DISCUSSION PAPER

August 2005 ■ RFF DP 05-21

Torts and the Protection of "Legally Recognized" Interests

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RESOURCES FOR THE FUTURE

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Abstract

The law of torts plays an important role in completing the legal property rights system by defining the extent to which property is protected from harm. It does this by defining the kinds of interests that will be recognized and protected from harm by the courts, the duty of care owed these recognized interests by others, and the manner in which they will be protected through monetary compensation, restitution, or injunction. Together, these three elements of torts define a right in the "bundle of rights" that constitute property. In this paper, we develop a systematic approach to formalizing the nature of the property rights protected by tort law. We use this approach to reexamine the literature on compensation for nonpecuniary damages. This reexamination demonstrates how recognizing tort's role in defining property rights and having a way of formalizing these rights can provide deeper insight into old questions torts scholarship.

Key Words: torts, property rights, liability, compensation, damages, insurance

JEL Classification Numbers: D31, D63, K0, K13

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Introduction

Richard Posner observed many years ago that the law of tort is primarily about protecting property rights (Posner 1977, 31). When Calabresi and Malamed wrote their groundbreaking paper on the efficiency implications of alternative means of protecting entitlements, they noted that the relationship between torts and property had been long neglected and that the questions they were examining were but one perspective on this relationship (Calabresi and Melamed 1972). This relationship is no longer neglected in the law and economics literature. A large, ongoing body of research has examined the question of when property rights are more efficiently protected by property rules or injunction and when they are more efficiently protected by liability rules (see, e.g., Ellickson 1973; Polinsky 1979; Rose-Ackerman 1985; Kaplow and Shavell 1996; Krier and Schwab 1997; Ayres and Goldbart 2003). This paper provides a different perspective on the relationship between the law of tort and property than has typically been taken in the law and economics literature.

In a society with constant social and physical interaction among individuals, a property rights system would be incomplete unless it defined the limits of permissible unintentional interference with property interests, and unless it provided a system of enforcement that gives meaning to those limits. Thus, one of the incidences of ownership must be the right to use property free from legally wrongful interference or harm by others (Keeton et al. 1988). If property can be defined as a bundle of rights (Honoré 1961; Penner 1996), then torts can properly be seen as defining and protecting specific sticks in that bundle. The role of torts in defining and enforcing property rights fulfills an important economic function that has not been fully explored in the law and economics literature. Tort law provides a reasonably objective and observable set of community standards (legal norms) that help settle expectations in the face of

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uncertainty. In the world envisioned by Arrow's and Debreu's models of exchange economies with uncertainty, tort law helps promote exchange by reducing added uncertainty about the security of initial endowments (Arrow 1952; Debreu 1959). It gives real, institutional meaning to what economic actors possess when they have an initial endowment.

In this paper we examine how one might systematically model the incidences of property created and enforced by tort law and analyze their effect on economic behavior. We then show how such a model can help provide deeper insights into the law and economics analysis of tort, using as an example the search for a unified approach to assessing compensation for nonpecuniary and pecuniary loss. The paper is organized as follows: In Section 1, we present a legal analysis of the entitlement conferred by tort law. This is then formalized in Section 2 in an economic model of the incidences of ownership defined and enforced by tort law. In Section 3 we show how this perspective on tort law can add to our understanding of the design and function of torts by reexamining the literature on insurance and tort compensation for nonpecuniary loss. We conclude in Section 4 with a summary of how tort law functions to create and protect rights in the bundle of rights that makes up property.

1 The Entitlement Conferred by Torts

The nature of the entitlement created and enforced by torts is complex. At a general level, torts has been seen as a "body of law which is directed toward the compensation of individuals [or other legal persons]…for losses which they have suffered within the scope of their legally recognized interests…where law considers that compensation is required (Keeton et al. 1984, 5–6). The Restatement of Torts Second refers to a basic purpose of torts as being to provide compensation for legally wrongful harm to protected interests (ALI 1965, §8). These basic definitions suggest that to know the nature of the entitlement created by tort protection, one needs to know 1) which interests are protected, 2) what interference is proscribed, and 3) what remedy will be provided if wrongful interference has harmed a protected interest. The incidence of the property rights created, defined, and enforced by torts is defined by these three elements.

Protected interests. The Restatement of Torts Second uses the term "interest" to denote an object of human desire (ALI 1977, §1). These interests range from interests in physical security and autonomy in the enjoyment of one's physical property or person, to interests "in emotional security and other intangible interests such as privacy," to interests "in economic security and opportunity" (Dobbs 2000, 3).

Tort law recognizes a variety of protected interests. From a formal modeling perspective, these can be thought of as bundles of tangible and intangible "goods." The most commonly protected interest can be thought of as a party's interest in the preinjury bundle of goods. If a drunk driver happens to crash into a garden wall, the garden's owner has reasonable assurance that the driver can be held liable for restoring the wall to its preinjury condition. In some circumstances, a party may have had not the actual enjoyment of the property prior to injury, but only the expectation of its future enjoyment. For example, in the case of tortious interference with contracts, tort law recognizes an interest in monetary expectations from the contract (ALI 1977, §911). In recent years, courts have heard arguments that individuals who have increased cancer risk due to exposure to a hazardous substance should be able to recover for the disutility caused by this increased risk (Cepelewicz and Wiechmann 1995). Were a court to recognize such an interest, it could be thought of as the victim's expected utility defined over potential states of health.[1] However, not all "interests" are "protected interests.“ In many instances, tort law does not recognize an object of human desire as a protected property interest. For example, in many jurisdictions a building owner has no protected interest to a view or to light unobstructed by a neighboring building, even though these features may constitute a significant portion of the property's market value (Miller and Starr 1989, §15.10). As the Restatement (ALI 1977, §1) puts it,

> If society recognizes a desire as so far legitimate as to make one who interferes with its realization civilly liable, the interest is given legal protection, generally against all the world, so that everyone is under a duty not to invade the interest by interfering with the realization of the desire.

Formally, an interest that is not protected can be thought of as a "protected" interest in the bundle of goods in their condition *after* the interference or harm.

Duty or proscribed interference. Even legally protected interests are not protected against *all* harm. Basic elements in the victim's case in a tort suit are to show that the

[1] Both here and in discussing torts' "make whole" rule of compensation, one is forced to ask whether the law looks at the subjective evaluations of the individual victim or a "representative" victim. The role of the jury in deciding not only the reasonableness of defendants' behavior in negligence cases, but also whether a particular interest is protected and whether damage awards are reasonable, suggests that what is in play is a community standard or evaluation of the victim's position rather than purely the victim's own subjective evaluation (Harper et al. 1986, §15.5 n. 10; Hetcher 2003). For simplicity of presentation, we will speak of the victim's utility. However, the modeling is perhaps better thought of as a representative consumer's utility, or more accurately, a jury's evaluation of the victim's position.

defendant's action was the legal (or proximate) cause of the victim's harm and that that action was a breach of the defendant's *duty* to the victim. That is, the plaintiff must show that the defendant harmed her by failing to meet the applicable standard of care (Keeton et al. 1988). The law and economics literature has contributed substantially to our understanding of the efficiency implications of alternative standards of care (see Shavell 1987; Miceli 1997). We take the choice of a standard as given and examine how it helps define property rights. For simplicity, we focus on the following three standards: simple negligence, strict liability, and no liability. The implications of more complex tort standards are left for future research.

Remedy. The nature of the remedy for abrogation of rights largely determines the practical meaning of a right. The standard tort remedy is monetary compensation (Keeton et al. 1988).[2] In general, courts hold that "the purpose of compensatory damages is to make the plaintiff whole—that is, to compensate the plaintiff for the damage that the plaintiff has suffered" (5th Circuit 1998, 170); or, stated differently, "torts seeks to put the victim in the position he was before the tort."[3] Juries are typically instructed that "the object of an award of damages is to place the plaintiff, as far as money can do it, in the situation he/she would have occupied if the wrong had not been committed" (Eades 1998, 3).[4]

These statements correspond very closely to the conventional economic concept of the Hicksian compensating variation as a measure of the change in a consumer's welfare. The compensating variation is the monetary compensation made after a change has occurred that

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[2] Depending on the circumstances, courts may also grant equitable relief in the form of an injunction or restitution (Keeton et al. 1988).

[3] Blackburn citing *Livingstone v. Rawyards Coal Co.* 1880 (as cited in Markesinis and Deakon (1994, 691), Restatement of Torts 2d 1977, §901).

[4] Here and elsewhere in this section, we make reference to jury instructions as collected and codified in hornbooks such as Eades (1998) and ABA (1996) because jury instructions create the expectations on which legal professionals (judges, attorneys) rely, and they effectively characterize the law for the jury as decisionmaker. Note that although the question of which interests are protected is primarily a matter of law for the court to determine, the assessment of damage awards is almost wholly the province of the jury (Eades 1998, 3, citing *Knodle v. Waikiki Gateway Hotel, Inc.*, 69 Haw. 376, 742 P.2d 377 (1987); *C.N. Brown Co. v. Gillen*, 569 A2d 1206 (Me. 1990); *Nord v. Shoreline Sav. Ass'n*, 57 Wash. App. 151, 787 P2d 66 (1990)). Efforts by judges to direct the jury to make a specific damage award, with the exception of statutory remedies such as disgorgement of profits or other restitutionary remedies, are typically overturned as being outside the court's power (see, e.g., *Canal Ins. Co. v. Cambron*, 240 GA 708, 242 S.E. 2d (1978)). Of course the jury's discretion is not without limits. The award cannot be arbitrary or without basis in evidence. Like other aspects of the trial, a jury's assessment of damages is reviewable by higher courts and can be voided for being either substantially higher or lower than the range of damages established by evidence (*Neyer v. U.S.*, 845 F2d 641 (6th Cir. 1988); *Kiser v. Schulte*, 648 A.2d (Pa. 1994)).

returns an economic agent to the utility level associated with a reference vector of goods that characterizes the prechange condition. In the tort setting, the reference vector of goods would be the bundle represented by the victim's protected interests. However, there are some important differences between the legal and economic conceptualizations of this protected interest. In tort, the jury instructions clearly indicate that 1) it is *not* the victim's evaluation of the change in her own utility that defines her protected interest and determines her compensation, it is a community evaluation of the change in her utility formed by the jury; and 2) it is not always her actual preinjury bundle of goods that counts, but rather her preinjury expectations.

For example, the most basic instruction regarding tort damages is that if the jury finds the defendant liable, they are to determine the amount of compensatory damages that would "fairly and fully" compensate the injured plaintiff (Eades 1998, 8). Jurors are not allowed to follow the "golden rule" of placing themselves in the plaintiff's shoes and granting the damages that they would wish if they themselves were the plaintiff; judgments can be voided if the judge's instructions permit jurors to do this (96 ALR 760–764 (1964)).[5] This is a corollary of the more general rule that the jury is to be instructed to avoid sympathizing with either party and to base their award on a dispassionate, fair assessment of the plaintiff's harm.[6] At the same time, juries are also admonished to award damages that are "fair compensation for *all* of the plaintiff's damages, *no more and no less*" (5th Circuit 1998, 170, emphasis added). In doing so, the jury is

[5] This is a very long-standing rule. "In *Paschall v. Williams* (1826) 11 NC (4 Hawks) 292, the Supreme Court of North Carolina criticized an instruction as to damages in an assault and battery case: if the jury were to imagine themselves placed in a similar situation with the plaintiff, what sum would they think sufficient to compensate them for such an injury;…by giving the plaintiff what they would be willing to take" (96 ALR 2d at 763 (1964)).

