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Optimal awards and penalties when the probability of prevailing varies among plaintiffs

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This article derives the optimal award to a winning plaintiff and the optimal penalty on a losing plaintiff when the probability of prevailing varies among plaintiffs. Optimality is defined in terms of achieving a specified degree of deterrence of potential injurers with the lowest litigation cost. Our main result is that the optimal penalty on a losing plaintiff is positive, in contrast to common practice in the United States. By penalizing losing plaintiffs and raising the award to winning plaintiffs (relative to what it would be if losing plaintiffs were not penalized), it is possible to discourage relatively low-probability-of-prevailing plaintiffs from suing without discouraging relatively high-probability plaintiffs, and thereby to achieve the desired degree of deterrence with lower litigation costs.

1. Introduction

■ This article derives the optimal award to a winning plaintiff and the optimal penalty on a losing plaintiff when the probability of prevailing varies among plaintiffs. Optimality is defined in terms of achieving a specified degree of deterrence of potential injurers with the lowest litigation cost. Our main result is that the optimal penalty on a losing plaintiff is positive, in contrast to common practice in the United States. This result is developed first in a model in which all suits are assumed to go to trial (Section 2) and then in a model in which settlements are possible (Section 3). In the former case, the result holds regardless of the bounds on the award and penalty, while in the

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latter case it holds if the award and penalty can be set sufficiently high. We conclude with some observations about two related topics—the British rule for allocating litigation costs and Becker's theory of public enforcement (Section 4).[1]

The essence of our argument is that if losing plaintiffs are not penalized, then it is possible to impose a penalty and raise the award so as to reduce the value of suits for relatively low-probability-of-prevailing plaintiffs and at the same time increase the value of suits for relatively high-probability-of-prevailing plaintiffs. This is feasible because, by definition, low-probability plaintiffs have a lower probability of winning at trial—or equivalently a higher probability of losing—than high-probability plaintiffs. As a result, imposing a penalty will disadvantage low-probability plaintiffs more than high-probability plaintiffs, while raising the award will benefit high-probability plaintiffs more than low-probability plaintiffs. Reducing the value of suits for low-probability plaintiffs will cause fewer of them to sue, thereby saving litigation costs, while raising the value of suits for high-probability plaintiffs increases the defendant's expected payment, thereby allowing deterrence to be maintained.

To illustrate the advantage of imposing a penalty on losing plaintiffs, consider the following numerical example. Let there be two potential plaintiffs, one with a probability of prevailing of .3 and the other with a probability of .8. Each is equally likely to be injured. If a suit is filed, assume that the case goes to trial and that both the plaintiff and the defendant incur $20,000 in trial costs. Suppose initially that the award to a winning plaintiff is $100,000 and that there is no penalty imposed on a losing plaintiff. Then the value of suit is $10,000 for the low-probability plaintiff (.3($100,000) − $20,000) and $60,000 for the high-probability plaintiff, so both will sue. The resulting level of deterrence achieved against the defendant is $75,000, and litigation costs are $40,000.[2] Now suppose that the award to a winning plaintiff is raised from $100,000 to $174,000 and a penalty of $46,000 is imposed on a losing plaintiff. The value of suit will fall to zero for the low-probability plaintiff (.3($174,000) − .7($46,000) − $20,000), but will increase to $110,000 for the high-probability plaintiff. This will lead only the high-probability plaintiff to sue, will achieve the same level of deterrence against the defendant, and will reduce litigation costs by half.[3]

2. The basic analysis

■ A risk-neutral injurer engages in conduct that causes harm to one of a number of risk-neutral potential victims. (We use the terms "injurer" and "defendant" interchangeably, and similarly "victim" and "plaintiff.") The probability of prevailing at trial varies among potential victims.[4] Each one knows his probability of prevailing,

[1] Our article is the first to demonstrate the desirability of a general policy of imposing a penalty on a plaintiff if he loses. Of related interest, however, are articles that evaluate alternative rules for allocating litigation costs. See, for example, Bebchuk and Chang (1996) and Gravelle (1993). Also of interest are articles that consider the use of penalties to control frivolous suits. See, for example, Katz (1990) and Polinsky and Rubinfeld (1993).

[2] The level of deterrence achieved against the defendant is .5[.3($100,000) + $20,000] + .5[.8(100,000) + $20,000] = $75,000. Litigation costs are $40,000 (the sum of the plaintiff's and the defendant's trial costs) because a suit will result whenever harm occurs.

[3] Although the low-probability plaintiff is indifferent between suing and not suing, the penalty could be raised slightly to make him strictly prefer not to sue. The level of deterrence achieved against the defendant is .5[.8($174,000) − .2($46,000) + $20,000] = $75,000. Litigation costs now are .5($40,000).

