Incentives: the Role of the Standard and Burden of Proof in Litigation

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ABSTRACT

We analyze the design of rules of proof in civil litigation for the purpose of providing potential tort-feasors with ex ante incentives to exert care. Ex post, once harm has occurred, evidence is imperfectly informative and may be distorted by the parties. We show that efficient rules are consistent with courts operating on the basis of the preponderance of evidence standard of proof, together with common law exclusionary rules. Inefficient equilibria may nevertheless also arise under the same set of rules. Directing courts as to the allocation of the burden of proof is then useful in selecting the better equilibrium. [JEL. D8, K4]

KEYWORDS: Evidentiary rules, proof, presumptions, deterrence.

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1. Introduction

Court decision-making is constrained by various rules and standards. In common law, *exclusionary rules* discard as inadmissible apparently relevant evidence. This includes evidence of similar facts (e.g., whether the defendant was previously involved in a similar case), evidence of character or of a reputation for behaving negligently or diligently, or evidence purporting to show that defendants of a particular type tend to behave in a particular way. In civil litigation, courts must decide on the basis of a preponderance of evidence, a *standard of proof* requirement. The preponderance standard means that a claim is deemed proved if, upon the evidence, it is more likely true than not true. There are also situations where the law imposes on courts the *burden of proof* assignment. For instance, the law may require that the defendant, rather than the plaintiff as is usually the case, bear the burden of proving that he did not cause harm or did not act negligently.

We analyze a model where the three judicial instruments just described can be justified on efficiency grounds. To illustrate, consider a medical liability case. The plaintiff claims that he suffered harm due to negligent oversight by his physician. Suppose that all the verifiable evidence pertaining to the case always becomes available to the court. The evidence may nevertheless be highly imperfect, i.e., the court faces a risk of error whether it rules in favor of the patient or the physician. An important issue is therefore the "degree of certainty" or standard of proof required by courts to reach a decision.

Demougin and Fluet (2005b) show that the preponderance standard has a remarkable property. In the case at hand, if courts rule on the issue of physicians' negligence on a preponderance of evidence, there will be maximum ex ante incentives for physicians to act nonnegligently. There is a proviso: in applying the standard, courts must abide by exclusionary rules. Evidence pertaining to a "propensity" for the defendant to act a certain way should be discarded as inadmissible. There is therefore an efficiency justification for the standard of proof and exclusionary rules in common law.

The foregoing result, however, rests on the restrictive assumption that evidence exogenously becomes available to the court. In the present paper, we extend the analysis to the case where verifiable evidence initially rests with the parties, who may attempt to shade the evidence submitted to the court. This introduces additional difficulties such as the weight that should be given to a testimony or the appropriate interpretation of the evidence submitted. If evidence can be manipulated, what does a preponderance of evidence mean?

The issue is straightforward if both parties are known to have access to all verifiable evidence and if submission costs are small compared to the stakes. As evidence will necessarily favor one party or the other, one of the "interested party" will find it in his interest to disclose it (Milgrom and Roberts, 1986). Equivalently, if all relevant evidence is not disclosed, a Bayesian judge or jury will draw the appropriate inferences. However, the classic unraveling result does not follow if the parties do not always have access to all the evidence and may be unequally informed. As is well known (e.g., Shavell, 1989, and Shin, 1998), parties may then be successful in not revealing facts harmful to their case.

The court's problem is then to interpret partial and possibly distorted evidence. Should this affect the standard of proof and exclusionary rules described above? For instance, if plaintiffs in medical liability cases are known to be able on average to present only limited evidence, should one lower the standard of proof they must meet? Should some weight now be given to the physicians' general propensity to act negligently? We show that, even though the parties can manipulate the submitted evidence and may be unequally informed, courts should abide by exactly the same rules as above.

We assume that, in applying these rules, courts are sophisticated decision-makers, i.e., they understand the parties' strategic incentives. As a result, they interpret limited evidence in a particular light. Suppose the plaintiff submits "mixed" evidence. By this we mean evidence which, under the preponderance standard, is consistent with either a decision for the plaintiff or against him, should additional evidence be forthcoming. Then it may be that, if the defendant does not come forward with countervailing evidence, the court will form a presumption against him. Such presumptions work like shifts in the burden of proof but they arise spontaneously, so to speak, in the manner courts interpret evidence under the preponderance standard.

So far, the implication is therefore that standard of proof and exclusionary rules are the only judicial tools needed to efficiently direct court decision-making. Specifically, these rules are efficient if the ultimate objective is to provide potential tortfeasors with the best ex ante incentives to exert care. In particular, it seems that there is no need to direct courts as to which party should bear the burden of proof. The allocation of the burden need not be decided “from above” since, in equilibrium, courts form the correct presumptions when only limited evidence is submitted. There is a sense, however, in which the foregoing result does not necessarily follow. While an efficient equilibrium always exists when courts operate under the appropriate standard of proof and exclusionary rules, other equilibria may exist as well.

The intuition is straightforward. Suppose again the victim only has access to limited evidence. Assume also that efficiency requires that the defendant be held liable given this evidence on its own. If in equilibrium the court holds a presumption against the defendant when this evidence is the only one submitted, then the victim will sue on the basis of this evidence alone. Moreover, the court will be justified, under the preponderance standard, to find that there was negligence. The reason is that, owing to the presumption against him, the defendant would most likely have come forward with additional evidence if it was in his favor. The fact that he did not therefore justifies the presumption. Call this equilibrium A, which by assumption here is the efficient one.

Now, consider another possibility. In equilibrium B, the court does not find the defendant liable under the limited evidence alone. Hence, the victim does not sue on this basis alone. If he did—which would now be out of equilibrium—the defendant would have no incentive to come forward with additional evidence since he (correctly) expects the plaintiff to fail. Thus, the court will interpret the limited evidence differently than in equilibrium A, because the defendant’s strategic incentives are different. As a result, the court concludes that the plaintiff’s evidence does not meet the standard of proof, i.e., that negligence has not been shown to be more likely than due care.

