Disgorgement Damages for Accidents

by

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Under the usual tort rules, damages for an accident equal the victim's loss (compensation). This paper departs from current law by proposing damages equal to the injurer's gain from untaken precaution divided by the probability of liability (disgorgement damages for accidents, or DDA). DDA is the minimum liability necessary to provide injurers with efficient incentives for care. DDA is smaller than compensation, so it typically induces more activity by injurers and less activity by victims. Calculating DDA generally requires different information than compensation. Consequently, some imperfections in information cause courts to distort incentives for care under compensatory damages and not DDA, while others have the opposite effect. Furthermore, the smaller size of damages under DDA compared to compensation can shrink or magnify the distortion in incentives for care caused by court and injurer errors. We distinguish three forms of DDA with different information requirements and the same incentive effects. A court can pick the form that fits the available information.

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Introduction

Under prevailing law, damages for an accident equal compensation for the victim's loss, and damages for an intentional wrong often equal the victim's loss

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(compensation) or the injurer's gain (disgorgement), whichever is larger.[1] This paper departs from current law by proposing disgorgement damages for accidents (DDA) when certain conditions are met.

DDA differs from conventional disgorgement of the gain from wrongdoing. Conventional disgorgement sets the injurer's liability equal to her gain from untaken precaution towards the injured plaintiff. In contrast, DDA sets the injurer's liability equal to her gain from untaken precaution divided by the probability of liability. Here is a numerical example for comparing compensation and disgorgement for accidents:

> *Example 1. Omitting a Test*. Doctor performs a beneficial procedure for a patient. In addition to the benefit, the procedure risks harmful side effects. A test that costs the doctor 20 can avoid the harmful side effects. Omitting the test causes harm of 1,000 to the patient with probability .10. Whenever harm materializes the doctor will be held liable for damages (i.e., enforcement is 100%). Doctor omits the test and the harm materializes. Patient sues for medical malpractice.

Assume the doctor is found negligent,[2] and consider the damages. Compensatory damages equal the plaintiff's harm of 1,000. Alternatively, with conventional disgorgement, the doctor is liable for her savings in untaken precaution towards the plaintiff, which equals 20. With DDA, however, the doctor is liable to the accident victim for her expected savings divided by the probability of liability. In Example 1, we assume that the probability of liability equals the probability of an accident caused by doctor's omitted care, which equals .1. Thus the doctor's liability under DDA is 20/.1 = 200.

200 is the minimal liability that provides the doctor in Example 1 with incentives to perform the test. To see why, compare the doctor's expected liability under DDA for omitting the test and the doctor's cost of performing it. The doctor's expected liability equals DDA times the probability of liability, or 200 x .1 = 20. The doctor's cost of performing the test also equals 20. Therefore DDA is the minimal liability that deters a

[1] We do not discuss faultless disgorgement. Faultless disgorgement is a case where the defendant has been unjustly enriched without doing anything wrong. For example, the plaintiff seeks to recover a payment intended for his creditor that was accidentally paid to the defendant (Restatement Third, Restitution and Unjust Enrichment 2011, § 6). Or the plaintiff seeks to recover her lost property that the defendant found.

[2] The doctor saved 20 by untaken precaution, which exposed the patient to an expected loss of 1,000 x .1 = 100. The burden of precaution (20) is less than the expected loss (100) caused by it, so the doctor is negligent by the Hand Rule.

rational doctor from omitting the test in Example 1. DDA is generally *the minimum deterring liability*.

In certain cases DDA has a practical advantage over compensation: the victim often loses utility from an accident and the injurer often gains money from untaken precaution. The former is often harder for courts to measure than the latter. To illustrate by Example 1, the victim's harm might consist in pain and suffering. Courts have no generally accepted method for monetizing pain and suffering. So the harm of 1,000 in Example 1 might be speculative. In contrast, the doctor's testing cost of 20 might be an accounting number provable by financial records. In this example, harm is harder to measure than omitted care.

DDA, however, involves measuring *expected* gain, not just omitted care. Consequently, DDA requires estimating the accident probability, which compensatory damages does not require. Scientists have generally accepted methods for estimating accident probabilities (e.g., Jonkman, Van Gelder, Vrijling 2003; Levitt & Porter, 2001).[3] Applying these methods in actual cases may yield uncontroversial or controversial results, depending on the circumstances. In Example 1, the probability of harm from omitting the test equals .1. This probability could be a statistical fact or a controversial assertion.

As explained, calculating DDA requires estimating the accident probability, whereas calculating compensatory damages does not require estimating it. In any case, the courts must determine liability. Determining liability under a community standard of care usually requires ascertaining a community practice, and comparing it to the injurer's care. Ascertaining the shortfall (if any) of the injurer's care from the community standard does not require estimating accident probabilities.

Instead of a community standard, liability may be determined by the Hand Rule. Determining liability under the Hand Rule requires comparing omitted care (B) to the

[3] In court, probabilistic estimations are often supported by expert testimonies, especially when precise statistics are required, such as in lost-of-chance malpractice claims. *See, e.g.*, Herskovits v. Group Health Coop., 99 Wn.2d 609, 612 (Wash. 1983) (expert testimony stated that the patient had a 39% chance of 5-years survival if the physician had diagnosed his cancer at Stage I, compared to a 25% chance when diagnosed at Stage II).

accident probability (P) and magnitude of harm (L). The court needs to know whether the cost of omitted care (B) was more or less than the resulting expected harm (BxL). These variables are the elements of DDA (B and P) and compensatory damages (L). Thus determining Hand Rule liability already involves the information required for DDA (B and P) and compensatory damages (L). Note, however, that applying the Hand Rule requires determining whether omitted care (B) is *more or less* than the resulting expected harm (PxL). Determining "more or less" requires rough and ready estimates, whereas determining damages requires exact estimates.

Regardless of whether liability depends on a community standard or the Hand Rule, the court can calculate DDA by an indirect approach that avoids estimating the probability that the accident *was caused* by omitted care. DDA can be implemented by knowing the probability of an accident *when* care was omitted, rather than knowing the probability of an accident *caused* by omitted care. Thus DDA can be implemented independent of proving causation. We will distinguish three forms of DDA with this characteristic. A court can pick the form of DDA that fits its available information. Even so, DDA can be easier or harder to implement than compensatory damages, depending on the case.

We have been comparing the information requirements of DDA and compensatory damages. Now we compare their incentive effects, where each measure has advantages and disadvantages.

First, as is well known, a negligence rule allows non-negligent injurers to escape liability for the risk to others from their activities (Shavell, 1980). As a result injurers' activity level is too high. Legal imperfections can ameliorate the problem by sometimes holding non-negligent injurers liable. When imperfections combine with higher damages, the injurer internalizes more risk of victim's harm caused by his risky activities, and restrains his activity more. Since compensatory damages are higher than DDA, compensatory damages provide more efficient incentives for the injurer's activity level than DDA.

The symmetrically opposite is true of victims. They bear the risk of harm that injurers externalize. With lower damages, the victim internalizes more risk of harm

caused by his risky activity and restrain his activity more. Since DDA is lower than compensatory damages, DDA provides more efficient incentives for the victim's activity level than compensatory damages.

Note, however, that this reasoning concerns externalization of costs, and it assumes no externalization of benefits. Some activities produce positive externalities, such as medical treatment, and compensatory damages might induce inefficiently low activity levels of injurers (Cooter & Porat, 2006). More generally, compensatory damages sometime create chilling effects on desired activities by injurers (Kaplow, 2015). One way to mitigate those effects is to reduce the damages' burden on the injurer. DDA does exactly that.

