Predictable and Unpredictable Error in Tort Awards: The Effect of Plaintiff Self Selection and Signalling

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Abstract

If a potential tort plaintiff can predict that the court will overestimate damages he is more likely to bring suit, but if the court is aware of this, it will adjust its awards accordingly. In general, court error implies that the court should moderate extreme awards whether they are high or low, because of regression towards the mean. Predictable error, however, tends to push the optimal adjustment downwards and unpredictable error pushes it upwards, because of plaintiff selection and signalling, respectively. The expectation of either kind of error leads plaintiffs to bring meritless suits.

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1. INTRODUCTION

A fundamental asymmetry in lawsuits is that the plaintiff files suit, not the defendant. This asymmetry is more than definitional, because if no suit is filed, losses lie where they fall, a result that is satisfactory to one party but not to the other. The selection of disagreements that end up in litigation is therefore not random, because potential plaintiffs are more likely to file suit when they think they will win. The question to be answered in this article is whether the fact that plaintiffs select which cases go to court should make courts more generous to plaintiffs, or less generous.

The answer will turn on whether the plaintiff can predict the direction of the court's error in evaluating evidence. Sometimes court error is predictable; the plaintiff knows that he himself is truly to blame for an accident but that a credible witness believes otherwise. Other times, court error is unpredictable; the plaintiff knows that often the judge's attention will be wandering at some point during the trial, but he does not know when. The plaintiff's expected payoff from the lawsuit are based on his knowledge of the true damage in this particular case and on his estimate of the court's error in measuring that damage. If the plaintiff cannot predict the court error, his filing decision is based only on his information about the true damages, but if he can predict the court error, it will be based partly on the direction of that error. How the court adjusts its damage awards in light of plaintiffs' incentives to file therefore depends on the predictability of its measurement error in evaluating evidence.

Court error and asymmetric information in lawsuits have been the subjects of considerable analysis. Cooter and Rubinfeld (1989) survey an extensive literature on the litigation process, much of which deals with pre-trial settlement when litigants possess different information.[1] The emphasis in this literature has been on the litigants' incentives rather than the court's, though any litigation model must include some specification of what the court does when the litigants fail to settle out of court. A somewhat different liter-

[1] See, for example, Png [1983], Bebchuk (1984), Reinganum & Wilde [1986], and Reinganum [1988].

ature looks at the selection of cases that go to trial, given the behavior of the court.[2] Court error has also been examined, especially in connection with the tradeoff between punishing the innocent and not punishing the culpable.[3]

What has been largely ignored is the court's rational response to its own error and its knowledge that litigants behave strategically. An exception is Daughety & Reinganum (1995), which analyses how the court can incorporate its knowledge that settlement has failed to occur and any details of the settlement negotiations that it knows. The present issue is based on an even more basic deduction. When the court observes that the plaintiff has filed suit, it must balance the probability that the plaintiff predicted that the court would overestimate damages against the probability that he actually has a good case.

The model below will divide the court's factfinding into two steps: (1) *measuring* the value of the damages given the evidence presented for the particular case, and (2) *estimating* the value of damages by incorporating not only the measured damages but also extraneous knowledge such as typical damage levels, the plaintiff's incentive to bring suit, and the likelihood of measurement error. The court might measure the damage to be \$10,000 using the evidence before it, but adding its knowledge of the plaintiff's incentives to bring suit when the evidence is favorably distorted might reduce the best estimate to \$8,000.[4]

The central intuition to be examined is that since the plaintiff is more likely to bring a case when he knows the court will overestimate damages, the court should scale back the award from what it would otherwise be. As will become apparent, although this has some truth to it, other effects are

[2]The seminal paper in this literature is Priest & Klein (1984); a recent example is Hylton (1993).

[3]On court error in a variety of contexts, see Schaefer [1978], Calfee & Craswell [1984], Good & Tullock [1984], Craswell & Calfee [1986], Png [1986], Rubinfeld & Sappington (1987), Polinsky & Shavell [1989, 1994], Sarath [1991], Kaplow (1994), and Tullock (1994).

[4]Whether the court is permitted by the law to go beyond measuring damages to estimate them is a jurisprudential and legal question that will not be addressed here, although Section 5 will briefly discuss "remittitur," a procedure by which the s court can threaten the plaintiff with a new trial unless he agrees to accept a reduced award.

also at work, and whether the intuition is valid will turn out to depend (a) on whether the court knows the level of damages typical in the type of case at hand, and (b) on the amount of court error that is predictable by the plaintiff. It will be shown that the court should always moderate extreme measurements of damage, and that if court error is largely unpredictable, the court should actually adjust awards upwards.

Three effects are at work. First, regression towards the mean will always justify moderating extreme awards: an extreme value of measured damage has a greater probability of being due to measurement error rather than high true damage. Second, predictability of the error leads to plaintiffs being more likely to bring suits with positive measurement error, and on this account, under circumstances explained below, the court will wish to reduce its awards. Third, unpredictable error means that sometimes courts will observe apparently weak suits being brought, and the court should adjust its award upwards because the plaintiff's willingness to bring suit is a credible signal that his true damages are higher than the court's measurement.

Section 2 of the article lays out a formal model of court error and derives a general proposition about adjusting extreme awards. Sections 3 and 4 examine situations of purely predictable and purely unpredictable error. Section 5 illustrates these situations with a numerical example and relates the theory to the law. Section 6 discusses meritless suits, and Section 7 concludes.

2. THE MODEL

The decisionmakers in the model will be a plaintiff and a court.[5] The plaintiff is an aggrieved party who decides whether to file suit based on his cost of litigation, his information about the true damage and the court's measurement error, and his knowledge of how the court forms its awards. The word "case" will be used to refer to potential "lawsuits", because when

[5]For a discussion of the effects of adding the possibility of settlement and allowing the defendant to be a decisionmaker in the model, see Section 5.

the plaintiff chooses whether to bring his grievance to court or not a distinction must be made. The court measures the damage with error, and uses that measurement together with its knowledge of how the plaintiff decides to file suit to form its award. The system is simultaneous, because the plaintiff's suit-bringing strategy depends on the court's measurement-adjusting strategy, which in turn depends on the plaintiff's suit-bringing strategy.

Let the true level of damage in a case be d, where d takes the value $\mu - 1$ with probability p, $\mu + 1$ with probability r, and μ with probability $q = 1 - p - r$. Let us assume, unless noted otherwise, that $p = r$, so the damage distribution is symmetric and μ represents the mean value of damage.

The measured value of damage depends not only on d but on two error terms, ϵ_p and ϵ_u. The error predictable by plaintiffs is ϵ_p, where

$$\epsilon_p = \begin{cases} -1 & \textit{with probability } \theta \\ 0 & \textit{with probability } 1 - 2\theta \\ +1 & \textit{with probability } \theta \end{cases} \tag{1}$$

The error not predictable by plaintiffs is ϵ_u, where

$$\epsilon_u = \begin{cases} -1 & \textit{with probability } \gamma \\ 0 & \textit{with probability } 1 - 2\gamma \\ +1 & \textit{with probability } \gamma \end{cases} \tag{2}$$

We will assume that courts have a positive probability of making some kind of error, so at least one of the error probabilities γ and θ is strictly positive.

The court's measurement of damage is $\hat{d}$, defined by

$$\hat{d} = d + \epsilon_p + \epsilon_u. \tag{3}$$

The plaintiff's forecast of the measured damage will therefore be

$$\tilde{d} = d + \epsilon_p. \tag{4}$$

True damage can be either low, medium, or high, while measured damage can take any of the seven values from $\mu - 3$ to $\mu + 3$. [6]

[6]Some values of $\hat{d}$ perfectly reveal d: if $\hat{d} = \mu - 3$, for example, it would be clear that

The court's award will be its *estimated* damage, which is not necessarily equal to the *measured* damage. The measured damage, $\hat{d}$, is a raw measurement, unadjusted by any considerations of equilibrium behavior or prior knowledge of what damage is most probable. The court's award, $a(\hat{d})$, will equal its estimate of the damages based on all available information, $E(d|\hat{d}, lawsuit)$. The information directly available consists of the parameter values and the damage measurement, but in addition the court may be able to deduce something about the plaintiff's private information from his decision to file suit.

