Deterrence, Lawsuits, and Litigation Outcomes under Court Errors*

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Abstract

This paper presents a strategic model of liability and litigation under court errors. Our framework allows for endogenous choice of level of care and endogenous likelihood of filing and disputes. We derive sufficient conditions for a unique universally-divine mixed-strategy perfect Bayesian equilibrium under low court errors. In this equilibrium, some defendants choose to be liable; some cases are filed; and, some lawsuits are dropped, some are resolved out-of-court and some go to trial. We find that court errors in identifying liability of negligent defendants, as well as damage caps and split-awards, reduce the likelihood of dispute but increase filing and reduce the deterrence effect of punitive damages. We derive conditions under which the adoption of the English rule for allocating legal costs reduces filing.

KEYWORDS: Deterrence; Punitive Damage Awards; Bargaining; Asymmetric Information; Court Errors

JEL Categories: K41, C70, D82

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1 Introduction

Punitive damage awards have been widely criticized for being capricious and "unpredictable". It is hard to predict which actions will be deemed grossly negligent during litigation. Firms are then unable to take specific measures to avoid liability, and therefore, the deterrence effect of punitive damages[1] cannot be realized (Economic Report of the President, 2004).[2] There is also a common perception that excessive punitive damage awards[3] generate a plaintiff's windfall (i.e., an amount in excess of the costs of pursuing the punitive claim), which promotes unnecessary litigation (Dodson, 2000) and the escalation of liability insurance premiums.[4] In an attempt to overcome some of these negative effects, several US states have implemented different kinds of tort reform (Sloane, 1993). Some reforms take the form of caps or limits on punitive damage awards[5] while others, called "split-awards", have mandated that a share of the award be allocated to the plaintiff with the remainder going to the state.[6] In addition, the adoption of the English rule for allocating

[1] Punitive damages are primarily intended to punish defendants for their egregious conduct against society and to deter others from engaging in similar conduct in the future (Sloane, 1993).

[2] Besides undermining deterrence, "unpredictability" of punitive damages may also affect the incentives to file a lawsuit and to litigate.

[3] Justice O'Connor stated that punitive damage awards had "skyrocketed" more than 30 times in the previous ten years, with an increase in the highest award from $250,000 to $10,000,000 (Browning-Ferris Indus., Inc. v. Kelco Disposal, Inc., 492 U.S. 257, 282, 1989).

[4] Note that liability coverage is widely spread in the United States. In 1990, the total tort liability payments were approximately $65 billion (more than 1% of the U.S. GDP), of which 93.5% were made by liability insurers (O' Connell, 1994).

[5] Damage caps have been widely implemented in the U.S. Approximately 30 states currently employ some form of liability limits (Babcock and Pogarsky, 1999).

There exist as many different cap schemes as states that employ them. Ranging from Georgia's straightforward cap, which limits punitive damages to $250,000, to elaborate attempts to tailor punitive damages to the assets of the defendant and the degree that the defendant benefited from its tortuous conduct. Some states employ a flat dollar cap, a multiplier of compensatory damages, or some combination of both. Some caps pertain to all civil cases, while others apply to certain classes of actions, such as medical malpractice or product liability. "[T]he variety of statutory damage limitations share a common feature–they circumscribe a previously unbounded array of potential trial outcomes" (Babcock and Pogarsky, 1999; p. 345). In this paper, we employ a straightforward cap, one that limits plaintiff's recovery to a specific dollar amount. i.e., reduces average plaintiff's recovery.

[6] Split-awards have been implemented in Alaska, Georgia, Illinois, Indiana, Iowa, Missouri, Oregon, and Utah. New Jersey, California and Texas have contemplated, but not yet adopted, split-award statutes (White, 2002).

Statutes vary with the state: the base for computation of the state's share can be the gross punitive award or the award net of attorney's fees; the state's share can be 50%, 60% or 75%; the destination of the state's funds can be the Treasury, the Department of Human Services or indigent victims funds. For details, see Dodson (2000), Epstein (1994), Stevens (1994), Sloane (1993).

legal costs (fee-shifting)[7] has been proposed.[8] Proponents of split-awards state that, contrary to damage caps that reduce both the incentives to file a lawsuit and deterrence, split-awards reduce the incentives to file a lawsuit but maintain adequate levels of deterrence and punishment (Sloane, 1993).

This paper attempts to capture the main effects of tort reform of "unpredictable" punitive damages and to assess the effects of "unpredictability" of punitive awards on deterrence and litigation. We present an original game-theoretic framework, which allows for endogenous decision on care, filing and disputes under asymmetric information, heterogeneous types of case merits, and "unpredictable" punitive damages. "Unpredictable" punitive damages are modeled by assuming that ambiguously defined guidelines for assessing gross negligence generate random mistakes from the court in assessing liability of defendants. As a result, "unpredictable" punitive damages are observed.[9] We then apply this framework to study the effects of court errors, damage caps and split-awards. Finally, we extend our benchmark model to study the effects of fee-shifting.

Our model consists of three stages. In the first stage, the potential injurer decides between taking due care or being negligent. This decision depends on the cost of preventing accidents and on the expected litigation loss in case of an accident. The level of care determines the probability that an accident occurs. If an accident occurs, the second stage, called the filing stage, starts. Nature decides the merit of the plaintiff's case from a continuum of types and informs the type to the plaintiff. The potential plaintiff then decides whether to file a lawsuit. If a lawsuit is filed, the third stage, called the pre-trial bargaining stage, starts. It consists of a signaling-ultimatum game, where two Bayesian risk-neutral parties, an uninformed plaintiff and an informed defendant,[10] negotiate prior to a costly trial. We derive sufficient conditions for a unique universally-divine

[7]Under the American rule each party pays her own litigation costs at trial. In contrast, under the English rule the loser at trial pays the litigation costs of the winner.

[8]Florida temporarily adopted (for the period 1980-1985) a mandatory fee-shifting rule in medical malpractice cases (see Hughes and Snyder, 1995; Snyder and Hughes, 1990).

[9]"In most states, there is an statute describing the conditions under which punitive damages may be awarded ... These statutes merely provide guidelines for awarding punitive damages. Because the guidelines have not been formulated into exact rules, there is much uncertainty about when punitive damages can be awarded." (Cooter and Ulen, 2004, p. 372).

[10]The defendant possesses information about its level of care and the decision of the court should the case go to trial.

(Banks and Sobel, 1987) mixed-strategy perfect Bayesian equilibrium under low court errors. In this equilibrium, some defendants choose to be liable; some cases are filed; and, some lawsuits are dropped, some are resolved out-of-court and some go to trial. We find that court errors in identifying liability of negligent defendants, as well as damage caps and split-awards, reduce the likelihood of dispute but increase filing and reduce the deterrence effect of punitive damages. We derive conditions under which the adoption of the English rule for allocating legal costs reduces filing.

Our analysis has several policy implications. First, it points to the significance of the strategic behavior of plaintiff and defendant for the analysis of the effects of tort reform on deterrence. In particular, the analysis indicates that damage caps and split-awards may reduce the expected loss for a negligent defendant and therefore both may reduce deterrence. Second, the analysis underlines the importance of the defendant's care decision for the study of the effects of tort reform on filing. It indicates that damage caps and split-awards may increase the plaintiff's expected payoff from suing by increasing the likelihood of confronting negligent defendants. Therefore, caps and split-awards may increase filing of lawsuits.

To the best of our knowledge, Hylton (1993) and Hylton (2002) are the only two papers that analyze liability and litigation using game-theoretic models which allow for endogenous decision on care, filing and disputes under asymmetric information and court errors. Hylton (1993) studies the effects of the English rule under certain model parameterization and finds that the likelihood of disputes and deterrence (when legal costs are high) are higher under the English rule. Hylton (2002) examines settlement rates, plaintiff win rates and compliance with the due-care standard. He also assesses the effects of the English rule under certain model parameterization and finds that this rule is superior to the American rule in terms of social welfare. The effects of court errors on settlement are ambiguous. The effects of court errors on deterrence and filing, and the effects of damage caps and split-awards are not analyzed.

Png (1987) and Landeo and Nikitin (2004) study tort reform by constructing game-theoretic models, which allow for endogenous decision on care and disputes under asymmetric information.

Filing and court errors are not studied. Png (1987) analyzes the effects of damage caps, changes in the negligence standard and the adoption of the English rules, and finds that damage caps reduce the investment in precaution, and fee-shifting lowers the level of care for careful defendants, increases the level of care for negligent defendants, and increases the frequency of trial. The effect of damage caps on disputes is ambiguous and the effects of damage caps on filing is not studied. Landeo and Nikitin (2004) extend previous work on split-awards (Kahan and Tuckman, 1995; Daughety and Reinganum, 2003)[11] by including the analysis of deterrence. Their model predicts that, holding filing constant, a decrease in the plaintiff's share of the award decreases the conditional probability of trial. In addition, split-awards reduce the expenditures on safety.

Snyder and Hughes (1990) and Hughes and Snyder (1995) empirically study the effects of the adoption of the English rule in Florida and find that the English rule increases plaintiff success rates at trial and the average jury awards. These findings suggest that the English rule lowers the filing and dropping of low-merit cases. Babcock and Pogarsky (1999) analyze the effect on settlement rates of a damage cap set lower than the value of the underlying claim, using a bargaining experiment. They find that damage caps constrain the parties' judgments and produce more settlement. Landeo, Nikitin, and Babcock (2004) experimentally study split-awards and find that this reform reduces disputes rates.

The paper is organized as follows. Section Two presents the setup of the benchmark model and describes the equilibrium solution. Section Three analyzes the effects of court errors, split-awards, and damage caps under this benchmark model. Section Four presents a modified version of the model under the English rule as a method for allocating legal costs and describes the effects of fee-shifting. Section Five contains concluding remarks and outlines possible directions for further research.

[11] Kahan and Tuckman (1995) construct a simultaneous-move game between a plaintiff and a defendant and find, in the absence of agency problems, that split-awards reduce the plaintiff's litigation expenses and, consequently, reduce the expected amount paid by the defendant. Daughety and Reinganum (2003) incorporate asymmetry of information and strategic behavior to the study of split-awards by modeling the pre-trial bargaining as a game of incomplete information. They find that holding filing constant, split awards simultaneously lower settlement amounts and the likelihood of trial.

2 The Benchmark Model

We model the interaction between a potential injurer[12] and a potential plaintiff, as a sequential game of asymmetric information under court errors. In this benchmark model, we assume that the allocation of the legal costs follows the American rule, i.e., each party pays its own legal costs.

We focus our analysis on an equilibrium in which, some defendants choose to be liable; some weak cases are filed; and, some lawsuits are dropped, some are resolved out-of-court and some go to trial. This equilibrium resembles the actual state of affairs of lawsuit termination.[13]

2.1 Model Setup

The potential injurer first decides its optimal level of care e, i.e., the one that minimizes its total expected loss L, where $e \, \epsilon \{0, 1\}$. We define the defendant's total expected loss function as $L = c(e) + \lambda(e)l$, where l is the expected loss from legal action. We take this loss as parametric in order to describe L, but ultimately l will be derived as the continuation value of the litigation stage, and hence it will differ for negligent and careful defendants. The endogenous probability that a defendant is careful is represented by p. The choice of level of care is privately known by the defendant. The potential plaintiff knows only that the defendant can choose between two possible levels of care. High level of care e^1 costs the injurer c, while low level of care e^0 costs nothing. The probability of accidents is $\lambda(e)$, where $\lambda^1 = \lambda(e^1) < \lambda(e^0) = \lambda^0$. The injurer is careful if the level of care chosen is $e = 1$, otherwise, the injurer is negligent.

If an accident occurs, the filing stage starts. Nature first decides the potential plaintiff's filing cost K_F from a continuum of filing costs. K_F is exogenous and represents the merits of the case. Low filing costs imply higher case merits (i.e., lower lawyer's effort in preparing the case). K_F is distributed on $[0, \bar{K}_F]$. We define $\phi(.)$ and $F(.)$ as the probability density and cumulative density functions of the distribution of plaintiffs by filing cost, respectively. The realization of K_F

[12] We will use the terms potential injurer and defendant interchangeably.

[13] Data from the U.S. Department of Justice indicate, for a sample of the largest 75 counties (1-year period ending in 1992), that 76.5% of product liability cases were disposed through agreed settlement and voluntary dismissal and 3.3% were disposed by trial verdict. The other 20.2% were disposed as follows: 4.5% by summary judgment, 0.5% by default judgment, 6% were dismissed, 2.7% by arbitration award, 6.1% by transfer, and 0.3% by other dispositions (Smith et al., 1995).

is revealed only to the potential plaintiff but $\phi(.)$ and $F(.)$ are common knowledge. Then, the potential plaintiff decides whether to file a lawsuit. The filing decision is based on the potential plaintiff's filing costs K_F and her beliefs about the negligence of the defendant conditional on the occurrence of an accident. With probability q she believes that the defendant is negligent, and with probability $(1-q)$ she believes that the defendant is careful.[14] A potential plaintiff will file a lawsuit if its expected payoff from suing (i.e., expected litigation payoff minus the cost of filing) is positive. The endogenous probability that a lawsuit is filed is represented by m.