Second, turning from activity level to precaution, a similar analysis applies. As is well known, if courts have perfect information, a negligence rule (with or without a contributory or comparative negligence defense) provides injurers and victims with efficient incentives to take care. But with imperfect information and courts' errors this goal cannot always be attained (Cooter and Ulen 2012).

Let's start with injurers. As explained, DDA is the minimum damages that deter injurers from omitting care. Consequently, a small under-estimation of DDA can cause damages to fall below the minimum, which gives injurer an incentive to omit care (cf. Polinsky & Shavell, 1994). In contrast, compensatory damages exceed the minimum damages that deter injurers from omitting care. Consequently, a small under-estimation of compensatory damages does not necessarily give the injurer an incentive to omit care. Compensatory damages often have a margin of error in incentivizing injurer's care that DDA lacks. This disadvantage of DDA would be mitigated if DDA were modified to provide a margin of error by adding slightly more damages, say 110% of DDA.

The symmetrically opposite is true of victims. By undercompensating victims, DDA efficiently strengthens victims' incentives to take care. Thus imagine that in Example 1 the victim could efficiently avoid the harm by taking care. Further assume that the victim's behavior is non-verifiable so he cannot be sanctioned for failing to take care. Under that assumption, the victim has no incentive to avoid an accident that causes 1,000

in harm and 1,000 in damages since he will be fully compensated. In contrast, the victim has a strong incentive to avoid an accident that causes 1,000 in harm and 200 in damages.

Third, because of imperfect information and courts' errors the injurer's expected costs under compensatory damages often jump at the legal standard (Calfee & Craswell 1984; Cooter 1982). In contrast, under DDA the change is usually continuous, but not always. Some kinds of court errors can create discontinuity in DDA, specifically court underestimates of the injurer's actual precaution.

As we have explained, under current law, disgorgement damages are explicitly given for intentional wrongs, not for accidents. Under the doctrine of unjust enrichment, current law may allow an accident victim to recover the injurer's saving from untaken precaution. Such suits are rare (or even non-existent) because the actual harm from an accident usually exceeds the injurer's savings from untaken precaution. In Example 1, the actual harm is 1,000 and conventional disgorgement is 20. Thus victims strongly prefer compensation rather than conventional disgorgement. In contrast, DDA equals 200. Thus a shift from conventional disgorgement to DDA reduces the gap between compensation and disgorgement. As noted, the value of compensation is sometimes speculative and the value of DDA is sometimes measurable. Victims may sometimes prefer to ask courts for measurable DDA instead of speculative compensatory damages.

However, our proposal goes beyond allowing accident victims to choose DDA instead of compensatory damages. In addition, we propose to disallow compensation and to limit damages to DDA in well-defined classes of cases satisfying two conditions: first, DDA is easier to measure than compensation, and, second, DDA creates better incentives. Incentives are better under DDA when reducing damages below compensation has positive effects on victims' precautions and activities that exceed any negative effects on injurer's precautions and activities. In these classes of cases, DDA would be the most generous legal remedy available to victims. We think that medical malpractice cases often satisfy the two conditions.

As far as we know, previous literature has not studied DDA systematically. Cooter & Porat briefly discussed the general idea in the context of medical malpractice (Cooter & Porat 2006). Saul Levmore raised the possibility of using a multiplier in

restitution cases but rejected it as generally impractical (Levmore 1990). Levmore has not discussed accident cases but only cases where the wrongdoing was intentional and the level of enforcement was less than 100%. Also, Levmore discussed the simplest version of restitution damages (gains saved divided by the probability of enforcement) but not other versions that we discuss. Alexander Stremitzer & Avraham Tabbach analyzed the conditions under which proportional liability is superior to compensatory damages, and also compared proportional liability to disgorgement damages (Stremitzer & Tabbach 2014). In their analysis they assumed that if disgorgement damages are awarded, a multiplier should be applied. They concluded that under certain conditions proportional liability provides better incentives to the parties than disgorgement damages.

Mitchell Polinsky & Steven Shavell analyzed the possibility of awarding damages equal to the injurer's gain instead of compensatory damages, but have not discussed accident cases (Polinsky & Shavell 1994). Polinsky & Shavell's main conclusion was that compensatory damages better deter than gain-based damages, and suggested that if disgorgement damages were allowed additional damages would be required to secure deterrence. The authors rightly mentioned that disgorgement damages, when lower than compensatory damages, may better incentivize the victims, but have not discussed other advantages of disgorgement damages that we discuss. Lastly, Porat & Stein 2001 considered another alternative to compensatory damages which potentially could also provide efficient incentives to injurers: risk-based liability. Under the latter rule damages are awarded for the expected harm rather than for actual harm. Porat & Stein explained that in most cases risk-based liability is much harder to enforce than harm-based liability, and therefore not implementable.

On its surface, the economic rationale for punitive damages resembles DDA. According to the economic rationale (which was rejected by the American Supreme Court in Philip Morris v. Williams 549 U.S. 346 (2007)), punitive damages should ideally equal compensatory damages divided by the probability of enforcement (Cooter 1982; Polinsky & Shavell 1998; Sharkey 2003; Craswell 1999; Karpoff & Lott 1999; Hylton & Miceli 2005). These papers apply a multiplier to offset enforcement error, whereas DDA applies a multiplier even with perfect enforcement of the law. Furthermore, these papers apply a multiplier to compensatory damages, whereas DDA

applies a multiplier to untaken precaution. Finally, these papers consider one kind of multiplier, whereas we discuss three types of multipliers for implementing DDA.

Finally, commentators on crimes have discussed the possibility of fines based on the illegal gains of offenders, taking into account under-enforcement. Gain-based liability has the potential to deter wrongdoing. However, these commentators discuss intentional harms, not accidents (Gruner 1992; Parker 1989).[4] The criminal law literature is far away from our DDA idea.

The paper proceeds as follow: Part I develops a model presenting three possible forms of DDA. This Part explains the advantages of DDA over compensation and vice versa. Part II applies DDA to cases where DDA is a more efficient remedy than compensation. Conclusions follow.

