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**WELFARE IMPLICATIONS OF  
COSTLY LITIGATION UNDER STRICT LIABILITY**

**Keith N. Hylton**  
(April 18, 2000)

Boston University, School of Law, Boston, MA 02215; [knhylton@bu.edu](mailto:knhylton@bu.edu). This is a substantial revision of an earlier paper titled "Welfare Implications of Strict Liability with Costly Litigation." I thank Michael Meurer and Steven Shavell for helpful comments on earlier drafts and take full responsibility for errors and omissions

*Abstract*

This paper examines a model of strict liability with costly litigation, and presents the conditions under which: (1) potential injurers take optimal precautions, (2) increasing litigation costs enhance precaution and social welfare, (3) the optimal level of liability exceeds the compensatory level, and (4) increasing the rate of settlement enhances social welfare. The results have implications for controversies surrounding fee shifting, optimal damage awards (e.g., punitive damages), and the desirability of settlement.

## I. INTRODUCTION

This paper examines the welfare implications of costly litigation in a regime of strict liability. There are several articles on this subject,<sup>1</sup> but they emphasize different results, and some of the results are difficult to reconcile.<sup>2</sup> This paper offers a simple framework that incorporates, generalizes, and reconciles some old results and offers new results as well. I examine the following questions: (1) Will injurers take optimal precautions? (2) What are the effects of increasing litigation costs on precaution and on social welfare? (3) What is the optimal level of liability? (4) What are the welfare implications of settlement?

One issue that recurs in analyzing these questions is the productivity of care on the part of the injurer in reducing harms to victims. Liability (or litigation) provides a “deterrence benefit” to the extent it reduces harms by inducing injurers to take care. However, this deterrence benefit depends on the productivity of injurer care. If harms are unresponsive to care, or care unresponsive to liability, the deterrence benefit from liability will be negligible. In general, additional liability is desirable only if care is sufficiently productive that the marginal deterrence benefit exceeds the marginal cost of litigation. For simplicity, I will define care as *productive* if it is sufficiently responsive to liability, and harms sufficiently responsive to care, that this condition holds. Since the optimal level of liability equates the marginal deterrence benefit and marginal litigation cost, this condition will not hold for liability levels above the optimal one. Some of the key results here depend on whether this productivity condition holds at liability

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<sup>1</sup> See Polinsky and Rubinfeld (1988a, 1988b); Hylton (1990); Shavell (1982b); Kaplow (1986); Rose-Ackerman and Geistfeld (1987). I should note that this analysis differs substantially from that of earlier analyses of strict liability, such as Posner (1973). The key difference here is that the earlier work ignores the influence of litigation costs on the injurer’s care decision. On the other hand, this article (unlike Posner’s) focuses only on the injurer’s care decision. The injurer’s activity level choice and comparative negligence issues are not examined in this article.

<sup>2</sup> Compare, for example, Shavell (1982b) with Menell (1983), suggesting conflicting implications on the social desirability of litigation -- later reconciled in Kaplow (1986) and Rose-Ackerman and Geistfeld (1987).

levels below the optimal.

First, on the optimality of care, I show that injurers take too little care relative to the social optimum when: (a) settlement is not permitted or (b) when the entire settlement surplus goes to the injurer. Otherwise – i.e., if settlements occur and the victim receives part of the surplus -- it is unclear whether injurers will exercise socially optimal precaution.<sup>3</sup>

Second, I derive the conditions under which increasing the cost of litigation leads to a reduction in social welfare. Generally the results are ambiguous, though there are two important cases in which the welfare effects are clear: (a) when the severity of the victim's harm is independent of the injurer's care level, welfare is decreasing in the victim's litigation cost; and (b) when care is productive (in the sense defined above), welfare is increasing in the injurer's litigation cost. These results can be used to analyze the welfare effects of practices or policies (e.g., contingency fees, fee shifting) that have the effect of increasing or decreasing the cost of litigation for one party or both parties.

The third and key result of this paper concerns the optimal level of liability. I show that setting the damage award equal to the sum of the victim's loss and the victim's litigation cost is socially optimal if: (a) injurer precaution is productive (at all liability levels below the optimum), and (b) lawsuits are not settled or, if settlements occur the injurer receives the entire settlement surplus. When care is not productive, or when plaintiff and defendant share the surplus, the optimal award is less than the sum of the victim's loss and litigation cost, and may even be less than the victim's loss.

Fourth, this paper suggests a new view on the welfare implications of settlement. Under the American litigation cost allocation rule, the welfare implications of settlement are ambiguous. The reason is that settlement reduces the total cost of litigation, which benefits society, but it also dilutes incentives to take care since the expectation of settlement reduces the

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<sup>3</sup> This extends Hylton (1990), which shows that injurers take too little care relative to the social optimum under strict liability.

injurer's expected liability.<sup>4</sup> I show that under a rule that shifts the plaintiff's litigation cost to the defendant, increasing the rate of settlement definitely enhances social welfare.<sup>5</sup>

These results have implications for controversies surrounding optimal damages, fee shifting, and settlement; though care must be taken in translating the results of this model into useful statements about optimal remedies and procedural rules. For example, the analysis provides theoretical support for fee shifting in favor of plaintiffs (e.g., the British rule) under appropriate conditions. This analysis also suggests that if detection is certain, and the only obstacle to plaintiffs bringing suit is the cost of litigation, the optimal adjustment to compensatory damages should not exceed the victim's cost of litigation.<sup>6</sup> Since this model does not examine intentional injuries, I do not claim that my results have any implications for punitive

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<sup>4</sup> Polinsky and Rubinfeld (1988b). Shavell (1996 and 1997) argues that the conflict between cost-reduction and deterrence-dilution is irrelevant, because society can use fines or subsidies to regulate the quantity of litigation and vary the level of the damage award in order to control incentives for care. For an analysis of optimal two-instrument or "decoupled" regulation, see Polinsky and Che (1991). The model in this paper, consistent with Polinsky and Rubinfeld (1988b), assumes that the only instrument available to courts is the damage award. This assumption is probably appropriate given that the administrative costs of using fines/subsidies to control the volume of litigation may be prohibitive. For an analysis of the administrative difficulties of using a tax/subsidy scheme to control the volume of litigation (in the context of Rule 68), see Hylton (1996).

<sup>5</sup> This implies that the welfare trade-off result in Polinsky and Rubinfeld (1988b) holds for all litigation cost allocation rules other than the British or pro-plaintiff rules. Since this paper examines a model of strict liability in which plaintiffs always win their suits, the British and pro-plaintiff rules are the same in this analysis. For a discussion of alternative litigation cost allocation rules, see Shavell (1982a) (examining American, British, Prodefendant, Proplaintiff allocation rules). The finding here that an increase in settlement is always socially desirable under pro-plaintiff fee shifting suggests that some argument other than the care reduction effect must be made to show that settlement may be undesirable. Although I have not incorporated it into this model, one could argue that settlement is undesirable because it reduces the public stock of common law decisions, which provide information, see Fiss (1984). A discussion of arguments against settlement can also be found in Shavell (1997).

