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Double-Edged Torts

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Abstract

Traditional economic models of tort law assign determinate roles to parties, modeling their behavior as if parties knew in advance whether fate would cast them in the roles of tortfeasors or victims. However, for a large class of activities, individuals take precautions ignorant of their roles in future accidents, or indeed whether an accident will occur at all. Further complicating the issue, there exists a category of precautions, which courts have not hitherto recognized, and which we will call “hybrid precautions,” that reduce both the probability of an individual becoming a tortfeasor and the probability that the same individual will become a victim of someone else’s negligence. In this paper, we extend the standard model to account for cases characterized by role-uncertainty and hybrid precautions, finding that incentives are not, as tort scholars have heretofore assumed, simply additive. We analyze and reassess the standard tort regimes when accounting for role-uncertainty and hybrid precautions, and we find that with respect to double-edged torts, the traditional formulation of negligence fails to incentivize efficient care levels. For such cases, we argue for a modification of the standard of due care that does effect efficient precautionary efforts.

Keywords: role-uncertainty, specialized care, hybrid care, Restatement (Third) of Torts (2010) § 3

JEL Codes: K13, K32

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1 Introduction

The standard tort model assumes the existence of three elements: a tortfeasor, a victim, and the event of an accident. Humble as these presuppositions may seem, a grave fallacy lurks underfoot. Tort remedies are meant to incentivize *ex ante* precautionary care via *ex post* assignments of liability; the law manipulates *effects* to affect *causes*. Of course, this temporal reversal of cause-and-effect is normally unproblematic in the law; we expect parties to adjust their behavior in anticipation of the consequences of their behavior. Imposing rules alters expected consequences, thereby altering behavior. So much is elementary. However, this mechanism relies upon the assumption that parties' roles are determinable in advance. In reality, many (perhaps most) potentially tortious activities do not allow parties to anticipate which role they will play. That is, parties engaged in certain "double-edged" activities simultaneously face the risk of being tortfeasors *and* the risk of being victims.

This creates a problem not fully addressed by existing tort law: in what way will a party be responsive to legal incentives intended specifically for potential tortfeasors or specifically for potential victims, when exposed to both possibilities concurrently? Without knowing in advance what roles parties will play, it is unclear to what extent they will be sensitive to role-specific incentives. Historically, tort scholars assumed that this analytical conceit was harmless, and that the incentives in role-uncertain situations were merely additive—i.e., simply the sum of tortfeasor incentives and victim incentives. We will find that this is not the case.

Further complicating the problem, the analytical distinction between "tortfeasor precautions" and "victim precautions" obscures the fact that a subset of precautions do double duty, reducing both the probability of being a tortfeasor and the probability of being a victim. An example may prove helpful: consider that driving sober reduces the probability of being a tortfeasor (a pure tortfeasor precaution), whereas wearing a seatbelt reduces the magnitude of damage for a victim (a pure victim precaution), but turning on headlights when driving at night has the *dual* benefit of making it easier to see others (reducing the probability of becoming a tortfeasor) and also making it easier to be seen by others (reducing the probability of becoming a victim). Unlike pure tortfeasor and pure victim precautions, turning on headlights exhibits characteristics of both types, and placing such an activity into either category would fail to capture its whole value. Such "hybrid precautions" are not captured in the standard model, and we will find that they warrant a separate analysis.

The vast majority of tort situations seem to possess at least some degree of role-uncertainty. Accident types which are not double-edged seem to be the exception rather than the norm (e.g., product liability or trespass). Likewise, the great majority of precautions produce dual benefits, reducing overall accident probability. Given the prevalence of double-edged torts, it therefore

seems acutely problematic that the economic analysis of tort law presently omits considerations of role-uncertainty and hybrid precautionary care. In this paper, we seek to rectify this omission, extending the standard tort model to account for role-uncertainty and hybrid precautions. We find that the standard formulation of negligence fails to incentivize efficient care levels in the presence of role-uncertainty and hybrid precautions, and we suggest a modification of the standard of due care, which would restore efficient care incentives.

This paper is divided into five sections. In Section 2, we frame the subject of our paper in broadly conceptual terms, laying out the basic elements of our analysis, and providing a brief review of the related literature. In Section 3, we model double-edgedness, finding that both simple negligence and negligence with the defense of contributory negligence yield inefficient care incentives. We suggest an alternative formulation of the standard of due care, which does succeed in incentivizing efficient care levels. We also observe the effect of role-uncertainty on activity levels. In Section 4, we relate our results to doctrinal tort law, discovering that courts have begun to recognize double-edgedness in recent cases, articulating a modification of due care standards consistent with our policy recommendation. Finally, in Section 5, we remark on the significance of double-edgedness in tort law generally, and conclude with a summary of our results.

2 Framing the Problem

2.1 The Revenge of the Coasean Critique: A Brief History

Traditionally, tort law assigns liability by designating individuals as either “tortfeasors” or “victims.” Coase (1960) criticized these labels as obfuscating the reciprocal nature of externalities, observing that “victims” impose a cost on tortfeasors inasmuch as “tortfeasors” impose a cost on victims. A polluting factory imposes an obvious cost on neighboring residents; however, less obviously, Coase points out that neighboring residents likewise impose a cost on a factory that refrains from polluting. From a Coasean perspective, a tort is simply an externality (or more accurately: two complementary externalities).

Sadly, despite the elegant symmetry of Coase’s perspective-neutral view, mainstream legal scholars continue to conceptualize tort law in terms of “tortfeasors” and “victims.” One reason why the Coasean critique may have failed to gain traction is simply that the law is meant to resolve a practical problem: it must assign liability. While observing symmetries and reciprocities may be conceptually elucidating, as a practical matter it is not particularly helpful. The law must place the burden of the externality on *someone’s* shoulders. Convention bestows on that party the label “tortfeasor.” The Coasean analysis does not help—at least not in

any obvious way—in determining who that ought to be.

Beginning with Calabresi (1970), the law and economics literature developed a number of rationales to explain and justify the dominant legal approach, identifying economic criteria for the allocation of liability (e.g., cheapest cost-avoider, best risk-bearer, etc.).¹ These criteria help determine the preferable liability regime in a given context and how to allocate the accident loss *ex post*.

Underlying these role-based analyses was the assumption that *ex post* liability assignment can be used to affect *ex ante* behavior: a set of liability rules for a given activity was thought preferable, because it created precautionary incentives for the potential tortfeasor and for the potential victim. Clearly, this line of reasoning is unproblematic in cases where it is obvious who the potential tortfeasors and potential victims are. For instance, in the domain of products liability, manufacturers are clearly the potential tortfeasors, and consumers are clearly the potential victims.