I. The Model

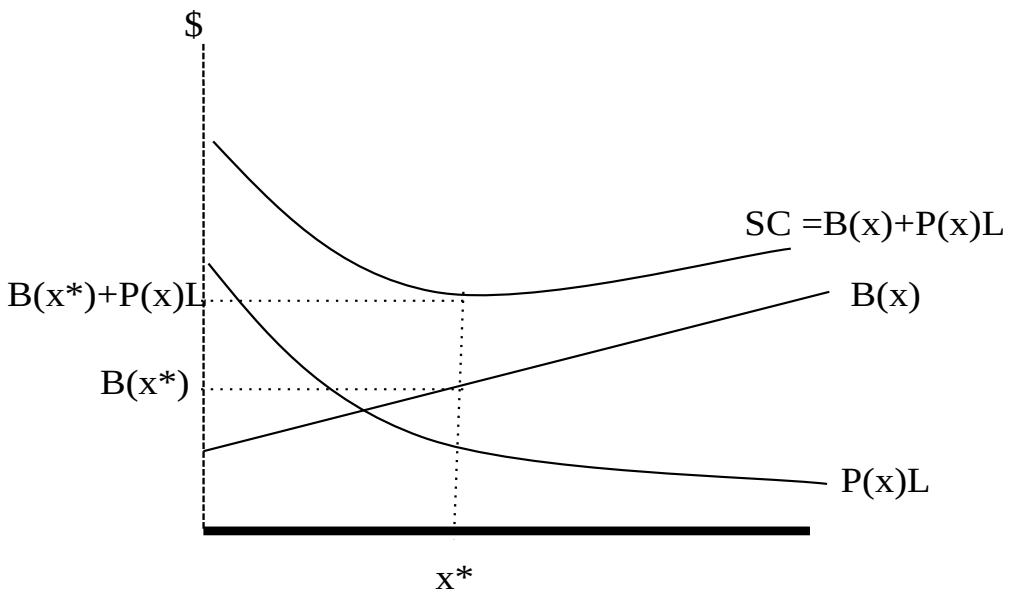
A. Main Results

We will adapt the classic economic model of tort incentives under a negligence rule, aiming for simplicity and not generality.[5] In the simplest version, the injurer chooses his precaution x, which determines the probability of an accident P(x). An accident results in loss L. The expected loss P(x)L decreases at a decreasing rate, as depicted in Figure 1. The cost of the injurer's precaution, or his burden of care, is denoted B(x). For simplicity, Figure 1 depicts B(x) as a linear function. The social cost of accidents SC equals the expected loss plus the injurer's burden of care, or SC=B(x)+P(x)L. In Figure 1, x* denotes the social optimum, which is the level of care that minimizes social costs.

[4] Indeed, under the sentencing guidelines (United States Sentencing Commission, Guidelines Manual, 2013) the amount of illegal gains is one consideration among others for criminal courts when determining the appropriate sanctions.

[5] Features described by Calabresi 1970, formalized by Brown 1973, and subsequently developed in various places, notably Shavell 1987 and Cooter and Ulen 2012.

Figure 1: Social Optimum



Figures 2 and 3 adapt Figure 1 to show the injurer's expected costs with compensatory and disgorgement damages, respectively. Under a negligence rule, the injurer is liable for accidental harm caused by care x below the legal standard x^0, and the injurer is not liable for accidental harm that materializes when care x equals or exceeds the legal standard x^0. In Figure 2 and 3, the legal standard divides the space into zones of liability and no liability. By assumption, the legal standard x^0 equals the socially optimal care x*. In the zone of no liability where $x \geq x^0$, the injurer bears the burden of care B(x) and pays no damages, as indicated by the solid line labeled B(x) in Figure 2 and 3. In the zone of liability where $x<x^0$, the injurer bears the burden of care B(x) plus damages -- compensatory damages in Figure 2 or disgorgement damages in Figure 3.

Under a negligence rule, the injurer owes damages to the victim who suffers harm caused by the injurer's omitted care. If the injurer satisfies the legal standard, an accident's probability equals $P(x^0)$. If the injurer takes precaution x, an accident's probability equals P(x). "Omitted care" refers to care below the legal standard, or $x<x^0$. Omitted care increases an accident's probability by $P(x)-P(x^0)$. But for the injurer's

omitted care, none of these accidents would occur. Under a negligence rule, the negligent injurer's probability of liability equals the increase in the accident probability caused by omitted care, or $P(x)-P(x^0)$.

When the injurer's negligence causes an accident, compensatory damages equal the victim's harm L. Thus the injurer's expected liability for compensatory damages equals L times the increase in accident probability caused by his omitted care, or $(P(x)-P(x^0))L$. The negligent injurer's expected costs equal the expected liability plus the burden of care, or $B(x)+P(x)L-P(x^0)L$ as depicted by the solid curve in Figure 2. Notice that this curve equals the social cost curve shifted down by $P(x^0)L$, or the extent of accidental losses when the injurer satisfies the legal standard.

In sum, the solid curve in Figure 2 depicts the injurer's expected costs as a function of his care under a negligence rule with compensatory damages. The rational injurer minimizes his expected costs by choosing the lowest point on this curve, which occurs at the legal standard ($x=x^0=x^*$).

Figure 2: Injurer's Private Costs with Compensatory Damages

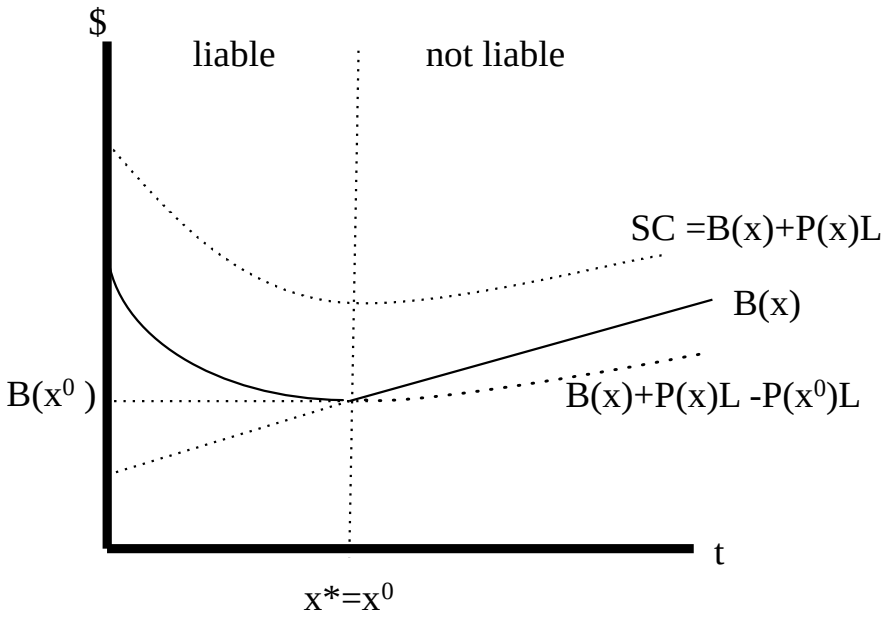


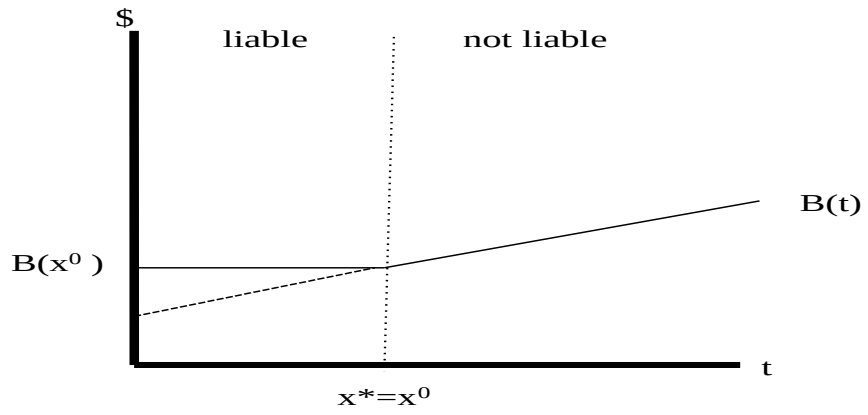
Figure 2 illustrates two familiar facts about the injurer's incentives under compensatory damages. First, the injurer has an incentive to satisfy the legal standard exactly, as represented by the fact that the lowest point on the curve $B(x)+P(x)L-P(x^0)L$ occurs where $x=x^0$. Second, the non-negligent injurer has no incentive to restrain activity level. Thus if z denotes injurer's activity and the accident probability is rewritten P(x,z), then the non-negligent injurer's expected cost of precaution and liability equals B(x) for all $x \geq x^0$ and for all z.

