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Soft Regulators, Tough Judges

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Abstract

Judges have a tendency to be more demanding than regulators. In the United States, a majority of the courts has adopted the rule that the unexcused violation of a statutory standard is negligence per se. However, the converse does not hold: compliance with regulation does not relieve the injurer of tort liability. In most European legal systems, the outcome is similar. We use a framework in which, on the one hand, the effects of tort law are undermined by insolvency and evidence problems and, on the other hand, regulation is expensive in terms of monitoring and information gathering. We show that a regulatory standard set below the socially optimal level of care can be sufficient to remove the shortcomings of tort law. In essence, this is because the injurer's cost function may have two local minima that make only major deviations from the socially desirable level of precaution advantageous for the injurer, but not minor violations. This may occur when precaution also or only reduces the magnitude of the harm and under liability for negligence.

Thus, minimum regulation can completely restore optimal liability incentives. Conversely, liability reduces the cost of enforcing regulation in two ways: first, enforcing minimum regulation rather than a standard set at the socially optimal level is cheaper because it requires lower monitoring levels; second, tort liability already provides a part of the sanction for sub-optimal behavior, thus allowing for a further reduction in monitoring.

Moreover, we show that minimum regulation does not need to be set at a very precise level. On the contrary, any level within a certain range is socially optimal. This allows regulators to further curb their cost by saving on information gathering.

We show that an imperfectly working tort system can be fully corrected by minimum regulation in a variety of circumstances (for instance, even if the injurer is unable to compensate for the harm at the optimal level of precaution, and even if the rule in force is strict liability or a cause-in-fact variant of negligence).

SOFT REGULATORS, TOUGH JUDGES

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ABSTRACT

Judges have a tendency to be more demanding than regulators. In the United States, a majority of the courts has adopted the rule that the unexcused violation of a statutory standard is negligence *per se*. However, the converse does not hold: compliance with regulation does not relieve the injurer of tort liability. In most European legal systems, the outcome is similar. We use a framework in which, on the one hand, the effects of tort law are undermined by insolvency and evidence problems and, on the other hand, regulation is expensive in terms of monitoring and information gathering. We show that a regulatory standard set below the socially optimal level of care can be sufficient to remove the shortcomings of tort law. In essence, this is because the injurer's cost function may have two local minima that make only major deviations from the socially desirable level of precaution advantageous for the injurer, but not minor violations. This may occur when precaution also or only reduces the magnitude of the harm and under liability for negligence.

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1. Introduction

This paper attempts to explain why tort law and regulation are sometimes used together, and why in these cases regulatory standards tend to be lower than liability standards. In the United States, a majority of the courts has adopted the rule that the unexcused[1] violation of a statutory standard is negligence *per se*, i.e. negligence in itself.[2] In other words, if a legislative body or regulatory authority defines a regulatory standard (which is aimed at the type of risk the victim suffered, and is specific enough),[3] then the non-compliance with the standard is considered to be sufficient to conclude that the injurer was negligent.

However, the converse does not hold.[4] Compliance with a regulatory norm does not relieve the injurer of liability. In general, statutes, ordinances and regulations are believed only to set the minimum standards of conduct.[5] Compliance with a legislative enactment or an administrative regulation does not prevent a finding of negligence if a reasonable person would have taken additional precautions.[6] Compliance may only play an indirect role: it can be evidence of reasonableness, that is, it may help to convince the court or jury that the injurer's precautionary measures were reasonable,[7] or that a product displayed a favorable risk-utility balance.[8] Such a compliance defense, however, is not conclusive.

In most European legal systems, the outcome is similar. Injurers who violated a regulatory

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[1] An excuse may for instance consist in an emergency or physical circumstances beyond the injurer's control. See Restatement (Second) of Torts §288A, In general, these excuses also relieve the violator from criminal sanctions (Prosser and Keeton, 1984, p. 228).

[2] Prosser and Keeton (1984, p. 230); Harper, James and Gray (1986, §17.6); Shulman, James, Gray, and Gifford (2003, p. 243); see also Speiser, Krause and Gans (2003, §9.8 et seq.). In a minority of jurisdictions, violation of a criminal statute is regarded only as a rebuttable presumption of negligence, or just evidence of negligence. Some American courts attach less weight to municipal ordinances (and some also to norms of regulatory agencies) than to statutes in this respect. (Prosser and Keeton, 1984, p. 230-231).

[3] The Restatement (Second) of Torts §286 states that courts may adopt the requirements of a legislative enactment or administrative regulation as the standard of conduct if the statute is specific enough, and has been designed to protect against the type of harm (risk) the victim suffered. In addition, the victim should belong to the class of persons the statute intended to protect. The Restatement (Third) of Torts: Products Liability §4 states that '…a product's noncompliance with an applicable product safety statute or administrative regulation renders the product defective with respect to the risks sought to be reduced by the statute or regulation'.

[4] To illustrate, suppose that the regulatory standard is set at 40. When an accident occurs and it emerges that the injurer's precaution level was 39, he will be found negligent under the per se rule. Nevertheless, even if his precaution level was 40, he might still be found negligent, as the courts might require a higher due care level, for instance 50, i.e. they might not accept a compliance defense.

[5] Prosser and Keeton (1984, p. 233); Statsky (1994, p. 65); see also Speiser, Krause, and Gans (2003, §9.13).

[6] Restatement (Second) of Torts §288 C. Similar provisions can be found in the Restatement (Third) of Torts: Products Liability § 4 (stating that 'a product's compliance with an applicable product safety statute or administrative regulation …does not preclude as a matter of law a finding of product defect') and the National Traffic and Motor Vehicle Safety Act of 1966 (§30103.e of title 49, U.S. Code, stating explicitly that 'compliance with a motor vehicle safety standard … does not exempt a person from liability at common law').

[7] Harper, James and Gray (1986, §17.6); Prosser and Keeton on The Law of Torts (1984, p. 233).

[8] Viscusi (1988, p. 300-301).

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norm (e.g. a speed limit) are automatically found negligent (or 'at fault'), while injurers who complied with the regulatory standard are not necessarily relieved of tort liability.[9]

The fact that regulatory standards are often set at a suboptimal level raises two questions. If a certain category of accidents is subject to ex ante regulation, why are these norms set below the socially optimal level, so that they need to be complemented by liability? Furthermore, if tort law is the system that ultimately induces injurers to choose optimal precaution levels, what is the point of having additional regulation?

To answer these questions, we employ a framework in which, on the one hand, the incentive effects of tort liability are undermined by the *judgment proof problem* (due to insolvency or liability caps) and the *disappearing defendant problem* (injurers are not always successfully sued).[10] As a result, injurers might take inefficient precaution under tort law alone,[11] for they internalize only a portion of the accident loss. On the other hand, setting regulatory standards precisely at the optimal level of precaution may be too costly for two reasons: gathering information on such a level ex ante may be too expensive and high standards require high monitoring levels, which are also a cost for regulators. If they are jointly used, as we will explain in the following, regulation removes the problems affecting liability, while liability limits the costs of regulation.

Our results are based on the fact that, in most cases, only large deviations from the socially optimal level of precaution are profitable for the injurer, while small departures actually increase his liability costs. By introducing a minimum regulatory standard, the injurer can be prevented from taking such very low levels of precaution and therefore finds it convenient to comply with the negligence standard despite the judgment proof or the disappearing defendant problem. In this framework, the purpose of regulation is not to provide incentives to take precaution but to enable the functioning of tort liability, while in turn tort liability is aimed at enforcing the optimal level of precaution. Previous contributions emphasized that injurers will comply with either the regulatory standard or the liability standard. Instead, in our analysis, injurers comply with both

[9] For a comparative overview see von Bar (2003), p. 45-47. Under French and Belgian law, the unexcused violation of a statutory duty automatically constitutes 'faute' (note that in France and Belgium, the term 'per se negligence' is not used since the term 'negligence' has a narrower meaning: it includes only violations of precautionary norms defined by courts; an injurer committed a 'fault' either when he violated a legislative norm or acted negligently.). Under Italian and Dutch law the outcome is similar as in France and Belgium. However, in Germany and Portugal, such a violation is considered only as a rebuttable presumption of fault.

[10] We prefer to analytically separate these two problems. In Summers (1983) and Shavell (1984a, 1984b, and 1986) these terms are considered as synonyms.

[11] It is reasonable to expect that injurers will take too little precaution. However, Beard (1990), has shown that insolvent injurer's may in fact take more than socially optimal precaution when his precaution expenditures reduce the assets available to pay damage compensation and thus his exposure to liability. Also see Macminn (2002), Miceli and Segerson (2003) and Dari-Mattiacci and De Geest (2003). Unless the injurer's wealth is so low that he is unable to pay for the precaution costs at the socially optimal level, our results also hold in this case, although they may

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standards at the same time.

Relying exclusively on regulation may also be an option; however, keeping liability in place has the advantage of reducing the costs of regulation. As we have argued, the optimal combination of liability and regulation implies that the regulatory standard be set below the socially optimal level of precaution. Given the same magnitude of fines, lower standards require less monitoring[12] and hence regulation is cheaper when complemented with liability. Moreover, if regulatory violations also trigger tort liability, then the expected regulatory fine can be lower, which further saves enforcement costs. In addition, sometimes it is sufficient to regulate only some of the injurer's precautionary measures (those affecting the magnitude of the harm).

Finally, we show that minimum regulation does not need to be set at a precise level of precaution, but can be set anywhere within a certain range. Therefore, the setting of minimum regulation requires less information than in the case regulation would be used alone. The saving in regulation costs is not likely to be counterbalanced by an increase in the ordinary costs of the liability system. In fact, tort liability requires neither monitoring nor the acquisition of information ex ante, as it operates after an accident occurred.