<sup>6</sup> Compare this to the multiplier approach urged in Polinsky and Shavell (1998). This paper suggests that multiplying damages is unnecessary if the key reason the probability of liability is less than 100 percent is that some plaintiffs find suit unprofitable under the American rule.

awards in cases of intentional harm.

I have tried to state the results here as plainly as possible, with few technical terms. The proofs in the text are simple and easy to interpret intuitively. Part II provides an informal discussion of key results and implications for the literature. Part III presents the model. Part IV discusses implications.

## II. LITERATURE REVIEW AND INFORMAL ANALYSIS

The results in this paper substantially modify the conclusions of four articles concerning the welfare implications of costly litigation under strict liability: Menell (1983), Polinsky and Rubinfeld (1988a), Polinsky and Rubinfeld (1988b), and Hylton (1990).

Let us start with Menell (1983) and Hylton (1990), two articles whose results are more closely related than appears obvious at first glance. The Menell article shows that private and social incentives to preclude an additional lawsuit by taking care are the same under strict liability. The reason is as follows. The social cost of the marginal lawsuit is the sum of the injurer's and victim's litigation costs. Thus, if both parties spend \$20 on litigation, the social cost of the marginal lawsuit is \$40. To the injurer, the cost of the marginal lawsuit is his liability to the marginal victim plus his litigation cost. But in the case of the marginal victim, liability is equal to the victim's litigation cost, since the marginal victim is the one who is indifferent between filing and not filing his lawsuit. Thus, the cost of the marginal lawsuit to the injurer will be \$40, the same as the social cost of the marginal lawsuit, and it follows that private and social incentives to preclude litigation are identical.

The Hylton article shows that strict liability results in too little care relative to the social optimum ("underdeters"), in a model in which litigants do not settle their cases. The Menell and Hylton results are related, as I show below, for the simple reason that in a model in which litigants do not settle, the suit preclusion incentive does not push the injurer's care away from the optimal level (again, because private and social incentives to preclude are the same). This leaves



two externalities attributable to litigation costs as sources of inefficiency, since litigation does not internalize the losses of victims who do not sue (because the litigation cost exceeds the anticipated award) or the litigation costs of victims who do sue. Because these externalities cause injurers to take too little care relative to the social optimum, it follows that strict liability underdeters in a model in which litigants do not settle.

This paper considers what happens when litigants can settle their disputes. In this model, it is unclear whether injurers exercise socially optimal precaution. There are two reasons for this ambiguity. First, with settlement the expected “net litigation cost” to the victim may be negative. For example, if the plaintiff’s litigation cost is \$20, and his expected portion of the settlement surplus is \$25, the expected net cost of litigation is -\$5, and the victim is overcompensated in settlement. If this is the case, the private incentive to take care may exceed the social incentive. Second, with settlement the private incentive to preclude an additional lawsuit may diverge from the social incentive, contrary to Menell’s result. The injurer will have an incentive to take too much care relative to the social optimum because he will add the plaintiff’s expected portion of the settlement surplus to his estimate of the cost of litigation. Thus, if the plaintiff’s expected portion of the settlement surplus is positive, the suit preclusion incentive will overdeter.

Polinsky and Rubinfeld (1988a) examines the optimal adjustment to compensatory damages, concluding that it may be positive or negative depending largely on the productivity of care. The results here are broadly consistent; however, this paper extends the Polinsky-Rubinfeld analysis by setting out the conditions under which the optimal award will include the victim’s litigation cost as an element and by examining the implications of settlement for the optimal level of liability. In particular, I show, in the case where suits are not settled, that if care is productive (in the sense defined earlier) the optimal award will equal the victim’s harm plus the victim’s litigation cost, and the optimal award will never exceed this level. This upper bound on the optimal award remains even when the possibility of settlement is taken into account. In the case in which care is not productive, I show that the optimal award is unambiguously less than

the level necessary to internalize the victim's litigation cost and expected losses of non-suing victims.

Polinsky and Rubinfeld (1988b) demonstrates that settlement has conflicting implications for social welfare, because it reduces the total litigation cost while also reducing incentives for injurer care. The analysis in this paper shows that under a rule that shifts the plaintiff's litigation cost to the defendant, there is no such welfare trade-off; settlement unambiguously enhances social welfare. The reason is that the fee-shifting rule results in either optimal care or excessive care. In the former case, increasing the frequency of settlement reduces only the total litigation cost; and in the latter case, increasing the frequency of settlement enhances welfare both by reducing care and the total litigation cost.

Because of the importance of the productivity of care in this analysis, one may wonder whether these results have any practical implications. It happens that the productivity condition identified here is the same as that governing the incentive to waive one's right to litigate. Under Coasean conditions, a potential plaintiff will enter into a waiver agreement with a potential defendant whenever the deterrence benefit from a lawsuit is less than the cost of litigation. The potential defendants (injurers) who do not enter into waiver agreements are, by definition, those for whom care is sufficiently productive that the deterrence benefit exceeds the cost of litigation. Thus, under Coasean conditions, the productivity condition central to several of the results below will be satisfied. I explore the implications of this argument in Part IV.

### III. THE MODEL

The model, a variant of Polinsky and Rubinfeld (1988b), assumes: one risk-neutral injurer and a continuum of risk-neutral victim types; for each victim type, the injurer's care level affects both the probability of harm and the magnitude of harm. I will use the following variables:

$x$  = injurer's level of care,

$z$  = index of victim types ( $0 \leq z \leq 1$ ),

$p(x, z)$  = probability of harm to victim type  $z$  ( $p_1 < 0$ ,  $p_2 > 0$ ,  $p_{11} > 0$ ),

$h(x, z)$  = harm to victim of type  $z$  ( $h_1 < 0$ ,  $h_2 > 0$ ,  $h_{11} > 0$ ),

$f(z)$  = probability density of  $z$ , where  $f(0) = 0$ .

$\alpha$  = victim's cost of litigation,

$\beta$  = injurer's cost of litigation.

I assume liability is strict, and (for the moment) that settlement is not an option.

Litigation costs are allocated according to the American rule, which requires each party to pay for its own litigation expenses.