Now we turn from compensation to disgorgement. The burden of satisfying the legal standard of care equals $B(x^0)$. The negligent injurer's actual burden of care equals B(x). The difference between them is the injurer's savings from omitted care, or $B(x^0)-B(x)$. DDA equals the negligent injurer's saving from omitted care times a multiple m, or $(B(x^0)-B(x))m$. Damages are different under disgorgement and compensation, but the conditions for liability are assumed to be the same. Recall that the injurer's expected liability under a negligence rule equals the increase in accident probability caused by his omitted care, or $(P(x)-P(x^0))$ times damages. Thus the negligent injurer's expected liability under disgorgement damages equals the probability of liability times disgorgement damages, or $(P(x)L-P(x^0)[(B(x^0)-B(x))m]$.

Substituting for the disgorgement multiplier m simplifies this expression. By definition of DDA, m equals the reciprocal of the increase in accidents caused by the injurer's omitted care, or $m=1/(P(x)-P(x^0))$. Substitute for m in the preceding expression and the negligent injurer's expected liability reduces to $B(x^0)-B(x)$. The negligent injurer's expected costs under DDA equals his burden of care plus his expected liability, or $B(x)+(B(x^0)-B(x))$, which equals his burden of care at the legal standard $B(x^0)$.

In sum, the solid curve in Figure 3 depicts the injurer's expected costs as a function of his care under a negligence rule with disgorgement damages. The rational injurer minimizes his expected costs by choosing the lowest point on this curve. As before, the rational injurer can minimize his expected costs by satisfying the legal standard ($x=x^0=x^*$).

Figure 3: Injurer's Private Costs with Disgorgement Damages



This point, however, is not the unique minimum. Any precaution in the range $0 \leq x \leq x^0$ is a minimum. DDA is the minimum liability that makes the injurer indifferent between satisfying the legal standard of care or falling below it. To achieve a unique minimum, increase damages slightly above DDA. A small increase in damages will cause the rational injurer to minimize his expected costs by choosing the legal standard $x=x^0$, not a point below the legal standard. For example, a 10% increase over disgorgement damages causes the negligent injurer to bear the cost of his precaution plus 1.10 times his savings from untaken precaution, or $B(x)+1.10(B(x^0)-B(x))$. Figure 4 depicts this fact by rotating the solid line denoted DDA up by 10%.

Figure 4: Injurer's Private Costs with 110% Disgorgement Damages

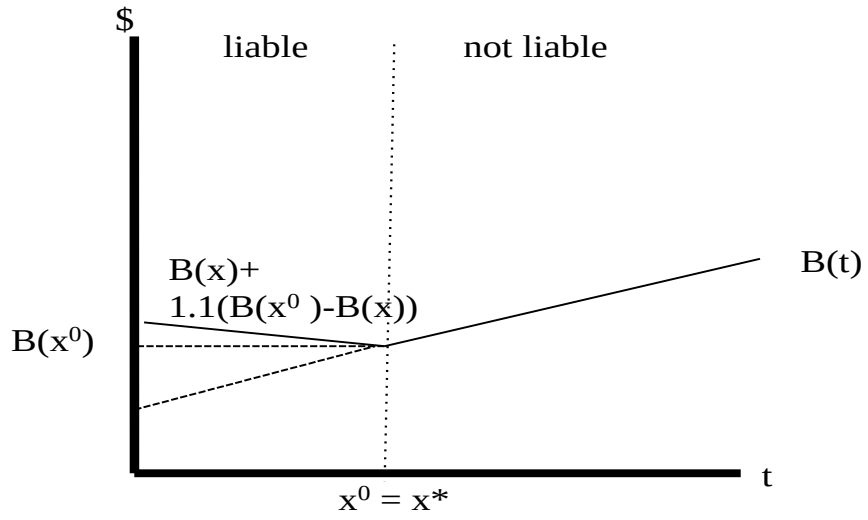
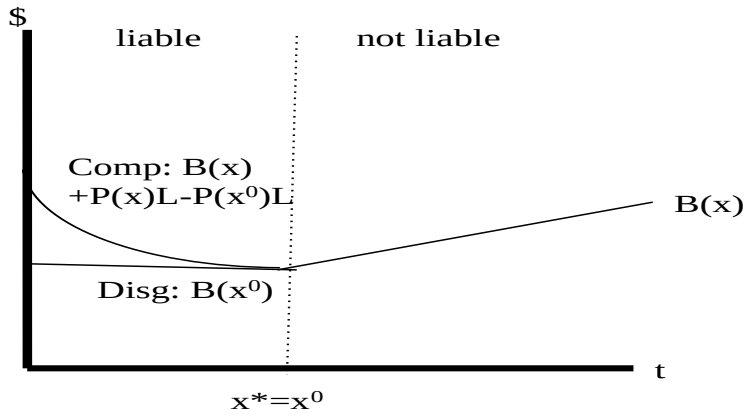


Figure 3 implies the same conclusions about injurer's incentives under DDA as the standard conclusions under compensation. First, the injurer has an incentive to satisfy the legal standard exactly, as represented by the fact that the solid curve in Figure 3 has no lower point than at $x=x^0$. Second, the non-negligent injurer has no incentive to restrain activity level. Thus the injurer's expected cost of precaution and liability equals B(x) for all $x \geq x^0$ and for all activity levels y.

Combining Figures 2 and 3 yields Figure 5, which contrasts the injurer's expected costs under compensatory and disgorgement damages. Interpreting Figure 5 explains our major conclusions about the difference in incentive effects between compensation and disgorgement.

Figure 5: Comparing Expected Costs Under Compensation and Disgorgement



First, amount of damages. Disgorgement damages are at least as small as compensatory damages. In Figure 5, the "Disg" curve lies below the "Comp" curve for low values of precaution x, and the two measures converge as the injurer's care x approaches the legal standard x^0. (Hand's definition of negligence implies convergence.[6])

Second, activity levels. A shift from compensatory damages to DDA has no effect on injurer's activity when the court makes no errors in determining liability and awarding damages, and when injurers make no errors in predicting courts' decisions, since the injurer satisfies the legal standard exactly in either case and bears no liability. However, with courts' and injurers' errors, injurers are often found liable, and their liability is higher under compensatory damages than under DDA. Thus, compensatory damages give the injurer stronger incentives to reduce his activity level. With compensatory damages the injurer's activity level is excessive (Shavell, 1980), and with DDA his activity level is even more excessive.

The symmetrically opposite is true of victims. DDA allows injurers to externalize more costs compared to compensatory damages. As a result, with DDA victims

[6] Whenever the injurer is negligent under the Hand formula, his untaken precautions are lower the expected harm that untaken precautions would have reduced, and they converge at the legal standard.

internalize more of the costs of their activities, therefore they engage in less activity, and their activity level is more efficient.

Sometimes, injurers' activities have positive externalities that increase social value (Cooter & Porat, 2006; Cooter & Porat, 2014). Furthermore, it is well known that compensatory damages might chill socially desirable activities (Kaplow, 2015). Reducing damages to the level of DDA (or close to it) might encourage more activity with positive externalities or decrease the chilling effect, thereby enhancing social welfare.