The cost of bringing suit, c, differs among plaintiffs and is distributed according to a distribution $G(c)$, where $G' > 0$ on the support $[\mu - 3, \mu + 3]$. The court does not observe the particular plaintiff's value of c, but it knows the general distribution function, $G(c)$. The plaintiff will decide whether to file suit based on his particular values of the litigation cost c, the measured damage forecast $\tilde{d}$, and the expected award given the plaintiff's forecast of measured damage, $E(a|\tilde{d})$. Let $F(\tilde{d})$ denote the proportion of plaintiffs whose litigation costs are low enough that they would bring suit given a forecast of measured damage of $\tilde{d}$. This takes the value

$$F(\tilde{d}) = \int_0^{E(a|\tilde{d})} d \cdot G(c)dc. \tag{5}$$

Since G is increasing in c, (5) implies that as the expected award increases, so does the fraction of plaintiffs who bring suit.

The court's objective is to estimate the true damage d as accurately as possible, given all available information, in deciding the award a.[7] This is

$d = \mu - 1$, $\epsilon_p = -1$, and $\epsilon_u = -1$. This feature of the model is accidental. I have verified the propositions for other error specifications which do not have the perfect-revelation property, such as, for example, when measurement errors are not cumulative and the measured damage is constrained to lie within $[\mu - 1, \mu + 1]$, the case in the working paper version of this article, Rasmusen (1992b).

[7]Formally, let the court's payoff function be $-[a(\hat{d}) - d]^2$, in which case it will choose an award equal to the expected value of the damage. Note that I have implicitly assumed that the court and the plaintiff are uninterested in setting precedents for future cases at the cost of reduced payoffs in the present case.

done using Bayes' Rule as follows:

$$a(\hat{d}) = E(d|\hat{d}, lawsuit) = \sum_{i=\mu-1}^{\mu+1} \left(\frac{Pr(\hat{d}, lawsuit|d=i)Pr(d=i)}{Pr(\hat{d}, lawsuit)} \right) i. \qquad (6)$$

The main task is to find the component $Pr(\hat{d}, lawsuit|d = i)$. Since $\tilde{d}$ can take five possible values, from $\mu - 2$ to $\mu + 2$, this equals

$$\begin{aligned} Pr(\hat{d}, lawsuit|d=i) &= \sum_{j=\mu-2}^{\mu+2} Pr(\hat{d}, lawsuit|\tilde{d}=j)Pr(\tilde{d}=j|d=i) \qquad (7) \\ &= \sum_{j=\mu-2}^{\mu+2} Pr(lawsuit|\tilde{d}=j)Pr(\hat{d}|\tilde{d}=j)Pr(\tilde{d}=j|d=i) \\ &= \sum_{j=\mu-2}^{\mu+2} F(\tilde{d})Pr(\hat{d}|\tilde{d}=j)Pr(\tilde{d}=j|d=i) \end{aligned}$$

It is then straightforward to find $Pr(\hat{d}, lawsuit)$, which equals

$$Pr(\hat{d}, lawsuit) = \sum_{i=\mu-1}^{\mu+1} Pr(\hat{d}, lawsuit|d=i)Pr(d=i). \qquad (8)$$

The Appendix performs the straightforward but lengthy calculations of (7) and (8) necessary to find the awards in equation (6) for all seven possible levels of measured damage.

PROPOSITION 1: In deciding its award, the court should increase low measured damages and reduce high measured damages. For any measured damage $\hat{d}$, if $\hat{d} < \mu$ then $a(\hat{d}) > \hat{d}$, and if $\hat{d} > \mu$ then $a(\hat{d}) < \hat{d}$.

Proof: There are seven possible values for $\hat{d}$. For $\hat{d} = \mu-3$ and $\hat{d} = \mu + 3$, the proposition is obvious from equations (35) and (41) in the Appendix. Inspection of equations (36) and (40) shows that in each equation the numerator of the fraction is less than the denominator, proving the proposition for $\hat{d} = \mu - 2$ and $\hat{d} = \mu + 2$.

Define z_1 and z_2 so that $a(\mu-1) = \mu - z_1/z_2$. $z_2 = z_1 + 2F(\mu)\gamma\theta r + F(\mu-1)(1-2\gamma)\theta q + F(\mu)\gamma(1-2\theta)q$. Thus, $z_1 < z_2$ and $\mu - z_1/z_2 > \mu - 1$.

Define z_3 and z_4 so that $a(\mu+1) = \mu + z_3/z_4$. Then $z_4 = z_3 + 2F(\mu)\gamma\theta r + F(\mu+1)(1-2\gamma)\theta q + F(\mu)\gamma(1-2\theta)q$. As a result, $z_3 < z_4$ and $a(\mu+1) = \mu + z_3/z_4 < \mu + 1$.

Proposition 1 is the effect of regression towards the mean, or, in Bayesian terms, of combining data with the prior mean to form a posterior mean that is between the two.[8] A high measured damage $\hat{d}$ might be produced either by a high value of the true damage d or by positive values of the errors ϵ_u and ϵ_p. Placing some probability on each of these events, the court's estimated damage is less than $\hat{d}$, although still higher than the average true damage value, μ. The court distrusts its own extreme measurements and moderates them in deciding the award.

Proposition 1 is fundamental to any analysis of court error. Even if there were no plaintiff selection and all cases appeared before the court, the court should still moderate extreme awards. Attention in the next propositions will therefore be focussed on whether the court should adjust moderate awards, which it would not do if there were not a biased selection of cases by plaintiffs. Proposition 1 also establishes a general reason for rational courts to choose an award different from the measured value of the damage. Any decisionmaker cognizant of his own fallibility should adjust the award in light of measurement error and regression towards the mean. Adjusting for the strategic behavior of the plaintiff, as will be done in the next sections, merely takes this process one step further.

3. AWARDS WHEN PLAINTIFFS CAN PREDICT THE COURT'S ERROR

If plaintiffs can predict the court's measurement error, then $\gamma = 0$ and measured damages range from $\mu - 2$ to $\mu + 2$. The optimal award equations (36) through (40) derived in the Appendix become

[8] Note that Proposition 1 is true even if $p \neq r$, e.g., even if the true damage is more commonly low than high and μ is not the mean damage. For a discussion of the characteristics of general continuous distributions that generate regression towards the mean, see Rasmusen (1992a).

$$\begin{aligned}
a(\mu-2) &= \mu-1 && (9)\\
a(\mu-1) &= \mu-\frac{(1-2\theta)p}{(1-2\theta)p+\theta q} && (10)\\
a(\mu) &= \mu+\frac{\theta(r-p)}{\theta p+(1-2\theta)q+\theta r} && (11)\\
a(\mu+1) &= \mu+\frac{(1-2\theta)r}{\theta q+(1-2\theta)r} && (12)\\
a(\mu+2) &= \mu+1 && (13)
\end{aligned}$$

The function $F(\tilde{d})$ is absent from the optimal awards in equations (9) through (13). That is because the court only considers the cases that appear before it, and $\hat{d}$ summarizes all the information about those cases. The plaintiff's willingness to go to court does not reveal anything about d that the court cannot discover by direct evaluation of the evidence in forming the measurement $\hat{d}$. Hence, the court's award does not depend on plaintiff behavior. In making his decision to file suit, the plaintiff is making use only of the court measurement $\hat{d}$ and the process by which the court adjusts measurements in forming awards, and does not make use of his knowledge of how $\hat{d}$ is split between the true damage d and the court error ϵ_p. Since the plaintiff's filing decision does not vary with his private information, the court cannot deduce anything useful from the fact that a suit is filed.

Regression to the mean is still present even when plaintiffs can predict court error: high awards are adjusted down, and low awards adjusted up. We can also say something about the court's adjustment when the damage measurement is moderate. Regression towards the mean implies that moderate awards are adjusted up or down depending on the proportion of cases that are meritless, with no adjustment at all if the distribution of true damage is symmetric, i.e., if $r = p$. Inspection of equation (11) yields Proposition 2, since the sign of the numerator in the last term of that equation depends on the sign of $(r - p)$.