A victim will sue if and only if his loss exceeds his litigation cost

$$h(x, z) > \alpha \quad (1)$$

Following Polinsky and Rubinfeld (1988b), I will define a *threshold* level of  $z$ ,  $z(x)$ , below which victims will not sue and above which victims will sue (given the level of  $x$ )

$$h(x, z(x)) = \alpha \quad (2)$$

The injurer's objective is to minimize his costs. Letting *TPC* stand for "total private costs," the injurer chooses  $x$  to minimize

$$TPC = x + \int_{z(x)}^1 p(x, z)[h(x, z) + \beta]f(z)dz \quad (3)$$

The injurer will choose  $x$  so that the "private first-order condition" (*PFOC*) is equal to zero:

$$\begin{aligned}
PFOC = & 1 + \int_{z(x)}^1 [p_1(x, z)h(x, z) + p(x, z)h_1(x, z)]f(z)dz \\
& + \int_{z(x)}^1 p_1(x, z)\beta f(z)dz \\
& - p(x, z(x))[h(x, z(x)) + \beta]f(z(x))z'(x) = 0
\end{aligned} \tag{4}$$

Let  $x^*$  represent the privately optimal level of care, the value of  $x$  that solves (4). The first term in (4), 1, reflects the increase in the injurer's costs from simply taking more care, because care is costly. The second term in (4) is negative and reflects the reduction in harms for which the injurer will be held liable as the injurer's care level increases. The injurer has an incentive to take care in order to reduce expected damages. The third term is negative and reflects the reduction in the injurer's expected litigation cost when he takes more care. The fourth term, which I will call the *litigation threshold effect*, is also negative and shows that the injurer's liability fall as he takes more care because the threshold level of  $z(x)$ —the level at which suit becomes profitable to the victim—increases as care increases. The threshold  $z(x)$  rises as the injurer takes more care because the victim's harm from injury decreases, which in turn means that more victims fall below the threshold  $z(x)$ . In other words, the threshold effect shows that the injurer's costs fall because marginal plaintiffs drop off as care increases. Thus, the injurer has an incentive to take care in order to preclude an additional lawsuit.

Total social cost ( $TSC$ ) is given by:

$$TSC = x + \int_0^1 p(x, z)h(x, z)f(z)dz + \int_{z(x)}^1 p(x, z)(\beta + \alpha)f(z)dz \tag{5}$$

where the first term represents the cost of care, the second the cost of injuries, and the third the expected total cost of litigation. A social planner would choose  $x$  to minimize total social cost, thus setting the following “social first-order condition” equal to zero:

$$\begin{aligned}
SFOC = & 1 + \int_0^1 [p_1(x, z)h(x, z) + p(x, z)h_1(x, z)]f(z) \\
& + \int_{z(x)}^1 p_1(x, z)(\beta + \alpha)f(z)dz \\
& - p(x, z(x))(\beta + \alpha)f(z(x))z'(x) = 0
\end{aligned} \tag{6}$$

The first proposition below revisits and extends a basic result, largely to aid interpretation of results that follow.

*Proposition 1: Injurers choose a level of care, under strict liability, that is below the socially optimal level.*

*Proof:* Since  $h(x, z(x)) = \alpha$ ,

$$\begin{aligned}
SFOC = & PFOC + \int_{z(x)}^1 p_1(x, z)\alpha f(z)dz \\
& + \int_0^{z(x)} [p_1(x, z)h(x, z) + p(x, z)h_1(x, z)]f(z)dz
\end{aligned} \tag{8}$$

where the second term on the right hand side of (8) represents the reduction in the victim's expected litigation costs that results when the injurer takes more care. The third term reflects the reduction in harms to victims who do not sue (because  $z$  falls below the threshold level) when the injurer takes more care. Since both terms are negative, the proposition follows. ■

Injurers take too little care relative to the social optimum for two reasons: they do not take into account the litigation costs of victims who sue, and they do not consider the losses of victims who do not sue because their litigation expenses exceed their losses (Hylton, 1990). This *litigation-cost externality* plays a key role below in determining the welfare effects of costly litigation.

The litigation threshold effect does not appear in (8) except through *PFOC*. Thus, to the extent an increase in care is desirable because it induces the marginal plaintiff not to bring suit, there is no divergence between private and social incentives. Although the injurer does not take  $\alpha$  into account explicitly, he is led by the threshold effect to take  $h(x, z(x))$  into account, and since  $h(x, z(x)) = \alpha$  his incentives are socially optimal. This confirms the key result of Menell (1983), that the injurer's incentive to preclude a lawsuit is socially optimal. Moreover, this analysis demonstrates the connection between Menell's result and the under-deterrence conclusion.

#### A. *Welfare Effects of Cost Changes*

I now examine the welfare implications of changes in litigation costs. Proofs for the claims in this section are in the appendix.

*Proposition 2: (1) If the victim's harm is independent of the injurer's care level, then the injurer's optimal care level falls as the victim's litigation cost increases. (2) If the victim's harm is dependent on the injurer's care level, then the effect of an increase in the victim's litigation cost on the injurer's optimal care level is ambiguous.*

The intuition is as follows. Increasing the victim's cost of litigation has two effects: (1) it makes suit unprofitable for more victims, thus shielding injurers from some lawsuits, and (2) it alters the value to the injurer of precluding an additional lawsuit by taking more care – i.e., the threshold effect. When the severity of the victim's harm is independent of the injurer's care ( $h_l = 0$ ) the threshold effect drops out of this analysis. The reason is that when greater injurer care cannot reduce the victim's harm level, the injurer loses the ability to preclude the marginal plaintiff from suing. Given this, the sole effect of increasing the victim's litigation cost is to shield the injurer from additional lawsuits, and this is why the level of care falls.

When the victim's harm is a function of the injurer's care level, the litigation threshold is

potentially significant and complicates the analysis because the impact of increasing the victim's litigation cost on the injurer's incentive to preclude a lawsuit is uncertain. In particular, when the victim's litigation cost increases, the expected value to the injurer of precluding a lawsuit changes, but the direction of change is unclear a priori. To be sure, given that the marginal plaintiff's harm is equal to his cost of litigation, the value of preclusion increases if the victim's litigation cost increases and everything else remains fixed. But everything else may not remain fixed. For example, if the percentage of victims at the threshold level falls sufficiently, the value of preclusion may fall after an increase in the victim's litigation cost.

*Proposition 3: If the injurer's optimal level of care declines with the victim's litigation cost ( $\partial x^*/\partial \alpha < 0$ ), then social welfare is decreasing in the victim's litigation cost. If the injurer's optimal care level increases with the victim's litigation cost ( $\partial x^*/\partial \alpha > 0$ ), then the welfare effect of an increase in the victim's litigation cost is ambiguous.*

*Corollary: If the victim's harm is independent of the injurer's care level, then social welfare falls as the victim's litigation cost rises.*

The explanation for Proposition 3 and its corollary is straightforward. An increase in the victim's litigation cost reduces welfare directly by raising total litigation costs. If the change also leads to a reduction in the injurer's care, then the total impact of an increase in the victim's litigation cost on welfare is unambiguously negative.

Both propositions 2 and 3 suggest unambiguous results in the case in which harm is independent of the injurer's care. Is there a real-world analogy to this case? The most plausible is the case in which a failure to take care increases the likelihood of an accident but not the severity of harm. For example, consider a failure to check the amount of fuel before embarking in a plane. This failure to take care increases the likelihood of a plane crash, but not the severity of harm given a crash. More generally, cases of durable precaution as emphasized by Grady

(1994) probably fall in the category of cases in which Proposition 3 applies.

