Hand Rule as Basis For Calculating Punitive Damages[1]

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Introduction

Traditionally, calculating punitive damages has resembled more alchemy than economics. Examining a defendant's wealth, taking into consideration the "reprehensibility" of an action, a defendant's wealth, and using guideposts of single-digit ratios to compensatory damages have all offered little, if any, guidance[3] to jurors when placed with the task of determining (1) whether punitive damages are necessary; and, (2) if necessary, how much. The economics literature offers a framework that seeks to answer the two aforementioned questions. This memo proposes that legal liability standards are not separate, but rather the foundation of the economic model needed to determine when and, if economically necessary, how much a defendant need pay in punitive damages. The central thesis of this memo rests in the consideration that the precautionary actions required to meet the needs of society are in concert and aligned with the actions required to meet the needs of a profit-maximizing firm, assuming an infallible judicial system. Punitive damages, economically speaking, serve only the role of rebalancing a cost-benefit environment in disequilibrium. The economics of punitive damages is not an amoral subject matter, but rather a manifestation of the morality required by the courts, as dictated by social norms.

This memo conceptually considers the bridge between a legal standard of negligence and its economic implications for calculating punitive damages. It does so in four sections. First, this memo provides a discussion of the economic rationale of the Hand Rule and illustrates how the legal standard of negligence is actually the economic equilibrium position of a profit-maximizing agent, such as a firm. Second, I discuss two aspects of reality that serve to distort this equilibrium, thereby creating situations where punitive damages become economically necessary. I provide a hypothetical example to illustrate this. Third, I expand upon the current economic literature to demonstrate how the concept of "reprehensibility" is conceptually imbedded within the model. Fourth, I provide a summary of the concepts discussed.

[3] Browning-Ferris Indus., Inc. v. Kelco Disposal, Inc. 492 U.S. 257, 281(1989), Justice Brennan noted that the instructions typically given to jurors, which advise them to consider the character and wealth of the defendant and the nature of the defendant's conduct, provide guidance that is "scarcely better than no guidance at all."

In addition, I provide a corresponding appendix that algebraically outlines the model while considering special cases and their implications. This appendix illustrates, via a hypothetical dichotomous choice model, how the continuous-function model introduced by Cooter (1989) in the economic literature complements, and is consistent with, the theoretical framework developed by Polinksy, and Shavell (1998).

I. Economics of the Hand Rule

Legal scholars frequently cite Judge Leonard Hand's opinion in *United States v. Carroll Towing Co. (1947)*[4] (the "Hand Rule") as an application of cost-benefit analysis in assigning liability in tort cases. Use of the Hand Rule in establishing liability, can be, arguably, conceptually extended to a role in calculating punitive damages. Indeed, Judge Hand's rule can be modified to not only serve as an articulation of when punitive damages are warranted. It can also serve as the foundation for determining the amount of punitive damages.

The Hand Rule defines the standard of negligence as (b) < (p) * (L), where (b) represents the burden of the precaution, (p) represents the probability of an incident, and (L) the loss to the injured party resulting from the incident. The philosophical foundation of the Hand Rule lies in the social norm that fairness requires potential injurers to give equal weight to their own costs and the costs they impose on others.[5] Failure to meet the standard of negligence would, hence, represent a situation whereby the potential injurer chose to impose a greater burden on the injured than he, himself, was willing to accept. In the converse, (i.e., (b) >= (p) * (L)), the burden of the precaution is greater than or equal to the expected loss, hence, the defendant is said to pass the negligence test. In other words, if a defendant could have made the world he envisioned an expected $50 safer by having spent $25 and didn't, he's liable. Yet, if the defendant could have made the world he envisioned an expected $10 safer by having spent $25, and didn't, he is not liable, according to the Hand Rule. Indeed, "if [the] cost of [the] safety

[4] U.S. v. Carroll Towing Co., 159 F. 2d 169 (2d cir. 1947).

[5] Robert D. Cooter, "*Punitive Damages For Deterrence: When and How Much?*" Alabama Law Review, Vol. 40., No. 3, (Spring 1989).

measure…exceeds the benefit in accident avoidance to be gained by incurring the cost, society would be better off, in economic terms, to forego accident prevention."[6]

Note the following characteristics of the variables (p) and (L) in the Hand Rule. First, the probability of an incident, (p), is an *ex-ante*, subjective probability made by the manufacturer, prior to the production of a product, usually derived through product testing. This ex-ante probability I define as (p_a). The *ex-post* value of (p), or (p_p), is derived through empirical observation, after a product has been out on the market for awhile. In the framework I consider, I propose that when a trier of fact determines a manufacturer has failed, in his judgment, the Hand Rule standard of negligence, he is actually estimating (p_a) with his actual (p_p). I merely wish to note that these are not the same. At best, (p_p) is an estimate of (p_a). Second, the loss to an injured party as a result of an incident, (L), is necessarily a finite number in the Hand Rule of negligence. Were (L) an infinite number, the Hand Rule standard of negligence would be rendered meaningless in that (b) could never be less than or equal to (p)*(L). An infinite (L) renders all defendants liable.