[6] "The damages that you award must be fair compensation for all the plaintiff's damages, no more and no less.…If you decide to award compensatory damages, you should be guided by dispassionate common sense," (5th Circuit 1998 at 170). "In determining damages,…you must not allow yourselves to be influenced by passion, prejudice, *or sympathy for one side or the other*. You must base your award solely on a fair and impartial consideration of all the evidence" (Eades 1998, 6, emphasis added).

"to apply to the facts in evidence that common knowledge and experience in life which men generally possess" (*Bates v. Friedman* (MoApp), 7 SW2d 452).[7]

Taken together, what is to be made of these rules? The prohibition on "golden rule" instructions is a clear statement that the jury is not to measure the victim's loss from the victim's subjective perspective. The admonition against sympathizing with the plaintiff is a rule against unconstrained maximization of the plaintiff's utility. Similarly, the requirement that the victim be fully compensated if liability is found rules against maximizing the defendant's utility. Thus the admonition against sympathy, coupled with the structure of the full compensation requirement and the explicit prohibition on assessing the damage award as what is desirable from the victim's own perspective, imposes a discipline on awards by requiring the jury to look evenhandedly at both the plaintiff and the defendant. The emphasis on fairness and on the jury bringing common knowledge and life experience to bear in assessing damages suggests that the jury is to apply an objective standard.[8]

As in the case of assessing the reasonableness of the defendant's conduct in negligence cases, there is a dynamic efficiency logic to these instructions for the determination of compensatory damages. The jury is intended to bring to bear experience with community expectations, both about reasonableness of behavior and fairness of compensation. Since both the injured and the injurer are presumed to live with that same general set of community expectations, they have general knowledge, in advance, of the care that is expected of them and the protection they can expect. It is this knowledge that helps settle expectations about the

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[7] Similarly, in a Michigan instruction, jurors were reminded that the purpose of compensatory damages is "limited to the amount of damages which the evidence reasonably satisfies the jury the plaintiff has sustained": "[the amount of damages] is left entirely to *the sound judgment and discretion of the jurors*.… [In determining damage awards] you are supposed to *use the same common sense and judgment about what he ought to have as you would in passing upon matters of equal importance*, the only limit being that it shall be full and fair compensation for the injuries shown to have been sustained under the testimony in the case" (*Wilton v. Flint*, 128 Mich 156, 87 NW 86, emphasis added). An Oklahoma jury in a business tort was instructed that "it is not necessary that any witness should have expressed an opinion as to the amount of such damage, but the jury may themselves make such estimate from the facts and circumstances in proof and *by considering them in connection with their knowledge, observation, and experience in business affairs of life* (*Muskogee Elec. Trac. Co. v. Mueller*, 39 Okl 63, 134 P 51, emphasis added).

[8] This is consonant with instructions on tort rules that hold that the defendant must "take their victim as they find them." For example, in assessing loss of future earnings, the jury is to consider what the plaintiff might *reasonably* have expected to earn, "given his health, education, opportunity for education, age, intelligence, industriousness" (Harper et al. 1986, sec. 25.8 nn. 4–6, emphasis added). It is not the victim's subjective assessment of her own position, but rather the jury's "fair," "impartial," "dispassionate," "commonsense" assessment of the change in position of a person with the victim's characteristics who has suffered as the victim has.

meaning of property ownership in the face of accidents and other unintentional harm (Dobbs 2000). In economic terms, the utility function that is employed for assessing the Hicksian compensating variation is something akin to that of a representative consumer. It is a representative individual from the jury's community who matches the objective position of the particular victim who has suffered this particular injury.

This is not to make light of the difficulty of measuring the compensating variation, which is often a difficult task for the jury. Even in the case of pure financial loss—as, for example, in awarding damages for tortious breach of contract—there can be significant uncertainty. This is a difficulty that courts explicitly recognize in both pecuniary and nonpecuniary damages cases.[9] For example, in a conventional business tort setting, a jury will be instructed to take into consideration "uncertainties and contingencies by which [past profits and losses] probably would have been affected,…[as well as] future uncertainties such as increase [sic] competition, increased operating costs, and changes in economic trends" (ABA 1998, 99).

2 A Formal Model of Tort Law's Protection of Legally Recognized Interests

In this section, we present a formal economic model that represents the functioning of tort law as described in the previous section. The interests protected by tort law can be represented as a bundle of market and nonmarket goods, denoted x and q, respectively. The market goods can be freely purchased at prices denoted by the vector p. The nonmarket goods cannot be purchased and their availability is fixed as far as the individual is concerned (i.e., taken by her as exogenous).[10] Given the individual's monetary wealth, denoted w, she is free to choose the bundle of market goods that gives her the maximum possible satisfaction subject to her budget constraint. The well-being she attains when confronted with prices, p, and endowed with wealth, w, and health, q, is denoted $v(p,w,q)$.[11] In the absence of an accident or injury, the

[9] "The difficulty or uncertainty in ascertaining or measuring the precise amount of any damages does not preclude recovery, and you, the jury, should use your best judgment in determining the amount of such damages, if any, based upon the evidence" (ABA 1998, 100). "If you should determine the wrong involved in this action to be of such a nature as to make it impossible to arrive at an exact figure that will reflect plaintiff's damages, you may award a sum which you can reasonably infer to reflect, roughly, compensation for the wrong" (Eades 1998, 16).

[10] Note that although we treat q as a scalar for simplicity, it could also be a vector.

[11] Following the discussion above, this utility function is taken to be that of a representative individual in the community who matches the victim's objective characteristics and circumstances, rather than her own idiosyncratic utility function. Note that since market prices do not play a significant role in the analysis that follows, to simplify the notation we will suppress prices and write the indirect utility function as $v(w,q)$.

victim's position consists of a bundle of pecuniary and nonpecuniary outcomes, w_n, and q_n, and without loss of generality, her utility in this condition can be denoted $v(w_n, q_n)$. In the event of an accident or injury, her position is denoted (w_a, q_a), where $w_a \leq w_n$ and $q_a \leq q_n$. If $w_a < w_n$, there is a pecuniary loss; if $q_a < q_n$, there is a nonpecuniary loss. In this condition, her utility is $v(w_a, q_a)$.

We consider three alternative sets of interests. One possibility is that the victim's interest is not recognized by the law; in that case, the victim could be said to have a protected interest in whatever condition she experiences after an otherwise tortious injury—that is, a protected interest in (w_a, q_a). The polar opposite case is when the victim has a protected interest in her uninjured (i.e., preinjury) condition; that is, she has a protected interest in (w_n, q_n). The third possibility is that she has a protected interest in an *expectation* over states with and without injury.

To model this expectation, we introduce π, the probability that the harm will occur.[12] Harm may result from another's actions, or it may be caused by things beyond anyone's control, as is the case with natural seepage of oil into coastal waters. In either case, the probability of harm is affected by the degree of care exercised by potential injurers, r. In tort cases, courts set a level of socially acceptable care, here denoted $\bar{r}$, either explicitly as in negligence cases or implicitly as in strict liability and no-liability cases. Since the standard of care varies for different types of torts, so too does the victim's expected level of protection. For simplicity, we consider three alternative tort rules: no liability, negligence, and strict liability. The risk of harm to potential victims is denoted $\pi(\bar{r}_{NL})$, $\pi(\bar{r}_N)$, and $\pi(\bar{r}_{SL})$. Shavell (1987) showed that where only the injurer is able to take precaution, the probability of harm decreases with the stringency of the standard of care, $\pi(\bar{r}_{NL}) > \pi(\bar{r}_N) \geq \pi(\bar{r}_{SL})$.[13] In real life, the idealized conditions that would lead everyone always to take exactly the social standard of care will never exist. Judges make errors in setting standards of care. Potential injurers have imperfect knowledge of the costs and expected consequences of taking care. Litigation is costly both financially and in terms of time. So the actual care that is taken is $\tilde{r}$, not $\bar{r}$, and the actual risk that potential victims face is

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[12] As with the utility function, the expectation represented by π is not the victim's idiosyncratic expectation but rather that of a representative member of her community who matches her objective characteristics and circumstances.

[13] Proof provided in Appendix I.

$\pi(\tilde{r})$.[14] Since victims base their behavioral decisions on the actual risk they face, their expected utility is $V(\pi(\tilde{r})) \equiv \pi(\tilde{r})v(w_a,q_a) + (1-\pi(\tilde{r}))v(w_n,q_n)$.[15] In contrast, the expectation protected by tort law is $V(\pi(\bar{r})) \equiv \pi(\bar{r})v(w_a,q_a) + (1-\pi(\bar{r}))v(w_n,q_n)$. The standard of care also affects the actual level of care taken. The actual likelihood of harm also decreases with the stringency of the standard of care, so again, $\pi(\tilde{r}_{NL}) \geq \pi(\tilde{r}_N) \geq \pi(\tilde{r}_{SL})$. Thus, both the socially "reasonable" likelihood of harm, $\pi(\bar{r})$, and the actual probability of loss, $\pi(\tilde{r})$, vary with the standard of care.

2.1 Remedies Implied by Recognized Interests

As noted above, the monetary damages afforded by tort compensation correspond to the Hicksian concept of compensating variation, hereafter denoted C. These damages vary with the protected interest and also with the required standard of care. If a victim has a protected interest in her preinjury bundle, (w_n, q_n), the compensation required to protect this interest is $C^n > 0$ such that

$$v(w_a + C^n, q_a) = v(w_n, q_n). \tag{1}$$

In this case, C^n is independent of both the socially required standard of care, $\bar{r}$, and the actual level of care, $\tilde{r}$.[16] When the loss is purely pecuniary, so that $w_a < w_n$ but $q_a = q_n$, $C^n = w_n - w_a$; thus, for the loss of a market good, C^n amounts to the market value of the good in its preinjury condition.[17] In contrast, if the victim's interest is not recognized, (w_a,q_a), no compensation is due, since only $C^a = 0$ satisfies

$$v(w_a + C^a, q_a) = v(w_a, q_a) \tag{2}$$

[14] Note that $\tilde{r}$ is *not* the level of care that defines their protected interest. Rather, they are protected against actions that do not meet the socially required standard of care, $\bar{r}$. As a result, a property interest in one's expectations is defined in terms of $\pi(\bar{r})$, not $\pi(\tilde{r})$.

[15] We are assuming that the von Neumann–Morgenstern axioms hold. This is a conventional specification of preferences and allows for the possibility of loss aversion. The basic structure of our argument would carry through for nonexpected utility as well.

[16] The results on the relative magnitudes of alternative compensation levels are proved in Appendixes II and III.