In circumstances such as these, burden of proof assignments imposed “from above” help select the better equilibrium. In the example, when efficient presumptions do not spontaneously arise, courts should be directed to put the burden of proof on the defendant. The purpose is to coordinate parties and courts on the good equilibrium, making sure that victims come forward even if it they have limited evidence. Such interventions—e.g., through statute law or jurisprudence from higher courts—are often observed. Although we formulated the example in terms of the need to put the burden of proof on the defendant, the reverse problem can also arise where courts are too lenient with plaintiffs.[1]

The paper develops as follows. Section 2 describes the basic tort situation that we have in mind. The next two sections adopt a mechanism design approach, without yet introducing courts as decision-makers. Section 3 analyzes the optimal mechanism for the purpose of inducing care, i.e., we determine how liability should be assigned on the basis of the evidence made available by the parties. The liability assignment function takes into account the potential tort-feasors' ex ante incentives to exert care and the parties' ex post incentives to submit and manipulate evidence. We show that the optimal mechanism involves a "more-likely-than-not" decision rule. Section 4 discusses how the mechanism can also be interpreted in terms of burden of proof assignments. Section 5 shows that the optimal liability assignment can be implemented by delegating decisions to courts, who now represent an additional player in the game. This requires that we analyze what general rules should constrain court decision-making. We argue that the appropriate rules include the preponderance of evidence standard of proof, exclusionary rules as in common law, and possibly also burden of proof assignments imposed "from above". Section 6 concludes.

2. The Model

A party, denoted D, undertakes a socially valuable activity which may impose harm on a third party, denoted P, depending on how the activity is undertaken. If D exerts high care h, no harm is imposed. If low care l is taken, party P suffers a loss of amount L. With low care party D obtains a private benefit c, for instance the cost saving from not exerting high care. When $c < L$, low care is socially undesirable and may be interpreted as carelessness or lack of appropriate diligence. The cost savings c is distributed according to the cumulative distribution function $G(c)$, but it is privately known to D at each instance where a choice of care level must be made. Thus, if D were fully liable whenever he causes harm, he would exert high care in all instances where $c < L$, hence with probability $G(L)$, which would be socially optimal.

The occurrence of harm—equivalently whether D caused harm by taking action l—is not directly verifiable. Only some body of verifiable evidence, denoted by x, is available. This may include witness testimony about D's behavior, expert opinion

[1] In our analysis as in actual practice, the plaintiff always bears the so-called "primary burden". Since he initiates the suit, he must provide some appropriate, albeit limited evidence if he is to stand a chance of winning.

about whether P suffered harm, etc. Ex ante, the content of the evidence x is uncertain with potential realizations in a countable set X and a probability distribution that depends on D's care level. We denote this probability by $p_j(x)$, where j is either h or l, so that $\sum_{x\in X} p_j(x) = 1$. In this formulation, it is possible that some realizations of the evidence reveal D's behavior or the occurrence of harm perfectly. This occurs when $p_h(x) = 0$ and $p_l(x) = 1$ or conversely when $p_h(x) = 1$ and $p_l(x) = 0$. If this were true for all $x \in X$, the verifiable evidence would be fully informative. We assume this is not the case.[2]

To illustrate, suppose P has utility function $u = \ln q + w$ where w is wealth and q is an index of physical well-being, say the individual's health status. If the physician or hospital takes high care, the potential health status is the random variable $\widetilde{q}_h$ while with low care it is $\widetilde{q}_l = \beta\widetilde{q}_h$, where $\beta < 1$. Thus, in money equivalents, the loss due to low care is $L = -\ln\beta$. If the only verifiable evidence were the individual's health status, i.e., $x = q$, this would generally constitute relatively poor evidence about the physician's care, depending on the extent to which the supports of $\widetilde{q}_h$ and $\widetilde{q}_l$ overlap. However, x could also include additional direct evidence about the physician's actions.

Party P (now the plaintiff) can sue party D (now the defendant) but can hope to prevail only by submitting verifiable evidence. The cost of submitting such evidence is assumed to be negligible. We first briefly consider the case where the parties have perfect access to the evidence x. The issue is how liability should be assigned, on the basis of verifiable evidence, in order to induce D to exert optimal care as often as possible. We impose the constraint that D cannot be held liable for more than the possible loss L (we discuss below the effect of allowing "punitive damages"). Let $\psi(x) \in [0,1]$ denote the decision rule for assigning liability. $\psi(x) = 1$ means that D is held liable for the full amount L when the submitted evidence is x, $\psi(x) = 0$ that he is not liable, while a value between zero and unity amounts to randomization or to damages for only a fraction of the potential harm.

For a given liability assignment rule, D's expected liability costs are

$$L \sum_{x\in X} p_j(x)\psi(x), \quad j = h, l.$$

[2] In what follows, $p_h(x) + p_l(x) > 0$ for all $x \in X$ (i.e., X is the union of the supports of the two distributions).

Taking the cost c into account, D therefore chooses not to impose harm if

$$\delta \equiv \sum_{x \in X} [p_l(x) - p_h(x)]\psi(x) \geq \frac{c}{L}\,. \tag{1}$$

The expression on the left-hand side, which we refer to as deterrence, is the increase in the probability of being held liable when action l is chosen rather than h. It is easily seen that $\delta \leq 1$ under any decision rule, a value of unity being feasible only if the evidence perfectly reveals D's behavior. Thus, with imperfectly informative evidence, high care is exerted only when $c \leq \delta L < L$, which means that there is insufficient deterrence. Clearly, the best liability assignment function is the one which maximizes deterrence—equivalently, this maximizes the probability $G(\delta L)$ that no harm is caused across instances where action l is socially undesirable.

Proposition 1. *The best liability assignment, as a function of the verifiable evidence $x \in X$, is $\psi^*(x) = 1$ when $p_l(x) > p_h(x)$, $\psi^*(x) = 0$ otherwise.*

The result is borrowed from Demougin and Fluet (2005b). To maximize deterrence, $\psi(x)$ should be set at its maximum value of unity when the expression in brackets in (1) is positive, and at its minimum value of zero when the expression is negative. When the expression is itself nil, the value of $\psi(x)$ is indifferent. We set it equal to zero in this case, which may be interpreted as putting the burden of persuasion on the plaintiff.

The proposition has a straightforward interpretation. $p_j(x)$ is the probability of the "data" represented by x conditionally on the hypothesis $j \in \{h, l\}$ being true. In standard statistical terminology, this would be referred to as the "likelihood" of hypothesis j on the basis of the observable data. Thus, the proposition states that the defendant should be fully liable when l is more likely than h, given the evidence. Under such a mechanism and assuming an arbitrarily small cost of submitting evidence, when $p_l(x) > p_h(x)$ the plaintiff files suit and submits x; otherwise, he does not file suit.