If a lawsuit is filed, a pre-trial bargaining negotiation starts. It is modeled as a signaling-ultimatum game between two Bayesian risk-neutral players, a potential injurer and a potential plaintiff.[15] The defendant has the first move and makes a settlement proposal. After observing the proposal, the plaintiff, who knows only the two possible choices of care that the defendant can choose, decides whether to drop the case, to accept the defendant's proposal (out-of-court settlement) or to reject the proposal (bring the case to the trial stage). The plaintiff's decision is based on her updated beliefs about the type of defendant she is confronting after observing the defendant's proposal. If the plaintiff drops the case, both players incur no legal costs. If the plaintiff accepts the defendant's proposal, the game ends and the defendant pays the amount proposed to the plaintiff.

If the plaintiff rejects the proposal, plaintiff and defendant incur exogenous legal costs (K_P and K_D, respectively) and the court decides whether to award punitive damages A to the plaintiff. We assume that A represents average plaintiff's recovery. "Unpredictable" punitive damages are modeled by assuming that ambiguously defined guidelines for assessing gross negligence generate random mistakes from the court in assessing liability of defendants. If the defendant is grossly negligent, with probability τ_1, the court erroneously identifies the defendant as a careful one and does not award punitive damages; and with the complementary probability $(1-\tau_1)$, the court

[14] The values for q and $(1-q)$ are taken as parametric during the pre-trial bargaining subgame, but they ultimately depend on the optimal decision of filing by the plaintiff and on the optimal levels of care chosen by the injurer in the first stage of the game, according to the cost of care and his expected litigation costs (that correspond to the equilibrium in the pre-trial litigation stage).

[15] We model the pre-trial bargaining stage by following Png (1987) and Landeo and Nikitin (2004).

awards punitive damages A. If the defendant is careful, with probability τ_2, the court erroneously identifies the defendant as a grossly negligent one and awards punitive damages A; and with the complementary probability $(1 - \tau_2)$, the court does not award punitive damages. Under the split-award regime, the plaintiff receives only a fraction f of the total punitive award and the state gets a share $(1 - f)$ of the award. We employ here a straightforward definition of cap, one that limits the plaintiff's recovery to a specific dollar amount, and therefore, reduces the average plaintiff's recovery.

The sequence of events in the game is shown in Figure 1.

[**INSERT FIGURE 1**]

Note that the total harm caused by an accident includes: 1) the private harm caused to the plaintiff, which we assume is fully compensated with the compensatory damage award; and, 2) the average social harm H, generated by the defendant's wanton behavior, and which warrants punitive damages. H may include additional losses directly caused to the plaintiff but not compensated with the compensatory award, such as time spent on and emotional distress caused by the compensatory damages lawsuit; and, social losses such as undermining of society's moral standards and institutions due to the wanton behavior of the defendant. Given that we have not assumed that the court perfectly estimates the social harm caused by the negligent behavior of the defendant, our model allows for H and A to be different. Given that A is determined by the jury and the information about the split-award statute is supposed to be kept from the jury, A does not depend on f. Then, we will treat A and f as exogenous parameters of the model.

Note also that, without loss of generality, for the sake of mathematical tractability and given that our primary goal is to explore the effect of tort reform on punitive damages (i.e., damage caps and split-award statute), we abstract from compensatory damages.[16]

[16] The model can be modified to incorporate compensatory damages, without altering the qualitative predictions presented here, in the following way. Assume that the court awards compensatory damages CDA (common-knowledge) whenever the accident happens (i.e., strict liability applies), but it awards punitive damages A only if the firm fails to achieve the due care standard for gross negligence. Assume also bifurcation of trial, i.e. two separate trials decide on compensatory and punitive damage awards; that the compensatory damages game has the same structure as the punitive damages game presented here; and that legal costs, K_{PCDA} and K_{DCDA} are paid by the plaintiff and defendant, respectively, only in case of trial. Then, in case of an accident, the plaintiff and the defendant do not have

2.2 Equilibrium under Low Court Errors

We focus our analysis on the equilibrium under low court errors, i.e., τ_1 and τ_2 are below some threshold, and $\tau_1+\tau_2 < 1$. This characteristic of court errors conforms to the empirical findings.[17] In this equilibrium, some defendants will choose to be negligent, while others will choose to be careful; and some weak cases are filed. In addition, some negligent defendants reveal their negligence through offers to settle, which are accepted by plaintiffs. Other negligent defendants try to hide their type by mimicking the behavior of careful defendants and make no offer. There is a sufficient number of those negligent and " dishonest" defendants for the information provided to the plaintiff by the action chosen by the defendant (refusal to settle) to be not transparent. Therefore, some plaintiffs respond to a refusal to settle by bringing their case to trial, while others drop their action.

This equilibrium constitutes the unique perfect Bayesian equilibrium of the game that survives Banks and Sobel's (1987) universal divinity refinement[18] under the following conditions:

$$(1-\tau_1)fA - K_P > \tau_2 A + K_D, \tag{1}$$

$$0 \leq \tau_1 < min\left\{\bar{\tau_1}, 1 - \frac{F^{-1}(m) + K_P}{fA}\right\}, \tag{2}$$

$$0 \leq \tau_2 < min\left\{\bar{\tau_2}(\tau_1), \frac{K_P}{fA}\right\}, \tag{3}$$

where $m = \frac{c}{[(1-\tau_1)fA - K_P)]\left[\lambda^0 - \lambda^1 \frac{(\tau_2 A + K_D)}{(1-\tau_1)A + K_D}\right]}$. $\bar{\tau_1}$ and $\bar{\tau_2}(\tau_1)$ correspond to the values for τ_1 and τ_2 for which $m = 1$ (see Proof of Proposition 1 in Appendix A).

Condition (1) rules out the pooling equilibrium where careful defendants behave as negligent defendants in the pre-trial bargaining stage. It also guarantees that at least some potential plaintiffs file a lawsuit (i.e., it ensures $m > 0$).[19] Conditions (2) and (3) guarantee that some but not all

asymmetric information with regard to prospective compensatory damage awards, and therefore, they settle out of court. Thus, every defendant will offer $CDA - K_{PCDA}$, and every plaintiff will accept.

Thus, the total loss function is given by $L = c(e) + \lambda(e)(CDA - K_{PCDA} + l)$, where l is the expected loss from legal action related to punitive damages. It is easy to show that all qualitative results presented in Sections 4 and 5 will hold.

[17] Tullock (1980) estimates the probability of legal error generally to be about 0.13.

[18] See Reinganum and Wilde (1986), Schweizer (1989), and Landeo and Nikitin (2004) for previous applications of the universal divinity refinement to litigation games.

[19] In addition, it ensures that $\tau_1 + \tau_2 < 1$.

defendants choose to be negligent (i.e., they ensure $q < 1$ and $q > 0$, respectively). Additionally, conditions (2) and (3) ensure that not all potential plaintiffs file a lawsuit (i.e., they ensure $m < 1$). Then, conditions (2) and (3) rule out the pooling perfect Bayesian equilibrium, where the deterrence effect of punitive awards totally vanishes. In this pooling equilibrium, no defendant chooses to be careful, all injured plaintiffs file a lawsuit and all cases are settled out-of-court.[20]

Under conditions (1)–(3), however, the pre-trial bargaining subgame has other partially separating equilibria[21] and other pooling equilibria, but they do not survive the universal divinity refinement (see Appendix A for details).

Proposition 1 characterizes the unique universally divine equilibrium of the game.

Proposition 1. Assume that conditions (1)–(3) hold. Then, the following strategy profile, together with the players' beliefs, represents the equilibrium path of the unique universally divine Perfect Bayesian equilibrium of the game.

Strategy Profile

1) The plaintiff files a lawsuit with probability $m = \frac{c}{[(1-\tau_1)fA-K_P]\left[\lambda^0-\lambda^1\frac{(\tau_2 A+K_D)}{(1-\tau_1)A+K_D}\right]}$. In response to an offer $S_1 = 0$, the plaintiff rejects the offer (goes to trial) with probability $\alpha = \frac{(1-\tau_1)fA-K_P}{(1-\tau_1)A+K_D}$ and accepts the offer (drops the action) with probability $(1-\alpha)$; the plaintiff always accepts the offer $S_2 = (1-\tau_1)fA - K_P$ (settles out-of-court).

2) The defendant chooses to be careful with probability $p = \frac{\left[\frac{(1-\tau_1)fA-F^{-1}(m)-K_P}{fA(1-\tau_1-\tau_2)}\right]\lambda^0}{\left[\frac{(1-\tau_1)fA-F^{-1}(m)-K_P}{fA(1-\tau_1-\tau_2)}\right]\lambda^0+\left[\frac{F^{-1}(m)+K_P-\tau_2 fA}{fA(1-\tau_1-\tau_2)}\right]\lambda^1}$. The negligent defendant makes no offer (offers $S_1 = 0$) with probability $\beta = \frac{(K_P-\tau_2 fA)(1-q)}{q[(1-\tau_1)fA-K_P]}$ and offers $S_2 = (1-\tau_1)fA - K_P$ with probability $(1-\beta)$. The careful defendant always makes no offer (offers $S_1 = 0$).

Plaintiff's Beliefs

[20] Intuitively, at high levels of court error (i.e., when $\tau_1 \geq \bar{\tau}_1$ or $\tau_2 \geq \bar{\tau}_2$), the incentives for filing are maximized, and the highest level of filing is achieved, i.e., $m = 1$. At those levels of error, filing is insensitive to the liability of defendants, and therefore, there are not incentives to invest in care.

[21] These other partially separating equilibria do not allow for cases to be dropped, and therefore, they do not conform to the empirical regularities on termination of lawsuits.

The equilibrium beliefs are as follows. If an accident occurs, the plaintiff believes with probability $(1-q)$ that she is confronting a careful defendant, and with probability q that she is confronting a negligent defendant. When the plaintiff receives an offer, she updates her beliefs using Bayes' rule: when she receives an offer $S_1 = 0$, she believes with probability $\frac{(1-q)}{q\beta+(1-q)}$ that she is confronting a careful defendant and with probability $\frac{q\beta}{q\beta+(1-q)}$ that she is confronting a negligent defendant; when the plaintiff receives an offer $S_2 = fA - K_P$, she believes with certainty that she is confronting a negligent defendant. The off-equilibrium beliefs are as follows. When the plaintiff receives an offer S' such that $0 < S' < (1-\tau_1)fA - K_P$ or when she receives an offer $S' > (1-\tau_1)fA - K_P$, she believes that this offer was made by a negligent defendant.

Proof. See Appendix A.

Although the model is solved formally in Appendix A, here we outline the main steps of the solution. The model is solved backwards. We start by finding the solution of the pre-trial bargaining subgame.[22] Then, we evaluate the plaintiff's filing decision and assess the defendant's choice of care.

Consider the expected payoffs for the plaintiff, careful and negligent defendants, in terms of α and β. The expected payoff for the plaintiff is $V_P = (1-q)[\alpha(\tau_2 fA - K_P) + (1-\alpha)(0)] + q\{\beta[\alpha[(1-\tau_1)fA - K_P] + (1-\alpha)(0)] + (1-\beta)[(1-\tau_1)fA - K_P]\}$; the expected payoff for the careful defendant is $V_{D_C} = \alpha(-\tau_2 A - K_D) + (1-\alpha)(0)$; and, the expected payoff for the negligent defendant is $V_{D_N} = \beta[\alpha(-((1-\tau_1)A + K_D)) + (1-\alpha)(0)] + (1-\beta)[-((1-\tau_1)fA - K_P)]$.

The values of α and β are calculated from the condition that both parties (the plaintiff and the negligent defendant) have to be indifferent between their strategies to mix them. So,

$$(1-\tau_1)fA - K_P = \alpha[(1-\tau_1)A + K_D] + (1-\alpha)(0), \tag{4}$$

[22] The values for q and $(1-q)$ are taken as parametric during the pre-trial bargaining subgame, but they ultimately depend on the optimal filing decision by the plaintiff and on optimal levels of care chosen by the injurer in the first stage of the game, according to the cost of care and his expected litigation costs (that correspond to the equilibrium in the pre-trial litigation stage).

and

$$0 = \frac{q\beta}{q\beta + (1-q)}[(1-\tau_1)fA - K_P] + \frac{1-q}{q\beta + (1-q)}(\tau_2 fA - K_P). \tag{5}$$

Equation (4) says that a negligent defendant is indifferent between admitting his negligence (i.e., offering $S_2 = (1-\tau_1)fA - K_P$) and stating that he is careful (i.e., offering $S_1 = 0$) with the risk to lose $(1-\tau_1)A + K_D$ if the case goes to court. Equation (5) says that a plaintiff is indifferent between dropping the case and getting a payoff of $S_1 = 0$ and going to court. Solving (4) for α and (5) for β, we get

$$\alpha = \frac{(1-\tau_1)fA - K_P}{(1-\tau_1)A + K_D}, \tag{6}$$

and

$$\beta = \frac{(K_P - \tau_2 fA)(1-q)}{q[(1-\tau_1)fA - K_P]}. \tag{7}$$

The expected litigation payoffs for the plaintiff and careful and negligent defendant are $V_P = [q(1-\tau_1) + (1-q)\tau_2]fA - K_P$, $V_{D^1} = -\left[\frac{(1-\tau_1)fA - K_P}{(1-\tau_1)A + K_D}\right](\tau_2 A + K_D)$ and $V_{D^0} = -[(1-\tau_1)fA - K_P]$, respectively.