[17] This will not be the case if the injured is loss-averse or exhibits other violations of the expected utility model. How this relates to jury assessment of damages is an open question.

regardless of $\bar{r}$ and $\tilde{r}$. In the case of a protected interest in one's expectation, the compensation, C_{SoC}^{E} is such that

$$\pi(\tilde{r}_{SoC})v(w_a + C_{SoC}^{E}, q_a) + (1-\pi(\tilde{r}_{SoC}))v(w_n, q_n) = \pi(\bar{r})v(w_a, q_a) + (1-\pi(\bar{r}))v(w_n, q_n) \quad (3)$$

where the subscript SoC denotes the respective standard of care, namely strict liability (SL), negligence (N), or no liability (NL), and the superscript denotes the protected interest, in this case an expectation. Here, even though the harm is to one's expectation, the compensation is made ex post, since tort law compensates only damage that has occurred.[18] Therefore, compensation is paid only in the state of loss, $v(w_a + C^E, q_a)$. Dharmapala and Hoffmann (2005) show that there is some positive probability of injurers' violating the negligence standard, even with perfect information and no error. In real life we see injurers regularly being held liable under a negligence standards. Therefore, both theoretically and empirically, it is reasonable to assume that there is some likelihood that a victim's injury will be caused by negligent behavior. A negligence standard implies compensation C_N^E such that the victim is indifferent between having expected utility based on the social standard of care $\bar{r}_N$ and having expected utility implied by actual behavior, $\tilde{r}_N$:

$$\begin{aligned}\pi(\tilde{r}_N)v(w_a + C_N^E, q_a) + (1-\pi(\tilde{r}_N))v(w_n, q_n) \\ = \pi(\bar{r}_N)v(w_a, q_a) + (1-\pi(\bar{r}_N))v(w_n, q_n) .\end{aligned} \quad (4)$$

In strict liability cases, the tort law protects an "expectation" that the victim's interest in her preinjury bundle of goods will be protected no matter the level of precaution taken; thus,

$$\pi(\tilde{r}_{SL})v(w_a + C_{SL}^E, h_a) + (1-\pi(\tilde{r}_{SL}))v(w_n, h_n) = v(w_n, h_n). \quad (5)$$

In cases in which no duty of care is owed, and therefore no liability exists, tort law "protects" the victim's actual expectations; hence $C_{NL}^E = 0$, since this satisfies

$$\begin{aligned}\pi(\tilde{r}_{NL})v(w_a + C_{NL}^E, h_a) + (1-\pi(\tilde{r}_{NL}))v(w_n, h_n) \\ = \pi(\bar{r}_{NL})v(w_a, h_a) + (1-\pi(\bar{r}_{NL}))v(w_n, h_n).\end{aligned} \quad (6)$$

[18] One of the elements of the plaintiff's case is to prove that she has suffered damage. Only under extraordinary circumstances will a court grant ex ante relief. And then, the ex ante relief is always in the form of an injunction and never in the form of money damages.

Table 1 summarizes these compensation rules, and Table 2 characterizes the levels of expected utility corresponding to interests created and protected by each rule.

2.2 Property Rights, Damage Awards, and Initial Endowments

A few generalizations can be made about the relationship between the magnitude of tort damage awards and the property rights presented in Table 1. First, damage awards vary with property rights in two ways. They vary with the extent of the interest recognized by tort law, and they vary with the standard of care that defines the level of expected interference that the holder of the interest must tolerate without protection of law. Second, damage awards in cases where there is no duty of care are indistinguishable from those in which there is no interest recognized by law. It is observationally equivalent to say that the law does not recognize an interest and to say that it does not protect it. From a conceptual perspective, it is useful to maintain the distinction between these two cases.[19] Third, since compensating variation differs across protected interests, so do damage awards. In short, the nature of the property right determines the damage award.[20]

Proposition 1. Tort damage awards are increasing in the extent of the interest protected by tort law and in the stringency of the standard of care. These awards can be ordered as follows:

$$0 = D^a = D^n_{NL} = D^E_{NL} \le D^E_N \le D^E_{SL} = D^n . \qquad (7)$$

The value of each property right to its holder can be ranked by the utility its holder derives from the initial endowment it defines. In an environment of uncertainty, the value of each property right also turns on its holder's expectation of both the likelihood of harm and the likelihood that this harm will be remedied. Because there is some possibility that the harm is caused by events outside human control or by nontortious human action, there is some possibility that even with perfect enforcement, the harm will not have a tort remedy. Let γ denote the probability of having an injury remedied under tort law, given that an injury has occurred. We assume for simplicity both that there is no uncertainty related to litigation and that litigation is costless. The interest holder's expected utility of her property right is then

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[19] For example, for many years courts refused to recognize that victims had a compensable interest in the emotional distress associated with tortious acts. Courts did not talk about this in terms of injurers' not having a duty to avoid unreasonable infliction of emotional distress, but rather by saying that the measure of these damages was too uncertain for the court to be willing to recognize the interest (Keeton et al. 1984, 55).

[20] Proofs of propositions are given in Appendix IV.

$$V_{SoC}(\pi_{SoC}, \mathrm{w}, \mathrm{q}) = \gamma\pi_{SoC} v(w_a + D_{SoC}^{PI}, q_a) + (1-\gamma)\pi_{SoC} v(w_a, q_a) + (1-\pi_{SoC}) v(w_n, q_n). \quad (8)$$

Under strict liability, γ = 1 and expected utility is just

$$V_{SL}(\pi_{SL}, \mathrm{w}, \mathrm{q}) = \pi_{SL} v(w_a + D_{SL}^{PI}, q_a) + (1-\pi_{SL}) v(w_n, q_n). \quad (9)$$

With no liability or "no duty of care," γ = 0 and expected utility is $V_{NL}(\pi_{NL}, \mathrm{w}, \mathrm{q}) = \pi_{NL} v(w_a, q_a) + (1-\pi_{NL}) v(w_n, q_n)$. (10)

But under negligence, γ may vary from 0 to 1 and expected utility is

$$V_N(\pi_N, \mathrm{w}, \mathrm{q}) = \gamma\pi_N v(w_a + D_N^{PI}, q_a) + (1-\gamma)\pi_N v(w_a, q_a) + (1-\pi_N) v(w_n, q_n). \quad (11)$$

It follows, therefore, that the expected utility from any particular protected interest increases with the degree of protection that the protected interest is given. It also follows that because tort damage awards increase with the extent of the protected interest, so does the interest holder's expected utility of the property right protected by tort law. Based on the ranking of damage awards and Shavell's finding that the likelihood of harm decreases with the stringency of the standard of care, one can rank the value, in terms of the interest holder's expected utility, of alternative property rights, defined and protected by tort law.[21]

Proposition 2. The value, in expected utility terms, of property rights defined and protected by tort law increases with the stringency of the social standard of care and the extent of the protected interest. The value of these property rights can be ordered as follows:

$$V^a = V_{NL} \le V_N^E \le V_N^n \le V_{SL}^E = V_{SL}^n. \quad (12)$$

In short, the greater the interest protected by a property right and the more protection it is granted, the more it is worth in terms of expected utility (see Table 2). This applies as much to the right to enjoy use of one's legally recognized interests free of tortious interference by others as it does to other incidences of property ownership: the rights to possess, to transfer, to manage, or to reap income from one's property or protected interests, among others (Honoré 1961).

[21] Proofs are provided in Appendix V.

3 An Application: Insurance Demand and Products Liability

What we have shown so far is that different standards of care and different protected interests in tort law lead to 1) different levels of well-being for consumers, and 2) different amounts of damages. Next, we show that these differences will also affect a consumer's economic behavior, including a consumer's decision to purchase insurance.

Interest in the relationship between torts and insurance dates back at least to the 1950s discussions about product liability reform (Ehrenzweig 1951; James 1957; P. Keeton 1959; R. Keeton 1959; Morris 1952). More recently, a proposal has been put forward to use insurance demand as a measure of tort damages in tort cases involving a preexisting contractual relationship between the parties (Danzon 1984, Calfee and Rubin 1992). Oi (1973) noted that strict product liability effectively creates a forced tied sale of product with "insurance" because the product price would include a premium to cover the injurer's expected tort loss. Danzon (1984) argued that it would be a distortion of this market to provide injured parties with compensation greater than the insurance they would buy if they were offered insurance with the loading on the *injurer's* liability insurance. Calfee and Rubin (1992), drawing on work by Cook and Graham (1977) and Viscusi and Evans (1990), argued that this measure of damages implies that in cases where there is a preexisting contract, nonpecuniary loss should not be compensated because people would usually not insure these losses if offered actuarially fair insurance. They noted that further research was needed to determine whether this same reasoning would apply to torts where there was no preexisting contract. We are aware of no studies that have presented this analysis. Viscusi (2000) applies Calfee and Rubin's (1992) conclusion to the assessment of compensation to Kuwaitis for injuries they sustained when Kuwait was invaded by Saddam Hussein prior to the first Gulf War, but without the further analysis needed to ensure that this extension is appropriate.

In the following section, we first consider how tort law affects consumers' decisions to cover pecuniary loss, and then discuss how it affects their decisions to cover nonpecuniary loss. Many of the results we discuss are old. But we show how an understanding of the ways in which alternative tort rules define and protect legally recognized interests affect consumers' expectations—and therefore behavior—supplements existing analysis to provide a more complete understanding of the likely effect of proposals for reform in tort rules.

Insurance demand for pecuniary loss. Consider a purely monetary loss under three of the property rights described in Section 2 above: an interest in the preinjury bundle, w_n protected by no duty of care, strict liability, or the due care standard of negligence. A purely monetary loss can be represented by the change from (w_n) to (w_a), where loss is $L = w_n - w_a$. With an interest in (w_n) protected by no duty of care, and probability of loss, π_{NL}, the expected utility of the holder of this interest is $V_{NL}(\pi_{NL}, w_a, w_n) = \pi_{NL} u(w_a) + (1-\pi_{NL}) u(w_n)$. A rational, risk-averse party will choose to insure the proportion η of total loss L that maximizes expected utility of loss, given insurance:

$$V_{NL}[\eta] = \pi_{NL} u(w_n - L - \eta P + \eta L) + (1-\pi_{NL}) u(w_n - \eta P), \qquad (13)$$

where P is the insurance premium for full coverage. With actuarially fair insurance, $\pi_{NL} L = P$, the first-order condition,

$$u'(w_n - L - \eta \pi_{NL} L + \eta L) = u'(w_n - \eta \pi_{NL} L), \qquad (14)$$

will be satisfied when $\eta = 1$. Thus, where the property right is to an interest in (w_n) "protected" by no duty of care, and loss is purely monetary, a rational, risk-averse individual offered actuarially fair insurance will fully insure (Mossin 1968).

There are three senses in which this optimum constitutes full insurance. First, it is full insurance in the sense that the amount of coverage purchased exactly offsets the loss, $\eta L = L$. Second, it is full insurance in the sense that net wealth is equalized across states of the world with and without loss, $w_a^I = w_n^I$. With insurance, the individual's net income in the state of loss can be denoted w_a^I, and her net income in the state with no loss can be denoted w_n^I. In the above model, $w_a^I = w_n - L - \eta \pi_{NL} L + \eta L$ and $w_n^I = w_n - \eta \pi_{NL} L$. It follows from equation (14) that optimal insurance implies full insurance, $w_a^I = w_n^I$. Third, it is full insurance in the sense that with this insurance, utility levels are equalized across states of the world; the individual is now indifferent as to which state occurs, $U_a^I = v(w_a^I) = v(w_n^I) = U_n^I$. It should be emphasized, however, that this optimum does not return the insured party to her initial wealth or utility level. Although the purchased coverage will be the full loss, $L = w_n - w_a$, a premium must always be paid, and insured wealth will always be less than initial wealth, $w^I = w_n - P$. Utility with even full insurance is, therefore, always less than the insured's initial utility, $U^I = v(w_n - P) < v(w_n) = U^o$. Full insurance is *not* full compensation of a monetary loss.

On the other hand, if the property right is to an interest in (w_n) protected by strict liability, the same individual offered actuarially fair insurance for a purely monetary loss will not fully insure. In the event that there is no loss, she will have (w_n). In the event that there is a loss, she knows that she will receive compensation C^n that suffices to restore her income to (w_n). Her expected utility, therefore, is $V_{SL}(\bar{\pi}_{SL}, w_a . w_n) = \bar{\pi}_{SL} u(w_n) + (1-\bar{\pi}_{SL}) u(w_n) = u(w_n)$. She faces no uncertainty, and she has no reason to purchase insurance, even if it is actuarially fair. This can be seen from the individual's insurance problem:

$$\max_{\eta} V_{SL}(\eta) = \pi_{SL} v(w_n - \eta\pi_{SL} L + \eta L) + (1 - \pi_{SL}) v(w_n - \eta\pi_{SL} L). \qquad (15)$$

Optimal insurance must satisfy the first-order condition

$$v'(w_a - \eta\pi_{SL} L + \eta L) = v'(w_n - \eta\pi_{SL} L), \qquad (16)$$

which holds only when $\eta = 0$. That is, the individual will purchase no insurance.