Consider now briefly the possibility of punitive damages $B > L$ when the defendant is held liable. A sufficiently large B obviously implements the first best provided we do not run into bankruptcy problems. The potential defendant now exerts high care if

$$c \leq B \sum_{x \in X} [p_l(x) - p_h(x)]\psi(x).$$

Optimal care requires that B be set so that

$$L = B \sum_{x \in X} [p_l(x) - p_h(x)] \psi(x).$$

This can be satisfied in an infinite number of ways, but clearly $\psi^*(x)$ leads to the smallest level of punitive damages, say B^*, consistent with the first best. Thus, another justification for the liability assignment function of proposition 1 is that it minimizes the punitive damages consistent with inducing optimal care.[3] Alternatively, it may be that the defendant's wealth is smaller than B^*, so that the first-best is unattainable. Holding the defendant liable up to his entire wealth and using $\psi^*(x)$ is then the best one can do.[4] In what follows, we stick to our earlier interpretation and assume compensatory damages, i.e., a liable defendant pays the plaintiff the amount L.

We henceforth relax the assumption that the parties have perfect access to all the potential evidence. To discard straightforward unraveling results, we also assume that society, as Principal, does not know the extent of the verifiable evidence available to the parties. Specifically, and to make things as simple as possible, suppose the complete body of evidence can be partitioned as $x = (y, z)$ with $y \in Y$ and $z \in Z(y)$ defined as the set of potential additional evidence consistent with the partial evidence y. Both parties always have access to y, but may not be able to also submit z. For example, the potential evidence x could consist of the content of two separate "files". The parties always have access to the first file y but may not be able to access the second file z. Moreover, the parties may differ in their capacity to present verifiable evidence. Party P observes z only with probability v, party D only with probability u, where $u, v \in (0, 1)$.

Such a set-up introduces the possibility that the parties will successfully manipulate the evidence (see Shin, 1998). Any reasonable liability assignment scheme requires that P submit at least y in order to prevail. Indeed, P is the only party with an interest in initiating proceedings and it is common knowledge that part y of the evidence is accessible to him. However, as parties may be only partly informed, when only y is disclosed society does not know whether this is because the parties

[3] Large punitive damages generate other distorsions since they inflate the cost of engaging in the risky activity, e.g., becoming a physician. See P'ng (1986).

[4] Allowing B to depend on x would not improve incentives.

did not observe all the potential evidence or whether an informed party chose not to disclose z. We denote by $z = \phi$ the case where society does not receive any additional information besides y. Note that we make the usual assumption that false evidence cannot be fabricated.

The issue is now to choose a liability assignment function of the form $\psi(y, z) \in [0, 1]$ where $y \in Y$, $z \in Z(y) \cup \{\phi\}$. Although the objective remains that of providing the best ex ante incentives to exert care—i.e., maximize deterrence—account must now be taken of the fact that $\psi(y, z)$ will also affect the parties' ex post incentives to disclose evidence. In turn, this will have repercussions on D's ex ante incentives to exert care. We tackle this problem in the next section.

3. Optimal Mechanism

The situation considered is described by the following time line. First, society chooses a function ψ for assigning liability on the basis of the submitted evidence, should P file suit (by default, no damages are paid if no suit is filed). Second, Nature chooses c according to the distribution $G(c)$, D observes c and decides between action h or l. Third, Nature chooses the evidence $x = (y, z)$ according to the joint probability distribution $p_j(y, z)$ depending on whether j is h or l, where $y \in Y$ and $z \in Z(y)$; Nature then also chooses with probability u (respectively v) whether P (respectively D) will be allowed to observe z. Fourth, both parties observe y and possibly also z; neither party knows whether the other has seen the complete potential evidence. At this stage, in step 1, party P decides whether to file suit, where filing suit entails the submission of the realization y; in step 2, if a suit has been filed, both parties decide simultaneously whether to submit additional evidence (if they can). Fifth, society assigns liability according to the mechanism on the basis of the overall evidence submitted, (y, z) or (y, ϕ) as the case may be.

Solving the game backwards, we first analyze the fourth stage consisting of the decision to file suit and the ensuing disclosure game. A unique solution is obtained if it is assumed that submitting evidence involves an arbitrarily small cost. Such a cost is incurred by P if he files suit and submits y in step 1. A similar cost is also incurred by any party submitting the additional evidence z in step 2. Under these assumptions, it is easily seen that the parties have dominant strategies in step 2. For instance, suppose the victim filed suit and the injurer observed z. If $\psi(y, z) < \psi(y, \phi)$

the injurer reveals z since by doing so he reduces the probability of paying damages. If $\psi(y,z) \geq \psi(y,\phi)$ he does not reveal z.[5]

Lemma 1. *The following strategy pair is the unique equilibrium of the file and disclosure game. (i) If P observes z and $\psi(y,\phi) < \psi(y,z)$, P files suit and then discloses z; if z is not observed or if $\psi(y,z) \leq \psi(y,\phi)$, P files suit provided $\psi(y,\phi) > 0$ but submits only y; in all other cases P does not file suit. (ii) If a suit has been filed and $\psi(y,z) < \psi(y,\phi)$, D discloses z if he can; otherwise he reveals nothing.*

We denote by $\overline{p}_j(y)$ the marginal probability of partial evidence y, given that D has chosen action j. We write $p_j(z\,|\,y)$ for the conditional probability of the additional evidence $z \in Z(y)$, given that the partial evidence is y and that care was j. Observe that this conditional probability, as well as the joint probability $p_j(y,z)$, is in terms of actual evidence and not for $z = \phi$. Conditional on y, the probability of D being held liable, when care level j was exerted, is equal to

$$\begin{aligned} e_j(y) \equiv \psi(y,\phi) &+ v \sum_{z\in Z(y)} p_j(z\,|\,y) \max[0, \psi(y,z) - \psi(y,\phi)] \\ &- u \sum_{z\in Z(y)} p_j(z\,|\,y) \max[0, \psi(y,\phi) - \psi(y,z)]. \end{aligned} \tag{2}$$

The expression follows directly from the outcome of the disclosure game, taking into account each parties' probability of accessing the complete evidence and the incentives to disclose.[6] Ex ante, as a function of the level of care, the probability of being held liable is therefore $\sum_{y\in Y} \overline{p}_j(y) e_j(y)$.

As in section 2, the best scheme is the one which maximizes the difference in expected liability costs between low and high care. This means that ψ must be chosen so as to maximize deterrence, now written as

$$\delta = \sum_{y\in Y} [\overline{p}_l(y) e_l(y) - \overline{p}_h(y) e_h(y)]. \tag{3}$$

Proposition 2. *When the parties may be only partly informed, the best liability assignment function satisfies: $\psi(y,z) = \psi^*(y,z)$ as defined in proposition 1 when*

[5] The injurer's belief as to whether the victim has also observed z is irrelevant. Similarly, the victim's belief about the injurer's care level is inconsequential.

[6] The expression is derived in the proof of proposition 2.