Our findings provide an explanation for the per se rule (violation of a regulatory standard implies tort liability) and of the general tendency of courts not to accept the compliance defense (compliance with regulation does not relieve of tort liability). The per se rule is also likely to reduce the costs of liability suits, since the liability standard is supposed to be higher than the regulatory standard and, thus, proving liability is easier. As we will illustrate, our results also apply to strict liability, although to a lesser extent.

In legal textbooks,[13] negligence per se is often justified on the basis that courts should respect decisions made by representative bodies in a democratic society. This account does not explain why compliance with a regulatory standard does not relieve the injurer from tort liability. If courts cannot set safety standards lower than those of a legislative body because they have to respect the decisions of that body, why would they be entitled to replace these regulatory standards by their own, higher safety standards? One could argue that in the absence of any explicit statements, courts may presume that it was the regulator's intention to set only minimum levels, but then it still needs to be explained why regulators would prefer to define minimum norms rather than maximum norms or, more simply, optimal norms.

In law-and-economics literature, it is well known that tort law and ex ante regulation are two

quantitatively change.

[12] See Polinsky and Shavell (1984).

[13] Prosser and Keeton (1984, p. 222), Harper, James and Gray (1986, §17.6). The argument goes back to Thayer (1913).

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alternative instruments of controlling externalities.[14] Economic explanations for the joint use of these instruments are rarer and focus on three different sets of justifications. Kolstad, Ulen, and Johnson (1990)[15] and Burrows (1999)[16] discuss the case in which there is uncertainty over the rule that will be applied ex post. Che (1990) and Trebilcock and Winter (1997) consider multidimensional precaution, in which some precautionary measures are controlled by regulation and others by liability. Shavell (1984b),[17] Schmitz (2000),[18] and Hiriart, Martimort and Pouyet (2004)[19] focus on the case in which injurer's are insolvent or are not sued by victims and regulators are poorly informed. Our analysis is closer to the latter line of research, although it differs from it in several respects.

First, previous literature has analyzed this problem at an aggregate level, showing that the combination of strict liability and regulation may yield *second best levels of precautions* over a population of potential injurers, some of whom abide by the regulatory standard, while others are provided incentives by liability.[20] We study the same problem under a more general model of accident prevention. At an individual level, we show how minimum regulation can harness some peculiarities in the injurer's cost function under a liability rule and thus induce *first best levels of precaution*. We then extend our analysis to the aggregate level.

Second, we employ a broader model of accident prevention, in which the injurer's precaution can affect not only the probability that an accident occurs (as in the literature), but

[14] Early contributions to this topic are Wittman (1977), Shavell (1984a). For more recent literature, see Innes (2004) and Boyer and Porrini (2004).

[15] In Kolstad, Ulen, and Johnson (1990), tort law is assumed to generate incentive problems because of uncertainty in the application of the negligence rule and regulation is used to repair such shortcoming. They employ a *joint-probability-magnitude model* as we do, but do not analyze the effects of the judgment proofness and disappearing defendant problems on the functioning of tort liability.

[16] Burrows (1999) builds further on the idea of instrumental uncertainty discussed in Kolstad, Ulen, and Johnson (1990) and analyzes cases in which the injurer faces uncertainty on both instruments.

[17] In Shavell (1984b), the analysis is based on a *probability model* (see footnote 21) and limited to strict liability (even though the results are also said to be qualitatively valid under negligence; see Shavell, 1984b, footnote 8). Liability is undermined by the judgment proof problem or the disappearing defendant problem, while regulation is hindered by informational shortcomings on the level of the harm (which denotes the injurer's type). Shavell (1984b) takes an aggregate approach and proves that some injurers (those who are less harmful) will follow the regulatory standard, while the others will be incentivized by liability. Thus implementing both liability and regulation achieves higher levels of social welfare than implementing one of them alone, although only second best levels. Our analysis is different in that we use a *joint-probability-magnitude model* (see footnote 21) and analyze both negligence and strict liability. Our focus is on the individual level and we show how the first best can be achieved. Our analysis also departs from Shavell's setting in another respect. Shavell (1984b) assumes that both the judgment proof problem and the disappearing defendant problem occur. As shown by Schmitz (2000), Shavell's result would not hold if only the judgment proof problem occurred. In our analysis, the two problems are separately analyzed and we derive the conditions under which our results hold for each of them.

[18] Schmitz' (2000) setting is similar to Shavell (1984b), but wealth varies among individuals.

[19] Hiriart, Martimort and Pouyet (2004) builds on and extends the analysis by Shavell (1984b). They allow for ex ante contracting between the injurer and the regulator and study how the injurer can be induced to reveal the information the regulator lacks. The regulator sets then ex ante first-best regulatory standard, while ex post liability only provides incentives to reveal information.

[20] An exception is Hiriart, Martimort and Pouyet (2004), where a first best outcome is attained through negotiation

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also the magnitude of the harm.[21] This difference bears on the shape of the insolvent injurer's cost function under a liability rule and hence on the way regulation impacts the injurer's behavior. In addition, we show that there are situations in which only some of the precautionary measures the injurer can take need to be regulated and not all of them.[22]

Third, we clearly distinguish between the dilution of incentives created by the judgment proof problem – injurers may be insolvent or their liability capped by law – and that deriving from the disappearing defendant problem – injurers may not be apprehended, their responsibility may not be provable, or victims may not sue them –, while under previous literature they are treated as having the same effect on the injurer's incentives.

Fourth, the literature has focused exclusively on the informational shortcomings of ex ante regulation. We also emphasize the novel point that lowering the regulatory standards saves enforcement costs, even if regulators are perfectly informed.

Fifth, we attempt to offer a more comprehensive explanation for both the per se rule and the non-conclusiveness of the compliance defense. Previous attempts mainly focus on strict liability, under which compliance with some level of due care is not an issue.[23]

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between the regulator and the injurer.

[21] In Dari-Mattiacci and De Geest (2005) we made a further distinction between the *magnitude* model (where more precaution only reduces the magnitude of the harm, e.g. nuisance to neighbors), the *probability* model (where more precaution reduces only the probability of an accident, e.g. an aircraft crash), *the joint-probability-magnitude model* (where a single precautionary measure reduces the magnitude and the probability at the same time, e.g. a car driver reducing his speed) and the *separate-probability-magnitude model* (where injurers can take one precautionary measure to reduce the magnitude and another separate measure to reduce the probability, e.g. radars reduce the probability of a shipwreck, lifeboats reduce the magnitude of the harm to passengers in the case of a shipwreck). In the formal analysis that follows we will employ the latter two more general models, as they encompass the former two. The distinction between precaution that reduces the magnitude of the harm (self-insurance) and precaution that reduces the probability of an accident (self-protection) is known in the insurance literature; see Ehrlich and Becker (1972). Boyd and Ingbermann (1994) first introduced this distinction in relation to then judgment proof problem.

[22] Trebilcock and Winter (1997) also discuss a case in which only some precautionary measures are subject to regulation. However, in their setting the choice of whether to regulate a precautionary measure depends on the cost of observing it ex ante. The measures that are too costly to observe will not be regulated and incentives will be provided by tort liability. Instead, in our model the choice is based on the effect of precaution on the probability or the magnitude of the accidental loss.

[23] Shavell (1984b) offers an explanation for the fact that compliance with regulation is not conclusive, but does not explain the per se rule – on the contrary, he argues against it (Shavell, 1984a, p. 371-372, even suggesting that there is no per se rule under American law; in emergency cases and cases with physical circumstances beyond the driver's control, which he mentions, however, the injurer would not be subject to the criminal sanctions under the regulatory system either). Shavell's (1984b) findings are largely driven by his assumption that regulators need to set a single due care level for all injurers, while tort law sets due care levels for each injurer individually. In this setting, courts may indeed require a higher than regulatory care level for some injurers and a lower care level for some others (presuming, in the latter case, that regulatory enforcement is imperfect so that there exist some injurers who do not fully comply with the regulatory norm). It should be noted that while in many cases, regulatory norms are more general than tort law norms, this is not an inherent characteristic of these instruments since regulation can be specific ('tailor-made'), and tort norms can be general (for instance when due care levels are based on the precaution costs of an average person). Schmitz (2000) and Kolstad, Ulen, and Johnson (1990) implicitly explain the non-conclusiveness of the compliance defense, but they do not explain the per se rule. Burrows (1999) endorses a parametric approach, depending on the degree of instrumental uncertainty and error in the two instruments, but suggests that the best way to solve problems of instrumental uncertainty is to create a regulation-led negligence system, that is, to have a strict per se rule and to make the compliance defence conclusive. A somewhat related, but analytically distinct finding of

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In section 2, we present the basic model of negligence, show how regulation can remedy the shortcoming of tort liability, and provide a formal justification for the per se rule and the general rebuttal of the compliance defense. In section 3, we extend the model to strict liability, and show that the results we demonstrate for the negligence rule apply to strict liability only if the injurer is solvent at the optimal level of precaution. Section 4 analyzes the effect of cause-in-fact on the functioning of the negligence rule. In section 5, we discuss the applicability of our results to the disappearing defendant problem. In section 6, we study the optimal setting of the regulatory standard in order to minimize the information-gathering and enforcement costs of regulation and we comment on how our results apply to a population of injurers or in the face of uncertainty. Section 7 concludes.

2. Negligence and minimum regulation combined

2.1. Injurers can take only one precautionary measure

We consider accidents that occur between two parties, who are strangers to each other: a victim (the party that suffers harm[24]) and an injurer (the other party). The injurer is rational, perfectly informed, utility-maximizing, and risk-neutral, and is the only party that can take precautions[25] in order to reduce the probability of the accident and the magnitude of the harm[26] – consider for example the effects of speed on the frequency and severity of traffic accidents. If the injurer is found negligent, the court awards the victim perfectly compensatory damages. The injurer's assets are limited and exogenously determined, and therefore, may be less than the victim's harm. Let:[27]

x = the injurer's precaution cost, $x \geq 0$;

$p(x)$ = the probability of an accident, $0 < p(x) < 1$, $p' < 0$, $p'' > 0$;

Shavell (1984b), Schmitz (2000), Kolstad, Ulen, and Johnson (1990) is that regulatory requirements should be lower when regulation is complemented by tort law than when regulation is used alone. In a different context (the discussion on the tort crisis), Huber (1985) and Viscusi (1988) argue that compliance with the regulations should immunize an injurer from liability. Their underlying assumption is that regulation is a better instrument for determining optimal risk levels in society.