[4] The probability might vary because victims differ in their ability to marshall evidence about issues relating to causality or fault. In product liability cases, for example, some victims may have kept packing material or a receipt as proof of purchase, while others may not have. In accident cases, evidence about fault sometimes may be destroyed and sometimes may not be.

but the injurer knows only the distribution of the probabilities among potential plaintiffs.[5]

In the basic analysis, all suits are assumed to go to trial. If the plaintiff wins, he receives an award from the defendant. If the plaintiff loses, he pays a penalty to the defendant. Both the award and the penalty cannot exceed some upper bound.[6] Each side bears its own trial costs.

The following notation will be used:

p = probability that the plaintiff will prevail at trial;

$f(p)$ = density of p among potential plaintiffs;

x = award paid to the plaintiff by the defendant if the plaintiff prevails at trial ($0 < x \leq \bar{x}$);

$\bar{x}$ = maximum possible award;

y = penalty paid by the plaintiff to the defendant if the plaintiff loses at trial ($0 \leq y \leq \bar{y}$);

$\bar{y}$ = maximum possible penalty;

c_p = plaintiff's trial cost ($c_p > 0$); and

c_d = defendant's trial cost ($c_d > 0$).

The population of potential plaintiffs is normalized to be unity.

A victim will file a suit if the expected value of the trial outcome exceeds his trial cost. Let

$V(p, x, y)$ be the expected value to a plaintiff of the trial outcome exclusive of his trial cost, given p, x, and y.

Note that

$$V(p, x, y) = px - (1 - p)y. \tag{1}$$

We assume that $x > c_p$, so that if the probability of prevailing is sufficiently high, a victim will bring a suit (otherwise a victim would not sue even if he were certain to win). Also, if the probability of prevailing is low enough, a victim will not find it worthwhile to sue. Let

$\hat{p}(x, y)$ be the value of the probability of prevailing below which a victim will not sue and above which he will sue,[7]

where $\hat{p}(x, y)$ is defined by

$$V(\hat{p}, x, y) = \hat{p}x - (1 - \hat{p})y = c_p. \tag{2}$$

[5] It is immaterial to our results whether plaintiffs know their probability of prevailing before harm has occurred or only after harm has occurred.

[6] For purposes of our analysis, it does not matter why the award and penalty are bounded (the limited wealth of the defendant and the plaintiff, considerations of fairness), provided that the defendant can pay the award and the plaintiff can pay the penalty. If some individuals cannot pay what they are assessed, the analysis would be more complicated, along the lines suggested by Polinsky and Shavell (1991) in the context of publicly imposed fines.

[7] We assume without loss of generality that a victim will not sue if $p = \hat{p}(x, y)$.

Solving for $\hat{p}$ yields

$$\hat{p}(x, y) = (y + c_p)/(x + y) < 1, \tag{3}$$

where the inequality follows from the assumption that $x > c_p$. We refer to $\hat{p}(x, y)$ as the "critical probability of prevailing."

The extent to which the defendant is deterred is determined by his expected payment to the plaintiff plus his trial cost. Let

$D(x, y)$ be the level of deterrence achieved given x and y,

and observe that

$$D(x, y) = \int_{\hat{p}}^{1} [V(p, x, y) + c_d] f(p)\, dp. \tag{4}$$

Also let

$L(x, y)$ be the level of litigation costs given x and y,

and note that

$$L(x, y) = \int_{\hat{p}}^{1} (c_p + c_d) f(p)\, dp. \tag{5}$$

In general, social welfare includes the gain to the defendant from engaging in the harmful conduct, the harm to the plaintiff, and the litigation costs borne by both parties. For our purposes, however, it is not necessary to derive the optimal award and penalty from the maximization of social welfare. We simply want to show that if the award and the penalty are less than their respective upper bounds, it always is possible to increase social welfare by raising both the award and the penalty. We shall do this by demonstrating that a higher award and penalty combination can be chosen that achieves the same degree of deterrence of the defendant—and therefore the same gain to the defendant and the same harm to the plaintiff—but does so with lower litigation costs.

To be precise, if $x' < \bar{x}$ is the initial award and $y' < \bar{y}$ is the initial penalty, we shall show that there exist feasible $x'' > x'$ and $y'' > y'$ such that $D(x'', y'') = D(x', y')$ and $L(x'', y'') < L(x', y')$.