$z \in Z(y)$; when $z = \phi$, $\psi(y, \phi) = 1$ if $\overline{p}_l(y)Q_l(y) > \overline{p}_h(y)Q_h(y)$ and $\psi(y, \phi) = 0$ otherwise, where

$$Q_j(y) \equiv (1-v)(1-u) + (1-u)v \sum_{z \in Z(y)} [1 - \psi^*(y,z)]\, p_j(z \mid y) + (1-v)u \sum_{z \in Z(y)} \psi^*(y,z)\; p_j(z \mid y)\,, \quad j = h, l. \tag{4}$$

Proof. See the Appendix.

The expression in (4) is the conditional probability of z not being revealed given D's care level and the realization y. The rationale is that z remains undisclosed either because both parties are uninformed or only one is informed but would not disclose evidence unfavorable to his case. Put differently, $\overline{p}_j(y)Q_j(y)$ is the probability of the event "partial evidence is y and z not revealed" given D's ex ante action. In statistical terminology, it is therefore the likelihood of action j on the basis of the available "data". Thus, the proposition shows that the more-likely-than-not criterion remains appropriate even when disclosure is an issue. The difference is that the probability assessments are equilibrium ones taking into consideration the parties' capability of submitting evidence and their motive for testifying a certain way.[7] The next section illustrates the result and discusses implications.

4. Burden of Proof

The more-likely-than-not property is akin to a standard of proof requirement, suggesting the preponderance of evidence standard in common law. The optimal scheme can also be interpreted as allocating the burden of proof.

In legal terminology, the plaintiff is said to bear the burden of proof if he looses unless he produces enough evidence supporting his claim. Conversely, the burden rests on the defendant if he is held liable unless he produces evidence in his favor. The procedure is nevertheless always initiated by the plaintiff who bears the "primary burden" of establishing that the case is worth hearing. In the model, this is captured by the fact that the plaintiff must file suit in order to obtain damages and cannot but submit y when a suit is filed. The burden of proof therefore refers to how the task of producing the additional evidence is apportioned between the parties.

[7] The result is derived for a binary partition of the body of evidence, but the argument obviously extends to finer partitions.

Definition: *The scheme is said to assign the burden of proof to the defendant if, in equilibrium, he is the only party with an incentive to submit additional evidence.*

To illustrate, suppose partial evidence is always sufficient on its own for the plaintiff to win. He then never submits z and the defendant can escape liability only by coming forward with appropriate counter-evidence. By contrast, the burden is on the plaintiff if the partial evidence is not always sufficient by itself. The plaintiff will then sometimes not file suit or, when informed of the complete evidence, will submit z when y by itself is insufficient.

The above abstracts from the possibility that the partial evidence is conclusive by itself. Suppose y is such that l would appear more likely than h for all z that could conceivably be produced. Under the optimal scheme, the plaintiff would then necessarily win. Alternatively, y may be such that h would be at least as likely as l for all conceivable z, in which case the plaintiff can only loose under the optimal scheme (and would in fact not file suit). In either case, the partial evidence is "conclusive" on its own.[8] In equilibrium, no party then submits additional evidence. Thus, the allocation of the burden of proof must refer to the liability assignment when partial evidence is not conclusive.

In this case we say the partial evidence is "mixed". Formally, y constitutes mixed evidence if there exists z, $z' \in Z(y)$ such that $p_l(y,z) > p_h(y,z)$ and $p_l(y,z') \leq p_h(y,z')$, i.e., the liability assignment can go either way depending on what additional evidence is submitted. According to the above definition, the burden of proof is therefore on the defendant if $\psi^*(y,\phi) = 1$ whenever the partial evidence is mixed. The plaintiff then always sues on the basis of mixed evidence and never has an incentive to submit z, which is submitted by the defendant only if it constitutes appropriate counter-evidence.

Corollary 1. *The optimal scheme assigns the burden of proof to the defendant if u is sufficiently larger than v.*

Proof. See the Appendix.

[8] Note that evidence is labelled conclusive in terms of the more-likely-than-not criterion. It need not be perfectly informative.

Observe that $u > v$ is not sufficient to ensure that the defendant bears the burden: he must stand a sufficiently better chance of being more informed than the plaintiff.[9] We illustrate the result through an example.

An example

Let the evidence set be $X = \{a, b, c, d, e, f\}$ with probabilities given as in the first two lines of table 1. The third line gives the likelihood ratio of l versus h on the basis of the complete evidence. Under the optimal scheme, the defendant is then liable if $x = e$ or f. The partial evidence y, in the middle part of the table, corresponds to a coarser partition of the complete evidence. Observe that the realization cd is conclusive evidence in favor of D (i.e., it does not matter whether the complete evidence is c or d), so that P would not sue when observing $y = cd$. By contrast, af and be represent mixed evidence. Thus, the defendant bears the burden according to our definition if he is held liable when the partial evidence is either af or be.

The bottom part of the table gives the likelihood ratio of l versus h under partial evidence and taking into account the parties' strategic incentives to disclose under the optimal scheme; that is,

$$\frac{\overline{p}_l(y)Q_l(y)}{\overline{p}_h(y)Q_h(y)}$$

where Q_h and Q_l are as defined in proposition 2. The defendant is held liable when this ratio is greater than unity.

When $u = v$, this likelihood ratio is the "naive" ratio $\overline{p}_l(y)/\overline{p}_h(y)$ already shown in the middle part of the table. Strategic incentives to conceal evidence cancel out and submissions are taken at their face value.[10] In this case, an uninformed plaintiff would sue only when $y = af$. If informed, he would also sue when $y = be$ and $x = e$; that is, he would file suit by submitting be and then submit e in a second step. According to our definition, the burden of proof is therefore on the plaintiff.

[9] While the condition in the corollary is sufficient, it is also necessary except in the particular case where, for any mixed evidence y, $p_l(y, z) \geq p_h(y, z)$ for all $z \in Z(y)$. In this case, the burden should be on the defendant irrespective of u or v. No deterrence is lost due to the possibility that the defendant may not be able to submit evidence showing that h is as likely as l (recall the discussion of proposition 1). Putting the burden on the plaintiff (i.e., $\psi(y, \phi) = 0$ for some mixed evidence y) entails less deterrence, given the possibility that the plaintiff could not produce additional evidence showing that l is more likely than h.

[10] From (4) in proposition 2, when $u = v < 1$, $Q_j(y) = 1 - u$ for all $y \in Y$, $j = h, l$.

When $u \neq v$, partial evidence acquires a different meaning. When $u = 0.6$ and $v = 0.8$, the burden is again on the plaintiff. An uninformed plaintiff then never sues since he would loose with only partial evidence, but an informed one sues if $x = e$ or f. Finally, when $u = 0.8$ and $v = 0.6$, the burden of proof is on the defendant. When the evidence is mixed, the plaintiff then always sues. If he can, the defendant will then submit counter-evidence if it is in his favor, i.e., when $x = a$ or b.

