

# Deterrence versus Judicial Error: A Comparative View of Standards of Proof

by

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We argue that the common-law standard of proof, given the rules of evidence, does not minimize expected error as usually argued in the legal literature, but may well be efficient from the standpoint of providing maximal incentives for socially desirable behavior. By contrast, civil law’s higher but somewhat imprecise standard may be interpreted as reflecting a trade-off between providing incentives and avoiding judicial error per se. In our model, the optimal judicial system has rules resembling those in the common law when providing incentives is paramount. When greater weight is given to avoiding error, the optimal system has civil-law features. (JEL: D 8, K 4)

## 1 Introduction

A striking difference between the common-law and civil-law systems is the standard of proof in civil disputes. In common law, the party with the burden of proof need only prove his claim by a so-called “preponderance of evidence” (or on a “balance of probabilities”). A claimant’s assertion is deemed established if it appears more likely true than not true, given the evidence presented to the court. By contrast, civil-law courts ordinarily require a higher degree of certainty, often described in terms of moral certainty

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or as *intime conviction*, and sometimes also said to be akin to the standard for criminal cases.<sup>1</sup> This points to a fundamental divergence between the two major legal systems with respect to the notion of proof in civil trials. A practical implication is that a plaintiff succeeding under common law could well have lost before a civil-law court.

Among common-law scholars, the usual justification for the preponderance standard is that it minimizes the frequency of mistakes. This seems an appropriate objective in that type I and type II errors (i.e., erroneously ruling against the defendant and against the plaintiff, respectively) may be taken to have equal weights in a civil dispute. From basic decision theory, it is well known that a decision rule prescribing the rejection of the less probable hypothesis minimizes expected error.<sup>2</sup> The common-law standard of proof therefore appears to be efficient from the standpoint of establishing the truth on average. This raises the question of what substantive aims might be pursued by the more stringent civil-law standard.

SHERWIN AND CLERMONT [2002] discuss several possible reasons, but conclude that the most satisfactory is a quest for legitimacy: “The civil law may retain its high standard with the aim of increasing the apparent legitimacy of judicial decisions... The standard of *intime conviction* insinuates to the parties and the public that judges will not treat facts as true on less than certain evidence” (pp. 241, 244).<sup>3</sup> At first sight, this would seem to suggest that civil-law countries care more about mistakes. However, a strong standard only makes it more difficult for the party with the burden of proof to prevail and is in fact at odds with error minimization on average, considering both type I and type II errors. Thus, in this view, the divergence is between the error minimization strategy pursued by common law and the legitimacy-seeking strategy of civil law, legitimacy being obtained by requiring very convincing evidence to rule in favor of the party with the burden of

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<sup>1</sup>“In continental European law, no distinction is made between civil and criminal cases with regard to the standard of proof. In both, such a high degree of probability is required that, to the degree that this is possible in the ordinary experience of life itself, doubts are excluded and probability approaches certitude.” (Nagel, *Evidence*, in *Encyclopaedia Britannica: Macropaedia*, 1974). This opinion is arguably extreme.

<sup>2</sup>See DE GROOT [1970]. Reference to this result in the legal literature is relatively recent and owes to the development of Bayesian decision theory in the 1950s. See for instance BROOK [1982] and the references therein.

<sup>3</sup>Other possible reasons discussed by the authors are that civil law may be mainly concerned with settling disputes, irrespective of the “quality” of the settlement, or that it seeks to discourage suits, thus reducing litigation costs.

proof.

Sherwin and Clermont also note that there are other, subtle differences in the approach to judicial proof. First, the common-law standard is well articulated and has been much commented upon. In applications, it is both invariant and relatively unambiguous. Contrariwise, “civil law does not enunciate its civil standard too expressly, loudly, or frequently” (p. 245). While a strong one, the standard of *intime conviction* is in practice somewhat variable: “Civil law judges likely apply a haphazardly variable civil standard” (p. 247). Secondly, whether through legal presumptions or through the judge’s interventions, civil law courts are more prone to shifts in the burden of proof, be it on the basis of access to proof or of likelihood of contention.<sup>4</sup> Given a high standard, shifting the burden will at times be determinant for the outcome of the trial. In negligence trials, when the burden is on the defendant to prove due care, this is sometimes interpreted as an implicit move towards strict liability. Thirdly, in contrast to the civil law’s free evaluation principle, it is well known that evidentiary rules in common law impose specific constraints on court decision-making, in particular the inadmissibility of seemingly relevant evidence.

