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05-01

LAW AND ECONOMICS WORKING PAPER SERIES

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DISAPPEARING DEFENDANTS V. JUDGMENT PROOF INJURERS: UPGRADING THE THEORY OF TORT LAW FAILURES

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ABSTRACT

In this paper, we study two ways in which liability can be reduced: caps (the *judgment proof problem*) versus proportional reductions (the *disappearing defendant problem*). Contrary to existing literature, we show that the judgment proof problem and the disappearing defendant problem have different incentive effects and hence yield dissimilar levels of social welfare. Moreover, when these two problems occur simultaneously they may have offsetting effects. Using a model of negligence with cause in fact, we also show that the negligence rule may yield lower (rather than greater) levels of social welfare than strict liability, depending on which of the two problems applies. Our model encompasses different precaution technologies as well as monetary vs. non-monetary precautions. The analysis is shown to have a number of theoretical and policy implications.

Keywords: insolvency, judgment proof, strict liability, negligence, disappearing defendant
JEL classification: K13, K32

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We are indebted to José Maria del Hoyo Lopez, Sonja Kesle, Eric Langlais, and the participants in the CASLE workshop at Ghent University for useful suggestions. The financial support by the DWTC, CP/01/381, is gratefully acknowledged.

1. Introduction

Liability rules provide potential injurers with incentives to take care.[1] As it often happens, this result is not achieved if injurers are not brought to court – the *disappearing defendant problem* (DD) – or if they do not pay the appropriate damage award – the *judgment proof problem* (JP).[2] Besides being a main source of concern for plaintiffs' lawyers, these issues have attracted the attention of legislatures,[3] legal scholars[4] and, since the inception of the economic analysis of tort law, also economists.[5]

Literature on this subject has established that any incidence that permits injurers to escape liability results in an externality and, consequently, in inefficient injurer precaution. This literature, however, does not distinguish between the incentive effects of DD and JP.[6] In this paper, we fill this gap in the literature, showing that DD and JP have different incentive effects both under strict liability and under negligence rules. This is due to the fact that DD is equivalent to a proportional reduction in the liability payment – damages are equal to a certain percentage of the harm –, while JP consists of a maximum cap on the damage award[7] –

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[1] This analysis also applies to settled cases insofar as settlement occurs in the shadow of the law.

[2] Note that the current use of these terms in the literature is somewhat different from ours (see further note 6). Our choice is motivated by the intuitive (almost onomatopoeic) link between this usage and the underlying notions.

[3] The CERCLA legislation of 1980, Pub.L. No. 96-510, 94 Stat. 2767 (codified as amended at 42 U.S.C. § 9601-9675 (759 F.2d 10321988 & Supp. II 1990)) and the EU Directive 2004/35/CE on environmental liability provide for environmental cleanup when no responsible party can be identified (DD). Since corporations may cause JP by selling all of their assets and distributing those proceeds of the sale the "trust fund" doctrine, recognized in most states, enforces continued liability for a brief time on former shareholders of a dissolved corporation for the corporation's debts. *Chaveriat v. Williams Pipe Line Co.*, 11 F.3d 1420, C.A.7 (Ill.), 1993, *Blankenship v. Demmler Mfg. Co.*, 89 Ill.App.3d 569, 44 Ill.Dec. 787, 789-90, 411 N.E.2d 1153, 1155-56 (1980); *In re RegO Co.*, 623 A.2d 92, 95 (Del.Ch.1992); see also Roe (1984).

[4] See Rosenberg (1984), Galanter (1996) and Gilles (2006) for a recent contribution.

[5] For the incipit of this literature see the works by Calabresi (1970), Brown (1973), Diamond (1974a and 1974b), Posner (1972), Shavell (1980), and Landes and Posner (1980). The effects of insolvency and lower apprehension rates on the injurers' incentives to take precaution were first analyzed by Summers (1983), Landes and Posner (1984), and Shavell (1986).

[6] Terminology reflects this trend. In fact, the notions of 'disappearing defendant' (Summers, 1983) and 'judgment proof injurer' (Shavell, 1986) have been used interchangeably and as synonyms to date, referring to both apprehension and insolvency problems. This paper proposes instead to distinguish between them.

[7] A related study to ours is Che and Gale (1998), analyzing the performance of different auction designs when bidders have limited willingness v. limited ability to pay. These constraints are both of the JP type, as they place

damages are equal to the harm if the harm is less than the cap, and damages are equal to the cap otherwise. In the traditional model of Summers (1983) and Shavell (1986) these situations amount to exactly the same incentive effects. Differences are only apparent if one considers more realistic extensions of this model, as we do. While some of these extensions have been analyzed in previous literature, to our knowledge these analyses have failed to (1) compare DD and JP in terms of incentive effects,[8] (2) analyze the combined effect of DD and JP and (3) notice that the negligence rule may result in less (not greater) care[9] than strict liability.

Our systematic approach has implications that go beyond the mere theoretical analysis of tort failures. DD and JP do not only result from facts of life, such as latent causation,[10] insolvency,[11] or low-value claims.[12] On the contrary, it is the legal system that often creates DD and JP, as in instances of statutes of limitations,[13] proportional or *pro rata* liability[14] (DD),

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an upper bound on the bidder's payments, although they operate in different ways in an auction setting.

[8] Even at the policy level, no clear distinction emerges. Punitive damages, the typical solution for DD (Becker, 1968; Cooter, 1989; Polinsky and Shavell, 1998), have also been advocated for JP (Boyd and Ingberman, 1994); vicarious liability (Sykes, 1981; Kornhauser, 1982; Arlen, 1994; Dari-Mattiacci and Parisi, 2003) and regulation (Shavell, 1984) are advocated in both sets of circumstances.

[9] With respect to the level of activity, see section 4.2.

[10] One important piece of legislation allows an owner or operator of a facility, to be held liable without finding causation: 42 U.S.C.A. § 9607(a)(1). Several courts explicitly have declined to read a causation requirement into section 9607(a). See *State of N.Y. v. Shore Realty Corp.*, 759 F.2d 1032, C.A.2 (N.Y.), 1985. *United States v. Cauffman*,No. CV 83-6318- KN(Bx), slip op. at 2-3 (C.D.Cal. Oct. 23, 1984) (citing other cases). The CERCLA legislation does not require causation; the EU Directive 2004/35/CE, instead, does require that causation be found.