Third, levels of care. Under DDA the injurer's expected liability $B(x^0)$-$B(x)$ is the minimum liability necessary to incentivize the injurer to take efficient precautions. If courts underestimate $B(x^0)$-$B(x)$, the injurer will not take care. Underestimation of damages under a compensatory damages rule is less sensitive to courts' errors, because the injurer would still have efficient incentives for care as long as damages do not fall below $B(x^0)$-$B(x)$. A possible way to mitigate this disadvantage of DDA is to add a margin of error of, say, 10%.

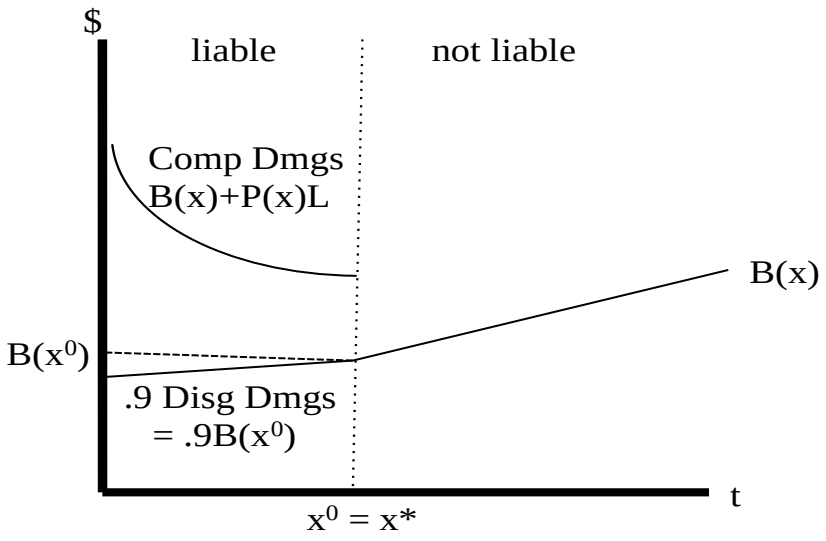
The symmetrically opposite is true of victims. As we have explained, with no courts' or injurers' errors, the injurer satisfies the standard of care under both DDA and compensatory damages and bears no liability. Furthermore, with no courts' and victims' errors, the victim takes efficient precautions. With errors, however, and in particular, when victim's behavior is non-verifiable, the victim might avoid efficient precautions. DDA, which allows the victim lower damages than compensatory damages, strengthens his incentives to take care.

Fourth, and finally, when care rises to the legal standard, the injurer's expected cost often jumps abruptly (discontinuity) with compensatory damages (Cooter 1982; Grady 1983; Kahan 1989), but not with DDA. With compensatory damages, the injurer is ideally liable for harm *caused* by his negligence, not for harm that occurs *when* he is negligent. To achieve this ideal, the courts must attribute cause perfectly. In reality, courts often cannot tell whether or not an accident would have occurred but for the injurer's omitted care. Consequently, causal attribution is imperfect, and the injurer may be held liable for some harm not caused by his negligence.

In notation, $P(x)L$ indicates the harm that occurs *when* the injurer is negligent ($x<x^0$), and $P(x)L$-$P(x^0)L$ indicates the harm *caused* by the injurer's negligence. In Figure

5 the negligent injurer is liable for $(P(x)L-P(x^0)L$, so Figure 5 assumes perfect causal attribution for compensatory damages. When causal attribution is imperfect, the curve labeled "Comp" in Figure 5 shifts up or down. If the injurer is held liable for *all* accidents that occur *when* he is negligent, including the accidents not caused by his negligence, then the injurer's expected liability shifts up by $P(x^*)L$ as depicted in Figure 6, and the injurer's expected liability equals $P(x)L$.

Figure 6. Injurer's Expected Costs with Imperfect Damages



In Figure 6, the injurer's expected costs under compensatory damages has two pieces, with a jump at the legal standard x^0. Eliminating this discontinuity requires perfect information by the court about whether omitted care caused the accident, which is difficult to obtain. In contrast, the injurer's expected costs under disgorgement damages do not jump at the legal standard x^0. With DDA, there is no discontinuity to eliminate: as the injurer takes more precautions, his expected liability falls continuously. Furthermore, DDA would yield the same expected liability regardless of whether courts accurately attribute the accident to the injurer's omitted care. Thus, if courts accurately attribute accidents to omitted care, the probability of liability would be $(P(x)-P(x^0)$, and the

multiplier m would be the reciprocal of $P(x)-P(x^0)$, resulting in expected liability of $B(x^0)-B(x)$. If instead courts would impose liability *when* accident occurred, regardless of whether it was caused by omitted care, the probability of liability would be P(x), and the multiplier m would be the reciprocal of P(x), resulting again in expected liability of $B(x^0)-B(x)$.[7]

Note, however, that discontinuity might also arise under DDA, but for different reasons. Thus, when courts lack information about actually taken precautions B(x), they might assume them to be zero, resulting in the injurer's expected liability to be $B(x^0)$ once the injurer is found negligent. Thus with DDA, discontinuity can arise from the court's lack of information about actually taken care, while with compensatory damages the discontinuity arises from lack of information about causation,.

A discontinuity in injurer's expected costs at the legal standard of care has some well-known consequences, which can be good or bad. Typically, discontinuity results in encouraging the injurer to take more precautions that he would have taken without discontinuity, since satisfying the standard of care reduces the injurer's liability from P(x)L to zero. In some cases discontinuity would result in over-deterrence (Calfee & Craswell 1984), but in some other cases discontinuity might compensate for courts' underestimation of damages and improves incentives (Cooter & Ulen, 2012).

Figure 6 depicts a situation in which the court underestimates disgorgement damages by 10%, thus awarding 90% of disgorgement damages or $.9(B(x^0)-B(x))$. Since disgorgement damages are minimally deterring, 90% of disgorgement damages are not deterring. Instead of satisfying the legal standard, the injurer responds by reducing precaution to zero.[8] To avoid this disadvantage, a court that is susceptible to underestimating disgorgement damages by 10% might aim to set damages slightly above 110% of estimated disgorgement damages. That however might not be necessary, if there is discontinuity in liability also under DDA, as we have explained above.

[7] We further elaborate on this point in *supra* Section B. Note that if a discontinuity is desirable, modifying DDA can easily create it. Adding a constant k to DDA causes the liability line "Disg" in Figure 5 to shift up by k, thus producing a jump of k in injurer's expected costs at the legal standard.

[8] The injurer's lowest point on the curve .9Disg Dmgs is at x=0.

B. Forms of Disgorgement Damages for Accidents

So far we implicitly assumed that the there is only one way to apply DDA: impose liability whenever the injurer was negligent and an accident occurred, at the amount of omitted care divided by the probability of an accident. Now we present three forms of DDA, and consider how courts' errors can arise, and their connection to those three forms.

Assume engaging in an activity risks accidents that differ according to the type of activity (e.g. automobile accident, household accident, side effect of drug, etc.) or the type of harm (e.g. property damage, lost income, lost opportunity, bodily harm, etc.). Denote each type of accident by i, where i=1,2,…,n. P_i indicates the probability that a loss of type i materializes, and L_i indicates the resulting loss. Care B reduces the probability and severity of all accidents. In notation, $P_i=P_i(B)$ where $p_i\leq 0$, and $L_i= L_i(B)$ where $L_i'\leq 0$, for all i=1,2,…,n.