If the property right to an interest in (w_n) is protected by the due care standard of negligence, the demand for insurance of a purely monetary loss will be still different. The potential victim's expected utility is then

$$\begin{aligned} V_N(\pi_N, \mathrm{w}, \mathrm{h}) = {} & \gamma\pi_N v(w_n - L - \eta\pi_N L + \eta L + C^n) + (1-\gamma)\pi_N v(w_n - L - \eta\pi_N L + vL) \\ & + (1 - \pi_N) v(w_n - \eta\pi_N L), \end{aligned} \qquad (17)$$

where γ is the likelihood of being compensated for damage caused by the harm. Optimal insurance must satisfy the first-order condition,

$$\gamma v'(w_a^I + C^n) + (1-\gamma) v'(w_a^I) = v'(w_n^I), \qquad (18)$$

where $w_a^I = w_n - L - \eta\pi_N L + \eta L$ and $w_a^I = w_n - \eta\pi_N L$. As long as $v'(w_a^I + C^n) \neq v'(w_n^I)$, the rational, risk-averse individual will purchase actuarially fair insurance against a monetary loss, $L = w_n - w_a$, but will not fully insure.

Two conclusions can be drawn from this analysis. The first is that even for purely monetary losses, property rights determine the demand for insurance.[22] This result should not be surprising. It is a simple application of the general theorem that competitive equilibria are continuous functions of initial endowments (Negishi 1972). The second conclusion is that with the risk of a monetary loss, the demand for insurance varies inversely with the compensation to which the victim is entitled. If there is no duty of care, there is no entitlement to compensation and the potential victim fully insures when offered actuarially fair insurance; with strict liability, the victim is entitled to full compensation and she chooses no insurance. Both the level of compensation and the purchase of insurance are functions of property rights defined by tort law.

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[22] Proofs are provided in Appendix VII.

They are inversely related precisely because the extent of property protection offered by tort law defines the risk of loss against which an individual may wish to insure.

Before concluding the discussion of torts involving a purely monetary outcome, it is useful to revisit the assumption of actuarially fair insurance. In real-world insurance markets, there are generally administrative costs associated with the issuance and administration of the insurance that raise the price of insurance above the actuarially fair premium. In a competitive insurance market, the insurance premium, *P*, will be set equal to the expected value of the loss, *E*[*L*], plus the variable cost of administering the insurance, or loading, *c*; that is, *P*=*E*[*L*]+*c*. A rational, risk-averse individual with a property interest in (w_n) protected by a no duty of care standard, who faces the risk of purely monetary loss and is offered insurance priced with a loading factor of *c*, will insure to

$$\max_{\eta} V_{NL}(\eta) = \pi_{NL} v\left(w_n - L - \eta(\pi_{NL} L + c) + \eta L\right) + (1 - \pi_{NL}) v\left(w_n - \eta(\pi_{NL} L + c)\right). \quad (19)$$

Optimal insurance demand must satisfy

$$v'\left(w_n - L - \eta(\pi_{NL} L + c) + \eta L\right) = c v'\left(w_n - \eta(\pi_{NL} L + c)\right). \quad (20)$$

If the individual were to fully insure, $\eta = 1$, this condition would hold with inequality. Faced with an insurance premium that includes a loading factor to cover administrative costs, a rational consumer would not fully insure.

As Danzon noted in 1984, this result is of particular importance under a view of tort law as compulsory insurance administered through the tort system. If compulsory insurance is administered through the tort system, the implied insurance premium must contain a substantial loading factor, since the loading factor reflects the cost of administering the insurance policy. The cost of administering an "insurance" system through torts claims is the cost of litigation and the cost of maintaining a judicial system. Thus, in very few cases would a rational individual fully insure even a monetary loss. This implies that if the insurance demanded were used as the measure of tort compensation, an investor who brings a civil action to recover damages from being defrauded by a stockbroker likely would be unable to recover her full monetary loss. Similarly, the damage award to a company that has lost substantial profit because an input supplier provided a defective product critical to its manufacturing process would be something less than actual financial losses.

Risk attitudes also influence insurance demand. In the above examples, we have assumed that the victim is risk averse. Risk-averse individuals will fully insure against monetary losses if offered actuarially fair insurance but will buy less than full coverage if the premium includes loading. Moreover, if absolute risk aversion is decreasing in wealth, as suggested by Arrow (1971), then insurance demand decreases with wealth (Mossin 1968). The logical implication of measuring tort compensation by insurance demand is that wealthier victims should be compensated less than poorer victims for the same monetary loss. This is at odds with torts rulings that bar consideration of plaintiff's wealth in determining compensatory damage awards.[23]

Insurance demand for nonpecuniary loss. As described above, nonpecuniary losses can be modeled using state-dependent or bivariate utility functions, $v(w,q)$, with the loss described by changes in the level of q. So an accident that damages only a nonmarket good would lower the injured party's utility from $v(w, q_n)$ to $v(w, q_a)$. An accident could also entail a monetary loss, such that the change is from (w_n, q_n) to (w_a, q_a). There is one special case, which will be important to our discussion, in which the distinction between bivariate and univariate utility is effectively eliminated. This is the case where money wealth, w, and the nonpecuniary outcome, *q*, are perfect substitutes, in which case the indirect utility function takes the form

$$U = v(w + q). \qquad (21)$$

In this case, money is completely fungible with other goods, not just for purchasing market commodities, as is always the case, but also in the sense that the individual perceives additional money as a perfect substitute for an adverse nonmarket outcome.[24] Since everything that the individual cares about is reducible to money in this case, (26) is effectively a univariate utility function.

Insurance in this bivariate context is different from insurance in a univariate context. In the univariate case, what is lost and what is provided by way of compensation when the loss occurs are the same item—money. The compensation is a perfect substitute for the loss, in the sense captured by the utility function (26). In the bivariate case, these are two different items: what is lost is q and perhaps *w*, whereas what is potentially available by way of compensation is more *w*, not more q. Unless the bivariate utility function has the structure of (26), the compensation is inherently *less* than a perfect substitute for what was lost. As Cook and Graham

[23] See, e.g., *Baker v. John Morrell*, 249 F. Supp. 2d 1138 (2003); and *Sielbergleit v. First Interstate Bank*, 37 F. 3 394 (1994) (reversing and remanding earlier verdict for admitting evidence of plaintiff's wealth as relevant to assessment of damages).

[24] Hanemann (1998) discusses this case and shows that perfect substitution between q and one or more market commodities in the direct utility function is a sufficient, though not necessary, condition for (18) to hold.

(1977) noted, this fundamentally changes the nature of the insurance. The conclusion that tort compensation of nonpecuniary losses provides unwanted insurance when the tort involves a preexisting contractual relationship between the parties relies heavily on this result. Cook and Graham characterize the difference in terms of the propensity of rational, risk-averse individuals to fully insure against a loss in the case of univariate utility, but less than fully insure in the case of bivariate utility. Yet it is not clear that definitions of full insurance developed under a univariate utility model apply with bivariate utility. In fact, it is not clear that one can *meaningfully* define what it means to fully insure where utility is bi- or multivariate. Looking to the univariate case, full insurance was defined in three ways. The most commonplace concept of full insurance was that coverage literally offsets the full loss, $\eta L = L$. This is really an in-kind concept of insurance, and it works in the univariate case because the loss and insurance payments are made with the same good, *w*. It does not work in the bivariate case because in this case the loss and the compensation involve two different goods, q and *w*. Alternatively, full insurance was defined as insurance coverage that smoothes wealth across states of the world. With bivariate utility, the insurance coverage that equalizes wealth across states of the world will be optimal insurance if and only if the marginal utility of wealth is independent of the nonpecuniary good. In this case, wealth is perfectly smoothed across states of the world where there is a bivariate utility and a purely nonpecuniary loss, yet there is no insurance. Finally, full insurance coverage was defined as coverage that equalizes postinsurance utility across state of the world. This is the definition of full insurance adopted by Cook and Graham (1977). They show that with bivariate utility, optimal insurance will equate utility levels across states of the world if and only if the utility function has the perfect substitution form of (26); that is, if and only if wealth is a perfect substitute for the lost nonpecuniary good. Under Cook and Graham's definition, people will fully insure. But in this case, bivariate utility is effectively univariate utility, so one has not really defined full insurance in a way that is meaningful for bi- or multivariate utility. At the very least, it is not a definition that is consistent with the definition of full insurance with univariate utility.

Under Cook and Graham's definition of full insurance, in general, people will not fully insure nonpecuniary loss. They will fully insure only as long as monetary wealth and nonpecuniary goods are perfect substitutes. That is, they will insure to equate utility across states of the world only if the marginal utility of wealth is independent of the level of the nonpecuniary good. If the marginal utility of wealth is increasing in loss of the nonpecuniary good, optimal insurance will move more wealth to the loss state. If the marginal utility of wealth is decreasing in loss of the nonpecuniary good, they will move less wealth to the loss state. Results from

Viscusi and Evans (1990) provide evidence to suggest that for most accidents involving personal injury, the marginal utility of wealth decreases with the accident. Based on Cook and Graham (1977) and Viscusi and Evans (1990), the insurance view of tort compensation concludes that most people would demand less than "full" insurance for loss of nonpecuniary goods (in the sense of smoothing utility). From this perspective, the existence of less than perfect substitution between monetary wealth and nonpecuniary goods can be seen as functioning much like loading. Even though loading leads people to less than fully insure monetary loss, courts have not yet been willing to see it as a reason to less than fully compensate tort victims for monetary loss.[25] Consistent application of use of insurance demand as a measure of tort compensation would require this.

4 Stability of Property Rights

In a framework that models how tort law defines incidences of property, the proposal to use insurance demand as a measure of tort compensation could be analyzed as a proposal to change the property right protected by torts based on efficiency concerns. U.S. courts and legislatures have made such changes in the past. The shift in product liability cases from a negligence to a strict liability standard in the mid-20th century could be modeled as a change from a property right defined as a protected interest in (w_a,q_a) protected by a negligence rule to a property right defined as a protected interest in (w_a, q_a) protected by a strict liability rule. This change was based on the efficiency argument that liability should lie with the least-cost risk bearer.

The proposal to use an insurance demand measure of tort compensation implies a property right defined as an interest in (w_n,q_n) enforced by the level of compensation that would be chosen through first-party casualty insurance, given the default protection of no liability. The proposed rule sets up a bargaining game between potential victims and the courts. Consider the decision process of a rational potential victim. The potential victim knows that if a defendant is liable, her compensable loss will be measured in terms of the insurance she would demand in a state of the world in which defendants have no liability. Under this rule, the court must set compensation equal to the victim's insurance demand. But the potential victim's best response,

[25] The collateral source rule prohibits juries from considering whether the plaintiff carried insurance when determining damage awards (Eades 1998).

knowing that the court will set compensation equal to her insurance demand, will be to revise her insurance demand accordingly. The court, in response, must revise the compensation granted. The victim's best response to this revision in compensation is to revise her insurance demand again. And the cycle goes on.

Consider the outcome of this Nash game in the case of a purely monetary loss with actuarially fair insurance with no loading and a risk-averse victim. The best response of a rational, risk-averse potential victim, seeing that her interest in (w_n) is protected under no liability, will be to demand full insurance. The court must then grant compensation equal to full insurance. The potential victim's best response to courts granting compensation equal to full insurance will be to demand no insurance. The court will then set compensation equal to zero, the new insurance demand. The process repeats itself ad infinitum. The sequence of damage awards for monetary loss can be described by the first-order difference equation

$$D_t = -D_{t-1} + L \tag{22}$$

where $D_0 = L$. The solution,

$$D_t = (-1)^t \left(D_0 - L/2\right) + L/2\,, \tag{23}$$

will oscillate forever between the alternative states of compensation equal to full insurance or no compensation. There is no stable equilibrium in this game. Tort liability, which presumably functions to provide some stability of expectations on which parties can base decisions about how to use their assets, will fail to do so.