The conditional probability of trial is

$$\alpha[1 - q(1-\beta)] = \frac{fA(1-q)(1-\tau_1-\tau_2)}{(1-\tau_1)A + K_D}. \tag{8}$$

Using the previous results on plaintiff's expected payoff from litigation, we analyze now the plaintiff's decision about filing.

A plaintiff will file a lawsuit if her expected payoff from suing (i.e., expected litigation payoff net of filing costs) is positive, that is if

$$[q(1-\tau_1) + (1-q)\tau_2]fA - K_P - K_F > 0. \tag{9}$$

Then, the probability of filing is

$$F(q(1-\tau_1)fA + (1-q)\tau_2 fA - K_P) \equiv m. \tag{10}$$

Now, we will proceed to analyze the defendant's choice of care. The defendant decides the level of care y taking into account $L^i = c(y^i) + m\lambda^i l^i$ $(i = 0, 1)$, where l^i is the expected loss from legal action, different for careful and negligent defendants.

$$\begin{cases} c + m\lambda^1 l^1 & \text{if} \quad y^1 \\ 0 + m\lambda^0 l^0 & \text{if} \quad y^0 \end{cases} \tag{11}$$

where c is the cost of care (i.e., cost of choosing to be careful); m is the probability that a lawsuit is filed; λ^i is the probability of an accident; $l^0 = [(1-\tau_1)fA - K_P]$ is the expected litigation loss for a negligent defendant, $l^1 = \left[(\frac{(1-\tau_1)fA-K_P}{(1-\tau_1)A+K_D}\right](\tau_2 A + K_D)$ is the expected litigation loss for a careful defendant.

We construct an equilibrium in which some defendants choose to be careful and others choose to be negligent. This is the equilibrium behavior that conforms to the asymmetry of the pre-trial bargaining subgame and to the real-world behavior of potential injurers.

The defendant will randomize only if he is indifferent between the expected payoffs from both strategies.

$$c + m\lambda^1 \left[\frac{(1-\tau_1)fA - K_P}{(1-\tau_1)A + K_D}\right](\tau_2 A + K_D) = m\lambda^0[(1-\tau_1)fA - K_P]. \tag{12}$$

This condition can be rewritten as

$$c = m[(1-\tau_1)fA - K_P]\left[\lambda^0 - \lambda^1 \frac{(\tau_2 A + K_D)}{(1-\tau_1)A + K_D)}\right], \tag{13}$$

where the left-hand side of equation (13) represents the defendant's cost of accident prevention and the right-hand side represents the defendant's benefit from accident prevention, i.e., difference in the unconditional expected litigation costs for negligent and careful defendants.

From equation (12), the indifference condition for randomization between y^1 and y^0, we find m, the probability of filing that supports the randomization of choice of care.

$$m = \frac{c}{[(1-\tau_1)fA - K_P)]\left[\lambda^0 - \lambda^1 \frac{(\tau_2 A + K_D)}{(1-\tau_1)A + K_D}\right]}. \tag{14}$$

It is important to note, that $m > 0$ because $\lambda^0 > \lambda^1$ (by assumption) and because condition (2) ensures that $\frac{\tau_2 A + K_D}{(1-\tau_1)A + K_D} < 1$. In addition, conditions (3) and (4) guarantee that $m < 1$ (see Proof of Proposition 1 in Appendix A).

Now we can obtain q, the probability that an accident is caused by a negligent defendant. From equation (10),

$$q(1-\tau_1)fA + (1-q)\tau_2 fA - K_P = F^{-1}(m). \tag{15}$$

Then,

$$q = \frac{F^{-1}(m) + K_P - \tau_2 fA}{fA(1-\tau_1-\tau_2)}. \tag{16}$$

The expression for q is always positive, because $K_P > \tau_2 fA$ by condition (3). In addition, condition (2) implies that $q < 1$ (see Proof of Proposition 1 in Appendix A).

Then, p, the probability that a defendant chooses to be careful is given by

$$p = \frac{\lambda^0(1-q)}{\lambda^0(1-q) + \lambda^1 q}. \tag{17}$$

Equivalently,

$$p = \frac{\left[\frac{(1-\tau_1)fA - F^{-1}(m) - K_P}{fA(1-\tau_1-\tau_2)}\right]\lambda^0}{\left[\frac{(1-\tau_1)fA - F^{-1}(m) - K_P}{fA(1-\tau_1-\tau_2)}\right]\lambda^0 + \left[\frac{F^{-1}(m) + K_P - \tau_2 fA}{fA(1-\tau_1-\tau_2)}\right]\lambda^1}. \tag{18}$$

Using the previous results, the probability of accident is $\mu = \lambda^1 p + \lambda^0(1-p)$, where p is given by equation (18). Now, we can derive the unconditional probability trial. The probability of trial conditional on occurrence of the accident is $\frac{fA(1-q)(1-\tau_1-\tau_2)}{(1-\tau_1)A+K_D}$, then the unconditional probability of trial is $\frac{fA(1-q)(1-\tau_1-\tau_2)}{(1-\tau_1)A+K_D} m\mu$. Given that $(1-q) = \frac{\lambda^1 p}{\lambda^0(1-p)+\lambda^1 p}$ is the probability that a defendant has been careful conditional on the occurrence of an accident, then, the unconditional probability of trial is equal to $\frac{fA\lambda^1 p(1-\tau_1-\tau_2)}{(1-\tau_1)A+K_D} m$, where m is given by equation (14) and p is given by equation (18).

3 Comparative Statics under the Benchmark Model

This section analyzes the effects of court errors, damage caps and split-awards, on the likelihood of disputes (conditional probability of trial) and filing (m), on the deterrence effect of punitive awards (p), and on the probability of an accident (μ). We assume that the changes in τ_1, τ_2, A, or f are small enough to preserve conditions (1)–(3).

3.1 Effects of Court Errors

Punitive awards have been widely criticized for their "unpredictability". It has been argued that this "unpredictability" lowers the deterrence effect of punitive damages. We show here that court errors in assessing liability of negligent defendants indeed lower deterrence. In addition, court errors increase filing but reduce the likelihood of disputes.

Proposition 2. An increase in the probability that a negligent defendant will be erroneously found no liable by the court, τ_1, decreases the probability of disputes, increases the probability of filing, decreases the deterrence effect of punitive awards and therefore, increases the probability of an accident.

Proof. See Appendix A.

An increase in τ_1 reduces the plaintiff's expected payoff from suing (expected litigation payoff net of filing cost) by lowering the expected recovery at trial. But, an increase in τ_1 also increases the plaintiff's expected payoff from suing by reducing deterrence and therefore, increasing the probability that an accident is caused by a negligent defendant q. This effect operates as follows. An increase in τ_1 reduces the expected litigation losses for a negligent defendant, and therefore, reduces the difference in expected litigation losses for careful and negligent defendants (i.e., potential injurer's benefit from taking care). Then, deterrence is reduced (and probability of accidents is increased), and therefore, the probability that an accident is caused by a negligent defendant, q, increases. We show that the increase in the plaintiff expected payoff from suing (due to an increase in q) offsets the reduction due to a lower expected recovery at trial. Hence, the probability of filing increases.[23]

In addition, given that an increase in τ_1 reduces the likelihood that a negligent defendant will be found liable in court, plaintiffs are less willing to go to court and therefore, plaintiffs accept

[23] Note that the increase in filing increases the incentives to take care. However, the effect of τ_1 on the difference in expected litigation losses for careful and negligent defendants offsets this second effect. As a consequence, an increase in τ_1 reduces deterrence.

more frequently out-of-court offers, i.e., the probability of rejection of a zero-offer by the plaintiff, α, goes down.[24] Hence, the probability of trial decreases.

Proposition 3. An increase in the probability that a careful defendant will be erroneously found liable by the court, τ_2, increases the probability of filing.

Proof. See Appendix A.

An increase in τ_2, i.e., an increase in the likelihood that a careful defendant will be found erroneously liable by the court, increases the plaintiff's expected payoff from suing. Thus, the incentives to file a lawsuit are higher and the probability of filing increases.[25]

3.2 Effects of Damage Caps and Split-Awards

We assess the effects of the adoption of damage caps and split-awards. Given that damage caps reduce the average plaintiff's recovery at trial A, the adoption of damage caps is represented by a reduction in A. The introduction of split-awards is represented by a reduction in f, the plaintiff's share of the punitive award.

Proponents of split-awards argue that, in contrast to caps that reduce both the plaintiff's windfall and the deterrence effect of the punitive awards, the split-award statute constitutes a "move toward effectuating the true purpose of punitive damages" (Sloane, 1993, p. 473).[26] They claim that split-awards reduce the plaintiff's windfall but maintain adequate levels of deterrence and punishment.[27] These claims are based on the observation that both, split-awards and damage caps

[24] Note also that an increase in τ_1 reduces the expected loss at trial for a negligent defendant $(1 - \tau_1)A + K_D$, and therefore, reduces the willingness of negligent defendants to make positive out-of-court offers (i.e., increases the likelihood that a zero offer comes from a negligent defendant). This will decrease the plaintiff's willingness to accept zero offers (i.e., increases α). However, we show that this latter effect is offset by the first effect of τ_1 (reduction in α).

[25] The effects of τ_2 on the deterrence effect of punitive awards, and on the probabilities of an accident and disputes are ambiguous.

[26] The main purposes behind the award of punitive damages are to punish defendants for their egregious conduct against society and to deter others from engaging in similar conduct in the future. In addition, punitive damages serve to encourage plaintiffs to bring forth minor criminal offenses that are not likely to be prosecuted yet nonetheless are offensive to society, and compensate plaintiffs for their attorneys' fees (Sloane, 1993).

[27] In addition, split-awards allow the plaintiffs to receive a share of the awards for payment of attorney fees and rewards for their civil duty as "private attorney generals" (Case Note, 1993; Dodson, 2000; Evans, 1998; Epstein, 1994; Stevens, 1994; Sloane, 1993).

reduce the plaintiff's recovery at trial, but contrary to damage caps, split-awards do not reduce the loss for the negligent defendant at trial. We show here, that the decision on care depends not only on the loss for the negligent defendant at trial but also on the out-of-court settlement outcomes (which are affected by both reforms). Given that the incentives to care are lower under both reforms, both split-awards and damage caps reduce the deterrence effect of punitive damages. We also show that, if we consider not only the effect of these reforms in reducing the plaintiff's expected recovery at trial but also the effect that operates through the reduction in deterrence, then we can conclude that both, split-awards and caps increase the likelihood of filing.

In addition, we find that the adoption of split-awards and damage caps reduce the likelihood of disputes.[28] Experimental studies conducted by Babcock and Pogarsky (1999), and Landeo, Nikitin, and Babcock (2004), on damage caps and split-awards, respectively, support our theoretical results.

Proposition 4. The introduction of damage caps or split-awards decrease the probability of disputes, increases the probability of filing, decreases the deterrence effect of punitive awards and therefore, increases the probability of an accident.

Proof. See Appendix A.

A decrease in A or f reduces the plaintiff's expected payoff from suing (i.e., reduces the incentives to file a lawsuit) by lowering the expected recovery at trial. But a reduction in A or f also increases the plaintiff's expected payoff from suing by lowering deterrence and therefore, increasing the likelihood of confronting a negligent defendant q. This effect operates in the following way. A decrease in A or f reduces the difference in expected litigation losses for negligent and careful de-

[28] Under split-awards, the minimum accepted proposal from the plaintiff goes down and maximum offer from the defendant does not change. Therefore, the adoption of split-awards widens the contract zone (i.e., the range of settlement values that make both sides better off than not settling.) In the case of damage caps, both the minimum accepted proposal by the plaintiff and the maximum proposal from the defendant go down. Therefore, caps can increase or decrease the contract zone. However, in a strategic framework, like the one studied here, the effect of a tort reform on disputes is primarily influenced by its effects on the minimum out-of-court settlement offer accepted by the plaintiff and proposed by the defendant. This offer is determined by taking into account the maximum expected recovery at trial for the plaintiff, which is lowered under both split-awards and caps. Therefore, plaintiffs are more willing to accept lower out-of-court offers, which will be offered more frequently by defendants. Hence, both reforms reduce the likelihood of disputes, i.e., the direction of the effects of both reforms on the likelihood of disputes is the same.

fendants and therefore, reduces the incentives to take care. As a consequence, the deterrence effect of punitive damages is reduced (and the probability of accidents increases). Then, it will be more likely that accidents be caused by negligent defendants, i.e., q will be higher. Hence, the plaintiff's expected payoff from suing will increase. We show that the increase in the plaintiff expected payoff from suing (due to an increase in q) offsets the reduction due to a lower expected recovery at trial. Hence, the probability of filing increases.[29]

In addition, given that a decrease in A or f reduces the expected recovery at trial, plaintiffs are less willing to go to court and therefore, plaintiffs accept more frequently out-of-court offers i.e., the probability of rejection of a zero-offer by the plaintiff, α, goes down. Hence, the probability of trial decreases.[30]

4 A Model of Liability and Litigation under the English Rule

This section presents first a model of liability and litigation under the English rule for allocating legal costs. Under the English rule, the losing party at trial pays the legal costs of both parties. Then, it discusses the effects of the adoption of the English rule by comparing the results from this model with the results from the benchmark model.