PROPOSITION 2: Consider a suit in which measured damage is mod-

erate and plaintiffs can predict the court error. The award should equal the measured damage if the damage distribution is symmetric, but be below it if low damage is generally more common than high. If $p = r$, then $a(\mu) = \mu$; but if $p > r$, then $a(\mu) < \mu$.

If high and low measured damages are equally likely, the court does not have to make any adjustment to a moderate measured level of damages to form its award, even though it is conscious that the error is predictable by plaintiffs and that plaintiffs are more likely to bring suit if they know the error will be in their favor.

If, however, low damage is more common than high damage for the type of injury in the case, then the court should not trust its measurement alone, but should reduce it in forming the award. If a chemical rarely causes birth defects, but seems to in the particular case before the court, the court should discount the evidence and make only a small award. This, like Proposition 1, is a result of regression towards the mean.

Note that this form of asymmetry is completely distinct from biased measurement error. If the court knows that its measurement is too high on average by amount x, it can easily adjust by subtracting x from its initial measurement. The problem in the present model is that the court should make use of information about average levels of damage, not about average levels of measurement error.

The situation with an asymmetric distribution of true damage has practical importance. The true damage from many activities is usually zero but might be measured to be positive a certain fraction of the time. Even if the court error is unbiased, a court which uncritically awarded measured damage would overcompensate plaintiffs because of the selection bias in which cases are filed as lawsuits. As an example, corporations' decision to switch materials suppliers may almost always be to the benefit of the shareholders, but if the court admits shareholder suits in the cases where the stock price subsequently falls, it will often mistakenly measure the damage to be positive. Knowing that most such suits are meritless, a better policy for the court would be to refuse to hear such suits at all, or to adjust the awards downwards in recognition of the fact that the apparent merit of most suits is due to court error.

Predictable Error When the Court Does Not Know the Prior Mean

Let us now modify the informational structure to allow for a less well-informed court. Propositions 1 and 2 relied on the assumption that the court knows that the type of case brought causes damage ranging from $\mu - 1$ to $\mu + 1$. If the court knows that $\mu = 1$, for example, the possible damages are 0, 1, and 2. Often, however, the court's prior information will not be so precise, and if the court does not know the mean value of damage it cannot use regression to the mean. If the court does not know whether the possible damages are (0,1,2) or (2,3,4), it does not know whether to regard $\hat{d} = 2$ as high or low and it cannot make the adjustments in Propositions 1 and 2.

What the court can do is to make an adjustment based on its beliefs as to the likelihood that the estimate $\hat{d} = 2$ is a low, medium, or high value. Let us look at the extreme case of "diffuse priors": the court has no prior information on the value of the mean damage, μ, but it does know that the three possible damage values are $\mu - 1$, μ, and $\mu + 1$. The court regards any value as equally likely to be low, medium, or high, and it will have to make the same adjustment for any damage measurement, since it cannot tell which finer adjustment is appropriate.[9]

Let us henceforth assume that the distribution of true damages is symmetric, departing from the generality of Proposition 2. If the court knew μ, as in Propositions 1 and 2, its awards would be derived by adapting equations (10) to (12) to set $p = r$. Defining $Z_1 \equiv \frac{(1-2\theta)p}{(1-2\theta)p+\theta(1-2p)}$, this yields

$$a(\mu - 2) \qquad = \mu - 1 \tag{14}$$

[9]Note that this situation of predictable error with diffuse priors is not the same as a situation with both predictable and unpredictable error. The diffuse priors refer to the beliefs of the court about the true damage, while the predictability of the error refers to the beliefs of the plaintiff. It is assumed throughout this article that the plaintiff knows that the mean value of court error is zero over all cases, including those that never become lawsuits.

$$
\begin{array}{lll}
a(\mu-1) & =\mu-\frac{(1-2\theta)p}{(1-2\theta)p+\theta(1-2p)} & =\mu-Z_1 \\
a(\mu) & & =\mu \\
a(\mu+1) & =\mu+\frac{(1-2\theta)p}{\theta(1-2p)+(1-2\theta)p} & =\mu+Z_1 \\
a(\mu+2) & & =\mu+1.
\end{array}
$$

If all cases were equally likely to become lawsuits, the court would, on average, set the award equal to the measured damage. $F(\tilde{d})$ is increasing, however, so the more positive the expected court error, the more likely a case is to appear in court. Since cases with higher expected damages generate more suits, the average adjustment by a court that knew μ would be downwards. When the court does not know μ, it still knows that suits with positive error are more likely than suits with negative error, and it can use this information to adjust the award, yielding Proposition 3.

PROPOSITION 3: If plaintiffs can predict the court's error and the court does not know the average value of damage, it should reduce every damage measurement in determining the award: $a(\hat{d}) < \hat{d}$.

Proof. If the court knew the value of μ, it would know how to adjust the damage measurement. In accordance with (13), on observing $\hat{d} = \mu - 1$ or $\mu - 2$ it would adjust upwards, on observing $\hat{d} = \mu + 1$ or $\mu + 2$ it would adjust downwards, and on observing $\hat{d} = \mu$ it would set the award equal to the measured damage.

Cases with $\hat{d} = \mu + 1$ are more likely to be brought in equilibrium than cases with $\hat{d} = \mu - 1$, however, because $F(\mu + 1) > F(\mu - 1)$. The probabilities of the five different values of $\tilde{d}$ are

$$(p\theta, p(1-2\theta)+(1-2p)\theta, (1-2p)(1-2\theta)+p\theta+p\theta, p(1-2\theta)+(1-2p)\theta, p\theta). \tag{15}$$

Let us invent the notation k_5, k_6, k_7 and rewrite vector (15) as $(p\theta, k_5, k_6, k_5, p\theta)$, so that the probability that a suit is brought at all is

$$k_7 = F(\mu-2)p\theta+F(\mu-1)k_5+F(\mu)k_6+F(\mu+1)k_5+F(\mu+2)p\theta. \tag{16}$$

The probability that, for instance, $\tilde{d} = \mu - 2$, conditional upon a suit having been brought at all is, by Bayes' Rule,

$$
\begin{aligned}
Prob(\tilde{d} = \mu - 2|suit) &= \frac{Prob(lawsuit|\tilde{d}=\mu-2)Prob(\tilde{d}=\mu-2)}{Prob(lawsuit)} \\
&= \frac{F(\mu-2)p\theta}{k_7}.
\end{aligned} \tag{17}
$$

Using probabilities in the manner of equation (17), and using the quantity of adjustment from equation (13), the average adjustment the court would like to make is

$$\frac{F(\mu-2)p\theta(1)}{k_7} + \frac{F(\mu-1)k_5(1-Z_1)}{k_7} + \frac{F(\mu)k_6(0)}{k_7} + \tag{18}$$

$$\frac{F(\mu+1)k_1(-(1-Z_1))}{k_7} + \frac{F(\mu+2)p\theta(-1)}{k_7}, \tag{19}$$

which equals

$$\frac{[F(\mu-2)-F(\mu+2)]p\theta + [F(\mu-1)-F(\mu+1)]k_5(1-Z_1)}{k_7} \tag{20}$$

Since $F(\mu-2) < F(\mu+2)$ and $F(\mu-1) < F(\mu+1)$, the court wishes to adjust downwards on average.

When the court knew the prior mean, the plaintiff's filing decision did not provide useful information, so no adjustment was made to moderate damage measurements. In Proposition 3, the filing decision does convey useful information: the court knows that cases with values of $\hat{d}$ above the mean are more likely to be filed, so it can deduce something about the value of μ from the fact of filing. Knowing that filed cases are more likely to have $\hat{d}$ above μ, the court adjusts its award downward from the measured damage.

Proposition 3 captures the intuition motivating this article, that plaintiff selection of cases gives courts reason to scale down their initial estimates of damages. Not knowing the typical value of damages, the court relies on its knowledge that plaintiffs are more likely to bring suit when they can predict that the court measurement will err in the positive direction.