[11] The injurer may be originally insolvent or become insolvent by the time that the harm becomes apparent (see Micheli and Segerson, 2001, on toxic torts). Even when the injurer is solvent, he may attempt to become judgment proof (Boyd and Ingberman, 1999; Arlen and MacLeod, 2005) by retaining minimal assets and/or hiding or protecting his assets so that acquisition of the assets will become more expensive for the plaintiff (Cohen, 1997, on legal malpractice).

[12] Victims may be unwilling to sue because their expected recovery is outweighed by a combination of factors: the cost of litigation might be too great, legal fees will be retained by the victim's attorney if the claim is successful, or the backlog of cases in the legal system may create a substantial delay for their own case.

[13] In addition to the normal statutes of limitation for liability claims, under CERCLA, any action for natural resource damages must commence within 3 years after the later of the either (1) the date of the discovery of the loss or (2) the date on which regulations are promulgated under section 9651(c) of the legislation (42 U.S.C.A. § 9613). In contrast, the EU Directive 2004/35/CE Article 10 states that a 5-year statute of limitations for the recovery of clean-up costs runs from date of completion of measures or identification of liable party, whichever is later.

[14] Under proportional or *pro rata* liability a defendant only pays for a fraction of the harm. This is the case for auditor liability under the Private Securities Litigation Reform Act of 1995, Pub. L. No. 104-67, 202 Stat. 737. See Narayanan (1994), Hillegeist (1999), Cousins, Mitchell and Sikka (1999) and Patterson and Wright (2003), studying auditor proportional liability; Rosenberg (1984), arguing for proportional liability in torts when causation cannot be easily established; Sollers (2001), proposing shareholder proportional liability for harm deriving from

liability caps[15] or damage caps[16] (JP). Thus, the policy relevance of our analysis is twofold, providing guidance for legal rules aimed at *remedying* existing DD and JP and shedding some light on the incentive effects of legal rules *generating* DD and JP.

Understanding the characteristics of the context in which DD and/or JP operate and the reasons why these problems arise is crucial for a correct choice of the model. To do so, we distinguish categories of accidents along two dimensions: (*i*) whether the injurer's precaution only curbs the probability of accidents (*probability model*) or it mitigates the magnitude of the accident loss (*magnitude model*)[17] and (*ii*) whether or not the precaution expenditures made by the injurer reduce his exposure to liability (*one-pocket model* or *two-pocket model*, respectively).[18] Table 1 accounts for various circumstances resulting in DD or JP and provides a

actions of the corporation. Joint and several liability may result in the apportionment of the damage payment among the jointly liable parties. See Kornhauser and Revez (2000), analyzing joint and several liability.

[15] Liability caps occur in instances of high-risk activities such as use of nuclear power, industrial activities, airlines, etc. (Innes, 2004). Liability caps involve a number of factors which we do not question here (Gillette, 1996). In the case of oil pollution, liability is limited under the Oil Pollution Act of 1990: An onshore facility's liability is capped at $350,000,000; total liability for tank vessels responsible under the Act is limited to the greater of $1200 per gross ton, $10,000,000 for vessels over 3000 tons, or $2,000,000 for vessels under 3000 tons (33 U.S.C.A. § 2701-2761).

[16] Generally, compensation is not awarded for total losses; instead, victims receive compensation in form of pecuniary damages related to the injury, in addition to an award for pain and suffering arising from the loss. Research indicates that most victims with nonfatal injuries are not fully compensated for their losses suffered (Galanter, 1996), although awards to victims have been increasing. An earlier study by Viscusi (1991) found that 62.5% of the cases awarding damages for bodily injury included damages for pain and suffering, although the pain and suffering damages varied greatly (See also Arlen, 1999). Another manner in which the law limits liability is through limited compensation for bodily injuries. For example, under Florida state law, claims against certain government agencies are limited to $100,000, per incident or occurrence, or, if liability insurance is purchased, then up to the limits of insurance coverage, whichever is greater (West's F.S.A. § 768.28). As a result, numerous cases in Florida have been limited to this damage cap (*State, Dept. of Transp. v Knowles* (1980, Fla. App. D2) 388 So 2d 1045. *See also Trianon Park Condominium Asso. v Hialeah* (1982, Fla. App. D3) 423 So 2d 911, in which the court held that aggregate damage awards to 65 home owners could not exceed a statutory maximum of $100,000 recoverable against a government defendant in actions arising from a single "incident or occurrence"). Pitchford (1995) shows that also the payment of insurance premiums may reduce the assets available for compensation, thus making the injurer (more) judgment proof.

[17] Boyd and Ingberman (1994) first made this distinction in relation to judgment proofness; Dari-Mattiacci and De Geest (2005) further elaborated on it.

[18] This terminology has been introduced by Dari-Mattiacci and De Geest (forthcoming). The two-pocket model refers to situations in which the injurer behaves as if he had two budgets: one to pay for precaution costs and the other to pay for damages. On the contrary, the one-pocket model refers to cases in which the injurer has one budget out of which both precaution expenditures and damage compensation are paid, thus the former reduces the amount of money available for the latter. Monetary precaution expenditures, for example, reduce the injurer's assets that are available for victims' compensation, while non-monetary precautions do not have the same effect. Beard (1990) first proved that judgment proof injurers behave differently in these two situations and showed that if precaution expenditures do reduce the injurer's exposure to liability, judgment proofness may result in too

pathfinder through the formal analysis.

[Table 1]

We show that while DD has invariant effects on the injurer's incentives to take precaution, the effects of JP greatly vary depending on these circumstances. Only in one case do judgment proof injurers and disappearing defendants take the same levels of precaution: when the injurer's precaution only affects the probability of the accidents and precaution expenditures do not reduce the injurer's liability (the standard two-pocket probability model used in Summers, 1983, and Shavell, 1986). Previous literature is almost unanimously based on this model.[19]

A careful analysis of the context in which the accident occurs is particularly important for JP. An obvious reason why JP may occur is because the valuation of the harm caused to the victim exceeds the injurer's assets. Here, we must consider whether or not the injurer took monetary precaution. The distinction between monetary and non-monetary precaution is essential to understanding the distinction between one-pocket and two-pocket models. Expenditures in monetary precaution will further reduce the injurer's assets, while non-monetary precaution leaves the injurer's assets unchanged. This means that when the injurer takes monetary precaution, not only does he reduce the expected accident loss, but he also reduces his exposure to liability. If the injurer takes monetary precaution and has limited assets, then the more the injurer spends in precaution, the less his assets become. This is considered a one-pocket situation. Within this model, we distinguish between the probability and the magnitude variant of the model.