However, not all tortious situations lend themselves to such analytical clarity. For example, consider the double-edged activity of hunting. When a hunter ventures into the forest, there is some risk that he will shoot another hunter, either by mistaking his comrade for a target or by mishandling his rifle. Likewise, the hunter also faces the risk of being shot by another hunter. He is at once a potential tortfeasor and a potential victim. In such cases, the Coasean equivalence reasserts itself, not merely as a reframing of the problem, but instead as a literal description of a factual equivalence of the positions of the parties. Hunters do not simply occupy complementary positions with respect to an abstracted externality—they face the very same type of externality in both roles at once.

2.2 Other Perspectives on Double-Edgedness

At a general level, double-edgedness may be characterized as a positive externality created by a precaution, such that exercise of the precaution reduces the probability of two (or more) accidents simultaneously. Although no prior literature exists on torts in the presence of role-uncertainty and hybrid precautions, there is some research dealing with the two elements individually.

Feldman & Kim (2006) examined role-uncertainty in situations where parties face exogenous indeterminateness. Their model was meant to analyze individuals with inconsistent

¹Calabresi (1970) introduced the “cheapest cost-avoider” criterion in the context of tort liability. Calabresi argued that the party who should bear the cost of an accident is the one who is best *able* to bear the cost of the accident (i.e., the one who can avoid the accident and reduce overall harm most efficiently, or cheaply). Parchomovsky & Stein (2010) point out that tort law scholarship accepts the “cheapest cost-avoider” principle, using it to explain existing legal rules in tort law—as well as other areas of law.

beliefs and to identify belief conditions, under which alternative liability rules might be preferable. However, whereas the Feldman & Kim (2006) setup modeled only one type of precautionary care under exogenously determined role-probability, we provide a more general framework for role-uncertainty, linking precautionary care levels not only to accident probability but also to role-probabilities.

On precaution externalities, there exist two papers which consider this problem, although neither deals specifically with the dual-purpose precautions we identify as “hybrid precautions” in this paper. Diamond (1974) considers the effects of precautions on total expected accident costs, including changes in expected accident costs for everyone else with whom the tortfeasor might have had an accident. The precaution externality in Diamond (1974) arises because the same precaution investment could produce benefits for multiple potential victims.

A second variant of precaution externality, identified in Cooter & Porat (2000), considers the risk of harm-to-self. The idea here is that for many kinds of torts, the occurrence of an accident results in losses for both the victim and the tortfeasor;² thus, investments in precautions reduce the probability of accident losses for both parties. Neither Diamond (1974) nor Cooter & Porat (2000) consider role-uncertainty in their analyses.

While role-uncertainty and precaution externalities are interesting phenomena independently, we believe it is their interaction which provides the greatest interest. In situations characterized by *both* role-uncertainty *and* hybrid precautions, it is intuitively obvious that the standard tort model will fail to determine efficient care levels. Role-uncertainty introduces the possibility of multiple potential accidents arising from a single interaction-type (due to the reciprocal nature of the parties’ activities), opening the door to precaution externalities, where one type of precaution may affect the probability of multiple distinct event-types. Because a due care standard, which fails to consider the total reduction in accident probabilities, captures only a fraction of the benefit of the precaution, such a due care standard will be less than the efficient level of care. Thus, the interaction of role-uncertainty and hybrid precautions—which we argue characterizes a majority of tort situations—will lead to insufficient precautions under negligence rules.

Thus, our contribution may be framed within the existing literature as a reformulation of Feldman & Kim (2006), in a substantially more complete model, which adds the element of hybrid precautions (without this element, the externality resulting in suboptimal negligence standards would not be captured). Alternatively, our contribution may be seen as generalization of Cooter & Porat (2000), focusing the analysis more tightly on the essential features of the problem and thereby expanding the scope of applicable cases. Further distinguishing our

²The type of situations Cooter & Porat (2000) have in mind are, e.g., automobile accidents where a negligent driver may, in addition to risking harm others, by the same negligent conduct, also risk harm to himself.

inquiry, whereas Cooter & Porat (2000)'s analysis offers an account of costs hidden from the consideration of courts (i.e., the expected cost of harm to self), our analysis considers the externality of potential tort cases upon other potential tort cases. Additionally, while the probability of harm-to-self is necessarily equal to the probability of harm-to-others (and where only one party with fixed role can play the role of tortfeasor) in Cooter & Porat (2000), we allow for independent accident probabilities as well as a more explicit characterization of the precaution externality.³

Finally, from a non-economic perspective, in the doctrinal law of torts, two papers touch on issues of great relevance to our present inquiry. Schwartz (1978) and Simons (1995) take opposing positions on how courts ought to manage precaution externalities. Schwartz (1978) and Simons (1995) do not use our term "hybrid precautions" (nor the technical description "precaution externalities") and their conceptions are subtly different from those we present. However, the issues they discuss tend to track, albeit loosely, the initial steps of our analysis. Schwartz (1978)'s view represents the *de facto* position that courts have taken, whereas Simons (1995)'s view represents a protean version of the standard of care under negligence that we will ultimately advocate in Section 3.2.2. Collectively, this prior literature has begun to influence a change in the law on precaution externalities to incorporate a more nuanced approach to precautions. The debate between Schwartz (1978) and Simons (1995), along with Cooter & Porat (2000) are explicitly cited in RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM (2010) in recognizing self-harm externalities. We hope that this paper will encourage lawmakers and courts to go further still in recognizing the pervasiveness of precaution externalities on incentives. We will discuss these developments in greater detail in Section 4.

2.3 The Elements of Double-Edgedness

The elements of the phenomenon we are describing as "double-edgedness" are (1) role-uncertainty, and (2) hybrid precautions. Thus far, it has sufficed to use these terms in an informal way. We will now offer a more precise description of these elements.

2.3.1 Role Uncertainty

We use the term "role-uncertainty" to refer to situations where parties are ignorant of what future role they will play. The vast majority of torts situations will be characterized by some amount of role-uncertainty. In a large number of activities, parties will be uncertain about their

³In Cooter & Porat (2000), the precaution externality is a consequence of particular factual circumstances, where the risk of harm to another creates a risk of harm to self. Our formulation of the externality as being the reduction in the probability of two independent potential accidents is at once applicable to a greater number situations and offers a more fine-grained analysis of the phenomenon.

future roles due to the symmetry of their positions with respect to others as a matter of fact. For example, automobile drivers, bicyclists, hunters, and skiers all suffer from role uncertainty with respect to others engaged in the same type of activity. A driver risks harming others in exactly the same way that he risks being harmed by others.

However, in other situations, the role-uncertainty may be less obvious. For example, skateboarders and property owners may be role-uncertain with respect to each other. Of course, as a factual matter, their roles are certain. However, there exist some possible accidents where the skateboarders are tortfeasors (e.g., if they damage the owner's property), and there are other possible accidents where the skateboarders are victims (e.g., if they are injured on the owner's property due to the owner's failure to maintain it), arising from the same initial facts. Thus, even though their positions are distinct as a matter of fact, their positions as prospective litigants are uncertain.