As a preliminary matter, let $\hat{p}'$ be the initial value of the critical probability of prevailing:

$$\hat{p}' = \hat{p}(x', y') = (y' + c_p)/(x' + y'). \tag{6}$$

Now define $y(x)$ to be the value of y that solves $\hat{p}'x - (1 - \hat{p}')y = c_p$ for a given x; then

$$y(x) = (\hat{p}'x - c_p)/(1 - \hat{p}'). \tag{7}$$

By construction, $\hat{p}(x, y(x)) = \hat{p}'$. In other words, for every combination of x and $y(x)$, the value of the critical probability of prevailing is the same as the initial value. Hence, litigation costs are the same with x and $y(x)$ as with x' and y'. Also by construction, $y(x') = y'$.

Now substitute $y(x)$ for y in $V(p, x, y)$ to get, using (1),

$$V(p, x, y(x)) = [(p - \hat{p}')x + (1 - p)c_p]/(1 - \hat{p}'). \tag{8}$$

It is clear from (8) that for all $p > \hat{p}'$, $V(\cdot)$ is strictly increasing in x. Thus, if x is raised above x', say to some x^o, and the penalty is set equal to $y(x^o)$, then $V(p, x^o, y(x^o)) > V(p, x', y')$ for all $p > \hat{p}'$. Since the critical probability of prevailing remains at $\hat{p}'$, it follows from (4) that deterrence will have risen above the initial level—that is, $D(x^o, y(x^o)) > D(x', y')$. Note also that $y(x^o) > y'$ since, from (7), $y(x)$ is strictly increasing in x. That it is possible to choose an $x^o > x'$ such that $x^o \leq \bar{x}$ and $y(x^o) \leq \bar{y}$ is clear, since x' and y' were less than their respective upper bounds and x^o can be set arbitrarily close to x'.

To restore deterrence to the initial level, keep y equal to $y(x^o)$ and lower x from x^o until deterrence falls to $D(x', y')$. If x were lowered back to x', deterrence would be lower than $D(x', y')$, since then the only effect would be to have raised y.[8] Thus, assuming continuity, there exists an x'' such that $x' < x'' < x^o$ and $D(x'', y'') = D(x', y')$, where $y'' = y(x^o) > y'$. And since $\hat{p}(\cdot)$ is strictly decreasing in x, $L(x'', y'') < L(x', y')$. This establishes the desired result.[9]

The reason it is possible to raise the award and the penalty so as to discourage suits without reducing deterrence is, in essence, that potential plaintiffs whose probability of prevailing is sufficiently high are favorably affected by these changes, while potential plaintiffs whose probability is relatively low are adversely affected. The former group benefits because the expected value of the increase in the award more than offsets the expected value of the increase in the penalty; the latter group suffers for the opposite reason. It is the detrimental effect on the latter group that causes fewer suits to be brought, while the beneficial effect on the former group allows deterrence to be maintained.

An immediate corollary of the analysis in this section is that the optimal award and penalty are such that one or the other is at its upper bound. Otherwise, it would be possible to raise them both so as to reduce litigation costs without affecting deterrence.[10]

To illustrate the preceding results, suppose that the probability of prevailing is uniformly distributed between zero and one. As in the discrete example in Section 1, assume that both the plaintiff and the defendant incur $20,000 in trial costs, that the initial award is $100,000, and that the initial penalty is zero. It is easily verified that this will lead potential plaintiffs whose probability of prevailing exceeds .20 to sue (80% of all potential plaintiffs), that the resulting level of deterrence achieved against the defendant is $64,000, and that litigation costs are $32,000. Suppose that the upper bound on both the award and the penalty is $200,000. It can then be shown that it is optimal to raise the award to $200,000 and to impose a penalty of $165,625. This will lead only plaintiffs whose probability of prevailing exceeds .51 to sue (49% of all potential plaintiffs), will achieve the same level of deterrence against the defendant, and will reduce litigation costs by over 38%, to $19,692.

3. Settlements

■ This section reconsiders the analysis of the previous section in a model in which settlements are possible.

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[8] Raising y alone lowers deterrence both because $V(\cdot)$ falls (see (1)) and $\hat{p}$ rises (from (3), the derivative of $\hat{p}$ with respect to y is $(x - c_p)/(x + y)^2 > 0$).

[9] Given our assumption that $y' \geq 0$, this result implies that the optimal y is positive. However, if this restriction on y were not imposed, the optimal y could be negative (if the level of deterrence achieved by x' and y' is sufficiently high).

[10] One might wonder whether social welfare can be raised further by offering potential plaintiffs a menu of award and penalty combinations (since a menu would provide more instruments with which to maximize social welfare). In the Appendix we demonstrate that any menu that leads plaintiffs to choose different award and penalty combinations is inferior to a policy of offering just one combination—the combination identified in this section.