If the injurer's precaution is non-monetary, the result is a two-pocket model. However, even if the injurer does take monetary precaution, but he is considered JP because of a liability cap, the cap does not change if the injurer takes more precaution, thus the result again is a two-pocket model. Also within this model, we distinguish between the probability and the magnitude variants.

Normally, when a defendant is both disappearing and judgment proof the outcome is worse

much rather than too little precaution. See also Macminn (2002) and Micheli and Segerson (2003) on this topic.

19 There are few exceptions to this trend, which we will account for while discussing the different types of

than when only one of these two problems occurs. However, since at times JP may result in injurers taking over-precaution, there are cases in which tort law failures have offsetting effects on each other and thus improve the outcome as compared with situations in which only JP or only DD materialize. This finding is particularly relevant when designing liability caps and / or proportional liability rules.

The next question that this paper addresses is whether the negligence rule may be less vulnerable to JP than strict liability. Law and economics literature on this topic unanimously answer in the positive.[20] The reason behind this result is simple: compliance with the socially optimal level of precaution is cheaper under the negligence rule than under strict liability. In fact, when the injurer takes the optimal level of precaution, he pays damages to the victim under strict liability, while he does not do so under the negligence rule. Thus, the socially desirable level of precaution is comparatively more attractive under the negligence rule than under strict liability. This feature of the negligence rule tends to counteract the effects of JP.

However, this model of negligence,[21] on which previous studies on JP are based, does not account for the causation requirement. In reality, a negligent injurer may avoid liability by showing that his negligence did not cause the accident, in the sense that the accident would have occurred even if the injurer had been non-negligent.[22] This possibility reduces the cost of non-

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models.

[20] This conclusion derives from Summers (1983) and Shavell (1986). Dari-Mattiacci and De Geest (2005) show that the traditional form of negligence is superior to strict liability also with precaution technologies different from that considered by Summers (1983) and Shavell (1986), but do not analyze cause in fact as we do in this study. Macminn (2002) suggests that injurers may take more precaution under strict liability than under negligence if cause in fact is considered. This is due to the fact that negligence with cause in fact implies a lower probability of paying damages than strict liability (since the injurer is not liable for the accidents that would have occurred even if he had not been negligent). If individuals are risk averse, strict liability implies a greater risk and hence may induce higher levels of precaution (although also the opposite may be true as risk-averse injurers may take greater care than the due level set under negligence). We do not reach the same conclusion because we focus on risk-neutral individuals. However, risk-neutral individuals may also take more care under strict liability if their precaution is monetary (i.e., in the one-pocket model introduced by Beard, 1990). We discuss this case in the text accompanying expression (22).

[21] This version of the negligence rule was first described by Brown (1973) and successively endorsed in the mainstream law and economics literature (Shavell, 1987, and Landes and Posner, 1987) and in the early articles on JP and DD (Summers, 1983, and Shavell, 1986).

[22] Causation is a general requirement both under strict liability and under negligence, in the sense that it needs to be established that the injurer's *conduct* caused the accident. We do not analyze this general requirement, as it operates in similar ways under strict liability and negligence. Instead, we focus on a specific causation requirement peculiar of the negligence rule. Even if it is clear that the injurer's *conduct* caused the accident, he

compliance and may thus erode the comparative advantage of the negligence rule. Consequently, as this paper shows, the conclusion that the negligence rule improves JP is only valid under the traditional model of negligence. This is not always true when cause in fact is taken into account.

It results that negligence with cause in fact does not improve DD, yielding the same result as strict liability. With regard to JP, the outcome depends again on the characteristics of the accident mentioned above: negligence with cause may in fact improve the problem, yield the same result as strict liability or even worsen the outcome depending on whether precaution curbs the magnitude or the probability of the accidental loss and on whether precaution expenditures reduce the injurer's exposure to liability.

This paper is organized as follows. In section 2, we present our formal analysis under strict liability and, in section 3, we extend the model to the two variants of the negligence rule. Section 4 concludes.

2. Analysis of strict liability

2.1. Model and social welfare

In this section, we will show that DD and the JP differ in terms of incentive effects. We first analyze these two problems in isolation and then evaluate their combined effects in a simple model. Our results are summarized in Table 2.

[Table 2]

We will consider accidents between an injurer and a passive victim, who are strangers to each other. Only the injurer is able to take precaution in order to reduce the expected harm to the victim. He is rational, utility maximizing and risk-neutral. Let x be the injurer's precaution cost

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will not pay damages if the accident was not caused by his *negligence*, that is, if the accident would have occurred anyway even if he had been non-negligent. This interpretation of the negligence was initially proposed by Grady (1983), who argued that such a model would be closer to the reality of tort law litigation than the traditional one employed by Summers (1983) and Shavell (1986). Kahan (1989) subsequently provided an economic formalization of the model. This rule is also known as the incremental damage rule and is discussed in Craswell and Calfee (1986). Macminn (2002) studies this type of negligence rule in one-pocket and two-pocket models and $l(x)$ the expected accident loss, with $l > 0$, $l' < 0$, $l'' > 0$. As it is usual, the objective of tort liability is taken to be the minimization of the total social cost of accidents, that is, the expected accident loss plus the precaution cost:[23]

(1) $$\min_x [l(x) + x]$$

Let x^* denote the unique level of precaution that minimizes (1) and hence solves $l' = -1$, and let it be positive. Here we analyze the injurer's behavior under strict liability; in the next section we will extend the analysis to the negligence rule. In both cases, courts are assumed to award perfectly compensatory damages to accident victims.

Under strict liability, the standard result is that a solvent injurer who faces liability for all of the accidents he causes[24] takes the socially optimal level of precaution x^*, because he fully bears his precaution costs x and is obliged to pay damages to the victim equal to the harm $l(x)$. Thus, the injurer's minimization problem is identical to (1).