Additionally, we observe that role uncertainty can arise from both symmetric and asymmetric risks—although symmetric risks are more characteristic. On the torts-contracts-property spectrum, “purer” torts are more likely to exhibit role-uncertainty, whereas harms that approach the property end of the spectrum are more likely to involve clearly defined roles (e.g., slip-and-fall cases, trespass).

2.3.2 Hybrid Precautions

“Hybrid care” describes those precautionary care efforts, which reduce *both* the probability that the party exercising the care will be a tortfeasor and the probability that the party exercising the care will be a victim. Generally, an increase in precautionary care will result in a decrease in the probability (or severity) of accidents. However, the effect of “tortfeasor care” will be confined to reducing the probability of those accidents where the actor is a tortfeasor, and not the probability of accidents where the actor is a victim. Likewise, “victim care” only reduces the probability of being a victim, without affecting the probability of being a tortfeasor.

Returning to our earlier example,⁴ let us identify hybrid care by contrasting it with role-specific precautions. First consider the customary practice of hunters to point their rifles toward the ground when not firing them. The rationale is that if the gun should discharge accidentally, it will innocuously fire into the earth, rather than harming a fellow hunter. Keeping one's gun pointed at the ground will not however reduce the probability of being shot by someone else, hence we can think of this precautionary measure as a pure tortfeasor precaution.

Another safety custom for hunters is to wear brightly colored clothing. The rationale is that this will make it easier for other hunters to see and avoid firing in the direction of their fellow

⁴We are indebted to David Pi for this example.

woodsmen. Since visible movement is often used to distinguish prey from the surroundings, bright colors also aid in signaling that hunter is not an animal. Obviously, this precaution is a victim precaution, since it does not diminish the probability of being a tortfeasor.

A third practice of hunters is to ascend to shoot at their prey from atop a tree. A number of devices—blinds, tree stands, tree “saddles”—are made to assist the hunter, who often spends long hours perched in trees, waiting for his quarry. In addition to the strategic benefit of ambushing their targets unseen, the precautionary care effects of this strategy are two-fold. First, by improving visibility and forcing the hunter to fire downward, it reduces the probability of accidentally shooting another hunter. Second, by removing the hunter from the normal line-of-fire of other hunters, it reduces the probability of being mistaken for a target or catching a stray bullet. Thus, tree-climbing generates the two-fold precautionary benefit, which we classify as “hybrid care.”

Consider also sexually transmitted disease torts.⁵ In sexual encounters, one is exposed to the simultaneous risk of transmitting or becoming infected with a venereal disease, and consequently the use of a prophylactic clearly falls under the category of hybrid precaution.

2.4 The Standard Model

We proceed from the standard model of tort law incentives given by Shavell (1980) and Shavell (1987). Private payoffs are described by:⁶

$$\begin{aligned} P_1 &= V_1(w) - wx - T_1 \\ P_2 &= V_2(z) - zy - T_2 \end{aligned} \tag{2.1}$$

⁵See, e.g., *McPherson v. McPherson*, 712 A.2d 1043 (ME 1998), where the plaintiff sued after contracting a sexually transmitted disease from the defendant. The defendant was unaware that he had the disease at the time of the infection. Very likely the injury could have been avoided, had the defendant used a prophylactic, but it is equally the case that he would not have been infected himself had he not failed to take that very same precaution in some earlier sexual encounter. There exist a long line of cases on this point, from *Crowell v. Crowell*, 105 S.E. 206 (N.C. 1920) to the famous case of *Aetna v. Sheft*, 989 F.2d 1105 (9th Circ. 1993) (where the estate of deceased actor Rock Hudson was the defendant).

⁶Interpretation of terms:

V_1	value of tortfeasor’s activity
V_2	value of victim’s activity
x	cost of tortfeasor’s precautions
y	cost of victim’s precautions
w	tortfeasor’s activity level
z	victim’s activity level
T_1	liability for the tortfeasor
T_2	liability for the victim.
p	the probability of an accident
L	the cost of the accident

That is, for both individuals 1 and 2, their payoffs in a potentially tortious activity are the benefit of their activity minus the cost of precautionary care, minus their liability (possibly zero).

The activities of the two parties generate the potential for an accident, which has the expected cost: $wzp(x, y)L$. From an economic perspective then, the problem of tort law is simply to assign the expected cost of the accident $wzp(x, y)L$ as between T_1 and T_2 , such that $P_1 + P_2$ is maximal, assuming that each of the two individuals will seek to maximize their payoffs P_i .

The misconception we described in the Subsection 2.1 arises because, when framing a tort, the law looks back at an accident from an *ex post* perspective, without considering the stochastic uncertainty and role-reciprocity of parties in an *ex ante* position. The same fallacy is reflected in the standard model, which assumes away role-uncertainty by assigning specific roles to individuals. By setting aside the uncertainty faced by the parties, the economic models of tort law anticipate parties will choose their levels of care and activity with foreknowledge of their future roles of “tortfeasor” and “victim.”⁷

We contend that many of the results in the literature hinge upon this artificial conceit, and that the calculation of incentives under those models will be inaccurate. In circumstances characterized by role-uncertainty, a model that assigns specific roles to the parties when they choose *ex ante* precautions will miss a fundamental element of the problem. In the next section we aim to construct a model, which captures double-edgedness.

3 The Double-Edged Model

3.1 Social Objective

To begin, consider a situation involving two individuals, 1 and 2, who both face the risk of an accident behind a veil of role-uncertainty. In the event of an accident, either individual may be the tortfeasor or the victim with non-zero probability. To keep our notation general, we will denote a role-uncertain individual as i , so that i could be either a tortfeasor or a victim. We assume individuals have consistent beliefs.

Each individual i carries out an activity, with a value equal to $V_i(w_i)$, where w_i denotes i 's activity level. The activity's value $V_i(w_i)$ increases with the activity level w_i in the relevant range, $V_w > 0$, at a decreasing rate, $V_{ww} < 0$.

The activity of individual i may also cause harm; precautions reduce the probability of such harm. In a setting characterized by role-uncertainty, parties may invest in precautions that

⁷Arlen (1990) extends the standard analysis to consider bilateral risk and shows that the main results hold if each party is allowed to sue her counterpart for her own damages.

reduce the overall probability of an accident, independently of whether they will end up being a tortfeasor or a victim. Let h_i denote individual i 's level of hybrid precaution per unit of activity w_i , where $h_i \in [0, \infty)$. We assume bilateral precautions, i.e., both individuals can invest in precautions.