4. AWARDS WHEN PLAINTIFFS CANNOT PREDICT THE COURT'S ERROR

The next situation to consider is when plaintiffs cannot predict court error, but they recognize it exists. We will start by again assuming that the prior mean μ is known to the court.

Since the error is unpredictable, $\theta = 0$ and measured damages lie in the interval $[\mu - 2, \mu + 1]$. Setting $p = r$ and defining W_1, W_2, and W_3 appropriately, equations (36) to (40) in the Appendix become

$$\begin{array}{lcll} a(\mu-2) & & & = \mu - 1 \\ a(\mu-1) & = & \mu - \frac{F(\mu-1)(1-2\gamma)p}{F(\mu-1)(1-2\gamma)p + F(\mu)\gamma(1-2p)} & = \mu - W_1 \\ a(\mu) & = & \mu + \frac{p[F(\mu+1)-F(\mu-1)]\gamma}{F(\mu-1)\gamma p + F(\mu)(1-2\gamma)(1-2p) + F(\mu+1)\gamma p} & = \mu + W_2 \\ a(\mu+1) & = & \mu + \frac{F(\mu+1)(1-2\gamma)p}{F(\mu)\gamma(1-2p) + F(\mu+1)(1-2\gamma)p} & = \mu + W_3 \\ a(\mu+2) & & & = \mu + 1 \end{array} \tag{21}$$

Note that $W_3 > W_1$, because $F(\mu + 1) > F(\mu - 1)$.

These expressions exhibit the same effect of regression towards the mean that appeared in Propositions 1 and 2. They also exhibit a signalling effect, which tends to increase the estimate, whatever the damage measurement may be. It is not true that $a(\mu + 1) > \mu + 1$, because regression towards the mean is still present, but the award is adjusted downwards less than it would have been if the error were predictable. The signalling effect arises because when the error is unpredictable, the information the court can extract from the fact of the plaintiff filing is that the plaintiff is more likely to have higher true damages. Since the plaintiff cannot predict the error, his decision to file suit is not based on it.

The signalling effect was also present in Section 2, when the model included both predictable and unpredictable error. Careful inspection of equation (38) in the Appendix shows that $a(\mu) > \mu$, the court will adjust moderate measured damages upwards.[10] Discussion of the effect was delayed until now to show that it is due to the unpredictable portion of court error; the signalling effect did not arise in Section 3, where the error was entirely predictable. Proposition 4 formalizes the difference in the impact of the two kinds of error.

[10] If damages are symmetric, $p = q$. Since filing is more likely when true damages are higher, $F(\mu - 1) > F(\mu + 1)$. From these two facts, it follows that the numerator of the fraction in equation (38) is positive.

PROPOSITION 4: For all but extreme levels of measured damage, the court's award will be greater if plaintiffs cannot predict court error than if they can. For $k \in (0,1)$ and $\hat{d} \in [\mu-1, \mu+1]$, $a(\hat{d}; \gamma = k, \theta = 0) > a(\hat{d}; \gamma = 0, \theta = k)$.

Proof. From equation (21) and the fact that higher awards induce more litigation so $F(\mu - 1) < F(\mu)$,

$$a(\mu-1; \gamma = k, \theta = 0) = \mu - \frac{F(\mu-1)(1-2k)p}{F(\mu-1)(1-2k)p + F(\mu)k(1-2p)} \tag{22}$$

$$> \mu - \frac{F(\mu-1)(1-2k)p}{F(\mu-1)(1-2k)p + F(\mu-1)k(1-2p)}. \tag{23}$$

From equation (13),

$$a(\mu-1; \gamma = 0, \theta = k) = \mu - \frac{(1-2k)p}{(1-2k)p + k(1-2p)}. \tag{24}$$

But this equals the right-hand side of (22), so it must be that $a(\mu - 1; \gamma = k, \theta = 0) > a(\mu - 1; \gamma = 0, \theta = k)$. The same procedure can be used straightforwardly to show that the proposition is also true for $\hat{d} = \mu$ and $\hat{d} = \mu + 1$. Q.E.D.

Unpredictable Error When the Court Does Not Know the Prior Mean

Let us now assume that the court does not know μ. The analysis is parallel to that for predictable error in Section 3, and yields Proposition 5, which says that all damages should be adjusted upwards.

PROPOSITION 5: If plaintiffs cannot predict court error and the court does not know the average value of damages, it should set the award to be greater than the measured damage: $a(\hat{d}) > \hat{d}$.

Proof: When the court observes a damage measurement of $\hat{d}$, it knows that the true damage is within one unit of that value, so d equals $\hat{d} - 1$, $\hat{d}$, or $\hat{d} + 1$. Since $G'(c) > 0$, for any adjustment rule the court uses, higher true damage will yield a higher percentage of cases litigated, so

$$F(\hat{d} - 1) < F(\hat{d}) < F(\hat{d} + 1). \tag{25}$$

This means that using Bayes's Rule, the court's estimated value of d given a suit was brought is

$$\left(\frac{F(\hat{d}-1)}{F(\hat{d}-1)+F(\hat{d})+F(\hat{d}+1)}\right)(\hat{d}-1)+\left(\frac{F(\hat{d})}{F(\hat{d}-1)+F(\hat{d})+F(\hat{d}+1)}\right)(\hat{d}) \\ +\left(\frac{F(\hat{d}+1)}{F(\hat{d}-1)+F(\hat{d})+F(\hat{d}+1)}\right)(\hat{d}+1). \quad (26)$$

Expression (26) is greater than $\hat{d}$ because of the inequalities in (25), so $a(\hat{d}) > \hat{d}$. Q.E.D.

Proposition 5 applies to a situation where the court cannot adjust for regression towards the mean, because it has no information on whether the measured damage is above or below the mean. Besides the measured damage itself, the court's only information is the filing decision, and this tells the court that that the true damage is more likely to be large without conveying any information on the size of the error. Thus, the court adjusts its award upwards from the measured damage.

In the first part of this section, it was noted that when the prior mean is known and error has both predictable and unpredictable components, the average award is adjusted upwards, $a(\mu) > \mu$. Proposition 5, however, applies only when the error is entirely unpredictable. If the prior mean is not known to the court and both kinds of court error are present, the selection effect and the signalling effect of Proposition 5 clash with each other, and it is not clear whether the court should adjust awards upwards or downwards. Thus, the policy conclusion depends on the empirical issue of which kind of error is more important in the type of case before the court.

5. NUMERICAL EXAMPLES, SETTLEMENT, AND REMITTITUR

Two forces besides regression to the mean are at work in the propositions above: selection and signalling. If plaintiffs can predict the error, the court knows that they have more incentive to bring suit if the error is positive, so the cases that become suits are selected nonrandomly. If the court reduces its awards in response, the selection bias remains but is muted. If plaintiffs cannot predict the error, on the other hand, the court knows that the only selection effect at work is that plaintiffs with higher true damages are more likely to bring suit. If the court increases its awards in response, the selection bias remains, because plaintiffs with high true damages have all the more reason to bring suit.

Signalling to other litigants is a well-known phenomenon and plays a large part in models of settlement, where reluctance to settle can signal a strong case to the other side. Signalling to the court is less common in litigation models. One exception is Rubinfeld and Sappington (1987), which looks at legal expenditure by the litigants as signalling in criminal cases, but does not examine the effect on the number of cases brought to trial. A second exception is Daughety & Reinganum (1995), in which a litigant signals the strength of his case to the court by his position in settlement negotiations. The signal in the present article is a simpler one: the plaintiff's willingness to incur the cost of bringing suit is a signal to the court of his knowledge that the true damage is high.

Table 1 uses numerical examples to illustrate the propositions. The fraction of cases litigated and the damage awards are shown for the different possible damage measurements by the plaintiff and the court. In every example, the distribution of true damages is symmetric with $p = q = r$, the filing cost $G(c)$ is uniform on [0,2], and the mean damage is $\mu = 1$.