Some types of accidents are verifiable by the court, and others are unverifiable. Assume the court holds the injurer liability for all verifiable accidents and not liable for unverifiable accidents. In notation, let Q denote the probability of liability, and let i=1,2,…,k denote the verifiable accidents. We are assuming:

$$Q_i(B) = P_i(B) \text{ for } i=1,2,\ldots,k \text{ (verifiable)}$$

$$Q_i(B) = 0 \text{ for } i= k+1,k+2,\ldots,n \text{ (unverifiable).}$$

When the court limits liability to verifiable accidents, the disgorgement multiple can be measured in several ways, each of which is minimally deterring. The court sometimes observes the overall probability of verifiable accidents, but not the probability of specific accident. In that case, the court should set the multiple m equal to the reciprocal of the *sum* of *verifiable* accident probabilities, which we call the *general reciprocal*.

When a verifiable accident occurs, the attribution of cause to the injurer's negligence can be perfect or imperfect. The general reciprocal's form depends on the attribution of cause. With perfect causal attribution, the general reciprocal is given by $m=1/\Sigma_1^k(P_i–P_i^o)$. With excessive causal attribution, the general reciprocal is given by

$m=1/\Sigma_1^k P_i$. Regardless of court errors in imputing cause to verifiable accidents, it is easy to see that the general reciprocal is minimally deterring.[9]

Alternatively, instead of observing the overall probability of verifiable accidents, the court sometimes observes the specific probability of the verifiable accident that materialized. In that case, the court should set the multiple m equal to the reciprocal of the probability of the verifiable accident that materialized multiplied by the number of kinds of verifiable accidents, which we call the *specific reciprocal*.

As explained above, when a verifiable accident occurs, the attribution of cause to the injurer's negligence can be perfect or imperfect. The specific reciprocal's form depends on the attribution of cause. With perfect causal attribution, the specific reciprocal is given by $m_i=1/k(P_i-P_i^*)$, where k denotes the number of kinds of verifiable accidents. With excessive causal attribution, the specific reciprocal is given by $m=1/k\Sigma_1^k P_i$. It is easy to see that the specific reciprocal is minimally deterring, regardless of court errors in imputing cause to verifiable accidents.[10]

To illustrate the specific reciprocal by extending Example 1, assume that untaken precaution saves 20 (B(x0)-B(x)=20) and sometimes causes two types of accidents (i=1,2). The probability that omitted care causes liability for accident of type 1 equals 1/10,[11] so the disgorgement multiple m_1 equals 5.[12] Thus expected liability for disgorgement from type 1 accidents equals 20x(1/10)x5=10. The probability that omitted

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[9] We assume that courts are informed about the probability of liability they impose, even if they are uninformed whether they accurately attribute verifiable accidents to omitted care. With perfect causal attribution, the probability of liability is given by $Q= \Sigma_1^k(P_i - P_i^*)$, and the general reciprocal is given by $m=1/ \Sigma_1^k(P_i - P_i^*)$. With excessive causal attribution, the probability of liability is given by $Q= \Sigma_1^k P_i$, and the general reciprocal is given by $m=1/ \Sigma_1^k P_i$. Minimal deterrence requires $B(x^0)-B(x)= Q(B(x^0)-B(x))m$. Substituting for Q and m reduces this equation to $B(x^0)-B(x)= B(x^0)-B(x)$.

[10] With perfect causal attribution, the probability of liability is given by $Q_i= (P_i-P_i^*)$, and the specific reciprocal is defined by $m_i=1/k(P_i-P_i^*)$. With excessive causal attribution, the probability of liability is given by $Q_i=P_i$ and specific reciprocal is defined by $m_i=1/kP_i$. Minimal deterrence requires $B(x^0)-B(x)= \Sigma_1^k[Q_i(B(x^0)-B(x))m_i]$. Substituting for Q_i and m_i reduces this equation to $B(x^0)-B(x)= B(x^0)-B(x)$.

[11] We assume in this, and in the next numerical example, perfect causal attribution. The example can easily be adapted to the assumption of excessive causal attribution.

[12] $m_i=1/kP_i \Leftrightarrow m_1=1/[2(1/10)] = 5$.

care causes accident of type 2 equals 2/10, so the disgorgement multiple m_2 equals 2.5.[13] Thus expected liability for disgorgement from type 2 accidents equals 20x(2/10)x2.5=10. Summing over the two types of accidents, the expected liability from untaken precaution of 20 equals 10+10.[14] Thus the injurer gains 20 for certain and expects liability of 20, which satisfies the condition for minimally deterring liability.

Another interesting damage measure mixes compensatory and disgorgement damages. Sometimes the court has information suggesting something unusual about the harm that materialized. Thus the court might know that the expected harm from verifiable accidents is $\Sigma_1^k P_i L_i$, whereas the materialized harm was L_i. Given this information, the court could apply a disgorgement multiple equal to the ratio of realized to expected harm: $m_i = L_i / \Sigma_1^k P_i L_i$. As before, it is easy to see that the *relative harm* multiple is minimally deterring, and that it remains minimally deterring regardless of court errors in imputing cause to verifiable accidents.[15]

To incorporate the preceding numbers into a numerical example, assume the injurer's probability of liability for accident of type 1 equals 1/10 that results in harm of 50, and the probability of liability for accident of type 2 equals 2/10 that results in harm of 100. Some algebra shows that the injurer gains 20 for certain from untaken precaution and expects liability of 20,[16] which is the condition for minimally deterring disgorgement for accidents as discussed above.

The following table summarizes our results.

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[13] $m_i = 1/kP_i \Leftrightarrow m_2 = 1/[2(2/10)] = 2.5$.

[14] $(B(x^0)-B(x)) = (B(x^0)-B(x))(1/kP_1)P_1 + (B(x^0)-B(x))(1/kP_2)P_2$
$\Leftrightarrow 20 = 20(1/2) + 20(1/2)$.

[15] With perfect causal attribution, the injurer who saves $B(x^0)-B(x)$ by omitting care expects to pay disgorgement damages of $\Sigma_1^k[(P_i - P_i^*)(B(x^0)-B(x))m_i]$, where $m_i = L_i / \Sigma_1^k[(P_i - P_i^*)L_i$ for i=1,2,…,k. Substituting for m_i, the preceding sum reduces to $B(x^0)-B(x)$, which is the condition for minimal deterrence.
Similarly, with excessive causal attribution, the injurer who saves $B(x^0)-B(x)$ by omitting care expects to pay disgorgement damages of $\Sigma_1^k[(P_i)(B(x^0)-B(x))m_i]$, where $m_i = L_i / \Sigma_1^k P_i L_i$ for i=1,2,…,k. . Substituting for m_i, the preceding sum reduces to $B(x^0)-B(x)$, which is the condition for minimal deterrence.

[16] The expected accidental harm from untaken precaution equals (1/10)50 + (2/10)100 = 25. Under the rule of relative harm, m1= 50/25=2 and m2=100/25=4. Thus we have
$(B(x^0)-B(x)) = (B(x^0)-B(x))[L_1P_1/(L_1P_1 + L_2P_2)] + (B(x^0)-B(x))[L_2P_2/(L_1P_1 + L_2P_2)] \Leftrightarrow$
$20 = (20)[(50/10)/25] + (20)[(100/5)/25]$.