Table 1: Burden of Proof

	Evidence $x = (y, z)$					
	a	b	c	d	e	f
$p_h(x)$	0.068	0.222	0.340	0.170	0.190	0.010
$p_l(x)$	0.004	0.042	0.328	0.166	0.330	0.130
$p_l(x)/p_h(x)$	0.059	0.189	0.965	0.976	1.737	13.00

	Partial evidence y		
	af	be	cd
$\overline{p}_h(y)$	0.078	0.412	0.510
$\overline{p}_l(y)$	0.134	0.372	0.494
$\overline{p}_l(y)/\overline{p}_h(y)$	1.718	0.903	0.969

	$\overline{p}_l(y)Q_l(y)/\overline{p}_h(y)Q_h(y)$		
	af	be	cd
$u = v$	1.718	0.903	0.969
$u = .6,\ v = .8$	0.953	0.650	0.969
$u = .8,\ v = .6$	3.104	1.153	0.969

5. Court Decision-Making

In the above analysis, the liability assignment rule was part of the design of a mechanism. Society specified (and committed to) a liability assignment for all possible evidentiary outcomes. We now discuss how the determination of liability can be delegated to a court, considered as a player in the game. The difference is that the court intervenes ex post and then only if a suit is filed and on the basis of the evidence submitted. We show that the court should decide on the basis of the preponderance of evidence standard of proof, together with common law exclusionary rules. Inefficient equilibria may nevertheless also arise under the same set of rules. Directing courts as to the allocation of the burden of proof is then useful in selecting the better equilibrium.

The initial game tree is therefore extended to include a terminal stage at which, if a suit has been filed, the court receives evidence of the form (y, ϕ) or (y, z) and decides whether D is liable. The court's decision is denoted $d \in \{0, 1\}$, where $d = 1$ means that D pays damages and $d = 0$ that he does not. If no suit is filed, the situation is the same as before, i.e., there is no court action and D does not pay damages.

Thus, the game now includes the players D, P and the court. We assume that everything is common knowledge, except D's cost of care c and his action $j \in \{h, l\}$ which are private information, the partial evidence y which is initially known only to D and P, and the additional evidence z which is initially known only to D and/or P if they are informed; as before, a party does not know whether the other party observed z, neither does the court know whether parties are informed.[11]

The complete description of the game requires a specification of the court's "utility function". We do this below in discussing rules of proof. Assume for the time being that the court's decisions assign liability optimally, so that $d(y, z) = \psi^*(y, z)$ for all $y \in Y$ and $z \in Z(y) \cup \{\phi\}$. Party D's choice of care level and the outcome of the disclosure game are then the same as before. Denote by $S_j(y, z)$ the equilibrium probability of the outcome "suit is filed and court receives evidence (y, z)", conditional on care level j having been exerted.

Standard of proof and exclusionary rules

The court is assumed to be a perfect agent abiding by the rules that the law imposes upon it. We seek general rules that will induce the court to determine liability optimally. Our first requirement is for the court to decide on the basis of a "preponderance of evidence", as this standard of proof is usually understood. Thus,

[11] Note that it is also common knowledge that P suffers a loss of amount L when D takes action l. Hence, the court's role is only to decide whether D took action h or l.

the court should hold D liable if and only if, upon the evidence received, the care level l is more probable than h. Put differently, the court must seek to maximize the probability of not making errors.[12]

We first consider how this rule fares when the court receives the complete evidence. Assuming the optimal liability assignment is implemented, the probability that in equilibrium the court observes (y, z), conditional on the defendant's care level, is

$$S_j(y,z) = \begin{cases} vp_j(y,z) & \text{if } \psi^*(y,z)=1,\ \psi^*(y,\phi)=0; \\ up_j(y,z) & \text{if } \psi^*(y,z)=0,\ \psi^*(y,\phi)=1; \\ 0 & \text{otherwise, } y \in Y,\ z \in Z(y), j=h,l. \end{cases} \tag{5}$$

For instance, if the plaintiff wins under (y, z), then in equilibrium only the plaintiff submits z provided y alone was not sufficient for the plaintiff to win. This explains the top entry on the right-hand side. The second entry is for the case where the additional evidence is submitted by the defendant. In all other cases, the probability that the court observes (y, z) is nil.

Applying Bayes' theorem along the equilibrium path (i.e., when $S_h(y, z) > 0$ or $S_l(y, z) > 0$ or both[13]), the court's posterior probability about the defendant's action, given the complete evidence (y, z), is therefore

$$\pi_j(y,z) \equiv \frac{\pi_j^0 S_j(y,z)}{\pi_h^0 S_h(y,z) + \pi_l^0 S_l(y,z)} = \frac{\pi_j^0 p_j(y,z)}{\pi_h^0 p_h(y,z) + \pi_l^0 p_l(y,z)}, \quad j=h,l;\ z \in Z(y), \tag{6}$$

where the second equality follows from (5) and where π_h^0, $\pi_l^0 = 1 - \pi_h^0$ denote the court's "priors" at the start of the proceedings. Under the preponderance of evidence standard, the court finds the defendant liable if $\pi_l(y, z) > \pi_h(y, z)$ or equivalently if

$$\pi_l^0 p_l(y,z) > \pi_h^0 p_h(y,z). \tag{7}$$

Recall that the optimal mechanism generates the deterrence level δ^*. Given the distribution function G over the cost of care, this translates into a probability $G(L\delta^*)$ that the defendant exerts care. Thus, in equation (6), a Bayesian player would

[12] Equivalently, its utility function has a payoff of 1 if $d = 1$ and $j = l$ or if $d = 0$ and $j = h$, and a payoff of 0 otherwise.

[13] By assumption, $p_h(y, z) + p_l(y, z) > 0$ for all $y \in Y$, $z \in Z(y)$. Hence, when the conditions in the top or middle entry of (5) hold, one of these probabilities is positive.

compute $\pi_h^0 = G(L\delta^*)$. Obviously, except nongenerically, a court deciding according to (7) will not implement the optimal liability assignment, which requires that D pays damages if $p_l(y,z) > p_h(y,z)$.