2.2. Framework of analysis

The injurer's liability costs can be expressed in a general framework as following:

(2) $$\min_x [ap(x)\min\{h(x), t - bx\} + x]$$

Exp. (2) contains all the elements of our models: $0 < a \leq 1$ denotes the probability that the injurer is held liable. If we have $a = 1$, there is no DD, as the injurer is apprehended all of the time and pays for the entire harm; instead, $a < 1$ characterizes DD models, where the injurer at times escapes liability or is only liable under proportional liability. JP is more complex and requires a two-dimensional taxonomy:

i) The function $l(x)$ from Exp. (1) is specified as $p(x)h(x)$, with $p' < 0$ and $h' = 0$ or $p' = 0$ and $h' < 0$.[25] This permits us to analyze the probability and the magnitude models separately. In

under both risk neutrality and risk aversion.

[23] See Calabresi (1970), Brown (1973), and Shavell (1987) on this formulation of the social cost function.

[24] For simplicity, the issue of causation under strict liability is not discussed. We will instead elaborate upon the interaction of the negligence rule with the requirement of cause in fact in the next sections.

[25] Obviously, the assumption made on the second derivative carries on, guaranteeing that the second conditions are met throughout the analysis. Dari-Mattiacci and De Geest (2005) study a wider array of specifications for JP,

the probability model, the injurer's care only affects the probability of accidents while the magnitude is exogenous (consider for example airplane accidents); thus, the expected accident loss $l(x)$ can be simply written as $p(x)h$, where h is a constant. In the magnitude model, the probability is exogenous and the injurer's precaution only reduces the magnitude of the harm (as for example lifeboats and safety belts do); thus, the expected accident loss $l(x)$ can be simply written as $ph(x)$, where p is a constant. As it is easy to verify, these distinctions are irrelevant under DD models and therefore we will use the general function $l(x)$, which encompasses both alternatives. On the contrary, in JP models, these distinctions are relevant and hence we will employ the specific function $p(x)h$ or $ph(x)$.

ii) The parameter $t > 0$ denotes the injurer's assets (or, alternatively, a liability or damage cap established by law). As it will be shown in the analysis, if t is sufficiently large no JP arises, as the injurer will pay $h(x)$ (in the magnitude model) or h (in the probability model). Otherwise, the injurer is potentially judgment proof and the parameter $b = \{0, 1\}$ becomes important, distinguishing one-pocket ($b = 1$, the expenditure in precaution reduces the assets available for liability) and two-pocket ($b = 0$, otherwise, as when precaution is a non-monetary variable and / or the injurer's liability is capped by law) models. In the following, we will present the analysis of the different models resulting from the feasible combinations of these characteristics. When possible, parameters equal to 1 and terms equal to 0 will be omitted in order to make the models easier to read.

2.3. The disappearing defendant problem under strict liability

If a solvent injurer (t sufficiently large) faces liability only for a subset of the accidents he causes, he will not fully internalize the consequences of his actions ($a < 1$). His minimization problem is:

(3) $$\min_x [al(x) + x]$$

He will therefore take a level of precaution $x_a < x^*$, which solves $l' = -1 / a$. By the Implicit

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including cases in which the injurer's care reduces both the probability of the accident and the magnitude of the harm. These cases are not discussed in the present article as they would add complications to the analysis without altering our main results.

Function Theorem, it is also easy to see that x_a is monotonically increasing in a; that is, the injurers takes more precaution when a approaches 1 and, vice versa, his precaution level drops when a decreases towards 0. Note that the distinctions between probability and magnitude precaution and between one- and two-pocket models are irrelevant in this setting.

2.4. The judgment proof problem under strict liability

Let us now turn to JP (a = 1). In this case, a simple taxonomy of accidents in four different categories can be made along the two dimensions considered, as shown in Table 2. JP has different effects on the injurer's precaution in each of these four cases, which we will individually review.

2.4.1. The two-pocket probability model

In this model, we have $l(x) = p(x)h$ and t is not affected by the injurer's precaution expenditures (b = 0). Therefore, the injurer's minimization problem is:

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

If $t \geq h$, the injurer will take x^*. If, however, $t < h$, the injurer will take $x_t < x^*$, which solves $p' = -1 / t$, and is monotonically increasing in t. It is easy to see that this model is analogous to the DD model. In fact, by simply setting $a = t / h$, we can rewrite $p' = -1 / t$ as $l' = -1 / a$, from which the equivalence between the two problems is evident. Early literature on JP focused exclusively on this type of model; thus, it legitimately treated JP and DD as two manifestations of the same phenomenon. As we will see in the following subsections, however, JP may take very different forms. We will analyze three other possible models, and thus show that the two problems should be treated separately.

2.4.2. The one-pocket probability model

The first variation of the basic model to be considered is the case in which the injurer's expenditures on precaution reduce his exposure to liability (b = 1). If, for instance, precaution is a monetary variable, the assets available for paying damages are $t - x$, instead of simply t as in the previous model. The injurer's minimization problem therefore becomes:

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

Under this model, when the injurer is insolvent he actually receives a precaution subsidy. In fact, a portion of the precaution expenditures he makes are refunded in terms of a smaller damage payment. An insolvent injurer pays $p(x)[t - x] + x$, which may also be written as $p(x)t + [1 - p(x)]\, x$. The latter expression shows that the injurer bears only a portion of the precaution costs, because in $p(x)$ cases (that is, when an accident occurs) this cost will be balanced by an equal reduction in liability. As a result, when the injurer's assets t are particularly low, the injurer will take less than socially optimal precaution. However, with larger assets, injurers actually take more than socially optimal precaution up to a certain threshold level of t, beyond which precaution drops to the optimal level.[26]

2.4.3. The two-pocket magnitude model

In a two-pocket ($b = 0$) magnitude model, we have $l(x) = ph(x)$. Thus, the injurer's minimization problem becomes:

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

It is easy to see that the injurer's cost is either minimized by x^*, when t is sufficiently large, or by $x = 0$, when t is low.[27] This binary outcome derives from the fact that the injurer is not insolvent at all levels of precaution, because the harm is determined by his precaution expenditures. Thus, he is insolvent only when his precaution is so low that the harm is greater than his assets. As a result, insolvency is actually determined by the injurer's precaution decisions.