While Sherwin and Clermont’s legitimacy-versus-error-minimization interpretation is not unconvincing, one may question whether it fits the three stylized facts just described. In the present paper we suggest an alternative, and in some respects symmetrical, explanation for the divergence between the common-law and civil-law standards.

Our argument draws on DEMOUGIN AND FLUET [2002].<sup>5</sup> In that paper, we analyze the issue of establishing negligence when evidence about a tort-feasor’s behavior is imperfect. Thus, we consider litigation about discretionary actions. We show that in this context common-law evidentiary rules are in fact inconsistent with error minimization. The reason is straightforward. To give an example, suppose it were known from sociological studies that female physicians are generally more likely to exert due care than male physicians. Would this “fact” be allowed to influence the court’s decision in a medical liability suit? Presumably not. According to the usual exclusionary rules, neither would evidence of similar facts (e.g., whether the physician was found negligent on other occasions) or evidence of character or

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<sup>4</sup>The theory is to impose the burden of proving a claim on the party who seeks to upset an existing situation or to demonstrate something contrary to the “normal” state of affairs.

<sup>5</sup>For a similar intuition see also LANDO [2002].

of a general reputation for behaving negligently or diligently. However, the decision-theoretic error minimization argument – i.e., updating probabilities on the basis of all available information – requires that any evidence bearing on the likelihood of a claim being true be taken into account.

On the other hand, we also show that preponderance of evidence together with exclusionary rules has a very striking property: it maximizes incentives to exert due care. Thus, common-law rules may not be efficient from the point of view of minimizing expected error, as usually argued in the legal literature, but they may well be so from the standpoint of providing incentives for socially desirable behavior. To emphasize, fact-avoiding evidentiary rules are generally inconsistent with “truth-seeking” but are useful in providing incentives.<sup>6</sup> This suggests that the substantive aim underlying the common-law standard of proof may be deterrence rather than error minimization. If this is correct, how are we then to interpret the more stringent civil-law standard?

A first observation is that, if the common law does not minimize error, requiring more convincing proof than under common law is not necessarily inconsistent with less error on average. Moreover, if civil law also cares about deterrence, its high but seemingly imprecise standard of proof may result from the particular trade-off it strikes between avoiding error and providing incentives. The civil-law standard would appear imprecise because the judicial system takes into account the *a priori* likelihood of the claim being true and the social loss from inappropriate deterrence. Thirdly, as shown in the remainder of the paper, this interpretation will be reinforced if it is observed that the burden of proof is at times shifted against the party with the *a priori* less likely contention.

To investigate this hypothesis, we consider a simple model where society may be concerned both with providing incentives and with avoiding judicial error. Obviously, error also matters from a pure deterrence point of view – see POLINSKY AND SHAVELL [1989] and KAPLOW AND SHAVELL [1994]. What we have in mind is that error *per se* may be a concern. Perhaps this captures legitimacy-seeking, as suggested by Sherwin and Clermont, but a concern for error *per se* could as well be interpreted as a concern for fairness in the sense of KAPLOW AND SHAVELL [1999]. As pointed out, there is in general a trade-off between the objectives of avoiding error and providing

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<sup>6</sup>See FLUET [2003] for a comparison of the equilibrium outcome under truth-seeking courts versus courts constrained by rules of evidence.

deterrence. Their relative weight in society's utility function will be reflected in the characteristics of the judicial system (rules of procedure, standard of proof, etc.). When providing incentives is paramount, the optimal judicial system is shown to have rules resembling those in the common law. When greater weight is given to avoiding error, the optimal system has civil-law features, including a higher but apparently imprecise standard of proof and a greater propensity to shifts in the burden of proof.<sup>7</sup>

The paper develops as follows. The next section presents the basic model. Section 3 analyzes the trade-off between deterrence and avoiding error. Section 4 shows how the optimal solution relates to stylized characteristics of the judicial systems. Section 5 concludes.

## 2 The Model

We use the same basic model as in DEMOUGIN AND FLUET [2002]. Specifically, potential tort-feasors undertake a socially valuable activity, which may impose an accidental loss of amount  $L$  on a third party. The probability of causing harm depends only on the potential injurers' level of care, which is either  $h$  or  $l$  with probability of accident  $p_l > p_h > 0$ . The opportunity cost of high care is  $c$  and is distributed according to the cumulative distribution function  $G(c)$ , with corresponding density  $g(c)$  and support  $[0, \bar{c}]$ . The interpretation is that potential tort-feasors have different characteristics and therefore face different costs of care. Alternatively, an individual's cost of care depends on the circumstances in which he finds himself.