[24] The assumption that only the victim suffers harm is usually referred to as a unilateral-risk-accident assumption and it has been shown not to affect the conclusions of the analysis; see Arlen (1990).

[25] In the literature, accidents of this type are often referred to as unilateral-precaution accidents. Given this restriction, a further distinction between negligence rules (simple negligence, contributory negligence, comparative negligence) is irrelevant.

[26] In Dari-Mattiacci and De Geest (2005) we refer to this model as the *joint-probability-magnitude model*. In the model usually employed in the literature, the harm is exogenous and the probability is the only variable under the control of the injurer. It is easy to see that this type of model, which we call *probability model*, is a special case of our more general framework (see footnote 21). A *joint-probability-magnitude model* is used in Kolstad, Ulen, and Johnson (1990), but they do not analyze the judgment proof problem.

[27] All functions are assumed continuously differentiable to any desired order.

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$h(x)$ = the magnitude of the harm, $h > 0$, $h' \leq 0$, $h'' \geq 0$;

t = the injurer's assets, $t > 0$.

We employ the standard social cost function:[28]

$$S(x) = p(x)h(x) + x \tag{1}$$

Let x^* denote the unique socially optimal level of precaution that solves $S' = 0$ and let it be positive. We will prove the following proposition:

Proposition 1: *(i) A regulatory standard lower than the socially optimal level of precaution is sufficient to remove the judgment proof problem; (ii) Once minimum regulation has removed the judgment proof problem, the negligence rule induces socially optimal precaution.*

Which implies that

Corollary 1.a: *(i) Non-compliance with regulation should be sufficient for a finding of negligence (per se rule). (ii) Compliance with the regulatory standard should not relieve the injurer of liability for negligence (no compliance defense).*

Assuming that the standard of negligence is set at the socially optimal level, the injurer's minimization problem is:

$$\min_x \begin{cases} p(x)\min\{h(x), t\} + x & \text{if} \quad x < x^* \\ x & \text{if} \quad x \geq x^* \end{cases} \tag{2}$$

The first line in (2) represents the cost that the injurer bears if he does not comply with due care. If negligent, the injurer minimizes this cost as follows:

$$\min_x \left[p(x)\min\{h(x), t\} + x \right] \Leftrightarrow \min\{\min_x [\, p(x)h(x) + x], \min_x [\, p(x)t + x]\}$$

which may be rewritten as:

$$\min\{\, p(x^*)h(x^*) + x^*, p(x_t)t + x_t\}$$

Where x^* is the socially optimal level of precaution, and x_t is the level of precaution that solves $p't + 1 = 0$. It is interesting to focus on cases with $p(x^*)h(x^*) + x^* > p(x_t)t + x_t$, in which the negligent injurer's cost in (2) is minimized by x_t.[29]

If the injurer complies with the negligence standard – second line in (2) – his costs are

[28] We construct the social cost as the sum of expected accident loss and precaution costs. See Calabresi (1970) and Brown (1973).

[29] If $p(x^*)h(x^*) + x^* > p(x_t)t + x_t$, the negligent injurer's costs are minimized by x^* and thus the injurer takes the socially optimal level of precaution under liability (strict liability or negligence) alone.

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clearly minimized by x^*. Thus, he will prefer to comply with rather than to violate the negligence standard if the compliance costs are lower than (or equal to) the cost of violating: $x^* \leq p(x_t)t + x_t$,[30] from which we can derive a threshold level of the injurer's assets below which the injurer violates the negligence standard (and takes $x_t(t) < x^*$, which increases in t)[31] and above which he complies (and takes x^*):

$$t^{n1} = \frac{x^* - x_t}{p(x_t)} \tag{3}$$

Now, consider an injurer whose assets are equal to $t < t^{n1}$. Such an injurer will consequently take the socially inefficient level of precaution x_t. The blackened line in figure 1 (including the dotted portion) depicts the pattern of the injurer's costs as a function of his level of precaution.

[FIGURE 1]

The figure shows that the injurer finds it advantageous to take x_t because, even though at that level of precaution he is negligent and hence liable for the damages he causes to the victim, because of his insolvency his total cost is less than x^*, which he would have to bear if he was non-negligent. However, as the graph shows, if the injurer is prevented from taking those low levels of precaution that lie on the dotted portion of the curve to the left of x_r, he will take x^*. It is to be noticed that such dotted portion does not cover the whole area in which the injurer is judgment proof, but only the part that triggers the lowest costs.

Formally, a level of x_r such that $x_t < x_r < x^*$[32] and $x^* = p(x_r)t + x_r$ guarantees $x^* \leq p(x) \min\{h(x), t\} + x$, for any $x \geq x_r$.[33] Therefore, if the option of taking $x < x_r$ is precluded, the injurer's cost will necessarily be lower at x^* then at any other feasible level of precaution.

Consequently, a regulator can set a minimum regulatory standard at r, which lies between x_r and x^*. Violation of such a standard is punished with the levy of an expected fine equal to $\varphi(x)$.[34] If the expected fine $\varphi(x)$ is such that $x^* \leq p(x)\min\{h(x), t\} + x + \varphi(x)$ for any $x < r$, then any level of precaution below r will trigger greater costs for the injurer than x^*. Levels of precaution

[30] It follows from the Envelop Theorem that the right-hand side increases monotonically in t, and thus there exist a level of t at which the equality in (3) holds.

[31] This result can be easily verified by direct application of the Implicit Function Theorem on $p'(x_t)t + 1 = 0$.

[32] That $x_r > x_t$ is obvious. That $x_r < x^*$ follows directly from the arguments brought in the text accompanying this footnote.

[33] If $h(x) \leq t$, the former inequality is always satisfied by definition of x^*. If $h(x) > t$, the inequality is satisfied because $p(x)t + x$ is increasing in x to the right of x_t.

[34] Obviously, we have $\varphi(x) > 0$ for $x < x_t$, and $\varphi(x) = 0$ otherwise. The expected fine is calculated as the product of the magnitude of the fine times the probability of apprehension. Insolvency does not affect the enforcement of the regulatory standard because the fine can be lowered below the level that drives the injurer insolvent and the probability of apprehension can be raised accordingly, in order to keep the level of the expected fine constant.

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between r and x^* also imply greater costs than x^*, as r lies to the right of x_r. Therefore, the combination of the minimum regulation and tort liability for negligence induces the injurer to take socially optimal precaution x^*. This result is also obtained if the injurer is bankrupt at the socially optimal level of precaution, that is if $t < h(x^*)$.[35]

It is remarkable that the optimal regulatory standard that guarantees this result can be set anywhere between x_r and x^*. Moreover, it is easy to show that x_r is monotonically decreasing in t,[36] therefore the range of $r \in [x_r, x^*]$ widens as t increases. This range gives an indication of the freedom regulators enjoy in setting regulatory standards meant to counteract injurer's insolvency. Such freedom may be relevant when regulators lack precise information on either of the two boundaries, as they may alternatively choose to set regulatory standards closer to one or the other, depending on the information they have available.

Moreover, while setting $\varphi(x)$, regulators may take into account the fact that also liability is in place and thus set the expected regulatory sanction at a lower level than if only regulation was employed. This permits to save enforcement costs.

It is also worth noticing that, by combining negligence with regulation, the first best level of precaution can be attained even though the regulatory standard is set below the socially optimal level of precaution.[37] Since the optimal regulatory standard can be set at a lower level than the negligence standard, it follows that violation of the regulatory standard necessarily implies that also the negligence standard has been violated – which is an endorsement of the *per se* rule – and that, instead, compliance with the regulatory standard does not imply compliance with the higher standard set by liability rules and thus it should not automatically relieve injurers of liability for negligence – which justifies the absence of a *compliance defense*.

Put differently, our analysis implies that, for the purpose of counteracting the judgment proof problem, while still exploiting the informational advantage of the courts over regulators, the violation of a regulatory standard is a sufficient but not necessary condition for a finding of negligence.

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[35] This result follows from the fact that for any t there always exists an x_r such that a regulatory standard $r \in [x_r, x^*]$, combined with a negligence standard x^*, induces the injurer to take x^*, which is easy to show.

[36] We know that x_r is such that $p(x_r)t + x_r = x^*$. Therefore we can write $\mathrm{d}\,(p(x_r)t + x_r) = \mathrm{d}\,x^* = 0$. From this we have $p't\,\mathrm{d}\,x_r + p(x_r)\,\mathrm{d}\,t + \mathrm{d}\,x_r = 0$, which yields $\mathrm{d}\,x_r / \mathrm{d}\,t = -\,p(x_r) / (p't + 1)$. Since x_r necessarily lies to the right of x_t, then $p't + 1 > 0$, and $\mathrm{d}\,x_r / \mathrm{d}\,t < 0$. As t approaches t^{n1}, x_r approaches x_t.

[37] In a recent paper, Ganuza and Gomez (2004) have demonstrated that the performance of the negligence rule could be improved by lowering the negligence standard. Considering again figure 1, it is clear that a negligence standard set at x^* induces the injurer to take x_t. On the contrary, with a negligence standard x^d, such that $x^d < p(x_t)t + x_t < x^*$, the injurer would take x^d. This approach improves caretaking by the injurer, since $x^d > x_t$, but, contrary to ours, does not reach the first best outcome, but a mere second best, precisely because $x^d < x^*$. The difference between these two approaches can be best understood in the following terms. Lowering the negligence standard induces the injurer to comply with the negligence standard by making compliance cheaper, but at the same time it compromises on the overall social cost of accidents. On the contrary, our approach is aimed at making violation of the negligence standard

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In addition, on the one hand, making injurers who violated the regulatory standard per se liable helps saving the enforcement costs of regulation, since, as we have noticed, the expected regulatory sanction can be lower if also liability is applied. Therefore, given the same magnitude of the sanction, the probability of apprehension can be set at a lower level, thus saving enforcement costs. On the other hand, proof of negligence for gross violations is made less cumbersome by the per se rule, as it is enough to demonstrate that the injurer violated a regulatory standard, thus also reducing the cost of bringing a law suit.