Let x_i be the care that individual i invests to avoid becoming a tortfeasor. Let y_i be the care that i invests to avoid becoming a victim.⁸ We model role-uncertainty by defining two probability functions: one which describes the probability that individual 1 is a tortfeasor, $p_1(x_1, y_2, h_1, h_2)$, and one which describes the probability that individual 2 is a tortfeasor, $p_2(x_2, y_1, h_1, h_2)$. For either individual i , let p_i denote the probability that there is an accident and that i is the tortfeasor, such that in a two-person world, the total probability of an accident $p = p_1 + p_2$.

We begin with the standard formulation of the social objective: the maximization of the value of risk-creating activities at the net of accident costs and precaution costs. The social welfare function is given by the Kaldor-Hicks summation of the value of activity of the two individuals, from which we subtract the expected cost of harm and of precautionary efforts exercised by both parties:

$$S = V_1(w_1) + V_2(w_2) - w_1 w_2 (p_1(x_1, y_2, h_1, h_2) + p_2(x_2, y_1, h_2, h_1))L - w_1(x_1 + y_1 + h_1) - w_2(x_2 + y_2 + h_2) \quad (3.1)$$

The socially optimal values for x_i , y_i , and h_i are identified by the following first order conditions ("FOC"):

$$-w_j p_{i x_i} L = 1 \quad (3.2)$$

$$-w_j p_{j y_i} L = 1 \quad (3.3)$$

$$-w_j (p_{i h_i} + p_{j h_i}) L = 1 \quad (3.4)$$

The efficient activity level values for w_1 and w_2 are identified by the following FOC:

⁸To be clear, x_i , y_i , and h_i represent three distinct and disjunct forms of care, and generally $h_i \neq x_i + y_i$.

$$V_{iw_i} = w_j(p_1 + p_2)L - x_i - y_i - h_i \quad (3.5)$$

3.2 Hybrid Care Incentives under Role Uncertainty

3.2.1 No Liability and Strict Liability

As is well established in the literature, strict liability and no liability only succeed in creating efficient incentives for the party who bears the cost of the accident, as determined by the liability rule. Role-uncertainty may mitigate, but does not correct the well-known externality and moral hazard problems created by no liability and strict liability.

Proposition 1 (Equivalence of No Liability and Strict Liability). *No liability and strict liability fail to incentivize efficient hybrid precautions. With symmetric role-uncertainty, strict liability and no liability yield the same level of hybrid care incentives.*

Proof. See Appendix. □

When considering hybrid care, the problem is exacerbated by the fact that parties will only seek the role-specific private benefit of hybrid care, depending on which party (designated by the liability regime) bears the cost of accidents.

Under a no liability regime, investments in tortfeasor-side precautions—either x_i or h_i —tend to be suboptimal, because under no liability, prospective tortfeasors fully externalize the risk of their activity and victims bear the full cost of accidents. Incentives to invest in precautions thus fall entirely on victims. Both parties instead face incentives as prospective victims behind the veil of role-uncertainty under a no liability regime. All precautionary efforts will therefore be invested in reducing victim-side probabilities.

Likewise, under a strict liability regime, prospective victims face a moral hazard problem which renders investment in victim-side precautions—either y_i or h_i —suboptimal. Again, even though both parties respond to the threat of strict liability and will invest in *some* amount of care under role-uncertainty, their precautionary efforts will be directed toward reducing only tortfeasor-side probabilities.

Interestingly, due to role-uncertainty, parties face the same hybrid care incentives incentives under strict liability and no liability. The idea behind this equivalence is that the direct (liability) incentives that are lost because of role-uncertainty are regained through indirect (self-care) incentives. Behind the veil of role-uncertainty, any shift in liability will be a double-edged sword that increases (or decreases) expected liability, but at the same time decreases (or increases) the amount of expected compensation.

3.2.2 Negligence

In their assessment of negligence, courts evaluate parties' behavior by looking at the precautions taken to avoid a particular, actual accident. The tortfeasor's behavior is evaluated against the standard of care that a reasonable person would have exercised under similar circumstances.⁹ In the present context, "similar circumstances" (detrimentally) abstracts away role-uncertainty.

In applying this standard, courts look to the precautions taken by parties as tortfeasors and victims. It bears mentioning here that in determining whether a party exercised due care, role-specific precautions are not substitutable. In other words, if a tortfeasor were found to have taken abundant victim-specific care, but insufficient tortfeasor-specific care, then he would nevertheless be found negligent. Likewise, if a victim were found to have exercised large amounts of tortfeasor-specific care, but insufficient victim-specific care, then he would be found contributorily negligent, as a victim of an accident.

Courts do not distinguish between specific and hybrid care. Indeed, we cannot find a single opinion that even recognizes the concept of hybrid care. This is likely due to the fact that courts are only implicated *after* the occurrence of an actual accident. Courts therefore think in terms of negligence and causation with respect to incidents that actually materialize, leading them to neglect the question whether parties took adequate precautions to prevent other hypothetical accidents that did not occur.

Consequently, courts are only concerned with that part of the hybrid care relevant to parties' roles in the tortious event. So for instance, when a tortfeasor goes to trial, the court would not take into account the reduction to victim-side probabilities that the tortfeasor's precautions might have generated. The court is concerned only with the effect of the precautions on the probabilities of the actual accident. Thus, half of the benefit of tortfeasor precautions (i.e., half the social benefit) gets ignored.

In this subsection, we will describe two formulations of simple negligence. The first, which we call SN^\dagger , describes how courts would generally assess hybrid care in negligence cases, accounting only for tortfeasor-side reductions in probability. The second, which we call SN^\ddagger , describes an alternative criterion for reasonableness, which accounts of the dual benefit of hybrid precautions. We will find, unsurprisingly, that SN^\ddagger generates superior social welfare as compared with SN^\dagger .

Under both formulations, it will be the case that x^* is characterized by the condition $-w_j p_{i x_i} L = 1$, which is efficient. Tortfeasor-specific care will therefore be efficient under either SN^\dagger or SN^\ddagger (as indeed it is in the standard model).

The critical distinction between SN^\dagger and SN^\ddagger is that SN^\dagger ignores the positive externali-

⁹Whenever relevant (e.g., comparative negligence and contributory negligence), the victim's behavior is evaluated against that of reasonable person under similar circumstances.

ties of hybrid precautions h_i . It looks only to the marginal benefit to the potential tortfeasor (i.e., the reduction in the probability p_i) and not to the marginal benefit that the same party receives as a potential victim (i.e., the reduction in probability p_j). By contrast, SN^\ddagger accounts for the dual benefits of hybrid precautions.