All individuals are risk-neutral. High care is the socially efficient action if it minimizes the sum of the cost of care and expected accident losses, that is, if

$$(1) \quad p_h L + c < p_l L, \quad \text{or equivalently, } c < (p_l - p_h)L.$$

Although injurers may face different costs of care, the above condition is assumed to hold in all circumstances. Thus,  $\bar{c} \leq (p_l - p_h)L$ .

Under the *strict liability rule*, individuals are held liable for any harm they may cause. This obviously induces socially efficient care provided causation

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<sup>7</sup>The economic literature on standards of proof has also focused on judicial error, but mainly in the context of criminal trials and usually with exogenously given type I and type II error costs (see RUBENFELD AND SAPPINGTON [1987], MICELI [1991], and DAVIS [1994]).

is always established without error and injurers have sufficient wealth to pay damages in full. We assume  $L$  is large compared to the injurers' wealth  $w$ . Since an injurer can then pay at most  $w$  if held liable, his private incentives are aligned with those of society if

$$(2) \quad c < (p_l - p_h)w \equiv c_S.$$

Individuals with cost of care above  $c_S$  undertake inadequate care, while others produce first-best care.

Under the *negligence rule*, an injurer is held liable following the occurrence of harm only if he is found to have exerted inadequate care. As is well known, the negligence rule may to some extent alleviate the inefficiency due to the injurers' limited wealth (see SHAVELL [1986]). When care is observed without error, a potential injurer exerts due care if  $c < p_l w$ . Since  $p_l w > c_S$ , more injurers are consequently induced to behave efficiently than under strict liability. We assume

$$(3) \quad p_l w < \bar{c},$$

which means that some potential injurers remain undeterred even under a perfect negligence rule.

Suppose now that an injurer's behavior is only imperfectly observable following the occurrence of harm. Hence, mistakes will be made under any negligence rule. Moreover, an injurer's cost of care,  $c$ , is private information. Which party bears the burden of persuasion and how evidence is evaluated characterize the negligence rule under consideration and determine the probability of being found negligent, given the level of care and the quality of the evidence likely to be available. We denote with  $\alpha_h$  the probability of a "false positive" or type I error – the injurer is found negligent even though he produced high care; similarly,  $1 - \alpha_l$  is the probability of a "false negative" or type II error – the injurer is not held liable even though he underproduced care. An injurer exercises due care if

$$(4) \quad c \leq (p_l \alpha_l - p_h \alpha_h)w \equiv c_N.$$

How  $\alpha_h$  and  $\alpha_l$  depend on legal rules is analyzed in the next sections.

Society is concerned both with incentives and with judicial error. Under the strict liability rule, given the present assumptions, there is no scope for mistakes, because no claim is ever made about an injurer's behavior – there is

no error, given that causation is always established. Society's loss is therefore equal to the expected *primary costs*, defined as the sum of the cost of care and accident losses, that is,

$$(5) \quad V_S = \int_0^{c_S} (c + p_h L) g(c) dc + [1 - G(c_S)] p_l L.$$

Under a negligence rule, primary costs will in general differ, and there is the additional social loss associated with judicial error. The total social loss under a negligence rule is written as

$$(6) \quad V_N = \int_0^{c_N} (c + p_h L) g(c) dc + [1 - G(c_N)] p_l L \\ + \lambda \{G(c_N) p_h \alpha_h + [1 - G(c_N)] p_l (1 - \alpha_l)\}.$$

The first two terms refer to primary costs, as under strict liability. In the third term, the quantity inside the curly brackets is the probability of judicial error. The parameter  $\lambda \geq 0$  is the weight of judicial error in society's loss function.

As already emphasized, the characteristics of the judicial system determine  $\alpha_h$  and  $\alpha_l$ , and therefore  $c_N$ . When a negligence rule is used, it should be structured so as to minimize  $V_N$ , thus taking into account both the probability of error and incentives to take care. Society could also decide instead to use the strict liability rule for a particular class of harm. Obviously, if society dislikes judicial error, the negligence rule is used only if it provides sufficiently more deterrence than strict liability, i.e., if  $c_N > c_S$  by an adequate margin.