The following sequence of events is assumed to occur. First, the victim decides whether to file a suit. Second, if a suit is filed, the defendant makes a single take-it-or-leave-it settlement offer (a refusal to settle corresponds to an offer of zero).[11] Third, the plaintiff decides whether to accept the defendant's offer or to go to trial.

Let

s be the settlement offer of the defendant.

Although s is a function of x and y, for simplicity we suppress this notation. Since a plaintiff whose probability of prevailing equals unity would obtain a net benefit of $x - c_p$ from going to trial, and all other plaintiffs would obtain less, this is the highest settlement offer the defendant would make. Thus,

$$0 \leq s \leq x - c_p.^{12} \tag{9}$$

We assume for simplicity that it is costless to file a suit. Consequently, a victim will file a suit regardless of his probability of prevailing at trial, since if the defendant offers any positive settlement, filing a suit and accepting the settlement offer is preferable to not filing the suit.

If the plaintiff accepts the defendant's offer, he obtains s; if he rejects it, his expected payoff at trial is $px - (1 - p)y - c_p$. Obviously, if p is low enough, the plaintiff will accept the settlement offer. Let

$\tilde{p}(x, y)$ be the value of the probability of prevailing below which a plaintiff will accept the settlement offer and above which he will go to trial,

where $\tilde{p}(x, y)$ is defined by

$$\tilde{p}x - (1 - \tilde{p})y - c_p = s. \tag{10}$$

Solving for $\tilde{p}$ yields

$$\tilde{p}(x, y) = (s + y + c_p)/(x + y) \leq 1; \tag{11}$$

the inequality follows from (9). We refer to $\tilde{p}(x, y)$ as the "critical probability of prevailing."[13]

Given the defendant's choice of the settlement offer, the level of deterrence achieved is

$$D(x, y) = \int_0^{\tilde{p}} sf(p)\, dp + \int_{\tilde{p}}^1 [V(p, x, y) + c_d]f(p)\, dp, \tag{12}$$

and litigation costs are

$$L(x, y) = \int_{\tilde{p}}^1 (c_p + c_d)f(p)\, dp. \tag{13}$$

[11] We assume that the defendant (the uninformed party) makes a settlement offer in order to avoid the "signalling" complications that would arise if the plaintiff (the informed party) made a settlement demand—the magnitude of the demand might convey information to the defendant about the plaintiff's type.

[12] It is natural to assume that the settlement amount is not negative. This would follow, for example, if a plaintiff can drop his suit at no cost after filing it, since then the defendant could not gain anything by making a negative settlement offer.

[13] Although this phrase was used to refer to $\hat{p}$ in Section 2, it is employed here as well since $\tilde{p}$ plays an analogous role and $\hat{p}$ will not be referred to in Section 3.

We first show that if x' is the initial award and y' is the initial penalty, there exist an $x'' > x'$ and a $y'' > y'$ such that $D(x'', y'') = D(x', y')$ and $L(x'', y'') < L(x', y')$.[14] This result does not take into account the upper bounds on the award and penalty. Subsequently, we shall discuss through an example how the optimal award and penalty depend on these bounds.

Let s' be the settlement offer chosen by the defendant when the award is x' and the penalty is y'. We assume that

$$s' < x' - c_p, \tag{14}$$

otherwise (if $s' = x' - c_p$), all plaintiffs would accept the settlement offer initially and it would be impossible to lower litigation costs further.

Let $\tilde{p}'$ be the initial value of the critical probability of prevailing:

$$\tilde{p}' = \tilde{p}(x', y') = (s' + y' + c_p)/(x' + y') < 1, \tag{15}$$

where the inequality follows from (14).

Define $y(x)$ to be

$$y(x) = (\tilde{p}'x - c_p)/(1 - \tilde{p}'). \tag{16}$$

It is easy to verify that

$$\tilde{p}(x, y(x)) = \tilde{p}' + [(1 - \tilde{p}')/(x - c_p)]s \geq \tilde{p}'. \tag{17}$$

Thus, by construction, for every x and $y(x)$ the value of the critical probability of prevailing is no less than the initial critical value. This ensures that, regardless of how the settlement amount changes, litigation costs are not higher with x and $y(x)$ than with x' and y'.

We next show that there exists an $x'' > x'$ such that $D(x'', y(x'')) > D(x', y')$ and $y(x'') > y'$. Starting from $x = x'$, let x grow without bound. First suppose that $\tilde{p}(x, y(x)) \to 1$ as $x \to \infty$; then it must be that $s \to \infty$ as well (otherwise, from (17), it is clear that $\tilde{p}$ would approach $\tilde{p}' < 1$). Therefore, the first integral in (12) increases without bound, implying that there exists an $x'' > x'$ such that $D(x'', y(x'')) > D(x', y')$; and since $y(x)$ is strictly increasing in x, $y(x'') > y(x') \geq y'$ (the last inequality follows from (15)).