Let h_i^\dagger denote the privately optimal investment in hybrid care under SN^\dagger . More precisely, let us define h_i^\dagger as the value satisfying the condition:

$$-w_j p_{ih_i} L = 1 \quad (3.6)$$

Likewise, let h_i^\ddagger denote the privately optimal investment in hybrid care under SN^\ddagger . We define h_i^\ddagger as the value satisfying the condition:

$$-w_j(p_{ih_i} + p_{jh_i})L = 1. \quad (3.7)$$

We model the private payoffs under both interpretations with the following schema, where h^\diamond is the standard of due care. In 3.8, the individual chooses his own precaution and activity level under role uncertainty. The four branches in 3.8 represent the possible allocations of the accident loss when the parties are bilaterally negligent (first branch), unilaterally negligent (second and third branch) or bilaterally diligent (fourth branch). Our comparison will then be between $h^\diamond = h^\dagger$ (under SN^\dagger) versus $h^\diamond = h^\ddagger$ (under SN^\ddagger).

$$\max_{(w_i, x_i, y_i, h_i)} P_i = \begin{cases} V_i - w_1 w_2 p_i L - w_i(x_i + y_i + h_i) & \text{if } (x_i < x_i^* \text{ or } h_i < h_i^\diamond) \\ & \text{and } (x_j < x_j^* \text{ or } h_j < h_j^\diamond) \\ V_i - w_1 w_2 (p_1 + p_2) L - w_i(x_i + y_i + h_i) & \text{if } (x_i < x_i^* \text{ or } h_i < h_i^\diamond) \\ & \text{and } (x_j \geq x_j^* \text{ and } h_j \geq h_j^\diamond) \\ V_i - w_i(x_i + y_i + h_i) & \text{if } (x_i \geq x_i^* \text{ and } h_i \geq h_i^\diamond) \\ & \text{and } (x_j < x_j^* \text{ or } h_j < h_j^\diamond) \\ V_i - w_1 w_2 p_j L - w_i(x_i + y_i + h_i) & \text{if } (x_i \geq x_i^* \text{ and } h_i \geq h_i^\diamond) \\ & \text{and } (x_j \geq x_j^* \text{ and } h_j \geq h_j^\diamond) \end{cases} \quad (3.8)$$

If we set $h^\diamond = h^\dagger$, then the standard of due care (for h) is where the marginal benefit of decreasing $w_1 w_2 p_i L$ is equal to the marginal cost h_i . By contrast, if we set $h^\diamond = h^\ddagger$, then the standard of due care is where the marginal benefit of decreasing $w_1 w_2 (p_i + p_j) L$ is equal to the marginal cost h_i . It is worth noting that h^\ddagger is higher than h^\dagger inasmuch it captures the positive externality of hybrid care in p_{jh_i} .

In the following propositions, we observe that formulation SN^\dagger does not generally incentivize a socially optimal care level h^{**} , because h^\dagger by definition does not account for the positive externality created by hybrid care in p_{jh_i} . Conversely, SN^\ddagger by accounting for p_{jh_i} incentivizes efficient hybrid care levels.

Proposition 2 (Efficiency of SN^\ddagger). *Under role-uncertainty, a SN^\ddagger negligence formulation incentivizes the adoption of efficient hybrid care levels. The due care standard under simple negligence, SN^\dagger , will not generally incentivize efficient investments in hybrid care.*

Proof. See Appendix. □

Proposition 2 has important implications for negligence cases. Since courts set the standard of due care at SN^\dagger rather than SN^\ddagger , our claims imply that the current negligence rule is suboptimal. This policy result is germane to the one reached by Diamond (1974) and Cooter & Porat (2000). In all three cases, the standard of care is raised when precaution externalities are taken into account. In Diamond (1974), precaution externalities take the form of a reduction in expected total costs when multiple prospective victims were affected by the same risk. In Cooter & Porat (2000), precaution externalities take the form of a reduction in the probability of a harm to the tortfeasor. In our case, precaution externalities take the form of a reduction in the probability of a different accident, in which the precaution taker might find himself as the victim rather than the tortfeasor. We should then question why courts have not hitherto imposed a SN^\ddagger standard of due hybrid care.

On first impression, we might hypothesize that courts are constrained from applying SN^\ddagger because it conflicts with the tort doctrines of cause-in-fact or proximate cause. The familiar formulation of negligence is: (i) that the tortfeasor owed and breached a duty of care to the victim; (ii) that the tortious conduct was in fact the proximate cause of the harm; (iii) that the victim was harmed.¹⁰

We may therefore reason that because SN^\ddagger requires courts to consider precautions aimed at *possible* events, the second element fails to obtain. That is, the SN^\ddagger standard of hybrid care incorporates victim-side probabilities, but since the tortfeasor did not end up actually being a victim, one cannot sensibly draw a causal connection between the victim-side probability reduction and the *actual* accident. The lack of victim-side hybrid precautions by the tortfeasor cannot be construed as a cause-in-fact or proximate cause of the accident.

However, that analysis is incorrect. To see why, let us consider the legal elements of causation. Causation in torts is generally analyzed into two sub-elements: (a) cause-in-fact,

¹⁰The traditional casebook formulation of negligence often breaks the first two elements down further for a total of five “elements”: (i) duty, (ii) breach, (iii) cause-in-fact, (iv) proximate cause, (v) damage. *See, e.g.,* Schwartz et al. (2010). For present purposes, the analytical distinction is immaterial, since duty and breach may be sensibly treated as a single element, while proximate cause conceptually subsumes cause-in-fact.

and (b) proximate cause. The first sub-element, cause-in-fact, is obviously irrelevant to whether the court sets the standard of care at SN^\dagger , SN^\ddagger , or indeed anything else. Either the actions of the defendant actually were the physical cause of the injury, or they were not. If they were, then cause-in-fact is satisfied. If they were not, then cause-in-fact fails. To abuse a well-worn example, if the infamous “butterfly in China” were sued for creating a hurricane on the other side of the globe, the cause-in-fact element would be met. Given the broadness of the element, it should be obvious that the standard of care will not be implicated.

What about proximate cause? Several overlapping theories of proximate cause exist, but the most commonly used standard by far is “foreseeability.” Foreseeability is meant to constrain the scope of causation, so that remote and unanticipated effects are legally eliminated from the scope of liability. Foreseeability does not bar the use of a SN^\dagger (or any other) standard, because if the underlying activity (e.g., driving, hunting, playing sports) caused a foreseeable risk, and the resultant injury were within the scope of that foreseeable risk, then foreseeability would be met regardless of the due care standard.

An alternative theory of proximate cause, which might be supposed to be more problematic for an SN^\ddagger standard, is the “risk rule.”¹¹ The risk rule constrains not only the foreseeable consequence of a type of activity, but also the relationship between due care and the harm. That is, the risks to others created by failing to exercise due care are what determine causality. This may seem problematic for SN^\ddagger , which sets the due care level by including consideration of victim probability. However, closer analysis will show that the risk rule does not bar consideration of victim probabilities in setting the due hybrid care standard.