The injurer makes an infra-marginal choice between being solvent and being insolvent. If solvent, his optimal precaution is clearly x^*, as he bears all costs as in the social optimum. If insolvent, his optimal precaution is $x = 0$, as he bears ex ante $pt + x$, and thus any precaution

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[26] Beard (1990). For a simple proof of these claims see Dari-Mattiacci and De Geest (forthcoming).

[27] The threshold level of the injurer's assets is $t = h(x^*) + x^* / p$. Note that the injurer may take no precaution at all even when his assets are large enough to pay compensatory damage if he takes optimal precaution; that is, when $t > h(x^*)$ (Dari-Mattiacci and De Geest, 2005).

expenditure only increases his costs without reducing his exposure to liability.[28] This choice depends in turn on the size of his assets.

2.4.4. The one-pocket magnitude model

In the one-pocket variant of this model ($b = 1$), the injurer's minimization problem becomes:

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

Contrary to the one-pocket probability model, however, the precaution subsidy is not sufficient to raise the level of precaution that an insolvent injurer takes. In fact, the precaution subsidy operates only with a probability p, the probability that an accident occurs. Thus the injurer only receives a partial refund of precaution. This is also true in the probability model, but there precaution reduces the probability of the accident, and so it has a positive value for the injurer. Instead, in the magnitude model, precaution is of no value for insolvent injurers, as the probability is exogenous. Thus, we have the same outcome as in the two-pocket magnitude model: the injurer takes either $x = 0$, for low levels of t, or x^*, for higher levels of t.[29]

[Figure 1]

2.5. Disappearing defendant and judgment proofness combined

So far, we have separately analyzed the two problems at issue. In reality however, they may occur together. As we would expect, when this happens the result is a further reduction of social welfare if compared with situations in which we have either of the two alone. However, there are cases in which they do counteract each other, thus improving social welfare.

As we have seen, in a one-pocket probability model, JP may induce injurers to take excessive precaution, whereas DD always reduces the level of precaution taken by injurers. Therefore, when they are jointly present, these two opposed forces might tend to rebalance the injurer's precaution and bring it closer to the social optimum.

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[28] See Dari-Mattiacci and De Geest (2005) for a formal proof of this claim.
[29] See Dari-Mattiacci and De Geest (forthcoming) for a formal treatment of this claim.

2.5.1. Probability models

It is trivial to show that, in a two-pocket probability model, the effects of DD add to the effects of judgment proofness in lowering the level of precaution taken by the injurer. The minimization problem is:

(8) $$\min_x [ap(x)\min\{h,t\} + x]$$

When the two problems are combined (with $t < h$ and $a < 1$) the level of precaution taken by the injurer will be x_{at} which solves $p'(x) = -1 / at$, which is clearly lower than x_t (solving $p'(x) = -1 / t$) and x_a (solving $p'(x) = -1 / ah$).

In a one-pocket probability model, the minimization problem is:

(9) $$\min_x [ap(x)\min\{h,t-x\} + x]$$

In this case, the dilution of the injurer's incentives due to DD could mitigate the over-precaution problem generated by judgment proofness. Consider a potentially judgment proof injurer with assets equal to $t = h + x^*$. In such a situation, the injurer will take a level of precaution that is higher than the optimal level, that is $x^t > x^*$.[30] Let us now introduce DD, that is, a probability of apprehension of $a < 1$. The injurer now bears the following costs: $ap(x)[t - x] + x$. His level of precaution will thus be x_{at}, which solves:

(10) $$p'(x) = -\frac{\frac{1}{a} - p(x)}{t - x} < -\frac{1 - p(x)}{t - x}$$

Since $p'(x) = -[1 - p(x)]/[t - x]$ is solved by $x_t > x^*$, then the above inequality yields that x_{at} is lower than x_t. We further need to establish whether x_{at} is greater or less than x^*. The first derivative of the injurer's cost evaluated at x^* yields $ap'(x^*)[t - x^*] - ap(x^*) + 1$ and is negative if x_{at} is greater than x^* and positive otherwise. After substituting $t = h + x^*$ (as we assumed above) and $p'(x^*)h = -1$ (from the definition of x^*), we have $x_{at} \leq x^*$ if the following condition is satisfied and $x_{at} > x^*$ otherwise.

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[30] In fact, x_t solves $p'(x_t)\ (t - x_t) - p\ (x_t) + 1 = 0$. Evaluating this expression at x^*, we obtain $p'(x^*)\ (t - x^*) - p\ (x^*) + 1 = p'(x^*)h - p\ (x^*) + 1 < 0$. Thus we have $x_t > x^*$.

(11) $$a \geq \frac{1}{1 + p(x^*)}$$

Thus, if the apprehension rate is sufficiently high, DD unambiguously improves JP, as it reduces the (excessive) level of precaution taken by the injurer without resulting in under-precaution. When the equality in (11) is satisfied, we obtain the socially optimal level of precaution. Nevertheless, even when a lower apprehension rate results in some level of under-precaution, it might still be true that the social welfare is higher than under JP alone.

Conversely, it is easy to see that this situation also yields higher social welfare than DD alone. In this case, while DD unambiguously results in under-precaution, JP may in fact raise the injurer's level of precaution to a level that is closer to the social optimum.

2.5.2. Magnitude models

In a two-pocket magnitude model, instead, the two problems combined definitively lower social welfare. Consider the case in which a potentially judgment proof injurer has just enough assets to take optimal precaution. That is, assume that $t = h(x^*) + x^* / p$.[31] Let us now introduce DD, that is, the probability of apprehension is $a < 1$. The minimization problem is:

(12) $$\min_x [ap \min\{h(x), t\} + x]$$

The optimal level of precaution for a solvent injurer becomes x_{at}, such that $aph'(x_{at}) + 1 = 0$. Re-writing the initial condition as $pt = ph(x^*) + x^*$, it is easy to show that the following (in)equalities hold:

(13) $$pt = ph(x^*) + x^* \Rightarrow apt = a\big(ph(x^*) + x^*\big) < a\big(ph(x_{at}) + x_{at}\big) < aph(x_{at}) + x_{at}$$

As a result, the cost of taking no precaution at all, apt, is lower than the cost $ap(x_{at}) + x_{at}$ of taking the higher level of precaution x_{at}. Therefore, we can conclude that a potentially judgment proof injurer, who would otherwise take optimal precaution, will instead take no precaution at all due to DD. Such level of precaution is lower than the level of precaution that the injurer would take under JP alone, but also than the level that the injurer would take under DD alone,

[31] In this case the injurer is in fact indifferent between taking x^* and bearing $ph(x^*) + x^*$, and taking $x = 0$ and

which is lower than optimal but generally positive, as we have seen in the previous section. In a one-pocket magnitude model, the minimization problem is:

(14) $$\min_x [ap \min\{h(x), t - bx\} + x]$$

It is easy to see that we have the same results as in a two-pocket magnitude model.