Establishing an Equilibrium Position from the Hand Rule

Would an economically rational manufacturer choose to violate the standard of negligence? Are the economic forces that motivate a firm's decisions at odds with the standards desired and subsequently imposed on them by the courts? The central thesis of this memo is that they are not. Both the economic forces that motivate profit-maximizing decisions and the social norms that motivate the legal standard of negligence complement one another. Economic theory and law are not at odds, but rather in unison.

The standard of negligence under the Hand Rule requires that firms balance the precautionary costs they themselves incur with the costs they may ultimately impose on society. This balance represents the equilibrium condition desired by our social norms

[6] Richard Posner, "A Theory of Negligence," 1 J. Legal Stud. 29, 29, 32-34 (1972).

and imposed by the courts. A graphical illustration of the Hand Rule is presented in Figure 1.

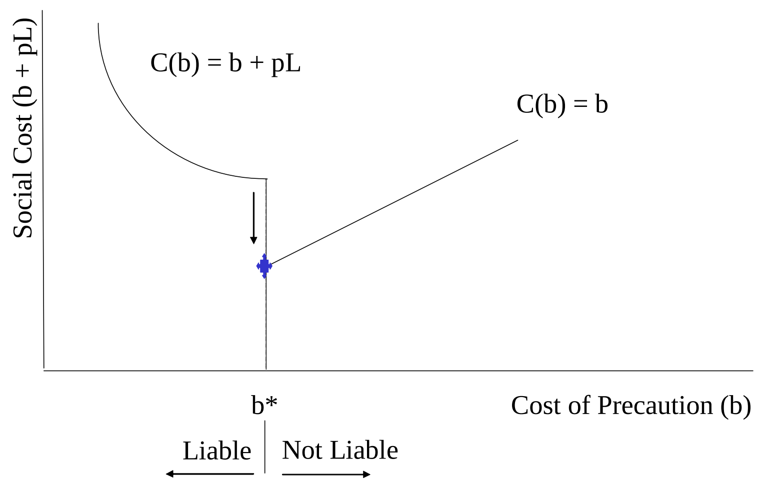
A firm faces two possible cost functions. Both cost functions obviously include the cost of the precaution (b). However, only if a firm violates the Hand Rule and refrains from taking socially beneficial precautions would the court require the firm to internalize the costs it imposes on others. In which case, a firm would face a cost function that includes both (b) plus the harm imposed on others (L). Note. Given that the cost of (L) is an expected cost in the *ex-ante* decision-making time of the manufacturer, it is not (L), but rather (p_a)*(L_a) in the eyes of the manufacturer.

Suppose a firm violates the Hand Rule, is sued and found liable. In this case, it faces not only the cost of the precaution (b), but also the court determination of the cost it imposes on others (p_a)*(L_a). The internalization of the costs it imposes on others serves as an incentive for a firm to take socially beneficial precautions and provides the manufacturer with feed back as to how well it had estimated *ex-ante* variables (p_a) and (L_a).

Now suppose a firm <u>does not</u> violate the Hand Rule (i.e., (b)>=(p)*(L)). In this case, it faces only the cost of the precaution (b). The Hand Rule would not require that the firm internalize the costs its actions impose on others. Of course, accidents will continue to occur. The probability of an accident (p) can never equal zero.[7] However, in the case where the level of precaution chosen by the manufacture (b) is greater than the socially desirable level of precaution (b*), the marginal increase in safety per precautionary dollar expended would be negative (i.e., the extra $25 dollars in precautionary expenditure would result in a social benefit of less than $25) and, subsequently, the defendant would pass the liability test.

[7] (p) is asymptotically bound by zero. In other words, a manufacturer could spend $100 billion dollars and although a marginal increase in safety would exist, the possibility of a malfunction is never fully eradicated. Instead, a manufacturer would have chosen a socially undesirable level of precautionary expenditure.

Figure 1: Graphic Representation of Hand Rule



When faced with the two cost functions in the illustration above a firm will always choose to operate at b*, where its costs are minimized. Just as the law (as characterized in the Hand Rule) requires firms operate at (b*) in order to minimize social costs, so too do firms wish to discover and operate at (b*). In consequence, economically rational firms will choose to operate exactly at b=pL (i.e., where the marginal increase in safety per precautionary dollar spent is equal to zero).[8] *This is the fundamental thesis of this note: an economically rational firm would never consciously choose to violate the Hand Rule standard of negligence, assuming an infallible judicial system and no miscalculation of (p) and (L).*

I now provide an example. To begin, I assume that no bad deeds go unpunished and all of the manufacturer's *ex-ante* calculations of variables are made without error. Suppose *ex-ante* expected revenue equals $1,000 given a ($p_a$) of 1 percent and a ($L_a$) of $100. The expected harm imposed on society would equal 1 percent * $100, or $1. I propose that if a manufacturer properly estimates the variables (p_a) and (L_a) and expects and encounters an infallible judicial system, it will always choose to take a level of precaution (b) equal to

[8] The argument structure is as follows. Premise 1: A firm is a profit-maximizing agent. Premise 2: Profit-maximizing agents seek to minimize costs. Premise 3: A firm would face a greater cost if they violate the negligence standard than if they comply with it. Conclusion: A firm will never choose to violate the standard of negligence.

the level of *expected* harm imposed. Let's see why this is the case, by reviewing each of the three options available to the firm.[9]

First, suppose a manufacturer chooses b > $1 (e.g., $5). In this case of a socially inefficient level of precaution, the firm's expected profits would equal $1,000 less $5, or $995. Note. Since b ≥ $1, the firm's cost function, C(b) = b, or $5 in this case.