2.2. Injurers can take magnitude-precaution and probability-precaution

So far, we have assumed that the injurer could only take one precautionary measure, which at the same time curbs the probability of an accident and abates the magnitude of the resulting harm. In many circumstances, however, the injurer may take different precautionary measures that control probability and magnitude separately (for instance, radars only reduce the probability of a shipwreck, while lifeboats only mitigate the magnitude of the harm to passengers in the case of a shipwreck).[38] The question we ask in this section is whether regulation should target both of these precautionary measures or not. In fact, we will show that this may not be necessary. More precisely:

Proposition 2: *When the injurer can separately affect the probability of the accident and the magnitude of the harm, if his assets are above a certain threshold, minimum regulation of only the magnitude precaution is sufficient to remove the judgment proof problem. Below that threshold, both magnitude precaution and probability precaution need to be regulated.*

Let us thus modify the previous model as follows:

s = the injurer's probability-precaution cost;

z = the injurer's magnitude-precaution cost;

$p(s)$ = the probability of an accident occurring, $0 < p < 1$, $p' < 0$, $p'' > 0$;

$h(z)$ = the magnitude of the harm, $h > 0$, $h' \leq 0$, $h'' \geq 0$.[39]

The social cost in this case is:

$$S(s,z) = p(s)h(z) + s + z \qquad (4)$$

Let s^* and z^* denote the unique (and positive, as we assume) levels of precautions that minimize (4). The injurer's minimization problem under negligence is:

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more expensive, thus without renouncing the first best result.

[38] In Dari-Mattiacci and De Geest (2005), we refer to this model as *separate-probability-magnitude model*.

[39] Further we assume that the product $p(s)h(z)$ is a strictly convex function of s and z.

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$$\min_{s,z}\begin{cases} p(s)\min\{h(z),t\}+s+z & if \quad s<s^* \text{ or } z<z^* \\ s+z & if \quad s\geq s^* \text{ and } z\geq z^* \end{cases} \tag{5}$$

As we have done for (2), the first line in (5) may be rewritten as:

$$\min\{p(s^*)h(z^*)+s^*+z^*,\, p(s_t)t+s_t\}$$

where s_t is the level of probability precaution that solves $p't + 1 = 0$. It is obvious that when the injurer is insolvent, that is, when $h(z) > t$, the optimal level of z is equal to zero. For this reason, z disappears from the optimal cost of the insolvent injurer, as depicted in the right-hand portion of the expression above.

As in the previous model, we focus on cases in which $p(s^*)h(z^*) + s^* + z^* > p(s_t)t + s_t$. The injurer will comply with the negligence standard if $s^* + z^* \leq p(s_t)t + s_t$, from which we can derive a threshold level of the injurer's assets below which the injurer violates the negligence standard (and takes $s_t < s^*$, and $z_t = 0$) and above which he complies (and takes s^* and z^*):

$$t^{n2} = \frac{s^*+z^*-s_t}{p(s_t)} \tag{6}$$

Now, let us consider a certain level $0 \leq z_r \leq z^*$ of the magnitude precaution z: z_r such that $s^* + z^* = p(s_t)t + s_t + z_r$ guarantees $s^* + z^* \leq p(s)\min\{h(z), t\} + s + z$, for any $z \geq z_r$ and any s.[40] That is, it guarantees that the injurer, if prevented from taking $z < z_r$, will take socially optimal precaution with respect to both s and z.

Such a $z_r \leq z^*$only exists if t is above a certain threshold level $t^\wedge$, which is such that $p(s_t)t^\wedge + s_t = s^*$.[41] If the injurer's assets are below such a threshold, then there exists two levels $s_t \leq s_r \leq s^*$ and $0 \leq z_r \leq z^*$ such that $s^* + z^* = p(s_r)t + s_r + z_r$, which guarantee $s^* + z^* \leq p(s)\min\{h(z), t\} + s + z$, for any $s \geq s_r$ and any $z \geq z_r$.[42]

From this it follows that, when the injurer can control probability and magnitude of accidental losses by using two different precautionary measures, regulation does not necessarily need to target both of them in order to address the judgment proof problem. If the injurer is sufficiently wealthy (his assets are above $t^\wedge$), regulation can only target magnitude precaution and impose a regulatory standard which may lie anywhere in the range $r_z \in [z_r, z^*]$. On the contrary,

[40] If $h(z) \leq t$, the inequality is always guaranteed by definition of s^* and z^*. If $h(z) > t$, the inequality holds because $p(s)t + s + z$ is increasing in s to the right of s_t, and it is linearly increasing in z.

[41] $z_r \leq z^*$ implies $z^* - z_r \geq 0$. Using $s^* + z^* = p(s_t)t + s_t + z_r$, we have $z^* - z_r = p(s_t)t + s_t - s^* \geq 0$ or $p(s_t)t + s_t \geq s^*$. Since by the Envelop Theorem we have that the left-hand side of the latter inequality is monotonically increasing in t, then there exist a threshold level of t above which the condition is satisfied and below which it is not. It is easy to show that $t^\wedge < t^{n2}$.

[42] It is easy to see that s_r and z_r can be set such that $s_r \leq s^*$ and $z_r \leq z^*$ as long as $s^* + z^* \geq s_r + z_r$. Using $s^* + z^* = p(s_r)t + s_r + z_r$, we have $(s^* + z^*) - (s_r + z_r) = p(s_r)t > 0$.

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if the injurer's assets are below $t^{\wedge}$, standards need to be set with respect to both precautionary measures in the ranges $r_s \in [s_r, s^*]$ and $r_z \in [z_r, z^*]$.

3. Strict liability and minimum regulation combined

3.1. Injurers can only take one precautionary measure

The analysis of the previous section has focused on the interaction of the negligence rule with regulatory standards. In this section, we extend the analysis to strict liability and inquire whether a combination of liability and regulation may also in this case advance social welfare. As we will show, in general this is true, although with some important restrictions. Again, let us consider the basic model presented in section 2. We will prove the following proposition.

Proposition 3: *Under strict liability, minimum regulation can only remove the judgment proof problem if the injurer is solvent at the optimal level of precaution and has some influence on the magnitude of the harm.*

The injurer's minimization problem is:

$$\min_x [\, p(x) \min\{h(x), t\} + x] \tag{7}$$

which may be rewritten as:

$$\min\{p(x^*)h(x^*) + x^*, p(x_t)t + x_t\}$$

As before, it is interesting to focus on cases with $p(x^*)h(x^*) + x^* > p(x_t)t + x_t$, in which the negligent injurer's costs are minimized by x_t, and hence this is the level of precaution taken by the injurer under strict liability alone. Now, consider a level of x_R such that $p(x^*)h(x^*) + x^* = p(x_R)t + x_R$. Such x_R guarantees that $p(x^*)h(x^*) + x^* \leq p(x)\min\{h(x), t\} + x$, for any $x \geq x_R$, thus the injurer is induced to take x^*, as shown in figure 2.

In addition, it is easy to see that the conditions above can only be satisfied if $t \geq h(x^*)$, that is, if the injurer is solvent at the optimal level of precaution. If not, at the optimal level of precaution the injurer only pays $p(x^*)t + x^* > p(x)t + x$ for some $x \geq x_R > x_t$,[43] thus he will not take x^*.

Further, it should be noticed that even if $t \geq h(x^*)$ the injurer may still take x_t instead of x^* in the absence of regulation. In fact, from (7), the threshold level of t below which a strictly liable

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[43] This follows from the fact that $p(x)t + x$ is increasing in x to the right of x_t.

injurer takes x_t is:[44]

$$t^{st1} = \frac{h(x^*) + x^* - x_t}{p(x_t)} \geq h(x^*) \tag{8}$$

This is only true, however, as long as $h' < 0$. On the contrary, if $h' = 0$, that is, if the injurer has no control on the magnitude of the harm, the injurer will take x^* under regulation plus strict liability only for $t \geq h$. Thus, the condition for regulation to be effective also becomes a condition for regulation to be unnecessary, as strict liability alone yields the socially optimal outcome.[45]

3.2. Injurers can take magnitude-precaution and probability-precaution

Concerning cases in which the injurer can take two different precautionary measures to reduce the magnitude of the harm and the probability of the accident, the results are similar to the negligence rule. The threshold level of t is however higher.

Proposition 4: *When the injurer can separately affect the probability of the accident and the magnitude of the harm, if the injurer is solvent at the optimal level of precaution, minimum regulation of the magnitude precaution is sufficient to remove the judgment proof problem. Below that threshold, minimum regulation cannot remove the judgment proof problem, even if both magnitude precaution and probability precaution are regulated.*

Using the same assumptions and notation as in section 2.2, we have that the injurer's minimization problem under strict liability is:

$$\min_{s,z}[\, p(s) \min\{h(z), t\} + s + z] \tag{9}$$

or

$$\min\{p(s^*)h(z^*) + s^* + z^*,\, p(s_t)t + s_t\}$$

The injurer will take $s^* + z^*$ if $p(s^*)h(z^*) + s^* + z^* \leq p(s_t)t + s_t$, from which we can derive a threshold level of the injurer's assets below which, under strict liability alone, the injurer takes $s_t < s^*$ and $z_t = 0$ and above which he takes s^* and z^*:

$$t^{st2} = \frac{p(x^*)h(x^*) + s^* + z^* - s_t}{p(s_t)} \tag{10}$$

Now let us consider a certain level $0 \leq z_R \leq z^*$ of the magnitude precaution z: z_R such that $p(s^*)h(z^*) + s^* + z^* = p(s_t)t + s_t + z_R$ guarantees that $p(s^*)h(z^*) + s^* + z^* \leq p(s) \min\{h(z), t\} + s +$

[44] For a formal proof see Dari-Mattiacci and De Geest (2005).