Hybrid care does not contradict the risk rule, because it does by definition affect “the risks that made the actor’s conduct tortious.”¹² Indeed, we have defined hybrid care as that which affects both tortfeasor probabilities and victim probabilities. Whereas the risk rule would exclude consideration of victim-specific precautions, which have no affect on tortfeasor probability, hybrid precautions remain relevant because by definition, they do affect tortfeasor probability.

It is worth pointing out that the *amount of care* that one has a duty to exercise is conceptually distinct from the *class of circumstances* in which one has such a duty. The former is a question of *how much* precautionary effort one owes to others, while the latter is a question of *whether* one has a duty of care at all. The risk rule only seems to be in conflict with a SN^\ddagger standard if one conflates the two dimensions of liability.

The risk rule may be (problematically) interpreted as stating that the extent of liability (i.e., the set of possible causal events, for which a tortfeasor may be liable) includes only those

¹¹ See RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL HARM § 29 (“An actors liability is limited to those physical harms that result from the risks that made the actors conduct tortious.”). See also Keeton (1963).

¹² *Id.*

risks that arise from a failure to exercise due care. However, while this is consistent with the text, it does not make sense. Due care assumes a set of circumstances, for which a potential tortfeasor has obligation to exercise a minimum amount of precaution. That set of circumstances cannot be defined as those occasions, where the tortfeasor has failed to exercise sufficient care. Such an understanding would be plainly circular, defining proximate cause in terms of the due care standard, and defining the due care standard in terms of the standard of care.

The proper conception of proximate cause is that it constrains the chain of causation, identifying circumstances when a duty of care is owed. If a jurisdiction adopts the risk rule for proximate cause, then the *scope* of liability is constrained to those risks, which the tortfeasor permitted, which caused the harm. The *magnitude* of the duty owed to potential victims is an independent question, and there is no reason to suppose that the risk rule is incompatible with SN^\ddagger any more than it is incompatible with SN^\dagger .

So if tort doctrine on causation does not force the use of SN^\dagger , then what *does* explain the courts' use of SN^\dagger rather than SN^\ddagger ? We suggest that it arises from a general tendency in the Anglo-American judicial tradition to artificially reduce problems (albeit often fruitfully) into binary "tests" or "conditions."¹³ The role-determinateness of tortfeasors and victims from an *ex post* perspective feeds the courts' predisposition to divide categories into twos, leaving them blind to the dual benefit of hybrid care. We suggest that the lack of recognition of hybrid care as a distinct category of care is the underlying reason for the common law adoption of the inefficient standard SN^\dagger .

Historically, the tendency of courts to count only those precautions which result in reductions in tortfeasor probability eventually hardened into an established rule,¹⁴ however recent scholarly recognition of self-harm risks has opened the door to an adoption of a SN^\ddagger standard, which we will discuss in greater detail in Section 4.

3.2.3 Contributory Negligence

At this point, it is fair to wonder whether the defense of contributory negligence can correct SN^\dagger , so that it will also incentivize optimal investment in hybrid care, without a modification of the standard of due care to SN^\ddagger . We find that this is not generally the case.

Let h° be defined by the FOC:

$$-w_j p_{j h_i} L = 1 \tag{3.9}$$

Under the traditional model for contributory negligence, victims i can only recover in the event

¹³See Shapiro (1986), 11-12.

¹⁴See, e.g., RESTATEMENT (SECOND) OF TORTS § 282.

that $-w_j p_j y_i L \leq 1$. In accounting for hybrid care, we model the potential victim's hybrid precautions in the same way that courts have treated potential tortfeasors' hybrid precautions, h_i^\dagger above. That is, the minimum standard of hybrid care necessary to avoid the defense of contributory negligence will simply be h° .

The private objective function under contributory negligence is given by 3.8 with the additional conditions that i will bear the burden of $w_1 w_2 p_j L$ whenever $h_i < h_j^\circ$.

It should be clear then that contributory negligence will fail to incentivize an efficient level of hybrid care, because parties will expend whichever is greater, h^\dagger or h° . However, we know from Proposition 2 that the optimal level of hybrid care is h^\ddagger , which is not generally equal to h^\dagger or h° .

Proposition 3 (Inefficiency of Contributory Negligence). *Under role-uncertainty, contributory negligence will not generally incentivize efficient hybrid care levels.*

Proof. See Appendix. □

To summarize the results from this section: we found that the conventional tort regimes failed to incentivize efficient hybrid care levels under role-uncertainty. Consequently, we offered an alternative conceptualization of negligence, SN^\ddagger , which does incentivize the adoption of efficient hybrid care. In legal terms, the content of “due care” under SN^\ddagger would be identified by looking at the marginal reduction in the cost of *accidents* (as opposed to a marginal reduction in the cost of *being a tortfeasor*) relative to the marginal increase in the cost of precautions.

3.3 Activity Level Incentives under Role Uncertainty

Having studied the effects of role-uncertainty on care levels, we now turn to its effect on activity levels. It is well established in the law and economics literature on tort law that the main determinant of activity level incentives is the allocation of the residual loss, i.e., the allocation of the loss when both parties adopt due care. Under conventional liability rules, the allocation of the residual loss falls alternatively on the tortfeasor (for all strict liability based rules) or on the victim (for no liability and all negligence-based rules). This implies that activity levels incentives are concentrated on one set of individuals, rather than shared between the parties.¹⁵

Proposition 4 (Spreading of Activity Level Incentives under Role-Uncertainty). *Given role-uncertainty, activity level incentives will be spread and both parties will reduce their activity in equilibrium.*

¹⁵The law and economics literature, *see, e.g.*, Polinsky & Che (1991), has identified decoupling as the only hypothetical legal regime for producing optimal legal incentives for both parties.

Proof. See Appendix. □

Corollary 4.1 (Irrelevance of Tort Law under Role-Uncertainty). *Under symmetrical role-uncertainty alternative liability rules have equivalent effects on activity level incentives.*

Proof. See Appendix. □

Recent research efforts on this topic have attempted to devise loss-spreading solutions to promote activity level incentives for both parties.¹⁶ In the presence of role-uncertainty, the residual loss is allocated between the parties on the basis of $\frac{p_i}{p_1+p_2}$, such as to induce both parties to reduce their activity levels. This reduction in activity levels will not reach the social optimum, but may nevertheless represent an improvement over circumstances characterized by role-certainty. This may be the case when the reduction of activity level imposes an increasing marginal cost, i.e., $V'' < 0$. This condition may be reasonably assumed, since individuals will forego less valuable activities to continue to carry out more valuable activities. Of course, this result needs to be reconciled with the cheapest cost-avoider paradigm, inasmuch as some activities may be more socially valuable than others.¹⁷

Corollary 4.1 establishes that the expected allocation of the residual loss is the same under all liability rules. Looking at the parties' *ex ante* choices, the law becomes irrelevant. Assuming away the second-order effects of precautions on activity levels, the same activity levels will be carried out under no liability, strict liability and negligence.¹⁸

From a policy perspective, this result implies that the criteria generally invoked for the choice of an optimal liability regime need to be reassessed. Even though the choice of liability can still play a role for care level incentives, the effects vanish in the domain of activity level incentives. Tort liability can be used to manipulate care levels and to shift *ex-post* accident costs, but will be ineffective at shifting *ex ante* activity level incentives between parties under role-uncertainty.