4.1 Equilibrium of the Model

The setup of this model is similar to the one presented in Section 2. The only difference is the rule for allocating legal costs in case of trial.

The structure of the equilibrium is also similar to the one adopted for the benchmark model. This equilibrium constitutes the unique perfect Bayesian equilibrium of the game that survives Banks and Sobel's (1987) universal divinity refinement under the following conditions:

[29]Note that the increase in filing increases the incentives to take care. However, the effect of A or f on the difference in expected litigation losses for careful and negligent defendants offsets this second effect. As a consequence, a decrease in A or f reduces deterrence.

[30]Note that in case of damage caps, there is an additional effect to consider. A reduction in A also decreases the expected loss at trial for a negligent defendant $(1-\tau_1)A + K_D$, and therefore, reduces the willingness of negligent defendants to make positive out-of-court offers (i.e., increases the likelihood that a zero offer comes from a negligent defendant). This will decrease the plaintiff's willingness to accept zero offers (i.e., increases α). However, this latter effect is offset by the first effect of A (reduction in α). Hence, the probability of trial decreases.

$$(1-\tau_1)fA - \tau_1(K_P + K_D) > \tau_2(A + K_P + K_D), \tag{19}$$

$$0 \leq \tau_1 < min\left\{\hat{\hat{\tau}}_1, \frac{fA - F^{-1}(\bar{m})}{fA + K_P + K_D}\right\}, \tag{20}$$

$$0 \leq \tau_2 < min\left\{\hat{\hat{\tau}}_2(\tau_1), \frac{K_P + K_D}{fA + K_P + K_D}\right\}, \tag{21}$$

where $\hat{m} = \frac{c}{[(1-\tau_1)fA-\tau_1(K_P+K_D)]\left[\lambda^0-\lambda^1\frac{\tau_2}{1-\tau_1}\right]}$. $\hat{\hat{\tau}}_1$ and $\hat{\hat{\tau}}_2(\tau_1)$ correspond to the values for τ_1 and τ_2 for which $\hat{m} = 1$.[31]

Proposition 5 characterizes the unique universally divine equilibrium of the game under the English rule.

Proposition 5. Assume that conditions (19)–(21) hold. Then, the following strategy profile, together with the players' beliefs, represents the equilibrium path of the unique universally divine Perfect Bayesian equilibrium of the game under the English rule.

Strategy Profile

1) The plaintiff files a lawsuit with probability $\hat{m} = \frac{c}{[(1-\tau_1)fA-\tau_1(K_P+K_D)]\left[\lambda^0-\lambda^1\frac{\tau_2}{1-\tau_1}\right]}$. In response to an offer $\hat{S}_1 = 0$, the plaintiff rejects the offer (goes to trial) with probability $\hat{\alpha} = \frac{(1-\tau_1)fA-\tau_1(K_P+K_D)}{(1-\tau_1)(A+K_P+K_D)}$ and accepts the offer (drops the action) with probability $(1-\hat{\alpha})$; the plaintiff always accepts the offer $\hat{S}_2 = (1-\tau_1)fA - \tau_1(K_P + K_D)$ (settles out-of-court).

2) The defendant chooses to be careful with probability
$\hat{p} = \frac{\left[\frac{(1-\tau_1)fA-F^{-1}(m)-\tau_1(K_P+K_D)}{(fA+K_P+K_D)(1-\tau_1-\tau_2)}\right]\lambda^0}{\left[\frac{(1-\tau_1)fA-F^{-1}(m)-\tau_1(K_P+K_D)}{(fA+K_P+K_D)(1-\tau_1-\tau_2)}\right]\lambda^0+\left[\frac{F^{-1}(\hat{m})+(1-\tau_2)(K_P+K_D)-\tau_2 fA}{(fA+K_P+K_D)(1-\tau_1-\tau_2)}\right]\lambda^1}$. The negligent defendant makes no offer (offers $\hat{S}_1 = 0$) with probability $\hat{\beta} = \frac{[(1-\tau_2)(K_P+K_D)-\tau_2 fA)(1-q)}{q[(1-\tau_1)fA-\tau_1(K_P+K_D)]}$ and offers $\hat{S}_2 = (1-\tau_1)fA - \tau_1(K_P + K_D)$ with probability $(1-\hat{\beta})$. The careful defendant always makes no offer (offers $\hat{S}_1 = 0$).

Plaintiff's Beliefs

The equilibrium beliefs are as follows. If an accident occurs, the plaintiff believes with probability $(1-\hat{q})$ that she is confronting a careful defendant, and with probability $\hat{q}$ that she is confronting a

[31]Conditions (19)–(21) are equivalent to conditions (1)–(3) in the benchmark model. Under these conditions, there are other partially separating equilibria and pooling equilibria, which are ruled out by the divinity criterion.

negligent defendant. When the plaintiff receives an offer, she updates her beliefs using Bayes' rule: when she receives an offer $\hat{S}_1 = 0$, she believes with probability $\frac{(1-\hat{q})}{\hat{q}\hat{\beta}+(1-\hat{q})}$ that she is confronting a careful defendant and with probability $\frac{\hat{q}\ \hat{\beta}}{\hat{q}\ \hat{\beta}+(1-\hat{q})}$ that she is confronting a negligent defendant; when the plaintiff receives an offer $\hat{S}_2 = (1-\tau_1)fA - \tau_1(K_P + K_D)$, she believes with certainty that she is confronting a negligent defendant. The off-equilibrium beliefs are as follows. When the plaintiff receives an offer $S^{'}$ such that $0 < S^{'} < (1-\tau_1)fA - \tau_1(K_P + K_D)$ or when she receives an offer $S^{'} > (1-\tau_1)fA - \tau_1(K_P + K_D)$, she believes that this offer was made by a negligent defendant.

Proof. See Appendix A.

The model is solved backwards. We start by finding the solution of the pre-trial bargaining subgame. Then, we evaluate the plaintiff's filing decision and assess the defendant's choice of care.

Note first that under the English rule, the expected payoff at trial for the careful and negligent defendants are $-\tau_2(A + K_P + K_D)$ and $-(1-\tau_1)(A + K_P + K_D)$, respectively. The expected payoff at trial of the plaintiff is $\tau_2 fA - (1-\tau_2)(K_P + K_D)$ if the defendant is careful, and it is equal to $(1-\tau_1)fA - \tau_1(K_P + K_D)$ if the defendant is negligent.

The values of $\hat{\alpha}$ and $\hat{\beta}$ are calculated from the condition that both parties (the plaintiff and the negligent defendant) have to be indifferent between their strategies to mix them.[32] Then,

$$\hat{\alpha} = \frac{(1-\tau_1)fA - \tau_1(K_P + K_D)}{(1-\tau_1)(A + K_P + K_D)}, \tag{22}$$

and

$$\hat{\beta} = \frac{[(1-\tau_2)(K_P + K_D) - \tau_2 fA)(1-q)}{q[(1-\tau_1)fA - \tau_1(K_P + K_D)]}. \tag{23}$$

The expected litigation payoffs for the plaintiff and careful and negligent defendant are $V_P = \hat{q}(1-\hat{\beta})[(1-\tau_1)fA - \tau_1(K_P + K_D)] = \hat{q}fA(1-\tau_1-\tau_2) + \tau_2 fA - [(1-\hat{q})(1-\tau_2) + \hat{q}\tau_1](K_P + K_D)$, $V_{D^1} = -\left[\hat{q}(1-\tau_1) + (1-q)\tau_2)\right]fA - [\hat{q}\tau_1 + (1-\hat{q})(1-\tau_2)](K_P + K_D)$ and $V_{D^0} = -[(1-\tau_1)fA - \tau_1(K_P + K_D)]$, respectively.

[32] These conditions are as follows: $(1-\tau_1)fA - \tau_1(K_P + K_D) = \hat{\alpha}[(1-\tau_1)(A + K_P + K_D)] + (1-\hat{\alpha})(0)$, and $0 = \frac{\hat{q}\hat{\beta}}{\hat{q}\hat{\beta}+(1-\hat{q})}[((1-\tau_1)fA - \tau_1(K_P + K_D)] + \frac{1-\hat{q}}{\hat{q}\hat{\beta}+(1-\hat{q})}[(\tau_2 fA(1-\tau_2)(K_P + K_D)]$, for the negligent defendant and plaintiff, respectively.

The conditional probability of trial is given by

$$\hat{\alpha}[1-\hat{q}(1-\hat{\beta})] = \frac{(fA+K_P+K_D)(1-q)(1-\tau_1-\tau_2)}{(1-\tau_1)(A+K_P+K_D)}. \tag{24}$$

Using the previous results on plaintiff's expected payoff from litigation, we analyze now the plaintiff's decision about filing.

A plaintiff will file a lawsuit if her expected payoff from suing (i.e., expected litigation payoff net of filing costs) is positive, that is if

$$\hat{q}fA(1-\tau_1-\tau_2)+\tau_2 fA-[(1-\hat{q})(1-\tau_2)+\hat{q}\tau_1](K_P+K_D)-K_F>0 \tag{25}$$

Then, the probability of filing is

$$F([\hat{q}(1-\tau_1)+\tau_2(1-\hat{q})]fA-[(1-\hat{q})(1-\tau_2)+\hat{q}\tau_1](K_P+K_D)) \equiv m. \tag{26}$$

The defendant is indifferent between taking care and not taking care in equilibrium, and then he randomizes between both strategies. The indifference condition is

$$c+\hat{m}\lambda^1\tau_2\left[fA-\frac{\tau_1}{1-\tau_1}(K_P+K_D)\right]=\hat{m}\lambda^0[(1-\tau_1)fA-\tau_1(K_P+K_D)] \tag{27}$$

Solving the last equation for $\hat{m}$, we obtain the probability of filing that supports the randomization of the choice of care.

$$\hat{m}=\frac{c}{[(1-\tau_1)fA-\tau_1(K_P+K_D)]\left[\lambda^0-\lambda^1\frac{\tau_2}{1-\tau_1}\right]} \tag{28}$$

It is important to note, that $m>0$ because $\lambda^0>\lambda^1$ (by assumption) and because condition (19) ensures that $\frac{\tau_2}{1-\tau_1}<1$. In addition, conditions (20) and (21) guarantee that $m<1$.

Then, using equation (27), we obtain $\hat{q}$, the probability that an accident is caused by a negligent defendant.

$$\hat{q}=\frac{F^{-1}(\hat{m})+(1-\tau_2)(K_P+K_D)-\tau_2 fA}{(fA+K_P+K_D)(1-\tau_1-\tau_2)}. \tag{29}$$

The expression for $\hat{q}$ is always positive, because $(K_P+K_D)>\tau_2(fA+K_P+K_D)$ by condition (21). In addition, condition (20) implies that $\hat{q}<1$.

Then, $\hat{p}$, the probability that a defendant chooses to be careful is given by

$$\hat{p} = \frac{\left[\frac{(1-\tau_1)fA - F^{-1}(m) - \tau_1(K_P+K_D)}{(fA+K_P+K_D)(1-\tau_1-\tau_2)}\right]\lambda^0}{\left[\frac{(1-\tau_1)fA - F^{-1}(m) - \tau_1(K_P+K_D)}{(fA+K_P+K_D)(1-\tau_1-\tau_2)}\right]\lambda^0 + \left[\frac{F^{-1}(\hat{m}) + (1-\tau_2)(K_P+K_D) - \tau_2 fA}{(fA+K_P+K_D)(1-\tau_1-\tau_2)}\right]\lambda^1}. \tag{30}$$

Using the previous results, we now derive the probability of accident $\mu = \lambda^1\hat{p} + \lambda^0(1-\hat{p})$ and the unconditional probability of trial $\frac{(fA+K_P+K_D)\lambda^1\hat{p}(1-\tau_1-\tau_2)}{(1-\tau_1)(A+K_P+K_D)}\hat{m}$, where $\hat{p}$ is given by equation (30) and $\hat{m}$ is given by equation (28).

4.2 Effects of Fee-Shifting

We now proceed to analyze the effects of adopting the English rule for allocating legal costs. We assume that conditions (1)–(3) and conditions (19)–(21) hold.

Empirical studies of the effects of the adoption of the English rule in Florida during the period 1980–1985 (Hughes and Snyder, 1995; Snyder and Hughes, 1990) indicate that fee-shifting results in higher compensations and higher frequency of cases where plaintiffs win. These findings suggest a reduction of filing of less meritorious cases. Our model indeed captures this effect. Proposition 6 summarizes this result.

Proposition 6. The adoption of the English rule as a method for allocating legal costs decreases filing if $\tau_1 < \frac{K_P}{K_P+K_D}$.

Proof. See Appendix A.

The condition $\tau_1 < \frac{K_P}{K_P+K_D}$ implies that τ_1 should be relatively small. This condition conforms to empirical findings (Tullock, 1980). Note also that this is a sufficient, but not necessary condition.

Intuitively, given that under the English rule the plaintiff should pay the legal costs of both parties in case of losing at trial, the plaintiffs expected payoff from suing is lower under the English rule. Then, the incentives to file a lawsuit are reduced and hence, the likelihood of filing is lower under the English rule.