Second, suppose a manufacturer chooses b < $1 (e.g., $0.25). In this case of a socially insufficient level of precaution, the firm's expected profits would equal $1,000 less ($0.25)+(1%)*($100), or $998.75. Note. Since b < $1, the firm's cost function, C(b) = b + pL, or $1.25 in this case.

Finally, suppose a manufacturer chooses b = $1. In this case of a socially desirable level of precaution, the firm's expected profits would equal $1,000 less $1, or $999. Note. Since b ≥ $1, the firm's cost function, C(b) = b, or $1 in this case.

In short, given the three options above, expected profits for a firm are greatest when operating at a socially desirable level of precaution. Therefore, an economically rational firm will always choose a socially desirable level of precaution and thereby not fail the Hand Rule standard of negligence when the accuracy of the judicial process is 100 percent and the firm correctly calculates variables (p) and (L). Successfully passing the Hand Rule standard of negligence would preclude the need for imposing punitive damages on defendant in the event of an accident.

II. Refinements

Does economic theory imply, therefore, that punitive damages have no role to play in the regulation of corporate behavior through civil litigation? The answer is not necessarily. The economic concepts include a result whereby punitive damages are necessary at times in order to counter-act factors that throw rational firms into socially desirable

[9] Note. For purposes of simplification, I assume in this example that expected revenue remains constant despite varying costs. In reality, expected revenue would also fluctuate, assuming costs are ultimately passed on to consumers. A more detailed example is presented in the dichotomous choice model within the appendix of this note.

disequilibrium. Punitive damages are necessary only in instances where the economic equilibrium of (b) = (p)*(L) has been distorted. However, the economic equilibrium position of the Hand Rule is difficult to achieve due to two distorting factors[10] I had assumed away in the previous example. Now I address them.

First, none of the three variables in the Hand Rule are ever known with certainty; rather they are always estimated. The burden of a precaution (b) is not readily estimated. It comprises both tangible and intangible costs. While tangible pecuniary costs for a given safety component may, at times, be estimable, the economic theory requires a need for the manufacturer to also calculate the cost of intangible items, such as possible damage to brand image, effects on product price premiums associated with consumer perception of quality, etc. Similarly, the probability of an incident (p_a) can be estimated *ex-ante* with product testing, but at best is merely an estimate of an estimate within a range of possibilities of the true (p^*). Finally, the amount of loss related to an incident, (L), varies greatly. The loss attributed to a product may range from (say) a destroyed fence to a lost life.[11] The uncertainty of these three variables makes it difficult for a firm to meet a Hand Rule standard of negligence, and consequently may ultimately motivate defendants to over invest in precautions (i.e., situations where the marginal increase in social benefit is less than the marginal increase in precautionary expenditure). Nevertheless, mistakes happen and the employees of firms do miscalculate costs. Should a firm pay punitive damages when it's employees make a miscalculation?[12]

A second factor serves to distort the equilibrium position of the Hand Rule. The judicial process is not without error: injured parties may decide not to sue, or, alternatively, those that do sue may lose in court even when the defendant firm has chosen to operate at a level of precaution (b) that is less than the socially desirable level of precaution (b*).[13]

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[10] Robert D. Cooter, "Punitive Damages for Deterrence: When and How Much?," *Alabama Law Review*, Vol. 40, Spring 1998, No. 3..

[11] I assume that the value of (L) is finite. For to assume an infinite value for (L) would render the cost curve C(b) = b + pL meaningless in that it would be vertical and hence fail to ever reach a minimum point.

[12] I discuss this further in the appendix.

[13] Alternatively, manufacturers may be found liable for actions they did not commit. This is discussed in more detail in the Appendix.

How does this get incorporated into our equilibrium equation? To begin, we need to introduce another variable into the Hand Rule.

Suppose the accuracy of the judicial process, (q), is 100 percent –that is, no bad deed goes unpunished; neither does the process over-detect liability. In this case, our theoretical equilibrium position remains unchallenged. Indeed, the Hand Rule assumes an infallible judicial system where (q) = 100 percent. That is, the firm will choose to operate at (b_a) = (p_a) * (L_a) * (q_a), where (q_a) equals 100 percent and (p_a), (L_a), and subsequently, (b_a), are believed to have been accurately measured *ex-ante*. However, the true accuracy of the judicial process, (q^*), may be less than 100 percent, which gives rise to enforcement error. If (q_a) is less than 100 percent, the requisite (b_a) needed to place the equation into equilibrium is *less than* the socially desirable level of precaution, (b^*), where (b^*) = (p^*) * (L^*) when (q^*) equals one. How are manufacturer and society balance re-attainted?