¹⁶Among such solutions, see the comparative non-negligence rule proposed by Calabresi (1965) and the comparative causation rule studied by Parisi & Fon (2004), Singh (2007), and Parisi & Singh (2010). Parisi & Fon (2004) examine the desirability of comparative causation based liability. The authors show that under a pure comparative causation rule, parties undertake inefficient care and activity levels, since they bear only a fraction of the accident loss. Parisi & Singh (2010) extend the model of Parisi & Fon (2004), in order to take into account that both parties' care and activity levels affect the causation of an accident and the expected loss in the event of an accident. In this framework, the rule of comparative causation induces efficient care for parties and a spreading of the accident loss. As a result, under comparative causation, also activity level incentives are spread between the parties, unlike traditional negligence or strict liability regimes. *See also* Dari-Mattiacci et al. (2011) and Carbonara et al. (2013)

¹⁷This may explain the immunities accorded to ambulances, police or firefighters.

¹⁸The second-order effects of precaution costs on activity levels are fully eliminated in the standard model with durable precautions, in which higher precautions costs do not affect the marginal cost of the activity.

4 The Rise of Hybrid Care in Recent Tort Doctrine

We extracted several policy insights from our model. Firstly, in activities characterized by role uncertainty, less attention ought to be given to activity level than in role-certain cases. Secondly, courts should adopt a heightened standard of due care in double-edged torts. Earlier, we suggested that the courts' failure to recognize hybrid care as a category of precautionary care was the reason why they adopted the inefficient due care threshold SN^\dagger . Unfortunately, in assessing due care under simple negligence, courts were myopically preoccupied with tortfeasors' reduction in tortfeasor probability (or victims' reduction in victim probability in case a contributory negligence defense is allowed), and the repeated affirmation of the principle led to a hardening of the common law, which we see in RESTATEMENT (SECOND) OF TORTS (1965), which describes the duty of care exclusively in terms of reducing the probability of harm *to others*.¹⁹

However, scholarly work since the publication of the RESTATEMENT (SECOND) OF TORTS has drawn considerable attention to self-harm concerns,²⁰ which influenced the drafters of RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM (2010), which now recognizes harm to self as a relevant factor.

A person acts negligently if the person does not exercise reasonable care under all the circumstances. Primary factors to consider in ascertaining whether the person's conduct lacks reasonable care are the foreseeable likelihood that the person's conduct will result in harm, the foreseeable severity of any harm that may ensue, and the burden of precautions to eliminate or reduce the risk of harm.²¹

The omission of specifying harm *to others* was a deliberate change.²² The Reporter's Note for § 3, cmt. b makes clear that consideration was given to the technical distinction between SN^\dagger and SN^\ddagger , which were represented by Schwartz (1978) and Simons (1995) respectively. It makes quite clear the RESTATEMENT's position:

[Schwartz (1978) is] mistaken. It is true that a defendant cannot be negligent unless its conduct imposes risk on some third party, while a plaintiff cannot be contributorily negligent unless the plaintiff's own conduct subjects himself to a risk of injury.

¹⁹REST. (2D) TORTS, §§ 4, 282.

²⁰Simons (1995) and Cooter & Porat (2000).

²¹RESTATEMENT (THIRD) (2010) § 3.

²²REST. (3D) TORTS § 3, cmt. b ("In fact, in many cases, the conduct of the defendant that is negligent—for example, a physician's misprescription of medication—creates a risk of harm only to a third party and not to the defendant. Conversely, in many cases the conduct of the plaintiff that is contributorily negligent—for example, carelessly climbing a household ladder—creates a risk only to the plaintiff and not to third parties. *However, in many other situations—especially those involving highway traffic—the conduct of the actor imperils both the actor and third parties. In such situations, all the risks foreseeably resulting from the actor's conduct are considered in ascertaining whether the actor has exercised reasonable care.*") (emphasis added).

Yet in cases in which the actor's conduct does involve risks to both the actor and to third parties, both sets of risks clearly bear on the overall reasonableness of the actor's conduct.

Our formulation of the heightened due care standard when hybrid precautions are available pushes the boundary one step further, suggesting that parties should invest in precautions up to the point that the reduction in the expected cost of *accidents* (as opposed to the expected cost of *being a tortfeasor*) equals the marginal cost of care.

The observations in the commentary of RESTATEMENT (THIRD) are aimed at self-harm rather than insufficient victim-side probability reduction. While a reduction in victim-side probability may be construed as a type of self-harm precaution, the point requires some finessing. Moreover, the discussions in RESTATEMENT (THIRD) as well as Simons (1995) seem to assume implicitly that contributory or comparative negligence situations are the only occasions where hybrid care may be at issue, whereas we found that contributory negligence *per se* actually fails to incentivize optimal hybrid care, while a modified version of simple negligence does. Nevertheless, these sources are extremely close to our conceptualization, and the wording of RESTATEMENT (THIRD) § 3 is sufficiently general that it could be used to justify imposing a SN^{\ddagger} standard of care.

As we remarked earlier, there do not seem to exist any judicial opinions yet recognizing hybrid care. However, no apparent doctrinal reason exists in the history of tort law why courts should not embrace SN^{\ddagger} , and indeed the RESTATEMENT (THIRD) implicitly anticipates such modification of negligence rules. We hope our analysis contributes to the nascent recognition of hybrid care and double-edgeness generally, demonstrating that SN^{\ddagger} is preferable from an efficiency standpoint, and furnishing a formal framework for further discussion.

Compatibility with existing tort doctrine and efficiency objectives notwithstanding, there may nevertheless exist fact-finding difficulties in adopting the SN^{\ddagger} standard, since it would seem to require courts to contemplate unrealized potentialities (i.e., expected accident costs that failed to materialize), a task for which courts may not be well suited. However, there exist at least two policy alternatives to account for double-edgedness, which avoid the problem of asking courts to contemplate counterfactual accidents.

First, we could look for regulatory solutions, requiring parties to exercise h^{**} level of precautions. However, such an approach also incurs all the ordinary problems of regulation—inflexibility with respect to idiosyncratic situations, imperfect enforcement, etc. These may nevertheless prove more practical than tasking courts with changing the standard of due care, when precaution externalities are involved.