Columns (1) and (2) both illustrate Proposition 1. In each of them, $a(0) > 0$ and $a(2) < 2$. In Column (1), the error is predictable and the court knows the mean true damage, as in Proposition 2. Since the distribution of true damages is symmetric, $a(1) = 1.00$. In Column (2), the error is unpredictable, and, as Proposition 4 predicts, the awards are greater for all but the extreme levels of measured damage.[11]

[11] $F(-1)$ and $F(3)$ are left blank in Column (2) because $\tilde{d}$ cannot equal $\mu - 2$ or $\mu + 2$ when no predictable error is added to the true damage of $\mu - 1, \mu$, or $\mu + 1$.

In Column (3), the court does not know the mean true damage. It must make the same adjustment whatever the level of measured damage, and it chooses to reduce the measured damage by 0.30, as Proposition 3 says it should. When the measured damage is 3, this results in a court award of 2.70, exceeding the largest possible true damage (which is 2). This is rational because a court which does not know the mean true damage also does not know it greatest possible value.

TABLE 1: NUMERICAL EXAMPLES

		(1) Predictable Error Only (Mean Known) ($\tilde{d} = \hat{d}$) $\gamma = 0, \theta = .2$	(2) Unpredictable Error Only (Mean Known) ($\tilde{d} = d$) $\gamma = .2, \theta = 0$	(3) Predictable Error Only (Mean Unknown) ($\tilde{d} = \hat{d}$) $\gamma = 0, \theta = .2$
	$F(-1)$	.000	—	.00
Proportion	$F(0)$	.125	**.16**	.00
of Cases	$F(1)$	.500	.61	.35
Litigated	$F(2)$	.875	.87	.88
$F(\tilde{d})$	$F(3)$	1.000	—	1.00
	$a(-1)$	0.00	0.00	-1.30
Adjusted	$a(0)$	0.25	0.54	-0.30
Court	$a(1)$	**1.00**	1.24	0.70
Award	$a(2)$	1.75	1.81	1.70
$a(\hat{d})$	$a(3)$	2.00	2.00	**2.70**

Assumed: $p = q = r = 1/3$. $G(c)$ is uniform on [0,2]. $\mu = 1$. Calculations are rounded.

Settlement Before Trial

The model used in this article has assumed that the court makes its decision without reference to the possibility that the litigants have tried to settle the case and failed to reach agreement. In reality, however, the majority of suits are settled before trial, and suits that reach trial are special in some way. The court might be able to deduce something about the strength of the case from the fact that it was not settled out of court.

To see this, consider a settlement model in the style of Reinganum & Wilde (1986).[12] The plaintiff knows the true damage, and the defendant does not. The plaintiff suggests one take-it-or-leave-it settlement amount to the defendant, and if the defendant rejects the suggestion, the case goes to trial, at some cost, and the court makes an award. If the equilibrium in this model is separating, plaintiffs with higher true damage request greater settlement amounts, but the defendant rejects them with greater probability. The plaintiff's willingness to risk going to court signals high damages to the defendant, and also to the court, which therefore adjust its awards upwards.

Signalling by filing suit is distinct from signalling by settlement offer. In the present model, the signal is the plaintiff's willingness to incur the cost of a suit, while in the settlement model it is his willingness to make a high settlement demand and risk going to trial. An important difference is that it is only the plaintiff who can signal by bringing suit, whereas it seems equally likely that either the plaintiff or the defendant could signal by holding out for a favorable settlement. In settlement signalling, if it is the defendant who knows the true damage and makes the offer, the model's conclusions are reversed: lower settlement offers signal lower damage, they are rejected more often, more weak cases reach trial, and the court will adjust its award downwards, not upwards. The conclusions of the court error model cannot be reversed so neatly. If the defendant, not the plaintiff, controlled the decision on whether to file the suit, it would never be filed, because in the absence of a suit he pays no damages.

In a combined model of pre-trial settlement and court error, both kinds of signalling would be present. They would reinforce or contradict each

[12]In Reinganum & Wilde (1986), the court does not act strategically, but Daughety & Reinganum (1995) have extended the model to strategic courts. The other major type of settlement model, deriving from Bebchuk (1984), assumes that the damage amount is known but the litigants differ in their opinions of who will win at trial. For details, see the survey by Cooter & Rubinfeld (1989).

other depending on which litigant had private information and whether the court error was predictable or unpredictable. Since court error would affect the signalling game only by changing the threat point of the expected trial outcome, I conjecture that the interaction between the two kinds of signalling would be relatively straightforward, if complex to model.

Judge, Jury, and Remittitur

The court error model suggests that a rational court would use more than the evidence to decide the award. Do courts actually incorporate prior information and recognize the implications of plaintiff selection bias? Viscusi (1991, p. 52) presents evidence that courts undercompensate large loss claims and overcompensate small loss claims, as Proposition 1 would suggest.[13] The extent to which courts can legally make adjustments to the measured damages is limited, however, by rules of evidence and procedure and by the prior information available to the courts.

The accepted division of labor in a jury trial is not between the use of evidence and the use of prior information, as in the court error model, but between questions of fact, decided by the jury, and questions of law, decided by the judge. The judge in a jury trial has no part in either measuring or estimating damages, apart from instructing the jury as to what evidence may be considered. Jurors are permitted and intended to use the priors of a typical citizen, but jurors with special expertise are screened out, and the jurors are unlikely to know much about the strategic incentives of players in the legal system. Even if they did, making use of that knowledge would be to go beyond the instructions from the judge.

The problem of court error arises even in bench trials, where the judge is the trier of fact, but the institution of the jury is an obvious source both of measurement error and lack of sophistication about the incentives of plaintiffs to bring suit. Use of a jury is commonly thought to help plaintiffs with weak

[13]The measure of loss is purely monetary, so it may be that relatively larger nonmonetary losses are associated with small loss claims, but it might also be that courts regress damages towards the mean.

cases, and evidence supports this. Clermont & Eisenberg (1992) find in federal civil trials that plaintiffs win a greater percentage of bench trials, in which the right to a jury is waived— ratios in the winning percentages of 1.15 for motor vehicles, 1.71 for product liability, and 1.72 for medical malpractice. On its face, this would seem to give plaintiffs an advantage when there is no jury, since they win more often, but that conclusion ignores the selection problem. If plaintiffs win less often in jury trials, yet they refuse to waive their right to a jury, the implication is that those plaintiffs think they would lose in a bench trial, given the weakness of their case, but are willing to gamble on a jury. Thus, the fact that plaintiffs lose more often in jury trials may indicate that even very weak cases are worth bringing before a jury.

James Blumstein, Randall Bovbjerg, and Frank Sloan have made two suggestions which would reduce the influence of both predictable and unpredictable court error by increasing the amount of prior information: injury award schedules, and award databases. Courts could be provided with a schedule relating the victim's age and severity of injury to the suggested award, much like the schedule the U.S. Sentencing Commission has provided for courts to use in criminal sentences (Bovbjerg, Sloan and Blumstein (1989), U.S. Sentencing Commission (1990)). The effect of this would be to provide prior information to the court with a suggestion, or perhaps an instruction, that it be used in determining the award. A second suggestion is to create a large database of awards in different types of cases, so that the court would have a better idea of typical damages as estimated by previous courts (Blumstein, Bovbjerg, and Sloan [1991]).

Judges do have tools at their disposal with which they can exclude suits brought in the hope of jury error. They can grant summary judgement to the defendant, on the grounds that there is no genuine issue of fact, and they can exclude certain kinds of evidence which might bias the jury. Even after the jury has heard the evidence, the judge can order a directed verdict, if he decides that the plaintiff has not presented a prima facie case. These tools are extreme, and directed verdicts and summary judgement are unsuitable for cases where the true damage is positive, if less than what the jury would award. A less blunt instrument is the use of the procedures of "remittitur" (which reduces damages) or "additur" (which increases them).[14] Under *remittitur*, the judge presents the plaintiff with two alternatives: a reduced award suggested by the judge, or a new trial on the grounds that no reasonable jury could have found such high damage. Such adjustments are surprisingly common. Shanley (1991) finds that 20 percent of cases end up with a result that differs from the jury decision, reducing the average payment to 71 percent of the jury award, and that larger awards are reduced more than smaller awards.[15] These various rules seem for the most part to help defendants rather than plaintiffs, which suggests that empirically the selection effect of predictable error is more important than the signalling effect of unpredictable error.