If, in addition, τ_2 is sufficiently big, the English rule raises the likelihood of disputes but also increases the deterrence effect of punitive damages and therefore, lowers the probability of an accident. Proposition 7 summarizes this result.

Proposition 7. The adoption of the English rule as a method for allocating legal costs increases the probability of disputes, increases the deterrence effect of punitive awards and therefore, decreases the probability of an accident if $\tau_1 < \frac{K_P}{K_P+K_D}$ and $\tau_2 > \frac{K_D}{K_P+K_D}$.

Proof. See Appendix A.

Note that the conditions $\tau_1 < \frac{K_P}{K_P+K_D}$ and $\tau_2 > \frac{K_D}{K_P+K_D}$ are sufficient but not necessary conditions.

The difference in expected litigation losses for negligent and careful defendants is higher under the English rule. Then, the incentives to take care may be greater and the deterrence effect may be higher under the English rule, even though the likelihood of filing is lower.

This higher deterrence under the English rule reduces the likelihood of confronting negligent defendants at trial and therefore, decreases the willingness of plaintiffs to go to trial (i.e., the probability of rejecting zero offers goes down). This effect decreases the likelihood of disputes. However, the higher deterrence also increases the willingness of defendants to make no offers (i.e., the probability of making zero offers goes up). This effect increases the likelihood of disputes. We show that, if τ_2 is big enough and τ_1 is small enough, the second effect offsets the first one, and therefore, the likelihood of disputes is higher under the English rule.[33]

5 Conclusions

This paper presents a strategic model of liability and litigation under court errors. The framework allows for endogenous decision about investment in accident prevention, and endogenous likelihood of filing and disputes. This article is not the first to consider liability and litigation in the same

[33] From the empirical findings (Tullock, 1980), we should infer that court errors are in general low. Then, even though τ_2 does not meet the sufficient condition on Proposition 7, we should expect that the results stated in that proposition be more likely as τ_2 increases.

framework but is the first to apply a framework with endogenous decisions on care, filing and dispute, under court errors, to the analysis of damage caps and split-awards.

We construct an equilibrium under low court errors, where some (but not all) defendants choose to be liable; some (but not all) cases are filed; and, some lawsuits are dropped, some are resolved out-of-court and some go to trial. We then use this benchmark model to analyze the effects of court errors, damage caps, split-awards and fee-shifting. We find that court errors in assessing liability of negligent defendants, as well as damage caps and split-awards, reduce the likelihood of dispute but increase filing and reduce the deterrence effect of punitive damages. We find conditions under which the adoption of the English rule for allocating legal costs reduces filing. Our model proves to be complete, i.e., it captures the main effects of tort reform of punitive damages, but tractable enough to be used as a tool for the analytical study of tort reform and court errors.

Our analysis has several policy implications. First, it points to the significance of the strategic behavior of plaintiff and defendant for the analysis of the effects of tort reform on deterrence. In particular, the analysis indicates that both damage caps and split-awards may reduce the expected loss for a negligent defendant and therefore they may reduce deterrence. Second, the analysis underlines the importance of the defendant's care decision for the analysis of the effects of tort reform on filing and indicates that damage caps and split-awards may increase the plaintiff's expected payoff from suing by increasing the likelihood of confronting negligent defendants. Therefore, caps and split-awards may increase filing of lawsuits.

Avenues for further research may involve an extension of this benchmark model by allowing the awards to depend also on the lawyer's effort. This model can be then used to evaluate the new method of lawyer's payment proposed by Polinsky and Rubinfeld (2003). Using an asymmetric information model of litigation, Polinsky and Rubinfeld (2003) show that this payment method aligns the interests of lawyers and clients, by providing the incentives to the lawyers to do exactly what a knowledgeable client would want him to do with respect to accepting the case, spending time on the case, and settling the case. However, their model does not allow for endogenous choice of level of care or court errors in assessing the liability of the defendant.

Appendix A. Proofs

Proofs of Propositions 1–7 follow.

Proof of Proposition 1.

The proof has three main parts. In the first part, we prove the existence of the partially separating equilibria of the pre-trial bargaining subgame, under conditions (1)–(3). In the second part, we show that the partially separating equilibrium of the pre-trial bargaining subgame, proposed in Proposition 1, is the only partially separating equilibrium of the pre-trial bargaining stage that survives the universal divinity refinement and therefore, is the unique universal divine PBE of the pre-trial bargaining stage. In the third part, we complete the proof of the existence and uniqueness of the equilibrium of the whole game, proposed in Proposition 1. First, we prove that some but not all potential plaintiffs file a lawsuit; second, we show that some but not all potential injurers are negligent; and, third, we prove that the described mixed-strategy equilibrium is the only equilibrium of the game.

Part 1. Existence of Perfect Bayesian Equilibria of the Litigation Game

Part 1.1. We eliminate the dominated and iteratively dominated strategies for each player.

Rationality suggests that since the plaintiff can get at most $(1-\tau_1)fA - K_P$ at trial, the plaintiff should accept any pretrial offer over $(1-\tau_1)fA - K_P$. That is, any strategy that calls for the plaintiff to reject an offer greater than $(1-\tau_1)fA - K_P$ is weakly dominated by a strategy in which he accepts the offer.[34] Rationality also suggests, given that the plaintiff can drop the case and lose nothing, the plaintiff should reject any pretrial offer $S < 0$. That is, any strategy that calls for the plaintiff to accept an offer lower than zero is dominated by a strategy in which he rejects the offer.

Because the plaintiff accepts all offers over $(1-\tau_1)fA - K_P$ (maximum payoff at trial), any strategy in which the defendant offers more than $(1-\tau_1)fA - K_P$ when she is negligent is iteratively

[34] It is only weakly dominated because the second strategy does not result in a strictly higher payoff against every one of the defendant's strategies. In particular, it does not result in a strictly higher payoff if the defendant's strategy is to refuse to offer a settlement (i.e., offer $S = 0$) whether negligent or careful.

dominated by a strategy in which she offers exactly $(1-\tau_1)fA - K_P$. Rationality also tells us that the defendant will offer no more than K_D (loss for a careful defendant at trial) if she is careful. Finally, because the plaintiff rejects all offers below zero, any strategy in which the defendant offers less than zero is iteratively dominated by a strategy in which she offers exactly zero. Then, the minimum possible offer is $S = 0$ and represents the defendant's refusal to settle.

Hence, after eliminating the dominated strategies and a first round of elimination of the iteratively dominated strategies for each player, we can restrict our attention to the offer space $[0, (1-\tau_1)fA - K_P]$ for the negligent defendant (i.e., a proposal cannot be negative or greater than the maximum payoff the plaintiff can get in court); and, to the offer space $[0, \tau_2 A + K_D]$, for the careful defendant (i.e., a proposal cannot be negative or greater than the maximum loss the careful defendant can get in court).

Let's apply iterative elimination of dominated strategies again. Because the careful defendant never offers more than $\tau_2 A + K_D$ and since the plaintiff can get $(1-\tau_1)fA - K_P$ at trial, rationality suggests that the plaintiff should reject any pretrial offer over $\tau_2 A + K_D$ and lower than $(1-\tau_1)fA - K_P$. That is, any strategy that calls for the plaintiff to accept such an offer is iteratively dominated by a strategy in which he rejects the offer. Rationality also tells us that the negligent defendant will not make any offer greater than $\tau_2 A + K_D$ and lower than $(1-\tau_1)fA - K_P$. Then, the offer space for a negligent defendant gets reduced to $[0, \tau_2 A + K_D]$ U $\{(1-\tau_1)fA - K_P\}$.

Part 1.2. We prove that in equilibrium the negligent defendant randomizes at most between two possible strategies. In Part 1.1. we show that the offer space for the negligent defendant is given by $[0, \tau_2 A + K_D]$ U $\{(1-\tau_1)fA - K_P\}$, then it suffices to show that there is no more than one equilibrium offer $S_1 \in [0, \tau_2 A + K_D]$.[35]

We consider 3 steps. First, we show that there is no equilibrium offer in this interval which is proposed by the negligent defendant only. Second, we show that there is no equilibrium offer in

[35] No more than one equilibrium offer $S_1 \in [0, \tau_2 A + K_D]$ implies that the negligent defendant randomizes at most between 2 possible strategies, one of which is $(1-\tau_1)fA - K_P$.

the interval proposed by the careful defendant only. Finally, we show that there is no two distinct equilibrium proposals proposed by both types of defendant.

Part 1.2.1.

If such an equilibrium offer $\tilde{S}$ existed, the plaintiff would reject it with probability 1. Hence the case would be resolved at trial, and the negligent defendant would lose $A + K_D$. He is better off offering $(1 - \tau_1)fA - K_P$ which is accepted with certainty.

Part 1.2.2.

If such an equilibrium offer $\tilde{S}$ existed, then the plaintiff would accept it with probability 1. Hence the negligent defendant would be better off, switching to this offer.

Part 1.2.3.

We prove it by contradiction. Assume that there exist two such offers, S_1 and S_2, such that $0 \leq S_1 < S_2 \leq \tau_2 A + K_D$. Denote by p_1 and p_2 the respective equilibrium probabilities of acceptance of these proposals by the plaintiff. Each type of defendant is indifferent between these proposals. Hence

$$S_1 p_1 + (1 - p_1)(\tau_2 A + K_D) = S_2 p_2 + (1 - p_2)(\tau_2 A + K_D) \tag{A1}$$

and

$$S_1 p_1 + (1 - p_1)[(1 - \tau_1)A + K_D] = S_2 p_2 + (1 - p_2)[(1 - \tau_1)A + K_D]. \tag{A2}$$

Subtracting the first equation from the second one, we get

$$(1 - p_1)(1 - \tau_1 - \tau_2)A = (1 - p_2)(1 - \tau_1 - \tau_2)A. \tag{A3}$$

Hence, $p_1 = p_2$.[36] But in that case defendants of both types are strictly better off offering S_1. Contradiction follows.

[36] The inequality $\tau_1 + \tau_2 < 1$ holds by assumption (1).

Part 1.3. We show that under conditions (1)–(3), there are infinitely many partially separating equilibria (one of them is the one stated in Proposition 1) and infinitely many pooling equilibria.[37]

Part 1.3.1. Existence of Partially Separating Equilibria of the Pre-Trial Bargaining Subgame

The description of the partially separating equilibria is as follows. If conditions (1)–(3) hold: 1) careful defendants offer S_1 such that $0 \leq S_1 \leq \tau_2 A + K_D$, and negligent defendants mix the two strategies, offer S_1 with probability $\tilde{\beta}$ and offer $S_2 = (1-\tau_1)fA - K_P$ with probability $(1-\tilde{\beta})$; 2) plaintiffs always file a lawsuit; plaintiffs always accept S_2[38] and mix between rejection (with probability $\tilde{\alpha}$) and acceptance (with probability $(1-\tilde{\alpha})$ when the offer is S_1 such that $0 < S_1 \leq \tau_2 A + K_D$.[39]

Consider the expected payoffs for the plaintiff, careful and negligent defendants, in terms of $\tilde{\alpha}$ and $\tilde{\beta}$. The expected payoff for the plaintiff V_P is

$$V_P = (1-q)[\tilde{\alpha}(\tau_2 fA - K_P) + (1-\tilde{\alpha})(S_1)] + q\{\tilde{\beta}[\tilde{\alpha}[(1-\tau_1)fA - K_P] + (1-\tilde{\alpha})(S_1)] + (1-\tilde{\beta})[(1-\tau_1)fA - K_P]\}. \qquad (A4)$$

The expected payoff for the careful defendant V_{D_1} is

$$V_{D_1} = \tilde{\alpha}(-\tau_2 A - K_D) + (1-\tilde{\alpha})(S_1). \qquad (A5)$$

And, the expected payoff for the negligent defendant, V_{D_0} is

$$V_{D_0} = \tilde{\beta}[\tilde{\alpha}(-((1-\tau_1)A + K_D)) + (1-\tilde{\alpha})(S_1)] + (1-\tilde{\beta})[-((1-\tau_1)fA - K_P)]. \qquad (A6)$$

The values of $\tilde{\alpha}$ and $\tilde{\beta}$ are calculated from the condition that both parties (the plaintiff and the negligent defendant) have to be indifferent between their strategies to mix them. So,

$$(1-\tau_1)fA - K_P = \tilde{\alpha}((1-\tau_1)A + K_D) + (1-\tilde{\alpha})S_1 \qquad (A7)$$

[37]Condition $0 < [q(1-\tau_1) + (1-q)\tau_2]fA - K_P < K_F$ rules out the equilibrium where no lawsuit is filed; and, condition $(1-\tau_1)fA - K_P > \tau_2 A + K_D$ rules out the pooling equilibrium where the careful defendant behaves as a negligent defendant by making a positive settlement offer.

A separating equilibrium is not possible in this game. Suppose that a separating equilibrium exists: careful defendants offer $S_1 \leq \tau_2 A + K_D$ and negligent defendants offer $S_2 \neq S_1$. Given that S_1 is always accepted by the plaintiff and S_2 is always rejected by the plaintiff, then the negligent defendant has an incentive to deviate to S_1 because $S_1 < (1-\tau_1)A + K_D$.

[38]A defendant offering S_2 reveals his type, and hence S_2 should be equal to $(1-\tau_1)fA - K_P$ to be always accepted.