If the loss is nonpecuniary, and assuming that the victim's marginal utility of wealth is decreasing in the nonpecuniary good, the victim's best response to a no-liability rule will be to demand less than full insurance. In this case, there will be an equilibrium level of insurance demand, but it will not be the initial insurance demand as expected under literature on insurance demand as a measure of tort compensation. A potential victim, seeing that her loss of q_n due to tortious actions will be protected by a no-liability standard, will respond by purchasing insurance, but that insurance may be more or less than full insurance. If her marginal utility of wealth is unaffected by the nonpecuniary loss, then the game will lead to the same instability encountered with monetary loss. If victims' marginal utility of wealth decreases with nonpecuniary loss, as suggested by Cook and Graham (1977) and Viscusi and Evans (1990), the picture changes. Potential victims, seeing that their loss of q_n will be protected by a no-liability rule, will best respond by choosing to carry less than full insurance. The court will set the damage award equal to this insurance demand. Potential victims, responding to the court's response, will see their loss as much smaller but nonzero, and will insure this small loss. Courts must respond by setting compensation equal to this reduced insurance demand. Potential victims, seeing their revised award, view their loss as slightly less than an uncompensated loss and will demand slightly less insurance than in the first round. Here, damage awards will also cycle according to a linear difference equation. But instead of being of the form represented by (27), it will have the general form

$$D_t = (-1/n)D_{t-1} + a \qquad (24)$$

where a and n are unknown positive constants and $D_0 = qL$ where $0<q<1$. As t => ∞, the resulting solution,

$$D_t = \left(\frac{-1}{n}\right)^t \left(D_0 - \frac{a}{1+1/n}\right) + \frac{a}{1+1/n} \qquad (25)$$

will eventually converge on a damage award, $D = \frac{a}{1+1/n}$, where $0 < \frac{a}{1+1/n} < qL$. Note that the same thing would happen with purely monetary loss and a risk-averse victim facing insurance with loading (or a tort system with positive administrative costs). Although in equilibrium the compensation rule will be stable, the resulting damage rule will not be the insurance demanded by an individual facing a loss for which there is no tort liability, $D = qL$, as is expected in the literature on insurance demand as an efficient measure of tort compensation (Calfee and Rubin 1992; Rubin 1993). Rather, it will be some unknown lower level.

Finally, consider the case of monetary loss with actuarially fair insurance, no loading, and a risk-neutral potential victim. The best response of rational, risk-neutral potential victims, seeing that their interest in (w_n) is “protected” under a no-liability rule, will be to demand *no* insurance. The court must then award no tort compensation. The court’s judgment not to award damages has no influence on the class of risk-neutral potential victims’ desire not to insurance. They will continue to demand no insurance. Although this would not be a comfortable result for most traditional tort theorists or courts, it is at least a stable rule. Is there a class of risk-neutral potential victims? The most likely candidates would be publicly held firms. In fact, the willingness of insurance companies to insure provides quite direct evidence of either risk neutrality or even a preference for risk.

Conclusion

Property law plays a critical function in a market economy by defining entitlements and settling expectations about how these entitlements will be protected. This set of expectations determines the value of the property both to its holder and to others in a market. To the extent that these expectations are well-defined and expectations about their protection are settled, market exchange is enabled. The law of torts plays an important role in completing the property rights system by defining the extent to which property is protected from harm. It does this by defining the kinds of interests that will be recognized and protected by the courts, as well as by defining the duty of care owed these recognized interests by others and the manner in which they will be protected through monetary compensation, restitution, or injunction. Together, these three elements of torts define a right in the bundle of property rights.

In this article, we develop a systematic approach to formalizing the nature of the property rights protected by tort law. We use this approach to reexamine the literature on compensation for nonpecuniary damages. This reexamination demonstrates how recognizing tort's role in defining property rights and having a way of formalizing these rights can provide deeper insight into old questions.

A fairly settled literature argues for use of insurance demand as a measure of compensation in torts, such as product liability, that involve a preexisting contractual relationship among the parties. In the case of harm to nonpecuniary goods, Calfee and Rubin (1992) argue that this compensation rule would result in not compensating damage to nonpecuniary goods in torts involving preexisting contracts.

A desire for parsimony (as well as equity) would seem to suggest that it is desirable to apply the same rule to protection of both pecuniary and nonpecuniary property. Use of formal analysis of the manner in which tort law defines property rights suggests that we have not yet solved the puzzle of finding a satisfactory, consistent compensation rule for both pecuniary and nonpecuniary loss. More importantly, it shows how use of formal analysis of the property rights defined by torts can help provide a more complete understanding of issues we thought were well understood in the law and economics literature.

References

American Bar Association (ABA), Section of Litigation. 1996. *Model Jury Instructions: Business Torts Litigation*. 3rd ed. Chicago: American Bar Association.

Arrow, Kenneth. 1952. "The Role of Securities in the Optimal Allocation of Risk-Bearing." *Review of Economic Studies* 41: 91–96.

———. 1971. *Essays in the Theory of Risk-Bearing.* Chicago: Markham Publishing Co.

Ayres, Ian, and Paul M. Goldbart. 2003. "Correlated Values in the Theory of Property and Liability Rules." *Journal of Legal Studies* 32: 121–51.

Calabresi, Guido, and A. Douglas Melamed. 1972. "Property Rules, Liability Rules and Inalienability: One View of the Cathedral." *Harvard Law Review* 85: 1089–128.

Calfee, John E., and Paul H. Rubin. June 1992. "Some Implications of Damage Payments for Nonpecuniary Losses." *Journal of Legal Studies* 21: 371–411.

Cepelewicz, Barry B., and Eric Watt Wiechmann. April 1995. "Genetic Injury in Toxic Tort Cases: What Science Can and Cannot Prove." *Defense Counsel Journal*: 201–10.

Cook, Phillip, and Donald Graham. 1977. "The Demand for Insurance and Protection: The Case of Irreplaceable Commodities." *Quarterly Journal of Economics* 91: 143–56.

Danzon, Patricia M. 1984. "Tort Reform and the Role of Government in Private Insurance Markets." *Journal of Legal Studies* 13 (August): 517–49.

Debreu, G. 1959. *Theory of Value.* New York: Wiley.

Dobbs, Dan B. 2000. *The Law of Torts.* St. Paul, MN: West Group.

Eades, Ronald W. 1998. *Jury Instructions on Damages in Tort Actions*. 4th ed. Charlottesville, VA: Lexis Law Publishing.

Ehrenzweig, Albert. 1951. *Negligence without Fault*. Berkeley: University of California Press.

Ellickson, Robert C. 1973. "Alternatives to Zoning: Covenants, Nuisance Rules, and Fines as Land Controls." *University of Chicago Law Review* 40: 681–781.

Fifth Circuit, District Judges Association Committee on Pattern Jury Instructions. 1998. *Pattern Jury Instructions (Civil Cases).* St. Paul, MN: West Group.

Hanemann, W. Michael. 1998. "The Economic Theory of WTP and TWA." In Ian Bateman and Ken Willis (eds.), *Valuing the Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EC and Developing Countries*. Oxford: Oxford University Press.

Harper, Fowler V., Fleming James Jr., and Oscar S. Gray. 1986. *The Law of Torts.* 2d ed. Boston: Little, Brown and Company.

Hofeld, Wesley Newcomb. 1919. *Fundamental Legal Conceptions as Applied in Judicial Reasoning*. New Haven: Yale University Press.

Honoré, A.M. 1961. "Ownership." In A.G. Guest (ed.), *Oxford Essays in Jurisprudence*. Oxford: Clarendon Press.

James, Fleming Jr. 1957. "General Products—Should Manufacturers Be Liable without Negligence?" *Tennessee Law Review* 24: 923–81.

Kaplow, Louis, and Steven Shavell. 1996. "Property Rules versus Liability Rules: An Economic Analysis." *Harvard Law Review* 109(4): 713–90.

Keeton, Robert E. 1959. "Conditional Fault in the Law of Torts," *Harvard Law Review.* 72(3): 401–44.

Keeton, W. Page. 1959. "Trespass, Nuisance and Strict Liability," *Columbia Law Review* 59: 457–75.

Keeton, W. Page, Dan B. Dobbs, Robert E. Keeton, and David Owen. 1984. *Prosser and Keeton on the Law of Torts* (5th Ed.). St. Paul, MN: West Publishing Co.

Keeton, W. Page, Robert Dobbs, and David Owen Keeton. 1988. *Prosser and Keeton on Torts.* 5th ed. St. Paul: West Publishing Co.

Krier, James E., and Stewart J. Schwab. 1997. "The Cathedral at Twenty-Five: Citations and Impressions." *Yale Law Journal* 106(7): 2121–147.

Landes, William M., and Richard A. Posner. 1987. *The Economic Structure of Tort Law*. Cambridge, MA: Harvard University Press.

Miceli, Thomas F. 1997. *Economics of the Law*. New York: Oxford University Press.

Morris, Clarence. 1952. "Hazardous Enterprises and Risk-Bearing Capacity." *Yale Law Journal* 61(7): 1172–79.

Mossin, Jan. 1968. "Aspects of Rational Insurance Purchasing." *Journal of Political Economy* 76(4): 553–68.

Negishi, Takashi. 1972. *General Equilibrium Theory and International Trade*. In Henri Theil (ed.), *Studies in Mathematical and Managerial Economics*, vol. 13. Amsterdam: North-Holland Publishing Co.

Oi, Walter Y. 1973. "The Economics of Product Safety." *Bell Journal of Economics* 4(1): 3–28.

Penner, J.E. 1996. "The 'Bundle of Rights' Picture of Property." *UCLA Law Review* 43: 711–820.

Polinsky, Mitchell. 1979. "Controlling Externalities and Protecting Entitlements: Property Rights, Liability Rule, and Tax-Subsidy Approaches." *Journal of Legal Studies* 8: 1–48.

Posner, Richard A. 1977, 1986, 1992. *Economic Analysis of the Law*. 3rd ed. Boston: Little, Brown.

(Restatement of Torts 2d) The American Law Institute. 1977. Restatement of Torts Second. Washington, DC: A.L.I. Publishers.

(Restatement of Torts 3rd) The American Law Institute. 1998. Restatement of Torts Third, *Products Liability*. Washington, DC: A.L.I. Publishers.

Rubin, Paul. 1993. *Tort Reform by Contract*. Washington, DC: American Enterprise Institute.

Rose-Ackerman, Susan. 1985. "Inalienability and the Theory of Property Rights." *Columbia Law Review* 85: 931–69.

Shavell, Steven. 1987. *Economic Analysis of Accident Law.* Cambridge, MA: Harvard University Press.

Viscusi, W. Kip. 2000. "Valuing the Health Consequences of War." In Jay Austin and Carl Brunch (eds.) *Environmental Consequences of War: Legal, Economic and Scientific Perspectives*. Cambridge, MA: Cambridge University Press.

———. 2000. "Misuses and Property Uses of Hedonic Values of Life in Legal Contexts." *Journal of Forensic Economics* 13: 111–25.

Viscusi, W. Kip, and William N. Evans. 1990. "Utility Functions that Depend on Health Status: Estimates and Economic Implications." *American Economic Review* 80(3): 353–74.