Alternatively, if $\tilde{p}$ does not approach unity as $x \to \infty$, then there exists an $\epsilon > 0$ and some arbitrarily large x, say x^h, such that $\tilde{p}(x^h, y(x^h)) < 1 - \epsilon$. Since

$$V(p, x, y(x)) = [(p - \tilde{p}')x + (1 - p)c_p]/(1 - \tilde{p}') \tag{18}$$

grows without bound in x for all $p > \tilde{p}'$, it follows that the second integral in (12) can be made arbitrarily large.[15] Hence, again there exists an $x'' > x'$ such that $D(x'', y(x'')) > D(x', y')$ and $y(x'') > y'$.

Next, keeping x equal to x'', raise y above $y(x'')$ until deterrence falls to $D(x', y')$. To see that this can be done, first note that as $y \to \infty$, $V \to -\infty$ for all $p < 1$ and $\tilde{p} \to 1$. This implies that if y is high enough, the defendant will choose $s = 0$. For if a positive s is chosen, the defendant's costs are at least s (everyone will file suit and at a

[14] Although the proof of this proposition parallels that used in Section 2, it is more complicated because deterrence now results in part from settlement payments and the defendant's choice of s changes as x and y change.

[15] That $p > \tilde{p}'$ over the range of integration in the second integral in (12) follows from (17).

minimum collect the settlement offer), whereas if $s = 0$, the defendant's costs approach zero as $y \to \infty$ (since the probability of suit goes to zero and the cost to the defendant of being sued declines with y). Hence, deterrence must approach zero as $y \to \infty$, implying (assuming continuity) that there exists a $y'' > y(x'') > y'$ such that $D(x'', y'') = D(x', y')$.

Finally, it remains to be shown that litigation costs fall. First observe from (11) that $\tilde{p}(x, y)$ can be written as

$$\tilde{p}(x, y) = [s/(x + y)] + [(y + c_p)/(x + y)]. \tag{19}$$

By construction, for every x and $y(x)$ combination, the second term in brackets equals $\tilde{p}'$ (see (16)). Since this term is strictly increasing in y, when x was held constant at x'' and y was raised from $y(x'')$ to y'', the second term increased above $\tilde{p}'$. Moreover, the first term in brackets is nonnegative. Thus, $\tilde{p}(x'', y'') > \tilde{p}'$, which implies that $L(x'', y'') < L(x', y')$ and completes the proof.

Although the analysis in this section is more complicated because of the possibility of settlements, the underlying intuition is similar to that discussed previously. Raising the award and the penalty benefits plaintiffs whose probability of prevailing is relatively high and disadvantages plaintiffs whose probability is relatively low. In Section 2 this had the effect of discouraging individuals in the latter group from filing suit, whereas here it discourages them from going to trial. In both instances, litigation costs fall as a consequence. Deterrence can be maintained, in Section 2 as well as here, because the expected value of the trial outcome is enhanced for the relatively high-probability-of-prevailing plaintiffs.

To illustrate how the results derived above relate to the upper bounds on the award and penalty, reconsider the example in Section 2, appropriately modified to allow for settlements.[16] Given the initial award of $100,000 and the initial penalty of zero, the defendant will make a settlement offer of $20,000. This offer will be rejected by plaintiffs whose probability of prevailing exceeds .4, resulting in their going to trial (60% of all potential plaintiffs). The resulting level of deterrence achieved against the defendant is $62,000 and litigation costs are $24,000.

It can be shown that if the upper bound on the award and penalty is less than $146,667,[17] then it is not possible to improve upon the initial situation by raising the award and penalty. But if the upper bound exceeds $146,667, it is possible to do better by raising the award and penalty (in a particular way) until the upper bound is reached. For example, suppose, as in Section 2, that the upper bound is $200,000. Then it is optimal to raise the award to $200,000 and to impose a penalty of $177,419. This will cause the defendant to lower his settlement offer to zero, which in turn will lead only potential plaintiffs whose probability of prevailing exceeds .52 to sue and go to trial (48% of all potential plaintiffs). The same level of deterrence will be achieved as before, but litigation costs will fall by approximately 21%, to $19,077.[18] Thus, as the general

[16] The defendant's optimal settlement offer in the example is $c_d - y$, provided $c_d - y$ is positive; otherwise the settlement offer is zero. (Without affecting our conclusions, we could make the example slightly more complicated so that the settlement offer also depends on the award x. Specifically, if the lower bound on the support of the (uniform) distribution of the probability of prevailing is positive rather than zero—say p_1—the optimal settlement offer would be $c_d + p_1x - (1 - p_1)y$.)