### 3 Trade-offs between Deterrence and Error

The mere occurrence of an accident provides indirect information about an injurer's care, since the probability of accident is greater with low care. Any additional evidence that might be used to infer care levels is taken to be summarized by the random variable  $x$ , with cumulative distribution functions  $F_h(x)$  and  $F_l(x)$  depending on the level of care actually exerted and with density functions  $f_h(x)$  and  $f_l(x)$ , both with the same support. We assume the monotone likelihood ratio property (MLRP) and take the likelihood ratio  $f_l(x)/f_h(x)$  to be strictly decreasing in  $x$ .<sup>8</sup>

As a preliminary step, consider the expression for  $V_N$  in (7). Clearly, for any given level of type I error  $\alpha_h$ , society would want the type II error  $1 - \alpha_l$

to be as small as possible. First, this would reduce the overall probability of error, which matters if  $\lambda > 0$ ; secondly, from (4) a larger  $\alpha_l$  increases the cost threshold  $c_N$ , which means that more injurers exert due care. From Neyman and Pearson's lemma, an efficient test of hypothesis – maximizing  $\alpha_l$  for a given  $\alpha_h$  – requires that the null hypothesis “care was  $h$ ” be rejected when  $f_l(x) > k f_h(x)$ , for some constant  $k$ . Given MLRP, the null hypothesis is therefore rejected when  $x < \hat{x}$ , where the critical value  $\hat{x}$  depends on the allowed type I error and is determined by  $\alpha_h = F_h(\hat{x})$ . We write  $\alpha_l(\alpha_h)$  for the maximized  $\alpha_l$  as a function of  $\alpha_h$ . It is easily verified that this function is increasing and concave. Specifically,

$$(7) \quad \alpha_l'(\alpha_h) = \frac{f_l(x)}{f_h(x)} > 0,$$

$$(8) \quad \alpha_l''(\alpha_h) = \frac{d[f_l(x)/f_h(x)]}{dx} \left( \frac{1}{f_h(x)} \right) < 0, \quad \text{where} \quad \alpha_h = F_h(x).$$

Moreover,  $\alpha_l(0) = 0$  and  $\alpha_l(1) = 1$ .

As noted above, because of the risk of judicial error, a negligence rule should only be used if it induces a sufficiently greater proportion of individuals to exert due care than with strict liability. From (2) and (4),  $c_N > c_S$  is equivalent to

$$(9) \quad \delta \equiv p_l \alpha_l - p_h \alpha_h > p_l - p_h.$$

We refer to  $\delta$  as the level of deterrence under the set of rules inducing the particular  $\alpha_h$  and  $\alpha_l$ . Specifically, deterrence is the increase in the probability of being held liable when low rather than high care is exerted. The condition (9) holds if for some type I error

$$(10) \quad \delta(\alpha_h) = p_l \alpha_l(\alpha_h) - p_h \alpha_h > p_l - p_h.$$

Before considering the conditions under which this inequality is satisfied, we first characterize the relationship between efficient tests of hypothesis and deterrence.

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<sup>8</sup>This is without loss of generality. Suppose the evidence is multidimensional and corresponds to the random vector  $(x_1, \dots, x_n)$  with density functions  $\varphi_h(x_1, \dots, x_n)$  and  $\varphi_l(x_1, \dots, x_n)$ . Then the value of the ratio  $\varphi_h/\varphi_l$  is itself a scalar random variable satisfying MLRP. Moreover, it summarizes all that is relevant in the underlying evidence.



LEMMA 1 *Consider an efficient test rejecting the null hypothesis “care was  $h$ ” when  $p_l f_l(x) > k p_h f_h(x)$  and accepting the hypothesis when  $p_l f_l(x) < k p_h f_h(x)$ , for some given  $k$ . Then the corresponding type I error  $\alpha_h$  satisfies*

$$(11) \quad \delta'(\alpha_h) = p_h(k - 1)$$

*if (11) has a solution. Otherwise, either  $\delta'(0) < p_h(k - 1)$  and  $\alpha_h = 0$  or  $\delta'(1) > p_h(k - 1)$  and  $\alpha_h = 1$ .*

In the lemma, the expression  $p_j f_j(x)$  is the probability of an accident occurring and of observing the additional evidence  $x$ , conditional on the level of care  $j$ . In statistical terminology, it would also be referred to as the “likelihood” of care level  $j$ , given the occurrence of an accident and the realization  $x$ . Thus,  $k$  is the critical relative likelihood of low versus high care under a test using these “data.” A larger  $k$  means a greater reluctance to reject the null hypothesis that the injurer exerted high care. From (11), given the concavity of the deterrence function, this implies a smaller type I error and therefore a larger type II error. Moreover, since the associated  $\alpha_h$  is unique,  $k$  uniquely determines the level of deterrence achieved.