[39]As the plaintiff accepts some of the offers of S_1, a negligent defendant has an incentive to mimic the behavior of the careful defendant and offer S_1 as well.

and

$$S_1 = \frac{q\tilde{\beta}}{q\tilde{\beta} + (1-q)}((1-\tau_1)fA - K_P) + \frac{1-q}{q\tilde{\beta} + (1-q)}(\tau_2 fA - K_P). \qquad (A8)$$

Equation (A4) says that a negligent defendant is indifferent between admitting his negligence (i.e., offering $S_2 = (1-\tau_1)fA - K_P$) and stating that he is careful (i.e., offering S_1) with the risk to lose $(1-\tau_1)A + K_D$ if the case goes to court. Equation (A5) says that a plaintiff is indifferent between dropping the case and getting a payoff of S_1 and going to court. Solving (A4) for $\tilde{\alpha}$ and (A5) for $\tilde{\beta}$ we get $\tilde{\alpha} = \frac{(1-\tau_1)fA - K_P - S_1}{(1-\tau_1)A + K_D - S_1}$ and $\tilde{\beta} = \frac{(S_1 + K_P - \tau_2 fA)(1-q)}{q((1-\tau_1)fA - S_1 - K_P)}$.[40]

Then, the expected payoffs for the plaintiff and careful and negligent defendant are $V_P = [q(1-\tau_1) + \tau_2(1-q)]fA - K_P$, $V_{D_1} = -\left\{\frac{S_1[(1-\tau_1)(1-f)A + K_P + K_D] + [(1-\tau_1)fA - K_P - S_1](\tau_2 A + K_D)}{(1-\tau_1)A + K_D - S_1}\right\}$ and $V_{D_0} = -[(1-\tau_1)fA - K_P]$, respectively.

The equilibrium beliefs are as follows. If an accident occurs, the plaintiff believes with probability $(1-q)$ that she is confronting a careful defendant, and with probability q that she is confronting a negligent defendant. When the plaintiff receives an offer, she updates her beliefs using Bayes' rule: when she receives an offer S_1, she believes with probability $\frac{(1-q)}{q\tilde{\beta} + (1-q)}$ that she is confronting a careful defendant and with probability $\frac{q\tilde{\beta}}{q\tilde{\beta} + (1-q)}$ that she is confronting a negligent defendant; when the plaintiff receives an offer S_2, she believes with certainty that she is confronting a negligent defendant.

The off-equilibrium beliefs are as follows. When the plaintiff observes an offer $S' < S_1$ or an offer $S_1 < S' < (1-\tau_1)fA - K_P$, she believes that she faces a negligent defendant. Then, the plaintiff rejects the offer with certainty because she will obtain a higher payoff $((1-\tau_1)fA - K_P)$ if she brings the negligent defendant to trial. Given that S' is rejected with certainty, the careful defendant will not make the offer S' because he will receive a higher payoff by offering S_1, which is accepted with positive probability in the proposed equilibrium. Given that the plaintiff will reject the offer S' with certainty, the negligent defendant will not make an offer S' because he will receive a higher payoff by offering $S_2 = (1-\tau_1)fA - K_P$ with probability $(1-\tilde{\beta})$ and S_1 with probability

[40] Note that $\tilde{\alpha}(S_1 = 0) = \alpha$ and $\tilde{\beta}(S_1 = 0) = \beta$, i.e., the equilibrium path just described corresponds to the partially separating perfect Bayesian equilibrium stated in Proposition 1.

$\tilde{\beta}$ (as stated in the proposed equilibrium).

Part 1.3.2. Existence of Pooling Equilibria of the Pre-Trial Bargaining Subgame

The description of the pooling equilibria is as follows. If $[q(1-\tau_1)+(1-q)\tau_2]fA - K_P > 0$ and $(1-\tau_1)fA - K_P > \tau_2 A + K_D$: 1) negligent and careful defendants offer the same amount S, where $0 < S \leq \tau_2 A + K_D$ and $S \geq [q(1-\tau_1)+(1-q)\tau_2]fA - K_P$; 2) plaintiffs always file a lawsuit; plaintiffs always accept the offer S.[41]

The equilibrium beliefs are as follows. If an accident occurs, the plaintiff believes with probability $(1-q)$ that she is confronting a careful defendant, and with probability q that she is confronting a negligent defendant. Given that defendants pool, when the plaintiff receives an offer, she cannot update her beliefs. Then, the plaintiff accepts if the offer is greater than or equal to her ex-ante expected return from trial ($S \geq [q(1-\tau_1)+(1-q)\tau_2]fA - K_P$).[42] The off-equilibrium beliefs compatible with this equilibrium are as follows. If the defendant offers $\tilde{S} \neq S$, then the plaintiff believes with certainty that he faces the negligent defendant and rejects the offer.

Part 2. Uniqueness of the Pre-Trial Bargaining Subgame Equilibrium

We prove that the PBE stated in Proposition 1 is the only PBE that survives the universal divinity refinement is the partially separating PBE, and therefore, this is the unique equilibrium of the litigation stage. We proceed first to apply the universal divinity refinement to the partially separating equilibria, and second, to the pooling equilibria. The implementation of the universal divinity refinement proceeds as follows. First, we find (for careful and negligent defendants) the minimum probability of acceptance (by the plaintiff) of an offer that differs from the equilibrium offers (deviation offer), such that the defendant is willing to deviate. Second, we compare these

[41] if $S \leq \tau_2 A + K_D$ fails to hold, the careful defendant will find it optimal to deviate, to offer 0, and go to trial; if $S \geq [q(1-\tau_1)+(1-q)\tau_2]fA - K_P$ fails to hold, the plaintiff will find it profitable to deviate and reject the proposal S.

Note also that there is no possible pooling with $S = 0$ and plaintiff accepting the offer with certainty: if every defendant offers $S = 0$, then the plaintiff will be better off by rejecting the offer because $[q(1-\tau_1)+(1-q)\tau_2]fA - K_P > 0$, i.e., her ex-ante expected payoff from going to trial is greater than the offer. Then, it would be optimal for the negligent defendant to deviate from offering $S = 0$ to $S' = (1-\tau_1)fA - K_P < (1-\tau_1)A + K_D$ (loss at trial).

[42] The plaintiff computes the ex-ante return from trial by using her prior beliefs and the payoffs at trial from confronting negligent and careful defendants. So, the ex-ante return from trial $q[(1-\tau_1)fA - K_P) + (1-q)(\tau_2 fA - K_P) = [q(1-\tau_1)+(1-q)\tau_2]fA - K_P$.

minimum probabilities. The defendant with the lower minimum probability will be the one the plaintiff should expect (with probability one) to deviate.

Part 2.1. Elimination of the Other Partially Separating Equilibria

Consider the deviation $S^{'}$ from an equilibrium offer S_1 or S_2. We will cover the analysis of three cases: $0 \leq S^{'} < \tau_2 A + K_D$, $S^{'} = \tau_2 A + K_D$ and $\tau_2 A + K_D < S^{'} < fA - KP$.

Case I: $0 \leq S^{'} < \tau_2 A + K_D$

For mathematical convenience, define $S^{'} = S_1 - \epsilon$. If $\epsilon < 0$, then the deviation offer $S^{'} > S_1$; and, if $\epsilon > 0$, then the deviation offer $S^{'} < S_1$.

Proceed first to analyze the case of the negligent defendant. The negligent defendant will be willing to deviate if

$$p_N(S_1 - \epsilon) + (1 - p_N)((1 - \tau_1)A + K_D) \leq [(1 - \tau_1)fA - K_P], \tag{A9}$$

where the left-hand side of the inequality represents the expected loss for the negligent defendant from deviating and the right-hand side represents his expected loss in equilibrium.[43] Solving for p_N we get

$$p_N \geq \frac{(1 - \tau_1)(1 - f)A + K_P + K_D}{(1 - \tau_1)A + K_D - S_1 + \epsilon}. \tag{A10}$$

Then, the minimum probability of acceptance of the deviation offer made by the negligent defendant is

$$\underline{p_N} = \frac{(1 - \tau_1)(1 - f)A + K_P + K_D}{(1 - \tau_1)A + K_D - S_1 + \epsilon}. \tag{A11}$$

Now find the minimum probability of acceptance of the deviation by the plaintiff, such that the careful defendant is still willing to propose it.

$$p_C(S_1 - \epsilon) + (1 - p_C)(\tau_2 A + K_D \leq$$

$$\leq \left[S_1(1 - \frac{(1 - \tau_1)fA - K_P - S_1}{(1 - \tau_1)A + K_D - S_1}) + (\tau_2 A + K_D)\frac{(1 - \tau_1)fA - K_P - S_1}{(1 - \tau_1)A + K_D - S_1}\right], \tag{A12}$$

[43]Note that in every partially separating PBE of the litigation game (under the conditions $qfA - K_P > 0$ and $fA - K_P > K_D$) the expected payoff for the negligent defendant is $fA - K_P$.

where the left-hand side of the inequality represents the expected loss for the careful defendant from deviating and the right-hand side represents his expected loss in equilibrium.[44] Solving for p_C we get

$$p_C \geq \frac{\tau_2 A + K_D}{\tau_2 A + K_D - S_1 + \epsilon} - \\ - \frac{[(1-\tau_1)(1-f)A + K_P + K_D]S_1 + [(1-\tau_1)fA - K_P - S_1](\tau_2 A + K_D)}{[(1-\tau_1)A + K_D - S_1](\tau_2 A + K_D - S_1 + \epsilon)} \tag{A13}$$

Then, the minimum probability of acceptance of the deviation offer made by the careful defendant is

$$\underline{p_C} = \frac{\tau_2 A + K_D}{\tau_2 A + K_D - S_1 + \epsilon} - \\ - \frac{[(1-\tau_1)(1-f)A + K_P + K_D]S_1 + [(1-\tau_1)fA - K_P - S_1](\tau_2 A + K_D)}{[(1-\tau_1)A + K_D - S_1](\tau_2 A + K_D - S_1 + \epsilon)} \tag{A14}$$

Compare the threshold probabilities for the negligent and careful defendant.

$$\underline{p_C} - \underline{p_N} = \frac{\tau_2 A + K_D}{\tau_2 A + K_D - S_1 + \epsilon} - \\ - \frac{[(1-\tau_1)(1-f)A + K_P + K_D]S_1 + [(1-\tau_1)fA - K_P - S_1](\tau_2 A + K_D)}{[(1-\tau_1)A + K_D - S_1](\tau_2 A + K_D - S_1 + \epsilon)} - \\ - \frac{(1-\tau_1)(1-f)A + K_P + K_D}{(1-\tau_1)A + K_D - S_1 + \epsilon} = \\ = \frac{-A(1-\tau_1-\tau_2)\epsilon[(1-\tau_1)(1-f)A + K_D + K_P]}{((1-\tau_1)A + K_D - S_1)(\tau_2 A + K_D - S_1 + \epsilon)((1-\tau_1)A + K_D - S_1 + \epsilon)}, \tag{A15}$$

where the expressions in bracket and parentheses are positive. Then, if $\epsilon < 0$, $\underline{p_N} < \underline{p_C}$; and, if $\epsilon > 0$, $\underline{p_N} > \underline{p_C}$.

Following the universal divinity refinement, if $0 \leq S' < \tau_2 A + K_D$ and $\epsilon < 0$ ($S' > S_1$), the plaintiff should believe that the deviation S' comes from a negligent defendant with probability one. On the other hand, if $\epsilon > 0$ ($S' < S_1$), the plaintiff should believe with probability one that the deviation S' comes from a careful defendant.

[44] Remember that $\tilde{\alpha}(S_1 = 0) = \alpha$. Given that we need to apply the results of this proof to check all partially separating PBE of the litigation game, we will use $\tilde{\alpha}$ in the computation of the expected payoff for the careful defendant. Note that in every partially separating PBE of the litigation game (under the conditions $qfA - K_P > 0$ and $fA - K_P > K_D$) the expected payoff for the careful defendant does depend on S_1.

Apply the universal divinity refinement to the other partially separating equilibria (where $0 < S_1 \leq K_D$). The off-equilibrium beliefs imply that the plaintiff should infer that any deviation $S^{'}$ comes from a negligent defendant. In case of $\epsilon > 0$ ($S^{'} < S_1$), these off-equilibrium beliefs do not survive the refinement. The plaintiff should believe that the deviation comes from a careful defendant and accept the offer. This response from the plaintiff will generate an incentive for the negligent defendant to deviate and offer $S_1 - \epsilon$. Hence, the other partially separating equilibria (where $0 < S_1 \leq K_D$) do not pass the test of universal divinity for $0 \leq S^{'} < \tau_2 A + K_D$.

We will apply now the universal divinity refinement to the empirically relevant equilibrium (where $S_1 = 0$). The off-equilibrium beliefs imply that the plaintiff should infer that any deviation comes from a negligent defendant. Note also that given that $S_1 = 0$ is the lowest possible offer, only deviations above S_1 (i.e., $S^{'} > S_1$) are possible. Therefore, the off-equilibrium beliefs survive the universal divinity refinement. Hence, the empirically relevant equilibrium passes the test of universal divinity for $0 \leq S^{'} < \tau_2 A + K_D$.

Case II: $S^{'} = K_D$

The minimum probability of acceptance of a deviation offer made by the negligent defendant is still given by equation (A8).