[45] A model in which the injurer has no effect on the magnitude of the harm is defined as *probability model*. See

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z, for any $z \geq z_R$ and any s, and the injurer will take socially optimal precaution with respect to both s and z.

Such an $z_R \leq z^*$ only exists if $t \geq h(z^*)$, that is, if the injurer is solvent at the optimal level of precaution. In fact, if $t < h(z^*)$, at the optimal level of precaution the injurer only pays $p(s^*)t + s^* + z^* > p(s_t)t + s_t + z$ for some $z \geq z_R$. Thus he would not take s^* and z^*.

Contrary to what we have shown for the negligence rule, if t is below this critical threshold, regulating both s and z will not remove the judgment proof problem. The logic of this result and the formal proof are analogous to those provided for the case studied in the previous section, in which the injurer's precaution reduces both the probability of the accident and the magnitude of the harm at the same time.

3.3. Comparison between strict liability and negligence

In the previous sections, we have shown that the judgment proof problem may be removed by a minimum regulatory standard lying anywhere within a defined range of the injurer's precaution. The upper limit of the range is always the socially optimal level of precaution x^*, while the lower limit depends on the liability rule.

The lower bound of the regulatory range is lower under the negligence rule than under strict liability,[46] as it may be noticed by comparing figures 1 and 2. Moreover, while we have shown that under the negligence rule we can always find an appropriate regulatory standard that eliminates the judgment proof problem, under strict liability this is only possible if two restrictive conditions are satisfied: the injurer must be able to reduce the magnitude of the harm by taking precaution, and he must be solvent at the optimal level of precaution.

Therefore, our analysis yields that, if there is a choice over the liability rule to be complemented with regulation, the negligence rule enjoys a broader applicability and, at the same time, provides a broader range for the setting of the regulatory standard, which thus can be set a lower levels.

In addition, it is also worth noticing that minimum regulation will be needed less often under negligence than under strict liability. In fact, the critical threshold of the injurer's assets, below which the injurer takes an inefficient level of precaution is lower under negligence ($t^{n1} < t^{st1}$ and $t^{n2} < t^{st2}$). This implies that there are some levels of the injurer's for which the negligence rule alone yields the socially optimal outcome, while strict liability alone would not and hence needs

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footnote 26.

[46] Under negligence the lower bound is $x_r = x^* - p(x_r)t$, which is clearly smaller than $x_R = x^* - p(x_R)t + p(x^*)h(x^*)$ under strict liability. The same can be easily shown for the case in which the injurer can take two different precautionary measures.

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to be complemented by regulation.[47]

4. Cause in fact and the negligence rule

Although they may quantitatively change, the core of our results also holds when the cause-in-fact variant of the negligence rule is considered. Under this model of negligence, proposed by Grady (1983) and subsequently formalized by Kahan (1989), a negligent injurer only pays incremental damages, that is, he does not pay for the damages that would have occurred anyway even if he had taken the optimal level of precaution.

This rule, condoning some liability costs to negligent injurers, reduces the pressure towards socially optimal precaution and thus may have less clear advantages over strict liability than the traditional form of negligence. In fact, it has been shown, that this rule has the same incentive effects as strict liability when the injurer has no influence on the magnitude of the harm.[48] Thus, in fact as we have proven for strict liability, a combination of regulation and negligence with cause in fact will not be viable if the injurer has no influence on the magnitude of the harm.

The second requirement concerning strict liability, that the injurer be solvent at the optimal level of precaution, however, does not apply to negligence with cause in fact, because the non-negligent injurer does not pay any damage award to the victim.

5. Disappearing defendants

In the previous sections, we assumed that the incentives provided by tort law were undermined by the judgment proof problem (a limit on the amount of damages injurers pay). Do our findings also hold for the disappearing defendant problem (the fact that injurers may not always be successfully sued)?

While both problems are sometimes considered analogous in the literature,[49] they are however analytically distinct in this context. In fact, the judgment proof problem affects the maximum magnitude of damages an injurer actually pays per accident, while the disappearing defendant problem proportionally reduces the probability of paying such damages. Let $0 \leq a \leq 1$ denote the probability that an injurer is successfully sued. This probability may be lower than 1 if, for instance, the injurer is difficult to identify or evidence is hard to find or decays with time.

[47] On the desirability of negligence over strict liability when there is a judgment proof problem, see Summers (1983), Shavell (1986) and Dari-Mattiacci and De Geest (2005).

[48] See Dari-Mattiacci (2004). In addition, if precaution reduces the injurer's exposure to liability (as for example when precaution is monetary) or injurers are risk averse, negligence with cause in fact may in fact yield a lower level of precaution than strict liability. See Macminn (2002).

[49] See footnote 10.

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It is easy to prove the following:

Proposition 5: *Under the negligence rule, minimum regulation can remove the disappearing defendant problem as it removes the judgment proof problem.*

The injurer's cost function under the negligence rule is as follows:

$$\min_x \begin{cases} ap(x)h(x) + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases} \tag{11}$$

The first line in (11) is minimized by $x_a < x^*$, which solves $p'h(x) + p(x)h' = -1/a$, whenever $a < 1$. Thus the injurer will take x^* if $x^* \leq ap(x_a)h(x_a) + x_a$. It is easy to see that there exists a certain level of the injurer's precaution level, x_r, such that $x_a < x_r < x^*$ and $x^* = ap(x_r)h(x_r) + x_r$, which guarantees $x^* \leq ap(x)h(x) + x$, for any $x \geq x_r$. The result is analogous to the one produced for the judgment proof problem.

With the negligence rule with cause in fact, however, the outcome is remarkably different.

Corollary 5.a: *Under the negligence rule with cause in fact, minimum regulation cannot remove the disappearing defendant problem.*

The injurer's cost function under the negligence rule is as follows:

$$\min_x \begin{cases} a[p(x)h(x) - p(x^*)h(x^*)] + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases} \tag{12}$$

As before, the first line in (12) is minimized by $x_a < x^*$, whenever $a < 1$, but the injurer will never take x^*. In fact for $x^* \leq a[p(x_a)h(x_a) - p(x^*)h(x^*)] + x_a$ to be satisfied we must have $ap(x^*)h(x^*) + x^* \leq ap(x_a)h(x_a) + x_a$, which can never be true by definition of x_a. Consequently, it is also easy to see that, there exists no level x_r of the injurer's precaution such that $x^* \leq a[p(x)h(x) - p(x^*)h(x^*)] + x$, or $ap(x^*)h(x^*) + x^* \leq ap(x)h(x) + x$ for any $x \geq x_r$. In fact, the only such x_r is equal to x^*. Moreover,

Proposition 6: *Under strict liability, minimum regulation cannot remove the disappearing defendant problem.*

The injurer's minimization problem under strict liability becomes:

$$\min_x [ap(x)h(x) + x] \tag{13}$$

It is easy to notice that (13) – the disappearing defendant problem – is typically different from (7) – the judgment proof problem. The injurer will take $x_a < x^*$, whenever $a < 1$. Consider a level of precaution x_R such that $ap(x^*)h(x^*) + x \leq ap(x)h(x) + x$ for any $x \geq x_R$. It is clear that, as above,

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this condition can be satisfied only by $x_R = x^*$, that is, the regulatory standard should be set at the optimal level of precaution in order to remove the disappearing defendant problem. Hence, a combination of liability and regulation is a viable way to induce first-best levels of precaution.

Above we saw a similar result in a specific case of judgment proofness, when the injurer's precaution only reduces the probability of the accident, while having no effect on the magnitude of the loss. The underlying logic of these two analogous results is the same and, in fact, when the harm is an exogenous variable, the judgment proof model can easily be rewritten as a disappearing defendant model. In both instances the injurer's cost function is monotonously increasing from x_a (x_t) towards x^*, and hence whatever the minimum standard imposed by regulation, the injurer has no incentive to take more precaution than the regulatory standard.

The disappearing defendant problem may therefore be tackled by a combination of liability and regulation only under the traditional form of the negligence rule. On the contrary, we have seen that the judgment proof problem may be counteracted by liability and minimum regulation combined under a broader set of circumstances. The results are only similar when the judgment proof problem affects accident contexts in which the injurer's precaution only reduces the probability of the accident.

6. The optimal setting and enforcement of regulation

In the previous sections, we have studied how regulation can remedy the dilution of incentives caused by the judgment proof and the disappearing defendant problems. We have concluded that, under certain conditions, a minimum regulatory standard set within a certain range and targeting only precautionary measures affecting the magnitude of the harm is enough to enable a first best functioning of tort liability. The point we make in this section is that, conversely, combining regulation with liability saves enforcement and information-gathering costs if compared with the use of regulation alone.

Concerning enforcement costs, other things being equal, such costs decrease if the regulator monitors injurers less often. As emphasized by economic theories of law enforcement, an agent can be successfully induced to comply with a rule if the expected sanction he faces if he violates the rule is at least equal to the cost of compliance. In turn, the expected sanction is given by the product of probability of apprehension and the magnitude of the sanction. Therefore, given the same fine, rules with lower costs of compliance require a lower probability of apprehension and, hence, enforcing them costs less.[50]

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[50] See footnote 12. For the sake of the argument, we are implicitly assuming that collecting fines is inexpensive. If this cost were also to be considered our argument would not be affected.

