. Conclusions

Biased perceptions of reality can generally be (at least partially) corrected by providing a better knowledge of the statistical probability of harm. Overconfidence poses a special threat to tort rules: according to empirical and experimental evidence,

the knowledge about statistical incidence of overconfidence only has a limited effect on the belief about one's own overconfidence bias. Hence, even if the potential tortfeasor knows that overconfidence may be construed as negligence, the threat of liability would not as such create optimal incentives.

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