PROPOSITION 1 *There exists a negligence rule satisfying  $c_N > c_S$  if and only if  $p_h f_h(x) > p_l f_l(x)$  for some  $x$ .*

The condition in the proposition is about the quality of the evidence. A negligence rule may provide more deterrence than strict liability only if there is a possibility that high care appears more likely than low care following the occurrence of harm.<sup>9</sup> We now characterize the test of hypothesis that maximizes deterrence.

PROPOSITION 2 *Deterrence is maximized if the injurer is held liable when  $p_l f_l(x) > p_h f_h(x)$  and is not held liable when  $p_l f_l(x) < p_h f_h(x)$ .*

Thus, deterrence is maximized for the particular test of hypothesis obtained by setting  $k = 1$ . In words, incentives to exert care are greatest if the injurer is held liable when it appears “more likely than not” that he exerted inadequate care. Observe that the deterrence-maximizing decision rule has a remarkably simple formulation, which applies irrespective of the particulars

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<sup>9</sup>The extreme case of absolutely uninformative evidence corresponds to  $f_h(x) = f_l(x)$  for all  $x$ . Any realization  $x$  is equally probable given either  $h$  or  $l$ . The condition of Proposition 1 is then not satisfied, since  $p_l > p_h$ .

of the situation. We next characterize the optimal trade-off between the provision of incentives and the avoidance of error.

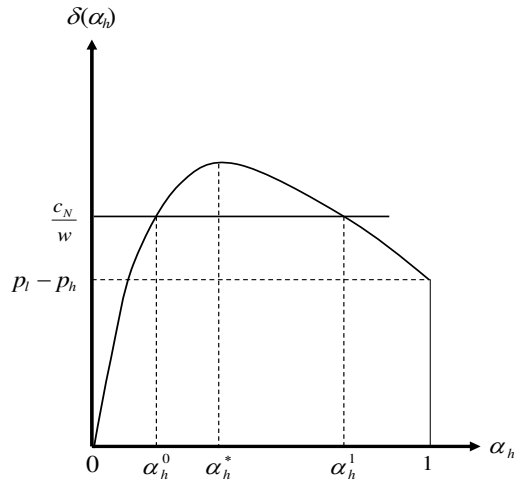
**PROPOSITION 3** *Suppose it is optimal for society to choose a negligence rule inducing the cost threshold  $c_N > c_S$ . If  $\lambda > 0$ , deterrence is not maximized and there exists  $\alpha_h^0 < \alpha_h^1$  satisfying*

$$(12) \quad c_N = w\delta(\alpha_h^0) = w\delta(\alpha_h^1),$$

*such that the chosen rule has type I error  $\alpha_h^0$  if  $G(c_N) > 1/2$  and type I error  $\alpha_h^1$  if  $G(c_N) < 1/2$ .*

The argument is illustrated in Figure 1. Deterrence can be greater than under strict liability (which amounts to setting  $\alpha_h = 1$ ) only when the condition of Proposition 1 is satisfied. Any level of deterrence above that under strict liability, but below maximum deterrence, is then consistent with two values for the type I error. One of these two values leads to a smaller overall probability of error. The smaller type I error (and hence the larger type II error) is preferable when due care is *a priori* more likely than inadequate care; that is, when the proportion  $G(c_N)$  of injurers exerting due care is greater than one-half. In contrast, there is a unique value of the type I error consistent with maximizing deterrence (labeled  $\alpha_h^*$  in the figure).

*Figure 1*  
Deterrence Curve



It is straightforward to analyze the comparative statics of the solution. A larger accidental loss  $L$  shifts the trade-off towards providing more deterrence, at the cost of more frequent errors. In the figure, this means a shift from either  $\alpha_h^0$  or  $\alpha_h^1$  towards  $\alpha_h^*$ . For instance, suppose the rule is characterized by the smaller type I error  $\alpha_h^0$ , which means that a majority of potential injurers exert due care. Larger accidental losses imply that deterrence is now relatively more valuable. As a result, in order to provide more incentives to exert care, society should be less reluctant to find an injurer negligent. This leads to an increase in the type I error and to a smaller type II error. Nevertheless, the overall probability of error increases, since careful injurers are more numerous than negligent ones. A greater weight  $\lambda$  accorded to judicial error would have the opposite effects.