Consider an expected fine $\varphi(x)$ such that the injurer pays a (costless to apply) fine f if $x < r$ and otherwise he pays nothing.[51] Then, the probability of apprehension $\pi \in [0, 1]$ must be such that $\varphi(x) = \pi f = r$, that is $\pi = r / f$. Given the same magnitude of the fine f, the enforcement costs depend on the probability π and can be assumed unitary without loss of generality. Thus, enforcement costs π to the regulator. It is now possible to show that tort liability allows for a reduction in the enforcement costs in three ways.

First, without tort liability, the regulatory standard should be set at $r = x^*$ in order to induce first best levels of precaution.[52] Thus, the enforcement costs are $\pi^* = x^* / f$. With tort liability, instead, the regulatory standard can be set as low as $r = x_r < x^*$. Thus, the enforcement costs can be reduced to $\pi_r = x_r / f < \pi^*$, that is, a less demanding regulatory standard saves some of the regulator's costs.

Second, levels of precaution below r trigger liability. Under strict liability, this is immediately evident. Under negligence, this is so because the optimal regulatory standard is less than the liability standard and hence (automatically, under the per se rule) triggers tort liability. As a result, there can be under-enforcement of the (already lowered) regulatory standard. Concerning the negligence rule, in section 2 we have shown that the injurer will take x^* if he is prevented from taking levels of precaution lower than x_r. To make sure that the injurer takes at least $r = x_r$, the expected fine has to be such that the cost of taking r is lower that the cost of taking x_t (which would be the optimal negligent injurer's choice, as illustrated in figure 1). Therefore, the expected fine must be at least so high that $p(x_t)t + x_t + \pi f = p(x_r)t + x_r$, that is $\pi = \{[p(x_r) - p(x_t)]t + x_r - x_t\} / f < x_r / f$.[53] Hence, the regulator may enforce a level of precaution $r = x_r$ by setting an expected fine which is actually lower than the cost of compliance, that is, he may under-enforce and rely on tort liability to make up for the remaining of the sanction. The same can be shown for strict liability.

A third reason why regulation combined with tort liability is less expensive in terms of enforcement is that, as we have seen, regulation may be limited to some of the precautionary measures that the injurer can take, namely precaution z affecting the magnitude of the harm.

The combination of liability and regulation, however, also saves information-gathering costs. In fact our analysis yields that the regulatory standard can be set anywhere within a certain

[51] A more complex design of the expected fine (e.g. a fine proportional to the injurer's care level) can in principle be possible, but it does not alter the qualitative results of our analysis. The same can be said concerning the possible costs of applying a fine. To keep matters simple, we assume that the fine is set at the maximum level allowed by the injurer's assets or by other considerations. Lowering the fine below this level increases enforcement costs as it requires more monitoring.

[52] For simplicity we consider that injurer's who are indifferent between compliance and non-compliance will comply.

[53] Since $x_r > x_t$, then $p(x_r) - p(x_t) < 0$.

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standard and hence requires less information than if it were to be set exactly at the optimal level. Relatively uninformed regulators can therefore still set regulatory standards that, freeing tort liability from the effects of the judgment proof and the disappearing defendant problem, induce first best levels of precaution.

Regulators may lack information on various elements of the model: the cost of precaution, the effect of precaution on the probability of accidents and the magnitude of the harm, the exact boundary of the optimal regulatory range and so forth. In the appendix, we analyze a possible way in which this lack of information may formally be taken into account, which is in line with previous literature.[54] We assume that regulators are not informed ex ante on the harm, which varies according to the injurer's type. This framework also accounts for the possibility that regulators set the regulatory standard outside the optimal regulatory range defined in the previous sections. Contrary to previous literature, however, our formal analysis shows that, also in this case, a positive fraction of injurers may take the first best level of precaution. The results are derived for the negligence rule. An extension to the cause in fact variant and strict liability would be tedious but straightforward, and would exceed the scope of this article. The results would then hold only under some restrictive conditions, similarly to what we have seen in the previous sections.

It is important to remark that even when regulators are perfectly (and inexpensively) informed, the saving on enforcement costs may be sufficient to make the joint use of regulation and liability more desirable than regulation alone. Therefore, our point is different from that already made in the literature, which is only grounded in the fact that regulators may be less informed than courts.

7. Concluding remarks

In this paper we argue that regulation and tort liability can be profitably combined when regulation can solve the dilution of liability incentives caused by the judgment proof or the disappearing defendant problem and liability can make regulation less expensive to apply. We hereby offer some additional remarks.

(a) The philosophy of minimum regulation

Its sole purpose is to correct the shortcomings of ex post liability. If the injurer is required by this type of regulation to take a positive level of precautions, but less than the optimal level, he might be led to take the optimal level under tort law. In essence, the philosophy of minimum regulation

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[54] See in particular Shavell (1984) and Schmitz (2000).

is to make sure actors are unable to escape responsibility for the negative externalities they cause. Holding them responsible is a task for liability law.

(b) Applicability to contracts.

Although our analysis only considers tort law, minimum regulation is a concept with a wider applicability. For instance, the incentives of contract law are also undermined by potential insolvency. Some forms of market regulation (like prudential regulation for banks, legal obligations in the eve of bankruptcy, consumer safety regulation) clearly have an insolvency preventing function as well.

(c) The per se negligence rule.

The negligence per se rule means that the violation of regulatory standards is a sufficient condition for a finding of negligence, which does not need to be further proved. We have supported this rule on the grounds that, given that the optimal regulatory standard combined with liability should be lower than the liability standard, violation of the former logically implies violation of the latter. As a result, making a finding of negligence easier may be a good way to reduce the cost of bringing a liability suit. In addition, if the violation of the regulatory standard triggers both the regulatory sanction and (if an accident occurs) also the payment of damages, enforcement of the regulatory standard is less expensive than without tort liability because the apprehension rate can be further lowered. However, we have also stated that the regulatory standard may be set at a uniform level for a whole population of injurers[55] and thus it may well be optimal for most of them but simply too high for some. In this event, the case for the per se rule is weakened, as it may not be the case that some over-deterrence be the reasonable price to pay for the application of a simple and rather inexpensive rule.

(d) Recommendation for doctrinal qualification.

It is important to distinguish the type of regulation this paper analyzes from other types of regulation. The compliance defense should indeed not be conclusive for the former, while this may not be the case for other types of regulation. In different settings than ours, it may indeed well be the case that regulation is a superior instrument to managing risks in society (as Huber, 1985, and Viscusi, 1988, suggested). Current legal doctrines insufficiently distinguish among the two. It is well possible that the overexpansion of tort law is partly caused by an insufficiently refined doctrinal distinction between these fundamentally different regulatory types.

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[55] See the appendix for a formal analysis of this issue.

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Appendix

In the following, we will apply our model to a population of injurers. Alternatively, the population can be seen as to describe a single injurer whose type is uncertain. To keep the analysis simple, we will assume that the harm deriving from accidents depends on the injurer's type ε, distributed according to $f(\varepsilon) > 0$ over $\varepsilon \in [\alpha, \omega]$, and with cumulative distribution $F(\varepsilon) \geq 0$. While judges observe the injurer's type ex post, regulators only know its probability distribution. Ex ante, the social cost function is:[56]

$$S(x, \varepsilon) = p(x)h(x, \varepsilon) + x$$

As a result, the first best level of precaution that minimizes the social cost can be written as a function of the injurer's type: $x^* = x^*(\varepsilon)$, which is also the upper limit of the regulatory range.[57] We will start from the case in which all injurers have the same wealth[58] and then extend the analysis to the opposite case in which wealth varies among individuals.[59] We will start from the negligence rule and prove the following proposition.

Proposition 7: *Under negligence and regulation:*

i) there is always a positive fraction of injurers who take socially optimal precaution
ii) the optimal regulatory standard is lower than under regulation alone
iii) the social cost is lower than under regulation alone
iv) the social cost is lower than under liability alone

A1.1. All injurers have the same wealth

If all injurers have the same wealth t, which is known to the regulator, the lower limit of the regulatory range x_r is such that $p(x_r)t + x_r = x^*(\varepsilon)$.[60] Thus, also x_r can be written as a function of ε, that is, $x_r = x_r(\varepsilon)$. When setting the regulatory standard r, the regulator does not know whether r will fall within the optimal regulatory range $[x_r(\varepsilon), x^*(\varepsilon)]$ or outside of it. Given a certain r, this will depend on the injurer's type ε, as figure 4 shows. That is, for some injurers r will fall within

[56] We also assume $\partial h / \partial \varepsilon > 0$, $\partial^2 h / \partial \varepsilon^2 > 0$, and $\partial^2 h / \partial x \, \partial \varepsilon < 0$.
[57] By the implicit function theorem we have $dx^* / d\varepsilon = - (\partial^2 S / \partial x \, \partial \varepsilon) / (\partial^2 S / \partial x^2) > 0$.
[58] This is the case discussed in Shavell (1984b), who discusses judgment proofness together with the disappearing defendant problem. Schmitz (2000) shows that Shavell's (1984b) results crucially depend on the joint occurrence of these two problems and they do not hold if only one of them is present. Instead, our results hold separately for each of the problems, even though under different conditions, because we also consider cases in which the injurer can reduce the magnitude of the harm and examine the negligence rule.
[59] Schmitz (2000) discusses the issue of varying wealth by making the assumption that there are only two types of injurers: low-wealth injurers and large-wealth injurers. We will use a continuous variable.

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the regulatory range and thus they will take socially optimal precaution, while for others it will fall to the right (they take too much precaution) or to the left (they take too little precaution).