[17] For simplicity, we are assuming in this discussion that the award and the penalty have the same upper bound.

[18] That the upper bound on the award and the penalty has to be sufficiently high (above $146,667) to effect this kind of improvement is due to the complex relationship among the award-penalty combination, the settlement amount, and the plaintiff's calculus. Raising the award and the penalty, holding deterrence constant, initially lowers the optimal settlement offer of the defendant and induces some plaintiffs to go to trial who otherwise would have accepted the settlement offer. This raises litigation costs. Eventually, however, the settlement amount falls to zero, after which further increases in the award and penalty discourage an

analysis in this section suggests, if the initial award and penalty are less than their respective upper bounds, it is possible to increase social welfare by raising both the award and the penalty if the bounds are sufficiently high.

4. Concluding remarks

■ This section explains how our analysis of optimal awards and penalties relates to the British rule for allocating litigation costs and to Becker's theory of public enforcement.

□ **The British rule for allocating litigation costs.** We assumed that each side paid for its own trial costs regardless of the outcome of the trial—a practice commonly referred to as the American rule. An alternative is the British rule, under which the loser pays the winner's litigation costs.

One could view a switch from the American rule to the British rule as a way of implementing the type of changes suggested in this article. Relative to the American rule, the British rule in effect increases the award to a winning plaintiff—by the amount of the plaintiff's litigation costs—and also imposes a penalty on a losing plaintiff—equal to the defendant's litigation costs. Thus, if the award otherwise cannot be varied and if the penalty otherwise would be zero, the British rule might be superior to the American rule for the reasons we discuss.

It is important to note, however, that neither the implicit award nor the implicit penalty under the British rule necessarily correspond closely to the optimal award and penalty. This can be seen in the numerical example. Recall that the initial award was $100,000, the initial penalty was zero, and each party incurred trial costs of $20,000. Thus, switching to the British rule would in effect raise the award to a winning plaintiff to $120,000 and impose a penalty of $20,000 on a losing plaintiff. In every version of the example, however, the optimal award and the optimal penalty are much higher. For instance, in the discrete version discussed in Section 1, the optimal award is $174,000—an increase equal to nearly four times the plaintiff's litigation costs—and the optimal penalty is $46,000—more than twice the defendant's litigation costs.[19]

□ **Becker's theory of public enforcement.** Our analysis of optimal awards and penalties in private litigation has an obvious parallel to Becker's (1968) theory of optimal public enforcement. Becker showed that a higher fine allows the probability of detection to be lowered without sacrificing deterrence; enforcement costs are saved as a consequence. In private litigation, we have shown that a higher award and penalty can lead to a lower probability of suit or trial without compromising deterrence; litigation costs are saved as a result. In both contexts, the sanction is raised, the probability of its imposition falls, and administrative costs are reduced.[20]

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increasingly higher fraction of potential plaintiffs from suing, which lowers litigation costs. A sufficiently large increase in the award and the penalty can accomplish the desired result. (If the analysis were generalized to allow for pretrial costs that vary among plaintiffs, raising the award and the penalty could improve social welfare even when the settlement amount is positive.)

[19] Moreover, it is easily shown in this example that the implicit adjustments to the award and penalty under the British rule would not be enough to discourage low-probability plaintiffs from suing, whereas the optimal award and penalty would deter such suits.

[20] Other policies governing private litigation—such as increasing damage awards instead of shifting plaintiffs' fees, and decoupling awards—also have been observed to be analogous to Becker's theory of public enforcement. See, for example, Kaplow (1993) and Polinsky and Che (1991). Another variation on this theme, suggested by one of the referees, would be to raise the award and allow only a fraction of plaintiffs to sue (selected on a random basis), without imposing a penalty on losing plaintiffs.

It is well known that a logical implication of Becker's theory is that fines should be as high as possible and the probability of detection should be correspondingly low. Our analysis implied an analogous result when settlements were ignored and a result similar in spirit when settlements were taken into account.

Becker's theory has been criticized on the grounds that severe fines, potentially as high as an individual's wealth, hardly ever are imposed. An analogous criticism could be leveled against the implications of our analysis. In both contexts, however, there are additional considerations—such as fairness or risk-bearing costs—that, if taken into account, would lead to the conclusion that the optimal fine or the optimal award or penalty is not as high as possible.

Appendix

■ In this Appendix we consider the possibility of offering plaintiffs a menu of award and penalty combinations rather than a single award and a single penalty. A menu might be thought desirable because it provides additional instruments with which to maximize social welfare. We shall show, however, that the single award-penalty combination that we derived in the text is optimal—that is, any menu that induces at least some plaintiffs to choose different award-penalty combinations must lead to a lower level of social welfare.