For the case of the careful defendant, note that his expected deviation loss is $\tau_2 A + K_D$ and his expected equilibrium loss is in the interval $(\frac{(1-\tau_1)fA-K_P}{(1-\tau_1)A+K_D}(\tau_2 A + K_D), \tau_2 A + K_D)$ (for $0 < S_1 < \tau_2 A + K_D$) and is equal to $\frac{(1-\tau_1)fA-K_P}{(1-\tau_1)A+K_D} < \tau_2 A + K_D$ (for $S_1 = 0$). Then, for any probability of acceptance, the careful defendant will not be willing to deviate when $S^{'} = \tau_2 A + K_D$.

By universal divinity, the plaintiff should expect that any deviation offer $S^{'} = \tau_2 A + K_D$ comes from a negligent defendant. Thus, all partially separating PBE pass the test of universal divinity for $S^{'} = \tau_2 A + K_D$.

Given that the partially separating PBE stated in Proposition 1 is the only partially separating equilibrium that survives the universal divinity refinement in both cases, then the equilibrium proposed in Proposition 1 is the only universal divine partially separating PBE.

Part 2.2. Elimination of the Pooling Equilibria

Consider the deviation $S^{'}$ from an equilibrium offer S. We will cover the analysis of two cases: $0 \leq S^{'} < \tau_2 A + K_D$ and $S^{'} = \tau_2 A + K_D$.

Case I: $0 \leq S^{'} < \tau_2 A + K_D$

For mathematical convenience, define $S^{'} = S - \epsilon$. If $\epsilon < 0$, then the deviation offer $S^{'} > S$; and, if $\epsilon > 0$, then the deviation offer $S^{'} < S$.

Proceed first to analyze the case of the negligent defendant. The negligent defendant will be willing to deviate if

$$p_N(S - \epsilon) + (1 - p_N)[(1 - \tau_1)A + K_D) \leq S, \tag{A16}$$

where the left-hand side of the inequality represents the expected loss for the negligent defendant from deviating and the right-hand side represents his expected loss in equilibrium.[45] Solving for p_N we get

$$p_N \geq \frac{(1 - \tau_1)A + K_D - S}{(1 - \tau_1)A + K_D - S + \epsilon}. \tag{A17}$$

Then, the minimum probability of acceptance of the deviation offer made by the negligent defendant is

$$\underline{p_N} = \frac{(1 - \tau_1)A + K_D - S}{(1 - \tau_1)A + K_D - S + \epsilon}. \tag{A18}$$

Now find the minimum probability of acceptance of the deviation by the plaintiff, such that the careful defendant is still willing to propose it.

$$p_C(S - \epsilon) + (1 - p_C)(\tau_2 A + K_D) \leq S, \tag{A19}$$

where the left-hand side of the inequality represents the expected loss for the careful defendant from deviating and the right-hand side represents his expected loss in equilibrium. Solving for p_C we get

$$p_C \geq \frac{\tau_2 A + K_D - S}{\tau_2 A + K_D - S + \epsilon}. \tag{A20}$$

[45]Note that in every pooling PBE of the litigation game (under the conditions $qfA - K_P > 0$ and $fA - K_P > K_D$) the expected payoff for the negligent defendant is S.

Then, the minimum probability of acceptance of the deviation offer made by the careful defendant is

$$\underline{p_C} = \frac{\tau_2 A + K_D - S}{\tau_2 A + K_D - S + \epsilon}. \tag{A21}$$

Note that inspection of equations (A21) and (A18) show that if $\epsilon < 0$, the left-hand side of the inequalities will be greater than 1. Given that the right-hand side of the inequalities correspond to probabilities (which cannot be greater than 1), the inspection of these equations permits us to conclude that the universal divinity refinement is not applicable for cases where $\epsilon < 0$. Then, we will proceed to the application of the universal divinity refinement only in cases where $\epsilon > 0$.

Compare the threshold probabilities for the negligent and careful defendant.

$$\underline{p_C} - \underline{p_N} = \frac{-A\epsilon(1-\tau_1-\tau_2)}{(\tau_2 A + K_D - S + \epsilon)((1-\tau_1)A + K_D - S + \epsilon)}, \tag{A22}$$

where A and the expressions in parentheses are positive. Then, if $\epsilon > 0$, $\underline{p_N} > \underline{p_C}$.

Following the universally divinity refinement, if $0 \leq S^{'} < \tau_2 A + K_D$ and $\epsilon > 0$ ($S^{'} < S$), the plaintiff should believe with probability one that the deviation $S^{'}$ comes from a careful defendant.

Apply the universal divinity refinement to the pooling equilibria (where $0 < S \leq \tau_2 + K_D$). The off-equilibrium beliefs imply that the plaintiff should infer that any deviation $S^{'}$ comes from a negligent defendant. These off-equilibrium beliefs do not survive the refinement. The plaintiff should believe that the deviation comes from a careful defendant and accept the offer. This response from the plaintiff will generate an incentive for the negligent defendant to deviate and offer $S - \epsilon$. Hence, the pooling equilibria (where $0 < S \leq \tau_2 A + K_D$) do not pass the test of universal divinity for $0 \leq S^{'} < \tau_2 A + K_D$.

Case II: $S^{'} = K_D$

The minimum probability of acceptance of a deviation offer made by the negligent defendant is still given by equation (A11).

For the case of the careful defendant, note that his expected deviation loss is K_D and his expected equilibrium loss is in the interval $(\frac{fA-K_P}{A+K_D}, K_D)$ (for $0 < S < K_D$) and is equal to $\frac{fA-K_P}{A+K_D} <$

K_D (for $S = 0$). Then, for any probability of acceptance, the careful defendant will not be willing to deviate when $S^{'} = K_D$.

By universal divinity, the plaintiff should expect that any deviation offer $S^{'} = K_D$ comes from a negligent defendant. Thus, all pooling PBE pass the test of universal divinity for $S^{'} = \tau_2 A + K_D$.

Given that no pooling PBE survive the universal divinity refinement in both cases, there is no universal divine pooling PBE.

Hence, the partially separating PBE stated in Proposition 1 is the unique universally divine PBE of the litigation stage. Q.E.D.

Part 3. Existence and Uniqueness of the Game Equilibrium

In the third part, we prove that some but not all potential plaintiffs file a lawsuit, that some but not all potential injurers are negligent, and that the described mixed-strategy equilibrium is the only equilibrium of the game.

Part 3.1. Some But Not All Potential Plaintiffs File A Lawsuit

We prove that $0 < m < 1$. The proof has two parts.

Part 3.1.1. $m > 0$

Given that $m = \frac{c}{[(1-\tau_1)fA-K_P)]\left[\lambda^0-\lambda^1\frac{(\tau_2 A+K_D)}{(1-\tau_1)A+K_D}\right]}$, it suffices to show that $\left[\lambda^0 - \lambda^1\frac{(\tau_2 A+K_D)}{(1-\tau_1)A+K_D}\right] > 0$. By assumption, $\lambda^0 > \lambda^1$; and by condition (1), $\tau_2 A+K_D < (1-\tau_1)fA-K_P$. Then, $\tau_2 A+K_D < (1-\tau_1)fA - K_P < (1-\tau_1)A + K_D$. Hence, $\frac{\tau_2 A+K_D}{(1-\tau_1)A+K_D} < 1$. Q.E.D.

Part 3.1.2. $m < 1$

We will prove that $m < 1$ if and only if $\tau_1 < \bar{\tau_1} = 1 - \frac{-B_1+\sqrt{B_1^2+4A_1C_1}}{2A_1}$, where $A_1 = fA^2\lambda^0$, $B_1 = fAK_D(\lambda^0 - \lambda^1) - A(K_P + \lambda^1 + c)$, and $C_1 = (\lambda^0 - \lambda^1)L_P K_D + cK_D$ and $\tau_2 < \bar{\tau_2}(\tau_1) = \frac{(1-\tau_1)A+K_D}{\lambda^1 A}\left[\lambda^0 - \frac{(1-\tau_1)FA-K_P}{c}\right] - \frac{K_D}{A}$

First, we show that m is increasing in τ_1 and τ_2. Next, we compute $\bar{\tau_1}$ and $\bar{\tau_2}$.

Part 3.1.2.1.

Differentiating m, the probability of filing, equation (14), with respect to τ_1, yields

$$\frac{\partial m}{\partial \tau_1} = -\frac{c}{[(1-\tau_1)fA - K_P]^2 \left[\lambda^0 - \lambda^1 \frac{(\tau_2 A + K_D)}{(1-\tau_1)A + K_D}\right]^2}[-fA\left(\lambda^0 - \lambda^1 \frac{(\tau_2 A + K_D)}{(1-\tau_1)A + K_D}\right) +$$

$$+[(1-\tau_1)fA - K_P]\frac{(\tau_2 A + K_D)}{[(1-\tau_1)A + K_D]^2}(-A)] > 0. \quad (A23)$$

Differentiating m, equation (12), with respect to τ_2 yields

$$\frac{\partial m}{\partial \tau_2} = -\frac{c}{[(1-\tau_1)fA - K_P] \left[\lambda^0 - \lambda^1 \frac{\tau_2 A + K_D}{(1-\tau_1)A + K_D}\right]^2}\left[-\lambda^1 \frac{A}{(1-\tau_1)A + K_D}\right] > 0. \quad (A24)$$

Hence, an increase in τ_1 or τ_2 raise filing.

Part 3.1.2.2.

1) Computation of $\bar{\tau}_1$.

The maximum feasible range of τ_1 consistent with $m < 1$ is attained if $\tau_2 = 0$. Given that m is increasing in τ_1, $m < 1$ if and only if $\tau_1 < \bar{\tau}_1$, where $\bar{\tau}_1$ is defined implicitly by $m(\tau_1 = \bar{\tau}_1, \tau_2 = 0) = 1$.

The condition $m(\tau_1 = \bar{\tau}_1, \tau_2 = 0) = 1$ can be rewritten as:

$$\frac{c}{[(1-\bar{\tau}_1)fA - K_P]\left[\lambda^0 - \lambda^1 \frac{K_D}{(1-\bar{\tau}_1)A + K_D}\right]} = 1 \quad (A25)$$

After some straightforward algebraic manipulations the last equation becomes:

$$A_1(1-\bar{\tau}_1)^2 + B_1(1-\bar{\tau}_1) - C_1 = 0, \quad (A26)$$

where $A_1 \equiv fA^2\lambda^0 > 0$, $B_1 \equiv fA\lambda^0 K_D - AK_P\lambda^1 - CA - \lambda^1 fAK_D$, and $C_1 \equiv (\lambda^0 - \lambda^1)K_P K_D + cK_D > 0$.

Equation (A26) is a quadratic equation in $1-\tau_1$. It has two roots, $1-\tau_1^1$ and $1-\tau_1^2$, such that $(1-\tau_1^1)(1-\tau_1^2) = -\frac{C_1}{A_1} < 0$. Hence, one root is negative, and the other one is positive. The negative value of $1-\tau_1$ means that $\tau_1 > 1$, which is impossible. Hence, to calculate $\bar{\tau}_1$, we need to calculate the positive (the larger) root of the equation (A26). Therefore,

$$1-\bar{\tau}_1 = \frac{-B_1 + \sqrt{B_1^2 + 4A_1C_1}}{2A_1}, \quad (A27)$$

and

$$\bar{\tau_1} = 1 - \frac{-B_1 + \sqrt{B_1^2 + 4A_1C_1}}{2A_1}. \qquad (A28)$$

2) Computation of $\bar{\tau_2}$.

Given that m is increasing in τ_2 for any given τ_1, $m < 1$ if and only if $\tau_2 < \bar{\tau_2}(\tau_1)$, where $\bar{\tau_2}(\tau_1)$ is defined implicitly by $m(\tau_1, \tau_2 = \bar{\tau_2}(\tau_1)) = 1$.

The last equation can be rewritten as:

$$\frac{c}{[(1-\tau_1)fA - K_P]\left[\lambda^0 - \lambda^1 \frac{\bar{\tau_2}A + K_D}{(1-\tau_1)A + K_D}\right]} = 1. \qquad (A29)$$

Solving the last equation for $\bar{\tau_2}$ yields

$$\bar{\tau_2} = \frac{(1-\tau_1)A + K_D}{\lambda^1 A}\left[\lambda^0 - \frac{(1-\tau_1)fA - K_P}{C_1}\right] - \frac{K_D}{A}. \qquad (A30)$$

Q.E.D.

Part 3.2. Some But Not All Potential Injurers Are Negligent

We prove that $0 < q < 1$

By condition (3), $K_P > \tau_2 fA$. Then, $0 < q$. In addition, condition (2) implies that $q < 1$. Q.E.D.

Part 3.3. Uniqueness of the Game Equilibrium

We prove that the described mixed-strategy equilibrium is the only equilibrium of the game.

Suppose that the probability of being careful is greater than the one set by equation (15) (it can be equal to one), i.e. $\tilde{p} > p$. This will imply a lower conditional (on the occurrence of the accident) probability that the defendant is negligent, $\tilde{q} < q$, determined by equation (14). Given that the expected payoff of the plaintiff, $[q(1-\tau_1) + (1-q)\tau_2]fA - K_P$ depends positively on q, it will be lower as well. Hence, the probability of filing m will be also lower. But in that case, the left-hand side of equation (10) will be greater than the right-hand side. Therefore, it will be optimal for *all* prospective defendants *not* to take care, which contradicts the initial assumption that $\tilde{p} > p$. The impossibility of the opposite case, $\tilde{p} < p$ can be shown similarly. Q.E.D.