*Proposition 4: The injurer's optimal level of care increases as his cost of litigation increases.*

An increase in the injurer's litigation cost increases the injurer's precaution for two reasons: (1) the increase makes it more costly for the injurer not to take care, given that he may be sued; and (2) as the injurer's litigation cost increases, the benefit to the injurer of precluding an additional lawsuit (by raising the threshold level of harm  $z(x)$ ) increases, inducing more care.

*Proposition 5: If care is productive, in the sense that the marginal deterrence benefit from increasing  $\beta$  exceeds the marginal litigation cost, then increasing the injurer's litigation cost leads to an increase in social welfare.*

Both the deterrence benefit (avoided harms net of avoidance costs) and the total litigation cost are increasing in  $\beta$ . It follows that if the productivity condition in Proposition 5 holds at sufficiently low levels of  $\beta$ , there will be a level of  $\beta$ , call it  $\beta^*$ , at which the marginal deterrence benefit and marginal litigation cost are equalized, thus minimizing social cost. Under these conditions welfare is increasing in  $\beta$  for  $\beta < \beta^*$ , and decreasing in  $\beta$  for  $\beta > \beta^*$ .<sup>7</sup>

Although the welfare effects of increasing litigation costs are ambiguous as a general matter, there is a special case in which clear welfare statements emerge. When the severity of the victim's harm is independent of the injurer's care level, and the deterrence benefit from

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<sup>7</sup> If  $\epsilon_x^p$  represents the elasticity of  $p(x, z)$  with respect to a change in  $x$ , and  $\epsilon_\beta^x$  represents the elasticity of  $x$  with respect to a change in  $\beta$ , then a sufficient condition for welfare to be increasing in the injurer's litigation cost is  $\epsilon_x^p \epsilon_\beta^x \geq \beta/\alpha$  evaluated at  $x^*$ .



increasing the injurer's litigation cost exceeds the contribution to total litigation costs, welfare is decreasing in the victim's litigation cost and increasing in the injurer's litigation cost.

### B. *Optimal Level of Liability*

In this part I examine the optimal adjustment to compensatory damages. If we add some positive amount to the compensatory award, victims will sue more frequently and deterrence will be enhanced. However, once this adjustment is equal to the victim's cost of litigation, suing is essentially free, so further upward adjustments should not encourage additional lawsuits. This suggests that the optimal adjustment will not exceed the victim's cost of litigation, which is confirmed in the following proposition.

*Proposition 6: Let  $\theta$  be added to compensatory damages, so that the victim receives a judgment equal to  $h(x, z) + \theta$ .*

(1) *The optimal adjustment  $\theta^*$  will never exceed  $\alpha$ .*

(2) *If for all  $\theta \leq \alpha$  care is productive (in the sense that the marginal deterrence benefit of increasing  $\theta$  is greater than or equal to the marginal litigation cost), then the optimal adjustment  $\theta^*$  is equal to  $\alpha$ . Otherwise, the optimal adjustment  $\theta^*$  is less than  $\alpha$  and may be negative.*

*Proof:* The injurer's goal is to minimize

$$x + \int_{z(x)}^1 p(x, z)[h(x, z) + \theta + \beta]f(z)dz \quad (9)$$

thus, the injurer chooses  $x^*$  so that

$$1 + \int_{z(x)}^1 (p_1 h + p h_1) f(z) dz + \int_{z(x)}^1 p_1 (\theta + \beta) f(z) dz - p(x, z(x))(h + \theta + \beta) f(z) z'(x) = 0 \quad (10)$$

where  $h(x, z(x)) = \alpha - \theta$ . This yields  $x^* = x^*(\theta)$  and a threshold index  $z(x^*, \theta)$ . We know from the proof of Proposition 1 that the first order condition for the social welfare problem (*SFOC*) can be written in terms of the private first order condition (*PFOC*). Differentiating the social welfare function with respect to  $\theta$ :

$$\begin{aligned} \frac{dTSC}{d\theta} = & \left[ \int_{z(x^*, \theta)}^1 p_1(x^*, z)(\alpha - \theta)f(z)dz + \int_0^{z(x^*, \theta)} (p_1 h + p h_1)f(z)dz \right] \frac{\partial x^*}{\partial \theta} \\ & + \frac{\partial TSC}{\partial z(x^*, \theta)} \frac{\partial z(x^*, \theta)}{\partial \theta} \end{aligned} \quad (11)$$

where

$$\frac{\partial TSC}{\partial z(x^*, \theta)} = -(\beta + \alpha)p(x^*, z(x^*, \theta))f(z(x^*, \theta)) \quad (12)$$

The last term of (11) is positive and reflects the impact of a change in  $\theta$  on the suit threshold  $z(x)$ . Total cost decreases as the threshold level increases; however, the threshold level decreases as  $\theta$  increases. The bracketed term in (11) measures the marginal deterrence benefit of increasing  $\theta$ , and the last term measures the marginal litigation cost that result from increasing  $\theta$ .

When  $\theta = \alpha$ , the first term in (11) is obviously zero, the second term equals zero because  $z(x^*, \theta) = 0$ , and the third term is equal to zero because  $\partial z(x^*, \theta)/\partial \theta = 0$ . Thus,  $\theta = \alpha$  is one solution to the first order condition  $dTSC/d\theta = 0$ . However, unless the marginal deterrence benefit is greater than the marginal litigation cost for all  $\theta < \alpha$ , we may have another point at which  $dTSC/d\theta = 0$  for some  $\theta_0 < \alpha$ . If the marginal deterrence benefit is smaller for some  $\theta_1$ , where  $\theta_0 < \theta_1 < \alpha$ , then  $\theta = \alpha$  may not be the global minimum of the social cost function.

The final step of the argument is to show that the optimal adjustment will never exceed  $\alpha$ . For  $\theta > \alpha$ ,

$$\frac{dTSC}{d\theta} = \left[ \int_0^1 p_1(\alpha - \theta) f(z) dz \right] \frac{\partial x^*}{\partial \theta} > 0 \quad (13)$$

and the result follows. ■

This is a similar though more detailed result than in Polinsky and Rubinfeld (1988b), which shows that the optimal adjustment to compensatory damages may be positive or negative depending on the productivity of care. While this is true, Proposition 6 shows that the adjustment will never exceed the victim's litigation cost, and that in cases in which care is productive (in the sense defined) the optimal adjustment will equal the victim's litigation cost. Productive care cases include those in which the victim's damages are large relative to litigation costs, and the injurer's care is highly responsive to changes in the level of the damage award.