6. MERITLESS SUITS

What level of litigation is efficient, and whether the United States has exceeded that level or not, are questions beyond the scope of this article, involving as they do the issues of optimal deterrence and the size of transaction costs. Where the court error model can be helpful, however, is in clarifying what is meant by excessive litigation. Much of the present-day concern about excessive litigation seems to arise from a perception that (a) too many plaintiffs bring suits that have little chance of winning large awards

[14] For general discussions, see Speiser, Krause, and Gans (1985) pp. 773-797, 960-977, and Sann (1976).

[15] *Additur*, which offers the same choice on the grounds that the measured damages are unreasonably low, is much less common than *remittitur*, and is not available in federal courts because it is held to violate the U.S. Constitution's Seventh Amendment's guarantee of a jury trial (*Dimick v. Scheidt*, 293 U.S. 474 (1935)). *Remittitur* is symmetric to *additur*, of course, but it is allowed to stand because it was well established as part of the common law in 1791. State courts vary on whether they allow *additur*, as it seems to be accepted that states are not bound by the Seventh Amendment (*Olesen v. Trust Co. of Chicago*, 245 F2d 522, (7th Cir.)). Even *remittur* has, since 1905, been unavailable in England (Sann, 1976, p. 301). Oddly enough, *additur* is never available for punitive damages, because those are entirely at the discretion of the jury, since they need have no relation to measured damage (Speiser, Krause, and Gans, 1985, p. 976).

and do not deserve to win them, and (b) some of these plaintiffs win large awards anyway.

One interpretation is that these are suits in which the expected value of the court award is less than the plaintiff's transaction costs of obtaining the award— what I will call "nuisance suits" or "frivolous suits" . A nuisance suit is brought to extract a settlement offer, or from the plaintiff's malice towards the defendant, or because the plaintiff is mistaken about his probability of winning.[16]

The court error model points out the need to be careful in defining frivolous suits, because it would be misleading to define a frivolous suit as a suit that both plaintiff and defendant recognize has no merit, as is sometimes done.[17] When courts make mistakes, it is not just the true merits that affect incentives, but the court's view of the merits, and the litigants' views of the court's view.

The court error model thus suggests a second interpretation of the problem of excessive litigation: that the problem is "meritless suits," in which the true damage is low, but the expected award is greater than the cost of bringing suit. A frivolous suit might not be meritless. The plaintiff might be able to predict that though the damage is large, the court error will be negative. Likewise, a meritless suit need not be frivolous. The plaintiff may know his case is meritless but be confident of fooling the court. Both kinds of suits create inefficiency by generating litigation costs and deterring potential targets from harmless behavior that might generate lawsuits. In addition, to the extent that courts adjust their awards as described in the present model, the presence of meritless suits reduces the number of meritorious suits. An immediate implication of Propositions 2 and 3 is that when court error is predictable, meritless suits impose a negative externality on plaintiffs with meritorious suits. If the fraction of meritless suits is high, the court reduces even moderate awards substantially. Depending on the distribution of litiga-

[16]For models of nuisance suits, see Rosenberg and Shavell (1985), Bebchuk (1988), and the general discussion in Cooter and Rubinfeld (1989).

[17]E.g., the definition of nuisance suit by Cooter and Rubinfeld (1989, p. 1083) .

tion costs, it is even possible that a majority of meritorious cases will not be brought.[18]

Both predictable and unpredictable error generate meritless but nonfrivolous suits. If positive error is predictable, the plaintiff can bring a meritless suit confident that he will be overcompensated. Even sizeable litigation costs will not deter these suits, and "loser pays" rules would only encourage them. If the court error is unpredictable, the plaintiff runs a risk in bringing suit, but if litigation costs are small relative to the potential award, it is worthwhile even if the probability of winning is also small. This would generate the pattern described above of many seemingly frivolous suits but a certain number of absurdly high awards. Thus, either systematic and predictable court bias in interpreting certain kinds of evidence or erratic and unpredictable court error can generate meritless suits.

This raises the question of whether the degree of predictability of court error increases or decreases the number of meritless suits. It can do either, as the following two examples will show.

Example 1: Predictability increases the number of meritless suits. Let the parameters be those of Table 1. First, suppose the error is predictable, as in Column (1) of Table 1. If $d = 0$, the predicted damage measurement of suits that are filed is either $\hat{d} = \tilde{d} = -1$ (with probability .2), $\hat{d} = \tilde{d} = 0$ (with probability .6) or $\hat{d} = \tilde{d} = 1$ (with probability .2). If $\tilde{d} = -1$, suit is brought with probability 0; if $\tilde{d} = 0$, with probability .125; and if $\tilde{d} = 1$ with probability .5. Thus, the overall probability of a meritless suit is (.2) (0) + (.6)(.125) + .2(.5) = .175.

Next, suppose the error is unpredictable, as in Column (2) of Table 1. If $d = 0$, then $\tilde{d} = 0$ also. Suit is brought with probability .16 when $\tilde{d} = 0$. Thus, the probability of a meritless suit is .16 when error is unpredictable. This is less than .175, so predictability *increases* the number of meritless suits.

[18] This externality is also noted in Bebchuk (1988).

The intuition behind Example 1 is that when the error is predictable, the plaintiff feels safe in bringing meritless suits with evidence that exaggerates the amount of damage, but if it is unpredictable, he is more reluctant because the court error may go against him rather than in his favor.

Example 2: Predictability reduces the number of meritless suits. Let the parameters be those of those of Table 2, which modifies Table 1 by putting a probability atom of weight .5 on $c = .30$, so half of all potential plaintiffs face costs of $c = .30$ from a lawsuit, and the rest are distributed with costs from 0 to 2.

If the error is predictable, the court's equilibrium awards are the same as in Example 1, because $F(\tilde{d})$ plays no role in the determination of the final awards. Column (2.1) of Table 2 shows that a meritless suit ($d = 0$) results in $\tilde{d} = -1$ with probability .2, $\tilde{d} = 0$ with probability .6, and $\tilde{d} = 1$ with probability .2. The probability of suit being brought, given a meritless case, is .2(.00)+ .8(.06) + .2(.75), or .20.

TABLE 2: MERITLESS SUITS

		(2.1) Predictable Error Only ($\tilde{d} = \hat{d}$) $\gamma = 0, \theta = .2$	(2.2) Unpredictable Error Only ($d = \tilde{d}$) $\gamma = .2, \theta = 0$
	$F(-1)$	**.00**	.00
Proportion	$F(0)$	**.06**	**.60**
of lawsuits	$F(1)$	**.75**	.77
Brought	$F(2)$	.95	.92
$F(\tilde{d})$	$F(3)$	1.00	1.00
	$a(-1)$	0.00	**0.00**
Final	$a(0)$	0.25	**0.30**
Court	$a(1)$	1.00	**1.08**
Award	$a(2)$	1.75	1.78
$a(\hat{d})$	$a(3)$	2.00	2.00

Assumed: $p = q = r = 1/3$. $G(c)$ is uniform on [0,2], except for an atom of weight .5 on $c = .30$. $\mu = 1$. Calculations are rounded.

If the error is unpredictable, as in Column (2.2) of Table 2, then a plaintiff with a meritless suit ($d = 0$) knows that the measured damage is $\hat{d} = -1$ with probability .2, $\hat{d} = 0$ with probability .6, and $\hat{d} = 1$ with probability .2, which yield awards of $a(-1) = 0.00$, $a(0) = 0.30$, and $a(1) = 1.08$, for an expected award of 0.40. This expected award exceeds 0.30, the modal litigation cost of plaintiffs, so a large number of plaintiffs decide to bring suit, and the proportion of meritless cases that become lawsuits is 0.60. This is higher than the proportion of meritless cases which become lawsuits when error is predictable (0.20), so predictability *reduces* litigation.

When the error is predictable in Example 2, the plaintiff knows from the start whether his meritless suit will lead to a high award, so often he will not bring suit. If the error is unpredictable, however, and the cost of bringing suit is low enough, it is worth bringing suit in the hope that the court will make misjudge the evidence.