3. Analysis of negligence

In this section, we will discuss the effects of tort law failures when the injurer is subject to liability for negligence. Under the negligence rule, the injurer pays damages only if his level of precaution was below the negligence standard, which for simplicity we assume is set at the optimal level x^*. The literature has traditionally prized the superiority of the negligence rule over strict liability as the appropriate liability rule for judgment proof injurers and disappearing defendants. The logic of this argument is simple: the negligence rule makes compliance with the optimal level of precaution cheaper, because non-negligent injurers do not compensate victims for harm. However, this result may be easily challenged when the requirement of cause in fact is introduced into the model. In this case, the defendant can exculpate himself by showing that his negligence did not cause the accident; that is, he might be able to show that the accident would have occurred anyway even if he had not been negligent. This rule results in an expected damage payment for negligent injurer that is less than under the traditional negligence rule, because it does not include damages for unavoidable accidents. For this reason, as we will show, the incentives provided by negligence with cause in fact may be inferior to those generated by the negligence rule without cause in fact and even inferior to those generated by strict liability.

The traditional model of negligence simply assumes that negligent injurers pay their precaution costs plus damage compensation to the victim, while non-negligent injurers only pay their precaution costs. The minimization problem of a (solvent and non-disappearing) injurer is:

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bearing *pt*. This point is formally proven in Dari-Mattiacci and De Geest (2005).

(15) $$\min_x \begin{cases} l(x)+x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

The traditional conclusion being that the injurer will take x^*. Nevertheless, the functioning of negligence in the courts may be different. Injurers, in fact, may claim that their negligence did not cause the accident, in the sense that the accident would have occurred even if they had been non-negligent. Therefore, a negligent injurer does not always pay damages to the victim (or he does not pay for the entire harm), as he is exonerated from paying damages that would have occurred anyway. In expected terms, the cost of those accidents amounts to $l(x^*)$. His minimization problem thus becomes:

(16) $$\min_x \begin{cases} l(x)-l(x^*)+x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

Also in this case it is easy to show that the injurer takes x^*. Although the performance of these two rules is identical under ideal conditions, it diverges when tort law failures are considered. Hereafter we will analyze the performance of these two variants of the negligence rule in the face of tort law failures. Our results are summarized in Table 3.

[Table 3]

3.1. The disappearing defendant problem under negligence

As we will see DD takes two very different forms under the two versions of the negligence rule. While negligence without cause in fact mitigates the problem, if compared to strict liability, negligence with cause in fact does not, yielding the same outcome as a strict liability rule. Under negligence without cause in fact, the injurers faces the following minimization problem:

(17) $$\min_x \begin{cases} al(x)+x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

We can see that, although the first expression in (17) is minimized by $x_a < x^*$ as soon as $a < 1$ (a situation that yields suboptimal precaution under strict liability), the injurer will still find it advantageous to take x^* if $x^* \leq al(x_a) + x_a$. Therefore there exists a threshold level of a (given by the former expression) above which the negligence rule yields socially optimal precaution, while strict liability would have induced the injurer to take too little precaution.

Under negligence with cause in fact, the conclusion reached above does not hold true. In fact, the injurer's problem is:

$$(18) \qquad \min_x \begin{cases} a[l(x) - l(x^*)] + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

The first condition in (18) is again minimized by x_a, but the condition for the injurer to take x^* becomes: $x^* \leq a[l(x_a) - l(x^*)] + x_a$, which may be rewritten as $al(x^*) + x^* \leq al(x_a) + x_a$, which can never by satisfied by definition of x_a. Therefore, the injurer will always take x_a under negligence with cause in fact as he does under strict liability.

3.2. The judgment proof problem under negligence

The performance of the negligence rule in the face of JP is quite different. The traditional negligence rule without cause in fact unambiguously improves JP as it does for DD; negligence with cause may improve JP, yield the same result as strict liability or even worsen the outcome.

3.2.1. The two-pocket probability model

Under negligence without cause in fact, the injurers faces the following minimization problem:

$$(19) \qquad \min_x \begin{cases} p(x)\min\{h,t\} + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

The first expression in (19) is minimized by $x_t < x^*$ as soon as $t < h$. However, the injurer will still find it advantageous to take x^* if $x^* \leq p(x_t)t + x_t$. Therefore, there exists a threshold level of t above which the negligence rule yields socially optimal precaution, while strict liability would have induced the injurer to take too little precaution.

Under negligence with cause in fact, the injurer's problem is:

$$(20) \qquad \min_x \begin{cases} [p(x) - p(x^*)]\min\{h,t\} + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

The first condition in (20) is again minimized by x_t if $t < h$, but, as before, the condition for the injurer to take x^* becomes: $x^* \leq [p(x_t) - p(x^*)]t + x_t$, which may be rewritten as $p(x^*)t + x^* \leq p(x_t)t + x_t$,, which can never be satisfied by definition of x_t. Therefore, the injurer will always take x_t as under strict liability. As we have concluded under strict liability, the two-pocket probability model corresponds to the DD model and the same results are reached. The results will be different in the following models.

3.2.2. The one-pocket probability model

Under negligence without cause in fact, the injurer faces the following minimization problem:

$$\text{(21)} \qquad \min_x \begin{cases} p(x)\min\{h, t-x\} + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

As soon as t is below a certain threshold level,[32] the first expression in (21) is minimized by x_t, which may be greater or less than x^*. We can see that if x_t is greater than x^* the injurer will take x^*, because he does not pay damages to the victim and hence has no incentives to increase his level of precaution above x^*. If x_t is less than x^*, then the injurer will still take x^* if $x^* \leq p(x_t)[t - x_t] + x_t$, while it always takes x_t under strict liability. Thus, also in this case, the negligence rule without cause in fact improves JP.