One way to understand Proposition 6 is to compare deterrence benefits and litigation costs. The social planner's task is to adjust compensatory damages to a level that maximizes the difference between the deterrence benefit and total litigation cost. The social planner adjusts compensatory damages with a view toward influencing the care choice of the injurer. If care is productive this is a relatively simple task; for then the private harm-reduction benefits of care can be aligned with the social harm-reduction benefits of care (and deterrence benefits maximized) by internalizing external harms to the injurer. External costs are internalized to the injurer when the victim's litigation cost is included in damages. Although this maximizes the total litigation cost (because  $z(x^*)=0$ ), it is the optimal result when deterrence benefits rise faster than litigation costs at liability levels below the optimal.

If care is unproductive, the social planner will choose an adjustment smaller than the victim's litigation cost, and perhaps negative. By choosing a damage award that fails to fully compensate victims, the social planner effectively bars some victims from bringing suit. Barring victims whose losses are relatively small is the same as restricting the right to sue to those whose losses are large. Given larger losses among suing victims, the difference between the deterrence

benefit and litigation cost increases. The social planner will reduce the level of the award, thereby barring additional victims from bringing suit, until the difference between the deterrence benefit from suit and litigation cost reaches a maximum. Indeed, if care is extremely unproductive, the social planner will bar all victims from bringing suit, as suggested in Shavell (1982).

Another way of explaining the optimal damages result in the case in which care is productive relies on the Menell's finding that the injurer's incentive to preclude an additional lawsuit is socially optimal. This implies that when care is productive the only role for the social planner is to adjust the level of compensatory damages in order to internalize external harms caused by the injurer. The relevant externalities are two: the litigation costs borne by victims who sue and the harms suffered by victims for whom suit would be unprofitable, and these harms are internalized when  $\theta = \alpha$ .

Consider a special case where the probability of harm is independent of the victim type, and given by  $p(x)$ , and the harm is simply  $z$ . The solution to the optimal adjustment problem can be expressed as:

$$\theta^* = \alpha + E(z/z < \hat{z}) \left( \frac{F(\hat{z})}{1 - F(\hat{z})} \right) + \frac{(\alpha + \beta)p(x)f(\hat{z})}{p'(x)(\partial x^*/\partial \theta)(h_2)(1 - F(\hat{z}))} \quad (14)$$

where  $\hat{z} = \alpha - \theta$ . This includes the solution  $\theta^* = \alpha$  as a special case. This equation establishes a link between the litigation context and optimal punishment theory in the case of bilateral precaution (Hylton, 1996). The first two terms impose a "tax" equal to the sum of the litigation cost of the victim who sues and the expected loss of victims who do not sue. This tax, consistent with optimal punishment theory, places greater weight on the harms of non-suing victims as the probability of liability falls. The third term (which is negative) allocates part of the social cost of litigation to the victim, in order to induce victims to sue less often. Thus, the optimal adjustment can be expressed as a type of modified optimal penalty, where the solution is pushed below the

level of the Becker (1968) model in order to induce care on the part of victims. This special case also reveals that when care is unproductive, the optimal adjustment will be less than the optimally-detering tax, which is the sum of the victim's litigation cost and the expected losses of non-suing victims.<sup>8</sup>

If the model were expanded to allow for two instruments for controlling social welfare - one to control the injurer's care, the other to control the incentive to sue - then it would be possible to ensure optimal care and optimal incentives to file suit. This would be desirable in the case in which care is unproductive. For example, one way to control injurer and victim incentives separately would be to tax injurers in order to internalize costs and to require victims to pay a fee in order to file a lawsuit. The optimal tax would correct the incentives of the injurer by internalizing the losses of victims who do not sue and the litigation costs of those who sue.<sup>9</sup> The filing fee could be set so that the frequency of lawsuits maximizes the difference between the deterrence benefit and total litigation cost. Two instrument schemes are discussed in Shavell (1996) and Polinsky and Che (1991).

### III. SETTLEMENT

To this point, I have assumed settlement was not an option available to the parties. Now I extend the results to take settlement into account. My goal in this part is to see how the results of the previous section change when settlement is taken into account. The results have implications for the social desirability of settlement.<sup>10</sup>

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<sup>8</sup> On the optimal tax, see Hylton (1990), at 165.

<sup>9</sup> Id.

<sup>10</sup> See Polinsky and Rubinfeld (1988b), Shavell (1996), and Spier (1997). Unlike Shavell (1996) and Spier (1997), this paper does not examine the divergence between private and social incentives to settle.

I assume parties incur no legal expenses if they settle. Let:

$\eta$  = probability of settlement, given suit

$\sigma$  = injurer's share of settlement surplus.

The amount the victim receives, in expectation, is given by

$$h(z,x) - a + \eta(1 - \sigma)(\beta + \alpha) \quad (15)$$

where  $\beta + \alpha$  is the settlement surplus - the amount saved by settling. The victim's expected payment is equal to his minimum demand,  $h(x, z) - \alpha$ , plus his expected share of the surplus.

The amount the injurer pays, in expectation, is given by

$$h(z, x) + \beta - \eta\sigma(\beta + \alpha) \quad (16)$$

which reflects the injurer's maximum offer,  $h(x, z) + \beta$ , less his expected portion of the surplus.

*Proposition 7: If the injurer receives the total settlement surplus ( $\sigma=1$ ), then the level of care under strict liability will be less than the socially optimal level. If the injurer shares the settlement surplus with the victim ( $\sigma < 1$ ), then it is unclear whether the injurer's optimal care level is less than the socially optimal level.*

*Proof:* The injurer minimizes

$$TPC = x + \int_{z(x)}^1 p(x,z)[h(x,z) + \beta - \eta\sigma(\beta + \alpha)]f(z)dz \quad (17)$$

The social welfare function is given by

$$\begin{aligned}
 TSC = x + \int_0^1 p(x,z)h(x,z)f(z)dz \\
 + \int_{z(x)}^1 p(x,z)(1-\eta)(\beta + \alpha)f(z)dz
 \end{aligned} \tag{18}$$

Taking derivatives and rearranging terms, we get

$$\begin{aligned}
 SFOC = PFOC + \int_0^{z(x)} (p_1 h + p h_1) f(z) dz \\
 + \int_{z(x)}^1 p_1(x,z) [\alpha - \eta(1-\sigma)(\beta + \alpha)] f(z) dz \\
 + p(x, z(x)) [\eta(1-\sigma)(\beta + \alpha)] f(z(x)) z'(x)
 \end{aligned} \tag{19}$$

Since the sign of the third term in (19) is unclear, and the sign of the fourth term is positive, the result follows. ■

There are now three externalities driving a wedge between private and social incentives for precaution. One is due to victims with small losses deciding not to sue because their litigation cost exceeds the expected award. This externality (as in the no-settlement model) results in injurers taking too little care relative the social optimum.

However, two factors suggest care may go beyond the socially optimal level. One is the expected litigation cost borne by plaintiffs who sue. If the plaintiff receives a sufficiently large share of the settlement surplus, this cost may be zero or negative. When the expected litigation cost is negative, the injurer should take less care, given that his failure to take care bestows a benefit (or is less harmful) to suing victims.