The key difference between the examples is in the cost of bringing suit. In Example 1, plaintiffs have an even distribution of litigation costs, so predictability of the error substantially increases the number of plaintiffs for whom suits are profitable. In Example 2, a large bloc of plaintiffs have low litigation costs and are willing to gamble on what an unpredictable court will do, but if the error is predictable many of them realize that while the cost of a suit is low, the benefit is even lower.

The two examples prove Proposition 6.

PROPOSITION 6: Increased predictability of court error can either increase or decrease the number of meritless suits.

Meritless suits will be most common when numerous cases of damage occur but only a few are due to tortious behavior. Product liability and employment law face this problem. Many people become sick or injured, and many lose existing jobs or fail to acquire new ones, but the great majority of harm is not caused by torts. Even unpredictable court error may induce lawsuits to be brought in the hope of a lucky award, and predictable error has an even stronger effect. It is easy, for example, to find misleading statistical evidence for employment discrimination. Even if no employer is discriminatory, half of them will employ less than the median proportion of racial minorities, and some of them will appear highly discriminatory. It is the applicants for jobs at those companies who will choose to file suit.[19] Knowing this, the court should discount such evidence.

If the distribution of cases is asymmetric and the probability of meritless cases is high, the court's optimal policy may be to scale back damages so much that no lawsuits of any kind, meritless or meritorious, are brought. The problem is one of false positives. When a large proportion of cases are meritless and court error is sizeable, then even if meritorious suits also exist it may be efficient to block all suits. This argument supports the exclusion of

[19] See Epstein (1992) p. 210, citing Follett & Welch (1983).

pain and suffering from damage awards, for example, because measurement error is particularly great for that category of damage.

7. CONCLUDING REMARKS

The model has shown that the effect of court error is not simply to bias damage awards upwards or downwards, because different biases go in different directions. Court error has three effects:

1. Regression to the mean. Both predictable and unpredictable error introduce regression towards the mean: extreme measured damage is more likely to have been produced by court error. The court should compensate by increasing small damage awards and reducing large ones.

2. Plaintiff selection. Predictable error encourages the plaintiff to file suit if the error is positive. If the court does not know whether to classify an award as large or small, it should adjust the award downwards.

3. Plaintiff signalling. Unpredictable error introduces a signalling effect because the willingness of a plaintiff to bring a suit with low apparent damages shows that he thought measured damages would be higher. The court should adjust the award upwards.

Both kinds of error encourage the filing of meritless suits, in which the true damage is zero. Predictable positive error creates the possibility of a suit that is both meritless and riskless for the plaintiff, while unpredictable error allows the plaintiff to gamble that his suit, while meritless, will nonetheless generate a positive award. If abundant opportunities are available to bring meritless suits, courts should adjust even moderate damage measurements downwards.

The analysis has assumed that the court's goal is to make the award match the true damage in the particular case as closely as possible. This is a much narrower issue than that of what level of award is optimal. Optimality depends on the law's goal, and if the goal is to deter harmful behavior, trying to match awards to damages on a case by case basis may not be the best policy. If a potential tortfeasor does not know whether his action will cause a minor or a major injury, it may be optimal to overcompensate major injuries because minor injuries do not generate lawsuits and receive zero compensation. If, on the other hand, potential tortfeasors fear heavy legal costs of defense, they may be overcautious and all awards should be scaled down (Polinsky and Rubinfeld [1988]). Or, it may be that courts should reduce the amount of litigation while keeping the damages paid out high by raising both the standard of proof and the size of awards (Polinsky and Che [1991]). Moreover, court error has important implications for the question of what level of penalty is optimal. Polinsky and Shavell (1994), for example, note that if the court awards penalties that are inefficiently and predictably small, then penalties based on the harm to the injured are superior to penalties based on the benefit to the injuror.

The present model ignores these considerations, and its conclusions must be considered as one more set of effects to add to the tangle. It does, however, address a question that most people think is at the heart of justice—- How can the court most accurately compensate plaintiffs for the damage done by defendants?— and concludes that a court which recognizes its own fallibility should use that knowledge in deciding its awards.

APPENDIX

The appendix uses the model in Section 2 to calculate the relevant probabilities used to calculate the expected value of d given $\hat{d}$. For notational convenience, let $\hat{d}_i$ denote $\hat{d} = \mu + i$, $\tilde{d}_i$ denote $\tilde{d} = \mu + i$, and d_i denote $d = \mu + i$. From equations (1) to (3) one can find $Pr(\hat{d}|\tilde{d})$ and $Pr(\tilde{d}|d)$ for different values of d, $\tilde{d}$, and $\hat{d}$.

For $\hat{d} = \mu - 3$ the Bayesian updating is very simple: $a(\mu - 3) = \mu - 1$. This is so because the only way that $\hat{d} = \mu - 3$ could arise is if $d = \mu - 1$ and both errors were negative. Similarly, $a(\mu + 3) = \mu + 1$. This leaves the intermediate values of $\hat{d}$, which do not perfectly reveal d. These can be broken down depending on which of the five values of $\tilde{d}$ has arisen.

For $\hat{d} = \mu - 2$, equation (7) becomes

$$\begin{aligned} Pr(\hat{d}_{-2}, lawsuit|d_i) &= \sum_{j=-2}^{2} F(j)Pr(\hat{d}_{-2}|\tilde{d}_j)Pr(\tilde{d}_j|d_i) \\ &= F(\mu-2)(1-2\gamma)Pr(\tilde{d}_{-2}|d_i) + F(\mu-1)\gamma Pr(\tilde{d}_{-1}|d_i) + F(\mu)(0) \end{aligned}$$

$$+F(\mu+1)(0)+F(\mu+2)(0). \tag{27}$$

Applying equation (27) to $i=\mu-1,\mu,\mu+1$, the three possible true values of damage, yields

$$\begin{aligned}
Pr(\hat{d}_{-2}, lawsuit|d_{-1}) &= F(\mu-2)(1-2\gamma)\theta+F(\mu-1)\gamma(1-2\theta) \\
Pr(\hat{d}_{-2}, lawsuit|d_{0}) &= F(\mu-2)(1-2\gamma)(0)+F(\mu-1)\gamma\theta \\
Pr(\hat{d}_{-2}, lawsuit|d_{1}) &= F(\mu-2)(1-2\gamma)(0)+F(\mu-1)\gamma(0)
\end{aligned}$$

and, from equation (8),

$$Pr(\hat{d}_{-2}, lawsuit)=F(\mu-2)(1-2\gamma)\theta p+F(\mu-1)\gamma(1-2\theta)p+F(\mu-1)\gamma\theta q$$

For $\hat{d}=\mu-1$, equation (7) becomes

$$\begin{aligned}
Pr(\hat{d}_{-1}, lawsuit|d_i) &= \sum_{j=-2}^{2} F(j)Pr(\hat{d}_{-1}|\tilde{d}_j)Pr(\tilde{d}_j|d_i) \\
&= F(\mu-2)\gamma Pr(\tilde{d}_{-2}|d_i)+F(\mu-1)(1-2\gamma)Pr(\tilde{d}_{-1}|d_i)+F(\mu)\gamma Pr(\tilde{d}_0|d_i) \\
&\quad +F(\mu+1)(0)Pr(\tilde{d}_1|d_i)+F(\mu+2)(0)Pr(\tilde{d}_2|d_i). \qquad (28)
\end{aligned}$$

Applying equation (28) to $i=\mu-1,\mu,\mu+1$, the three possible true values of damage, yields

$$\begin{aligned}
Pr(\hat{d}_{-1}, lawsuit|d_{-1}) &= F(\mu-2)\gamma\theta+F(\mu-1)(1-2\gamma)(1-2\theta)+F(\mu)\gamma\theta \\
Pr(\hat{d}_{-1}, lawsuit|d_{0}) &= F(\mu-2)\gamma(0)+F(\mu-1)(1-2\gamma)(\theta)+F(\mu)\gamma(1-2\theta) \\
Pr(\hat{d}_{-1}, lawsuit|d_{1}) &= F(\mu-2)\gamma(0)+F(\mu-1)((1-2\gamma))(0)+F(\mu)\gamma\theta
\end{aligned}$$

and, from equation (8),

$$Pr(\hat{d}_{-1}, lawsuit)=F(\mu-2)\gamma\theta p+F(\mu-1)(1-2\gamma)[(1-2\theta)p+\theta q]+F(\mu)\gamma[\theta p+(1-2\theta)q+\theta r]$$