However, the second and possibly more appealing alternative may simply be to retain the present standard of due care, and to instead use the assignment of liability to effect higher

investment in hybrid care for at least one party. The idea with a liability rule solution would be to assign residual liability on the party, who has a greater share of available hybrid precautions. Of course, we have already observed that the vast majority of precautions in *any* double-edged tort will be “hybrid” to some greater or lesser degree. However, to the extent that the “hybridity” of available precautions and the effectiveness of hybrid precautions are greater for one party than another, residual liability should be assigned to that party.

5 Conclusion

Let us now step back and situate the foregoing results within a broader context. One view of human activity is that it is orderly; that a bright line may be drawn in any interaction between those who act, and those who are acted upon. Another view is that human activity is chaotic; that people are like billiard balls, knocking against each other unpredictably as they roll about the wide world. We do not think one view superior to the other, for both are plausible approaches to understanding the multifarious social interactions we observe.

However, we find that in the realm of accidental injury, the latter perspective has been sorely neglected. It takes little imagination to recognize the vast and variegated activities, in which one might find oneself in the position of a billiard ball—at once the potential recipient and the potential precipitator of harm. And to the extent that the *raison d’être* of tort law is to minimize the social cost of accidents, our billiard ball conception generates divergent results from the role-determinate model, which we believe to be a closer fit to reality.

To summarize briefly our main results: We found that in double-edged torts, activity levels are insensitive to changes in liability regime. Further, we found that none of the traditionally recognized tort regimes are capable of incentivizing efficient levels of hybrid care. However, we showed that raising the standard of care under simple negligence to account for the marginal reduction in the probability of an *accident*—as opposed to a reduction in the probability of being a *tortfeasor* specifically—would incentivize an efficient care level. This corresponds to the precaution level that a hypothetical “single owner” of the tortfeasor’s and victim’s activities would undertake to maximize his aggregate payoffs.²³

The “single owner” framing of the problem appeals to intuition. Imagine a mother of two children playing together boisterously. The mother prudently exhorts her children to “be

²³Epstein (1993) presents the “single owner test” as an intuitive gloss on the efficient allocation of resources, imagining that the activities of multiple parties were performed by a single individual. The idea is that since a single owner would internalize the externalities that two (or more) parties might cast on each other, the privately optimal choice of a single owner corresponds to the socially optimal allocation of resources among parties. Thus, the privately optimal precautionary care level for a single actor undertaking multiple activities corresponds with the socially efficient precautionary care levels for multiple parties undertaking a division of the same activities.

careful!” We need not strain our analytical resources to understand the parent’s counsel. Unlike tort law, the mother is not thinking in terms of her children being “tortfeasors” or “victims”: she simply wants her children to avoid being involved in accidents *tout court*. Of course, legal systems use threats of liability rather than motherly advice, but while the mechanisms for incentivizing precautions may be different, the problems addressed by tort law and concerned mothers are ultimately the same. Like the heedful parent, tort law should entreat people to follow such an all-embracing conception of due care. Though formal analysis gives weight and legitimacy to the idea, and though expressing the idea in legal terms may be complex, our underlying insight is eminently simple. The ultimate aim of tort law should not be to encourage people to exercise some arbitrary mix of role-directed precautions, but rather to exercise care in such a way as to reduce accidents generally.

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6 Appendix

Proposition 1

Proof. We first prove the inefficiency of incentives under (A) no liability, and then for (B) strict liability. We then demonstrate (C) the equivalence of incentives given role-reversibility:

(A) Under no liability, the private objective function is: $\max_{(y_i, h_i)} P_i^{NL} = V_i(w_i) - w_1 w_2 p_j L - w_i(x_i + y_i + h_i)$. The private optimum is identified by the FOCs:

$$-w_j p_j y_i L = 1 \quad (6.1)$$

$$-w_j p_j h_i L = 1 \quad (6.2)$$

$$V_{i w_i} = w_j p_j L + x_i + y_i + h_i \quad (6.3)$$

From FOCs 3.4 and 6.2, $h_i^{**} = h_i^*$ only when $p_{i h_i^{**}} = 0$. However, since p_i is independent of p_j , it will not always be the case that $p_{i h_i} = 0$ at socially optimal h_i , and therefore it is not generally the case that $h_i^* = h_i^{**}$.

(B) Under strict liability, the private objective function for individual i is: $\max_{(x_i, h_i)} P_i^{SL} = V_i(w_i) - w_1 w_2 p_i L - w_i(x_i + y_i + h_i)$. The private optimum is identified by the FOCs:

$$-w_j p_i x_i L = 1 \quad (6.4)$$

$$-w_j p_i h_i L = 1 \quad (6.5)$$

$$V_{i w_i} = w_j p_i L + x_i + y_i + h_i \quad (6.6)$$

The proof is the mirror image of the proof for no liability, swapping the terms p_i and p_j .

(C) The proof for hybrid care equivalence arises directly from the comparison of FOCs 6.2 and 6.5 given the assumptions of symmetrical role-uncertainty. The proof for activity level equivalence arises directly from a comparison of FOCs 6.1, 6.5, 6.3 and FOCs 6.4, 6.5, 6.6.

□

Proposition 2

Proof. From 3.4 and 3.7, when SN^\ddagger is adopted, $h_i^{**} = h_i^\ddagger$. When SN^\dagger is adopted, 3.6 is equivalent to 6.5 and the same proof of Proposition 1 applies. Hence, $h_i^\dagger < h_i^\ddagger = h_i^{**}$. \square

Proposition 3

Proof. We need to prove that if $h^\dagger \neq h^\circ$, where h° is defined according to 3.9, then $h^\dagger \neq h^\ddagger \neq h^\circ$. First, from comparing 3.6 and 3.9, $h^\dagger \neq h^\circ$ when $p_{ih_i} \neq p_{jh_i}$. Under this condition, $h^\dagger \neq h^\ddagger \neq h^\circ$ follows directly from Proposition 2. \square

Proposition 4

Proof. FOC 6.3 applies to both individual 1 and individual 2, assuming $p_1 > 0$, $p_2 > 0$. This implies that both parties will reduce their activity levels. Under symmetry (i.e., $p_i \approx p_j$), all parties will reduce their activity levels equally, *ceteris paribus* at equilibrium. A similar reasoning applies for FOC 6.6 under strict liability. Under negligence, FOC 3.8 applies where the equilibrium payoff is $V_i - w_1w_2p_jL - w_i(x_i + y_i + h_i)$. The privately optimal activity level will be

$$V_{iw_i} = w_jp_jL + x_i + y_i + h_i \quad (6.7)$$

and again, the parties will reduce activity levels to the same extent under role-uncertainty. \square

Corollary 4.1

Proof. Under symmetric role-uncertainty, $p_i = p_j$, and FOCs 6.3, 6.6 and 6.7 are identical. This implies that the choice of liability scheme is irrelevant to activity level incentives. \square