Tables

Table 1. Damage Awards under Tort Law

	Recognized Interests and Corresponding Compensation Rules		
	(w_n, q_n) $\Leftrightarrow C^n$ s.t. $v(w_a + C^n, q_a) = v(w_n, q_n)$	(w_a, q_a) $\Leftrightarrow C^a$ s.t. $v(w_a + C^n, q_a) = v(w_a, q_a)$	$V(\pi(\bar{r}), \mathrm{w}, \mathrm{q})$ $\Leftrightarrow C^E$ s.t. $V(\pi(\bar{r}), C^E, \mathrm{w}, \mathrm{q}) = V(\pi(\bar{r}), \mathrm{w}, \mathrm{q})$
Standards of Care/ Cause of Action			
No Duty of Care (no liability) $\forall\ r\ D = 0$	D^n_{NL} s.t. $\forall\ r$ $D^n_{NL} = 0$	D^a_{NL} s.t. $\forall\ r$ $D^a_{NL} = C^a = 0$	D^E_{NL} s.t. $\forall\ r$ $D^E_{NL} = C^E_{NL} = 0$
Negligence (reasonable care) $\forall\ r < \bar{r}\ \ D = C$	D^n_N s.t. $\forall\ r < \bar{r}$ $D^n_N = C^n$	D^a_N s.t. $\forall\ r < \bar{r}$ $D^a_N = C^a = 0$	D^E_N s.t. $\forall\ r < \bar{r}$ $D^E_N = C^E_N = 0$
Strict Liability $\forall\ r\ D = \mathrm{C}$	D^n_{SL} s.t. $\forall\ r$ $D^n_{SL} = C^n$	D^a_{SL} s.t. $\forall\ r$ $D^a_{SL} = C^a = 0$	D^E_{SL} s.t. $\forall\ r$ $D^E_{SL} = C^E_{SL}$

Table 2. Ranking of Expected Utility of Property Rights/Initial Endowments Defined and Protected under Tort Law

Ranking (1=lowest, 4=highest)	*Recognized Interest*	*Standard of Care*	*Damage Award*	*Expected Utility of Initial Endowment/Property Right*
1	(w_a, q_a)	Any	$\forall r, D^a = C^a = 0$	$V^a = (\pi_{NL})v(w_a, q_a) + (1-\pi_{NL})v(w_n, q_n)$
1	Any	no duty of care	$\forall r, D_{NL} = C_{NL} = 0$	$V_{NL} = (\pi_{NL})v(w_a, q_a) + (1-\pi_{NL})v(w_n, q_n)$
2	Expectation	negligence (reasonable care)	$\forall r < \bar{r}, D_N^E = C_N^E$	$V_N^E = \gamma\pi_N v(w_a + C_N^E, q_a) + (1-\gamma)\pi_N v(w_a, q_a) + (1-\pi_N)v(w_n, q_n)$
3	(w_n, q_n)	negligence (reasonable care)	$\forall r < \bar{r}, D_N^n = C^n$	$V_N^n = \gamma\pi_N v(w_a + C^n, q_a) + (1-\gamma)\pi_N v(w_a, q_a) + (1-\pi_N)v(w_n, q_n)$
4	Expectation	strict liability	$\forall r, D_{SL}^E = C_{SL}^E$	$V_{SL}^E = (\pi_{SL})v(w_a + C_{SL}^E, q_a) + (1-\pi_{SL})v(w_n, q_n)$
4	(w_n, q_n)	strict liability	$\forall r, D_{SL}^n = C^n$	$V_{SL}^n = (\pi_{SL})v(w_a + C^n, q_a) + (1-\pi_{SL})v(w_n, q_n)$

Note: Utility levels given equal ranking are equal.

V_{SoC}^{RI} = the expected utility of a property right in recognized interest , *RI*, protected by standard of care, *SoC*

$\bar{r}$ = due care or level of care required to avoid liability under negligence

$w = (w_a, w_n)$, $q = (q_a, q_n)$

Appendix I. Ordering of Actual Care Taken under Alternative Property Interest/Standard of Care Pairings

Let

r = level of precaution taken by tortfeasors

x = activity level

π = probability of harm

x(r); $x'(r) < 0$

π(r,x(r)); $\pi_x > 0,\ \pi_r = \frac{\partial \pi}{\partial x}\frac{\partial x}{\partial r} + \frac{\partial \pi}{\partial r} < 0.$

l(r) = victim's expected loss

$u(x)$ = tortfeasor's gross utility. $u(x) > 0, u'(x) > 0, u''(x) > 0$; for x > x̂, $u'(x) = 0$.

c(r) = tortfeasor's cost of precaution

1. Following Shavell (1987), for a given recognized interest, the Social Planner's problem is to

$$\max_{x,r} \textit{Social Welfare} = W\left(U_{tortfeasor}, \mathrm{E}\left[U\left(loss_{property\ owner}\right)\right]\right)$$

$$= u(x) - rx - l(r)$$

$$u'(x) = x \quad \Rightarrow x^*$$

$$l'(r) = -r \quad \Rightarrow r^*$$

This can be interpreted as maximization of total and therefore average net utility. Similarly, the tortfeasor's problem can be interpreted as the problem of a representative or average tortfeasor. Potential tortfeasors problem under

i) No Liability will be to

$$\max_{x,r} \quad u(x) - rx$$

$$\Rightarrow \quad r = 0, \quad x = \hat{x}$$

ii) Strict Liability, the tortfeasor's problem is the same as the social problem; that is, to

$$\max_{x,r} \quad u(x) - rx - l(r).$$

Therefore, r = r*, and

$u'(x) = r^* + l(r^*)$, which implies that x = x*.

iii) Negligence, assuming that the cost of taking care increases with the level of care taken, and that the court sets due care required to avoid liability under negligence at the socially optimal level of care, tortfeasors will take the socially optimal level of care and will not be held liable for damages. Therefore, their problem is,

given r = r*, to

$$\max_{x,r} \quad u(x) - r^* x$$

$$u'(x) = r^* < r^* + l(r^*) \quad \Rightarrow \quad x_N > x^* = x_{SL}$$

Shavell (1987).

---

2. Shavell (1987) established that for a given property interest, (w_n, h_n),

$x_{NL}^n \geq x_N^n \geq x_{SL}^n = x^*$; and $0 = r_{NL}^n \leq r_N^n = r_{SL}^n = r^*$, where x* and r* are the socially optimal level of activity and care, respectively.

i) Since $r_N^n = r_{SL}^n = r^*$, and $x_N^n > x_{SL}^n$, it follows that $\pi(r_N^n; x_N^n) > \pi(r_{SL}^n, x_{SL}^n)$.

ii) a) For a given $x = \bar{x}$, $\pi(r_{NL}^n) > \pi(r_N^n)$ since $0 = r_{NL}^n < r_N^n$.
b) For a given $r = \bar{r}$, $\pi(x_{NL}^n) > \pi(x_N^n)$ since $x_{NL}^n > x_N^n$.
Therefore, $\pi(r_{NL}^n, x_{NL}^n) > \pi(r_N^n, x_N^n)$.

It follows that $\pi(r_{NL}^n, x_{NL}^n) > \pi(r_N^n; x_N^n) > \pi(r_{SL}^n, x_{SL}^n)$.

3. For a recognized interest in (w_a, q_a), l(r) in Shavell's model is equal to zero. Therefore, no matter the standard of care, the injurer's problem is to

$$\max_{x,r} \quad u(x) - rx$$

$$\Rightarrow \quad r = 0, \quad x = \hat{x}$$

Therefore, $\pi(r_{SoC}^a, x_{SoC}^a) = \pi(r_{NL}^n, x_{NL}^n)$

4. For recognized interest in, V(π(r), w, q):

i) with strict liability, choice of x and r are independent of l(r). Since $C_{SL}^{E} = C^{n}$, it follows that l(r) is the same for V(π,w,q) and v(w_n, q_n) where both are protected by strict liability. Therefore $r_{SL}^{E} = r^{n} = r*$ and $x_{SL}^{E} = x^{n} = x*$ and $\pi\left(r_{SL}^{E}, x_{SL}^{E}\right) = \pi\left(r_{SL}^{n}, x_{SL}^{n}\right) = \pi\left(r*, x*\right)$.

ii) with negligence, by the same argument as applied by Shavell in the case of a recognized interest in $\left(w_n, q_n\right)$, on average potential tortfeasors will take precaution level r*. Since the potential tortfeasor's optimization problem for negligence is independent of l(r) and therefore of C_{SoC}^{PI}, $x_{N}^{E} = x_{N}^{n} \geq x*$.

Therefore, $\pi\left(r*, x_{N}^{E}\right) = \pi\left(r*, x_{N}^{n}\right)$.

Conclusion

Mean probability of loss is increasing in the protection given the recognized interest and independent of the particular recognized interest. That is,

$$\pi\left(r_{SoC}^{a}, x_{SoC}^{a}\right) = \pi\left(r_{NL}^{a}, x_{NL}^{a}\right) = \pi\left(r_{NL}^{E}, x_{NL}^{E}\right) = \pi\left(r_{NL}^{n}, x_{NL}^{n}\right)$$
$$\geq \pi\left(r_{N}^{E}, x_{N}^{E}\right) = \pi\left(r_{N}^{n}, x_{N}^{n}\right)$$
$$\geq \pi\left(r_{SL}^{E}, x_{SL}^{E}\right) = \pi\left(r_{SL}^{n}, x_{SL}^{n}\right) = \pi\left(r*, x*\right),$$

or: $\pi^{a} = \pi_{NL} \geq \pi_{N} \geq \pi_{SL} = \pi*$.

Appendix II. Compensation Implied by Alternative Recognized Interests

In general, C s.t. $v(\text{damaged interest} + C) = v(\text{protected property interest})$

1. C^n s.t. $v\left(w_a + C^n, \mathrm{q_a}; \mathrm{p}\right) = v\left(w_n, \mathrm{q_n}; \mathrm{p}\right)$.
   $C^n(\mathrm{w}, \mathrm{h}; \mathrm{p}) = v^{-1}\left(v\left(w_n, \mathrm{q_n}\right), \mathrm{q_a}, \mathrm{p}\right) - w_a > 0$

2. C^a s.t. $v\left(w_a + C^a, \mathrm{q_a}; \mathrm{p}\right) = v\left(w_a, \mathrm{q_a}; \mathrm{p}\right)$
   $C^a(\mathrm{w}, \mathrm{h}; \mathrm{p}) = v^{-1}\left(v\left(w_a, \mathrm{q_a}\right), \mathrm{q_a}, \mathrm{p}\right) - w_a = 0$

3. C_{NL}^E s.t. $\pi_{NL} v\left(w_a + C_{NL}^E, \mathrm{q_a}\right) + \left(1 - \pi_{NL}\right) v\left(w_n, \mathrm{q}_n\right) = \pi_{NL} v\left(w_a, \mathrm{q_a}\right) + \left(1 - \pi_{NL}\right) v\left(w_n, \mathrm{q_n}\right)$
   $C_{NL}^E = v^{-1}\left(v\left(w_a, \mathrm{q_a}\right), \mathrm{q_a}\right) - w_a = C^a = 0$

4. C_N^E s.t. $\pi_N v\left(w_a + C_N^E, \mathrm{q_a}\right) + \left(1 - \pi_N\right) v\left(w_n, \mathrm{q_n}\right) = \bar{\pi} v\left(w_a, \mathrm{q_a}\right) + \left(1 - \bar{\pi}\right) v\left(w_n, \mathrm{q_n}\right)$

$$C_N^E = v^{-1}\left(\left[\frac{\bar{\pi} v\left(w_a, \mathrm{q}_a\right) + \left(1 - \bar{\pi}\right) v\left(w_n, \mathrm{q_n}\right) - \left(1 - \pi_N\right) v\left(w_n, \mathrm{q_n}\right)}{\pi(r)}\right], \mathrm{q_a}\right) - w_a$$

$$= v^{-1}\left(\left[v\left(w_n, \mathrm{q_n}\right) + \frac{\bar{\pi}}{\pi_N}\left[v\left(w_a, \mathrm{q_a}\right) - v\left(w_n, \mathrm{q_n}\right)\right]\right], \mathrm{q_a}\right) - w_a$$

5. C_{SL}^E s.t. $\pi_{SL} v\left(w_a + C_{SL}^E, \mathrm{q_a}\right) + \left(1 - \pi_{SL}\right) v\left(w_n, \mathrm{q_n}\right) = v\left(w_n, \mathrm{q_n}\right)$
   $C_{SL}^E = v^{-1}\left(v\left(w_n, \mathrm{q_n}\right), \mathrm{q_a}\right) - w_a = C^n$

Appendix III. Order of Compensation Levels Required to Restore Victims to the Utility Level Defined by the Protected Property Interest

Assume $0 \le v(w_a, \mathrm{q_a}) \le v(w_n, \mathrm{q_n}), v'(w_a, \mathrm{q_a}) < 0, v'(w_n, \mathrm{q_n}) > 0$, $\mathrm{w_a} < \mathrm{w_n}$, $\mathrm{q_a} < \mathrm{q_n}$, and p is exogenously determined.