#### 4 *Legal Rules*

The foregoing section analyzed the solution to society's problem but did not explicitly consider the relationship with legal rules. The focus was on solving a simple principal-agent problem, given the preferences of society as principal and assuming that evidence about injurers' behavior was exogenously made available. The issue of legal rules arises when one considers how implementation of the optimal mechanism can be delegated to courts. The question is then what set of rules (rules of procedure, standard of proof, etc.) will lead courts to choose the socially efficient solution and whether, in fact, this is at all possible through general rules, which by definition must operate in circumstances that cannot be foreseen in detail.

Consider first the case where society is not concerned with judicial error, that is,  $\lambda = 0$ . Then legal rules should be structured so as to maximize deterrence. We know from Proposition 2 that there exists a simple, invariant decision rule that does this and under which "priors" concerning the proportion of injurers exerting due care are irrelevant. One possible formulation of a legal rule is then as follows: Put the burden of proof on the victim, disregard any information about "priors," and consider negligence to be proved if and only if the likelihood of low versus high care satisfies

$$(13) \quad \frac{p_l f_l(x)}{p_h f_h(x)} > k,$$

using the particular standard of proof defined by  $k = 1$ . Alternatively, put the burden of proof on the injurer, and consider due care to be proved –

thereby allowing the injurer to escape liability – if and only if

$$(14) \quad \frac{p_h f_h(x)}{p_l f_l(x)} > k,$$

under the standard of proof  $k = 1$ . In either case, this implements the “more likely than not” criterion defined in Proposition 2.

In the above formulation, the standard of proof refers to the minimum likelihood threshold for proving a claim. This captures the notions such as the “weight of evidence” or “weight of proof” required to convince the court. The assignment of the burden of proof refers to who must prove what. Thus, if the victim has the burden of proving the defendant’s negligence, the burden of proof is discharged if the evidence shows that negligence is more than  $k$  times more likely than due care, where  $k$  is the threshold weight of evidence required. Conversely, if the burden is on the injurer to prove due care, the burden is discharged only if due care is more than  $k$  times more likely than negligence. When  $k$  is greater than unity and large, who bears the burden will obviously matter. By contrast, when the threshold is  $k = 1$ , which may be interpreted as the common law’s preponderance-of-evidence standard, the allocation of the burden of proof has no effect on deterrence.<sup>10</sup> Note that, since evidence is taken to be exogenous, a party does not need to actually produce it. The concept of burden of proof is therefore used here in the sense of the “burden of persuasion” rather than the “burden of production.”<sup>11</sup>

The appropriate legal rules can also be described in more Bayesian terms as follows. Courts should approach each case with equal “normative” probability priors about whether the injurer exerted  $h$  or  $l$ , they should update only on the basis of admissible evidence, and they should find in favor of the party with the burden of proof if the posterior probability of his claim exceeds 50%. Evidence about the proportion of injurers exerting due care would not be admissible. In summary, we have the following characterization.

**COROLLARY 1** *When  $\lambda = 0$ , an optimal legal rule is to disregard evidence about priors with respect to injurers’ behavior and to put the burden of per-*

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<sup>10</sup>In the present formulation, the evidence set satisfying  $p_l f_l(x) = p_h f_h(x)$  has measure zero, but this need not be the case when  $x$  is multidimensional. With  $k = 1$ , shifting the burden from one party to the other could then affect the type I and II errors, although with no effect on deterrence.

<sup>11</sup>In DEMOUGIN AND FLUET [2002] we also discuss the role of presumptions and burden of proof when parties can manipulate the evidence.

*suasion indifferently on the victim or on the injurer, with the standard of proof  $k = 1$ .*

Consider now the case where society is also concerned with judicial error. Obviously, priors then become relevant. More to the point, there now seems to be no simple formulation for the set of rules allowing implementation to be delegated to courts. In particular, one may question whether the concept of standard of proof, as defined above, is at all useful. The problem is that the optimal critical likelihood ratio now depends on many factors and will differ between situations. Thus, the optimal trade-off between avoiding error and providing incentives will depend on the severity of losses in the category of cases considered, on the proportion of injurers with a high cost of effort, on the productivity of effort in reducing expected losses, etc. Suppose courts indeed implement the socially efficient solution. To an outside observer bent on interpreting court decisions in terms of a standard of proof, the implicit standard would then necessarily appear “haphazardly variable,” to use Sherwin and Clermont’s words.