Table 1: Forms of DDA Defined by the Multiple m_i[17]

Name	Multiple	DDA
"specific reciprocal"	$m_i=1/kP_i$	$(B(x^0)-B(x))/kPi$
"general reciprocal"	$m_i= 1/\Sigma P_i$	$(B(x^0)-B(x)) /\Sigma Pi$
"relative harm"	$m_i=L_i/\Sigma L_iP_i$	$(B(x^0)-B(x))Li/\Sigma LiPi$

C. Information Requirements for the Different Forms

The three forms of DDA provide minimally deterring liability, but each form of DDA requires the court to have different information in order to calculate damages. We will compare the required information. Any form of DDA in the preceding table requires knowing the saving in costs from untaken precaution. That is the defining characteristic of disgorgement damages for accidents. Two of the forms—specific reciprocal and general reciprocal—do not require accurate information about the actual and expected harm, but only rough estimation about expected harm in order to determine whether the injurer was negligent. Note that in order to determine negligence courts should compare expected harm to precautions, and determine which is higher; they don't need to know the exact figures.

Each form of DDA requires further information to compute the multiple m_i, which involves estimating a probability. The form of DDA based on the *specific reciprocal* requires the court to compute the probability of the injury that actually materialized either *because* of the injurer's negligence or *when* the injurer was negligent and also the number of different types of accident that could have materialized, again either *because* of the injurer's negligence or *when* the injurer was negligent. To illustrate, assume that omitting the test in Example 1 could cause injury of type 1 or injury of other types. The court wants to apply DDA to type 1 injury based on the specific reciprocal. To do so, the court needs information about the probability of type 1 injury, the number of other types of injuries, and the costs of the omitted test. The court does not need to know the probability of the other types of injury. Note one important feature of this form, and also the other forms, of DDA: *DDA can be implemented without proving causation*.

[17] For presentation convenience the table assumes excessive causal attribution. It should easily be adapted for perfect causal attribution.

In contrast, to apply DDA based on the *general reciprocal* to any type of injury, the court needs information about the total probability of all types of injuries resulting in liability (again, either *because* of the injurer's negligence or *when* the injurer was negligent). To illustrate by Example 1, assume as before that omitting the test could cause injury of type 1 or injury of other types. Assume that the court knows the probability that some kind of accident will occur, but not the probability that a particular type of accident will occur. The court also knows the savings from omitting the test. Thus the court know all of the information needed to apply DDA based on the general reciprocal.

Finally, suppose courts have information about the harm caused by untaken care, so the courts could impose liability for actual harm to a victim, but the courts prefer to impose minimally disgorging damages. In that case the courts can use the form of DDA based on *relative harm*. In order to implement this option, courts should have information about the expected and actual harm from untaken precaution (either *caused* by negligence or occurs *when* negligence takes place).[18] To illustrate its implementation, assume as before that omitting the test could cause injury of type 1 or other types of injury. The court might know the expected harm from omitting the test, the specific harm from injury of type 1, and the cost of the omitted test, in which case the court can compute the damages owed to the injured victim under the relative harm form of DDA.

Table 2: Information Required to Implement Forms of DDA[19]

Information/Liability options	**DDA 1 Specific Reciprocal**	**DDA 2 General Reciprocal**	**DDA 3 Relative Harm**
Untaken Precautions $B(x^0)-B(x)$	yes	yes	yes
Types of Possible Accidents k	yes	no	no
Victim's Harm L_i	no	no	yes
Expected Harm $\Sigma L_i P_i$	no	no	yes
Probability of Injury ΣP_i	no	yes	no
Probability of Specific Injury P_i	yes	no	no

[18] Even if they don't have accurate information about the exact amount of expected harm, they might be able to estimate it.

[19] Also here the table assumes excessive causal attribution. It should easily be adapted for perfect causal attribution.

D. Over-compensating Forms and Victims' Moral Hazard

While expected DDA is less than expected compensation, the measure of recovery *in a specific case* could be higher under DDA. To illustrate, assume that untaken precaution is 10. In accidents of type 1, harm is 200 and the probability is 0.02 for expected harm of 4. Assume that accidents of type 1 are verifiable. In accidents of type 2, harm is 40 and the probability is 0.2 for expected harm of 8. Assume that accidents of type 2 are unverifiable, which implies that the *specific reciprocal* and the *relative harm* are impractical. The *general reciprocal,* however, is practical. Accordingly, when accident of type 1 occurs and harm of 200 materializes, liability under the *general reciprocal*, would be 10/0.02=500, which is 2.5 times higher than compensatory damages of 200. The fact that victims of type 1 accidents are over-compensated, could raise a moral hazard problem: victims are likely to induce accidents of type 1 when they can do it in a non-verifiable ways. When this is a real concern, compensation would be more efficient than DDA.

Assume now that accidents of Type 1 and Type 2 are both verifiable. With the *general reciprocal*, liability for each accident is $10/(0.2+0.02)\approx 45$ which is higher than compensatory damages of 40 for accidents of type 2. Thus victims of accidents of type 2 are over-compensated, and consequently victims might induce accidents of type 2.

With the *specific reciprocal,* however, the victims of type 1 accidents are over-compensated. Liability for accident of type 1 is 10/(2*0.02)=250 which is higher than compensatory damages of 200. Consequently victims might induce accidents of type 1.

The *relative harm* form of DDA could be a possible solution to the victim's moral hazard problem described above, as long as courts have information about untaken precautions, expected harm and the harm. Thus, under the *relative harm,* liability would be 10/12 (which is the ratio between untaken precautions of 10 and expected harm of 12) of the harm in each accident, regardless of its type. Under that form of DDA victims are never over-compensated.

II. Implementing DDA

As we have explained, DDA, in two of its efficient forms (*specific reciprocal* and *general reciprocal*), does not require courts to measure the victim's actual harm. This is a *practical* advantage of DDA over compensation whenever harm is unmeasurable or difficult to measure. Measuring is impossible or difficult when harm is subjective, unobservable, or speculative, as with death, disfigurement, indignity, or hidden profits.

In contrast, implementing DDA in any form requires information on untaken precaution. The realized savings from untaken precaution often has monetary value that is relatively easy to measure, but sometimes they are hard to measure. The three forms of DDA require additional information about probabilities of accidents, as we explained in details in Section I.D. supra. This additional information could be hard to get, and then compensatory damages would be preferable to DDA. But in some cases this information is available, especially in the medical context (e.g., Jonkman, Van Gelder & Vrijling 2003; Levitt & Porter, 2001).[20] And recall that for applying DDA, it is enough to have information about the probabilities of accidents *when* the injurer's negligence took place, not the probabilities of accidents *caused* by the injurer's negligence. Thus DDA does not require proving causation between negligence and harm.

In this Part of the paper we offer some implementation of DDA, in those cases when DDA may have an advantage over compensatory damages. This is not to suggest that DDA is superior to compensation in general, but only to show when it might be superior.

A. Unmeasurable Harms

Consider the following example:

> *Example 2: Intangible Harms.* Driver hits Pedestrian in a road accident and causes bodily injury. Until the time of the trial, Pedestrian could not work, and suffered tangible harm of lost income and intangible harm of pain and suffering. In the future, Pedestrian might be limited in his ability to work and he might suffer additional pains. These future harms are hard to prove.

[20] *See, e.g.*, Herskovits v. Group Health Coop., *supra* note 3.

Under current law, it is likely that Pedestrian would be under-compensated. Courts are reluctant to allow damages for speculative harms (Dobbs 2000) and Pedestrian's future harms might be considered speculative, in particular his future pains and suffering.[21] Assuming Example 2 represents typical difficulties in proving future harms, injurers like Driver would be under-deterred.[22]

> *Example 3: Lost Chances of Recovery.* Patient suffers from a disease and his chances of recovery are close to zero without proper treatment. Doctor, who was aware of Patient's disease, negligently mistreated her, and Patient did not recover. If Doctor had treated Patient properly, Patient's chances of recovery would have been 30%.