An additional requirement is therefore introduced in the form of "evidentiary rules". We ask the court to abstract from its knowledge of the cost distribution G and to approach the case with "normative" priors $\pi_h^0 = \pi_l^0 = \frac{1}{2}$. The interpretation is that the court should hold prior odds of 1 to 1 about whether the plaintiff has a valid case and disregard information pertaining to the defendant's reputation for behaving a certain way or to his propensity to act negligently. For instance, it should put on an "equal" footing defendants drawn from two populations differing by the cost distribution G, hence differing in the actual prior probability of having exerted care. We refer to the standard of proof and evidentiary rules as the "rules of proof".

Proposition 3. *The optimal liability assignment is part of a sequential equilibrium with court decision-making constrained by the rules of proof.*

Obviously, a court abiding by the rules of proof does not minimize the actual probability of error.[14] Rather, it is as if the court sought to minimize error from the perspective of an agent holding neutral priors about the individual case upon which it has to decide. Note that this provides a way out of such classic conundrums as the "bus case" and the "gate crasher's paradox". In the latter, 600 of the 1000 people in the audience of a rock concert crashed the gate and did not pay the ticket. Assuming all legitimate ticket stubs have been lost, should someone picked at random in the audience be held liable, given that there is a 60% chance that he was a gate crasher? According to the rules of proof described above, "naked" statistical evidence pertaining to $1 - G(L\delta^*)$, i.e., the probability that a randomly chosen defendant exerted low care, should simply not be considered.[15]

[14] This is discussed further in Fluet (2003) and Demougin and Fluet (2005a).

[15] Evidentiary rules force the court to reconstruct the game tree, so to speak. One possibility is as follows. At an initial stage, Nature chooses between branch a with probability γ and branch b with probability $1 - \gamma$. Under a, the game tree described in the text ensues. Under b, the cost of care distribution differs and is now as follows: there is a fifty-fifty chance that c is zero or that it is very large. Hence, under b, deterrence does not matter and D chooses high care half of the time. The court does not observe Nature's initial move and its priors are that γ is arbitrarily small. Proposition 3 states that the optimal liability assignment is then part of a sequential (or perfect Bayesian) equilibrium in which the court seeks to minimize error.

The foregoing discussion showed that, under the rules of proof, the court's decision is consistent with the optimal mechanism when the evidence is complete. To prove proposition 3, it remains to show that this is also true when the evidence is (y, ϕ) at the close of the proceedings.

In equilibrium such an outcome only occurs when $\psi^*(y, \phi) = 1$ (i.e., the plaintiff's equilibrium action is to sue and submit only y) and the defendant is either uninformed of the true z or is informed, but gains nothing by submitting it since $\psi^*(y, z) = 1$ as well. When $\psi^*(y, \phi) = 0$, the outcome (y, ϕ) is not part of the equilibrium since an uninformed plaintiff does not sue. Therefore, the probability of "suit is filed and evidence is (y, ϕ)", conditional on the level of care, is

$$S_j(y, \phi) = \begin{cases} \overline{p}_j(y) \left[1 - u + u \sum_{z \in Z(y)} \psi^*(y, z) p_j(z \mid y)\right] & \text{if } \psi^*(y, \phi) = 1; \\ 0 & \text{otherwise, } j = h, l. \end{cases} \tag{8}$$

With normative priors, along the equilibrium path, the posterior probabilities about the defendant's action are therefore

$$\pi_j(y, \phi) = \frac{(\frac{1}{2}) S_j(y, \phi)}{(\frac{1}{2}) S_h(y, \phi) + (\frac{1}{2}) S_l(y, \phi)}, \quad j = h, l.$$

Hence, $\pi_l(y, \phi) > \pi_h(y, \phi)$ if $S_l(y, \phi) > S_h(y, \phi)$. We show that the latter holds along the equilibrium path. From proposition 2, $Q_j(y)$ can be rewritten as

$$Q_j(y) = 1 - v \sum_{z \in Z(y)} \psi^*(y, z) p_j(z \,|\, y) - u \sum_{z \in Z(y)} [1 - \psi^*(y, z)] p_j(z \,|\, y).$$

Substituting in (8), we get

$$S_j(y, \phi) = \overline{p}_j(y) \left[Q_j(y) + v \sum_{z \in Z(y)} \psi^*(y, z) p_j(z \mid y) \right], \quad j = h, l.$$

Therefore,

$$\begin{aligned} S_l(y, \phi) - S_h(y, \phi) = {} & [\overline{p}_l(y) Q_l(y) - \overline{p}_h(y) Q_h(y)] \\ & + v \sum_{z \in Z(y)} \psi^*(y, z) \left[p_l(y, z) - p_h(y, z) \right] \quad > \quad 0. \end{aligned}$$

The sign follows because $\psi^*(y, \phi) = 1$. By proposition 2, the first bracket on the right-hand-side is then positive. By proposition 1, the second expression is nonnegative.

Thus, along the equilibrium path, the court's decisions under the rules of proof implement the optimal liability assignment. In the appendix we discuss out-of-equilibrium beliefs that sustain the equilibrium.

Multiple equilibria and burden of proof

The foregoing analysis showed that the optimal liability assignment is consistent with court operating on the basis of the preponderance standard and exclusionary rules. Observe that the discussion did not refer to the allocation of the burden of proof, although section 4 showed that the optimal mechanism entailed a burden of proof assignment. Under the rules of proof, the appropriate allocation of the burden arose "spontaneously" in equilibrium, in the form of presumptions in favor of or against the defendant. However, this abstracts from the possibility that there may be other equilibria, inefficient ones, that are also consistent with the rules of proof. We illustrate this possibility with the example in Table 1.

Recall from section 4 that the defendant was said to bear the burden of proof if he is the only party with a possible incentive to submit z. The burden is on the plaintiff if he also has such an incentive. In the optimal mechanism, the defendant bears the burden when $u = .8$ and $v = .6$, i.e., he is always held liable when the partial evidence is mixed, which is when y is either af or be. By contrast, the plaintiff bears the burden when $u = .6$ and $v = .8$, since mixed evidence is then not sufficient for the plaintiff to win.

Table 2 reproduces the optimal liability assignment $\psi^*(y, \phi)$ for these two cases. We show that the court's decisions $d(y, \phi)$ represented in the table, and which assign liability differently, are nevertheless consistent with the rules of proof. The table gives $d(y, \phi)$ only for mixed evidence; in all other cases the court's decision is the same as ψ^*.

Consider first the case $u = .6$, $v = .8$. In contrast to the optimal liability assignment, it is now as if the court had a presumption against the defendant. The plaintiff therefore always sues when the evidence is mixed and he never submits z. Let $S_j(y, \phi)$ denote the probability of "suit is filed and evidence is (y, ϕ)" consistent with the court's decisions. Since the plaintiff wins under (y, ϕ), the probability $S_j(y, \phi)$ is as defined in equation (8): it is the probability of the partial evidence being y times the probability that the defendant is either uninformed or is informed of unfavorable evidence. As shown in the table, we then have $S_l(y, \phi) > S_h(y, \phi)$. Holding the defendant liable is therefore warranted under the rules of proof.