It is nevertheless possible to provide some characterization. Suppose  $\alpha_h$  is the optimal type I error in some particular class of cases, given that society cares about judicial error. From Lemma 1, assuming  $0 < \alpha_h < 1$ , there exists a constant  $k_v$  satisfying

$$(15) \quad \delta'(\alpha_h) = p_h(k_v - 1)$$

and such that the injurer is found liable only if  $p_l f_l(x) > k_v p_h f_h(x)$ . From the above discussion, this corresponds to the burden of proof being on the victim and to the use of the standard of proof  $k_v$ . Equivalently, the same  $\alpha_h$  also satisfies

$$(16) \quad \delta'(\alpha_h) = p_h \left( \frac{1}{k_i} - 1 \right),$$

where  $k_i$  is such that the injurer avoids liability only if  $p_h f_h(x) > k_i p_l f_l(x)$ . This corresponds to putting on the injurer the burden of proving due care, with the standard  $k_i$ . Now, by Proposition 3, if inadequate care is *a priori* unlikely,  $\delta'(\alpha_h) > 0$  and therefore  $k_v > 1$ . If due care is *a priori* unlikely,  $\delta'(\alpha_h) < 0$  and therefore  $k_i > 1$ . Thus, we have the following.

**COROLLARY 2** *When  $\lambda > 0$ , an optimal legal rule is for the victim to bear the burden of proving negligence if inadequate care is a priori unlikely, and*

*otherwise for the injurer to bear the burden of proving due care. In either case, the standard of proof satisfies  $k > 1$  and is decreasing in the amount of loss  $L$ .*

Corollary 1 suggested that, at least when the issue in dispute is the defendant's behavior, providing incentives rather than minimizing error better captures the characteristics of evidentiary rules and standard of proof in the common law. Corollary 2 suggests that the higher and imprecise standard used in civil-law courts, together with the more frequent shifts in the burden of proof, can be rationalized as resulting from a concern for judicial error. The argument is straightforward. First, using the concept of standard of proof borrowed from common law, it is possible to rationalize the use of a higher standard than preponderance if society trades off deterrence and error. Secondly, in this rationalization, the burden of proof will be on the party with the less likely contention. Thirdly, the appropriate standard would depend on circumstances, for instance, the importance of providing incentives as captured in the corollary by  $L$ .

## 5 *Concluding Comments*

Our paper suggests caution in interpreting what legal systems do or attempt to do. Standards of proof are major conceptual tools in the common law. Regarding the preponderance standard, the error-minimization interpretation is a well-established view, although common-law scholars are usually at pains to reconcile it with exclusionary rules. Starting with the premise that the preponderance standard minimizes expected error and approaching the notion of proof in civil law through the common law's notion of standards of proof, one is drawn to the conclusion that civil law accords less importance to seeking the truth.

This raises the question of what the civil law is in fact up to. The above thesis is clearly not without merit, and we do not claim to have the final word. However, as our analysis shows, it can also reasonably be argued that error minimization is a misconception of what the common law actually does. Specifically, it is a mistake to focus on the standard of proof without also taking exclusionary rules into account. One possible implication is then that civil law may, after all, accord more importance to truth-seeking.

Another implication of our analysis concerns the usefulness of simple rules, such as standards of proof in the common-law sense. Simple, un-

ambiguous rules are appropriate only if the judicial system pursues simple aims, such as either maximizing incentives or minimizing average error.<sup>12</sup> With more multidimensional aims, formulating a simple rule that will be efficient across a variety of situations does not appear feasible. In other words, more discretion is needed in order to take into account the various trade-offs in particular situations. Preponderance of evidence is certainly less equivocal than *intime conviction* or the equivalent, but it also allows the judge much less discretion. Perhaps some degree of fuzziness is useful if court rulings are to reflect conflicting aims.

### *Appendix*

PROOF OF LEMMA 1 The result follows from the concavity of  $\delta(\alpha_h)$ , i.e.,  $\delta''(\alpha_h) = p_l \alpha_l''(\alpha_h) < 0$ , and noting that

$$\begin{aligned} \delta'(\alpha_h) &= p_l \alpha_l'(\alpha_h) - p_h \\ &= p_l \frac{f_l(x)}{f_h(x)} - p_h, \quad \text{where } \alpha_h = F_h(x). \end{aligned}$$