By introducing a "total liability multiple" (m), equal to the reciprocal of the enforcement error, (q), there can be a counteracting effect.[14] In economic terms, a total liability multiple (m), imposed on the manufacturer, would force it to internalize fully the costs it imposes on others if (m) is set equal to 1 / (q).

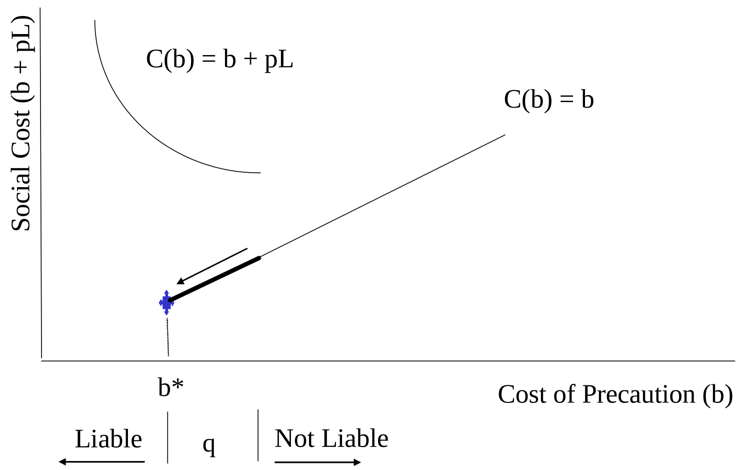
$$b = pL * \underbrace{q}_{\text{Enforcement Error}} * \overbrace{m}^{\text{Total Liability Multiple}}$$

(Accuracy of the Judicial Process)

The Hand Rule economic equilibrium has not been altered by the introduction of (q) and (m). To the contrary, the Hand Rule economic equilibrium merely assumed (q) and (m) both equaled one. In circumstances where (q) < 1, the reciprocal (m) needs to be introduced to bring the Hand Rule back into economic equilibrium

14 Robert D. Cooter, "Punitive Damages for Deterrence: When and How Much?," *Alabama Law Review*, Vol. 40, Spring 1998, No. 3., Pages 1150-1151.

Figure 2: Enforcement Error as a Destabilizing Factor



Explaining the Total Liability Multiple

The total liability multiple (m) is not the same as a punitive multiple. The reciprocal of the inaccuracy of the judicial process, (m), rebalances the Hand Rule standard of negligence. It also becomes an input in calculating total damages. Total damages are equal to compensatory damages (d), as determined *ex-post* by the trier of fact (i.e., an estimate of (L_p)), multiplied by the total liability multiple. Punitive damages equal total less compensatory damages. What has been traditionally called a punitive multiple is not the same as a total liability multiple as discussed here. For example, assume a jury awards a plaintiff $1 million in compensatory damages (d) and determines the inaccuracy of the judicial process (q) is 20% (i.e., 1 out of 5 guilty defendants will escape liability). A total liability multiple (m) equal to 5 would be needed to place the Hand Rule standard of negligence condition back into equilibrium. A total liability multiple (m) of 5 multiplied by compensatory damages (d) of $1 million would give us total damages of $5 million. That $5 million in total damages is made up of $4 million and $1 million in punitive and compensatory damages, respectively. The punitive multiple in this case is 4, not 5 like the total liability multiple.

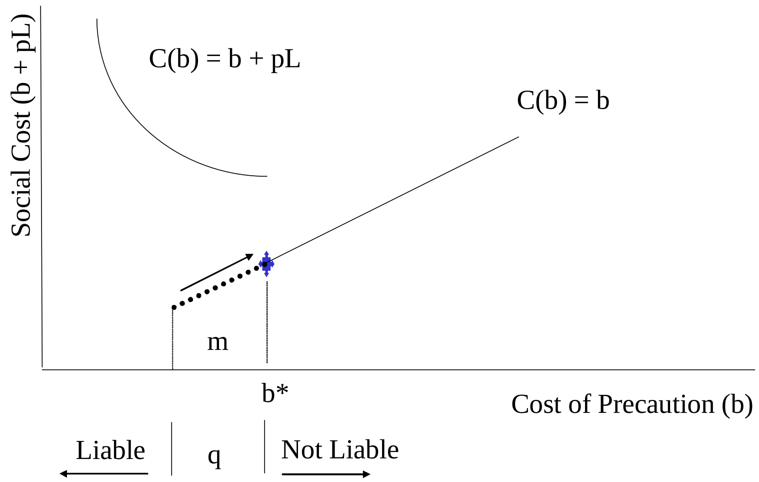
Illustrating the Applicability of the Total Liability Multiple