Some jurisdictions would allow damages for lost chances of recovery (Dobbs 2000), which in Example 3 would equal 30% of Patient's ultimate harm.[23] Some other jurisdictions would not allow recovery in cases represented by Example 3, reasoning that causation has not been established by the preponderance of the evidence (Dobbs 2000). With no liability, doctors would be under-deterred to find the proper treatment for such patients (Porat, 2011).

In the cases like examples 2 and 3, the victim's harms inflicted by the injurer are hard to verify, and under-deterrence of the injurer may result. DDA is a possible alternative to compensatory damages in such cases. Instead of verifying the actual harm, courts should verify the cost of untaken precautions and probability of injury, as required for the specific or general reciprocal form of DDA.[24] DDA provides minimally deterring incentives for the injurer to satisfy the legal standard of care. Note that if under a compensatory damages rule courts might over, rather than under-estimate the victim's harm in either example 2 or 3, DDA might also be a plausible solution. In that latter event, the case for DDA would be stronger with Example 3 than with Example 2, since the injurer's activity produces positive externalities with the former but not the latter

[21] For the difficulties to recover for future harms, see e,g., Askey v. Occidental Chemical Corp. 102 A.D.2d 130 (N.Y. 1984); Budd v. Nixen 6 Cal. 3d 195 (1971).
[22] In either case, victims like Pedestrian would be under-compensated, which improves Pedestrians incentives for precaution. *See infra* Section B.
[23] See e.g., Dickhoff v. Green 836 N.W.2d 321 (Minn. 2013).
[24] Note that the *relative harm* DDA is not a viable option for cases represented by examples 2 and 3, because for that version of DDA to work courts should be able to verify actual harm, which is problematic in the two examples.

(Cooter & Porat, 2006). With positive externalities (like practicing medicine) the effect of DDA in encouraging the injurer's activity level, comparing to compensation, might be desirable, while with negative externalities (like driving) it might be undesirable.

B. Victim's Incentives

Consider the following example:

> *Example 4. Fire*. A fire breaks out at Owner's factory, causing property damage to Neighbor. Efficiency required both Owner and Neighbor to take a certain level of precautions, but most of Neighbor's precautions are non-verifiable.

Ideally, both Owner and Neighbor should take precautions, but under a compensatory damages rule Neighbor takes less than optimal precautions, knowing that if fire from Owner's factory injures him only Owner will be found negligent, and will compensate him for the entire harm.[25] Alternatively, if Neighbor expects to be under-compensated for losses from fires negligently caused by Owner, Neighbor might take precautions, even if non-verifiable. Liability for a fraction of compensatory damages might incentivize Owner to take too little precaution. In contrast, DDA is the minimum liability that provides Owner with incentives to take care as required for efficiency. At the same time DDA provides incentives for Neighbor to take care.

C. Over-Deterrence caused by Discontinuity

Consider this Example:

> *Example 5: Speeding*. Driver hits Pedestrian while driving his car at 51mph. The reasonable speed to drive was 50 mph. Therefore Driver is found liable for Pedestrian's harm.

Under current law, liability should be imposed on Driver only when the accident would have been prevented if Driver's speed had been 50 mph or lower. Courts, however, might impose liability without exploring the causation issue, so Driver would pay damages even when the accident would have been occurred at a lower speed (Cooter 1982). Therefore, it is often said that a negligence rule creates discontinuity in liability:

[25] For analysis of cases of alternative care when full rather than partial compensation to the victim provides efficient incentives to the parties, see D'Antoni & Taccach, 2014.

when the injurer satisfies the standard of care he is never liable (driving 50 mph immunizes Driver from liability), but when he does not satisfy the standard of care he is sometimes liable for the ensuing harm even if his negligence did not cause it. Discontinuity of liability might distort injurers' incentives by creating over-deterrence: since injurers can never know where exactly the standard of care lies, or where exactly the court would set that standard, they would over-comply in order to avoid liability (Cooter & Porat, 2014). [26]

To remove discontinuity, courts may apply DDA. As we have explained DDA can avoid the discontinuity of liability if desired. Specifically, excessive causal attribution does not create a discontinuity in the injurer's cost, because excessive causal attribution increases the probability of liability and decreases disgorgement damages by offsetting amounts. Thus, in Example 5, if a court imposes liability for accidents that are not caused by Driver's excessive speed, it would also decrease the disgorgement multiple by an offsetting amount.

Note, that DDA might have its own discontinuity: if courts cannot verify the amount of precautions actually taken by the injurer, they might proceed with the assumptions that no precaution was taken. That could yield discontinuity of liability.[27] This concern, however, is not applicable to Example 5.

D. Chilling Effects

Consider the following Example:

> *Example 6: Choice between Risky Procedures.* In a public hospital Doctor has to choose which out of two procedures, A or B, to administer for his patient. Procedure A is best for to the patient but its implementation might expose the doctor to higher liability risk than the implementation of procedure B. The reason for this higher exposure is, that Doctors might be considered negligent in implementing the procedures, and that risk is higher with procedure A.

[26] Under different assumptions, Example 5 could illustrate under-, rather than over-deterrence. Thus Example 5 could represent a case where courts would not impose liability, reasoning that it is more likely than not that the accident would have occurred even if Driver had slowed down. For a similar case where no liability was imposed, see Wilkerson v. Kansas City S. Ry. 772 So. 2d 268 (La. 2000). If that is what courts do in such cases, under-deterrence would result [Cooter & Porat, 2014].

[27] *Supra* Section I.A.

In Example 6, under current law, doctors might choose procedure B over procedure A, which is often called defensive medicine. Defensive medicine is an instance of the chilling effects phenomenon: doctors' right choices might sometimes be "chilled", so they prefer the choice which is best for them rather for their patient (Cooter & Porat, 2006; Porat, 2007).

The law could mitigate the chilling effect in Examples 6 in various ways. First, it could absolve doctors of any liability when chilling effect and defensive medicine is a major concern. Second, it could impose liability on doctors only for gross negligence but not for simple negligence. Third, when each procedure entails risks, it could lower liability to reflect the net, rather than gross risks the doctor created (Cooter & Porat, 2006; Porat, 2007).

A fourth option is to reduce damages to the DDA level. In many medical malpractice cases, as illustrated by Example 1, the cost of untaken precautions can be measured easily. Moreover, when the patient's harm is hard to measure, some forms of DDA can be applied without the need to measure the harm (*specific reciprocal* and *general reciprocal*). Furthermore, in medical malpractice cases, statistical evidence about probabilities is often available.[28]

Conclusion

In this paper we propose a novel rule according to which untaken precautions, rather than harm, are the basis of liability for accidents. We call this rule "disgorgement damages for accidents" (DDA). DDA has three forms – the *general reciprocal*, the *specific reciprocal* and the *relative harm* – that are equivalent with respect to the injurer's incentives for precaution. Each form gives the minimum expected liability to deter injurers from taking less care than the legal standard. The main difference is the information needed to implement them.

[28] *Supra* text accompanying note 3.

DDA and compensatory damages are often mirror images of each other: one's advantage is the other's disadvantage. In some cases the balance of advantage favors DDA over compensation, while in other cases the reverse is true. We favor reforming the law to adopt DDA where it is easier to measure than compensatory damages and its incentive effects are better on balance. Specifically, we think that medical malpractice cases are good candidates for applying DDA.

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