*Q.E.D.*

PROOF OF PROPOSITION 1 Since  $\delta(1) = p_l - p_h$ , the condition (10) holds if and only if  $\delta'(\alpha_h) < 0$  for some  $\alpha_h < 1$ . Suppose  $p_l f_l(x) \geq p_h f_h(x)$  for all  $x$ . From the lemma, this implies that (11) does not have a solution for  $k < 1$ , and therefore  $\delta'(\alpha_h) \geq 0$  for all  $\alpha_h$ . Conversely, suppose  $\delta'(\alpha_h) < 0$  for some  $\alpha_h < 1$ . Then (11) has a solution for some  $k < 1$ . But the associated test then accepts the null hypothesis over a set of positive measure such that

$$p_h f_h(x) \geq \frac{p_l f_l(x)}{k} > p_l f_l(x).$$

*Q.E.D.*

PROOF OF PROPOSITION 2  $\delta(0) = 0 < p_l - p_h = \delta(1)$ ; hence deterrence is maximized for some  $\alpha_h > 0$ . If the maximum is an interior one,  $\delta'(\alpha_h) = 0$  and the lemma implies a test of hypothesis with  $k = 1$ . If the maximum

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<sup>12</sup>We focused on a very simple setup where minimizing primary costs led to a simple decision rule. In fact, as shown by GAUBE [2005], simple decision rules are not always feasible even when objectives are unidimensional.

is a corner solution at  $\alpha_h = 1$ , then  $c_N = c_S$  and Proposition 1 implies  $p_l f_l(x) \geq p_h f_h(x)$  for all  $x$ . Hence, a test of hypothesis with  $k = 1$  also maximizes deterrence. *Q.E.D.*

**PROOF OF PROPOSITION 3** Write  $V_N$  as a function of  $\alpha_h$  in (7), noting that  $c_N = w\delta(\alpha_h)$ . The first-order condition for minimizing  $V_N$  is

$$(17) \quad \begin{aligned} V'_N(\alpha_h) = & \{c_N - (p_l - p_h)L + \lambda[p_h\alpha_h - p_l(1 - \alpha_l)]\} g(c_N)w\delta'(\alpha_h) \\ & + \lambda \{G(c_N)p_h - [1 - G(c_N)]p_l\alpha'_l(\alpha_h)\} = 0. \end{aligned}$$

$c_N > c_S$  implies  $\alpha_h < 1$ . Suppose, contrary to the claim, that deterrence is maximized. Then  $\delta'(\alpha_h) = p_l\alpha'_l(\alpha_h) - p_h = 0$  and therefore

$$\begin{aligned} V'_N(\alpha_h) &= \lambda \{G(c_N)p_h - [1 - G(c_N)]p_l\alpha'_l(\alpha_h)\} \\ &= \lambda p_h[2G(c_N) - 1], \end{aligned}$$

implying that (17) can then be satisfied only if  $G(c_N) = 1/2$ , which is non-generic. Thus, generically, the solution is characterized by  $\delta'(\alpha_h) \neq 0$ , and deterrence is not maximized. Since  $c_N > c_S$ , we have  $\delta(\alpha_h) > p_l - p_h = \delta(1)$ . Given the concavity of  $\delta(\alpha_h)$  and the fact that  $\delta(0) = 0$ , there exist  $\alpha_h^0$  and  $\alpha_h^1$  satisfying (12), as claimed (see Figure 1). It follows that

$$(18) \quad \begin{aligned} V_N(\alpha_h^0) - V_N(\alpha_h^1) &= \lambda \{G(c_N)p_h\alpha_h^0 + [1 - G(c_N)]p_l(1 - \alpha_l(\alpha_h^0))\} \\ &\quad - \lambda \{G(c_N)p_h\alpha_h^1 + [1 - G(c_N)]p_l(1 - \alpha_l(\alpha_h^1))\} \\ &= \lambda p_h(\alpha_h^0 - \alpha_h^1)[2G(c_N) - 1], \end{aligned}$$

where the last equality follows from

$$p_l\alpha_l(\alpha_h^0) - p_h\alpha_h^0 = \delta(\alpha_h^0) = \delta(\alpha_h^1) = p_l\alpha_l(\alpha_h^1) - p_h\alpha_h^1.$$

Since  $\alpha_h^0 < \alpha_h^1$ , we have  $V_N(\alpha_h^0) < V_N(\alpha_h^1)$  when  $G(c_N) > 1/2$ , implying that the rule with  $\alpha_h^0$  should then be chosen; likewise, when  $G(c_N) < 1/2$ , the rule with  $\alpha_h^1$  should be chosen. *Q.E.D.*

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