In order to better illustrate the applicability of the total liability multiple, I offer an example a typical juror might readily comprehend. Suppose the defendant is an individual, rather than a firm. Suppose the defendant is a driver who broke the speed limit by traveling at excessive speeds on a rural road at 3am. In this case, the defendant did not believe he was driving at excessive speeds – he may have been driving 65 mph in what he thought was a 65 mph zone, but instead turned out to be 45 mph. He had miscalculated at the level of precaution required of him. He did not knowingly break the law. As such, he chose a much lower level of precaution (in this case, the level of constraint on his velocity), (b_a), than he would have had he properly estimated (p_a) and (L_a). Moreover, he perceived (q) to be equal to 100 percent (i.e., he drove as if a patrol car was tailing him as he drove). If he is caught, what does the economic theory we have been discussing tell us about what his punishment should be? A miscalculation or mistake does not warrant punitive damages.

But now, suppose he had a known the speed limit was 65mph, but had believed he could evade detection. He did not think a patrolman was behind him; and he was right. Given the existence of imperfect enforcement, a total liability multiple would be warranted in this case. Suppose the rural policeman who stopped the driver for speeding was the judge and the jury in this case. Further suppose the standard ticket for driving at the speed he'd clocked the defendant was $10 (i.e., compensatory damages = $10, or the cost of reimbursing the municipality for processing the ticket). If the probability of escaping liability (i.e., 1 – q) in this town was 90 percent, the accuracy of the judicial process equals 10 percent (i.e., 1 out of every 10 speeding drivers escapes liability). Economic theory would advocate a total liability multiple equal to the reciprocal of 10 percent (i.e., 10). In this case, the unlucky driver would have a total liability of $100 (i.e., 10 * $10), composed of $10 in compensatory and $90 in punitive damages.[15]

[15] Note. Total damages equal compensatory damages, (d), multiplied by the total liability multiple, (m).

Figure 3: Punitive Multiple As a Stabilizing Factor



Summarizing the Economic Punitive Damages Theory

The conceptually expanded Hand Rule provides not only a standard of negligence from which to determine when punitive damages are warranted, but also acts as the economic framework for determining how much should be awarded in punitive damages.

Let's bring together everything now into an applicable equation for calculating punitive damages that conforms to the theory.

Total damages equals compensatory damages (d) multiplied by the total liability multiple (m). What is (d) and what is (m)? Compensatory damages, (d) are the courts *ex-post* estimated calculation of (L).[16] The total liability multiple, (m) is the reciprocal of (q). Starting from our equilibrium position: (b) = (p) * (L) * (q), we see that (q) = (b) / ((p) * (L)), hence its reciprocal equals (pL)/(b). Therefore, total damages equals (L) * (pL)/(b). We can now derive punitive damages, which equal total damages less compensatory damages, or $[(pL^2) / (b)] – L$.

[16] Note. In cases where a death is involved, (L) may be viewed as priceless or incalculable. Nevertheless, the trier of fact must place a monetary value on non-monetary item, such as life, at times. This monetary value represents compensatory damages and is an estimate of the (L_{-p}).

III. How Does Reprehensibility Play a Role?

This is essentially where economic literature takes the Hand Rule in terms of constructing an economic framework in which to analyze punitive damages in deterrence theory: Inaccuracies in the judicial system alter firms' perception of requisite precautionary expenditures, knocking the economic equilibrium of the Hand Rule into disequilibrium.

What about retribution? What about punishment? What about the concept of reprehensibility? Are economists amoral? Do they not recognize that juries want retribution in addition to deterrence?

Economic reasoning appears flawed because it appears to ignore retribution. However, I consider whether or not the concept of retribution can be shown to be imbedded in the total liability multiple. The remainder of this memo seeks to demonstrate that the economic foundation of deterrence theory encompasses the current legal concept of reprehensibility.[17] Finally, I hope to provide a framework whereby one can apply these concepts in the courtroom.

The courts have stated that while "compensatory damages are intended to redress a plaintiff's concrete loss," "punitive damages are aimed at the different purpose of deterrence and retribution."[18] I will conceptually label the deterrence aspect of the total liability multiple (m1) and the retribution aspect (m2). The total liability multiple (m) has thus far only addressed the issue of deterrence (i.e., (m) = (m1)). How do economists interpret and explain the language of the court with regard to the issue of retribution beyond deterrence? From an economic perspective, it is possible that a firm may actively seek to increase their probability of escaping liability so as to decrease the accuracy of the judicial process, (q). One would conclude then that the higher the probability of escaping

[17] A complete formalized economic model is not presented in this memo. I provide only one way in which the reader might want to think about incorporating only one aspect of reprehensibility in determining punitive damages.