Let us thus define two cut-off levels of ε. Let β be an injurer type such that, given a certain regulatory standard r, $r = x^*(\beta)$, and let γ be a type such that $r = x_r(\gamma)$. From the analysis of the previous sections it follows that if $\varepsilon > \gamma$, then $r < x_r(\varepsilon)$, that is, the regulatory standard falls to the left of the optimal regulatory range and the injurer takes too little precaution; if $\varepsilon < \beta$, then $r > x^*(\varepsilon)$, that is, the regulatory standard falls to the right of the optimal regulatory range and the injurer takes too much precaution. Instead, if $\beta \le \varepsilon \le \gamma$, then $x_r \le r \le x^*$, that is, the regulatory standard falls within the optimal regulatory range and the injurer therefore takes the socially optimal level of precaution $x^*(\varepsilon)$. While setting r ex ante, regulators thus minimize[61]

$$E(S) = \int_{\alpha}^{\beta(r)} S(r,\varepsilon) f(\varepsilon) d\varepsilon + \int_{\beta(r)}^{\gamma(r)} S(x^*(\varepsilon),\varepsilon) f(\varepsilon) d\varepsilon + \int_{\gamma(r)}^{\omega} S(r,\varepsilon) f(\varepsilon) d\varepsilon$$

Differentiating for r, rearranging, and substituting $r = x^*(\beta)$ and $r = x_r(\gamma)$, the first order condition yields:[62]

$$\begin{aligned} &\frac{\partial \gamma(r)}{\partial r}\left[S(x_r(\gamma(r)),\gamma(r)) - S(x^*(\gamma(r)),\gamma(r))\right] f(\gamma(r)) \\ &- \int_{\gamma(r)}^{\omega} \frac{\partial S(r,\varepsilon)}{\partial r} f(\varepsilon) d\varepsilon = \int_{\alpha}^{\beta(r)} \frac{\partial S(r,\varepsilon)}{\partial r} f(\varepsilon) d\varepsilon \end{aligned} \qquad (14)$$

That is, the optimal regulatory standard r^* balances the marginal costs in terms of social welfare loss of a too low standard (which would cause under-precaution) with the marginal costs of a too high standard (which would cause over-precaution).

The first two terms in (14) depict the marginal cost of a too low regulatory standard (a standard below x_r). Figure 4 is illustrative of this situation. When the regulatory standard falls below x_r the social cost suddenly and discontinuously rises from the optimal level to an

[60] Note that x_r is a monotonically increasing function of x^*.

[61] As we have shown in the previous sections, there exists a threshold level of t (t^{n1}, t^{n2}, t^{st1}, or t^{st2}, depending on the case) above which a potentially judgment injurer takes socially optimal precaution x^* under liability alone. Thus, in this case, regulation is at best redundant (if set below x^*) and potentially harmful (if set above x^*). It is easy to show that, even if t is constant, when ε varies also the threshold level of t varies and hence the regulator cannot discriminate between cases in which regulation is necessary and cases in which it is not necessary. The fact that regulation may be implemented even when unnecessary affects the model as follows. If $t > t^{n1}$, then we have $\gamma = \omega$, that is the region in which regulation induces under-precaution shrinks until it completely disappears. The same applies to the model with varying assets.

[62] Although figure 4 shows a discontinuity, $E(S)$ does not necessarily depict such discontinuity as it also depends on the distribution of the error factor. For the sake of the argument it is reasonable to assume that $E(S)$ is continuously differentiable and convex in r.

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inefficient level. The first term in (14) accounts for this discontinuity, while the second term[63] accounts for the marginal rise in social cost (the slope of the function).

The last term in (14) depicts the marginal cost of a too high standard, which, as it is evident from figure 4, rises continuously as the regulatory standard overcomes the socially optimal level of precaution. If the regulatory standard is too low and falls below x_t, which is the level of precaution that a judgment proof injurer would take under liability alone, the injurer takes x_t, which justifies the flat left-hand side segment in figure 4.[64]

The proportion of injurers that take socially optimal precaution is given by

$$F(\gamma(r^*)) - F(\beta(r^*)) \tag{15}$$

which is positive if $\gamma(r^*) > \beta(r^*)$ and zero if $\gamma(r^*) = \beta(r^*)$. Under the negligence rule, it follows from proposition 1 that $x_r(\varepsilon) < x^*(\varepsilon)$ for any ε, which implies that $\gamma(r^*) > \beta(r^*)$.[65] Thus, under the negligence rule there is always a positive fraction of the injurers who take socially optimal precaution.

It is also easy to see that the combination of regulation and liability is superior to regulation alone and that, when combined with liability, regulation should be set at a lower level. In fact, under regulation alone, all injurers will take r. The optimal r in this case is equal to the expected optimal level of precaution x^E that minimizes the ex ante social cost:[66]

$$\overline{S}(x) = \int_{\alpha}^{\omega} S(x,\varepsilon) f(\varepsilon) d\varepsilon$$

and thus solves

$$\int_{\alpha}^{\omega} \frac{\partial S(x,\varepsilon)}{\partial x} f(\varepsilon) d\varepsilon = 0$$

Substituting x^E into the first derivative of $E(S)$ we obtain:

$$\frac{\partial \gamma(x^E)}{\partial x^E}\left[S(x^*(\gamma(x^E)),\gamma(x^E)) f(\gamma(x^E)) - S(x^E,\gamma(x^E)) f(\gamma(x^E))\right]$$
$$-\int_{\beta(x^E)}^{\gamma(x^E)} \frac{\partial S(x^E,\varepsilon)}{\partial x^E} f(\varepsilon) d\varepsilon$$

[63] Note that this term is positive, since the derivative of the social cost is negative to the left of x^*.

[64] Since under the assumptions of this section the regulator knows x_t, the regulatory standard will never be set below this level. Therefore, this possibility is not accounted for in the analysis that follows.

[65] In fact, $x_r(\varepsilon) < x^*(\varepsilon)$ implies $x_r(\beta(r^*)) < x^*(\beta(r^*))$. Recalling that $r = x^*(\beta)$ and $r = x_r(\gamma)$, we can write $x_r(\gamma(r^*)) = x^*(\beta(r^*))$, which implies $\gamma(r^*) > \beta(r^*)$.

[66] See also Shavell (1984b) on this point.

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Since $\gamma(x^E) > \beta(x^E)$, this expression is positive. Which implies that the optimal regulatory standard when regulation and liability are employed together is always lower than the optimal regulatory standard when regulation alone is implemented, $r^* < x^E$. Regulation plus liability is superior to regulation alone because, assuming regulation is set at $r = x^E$ in both cases (that is, even if we compare the optimal regulation-alone standard with a suboptimal regulation-plus-liability standard), under regulation alone all injurers take r, while under regulation plus liability some of them will take $x^*(\varepsilon)$, which clearly reduces the social cost.

The combination of liability and regulation is also superior to liability alone. Under liability alone the injurer will take either x_t or $x^*(\varepsilon)$, if the negligence standard is set at $x^*(\varepsilon)$. If regulation is added and the regulatory standard is suboptimally set at x_t, then the outcome is the same as under liability alone. Thus, by setting r^* optimally the outcome must necessarily be better.

A1.2. Injurers' wealth varies

Now also assume that the injurer's wealth is subject to random variation: t is distributed according to $g(t) > 0$ between t_{min} and t^{max}, with cumulative distribution $G(t) \geq 0$. In this case the lower limit of the regulatory range r also depends on t, as $p(x_r)t + x_r = x^*$. Thus, we can write $x_r = x_r(t, \varepsilon)$.[67] Therefore, also γ will depend on t, as it is such that $x_r(t, \gamma) = r$, which yields $\gamma = \gamma(r, t)$. As a result of the uncertainty surrounding the level of the injurer's assets, also the level of precaution taken by a judgment proof injurer $x_t(t)$ varies. For this reason, for any given level of r, not all injurers will take r. In fact, it will be convenient to take more precaution than r when $x_t > r$, precisely because compliance with regulation does not exclude liability.

In addition to the two cut-off points defined in the previous model, we also need to define a cut-off level of t above which the injurer prefers to take x_t rather than r: let t_r be a level of t such that $x_t(t_r) = r$. Hence, the expected social cost may be rewritten as follows:

$$E(S) = \int_{\alpha}^{\beta(r)} S(r,\varepsilon) f(\varepsilon) d\varepsilon + \int_{t_{\min}}^{t^{\max}} \left[\int_{\beta(r)}^{\gamma(r,t)} S(x^*(\varepsilon),\varepsilon) f(\varepsilon) d\varepsilon \right] g(t) dt$$
$$+ \int_{t_{\min}}^{t_r(r)} \left[\int_{\gamma(r,t)}^{\omega} S(r,\varepsilon) f(\varepsilon) d\varepsilon \right] g(t) dt + \int_{t_r(r)}^{t^{\max}} \left[\int_{\gamma(r,t)}^{\omega} S(x_t(t),\varepsilon) f(\varepsilon) d\varepsilon \right] g(t) dt$$

Whose first order condition yields:

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[67] It is easy to show that x_r is increasing in ε and decreasing in t.

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$$\int_{t_{\min}}^{t_r(r)}\left[\frac{\partial\gamma(r,t)}{\partial r}\left(S(r,\gamma(r,t))f(\gamma(r,t))-S(x^*(\gamma(r,t)),\gamma(r,t))f(\gamma(r,t))\right)\right]g(t)dt$$
$$+\int_{t_r(r)}^{t^{\max}}\left[\frac{\partial\gamma(r,t)}{\partial r}\left(S(x_t(t),\gamma(r,t))f(\gamma(r,t))-S(x^*(\gamma(r,t)),\gamma(r,t))f(\gamma(r,t))\right)\right]g(t)dt \qquad (16)$$
$$-\int_{t_{\min}}^{t_r(r)}\left[\int_{\gamma(r,t)}^{\omega}\frac{\partial S(r,\varepsilon)}{\partial r}f(\varepsilon)d\varepsilon\right]g(t)dt=\int_{\alpha}^{\beta(r)}\frac{\partial S(r,\varepsilon)}{\partial r}f(\varepsilon)d\varepsilon$$

As in the previous case, the optimal regulatory standard balances the marginal costs of under-precaution with those of over-precaution. However, in this case, the marginal costs of under-precaution also depend on the distribution of t, in two ways. First, the magnitude of the discontinuity in figure 4 also depends on t. For low levels of t, the injurer takes r, while for greater levels of t the injurer takes x_t. Second, the slope of the social cost curve also depends on t, but it is zero (the curve is flat) and hence does not show up in (16) when t is above t_r. The marginal cost due to over-precaution does not depend on t, because in this case the injurer always takes r. The same can be proved as in the previous subsection.[68]

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[68] We implicitly assume that liability cannot be tailored to individual wealth and thus the due level of care will not depend on t. See Ganuza and Gomez (2004) for a discussion of the negligence rule when the negligence standard is a function of the injurer's wealth, also observing that legal systems tend not to do so.