Under the negligence rule with cause in fact, the injurer's problem is:

$$\text{(22)} \qquad \min_x \begin{cases} [p(x) - p(x^*)]\min\{h, t-x\} + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

The first condition in (22) is minimized by $x_c < x_t$[33] and, as before, if x_c is greater than or equal to x^*, then the injurer takes x^*. If, on the contrary, x_c is less than x^*, then the injurer would take x^* only if $x^* \leq [p(x_c) - p(x^*)][t - x_c] + x_c$, which can never be the case.[34] Thus negligence with cause in fact can only correct over-precaution but not under-precaution.

It is further interesting to notice that, in the case of under-precaution, since x_c is less that x_t, the negligence rule with cause in fact results in a worse outcome compared to that of strict liability. This is due to the fact that the marginal benefit of precaution in a one-pocket model

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[32] See section 2.4.2.

[33] Consider that x_c solves $p'[t - x] - p(x) + p(x^*) + 1 = 0$. Evaluating the latter at x_t we have $p'(x_t)[t - x_t] - p(x_t) + p(x^*) + 1 = p(x^*) > 0$, which implies $x_c < x_t$. Evaluating the same expression at x^* we have $p'[t - x^*] + 1 \geq 0$ if $t \leq h + x^*$, which implies $x_c \leq x^*$. On the contrary, we have $p'[t - x^*] + 1 < 0$ if $t > h + x^*$, which implies $x_c > x^*$.

[34] The following inequality necessarily holds $x^* \leq [p(x_c) - p(x^*)][t - x_c] + x_c < [p(x_t) - p(x^*)][t - x_t] + x_t$ (by definition of x_c), which implies $x^* + p(x^*)[t - x_t] < p(x_t)\ [t - x_t] + x_t$, which in turn can never hold true by definition of x_t.

depends on the probability that the injurer will pay damages, because precaution also reduces the injurer's exposure to liability. Under negligence with cause in fact, such probability is lower because the injurer does not pay damages if the accident is not caused by his negligence, while he would have to pay under strict liability. Therefore, incentives to take precaution may be weakened by the negligence rule.[35]

3.2.3. The two-pocket magnitude model

In the two-pocket magnitude model, the difference between the two variants of the negligence rule disappears. Under the negligence rule without cause in fact the injurer's problem is:

$$(23)\qquad \min_x \begin{cases} p\min\{h(x),t\}+x & if \quad x<x^* \\ x & if \quad x\geq x^* \end{cases}$$

If $t < h(x^*) + x^* / p$, the first expression in (23) is minimized by $x = 0$, which is the level of precaution that the injurer would take under strict liability. However, here the injurer still takes x^* if $x^* \leq pt$. Thus, the threshold level of t is lower then under strict liability, as it is $t = x^* / p$. Thus the problem improves.

Under negligence with cause in fact, we have:[36]

$$(24)\qquad \min_x \begin{cases} p\min\{h(x)-h(x^*),t\}+x & if \quad x<x^* \\ x & if \quad x\geq x^* \end{cases}$$

It is easy to show that we can reach exactly the same conclusions as under negligence without cause in fact, thus the two versions of the negligence rule improve JP in the same way.

[35] See also Macminn (2002), supra footnote 20.

[36] The standard concept of cause in fact (Grady, 1983; Kahan, 1989) applies to probability precaution, implying that the injurer pays for the whole harm but not for all accidents. Applied to magnitude precaution, cause in fact implies that the injurer pays for all accidents, but not for the whole harm. He only pays for the portion of harm that would have not occurred if he had been non-negligent. Whether or not courts also apply cause in fact to the magnitude of the harm is a question we do not address in this paper, which is concerned with more theoretical issues. Moreover, our result – that cause in fact does not alter the performance of the negligence rule – would not change if we were to adopt a more conservative view of cause in fact and consider it applicable only to probability precaution. In fact, since the probability is exogenous in our model, the negligence rule with cause in fact and the same rule without cause in fact would be equivalent.

3.2.4. The one-pocket magnitude model

Under the negligence rule without cause in fact we have:

$$(25) \qquad \min_x \begin{cases} p \min\{h(x), t-x\} + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

while under negligence with cause in fact we have:

$$(26) \qquad \min_x \begin{cases} p \min\{h(x) - h(x^*), t-x\} + x & if \quad x < x^* \\ x & if \quad x \geq x^* \end{cases}$$

Both of these two models yield the same outcome as above. Thus, also in this case the negligence rule improves JP irrespective of the causation requirement.

4. Conclusions

The fundamental message of this paper is that the disappearing defendant problem and the judgment proof problem have different incentive effects, due to the fact that the former amounts to a proportional reduction in liability, while the latter consists of a cap on the liability payment. Therefore their incentive effects do not always add up when these problems are combined; on the contrary, as we show, there are cases in which they offset each other. The incentive difference persists under different liability rules. We analyze strict liability and negligence, and by taking the requirement of cause in fact into consideration, we show that the traditional claim that negligence is superior to strict liability does not always hold.

Our results have been derived using a simple model in which injurers are risk-neutral, victims are passive actors and are not able to take precaution, and issues concerning activity levels are not taken into account. Relaxing these assumptions is a task that exceeds the scope of the present analysis. In the following subsections, we limit ourselves to some considerations on existing literature and future research.

4.1. Risk aversion

Our model analyzes the behavior of risk-neutral injurers. This assumption may be justified for firms, but, in reality, most individuals are most likely risk averse. Risk-averse individuals may be expected to take different levels of precaution than risk-neutral ones,[37] because, in addition to the cost of precaution and the burden of liability, they also bear a risk-related cost as a consequence of the fact that caretaking does not eliminate the possibility of accidents but only reduces their expected costs. As shown in Macminn (2003), risk aversion may affect the relative performance of liability rules.