Let $\{(x_1, y_1), \ldots, (x_N, y_N)\}$ be the combinations in the menu. Each plaintiff can choose one combination, which will determine the award he will obtain if he prevails at trial and the penalty he will pay if he loses. Assume without loss of generality that the combinations are arranged in ascending order in terms of the x's and that the x's are strictly increasing (if two consecutive combinations had the same x, then the combinations either would be identical or one never would be chosen—the one with the higher y). Similarly, assume without loss of generality that the y's are strictly increasing (given that the x's are strictly increasing, if the penalty declined or remained the same between two consecutive combinations, the first combination never would be chosen).

Next observe that if two plaintiffs choose different combinations from the menu, the plaintiff with the higher probability of prevailing will choose a higher combination. This will be proved by contradiction. Suppose two plaintiffs whose probabilities of prevailing are p' and $p'' > p'$ choose (x', y') and (x'', y''), respectively, where $x' > x''$ and $y' > y''$. For this to occur, the following incentive-compatibility constraints must hold:

$$p'x' - (1 - p')y' - c_p > p'x'' - (1 - p')y'' - c_p, \tag{A1}$$

and

$$p''x'' - (1 - p'')y'' - c_p > p''x' - (1 - p'')y' - c_p. \tag{A2}$$

These conditions can be rewritten as

$$p''[(x' - x'') + (y' - y'')] < 0 < p'[(x' - x'') + (y' - y'')], \tag{A3}$$

where the terms in brackets are positive by the maintained assumption that $x' > x''$ and $y' > y''$. But (A3) implies that $p'' < p'$, a contradiction.

We next show that, given plaintiffs' choices from the menu, the expected value of the trial outcome exclusive of trial cost is piecewise linear and convex in the probability of prevailing. We refer to this function as $V_m(\cdot)$. By the result in the previous paragraph, each piece of $V_m(\cdot)$ corresponds to the plaintiffs who choose the same combination from the menu. For the plaintiffs who choose (x_j, y_j),

$$V_m(p, x_j, y_j) = px_j - (1 - p)y_j = -y_j + (x_j + y_j)p, \tag{A4}$$

which is linear with positive slope $x_j + y_j$. Since $x_{j+1} + y_{j+1} > x_j + y_j$ and combination (x_{j+1}, y_{j+1}) is chosen by plaintiffs with higher probabilities of prevailing, the pieces of $V_m(\cdot)$ have increasing slope. Hence, $V_m(\cdot)$ is piecewise linear and convex.[21]

We next demonstrate that if $x_N < \bar{x}$ and $y_N < \bar{y}$, it is possible to construct another menu that increases social welfare. Since this argument parallels that used in Section 2, we merely sketch it here. If $x_N < \bar{x}$ and

[21] $V_m(\cdot)$ clearly is continuous, since it is the maximum of continuous functions (the lines corresponding to (A4) for $j = 1, \ldots, N$).

$y_N < \bar{y}$, add a constant, α, to each x in the menu, where α can be arbitrarily small. This adjustment does not affect any plaintiff's choice from the menu. Then raise each y in the menu by $\beta(\alpha) = \hat{p}'\alpha/(1 - \hat{p}')$, where $\hat{p}'$ is the initial value of the critical probability of prevailing (the value before α is added to the x's and before β is added to the y's). This adjustment to the y's also does not affect any plaintiff's choice from the menu. By construction, the critical probability of prevailing is not affected. It also can be shown that $p(x + \alpha) - (1 - p)(y + \beta(\alpha))$ is increasing in α for all $p > \hat{p}'$. Hence, deterrence will have increased. Now lower the x's by a constant amount until deterrence returns to its original level. This last change raises the critical probability of prevailing and thereby lowers litigation costs. Thus, the best possible menu must have $x_N = \bar{x}$ or $y_N = \bar{y}$.

Let x^* and y^* be the optimal values of the award and penalty when only one combination is offered. As seen in Section 2, either $x^* = \bar{x}$ or $y^* = \bar{y}$. Suppose first that $x^* = \bar{x}$. If $x_N = \bar{x}$, then y_N must exceed y^* if deterrence under the menu is to equal deterrence under the single combination (x^*, y^*). To see why, suppose that $x_N = \bar{x}$ and $y_N \leq y^*$. Since every plaintiff could choose the (x_N, y_N) combination from the menu, every plaintiff would be at least as well off under the menu as under the single combination (x^*, y^*); those who chose a different combination would be strictly better off, implying that deterrence under the menu would exceed deterrence under the single combination (x^*, y^*). Hence, for deterrence to be the same, y_N must exceed y^*.