Figures

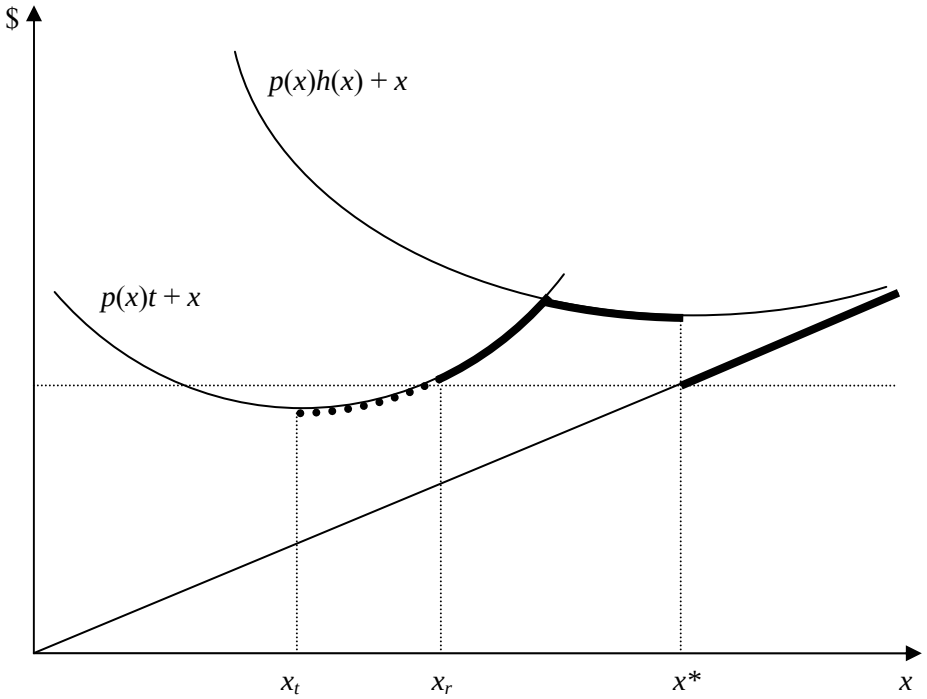

FIGURE 1: *Negligence and regulation combined* ($t < t^{st1}$)

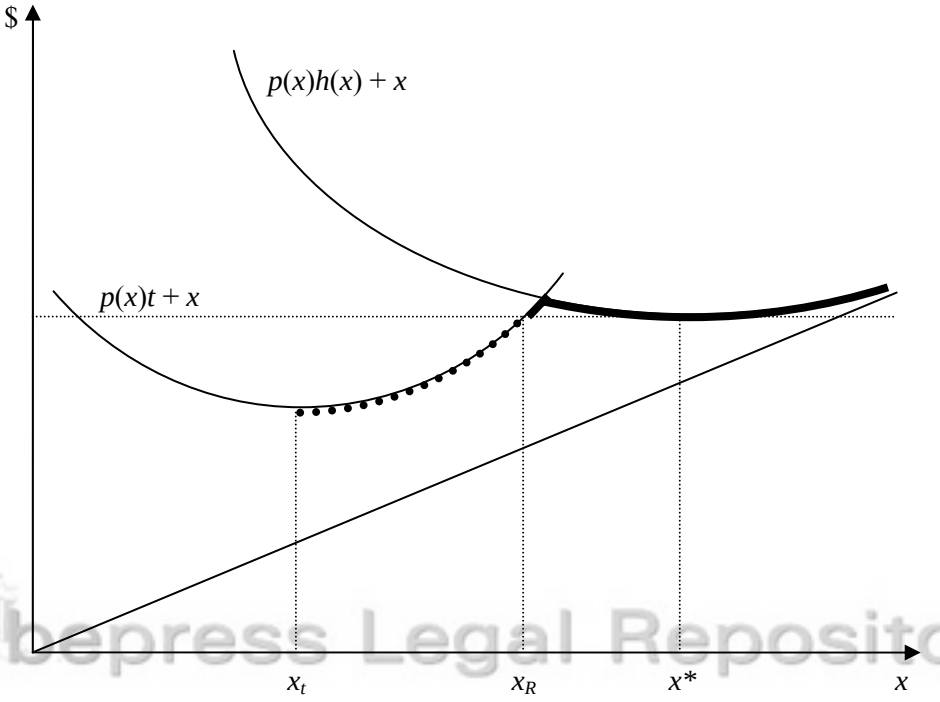

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FIGURE 2: *strict liability and regulation combined* ($t < t^{n1}$)

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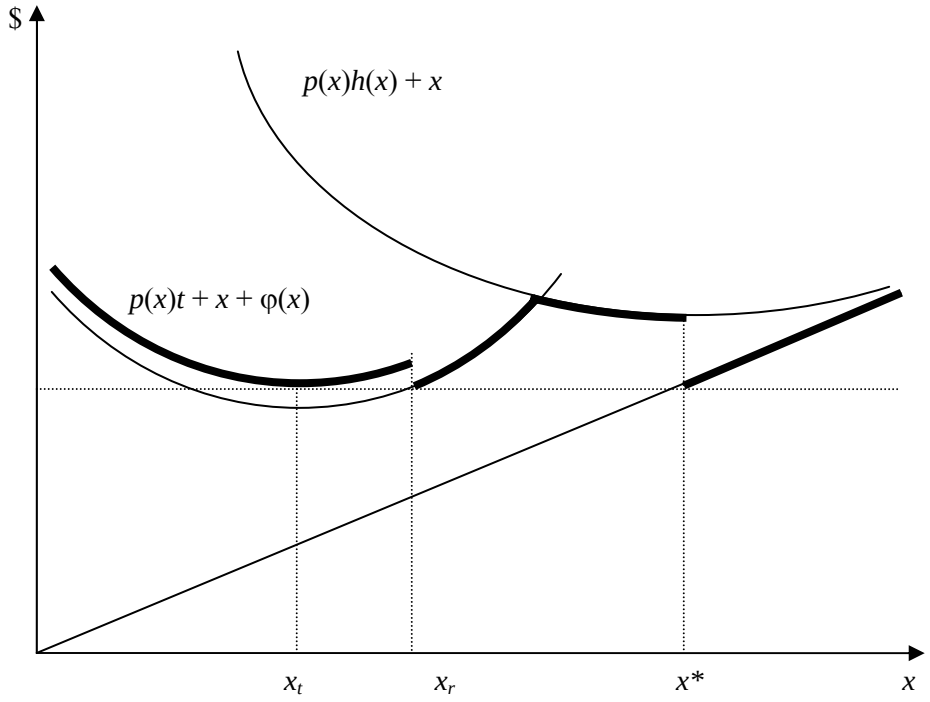

FIGURE 3: *Optimal enforcement of regulation under the negligence rule*

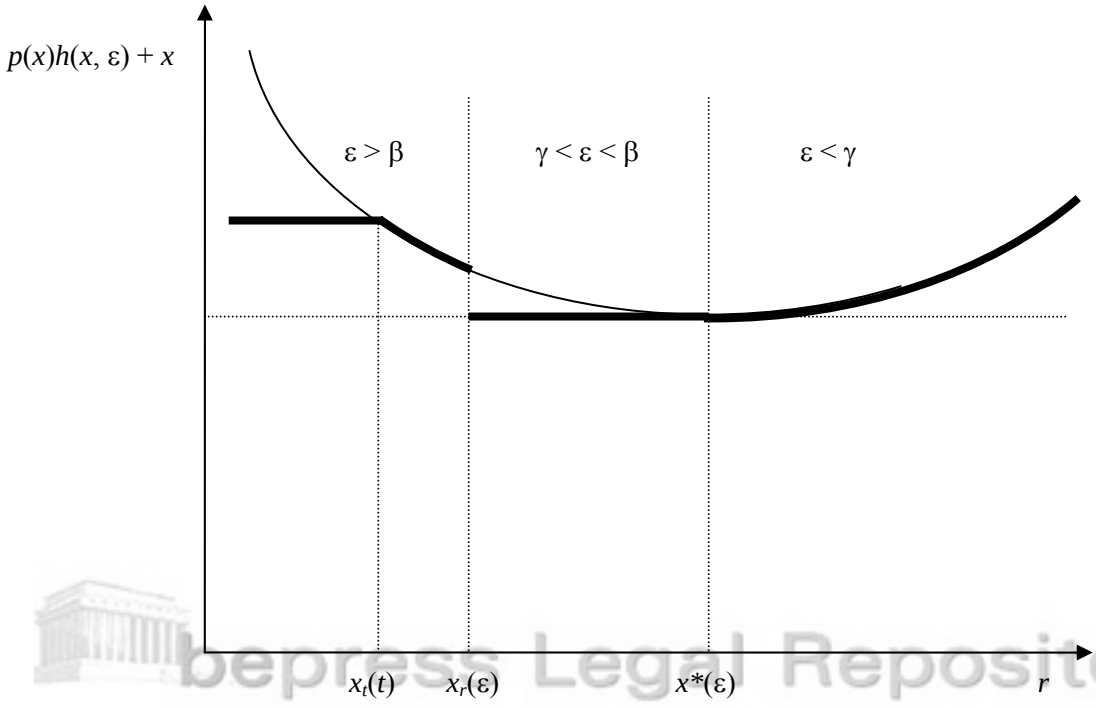

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FIGURE 4: *social loss with liability and regulation combined*