For $\hat{d}=\mu$, equation (7) becomes

$$\begin{aligned}
Pr(\hat{d}_{0}, lawsuit|d_i) &= \sum_{j=-2}^{2} F(j)Pr(\hat{d}_{0}|\tilde{d}_j)Pr(\tilde{d}_j|d_i) \\
&= F(\mu-2)(0)Pr(\tilde{d}_{-2}|d_i)+F(\mu-1)\gamma Pr(\tilde{d}_{-1}|d_i)+F(\mu)(1-2\gamma)Pr(\tilde{d}_0|d_i) \\
&\quad +F(\mu+1)\gamma Pr(\tilde{d}_1|d_i)+F(\mu+2)(0)Pr(\tilde{d}_2|d_i) \qquad (29)
\end{aligned}$$

Applying this to $i = \mu-1, \mu, \mu+1$ gives

$$\begin{aligned}
Pr(\hat{d}_0, lawsuit|d_{-1}) &= F(\mu-1)\gamma(1-2\theta) + F(\mu)(1-2\gamma)\theta + F(\mu+1)\gamma(0) \\
Pr(\hat{d}_0, lawsuit|d_0) &= F(\mu-1)\gamma\theta + F(\mu)(1-2\gamma)(1-2\theta) + F(\mu+1)\gamma(0) \\
Pr(\hat{d}_0, lawsuit|d_1) &= F(\mu-1)\gamma(0) + F(\mu)(1-2\gamma)\theta + F(\mu+1)\gamma(1-2\theta)
\end{aligned}$$

and, from equation (8),

$$\begin{gathered}
Pr(\hat{d}_0, lawsuit) = F(\mu-1)\gamma[(1-2\theta)p + \theta q] + \\
F(\mu)(1-2\gamma)[\theta p + (1-2\theta)q + \theta r] + F(\mu+1)\gamma(1-2\theta)r
\end{gathered} \tag{30}$$

For $\hat{d} = \mu+1$, equation (7) becomes

$$\begin{aligned}
Pr(\hat{d}_1, lawsuit|d_i) &= \sum_{j=-2}^{2} F(j)Pr(\hat{d}_1|\tilde{d}_j)Pr(\tilde{d}_j|d_i) \\
&= F(\mu-2)(0)Pr(\tilde{d}_{-2}|d_i) + F(\mu-1)(0)Pr(\tilde{d}_{-1}|d_i) + F(\mu)\gamma Pr(\tilde{d}_0|d_i) \\
&\quad + F(\mu+1)(1-2\gamma)Pr(\tilde{d}_1|d_i) + F(\mu+2)(\gamma)Pr(\tilde{d}_2|d_i). \qquad (31)
\end{aligned}$$

Applying this to $i = \mu-1, \mu, \mu+1$ yields

$$\begin{aligned}
Pr(\hat{d}_1, lawsuit|d_{-1}) &= F(\mu)\gamma\theta + F(\mu+1)(1-2\gamma)(0) + F(\mu+2)\gamma(0) \\
Pr(\hat{d}_1, lawsuit|d_0) &= F(\mu)\gamma(1-2\theta) + F(\mu+1)(1-2\gamma)\theta + F(\mu+2)\gamma(0) \\
Pr(\hat{d}_1, lawsuit|d_1) &= F(\mu)\gamma\theta + F(\mu+1)(1-2\gamma)(1-2\theta) + F(\mu+2)\gamma\theta
\end{aligned}$$

and, from equation (8),

$$Pr(\hat{d}_1, lawsuit) = F(\mu)\gamma[\theta p+(1-2\theta)q+\theta r]+F(\mu+1)(1-2\gamma)[\theta q+(1-2\theta)r]+F(\mu+2)\gamma\theta r \tag{32}$$

For $\hat{d} = \mu+2$, equation (7) becomes

$$\begin{aligned}
Pr(\hat{d}_2, lawsuit|d_i) &= \sum_{j=-2}^{2} F(j)Pr(\hat{d}_2|\tilde{d}_j)Pr(\tilde{d}_j|d_i) \\
&= F(\mu-2)(0)Pr(\tilde{d}_{-2}|d_i) + F(\mu-1)(0)Pr(\tilde{d}_{-1}|d_i) + F(\mu)(0)Pr(\tilde{d}_0|d_i) \\
&\quad + F(\mu+1)\gamma Pr(\tilde{d}_1|d_i) + F(\mu+2)(1-2\gamma)Pr(\tilde{d}_2|d_i). \qquad (33)
\end{aligned}$$

Applying this to $i = \mu-1, \mu, \mu+1$ yields

$$\begin{aligned}
Pr(\hat{d}_2, lawsuit|d_{-1}) &= F(\mu+1)\gamma(0) + F(\mu+2)(1-2\gamma)(0) \\
Pr(\hat{d}_2, lawsuit|d_0) &= F(\mu+1)\gamma\theta + F(\mu+2)(1-2\gamma)(0) \\
Pr(\hat{d}_2, lawsuit|d_1) &= F(\mu+1)\gamma(1-2\theta) + F(\mu+2)(1-2\gamma)\theta
\end{aligned}$$

and, from equation (8),

$$Pr(\hat{d}_2, lawsuit) = F(\mu+1)\gamma\theta q + F(\mu+1)\gamma(1-2\theta)r + F(\mu+2)(1-2\gamma)\theta r \quad (34)$$

Combining the calculations above to fill in the terms in equation (6) yields the court's adjusted awards for different levels of deviations from the average measured damage:

$$a(\mu-3) = \mu - 1 \quad (35)$$

$$a(\mu-2) = \mu - \frac{[F(\mu-2)(1-2\gamma)\theta + F(\mu-1)\gamma(1-2\theta)]p}{[F(\mu-2)(1-2\gamma)\theta + F(\mu-1)\gamma(1-2\theta)]p + F(\mu-1)\gamma\theta q} \quad (36)$$

$$a(\mu-1) = \mu - \frac{[F(\mu-2)\gamma\theta + F(\mu-1)(1-2\gamma)(1-2\theta) + F(\mu)\gamma\theta]p - F(\mu)\gamma\theta r}{F(\mu-2)\gamma\theta p + F(\mu-1)(1-2\gamma)[(1-2\theta)p + \theta q] + F(\mu)\gamma[\theta p + (1-2\theta)q + \theta r]} \quad (37)$$

$$a(\mu) = \mu + \frac{-[F(\mu-1)\gamma(1-2\theta) + F(\mu)(1-2\gamma)\theta]p + [F(\mu)(1-2\gamma)\theta + F(\mu+1)\gamma(1-2\theta)]r}{F(\mu-1)\gamma[(1-2\theta)p + \theta q] + F(\mu)(1-2\gamma)[\theta p + (1-2\theta)q + \theta r] + F(\mu+1)\gamma(1-2\theta)r} \quad (38)$$

$$a(\mu+1) = \mu + \frac{-[F(\mu)\gamma\theta]p + [F(\mu)\gamma\theta + F(\mu+1)(1-2\gamma)(1-2\theta) + F(\mu+2)\gamma\theta]r}{F(\mu)\gamma[\theta p + (1-2\theta)q + \theta r] + F(\mu+1)(1-2\gamma)[\theta q + (1-2\theta)r] + F(\mu+2)\gamma\theta r} \quad (39)$$

$$a(\mu+2) = \mu + \frac{[F(\mu+1)\gamma(1-2\theta) + F(\mu+2)(1-2\gamma)\theta]r}{F(\mu+1)\gamma\theta q + [F(\mu+1)\gamma(1-2\theta) + F(\mu+2)(1-2\gamma)\theta]r} \quad (40)$$

$$a(\mu+3) = \mu + 1 \quad (41)$$

Equations (35) to (41) that are used to prove the propositions in the main text.

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