Table 2: Inefficient Equilibria

	$u = .6$, $v = .8$		$u = .8$, $v = .6$	
	Partial evidence y		Partial evidence y	
	af	be	af	be
$\psi^*(y, \phi)$	0	0	1	1
$d(y, \phi)$	1	1	1	0
$S_l(y, \phi)/S_h(y, \phi)$	3.51	1.24	5.61	0.90[a]

[a]Out of equilibrium, as described in the text.

When $u = .8$ and $v = .6$, the liability assignment under the optimal mechanism is for the defendant to bear the burden of proof. However, the court now holds a presumption against the plaintiff. In equilibrium, an uninformed plaintiff does not sue when the partial evidence is *be* since he has nothing to gain (an informed plaintiff would sue only if the complete evidence is e). Accordingly, the defendant's equilibrium strategy prescribes that he remains passive when *be* is submitted. The observation of "suit is filed and evidentiary outcome is *be*" is therefore out of equilibrium. In Table 2, the out-of-equilibrium beliefs are that an uninformed plaintiff sues by mistake with probability ε. Hence, the outcome *be* has probability $(1 - v)\overline{p}_j(y)\varepsilon$ conditional on the level of care, leading to the posterior odds in table 2.[16] Thus, under the rules of proof, the defendant is not held liable, which sustains the equilibrium.

In either case the intuition is the same. An equilibrium is based on self-sustaining "spontaneous" presumptions. These affect equilibrium strategies, which in turn affect how the evidence is interpreted, hence the possibility of multiple equilibria under the

[16]There are other possibilities. The court could rationalize the out-of-equilibrium outcome as a suit by either an uninformed plaintiff or an informed one with unfavorable evidence. This would lead to even smaller posterior odds S_l/S_h. The equilibrium is sustained as long as the court does not put too much weight on the possibility that an informed plaintiff sued on the basis of favorable complete evidence, but then "forgot" to submit z.

same rules of proof. In the analysis so far, there is no reason why the efficient presumptions should arise.

This suggests a role for additional judicial tools in order to help select the right equilibrium. One possibility is to impose on courts the allocation of the burden of proof. For instance, in cases corresponding to $u = .6$ and $v = .8$, courts should operate under the guideline that plaintiffs bear the burden. As noted in the introduction, this means that the allocation of the burden is now determined "from above" and not at the level of the particular court. This could be through statute law or on the basis of jurisprudence considered to be consistent with efficiency. The point is that the appropriate allocation of the burden does not necessarily follow from the rules of proof alone, but requires additional criteria—for instance, deterrence considerations. Obviously, a burden of proof assigned "from above" constitutes a crude guideline which in practice would apply to large classes of cases, irrespective of the detailed information only available at the court level. Thus, guidelines concerning the burden of proof will not always be sufficient to ensure coordination on the efficient equilibrium.

6. Concluding Remarks

Posner (1999) remarked that the economic literature on the law of evidence is scanty in relation to its scope and importance. While there is an already vast literature on litigation, the basic common law rules constraining court-decision making—the preponderance standard and exclusionary rules—have been little discussed from the usual standpoint of law and economics. Our analysis shows that the rules can be given a relatively straightforward efficiency interpretation. The results nevertheless warrant further considerations since our analysis abstracted from many relevant considerations: discovery rules, the costly uncovering of evidence, out-of-court settlements, and the like.[17]

An extension of the present paper would be to dwell deeper into the characterization of courts as "constrained-Bayesians". It has been noted elsewhere (in particular Daughety and Reinganum, 2000) that the trial process cannot be purely Bayesian due to evidentiary rules and other features of the procedure. The fact that discarding some

[17] See Spier (2004) for an up-to-date survey of the many issues that could have been considered and of the economic literature on litigation in general.

evidence may be useful in providing incentives has also been noted (e.g., Schrag and Scotchmer, 1994). Keeping with the general format of the present analysis, one could analyze the efficiency of exclusionary rules—i.e., under what criterion is evidence ruled admissible—when the set of litigated issues is enlarged. If the only disputed issue is a party's discretionary behavior, as was the case here, exclusionary rules and preponderance are efficient in the sense of providing maximum incentives. However, litigation may also be about a non-discretionary exogenous fact. For instance, a party's behavior may be observable without error, but there is uncertainty as to whether circumstances were such that the party was right to act the way he did. Presumably, there is no role for excluding evidence with respect to this issue—as was the case in the present paper with respect to whether a party was informed of the complete evidence. The objective would therefore be to see how far one can go in deriving the common law rules of proof under the assumption that the law's primary objective is the provision of incentives (hence the truth is assumed to have no value per se). The analytical challenge is to characterize what optimally "constrained-Bayesian" means in a more complex environment than in the present paper.

Appendix

Proof of proposition 2: We first justify the expression for $e_j(y)$ in (2). Let $Z^+(y) \subset Z(y)$ be the set of z's such that $\psi(y,z) > \psi(y,\phi)$. Similarly, let $Z^-(y) \subset Z(y)$ be the set of z's such that $\psi(y,z) < \psi(y,\phi)$. An informed plaintiff submits z only if $z \in Z^+(y)$; an informed defendant submits z only if $z \in Z^-(y)$. Then

$$\begin{aligned} e_j(y) = &\left(1 - v \sum_{z\in Z^+(y)} p_j(z\,|\,y) - u \sum_{z\in Z^-(y)} p_j(z\,|\,y)\right)\psi(y,\phi) \\ &+ v \sum_{z\in Z^+(y)} p_j(z\,|\,y)\psi(y,z) + u \sum_{z\in Z^-(y)} p_j(z\,|\,y)\psi(y,z). \end{aligned} \tag{9}$$

The expression in the right-hand side parenthesis equals

$$\left(1 - \sum_{z\in Z^+(y)} p_j(z\,|\,y) - \sum_{z\in Z^-(y)} p_j(z\,|\,y)\right) + (1-v) \sum_{z\in Z^+(y)} p_j(z\,|\,y) + (1-u) \sum_{z\in Z^-(y)} p_j(z\,|\,y).$$

This is the probability that additional evidence will not change the probability of liability compared to $\psi(y,\phi)$, plus the probability that it would have but the interested party was uninformed. Hence, it is the probability of "no change". The second term in (9) is easily seen to equal the probability of $Z^+(y)$ times the probability that the plaintiff is informed, times the expected probability of liability given $z \in Z^+(y)$. A similar interpretation holds for the third term.