We now can demonstrate the claimed result in the case in which $x^* = \bar{x}$ and $x_N = \bar{x}$. Recall that the pieces of $V_m(\cdot)$ are given by (A4). The corresponding function under the single award-penalty combination—which we shall refer to as $V_s(\cdot)$—is given by

$$V_s(p, x^*, y^*) = px^* - (1 - p)y^* = -y^* + (x^* + y^*)p, \tag{A5}$$

which is linear with positive slope $x^* + y^*$. For the plaintiff with the highest probability of prevailing—which we assume to be $p = 1$—the two functions have equal value, since $x^* = x_N = \bar{x}$; but the slope of $V_m(\cdot)$ is steeper because $x_N + y_N = \bar{x} + y_N > x^* + y^* = \bar{x} + y^*$ (that $y_N > y^*$ was demonstrated in the previous paragraph).[22] For a range of probabilities less than the highest probability, therefore, $V_m(\cdot)$ lies below $V_s(\cdot)$. Consequently, to accomplish the same level of deterrence under the menu as under the single award-penalty combination, as p declines $V_m(\cdot)$ must cross $V_s(\cdot)$ before reaching the critical probability of prevailing under the single award-penalty combination, and then exceed $V_s(\cdot)$ as p declines further. Otherwise, deterrence under the menu would be unambiguously lower than under the single combination (x^*, y^*).[23] This implies, however, that the critical probability of prevailing under the menu must be less than under the single combination (when deterrence is the same), which is to say that the menu leads to higher litigation costs and lower social welfare.

The remaining cases can be treated briefly. If $x^* = \bar{x}$ and $y_N = \bar{y}$, then $V_m(\cdot)$ is lower than $V_s(\cdot)$ for the plaintiff with the highest probability of prevailing (since $x_N < x^* = \bar{x}$), and the rest of the logic follows as previously. If $y^* = \bar{y}$ and $x_N = \bar{x}$, deterrence under the menu will always exceed deterrence under the single combination (x^*, y^*); hence this case is irrelevant. If $y^* = \bar{y}$ and $y_N = \bar{y}$, then x_N must be lower than x^* if deterrence is the same under both systems; again $V_m(\cdot)$ is lower than $V_s(\cdot)$ at the highest probability of prevailing and the previous logic applies.

We have now established the claimed result: Any menu that induces at least some plaintiffs to choose different award-penalty combinations must lead to a lower level of social welfare than the single award-penalty combination that we derived in the text. (Although we proved this result for menus for which $x_N = \bar{x}$ or $y_N = \bar{y}$, it is clear that the result holds, and is even stronger, if neither x_N nor y_N are at their respective upper bounds; for then deterrence under the menu would be lower than otherwise, requiring an even lower critical probability of prevailing in order to duplicate the level of deterrence under the single combination (x^*, y^*).)

Finally, note that the analysis in this article can be interpreted in mechanism design terms. The single award-penalty combination that we examined in the text can be thought of as a mechanism in which prospective plaintiffs announce their types (their p's) and then are pooled into two groups, with plaintiffs whose probability of prevailing is above a threshold (the critical probability of prevailing) bringing suit subject to the single award-penalty combination and all others not suing. Individuals strictly prefer to reveal whether they are above or below the threshold probability (except, of course, those at the threshold), but are indifferent

[22] The claimed result also holds if the maximum probability is less than unity. The only difference is that $V_m(\cdot)$ would be lower than $V_s(\cdot)$ at the highest probability (since, for $p < 1$, the fact that $y_N > y^*$ is relevant); the remainder of the argument follows without modification.

[23] If $V_m(\cdot)$ crossed $V_s(\cdot)$ at a lower probability than the critical probability of prevailing under the single award-penalty combination, this would imply that the critical probability of prevailing under the menu would be higher than the single award-penalty combination; consequently, $V_m(\cdot)$ would be below $V_s(\cdot)$ at every probability above the critical probability under the menu except at $p = 1$ (where the two functions have equal value).

regarding whether to reveal their precise type. The menu of award and penalty combinations considered in this Appendix can be characterized as a mechanism in which plaintiffs announce their types and then are assigned to one of N groups, each corresponding to a different award-penalty combination; plaintiffs whose probabilities of prevailing are above a threshold bring suit subject to the assigned award-penalty combination and all others do not sue. A menu can induce the plaintiffs whose probabilities are above the threshold to strictly prefer to reveal which one of several probability ranges their types are within. In effect, we have shown in this Appendix that the single award-penalty combination is the optimal mechanism.

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