[18] Cooper Industries, Inc. v. Leatherman Tool Group, Inc., 532 U.S. 424, 432 (2001).

liability, the higher the enforcement error within the judicial system and the lower the accuracy of the judicial process, (q), hence the higher the punitive multiple (m).[19]

$$\uparrow \quad \text{Multiple (m)} = \frac{1}{\text{Enforcement Error (q)}} \downarrow$$

One might argue, however, that this provides little, if any guidance, when it comes to separating (m1) and (m2), let alone in estimating the total liability multiple (m). If punitive damages are directly correlated with reprehensibility, how then does one quantify reprehensibility (i.e., (m2))? More importantly, why would a firm choose to act reprehensibly? What possible benefit could it receive from doing so?

Suppose a firm believes the probability of escaping liability exists. Suppose the defendant actively seeks to increase that probability by lying to the public or possibly shredding documents that might implicate them as the source of an alleged harm. Or, in our earlier example, suppose the fast driver has a radar detector. In effect, the manufacturer incurs a burden of precaution that is less than (b*) by not only capitalizing on the existence of enforcement error but by *deliberately seeking* to reduce the chances of being found liable.[20] It is the "*deliberately seeking*" aspect of the defendant's actions that would be labeled "reprehensible" in economic terms and which we label (m2).

In other words, the defendant's actions become "reprehensible" when it attempts to actively shift the fault line for the standard of negligence to the left as illustrated in Figure 2. By doing so, the firm has lessoned its burden of precaution. The more "reprehensible" (defined as actions to increase the probability of escaping liability) the defendants' actions, the greater the total liability multiple needed to offset its destabilizing effect. The role of a retributive aspect of the total liability multiple (m2) would be to counteract the "reprehensible" actions of the defendant (i.e., his attempts to distort, or further distort, the efficiency of the judicial system).

[19] Probability of Being Caught = (1 – Probability of Escaping Liability) = Enforcement Error (q).

[20] Note. Legal acts, such as hiring counsel, whereby one directly seeks to defend oneself from an allegation are not "reprehensible" acts. "Reprehensible" acts as defined here involve illegal actions on behalf of the defendant to capitalize on the courts' deficiencies.

As previously stated, the total liability multiple (m) can be divided into two components—(m1) and (m2). While the first component, (m1) represents the deterrence portion of the punitive multiple necessary to offset the destabilizing effect of the existence of enforcement error, the second component, (m2) is intended to address issues of retribution. For example, assume the probability of escaping liability equals 90 percent, the accuracy of the judicial process (i.e., the enforcement error (q)) would equal 10 percent. Hence, the reciprocal (m1) would equal 10. The second component, (m2) would represent the "reprehensibility" or punitive portion of the punitive multiple necessary to offset the destabilizing effect of *deliberately seeking* to increase the enforcement error.

This second component of the total liability multiple is very difficult, if not impossible, to quantify accurately. The punitive theory proposed above, however, arguably embodies it within its framework. Using the same example of our unfortunate driver, imagine now that the patrolman spots a radar detector in our lead-foot driver's car. Further suppose our patrolman knows that the probability of escaping liability is 90 percent without a radar detector, but 95 percent with one. That is, one out of ten lead-foot drivers will escape a speeding ticket without a radar detector, where one out of twenty lead-foot drivers will escape with a radar detector. The accuracy of the judicial process is lowered to 5 percent. Now our patrolman would add to the total liability multiple in the form of (m2). Our total liability multiple, (m) would equal the reciprocal of 5 percent, or 20. Specifically, (m2) would equal the marginal impact on the probability of escaping liability brought on by the "reprehensible" actions of the defendant, or in this example, 10.[21]

In short, these are not easily quantifiable probabilities, and some might argue, unquantifiable. Nevertheless, to say that economics completes ignores the concept of reprehensibility may not be entirely true. At present, however, the need to further formalize the concept of reprehensibility, and all its interpretations, into the model is needed.

[21] Total liability multiple (m) = (m1) + (m2), where (m) = 20, given that (q) = 5 percent with a radar and (m) = 10, given that (q) = 10 percent without a radar. The retribution component, (m2) is equal to the difference of the total liability multiple with and without a radar (i.e., 20 – 10 = 10).

IV. Summary

To summarize, the Hand Rule provides courts not only with a standard of negligence but also the economic equilibrium position at which an economically rational firm, would choose to operate. The equation, (b) = (p) * (L), not only represents the fault line in the Hand Rule but also the equilibrium position for a firm. Miscalculations of these unknown variables may lead to unintentional breaches of the negligence standard. In such cases, compensatory damages are sufficient and punitive damages would not be warranted. A firm need not internalize the costs it imposes on others if taking extra precautionary measures are not socially beneficial (i.e., it passes the Hand Rule standard of negligence). Punitive damages are warranted if and only if (1) the firm fails to make socially beneficial precautions; (2) accuracy of the judicial process is low (i.e., the probability of escaping liability is high); and (3) a firm consciously and/or deliberately seeks to capitalize on the existence of the courts' imperfections. In such instances, a total liability multiple, (m), equal to the reciprocal of the enforcement error, (q), would serve to stabilize the effects of (q). Deriving an equation from the theory renders punitive damages, when (q) < 1, equal to $[(pL^2)/(b)] - (L)$.