The third factor suggesting the injurer should take less care is the threshold effect. In deciding whether to take care in order to preclude a lawsuit, the injurer considers  $h(x, z(x)) + \beta - \eta\sigma(\beta + \alpha)$ . However, a social planner would be concerned only with the additional social cost generated by the marginal lawsuit,  $(1 - \eta)(\beta + \alpha)$ . In the case of the marginal lawsuit, where

$h(x,z(x)) = \alpha$ , the difference between the injurer's private costs and social costs is  $\eta(1 - \sigma)(\beta + \alpha)$ , which is the plaintiff's share of the settlement surplus. In other words, the injurer has an incentive to exercise *too much care* because he adds the plaintiff's share of the settlement surplus to the real social cost of the lawsuit.

It should be clear that if  $\sigma = 1$  (injurer gets the entire settlement surplus), Proposition 1 continues to hold, i.e. strict liability underdeters. Since the victim's net litigation costs are positive in this case, the injurer's failure to consider those costs results in socially inadequate precaution. On the other hand, since the injurer appropriates the settlement surplus, he takes into account all relevant costs when deciding whether to raise his care level in order to preclude a lawsuit. Thus, when the injurer gets the entire surplus, the threshold externality disappears, and the litigation-cost externality has the same negative impact on precaution as in the regime without settlement.<sup>11</sup>

The welfare effects of increasing litigation costs are more complicated when settlement is taken into account. When  $\sigma = 1$ , the previous section's analysis of increasing costs remains intact, so Propositions 2 through 5 remain valid. However, when  $\sigma < 1$  the analysis yields fewer unambiguous results. In addition to the reasons for ambiguity suggested in Proposition 7, there is the additional problem that the effect of an increase in the plaintiff's (or defendant's) litigation cost may be offset by an increase in the plaintiff's (or defendant's) share of the settlement surplus. This makes it difficult to determine the effects of increasing costs on incentives for precaution. If the plaintiff's share of the settlement surplus is non-decreasing in  $\alpha$  (which requires  $\partial(\eta\sigma)/\partial\alpha \geq 0$ ), then Proposition 2 remains valid in the model with settlement;<sup>12</sup>

<sup>11</sup> I should note here that the ambiguous result regarding the optimality of care differs from the analysis in Shavell (1996). Shavell shows that the level of the tax that should be applied to the injurer in order to induce optimal care when settlement is possible. However, Shavell's model assumes that the injurer's share of the settlement surplus is one (i.e.,  $\sigma = 1$ ); thus his result is entirely consistent with this model, given his assumption  $\sigma = 1$ .

<sup>12</sup> Two cases come to mind in which this condition probably holds. One is the case where  $\sigma = 0$ , which is a feature of asymmetric information models in which the uninformed plaintiff makes the settlement demand (see Bebchuk, 1984). The other is the standard Landes-Posner-



otherwise the effects of increasing  $\alpha$  are ambiguous. Similarly, if the defendant's share of the settlement surplus is non-increasing in  $\beta$  (which requires  $1 - \eta\sigma - [\partial(\eta\sigma)/\partial\beta](\beta + \alpha) \geq 0$ ), then Proposition 4 remains valid in the model with settlement.

Now consider what remains of Proposition 6 when settlement is incorporated. Again assume damages awarded by the court are  $h(x, z) + \theta$ .

*Proposition 9: If the injurer receives the total settlement surplus ( $\sigma=1$ ), then Proposition 6 remains valid. If the injurer shares the settlement surplus with the victim ( $\sigma < 1$ ), then setting  $\theta = \alpha$  results in socially excessive care, and the optimal adjustment  $\theta^*$  is less than  $\alpha$ .*

*Proof:*

$$\frac{dTSC}{d\theta} = \left. \frac{\partial TSC}{\partial x} \right|_{x^*} \frac{\partial x^*}{\partial \theta} + \frac{\partial TSC}{\partial z(x)} \frac{\partial z(x)}{\partial \theta} \quad (20)$$

where

$$\begin{aligned} \frac{\partial TSC}{\partial x} = & \int_0^{z(x)} (p_1 h + p h_1) f(z) dz \\ & + \int_{z(x)}^1 p_1 [\alpha - \theta - (1 - \sigma)\eta(\alpha + \beta)] f(z) dz \\ & + p(x, z(x)) [\eta(1 - \sigma)(\beta + \alpha)] f(z(x)) z'(x) \end{aligned} \quad (21)$$

if  $\sigma=1$ , this problem reduces to the equivalent of that observed in Proposition 6. If  $\sigma \leq 1$ , setting  $\theta \geq \alpha$  yields  $z(x) = 0$ ,  $z'(x) = 0$ , and  $\partial z(x^*)/\partial \theta = 0$ ; so it follows that for  $\theta \geq \alpha$

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Gould settlement model (see, e.g., Shavell 1982a for analysis of this model), in which the probability of a settlement increases as the settlement surplus increases. Thus if  $\sigma$  remains fixed and the probability of a settlement increases, Propositions 2 and 3 will remain valid in the settlement model.

$$\frac{dTSC}{d\theta} = [\alpha - \theta - (1 - \sigma)\eta(\alpha + \beta)] \left[ \int_0^1 p_1 f(z) dz \right] \frac{\partial x^*}{\partial \theta} > 0 \quad (22)$$

i.e., social cost is increasing in  $\theta$  for  $\theta \geq \alpha$ . It is desirable, therefore, to reduce  $\theta$  below  $\alpha$  in order to encourage the injurer to take less care. ■

The intuition is as follows. When the injurer shares the settlement surplus with the victim and  $\theta = \alpha$ , the victim will be overcompensated by a lawsuit, because he receives as compensation  $h(x, z) + \eta(1 - \sigma)(\beta + \alpha)$ . Given this, the injurer should take less care than is privately optimal.

Now let us consider the effects of settlement on social welfare. Would society be better off if settlement were prohibited? Polinsky and Rubinfeld (1998b) show that introducing settlement has ambiguous welfare effects, which implies society may be better off reducing the frequency of settlement. The reason is that settlement reduces the total cost of litigation, which enhances social welfare, but on the other hand reduces injurers' incentives for care, which reduces social welfare. To see the latter point, note that because the plaintiff must maintain the credibility of his threat to sue, litigation costs bar some victims from bringing suit, and to the same extent as in the regime without settlement. On the other hand, a reduction in the injurer's expected litigation cost (because he anticipates settlement) reduces his care level (Proposition 4).

It happens that the welfare trade-off result of Polinsky and Rubinfeld depends on the assumption that litigation costs are allocated under the American rule. If the victim's litigation cost is shifted to the injurer, then the case for settlement becomes unambiguously positive.