1. $C^a = 0$. Follows directly from defining C^a s.t. $v(w_a + C^a, \mathrm{q_a}; \mathrm{p}) = v(w_a, \mathrm{q_a}; \mathrm{p})$.

1. 2. $C^n > 0$. By assumption $v(\mathrm{w}, \mathrm{h}; \mathrm{p})$ is increasing in w and h, $w_a < w_n$, and $\mathrm{q_a} < \mathrm{q_n}$. As a result, $v(w_a, \mathrm{q_a}; \mathrm{p}) < v(w_n, \mathrm{q_n}; \mathrm{p})$. It then follows from defining C^n s.t. $v(w_a + C^n, \mathrm{q_a}; \mathrm{p}) = v(w_n, \mathrm{q_n}; \mathrm{p})$ that $C^n > 0$.

3. Proposition: $C_{NL}^E = 0$. Define
   C_{NL}^E s.t. $\pi_{NL} v(w_a + C_{NL}^E, \mathrm{q_a}) + (1-\pi_{NL}) v(w_n, \mathrm{q_n}) = \pi_{NL} v(w_a, \mathrm{q_a}) + (1-\pi_{NL}) v(w_n, \mathrm{q_n})$.
   By assumption, $v(\mathrm{w}, \mathrm{q}; \mathrm{p})$ is monotonically increasing in w and q. Therefore, inverting, it follows that

$$C_{NL}^E = v^{-1}\left(\frac{\pi_{NL} v(w_a, \mathrm{q_a}) + (1-\pi_{NL}) v(w_n, \mathrm{q_n}) - (1-\pi_{NL}) v(w_n, \mathrm{q_n})}{\pi_{NL}}, \mathrm{q_a} \right) - w_a$$
$$= v^{-1}(v(w_a, \mathrm{q_a}), \mathrm{q_a}) - w_a = C^a = 0.$$

4. Proposition: $C_N^E \le C_{SL}^E = C^n$.
   Define C_{SL}^E s.t. $\pi_{SL} v(w_a + C_{SL}^E, \mathrm{q_a}) + (1-\pi_{SL}) v(w_n, \mathrm{q_n}) = v(w_n, \mathrm{q_n})$

   By assumption, $v(w, \mathrm{q}; \mathrm{p})$ is monotonically increasing in w and q. Therefore, inverting, it follows that

$$C_{SL}^E = v^{-1}\left(\frac{v(w_n, \mathrm{q_n}) - (1-\pi_{SL}) v(w_n, \mathrm{q_n})}{\pi_{SL}}, \mathrm{q_a} \right) - w_a$$
$$= v^{-1}(v(w_n, \mathrm{q_n}), \mathrm{q_a}) - w_a$$
$$= C^n$$

   Define C_N^E s.t. $\pi_N v(w_a + C_N^E, \mathrm{q_a}) + (1-\pi_N) v(w_n, \mathrm{q_n}) = \overline{\pi}_N v(w_a, \mathrm{q_a}) + (1-\overline{\pi}_N) v(w_n, \mathrm{q_n})$
   By assumption, $v(w, h; \mathbf{p})$ is monotonically increasing in w and h. Therefore, inverting, it follows that

$$C_N^E = v^{-1}\left(\frac{\bar{\pi}v(w_a,\mathrm{q_a}) + (1-\bar{\pi})v(w_n,\mathrm{q_n}) - (1-\pi_N)v(w_n,\mathrm{q_n})}{\pi_N}, \mathrm{q_a}\right) - w_a$$
$$= v^{-1}\left(v(w_n,\mathrm{q_n}) + \frac{\bar{\pi}}{\pi_N}[v(w_a,\mathrm{q_a}) - v(w_n,\mathrm{q_n})], \mathrm{q_a}\right) - w_a.$$

Since $v(\mathrm{w,h;p})$ is increasing in w and h, $v(w_a,\mathrm{q_a;p}) < v(w_n,\mathrm{q_n;p})$ and $v(w_a,\mathrm{q_a;p}) - v(w_n,\mathrm{q_n;p}) < 0$. Since $0 < \pi_N$ and $0 < \bar{\pi}$, it follows that $C_N^E \le C_{SL}^E = C^n$.

5. Proposition: $0 \le C_N^E$.
   i) Proposition: $C_N^{EA} < C_N^{EP} = C_N^E$.

   Let
   C_N^{EA} s.t. $\pi_N v(w_a + C_N^{EA},\mathrm{q_a;p}) + (1-\pi_N)v(w_n + C_N^{EA},\mathrm{q_n;p}) = \bar{\pi}v(w_a,\mathrm{q_a;p}) + (1-\bar{\pi})v(w_n,\mathrm{q_n;p})$
   and
   C_N^{EP} s.t. $\pi_N v(w_a + C_N^{EP},\mathrm{q_a}) + (1-\pi_N)v(w_n,\mathrm{q_n}) = \bar{\pi}v(w_a,\mathrm{q_a}) + (1-\bar{\pi})v(w_n,\mathrm{q_n})$.
   Note that the rhs of these definitions are the same: $\bar{\pi}v(w_a,\mathrm{q_a;p}) + (1-\bar{\pi})v(w_n,q_n;p)$.

   Suppose $C_N^{EA} > C_N^{EP}$. Then
   $$\pi_N v(w_a + C_N^{EA},\mathrm{q_a;p}) + (1-\pi_N)v(w_n + C_N^{EA},\mathrm{q_n;p})$$
   $$\ge \pi_N v(w_a + C_N^{EA},\mathrm{q_a;p}) + (1-\pi_N)v(w_n,\mathrm{q_n;p})$$
   $$> \pi_N v(w_a + C_N^{EP},\mathrm{q_a;p}) + (1-\pi_N)v(w_n,\mathrm{q_n;p})$$
   $$= \bar{\pi}v(w_a,\mathrm{q_a;p}) + (1-\bar{\pi})v(w_n,\mathrm{q_n;p}).$$
   which is a contradiction.

   Therefore, $C_N^{EA} \le C_N^{EP}$. E.g., if v() were linear, then $C_N^{EA} = \pi(\mathrm{r})C_N^{EP}$. Therefore $C_N^{EA} \le C_N^{EP}$.

   ii) Proposition: $0 \le C_N^{EA}$, assuming that courts do not require owners to compensate society when the average precaution level leads to $\pi_N \le \bar{\pi}$.
   a) Let $\pi_N = \bar{\pi}$, then $C_N^{EA} = 0$ follows directly from the definition of C_N^{EA}.

   b) Let $\pi_N > \bar{\pi}$. Suppose $C_N^{EA} = 0$. Then
   $$\pi_N v(w_a + C_{\mathrm{N}}^{\mathrm{EA}},\mathrm{q_a}) + (1-\pi_N)v(w_n + C_{\mathrm{N}}^{\mathrm{EA}},\mathrm{q_n}) < \bar{\pi}v(w_a,\mathrm{q_a}) + (1-\bar{\pi})v(w_n,\mathrm{q_n})$$

which is a contradiction. Because expected utility is strictly increasing in C_N^{EA}, it follows that $C_N^{EA} > 0$.

c) Let $\pi_N < \overline{\pi}$. Suppose $C_N^{EA} = 0$. Then
$\pi_N v(w_a + C_{\mathrm{N}}^{\mathrm{EA}}, \mathrm{q_a}) + (1-\pi_N)v(w_n + C_{\mathrm{N}}^{\mathrm{EA}}, \mathrm{q_n}) < \overline{\pi}v(w_a, \mathrm{q_a}) + (1-\overline{\pi})v(w_n, \mathrm{q_n})$
which is a contradiction. Because expected utility is strictly increasing in C_N^{EA}, it follows that $C_N^{EA} < 0$. But in fact, the role of courts in torts actions has been to protect property owners against behavior that fails to meet the social standard of care, i.e. against $r_N \le \overline{r}$. It has not been to force property owners to pay for the privilege of living in a setting in which people, on average, act with precaution that exceeds the social standard of care. The institutional purpose of torts law constrains C_N^{EA} to be nonnegative.

iii) Therefore, it follows that $0 \le C_N^{EA} \le C_N^{EP} = C_N^E$.

Summary

1. Compensation for damage to expectations is increasing in the protection given the interest:
   $C_{NL}^E \le C_N^E \le C_{SL}^E$.

2. Compensation is bounded from above by C^n:
   $C_{SL}^E = C^n$.

3. Compensation is bounded below by zero:
   $0 = C^a = C_{NL}^E$.

4. Combining 1 through 3, all compensation levels can be completely ordered:
   $0 = C^a = C_{NL}^E \le C_N^E \le C_{SL}^E = C^n$.

5. Finally, the above ordering also holds for pure nonmonetary losses (q_a;w), for pure monetary losses (w_a;q), and for mixed losses (w_a, q_a).

Appendix IV. Ordering Damage Payments

Let D_{SoC}^{PI} denote the damage award for protected interest, PI, protected by standard of care, SoC.

1. Any “protected” interest and no duty of care implies $D_{NL} = 0$.
2. Protected interest in $(w_a, \mathrm{q_a}; \mathrm{p})$ and any standard of care implies, for all r, $D^a = 0$
3. Protected interest in $(w_n, \mathrm{q_n}; \mathrm{p})$ and negligence implies, for r>r*, $D^n = C^n$.
4. Protected interest in $(w_n, \mathrm{q_n}; \mathrm{p})$ and strict liability implies, for all r, $D^n = C^n$.
5. Protected interest in expectation and negligence implies, for r>r*, $D_N^E = C_N^E$.
6. Protected interest in expectation and strict liability implies, for all r, $D_{SL}^E = C_{SL}^E$.

Conclusion: $0 = D^a = D_{NL} \le D_N^E \le D_{SL}^E = D^n$, where the ordering follows the ordering of C_{SoC}^{PI} in appendix iii.

Appendix V. Expected Utility of Property Rights/Initial Endowments

In general, expected utility derived from a property right protected by torts is defined as
$V_{SoC}^{PI}(\pi_{SoC}, \gamma, \mathrm{w}, \mathrm{q}) = \gamma\pi_{SoC} v(w_a + D_{SoC}^{PI}, \mathrm{q}_a) + (1-\gamma)\pi_{SoC} v(w_a, \mathrm{q}_\mathrm{a}) + (1-\pi_{SoC}) v(w_n, \mathrm{q}_n)$
where $\gamma = 0$ for no liablity; $\gamma = 1$ for strict liability, and $0 < \gamma < 1$ for negligence.