The role of reprehensibility is present in so-called deterrence theory. The total liability multiple, (m), we suggest, is made up of two components – deterrence, (m1), and punishment, (m2). Whereas the deterrence component, (m1), serves to correct for the natural tendency of enforcement error in a particular situation; the punishment component, (m2), serves to punish the defendant for engaging in "reprehensible" actions (i.e., actions that *directly seek* to increase their probability of escaping liability). While both components are difficult to quantify, it is the determination of the total liability multiple (m) that matters in determining punitive damages and can be inferred from a case. In short, the concept of reprehensibility is already a component of the total liability multiple, yet it is rarely identified as such.

Appendix:

(1) Hand Rule Economic Equilibrium Model:

$(b^*) = (p^*) * (L^*) * (q^*) * (m^*)$

Where, (b^*) = socially desirable level of precaution
(p^*) = actual probability of an incident
(L^*) = actual loss incurred
(q^*) = accuracy of judicial process (= 1 in theory)
$(m^*) = 1 / (q^*)$

(2) Manufacturer's Perspective:

$(b_a) = (p_a) * (L_a) * (q_a) * (m_a)$

Where, (b_a) = manufacturer's expected socially desirable level of precaution (b^*).
(p_a) = manufacturer's ex-ante estimation of (p^*)
(L_a) = manufacturer's ex-ante estimation of (L^*)
(q_a) = manufacturer's ex-ante estimation of (q^*)
$(m_a) = 1 / (q_a)$

Note. Assuming

(1) $(p_a) = (p^*)$;
(2) $(L_a) = (L^*)$;
(3) $(q_a) = (q^*)$; and,
(4) $(m_a) = (m^*)$, then
(5) $(b_a) = (b^*)$

(3) Trier of Facts' Perspective:

$(b_p) = (p_p) * (L_p) * (q_p) * (m_p)$

Where, (b_p) = trier of facts' perceived socially desirable level of precaution (b^*).
(p_p) = trier of facts' ex-post observation of (p^*)
(L_p) = trier of facts' ex-post observation of (L^*)
(q_p) = trier of facts' ex-post perception of (q^*)
$(m_p) = 1 / (q_p)$

Note. Assuming

(1) $(p_a) = (p_p)$;
(2) $(L_a) = (L_p)$;
(3) $(q_a) = (q_p)$; and,
(4) $(m_a) = (m_p)$, then
(5) $(b_a) = (b_p)$

(4) Paradox Explained of (q_a) > 1.

Suppose the manufacturer views $q_a > 1$. That is, suppose the manufacturer believes *ex-ante* that they are likely to be sued and found liable for wrongs they did not commit. In such a case, (b_a) would be greater than (b^*), assuming an accurate estimation of (p) and (L). More than likely, a large firm with large litigation defense history is more likely to take precautionary expenditures that exceed the Hand Rule's theoretical optimum. If found liable, that is if (b_P) < (b^*), while (b_a) > (b^*), the result must be due to a miscalculation of (p_a) and (L_a). If breach of the standard of negligence is due to a miscalculation, *which is the only theoretical explanation if (q_a)>1*, punitive damages equal the ill-gotten gains obtained from that miscalculation. That is, punitive damages equals *ex-ante* profits given *ex-ante* inputs less *ex-post* profits given actual input values (or as you will see in the dichotomous choice model example in (5) of this appendix – compensatory damages only.

(5) Discrete versus Continuous Functions in Decision-Making Considered

Most economics-based equilibrium models assume continuously variable choices, rather than discrete choices, with regard to precautionary expenditures. In many instances of product liability, however, the question is not whether the defendant chose to incur an additional dollar amount of precautionary expenditures, but rather whether or not the defendant chose to include a precautionary device or not. That is, there exists not a range of preventative actions, but rather only one, or perhaps a few. As such, (b) may not be a continuous and differential function at all, but rather a discrete dichotomous choice.[22]

Below we provide an example of a discrete dichotomous choice model. We first utilize the premises expressed by Polinsky and Shavell in their formulation of deterrence theory in order to estimate punitive damages. Next, we apply Cooter's model to the same example to demonstrate that both sets of authors are advocating merely different ways of saying the same thing. Whether the level of precautions incurred by a defendant is continuous (i.e., a Cooter model) or discrete (i.e., a Polinsky / Shavell model), the outcome will be identical.

Suppose a manufacturer of a product had two options; to build a product with or without a particular safety feature. In addition, suppose the cost to produce the product were equal to $45,000 or $15,000 with and without the safety feature, respectively. Assuming a 20 percent mark-up, the cost of the product (i.e., price) to the consumer might equal $54,000 or $18,000, respectively. Assume further that the firm's price elasticity analysis shows that at those prices it could expect to sell 1 or 5 million units, respectively. Therefore, the manufacturer would expect revenue of $54 or $90 billion and profits of $9 or $15 million prior to legal considerations, respectively. The following table illustrates this.