*Proposition 10: If damages are adjusted by adding  $\theta = \alpha$ , then settlement can only enhance social welfare.*

*Proof:* Introducing settlement reduces the social burden of litigation. To see this,

note that total social cost when settlement is possible is

$$TSC = x + \int_0^1 p(x, z)h(x, z)f(z)dz + (1 - \eta) \int_{z(x)}^1 p(x, z)(\beta + \alpha)f(z)dz \quad (23)$$

This clearly falls as  $\eta$  increases, everything else fixed. Consider the effect of settlement induced changes in precaution

$$\frac{dTSC}{d\eta} = \frac{\partial TSC}{\partial x} \Big|_{x^*} \frac{\partial x^*}{\partial \eta} + \frac{\partial TSC}{\partial \eta} \quad (24)$$

where  $\partial TSC/\partial \eta < 0$ . It follows from Proposition 9 that  $\partial TSC/\partial x \Big|_{x^*} = 0$  when  $\sigma = 1$ , and  $\partial TSC/\partial x \Big|_{x^*} > 0$  when  $\sigma < 1$ . Also, since the injurer's expected payment falls as  $\eta$  increases,  $\partial x^*/\partial \eta < 0$ , and the result follows. ■

In other words, settlement is an unambiguously good thing when damages are adjusted upward by an amount equal to the victim's litigation cost.<sup>13</sup> In the case where the injurer pockets the entire settlement surplus, this follows from the fact that the injurer's care is socially optimal

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<sup>13</sup> Although, as noted earlier, this paper does not focus on the divergence between private and social incentive, it is a straightforward implication of Proposition 10 that if damages are adjusted upward by  $\alpha$ , and the probability of settlement is less than one, then the private incentive to settle is inadequate. This is because society always gains from settlement. This result seems to differ from that of Spier (1997), which shows that the private incentive to settle may be excessive. However, Spier (1997) examines a negligence regime, while this paper examines strict liability. In a negligence regime, with costly litigation and accurate courts, social welfare can be improved by enabling victims to commit to bring suit – this is demonstrated in Spier, and suggested by Ordover (1978) (and also Hylton (1990)) though the Ordover and Hylton

when  $\theta = \alpha$ . Given socially optimal care, increasing settlement necessarily reduces social cost.

The more interesting case is when there is a potential conflict between settlement's influences on litigation costs and precaution, as in Polinsky and Rubinfeld (1988b). The model here shows that when damages are adjusted upward by an amount equal to the victim's litigation cost, there is no conflict between the cost-reduction and precaution effects of settlement.

#### IV. IMPLICATIONS

With such a simple model, one must take care in deriving policy implications. This analysis has implications largely for three issues: the allocation of litigation costs, punitive damages, and contingency fees or subsidization of litigation.

##### A. Allocation of Litigation Costs

In the model without settlement, it was shown that when care is productive (in the sense that deterrence benefits rise faster as a function of the level of liability than total litigation costs at liability levels below the optimal), welfare is maximized under a simple scheme in which the injurer is held liable for the victim's loss and the victim's litigation cost. The model suggests that care is productive when the likelihood of harm falls substantially with an increase in the injurer's level of care, the injurer's care is highly responsive to changes in the level of liability, and victim losses are large relative to litigation costs.

Should one expect care to be productive in this sense? If care is not productive, then injurers and victims will have incentives to enter into pre-dispute waiver agreements (Hylton, 2000). Thus, if transaction costs are low, care will be productive among those potential victim-

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articles do not examine the settlement process.

injurer pairs that have not entered into waiver contracts.

The simple optimality result found in the model without settlement is less certain in the model that incorporates settlement. If injurers appropriate the entire settlement surplus, the optimality result remains – i.e., social welfare is maximized when the damage award is the sum of the victim's loss and litigation cost. However, if the settlement surplus is shared between the victim and injurer, setting the award equal to the sum of the victim's loss and litigation cost results in excessive precaution. In this case victims are overcompensated (since the ones who litigate are fully compensated and the ones who settle are overcompensated), which suggests that injurers should take less care since their lapses bestow a benefit on some victims.

This generates the question whether it makes sense to assume that the injurer generally appropriates the entire surplus. There is a strong argument for this assumption. If the injurer offers the victim a settlement that covers his loss, the victim's threat to sue loses its credibility after the offer, unless the victim anticipates receiving a super-compensatory award. Given this, the injurer probably can appropriate the surplus in the typical case. Moreover, an expectation that the injurer will get the entire surplus could be supported by a rule refusing to enforce the over-compensatory portion of a settlement. The common-law rule prohibiting enforcement of penalty clauses in liquidated damages agreements arguably serves this function already, since a liquidated damages provision is in essence a pre-dispute settlement agreement.

The upshot is that the result of the simple no-settlement model -- that social welfare is maximized by shifting the victim's litigation cost to the injurer -- appears to be the appropriate default rule in settings where transaction costs are low. Of course, the model here is unrealistically simple in several ways: it assumes strict liability and that the victim wins his lawsuit. In this model, both the British rule (loser pays litigation cost) and pro-plaintiff fee shifting (losing defendant pays) are equivalent. Given this, the finding that the optimal damage award includes the victim's litigation cost can be interpreted as supporting either the British or pro-plaintiff rule. Moreover, in a model that allows for the possibility of frivolous lawsuits, the British rule would probably dominate the pro-plaintiff rule.

When care is unproductive and transaction costs are high, a rule shifting the victim's litigation cost to the injurer will result in socially excessive litigation. For example, automobile drivers have incentives to take care largely to prevent harming themselves rather than to avoid liability, thus their precaution is unlikely to be responsive to changes in liability. Moreover, transaction costs between potential automobile injurers and victims are high, so pre-dispute waivers will not be traded among them. This suggests shifting the victim's litigation cost is not the appropriate default rule in the automobile accident setting.

## B. Punitive Damages

Examining a model of strict liability for lapses of care, Polinsky and Shavell (1998) argue that damages should be adjusted upward by dividing the compensatory award by the probability of liability. The model here is narrower in the sense that I assume (unlike Polinsky and Shavell) that detection is certain and that the plaintiff will prevail. The probability of liability is less than one in this model only because litigation costs bar some victims from suing.

My analysis indicates that an upward adjustment over the compensatory level is appropriate only when injurer care is productive (in the sense defined above), and that the upward adjustment should be capped by the victim's cost of litigation. In general, the direction of the optimal adjustment to compensatory damages depends on whether enhancing injurer care contributes more to social welfare than reducing litigation costs, and the optimal adjustment itself equates the marginal benefit from deterrence to the marginal cost of litigation. Further, the optimal liability result here suggests that it is important to determine the reason that the probability of liability is less than one, since different solutions to the optimal liability question are appropriate in different cases.

## C. Contingency Fees and Subsidizing Litigation Generally

Whether subsidizing litigation is desirable depends, in this model, on something I have called “the litigation threshold effect”. I refer to the incentive of an injurer to take care in order to preclude an additional lawsuit. This paper shows, confirming Menell (1983), that the injurer’s incentive to preclude an additional lawsuit is socially optimal. In other words, the threshold effect does not push the injurer’s care level away from the social optimum.