For example, in cases in which we show that the negligence rule with cause in fact yields the same outcome as strict liability, we emphasize that negligence with cause in fact may yield lower levels of precaution than strict liability, as the risk of paying damages is lower under the former. Under strict liability injurers face a risk of liability equal to the probability that an accident occurs, while under the negligence rule with cause in fact the probability of paying damages if negligent is lower than the probability that an accident occurs. This is because under this rule injurers do not pay damages for accidents that were not caused by their negligence.

In addition to what noted by Macminn (2003), it is further interesting to remark that risk-aversion may cause over precaution under strict liability more often than we have postulated under the risk-neutrality assumption. The negligence rule (both with and without cause in fact) is likely to solve this problem, as injurers have no incentive to take more than the required level of care.

4.2. Levels of activity

In our analysis we have focused on the levels of care, that is, we have assumed that the injurer's precaution is verifiable before the court at a negligible cost. However, injurers may be able to take some precautionary measures that are not verifiable, which are usually referred to as levels

[37] Gollier, Koehl, and Rochet (1997). The literature on insurance has long analyzed the effect of risk-aversion on the propensity for parties to undertake actions that reduce the probability of an accident and / or the magnitude of the loss. This literature goes under the heading of self-insurance v. self-protection, starting with Ehrlich and Becker (1972). See also Dionne and Eeckhoudt (1985); Briys and Schlesinger (1990); Jullien, Salanie, and Salanie (1999); Lee (1998); Chiu (2000).

of activity. Shavell (1980) shows that injurers have incentives to take such additional precautionary measures only under strict liability and do not under negligence. In the context of tort law failures, considerations concerning the levels of activity may bear on the choice between strict liability and negligence. Shavell (1986) discusses the injurer's level of activity as affected by the requirement to purchase insurance coverage.

4.3. Bilateral accidents

Analysis of the JP and DD, including ours, are generally grounded in a unilateral-care framework, in which only the injurer is able to take precautions in order to reduce the occurrence and the magnitude of accidents. This assumption may hold true in many highly risky activities, such as the management of nuclear power plants or other activities which may cause damage to a large number of people or to the environment. These activities are often characterized by the fact that victims are passive or of little help. In other contexts, however, victims' precaution may be important for accident prevention and hence tort law should in these cases also be concerned with the incentives to victims. It is known that a simple rule of strict liability will fail with respect to this task, while negligence provides incentives to take care to both parties. Nevertheless, a strict liability rule may be suitable to produce incentives for both parties by introducing a defense of negligence. The qualitative results of this analysis may still hold in a framework in which both parties' care is considered, but the quantitative effects of different liability rules will also surely depend on whether the parties' precautionary measures are substitutes or complements to each other.

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FIGURES

Circumstances	*Model*
Judgment proof problem	
Limited or hidden assets	With monetary precaution: one-pocket probability model or one-pocket magnitude model With non-monetary precaution: two-pocket probability model or two-pocket magnitude model
Liability caps	Two-pocket probability model or two-pocket magnitude model
Damage caps	Two-pocket probability model or two-pocket magnitude model
Disappearing defendant problem	
Injurer cannot be found	Two-pocket probability model
Causation difficult to establish	Two-pocket probability model
Statute of limitations	Two-pocket probability model
Low-value claims	Two-pocket probability model
Proportional liability	Two-pocket probability model
Joint and several liability	Two-pocket probability model

TABLE 1: *Disappearing defendant and judgment proof problems*

Judgment proof problem		
Probability models	*Two-pocket*	Under-precaution
	One-pocket	Under-precaution *or* over-precaution
Magnitude models	*Two-pocket*	No precaution *or* optimal precaution
	One-pocket	No precaution *or* optimal precaution
Disappearing defendant problem		Under-precaution

TABLE 2: *The effects of tort law failures under strict liability*

Judgment proof problem		**Without cause in fact**	**With cause in fact**
Probability models	*Two-pocket*	√	no
	One-pocket	√	corrects over-precaution but worsens under-precaution
Magnitude models	*Two-pocket*	√	√
	One-pocket	√	√
Disappearing defendant problem		√	no

TABLE 3: *Whether the negligence rule improves the problem compared to strict liability*

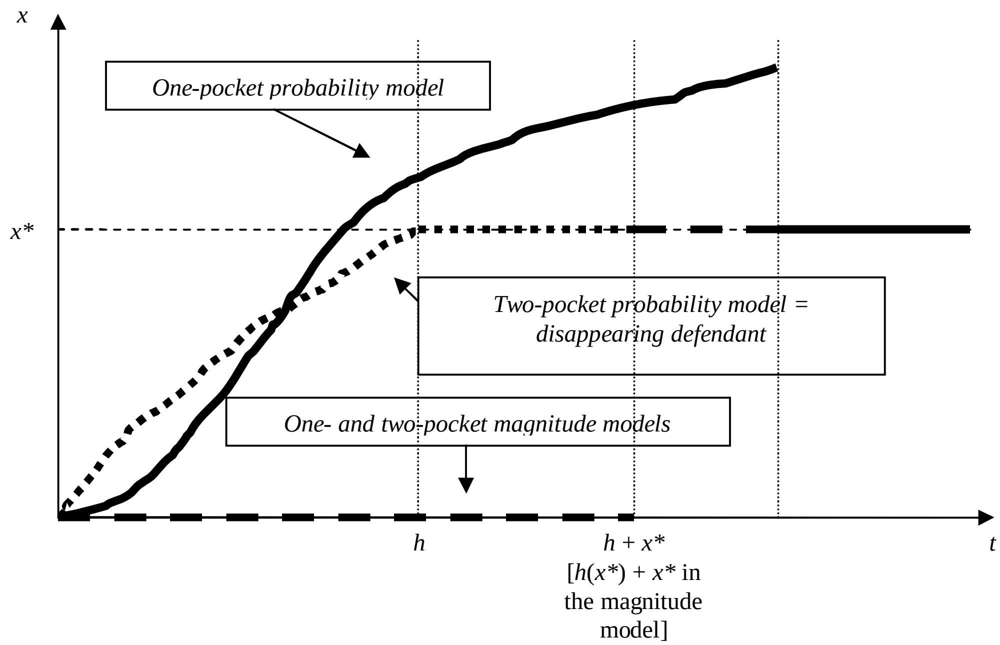

FIGURE 1: *Effects of the level of assets t on the injurer's precaution x in the different models of judgment proofness and in the model of disappearing defendant under strict liability*