[22] This issue is addressed in detail in "The Hand Rule and *United States v. Carroll Towing Co.* Reconsidered," Working Paper No. 2002-27, Allan M. Feldman and Jeonghyun Kim, October 2002.

	[A]	[B]	[C]	[D]	[E]
	Cost to Produce	**Cost to Consumer**	**Expected Sales**	**Expected Revenue**	**Expected Profit**
Product with Higher Cost Precaution	$45,000	$54,000	1 million units	$54 billion	$9 billion
Product with Lower Cost Precaution	$15,000	$18,000	5 million units	$90 billion	$15 billion

Notes:
[A] equals the actual versus but-for costs of production inurer would have faced ex-ante.
[B] equals [A] times the expected gross mark up of (in this case) 20%.
[C] is estimated via price elasticity analyses.
[D] equals [C] times [B].
[E] equals [D] - ([C]*[A]).

We know from our previous discussion, however, that expected profits with legal considerations are different, and far more uncertain. Assume the manufacturer chose to produce a product with the precautionary device, thereby taking on the precautionary expenditure (b) that is equal to or greater than (b*). According to the Hand Rule, the firm should not be held liable in court and consequently its expected legal liability would equal zero. Now assume, however, the manufacturer chose to produce with a less costly afety feature (i.e., (b) is not equal to or less than (b*)), and an accident occurred. In this scenario, the manufacturer might, according to the Hand Rule, be found liable and required to pay compensatory, and possibly, punitive damages.
Compensatory and possible punitive damages make up the possible legal liability a firm would face in this case, (y). The probability of being sued and found liable, (x), multiplied by the possible legal liability (y) equals the expected legal liability to a firm. Subtracting the expected legal liability to a firm from expected pre-liability profits equals total expected profits. If the firm chooses to include the more expensive safety feature, (y) equals $0, so (x) is irrelevant. If a firm chooses to produce with the lower cost safety feature, (y) is greater than $0, and (x) becomes relevant. In this example, total expected profits for this manufacturer, hence, would equal $9 million with the precaution and $15 million less (x) * (y) without the precaution.[23]

Assuming the manufacturer operates as a risk-neutral rational profit-maximizing agent, the firm would choose to manufacture the product with the precaution if and only if the total expected profits from doing so (i.e., $9 million) were greater than or equal to the total expected profits from not doing so (i.e., $15 million less (x) * (y)). However, those two variables, (x) and (y) are unknown at the time of production. Yet from these two variables, punitive damages can be derived.

Three simple mathematical examples illustrate how damages are directly tied to the probability of escaping liability. Assume the probability of escaping liability is zero percent and the probability of being sued and found liable is 100%. In this case, no

[23] Expected profits with the safety feature equal $9 million less (x)*(y), where (y) equals zero, hence $9 million.

punitive damages would be warranted. That is, 9 = 15 – (x) * (100%), hence (x) = $6 million, where total damages equal $6 million and punitive damages equal $0. Now allow for the possibility of escaping liability. Assume the probability of being sued and found liable is low (say) 10 percent (i.e., the possibility of escaping liability is 90 percent). Punitive damages would need to equal $54 million to deter a manufacturer, *ex-ante*, into producing a product with the precaution and still maximize profits. That is, if 9 = 15 – (x) * (10%), then (x) = $60 million where total damages equal $6 million and punitive damages equal $54 million. Similarly, if the probability of being found liable is high (say) 80 percent, punitive damages would need to equal only $1.5 million in order to deter a manufacturer, *ex-ante*, into producing a product that includes the precautionary device and still maximizes profits. That is, if 9 = 15 – (x) * (80%), then (x) = $7.5 million where total damages equal $6 million and punitive damages equal $1.5 million. In short, a positive relationship between the probability of escaping liability and punitive damages exists.

Probability of Being Found Liable	100%	80%	10%
Probability of Escaping Liability	0%	20%	90%
Compensatory Damages ($US mil)	6	6	6
Punitive Damages ($US mil)	-	1.5	54
Total Damages ($US mil)	6	7.5	60
<u>Hand Rule (Cooter)</u>			
Enforcement Error (q)	100%	80%	10%
Cost of the Precaution (b)	30	30	30
Total Liability Multiple (m)	1	1.25	10
Punitive Damages ($US mil)	-	1.5	54
Total Damages ($US mil)	6	7.5	60

This example serves to illustrate what Cooter, Polinsky and Shavell argue in slightly different matters. Polinsky and Shavell state "the proper level of *total damages* to impose on [an injurer], if he is found liable, is the harm caused multiplied by the reciprocal of the probability of being found liable."[24] The "probability of being found liable" is equivalent to Robert Cooter's enforcement error, (q), and its reciprocal is therefore equivalent to we've been calling the total liability multiple, (m). As the probability of being found liable decreases, punitive damages increase exponentially and vice versa. In short, both models of deterrence theory by these authors render the same result.

[24] A. Mitchell Polinsky and Steven Shavell, "Punitive Damages: An Economic Analysis," *Harvard Law Review*, Vol. 111, February 1998, No. 4., page 874.