The threshold effect does, however, complicate the analysis of the welfare effects of increasing litigation costs. Consider the effects of increasing the victim’s litigation cost. When the threshold effect is zero, as is the case when the severity of injury is unrelated to the injurer’s care, increasing the victim’s litigation cost has a predictable result. Specifically, it reduces welfare by shielding the injurer from lawsuits that would deter careless conduct, causing the injurer to reduce his care even further below the socially optimal level. However, when the threshold effect is positive, the welfare effect of increasing the victim’s litigation cost is ambiguous, because an increase in the victim’s litigation cost may enhance the injurer’s incentive to take care in order to preclude a lawsuit.

To see the implications of threshold effects in policy analysis, consider the welfare implications of contingency fees. Since they shift risk to the less-risk-averse attorney, they have the effect of reducing the victim’s litigation cost. If threshold effects are negligible, this analysis implies that contingency fee arrangements enhance social welfare. On the other hand, if threshold effects are substantial, then the welfare implications of contingency fees are ambiguous.

#### IV. CONCLUSION

This paper has reexamined and extended results on the welfare effects of costly litigation under strict liability. My aim has been to pull together disparate analyses under a single framework, reconcile seemingly contradictory results, and extend the analysis. The key result of this paper has the implication that if damages are high relative to litigation costs, and injurer care

is highly responsive to changes in the level of liability, lawsuits should be encouraged by making the victim's litigation cost an element of damages. Moreover, under such a cost-shifting scheme, increasing the frequency of settlement would enhance social welfare.

Of course, it should be kept in mind that I have examined a simple model – one in which the parties are risk neutral, a rule of strict liability applies, and injurers are sued for lapses of care rather than intentional wrongs. I have not allowed for the possibility of bad faith litigation. Relaxing these assumptions may yield different implications for optimal damage awards. For example, allowing for bad faith lawsuits or for the possibility of legal error may yield the implication that the British rule is superior to one that permits only the successful plaintiff to collect his litigation cost from the defendant. Future research on the welfare effects of litigation should expand upon this model to incorporate such features as bad faith litigation, legal error, negligence standards, and intentional wrongs.



## Appendix

*Proof of Proposition 2:* Let  $x^*$  represent the injurer's optimal care level, and let  $\Delta > 0$  represent the second-order condition associated with (4). Then

$$\frac{\partial x^*}{\partial \alpha} = \frac{-\left[\frac{\partial PFOC}{\partial \alpha}\right]}{\Delta} \quad (\text{A1})$$

where

$$\begin{aligned} \frac{dPFOC}{d\alpha} = & -p_1(x, z(x))(\alpha + \beta)f(z(x))\frac{\partial z}{\partial \alpha} - p(x, z(x))f(z)\left[h_1\frac{\partial z}{\partial \alpha} + \frac{\partial z}{\partial x}\right] \\ & - p_2(x, z(x))(\alpha + \beta)f(z(x))\frac{\partial z}{\partial \alpha}\frac{\partial z}{\partial x} \\ & - p(x, z(x))(\alpha + \beta)f'(z(x))\frac{\partial z}{\partial \alpha}\frac{\partial z}{\partial x} \\ & - p(x, z(x))(\alpha + \beta)f(z(x))\frac{\partial^2 z}{\partial z\partial \alpha} \end{aligned} \quad (\text{A2})$$

Using (2), we know that as  $\alpha$  varies (2) traces a relationship of the form  $h(x, z(x, \alpha)) = \alpha$ . It follows from this that  $\partial z/\partial \alpha = 1/h_2 > 0$  and  $\partial z/\partial x = -h_1/h_2 > 0$ ; so

$$\begin{aligned} \frac{dPFOC}{d\alpha} = & -p_1(x, z(x))(\alpha + \beta)f(z(x))\left(\frac{1}{h_2}\right) \\ & - p_2(x, z(x))(\alpha + \beta)f(z(x))\left(\frac{-h_1}{h_2^2}\right) \\ & - p(x, z(x))(\alpha + \beta)f'(z(x))\left(\frac{-h_1}{h_2^2}\right) \\ & - p(x, z(x))(\alpha + \beta)f(z(x))\left(\frac{-h_{21}}{h_2^2}\right) \end{aligned} \quad (\text{A3})$$

If  $h_1 = 0$ , then

$$\frac{dPFOC}{d\alpha} = -p_1(\alpha + \beta)f \frac{\partial z}{\partial \alpha} > 0 \quad (\text{A4})$$

and the result follows. ■

*Proof of Proposition 3:* Differentiating the social cost function evaluated at  $x^*$ , and taking advantage of (7), we have

$$\begin{aligned} \frac{dTSC}{d\alpha} = & \left[ \int_{z(x)}^1 p_1(x, z) \alpha f(z) dz + \int_0^{z(x)} [p_1(x, z) h(x, z) + p(x, z) h_1(x, z)] f(z) dz \right] \Big|_{x^*} \frac{\partial x^*}{\partial \alpha} \\ & + \int_{z(x)}^1 p(x, z) f(z) dz \Big|_{x^*} \end{aligned} \quad (\text{A5})$$

The first component in the bracketed term represents the litigation costs born by victims who sue. This is negative because an increase in the injurer's care level reduces these costs. The second component in the bracketed term represents the losses borne by victims who do not sue, and this is also negative because these costs fall as the injurer's care increases. If  $\partial x^*/\partial \alpha < 0$  the entire bracketed term of (15) is positive, and negative if  $\partial x^*/\partial \alpha > 0$ . The third and final term is positive because it reflects the increase in the deadweight litigation costs that result when  $\alpha$  increases.

The result follows. ■

*Proof of Proposition 4:* Letting  $\Delta > 0$  represent the second order condition associated with (4),

$$\frac{\partial x^*}{\partial \beta} = \frac{-\left[ \frac{\partial PFOC}{\partial \beta} \right]}{\Delta} \quad (\text{A6})$$

where

$$\frac{\partial PFOC}{\partial \beta} = \int_{z(x)}^1 p_1(x, z) f(z) dz - p(x, z(x)) f(z) z'(x) \quad (A7)$$

and since this is negative the result follows. ■

*Proof of Proposition 5:* Differentiating the social welfare function and evaluating it at  $x^*$

$$\begin{aligned} \frac{dTSC}{d\beta} = & \left[ \int_{z(x)}^1 p_1(x, z) \alpha f(z) dz + \int_0^{z(x)} [p_1(x, z) h(x, z) + p(x, z) h_1(x, z)] f(z) dz \right]_{x^*} \frac{\partial x^*}{\partial \beta} \\ & + \int_{z(x^*)}^1 p(x^*, z) f(z) dz \end{aligned} \quad (A8)$$

The first term in (A8) is negative. The second term, also negative, reflects the benefits that result because the injurer takes more care as  $\beta$  increases. The third term reflects the increase in deadweight litigation costs, and is positive. ■

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