1. Given a recognized interest in (w_a,h_a) protected by any standard of care, $D^a = 0$ for all r, and $\pi_{SoC} = \pi_{NL}$. Expected utility is then
$$V^a(\pi_{NL}, \gamma, \mathrm{w}, \mathrm{h}) = \gamma\pi_{NL} v(w_a + 0, \mathrm{q}_\mathrm{a}) + (1-\gamma)\pi_{NL} v(w_a, \mathrm{q}_\mathrm{a}) + (1-\pi_{NL}) v(w_n, \mathrm{q}_\mathrm{n})$$
$$= \pi_{NL} v(w_a, \mathrm{q}_\mathrm{a}) + (1-\pi_{NL}) v(w_n, \mathrm{q}_\mathrm{n})$$

2. Given any recognized interest protected by no duty of care, $D_{NL} = 0$ for all r, and $\pi_{SoC} = \pi_{NL}$. Expected utility is then
$$V_{NL}(\pi_{NL}, \gamma, \mathrm{w}, \mathrm{h}) = \pi_{NL} v(w_a, \mathrm{q}_\mathrm{a}) + (1-\pi_{NL}) v(w_n, \mathrm{q}_\mathrm{n}).$$

3. Given a recognized interest in $V(\pi(\bar{r}), \mathrm{w}, \mathrm{h})$ protected under negligence, $D_N^E = C_N^E$ for all $r < \bar{r}$, and $\pi_{SoC} = \pi_N$. Expected utility is then
$$V_N^E(\pi_N, \gamma, \mathrm{w}, \mathrm{h}) = \gamma\pi_N v(w_a + D_N^E, \mathrm{q}_\mathrm{a}) + (1-\gamma)\pi_N v(w_a, \mathrm{q}_\mathrm{a}) + (1-\pi_N) v(w_n, \mathrm{q}_\mathrm{n}).$$

4. Given a recognized interest in (w_n,h_n) protected under negligence, $D_N^n = C^n$ for all $r < \bar{r}$, and $\pi_{SoC} = \pi_N$. Expected utility is then
$$V_N^n(\pi_N, \gamma, \mathrm{w}, \mathrm{h}) = \gamma\pi_N v(w_a + D_N^n, \mathrm{q}_\mathrm{a}) + (1-\gamma)\pi_N v(w_a, \mathrm{q}_\mathrm{a}) + (1-\pi_N) v(w_n, \mathrm{q}_\mathrm{n}).$$

5. Given a recognized interest in $V(\pi(\bar{r}), \mathrm{w}, \mathrm{h})$ protected under strict liability, $D_{SL}^E = C^n$ for all r, and $\pi_{SoC} = \pi^*$. Expected utility is then
$$V_{SL}^E(\pi^*, \gamma, \mathrm{w}, \mathrm{h}) = \pi^* v(w_a + D_{SL}^E, \mathrm{q}_\mathrm{a}) + (1-\pi^*) v(w_n, \mathrm{q}_\mathrm{n}).$$

6. Given a recognized interest in (w_n,q_n) protected under strict liability, $D_{SL}^n = C^n$ for all r, and $\pi_{SoC} = \pi^*$. Expected utility is then
$$V_{SL}^n(\pi^*, \gamma, \mathrm{w}, \mathrm{h}) = \pi^* v(w_a + D_{SL}^n, \mathrm{q}_\mathrm{a}) + (1-\pi^*) v(w_n, \mathrm{q}_\mathrm{n}).$$

Appendix VI. Ranking Expected Utility Property Rights Defined by Torts

1. Given expected utility as a function of protected interest and standard of care, where the expected utility, V_{SoC}^{PI} , is given as

   (1) $V^{a} = (\pi_{NL})v(w_a, q_a) + (1-\pi_{NL})v(w_n, q_n)$

   (2) $V_{NL} = (\pi_{NL})v(w_a, q_a) + (1-\pi_{NL})v(w_n, q_n)$

   (3) $$V_N^E = \gamma\pi_N v(w_a + D_N^E, q_a) + (1-\gamma)\pi_N v(w_a, q_a) + (1-\pi_N)v(w_n, q_n)$$

   (4) $$V_N^n = \gamma\pi_N v(w_a + D^n, q_a) + (1-\gamma)\pi_N v(w_a, q_a) + (1-\pi_N)v(w_n, q_n)$$

   (5) $V_{SL}^E = (\pi_{SL})v(w_a + D_{SL}^E, q_a) + (1-\pi_{SL})v(w_n, q_n)$

   (6) $V_{SL}^n = (\pi_{SL})v(w_a + D^n, q_a) + (1-\pi_{SL})v(w_n, q_n)$;

2. And given that $0 = D^a = D_{NL}^n = D_{NL}^E \le D_N^E \le D_{SL}^E = D^n$ from appendix iii;

3. It follows that
   i. (4) = (5) = (6), i.e, $V_{SL}^E = V_{SL}^n = V_N^n$ since $D_{SL}^E = D^n = C^n$.
   ii. (3) ≤ (4), i.e, $V_N^E \le V_N^n$ since $D_N^E \le D^n$.
   iii. (2) ≤ (3) , i.e. $V_{NL} \le V_N^E$ since $D_{NL}^E = D_{NL}^n \le D_N^E$.
   iv. (1) = (2), i.e. $V^a = V_{NL}$ since $D^a = D_{NL}^E = D_{NL}^n = 0$.

4. Thus, $0 = V^a = V_{NL} \le V_N^E \le V_N^n = V_{SL}^E = V_{SL}^n$.

Appendix VII. Insurance Demand for Nonmonetary Loss as a Function of Property Rights

The insurance problem changes slightly when the loss is purely nonmonetary.

The risk-averse individual's problem becomes

(13) $\max_{w_n, w_a} \pi v(w_a, q_a) + (1-\pi) v(w_n, q_n) \quad \text{s.t.} \quad \pi w_a + (1-\pi) w_n = w$

Since $w_n = w - \theta$ and $w_a = w - \theta + A$

$$\pi w_n + (1-\pi) w_a = w$$
$$\pi(w-\theta) + (1-\pi)(w - \theta + A) = w$$
$$\pi A = \theta$$

(1) can be rewritten

$$\max_A \pi v(w + (1-\pi)A, q_a) + (1-\pi) v(w - \pi A, q_n)$$

with corresponding FOC:

$$\max_A v'(w + (1-\pi)A, q_a) = v'(w - \pi A, q_n)$$

If marginal utility of wealth is invariant to the state of the world, then insurance of A=0 is optimal. In this case, $w_n = w_a$.

If marginal utility of wealth is decreasing in q, as is maintained by Viscusi and Evans (1991), then insurance A<0 is optimal. In this case, $w_n > w_a$.

If marginal utility of wealth is increasing in q, as might be expected from a Beckerian household model with wealth effects swamping substitution effects, then insurance A>0 is optimal. In this case, $w_n > w_a$.

Nonmonetary Insurance and Property Rights

How does insurance of nonmonetary losses vary with property rights?

1. If the property interest is in (w,q_n) or is any property interest protected by a no-liability rule, then compensation C =0, and the individual's problem is (13) above with $\pi = \pi_{NL}$.
$$V^a = V_{NL}(\pi_{NL}, \gamma, \mathrm{w}, \mathrm{q}, \mathrm{A}) = \pi_{NL} v(w - \pi A + A, \mathrm{q_a}) + (1 - \pi_{NL}) v(w - \pi A, \mathrm{q_n})$$

If the property interest is in expectations protected by negligence, then the risk-averse individual's problem is to

$$\max_A V_N^n(\pi_N, \gamma, \mathrm{w}, \mathrm{q}, \mathrm{A}) = \gamma \pi_N v(w + (1 - \pi_N)A + C_N^E, \mathrm{q_a}) + (1-\gamma)\pi_N v(w + (1 - \pi_N)A, \mathrm{q_a}) + (1 - \pi_N) v(w - \pi_N A, \mathrm{q_n})$$

or

$$= \gamma \pi_N v_a \begin{pmatrix} w + (1 - \pi_N)A + \\ v_a^{-1}\left(v_{\mathrm{n}}(w + (1 - \pi_N)A) + \dfrac{\overline{\pi}}{\pi_N}\left[v_{\mathrm{a}}(w - \pi_N A) - v_{\mathrm{n}}(w + (1 - \pi_N)A) \right] \right) \end{pmatrix} + (1-\gamma)\pi_N v_{\mathrm{a}}(w + (1 - \pi_N)A) + (1 - \pi_N) v_{\mathrm{n}}(w - \pi_N A)$$

FOC:

$$= \gamma v_a' \left((1 - \pi_N) + v_a^{-1\prime}\left((1 - \pi_N)\left(1 - \frac{\overline{\pi}}{\pi_N}\right) v_{\mathrm{n}}' - \overline{\pi} v_{\mathrm{a}}' \right) \right) + (1 - \pi_N)\left[(1-\gamma) v_{\mathrm{a}}' - v_{\mathrm{n}}' \right] = 0$$

$$= \gamma v_a' \left((1 - \pi_N) + v_a^{-1\prime}\left(\left(1 - \frac{\overline{\pi}}{\pi_N} - \pi_N + \overline{\pi}\right) v_{\mathrm{n}}' - \overline{\pi} v_{\mathrm{a}}' \right) \right) + (1 - \pi_N)\left[(1-\gamma) v_{\mathrm{a}}' - v_{\mathrm{n}}' \right] = 0$$

3. If the property interest is in (w,q_n) protected by negligence, then the risk-averse individual's problem is to

$$\max_A V_N^n(\pi_N, \gamma, \mathrm{w}, \mathrm{q}, \mathrm{A}) = \gamma \pi_N v(w + (1 - \pi_N)A + C_N^n) + (1-\gamma)\pi_N v(w + (1 - \pi_N)A, \mathrm{q_a}) + (1 - \pi_N) v(w - \pi_N A, \mathrm{q_n})$$

$$= \gamma \pi_N v(w + (1 - \pi_N)A + v^{-1}(v(w, \mathrm{q_n}), \mathrm{q_n}), \mathrm{q_a}) + (1-\gamma)\pi_N v(w + (1 - \pi_N)A, \mathrm{q_a}) + (1 - \pi_N) v(w - \pi_N A, \mathrm{q_n})$$

FOC:

$$\gamma v'\left(w + (1 - \pi_N)A + v^{-1}\left(v(w, q_n), q_n\right), q_a\right) + (1 - \gamma)v'\left(w + (1 - \pi_N)A, q_a\right) = v'\left(w - \pi_N A, q_n\right)$$

4. If the property interest is in (w,q_n) protected by strict liability, then the risk-averse individual's problem is to

$$\max_A V_{SL}^n(\pi^*, \gamma, \mathrm{w}, \mathrm{q}, \mathrm{A}) = \pi^* v\left(w + (1 - \pi^*)A + C^n\right) + (1 - \pi^*)v\left(w - \pi A, q_n\right)$$
$$= \pi^* v\left(w + (1 - \pi^*)A + v^{-1}\left(v(w, q_n)q_n\right), q_a\right) + (1 - \pi^*)v\left(w - \pi A, q_n\right)$$

FOC:

$$v'\left(w + (1 - \pi^*)A + v^{-1}\left(v(w, q_n)q_n\right), q_a\right) = v'\left(w - \pi A, q_n\right)$$

5. If the property interest is in expectations protected by strict liability, then the risk-averse individual's problem is to

$$\max_A V_{SL}^E(\pi^*, \gamma, \mathrm{w}, \mathrm{q}, \mathrm{A}) = \pi^* v\left(w + (1 - \pi^*)A + C_{SL}^E\right) + (1 - \pi^*)v\left(w - \pi A, q_n\right)$$
$$= \pi^* v\left(w + (1 - \pi^*)A + v^{-1}\left(v(w, q_n)q_n\right), q_a\right) + (1 - \pi^*)v\left(w - \pi A, q_n\right)$$

FOC:

$$v'\left(w + (1 - \pi^*)A + v^{-1}\left(v(w, q_n)q_n\right), q_a\right) = v'\left(w - \pi A, q_n\right)$$

The same as in (2) above.