Expression (9) can be rewritten as

$$\begin{aligned} e_j(y) = \psi(y,\phi) + v \sum_{z \in Z^+(y)} & p_j(z\,|\,y)\psi(y,z)\left[\psi(y,z) - \psi(y,\phi)\right] \\ & - u \sum_{z \in Z^-(y)} p_j(z\,|\,y)\left[\psi(y,\phi) - \psi(y,z)\right], \end{aligned}$$

which is equivalent to (2).

The optimal ψ maximizes deterrence defined as

$$\begin{aligned} \delta &= \sum_{y \in Y} [\overline{p}_l(y)e_l(y) - \overline{p}_h(y)e_h(y)] \\ &= \sum_{y \in Y} [\overline{p}_l(y) - \overline{p}_h(y)]\psi(y,\phi) + \sum_{y \in Y} \sum_{z \in Z(y)} [p_l(y,z) - p_h(y,z)]\tau(y,z), \end{aligned} \tag{10}$$

where we substituted for $e_j(y)$ from (2) and where

$$\tau(y,z) = v \max[0, \psi(y,z) - \psi(y,\phi)] - u \max[0, \psi(y,\phi) - \psi(y,z)]. \tag{11}$$

The second term in (10) is maximized if $\tau(y,z)$ is as large as possible when $p_l(y,z) > p_h(y,z)$ and as small as possible when $p_l(y,z) < p_h(y,z)$. Taking $\psi(y,\phi)$ as given, this implies

$$\psi(y,z) = \begin{cases} 1 & \text{when} \quad p_l(y,z) > p_h(y,z), \\ 0 & \text{when} \quad p_l(y,z) < p_h(y,z). \end{cases}$$

Thus, $\psi(y,z) = \psi^*(y,z)$ for $z \in Z(y)$, which proves the first claim in the proposition. Substituting this result in (11) and from the latter in (10) yields

$$\begin{aligned} \delta &= \sum_{y \in Y} [\overline{p}_l(y) - \overline{p}_h(y)]\psi(y,\phi) \\ &\quad + \sum_{y \in Y} \sum_{z \in Z(y)} [p_l(y,z) - p_h(y,z)] \left\{ v\psi^*(y,z)[1 - \psi(y,\phi)] - u[1 - \psi^*(y,z)]\psi(y,\phi) \right\} \\ &= v \sum_{y \in Y} \sum_{z \in Z(y)} [p_l(y,z) - p_h(y,z)]\psi^*(y,z) \\ &\qquad + \sum_{y \in Y} [\overline{p}_l(y)Q_l(y) - \overline{p}_h(y)Q_h(y)]\psi(y,\phi), \end{aligned} \tag{12}$$

where

$$Q_j(y) = 1 - v \sum_{z \in Z(y)} \psi^*(y,z) p_j(z\,|\,y) - u \sum_{z \in Z(y)} [1 - \psi^*(y,z)] p_j(z\,|\,y)$$

or equivalently

$$Q_j(y) = (1-v)(1-u) + (1-u)v \sum_{z \in Z(y)} [1 - \psi^*(y,z)] p_j(z\,|\,y) \\ + (1-v)u \sum_{z \in Z(y)} \psi^*(y,z) p_j(z\,|\,y).$$

Choosing $\psi(y,\phi)$ to maximize the second term in (12) implies

$$\psi^*(y,\phi) = \begin{cases} 1 & \text{when } \overline{p}_l(y)Q_l(y) > \overline{p}_h(y)Q_h(y), \\ 0 & \text{when } \overline{p}_l(y)Q_l(y) < \overline{p}_h(y)Q_h(y), \end{cases}$$

thereby proving the second claim. ■

Proof of corollary 1: The optimal scheme assigns liability according to the sign of

$$\eta(y) \equiv \overline{p}_l(y)Q_l(y) - \overline{p}_h(y)Q_h(y) = (1-v)\mu^+(y) + (1-u)\mu^-(y) \tag{13}$$

where

$$\mu^+(y) \equiv \sum_{z \in Z(y)} \psi^*(y,z)[p_l(y,z) - p_h(y,z)] \geq 0, \tag{14}$$

$$\mu^-(y) \equiv \sum_{z \in Z(y)} [1 - \psi^*(y,z)][p_l(y,z) - p_h(y,z)] \leq 0, \tag{15}$$

and where the sign follows from proposition 2. The burden is on the defendant if $\eta(y) > 0$ when the evidence is mixed. Now, mixed evidence implies $\mu^+(y) > 0$. Hence, $\eta(y) > 0$ when $v < u = 1$. By continuity, it follows that there exists $u_c \in (v, 1)$ such that $\eta(y) > 0$ if $u \geq u_c$. ■

Proof of proposition 3: We complete the argument in the text by specifying out-of-equilibrium beliefs. These are non trivial only when the evidence is incomplete and such that $\psi^*(y,\phi) = 0$, which can only result from the plaintiff deviating from his equilibrium strategy (the defendant's equilibrium strategy is to remain passive when such a y is submitted). There are three possibilities: the plaintiff was uninformed but nevertheless sued on the basis of y alone; he was informed, but $\psi^*(y,z) = 0$ and he nevertheless sued, disclosing only y; he was informed and $\psi^*(y,z)=1$, hence he should have sued as prescribed by the equilibrium but then "forgot" to also submit z. Out-of-equilibrium beliefs sustain the equilibrium if they put zero weight on the third possibility and put equal weight on the first two with, say, an ε probability of mistake on the part of the plaintiff. The probability of (y,ϕ), conditional on the care level, is then

$$\begin{aligned} s_j &\equiv \overline{p}_j(y)\left[1-v+v\sum_{z\in Z(y)}(1-\psi^*(y,z))\,p_j(z\mid y)\right]\varepsilon \\ &= \overline{p}_j(y)\left[Q_j(y)+u\sum_{z\in Z(y)}(1-\psi^*(y,z))\,p_j(z\mid y)\right]\varepsilon, \quad j=h,l. \end{aligned}$$

Hence,

$$\frac{s_l-s_h}{\varepsilon}=[\overline{p}_l(y)Q_l(y)-\overline{p}_h(y)Q_h(y)]+u\sum_{z\in Z(y)}(1-\psi^*(y,z))\,[p_l(y,z)-p_h(y,z)]\leq 0.$$

By proposition 2, the expression in the first bracket is nonpositive when $\psi^*(y,\phi)=0$. By proposition 1, the second term on the right-hand-side is also non positive. Thus, the defendant is not held liable under the preponderance standard, as required to sustain the equilibrium. ■

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