Proof of Proposition 2.

Differentiating the conditional probability of trial, equation (8), with respect to τ_1 yields

$$\frac{-fA(1-q)[(1-\tau_1)A+K_D]+AfA(1-\tau_1-\tau_2)(1-q)}{[(1-\tau_1)A+K_D]^2}=\frac{-fA(1-q)(\tau_2 A+K_D)}{[(1-\tau_1)A+K_D]^2}<0. \quad (A31)$$

Hence an increase in τ_1 reduces the conditional probability of trial.

Differentiating m, the probability of filing, equation (14), with respect to τ_1, yields

$$\frac{\partial m}{\partial \tau_1}=-\frac{c}{[(1-\tau_1)fA-K_P]^2\left[\lambda^0-\lambda^1\frac{(\tau_2A+K_D)}{(1-\tau_1)A+K_D}\right]^2}[-fA\left(\lambda^0-\lambda^1\frac{(\tau_2A+K_D)}{(1-\tau_1)A+K_D}\right)+$$

$$+[(1-\tau_1)fA-K_P]\frac{(\tau_2A+K_D)}{[(1-\tau_1)A+K_D]^2}(-A)]>0. \quad (A32)$$

Hence, an increase in τ_1 raises filing.

Differentiating q, equation (16), with respect to τ_1 yields

$$\frac{\partial q}{\partial \tau_1}=\frac{(F^{-1}(m))'\frac{\partial m}{\partial \tau_1}fA(1-\tau_1-\tau_2)+fA(F^{-1}(m)+K_P-\tau_2 fA)}{[fA(1-\tau_1-\tau_2]^2}>0, \quad (A33)$$

because $\tau_1+\tau_2<1$. Differentiating equation (18) with respect to τ_1, we get

$$\frac{\partial p}{\partial \tau_1}=\lambda^0\frac{-\frac{\partial q}{\partial \tau_1}[\lambda^0(1-q)+\lambda^1 q]-(1-q)\left[-\lambda^0\frac{\partial q}{\partial \tau_1}+\lambda^1\frac{\partial q}{\partial \tau_1}\right]}{[\lambda^0(1-q)+\lambda^1 q]^2}=\frac{-\lambda^0\lambda^1\frac{\partial q}{\partial \tau_1}}{[\lambda^0(1-q)+\lambda^1 q]^2}<0. \quad (A34)$$

In words, an increase in the level of court error τ_1 reduces the probability that the potential defendant chooses to be careful, and hence, reduces the general level of care, and increases the unconditional probability of an accident, $\mu=\lambda^0+p(\lambda^1-\lambda^0)$.

Q.E.D.

Proof of Proposition 3.

Differentiating m, equation (14), with respect to τ_2 yields

$$\frac{\partial m}{\partial \tau_2}=-\frac{c}{[(1-\tau_1)fA-K_P]\left[\lambda^0-\lambda^1\frac{\tau_2A+K_D}{(1-\tau_1)A+K_D}\right]^2}\left[-\lambda^1\frac{A}{(1-\tau_1)A+K_D}\right]>0. \quad (A35)$$

Q.E.D.

Proof of Proposition 4.

The proof proceeds in two parts. First, we show the effects of the introduction of damage caps, and second we prove the effects of the introduction of split-awards.

Part 1.

Differentiating the conditional probability of trial, equation (8), with respect to A yields

$$\frac{f(1-q)(1-\tau_1-\tau_2)[(1-\tau_1)A+K_D]-(1-\tau_1)fA(1-q)(1-\tau_1-\tau_2)}{[(1-\tau_1)A+K_D]^2}=$$

$$=\frac{f(1-q)(1-\tau_1-\tau_2)K_D}{[(1-\tau_1)A+K_D]^2}>0. \qquad (A36)$$

Hence, the introduction of damage caps, i.e., the reduction in A, reduces the conditional probability of trial.

Differentiating the probability of filing, equation (14), with respect to A yields

$$\frac{\partial m}{\partial A}=-\frac{c}{[(1-\tau_1)fA-K_P]^2\left[\lambda^0-\lambda^1\frac{(\tau_2A+K_D)}{(1-\tau_1)A+K_D}\right]^2}\left[(1-\tau_1)f\left(\lambda^0-\lambda^1\frac{\tau_2A+K_D}{(1-\tau_1)A+K_D}\right)+\right.$$

$$\left.+[(1-\tau_1)fA-K_P](-1)\lambda^1\frac{\tau_2[(1-\tau_1)A+K_D]-(1-\tau_1)(\tau_2A+K_D)}{[(1-\tau_1)A+K_D]^2}\right]=$$

$$=-\frac{c}{[(1-\tau_1)fA-K_P]^2\left[\lambda^0-\lambda^1\frac{(\tau_2A+K_D)}{(1-\tau_1)A+K_D}\right]^2}\left[(1-\tau_1)f\left(\lambda^0-\lambda^1\frac{\tau_2A+K_D}{(1-\tau_1)A+K_D}\right)+\right.$$

$$\left.+[(1-\tau_1)fA-K_P]\lambda^1\frac{(1-\tau_1-\tau_2)K_D}{[(1-\tau_1)A+K_D]^2}\right]<0. \qquad (A37)$$

Therefore, a reduction in A increases the probability of filing.

Differentiating q, equation (16), with respect to A yields

$$\frac{\partial q}{\partial A}=\frac{\left[(F^{-1}(m))'\frac{\partial m}{\partial A}-\tau_2f\right]fA(1-\tau_1-\tau_2)-f(1-\tau_1-\tau_2)[F^{-1}(m)+K_P-\tau_2fA]}{[fA(1-\tau_1-\tau_2]^2}<0. \qquad (A38)$$

The last inequality holds because $\frac{\partial m}{\partial A}<0$ and $F^{-1}(m)+K_P-\tau_2fA>0$. Hence,

$$\frac{\partial p}{\partial A}=\lambda^0\frac{-\frac{\partial q}{\partial A}[\lambda^0(1-q)+\lambda^1q]-(1-q)(\lambda^1-\lambda^0)\frac{\partial q}{\partial A}}{[\lambda^0(1-q)+\lambda^1q]^2}=-\frac{\lambda^0\lambda^1\frac{\partial q}{\partial A}}{[\lambda^0(1-q)+\lambda^1q]^2}>0. \qquad (A39)$$

In words, an increase in the expected level of court award reduces the probability that the potential defendant chooses to be careful, and hence, reduces the general level of care, and increases the unconditional probability of an accident, $\mu = \lambda^0 + p(\lambda^1 - \lambda^0)$.

Part 2.

Differentiating the conditional probability of trial, equation (8), with respect to f yields

$$\frac{A(1-q)(1-\tau_1-\tau_2)}{(1-\tau_1)A+K_P} > 0. \tag{A40}$$

Differentiating the probability of filing, equation (14), with respect to f yields

$$\frac{\partial m}{\partial f} = -\frac{c(1-\tau_1)A}{[(1-\tau_1)fA-K_P]^2\left[\lambda^0-\lambda^1\frac{\tau_2 A+K_D}{(1-\tau_1)A+K_D}\right]} < 0. \tag{A41}$$

Differentiating q, equation (16), with respect to f yields

$$\frac{\partial q}{\partial f} = \frac{\left[(F^{-1}(m))'\frac{\partial m}{\partial f}-\tau_2 A\right]fA(1-\tau_1-\tau_2)-A(1-\tau_1-\tau_2)[F^{-1}(m)+K_P-\tau_2 fA]}{[fA(1-\tau_1-\tau_2)]^2} < 0. \tag{A42}$$

The last inequality holds trivially because $(F^{-1}(m))' > 0$ and $\frac{\partial m}{\partial f} < 0$.

Hence,

$$\frac{\partial p}{\partial f} = \lambda^0\frac{-\frac{\partial q}{\partial f}[\lambda^0(1-q)+\lambda^1 q]-(1-q)(\lambda^1-\lambda^0)\frac{\partial q}{\partial f}}{[\lambda^0(1-q)+\lambda^1 q]^2} = -\frac{\lambda^0\lambda^1\frac{\partial q}{\partial f}}{[\lambda^0(1-q)+\lambda^1 q]^2} > 0. \tag{A43}$$

Q.E.D.

Proof of Proposition 5.

Following the steps described in the proof of Proposition 1, it is easy to show that Proposition 5 holds. Q.E.D.

Proof of Proposition 6.

The proof proceeds in three parts. First, we show that under condition $(1-\tau_1)K_P > \tau_1 K_D$, $(1-\tau_1)fA-K_P < (1-\tau_1)fA-\tau_1(K_P+K_D)$. Second, we prove that $\lambda^0-\lambda^1\frac{\tau_2 A+K_D}{(1-\tau_1)A+K_D} < \lambda^0-\lambda^1\frac{\tau_2}{1-\tau_1}$. Third, we conclude that under the American rule the probability of filing, m is higher than under the English rule.

Part 1.

By the assumption of Proposition 6,

$$(1-\tau_1)fA - K_P - [(1-\tau_1)fA - \tau_1(K_P+K_D)] = \tau_1 K_D - (1-\tau_1)K_P < 0. \tag{A44}$$

Part 2.

$$\lambda^0 - \lambda^1\frac{\tau_2 A + K_D}{(1-\tau_1)A+K_D} - [\lambda^0 - \lambda^1\frac{\tau_2}{1-\tau_1}] = \lambda^1\left[\frac{\tau_2}{1-\tau_1} - \frac{\tau_2 A + K_D}{(1-\tau_1)A+K_D}\right] =$$
$$= -\lambda^1\frac{K_D(1-\tau_1-\tau_2)}{(1-\tau_1)[(1-\tau_1)A+K_D]} < 0. \tag{A45}$$

Part 3.

In parts 1 and 2, we show that both terms in the denominator of the expression for m under the American rule are smaller than corresponding terms under the English rule. Hence, m, is lower under the English rule. Q.E.D.

Proof of Proposition 7.

Define

$$\frac{P^{ER}_{trial}}{P^{AR}_{trial}} = \frac{1-\hat{q}}{1-q}\frac{(fA+K_P+K_D)[(1-\tau_1)A+K_D)}{(1-\tau_1)(A+K_P+K_D)fA}. \tag{A46}$$

The proof proceeds in three parts. First, we show that the second term of equation (A42), $\frac{(fA+K_P+K_D)[(1-\tau_1)A+K_D)}{(1-\tau_1)(A+K_P+K_D)fA}$, is always greater than unity. Second, we prove that $\hat{q} < q$ if $\tau_2 > \frac{K_D}{K_P+K_D}$. Finally, we show that under the condition $\tau_2 > \frac{K_D}{K_P+K_D}$, the term $\frac{1-\hat{q}}{1-q}$ is greater than unity and $\hat{p} > p$, i.e., the level of care is higher under the English rule.

Part 1.

The term $\frac{(fA+K_P+K_D)[(1-\tau_1)A+K_D)}{(1-\tau_1)(A+K_P+K_D)fA}$ can be rewritten as

$$\frac{fA^2 + AK_P + AK_D + \frac{fAK_D}{1-\tau_1} + \frac{K_PK_D}{1-\tau_1} + \frac{K_D^2}{1-\tau_1}}{fA^2 + fAK_P + fAK_D} > 1, \qquad (A47)$$

because $AK_P > fAK_P$ and $AK_D > fAK_D$.

Part 2.

$\hat{q} < q$ if and only if

$$\frac{F^{-1}(\hat{m}) + (K_P + K_D)(1-\tau_2) - fA\tau_2}{fA + K_P + K_D} < \frac{F^{-1}(m) + K + P - \tau_2 fA}{fA}. \qquad (A48)$$

Given that $fA + K_P + K_D > fA$ and $\hat{m} < m$ (filing is lower under the English rule), $(K_P + K_D)(1-\tau_2) < K_P$ is a sufficient condition for $\hat{q} < q$ to hold. It is straightforward to show that $(K_P + K_D)(1-\tau_2) < K_P$ is equivalent to $\tau_2 > \frac{K_D}{K_P+K_D}$.

Part 3.

$\frac{1-\hat{q}}{1-q} > 1$ if and only if $\hat{q} < q$. Hence, $\frac{1-\hat{q}}{1-q} > 1$ holds if $\tau_2 > \frac{K_D}{K_P+K_D}$. Therefore, under this condition $\frac{P^{ER}_{trial}}{P^{AR}_{trial}} > 1$. Furthermore, $\hat{q} < q$ implies $\hat{p} > p$. In words, a switch to the English rule raises the level of care, and hence reduces the unconditional probability of accident.

Q.E.D.

References

Babcock, L. and Pogarsky, G.. "Damage Caps and Settlement: A Behavioral Approach." *Journal of Legal Studies,* Vol. 28 (1999), pp. 341–370.

Banks, J.S. and Sobel, J. "Equilibrium Selection in Signaling Games." *Econometrica,* Vol. 55 (1987), pp. 647–661.

Economic Report of the President. United States Government Printing Office, Washington, pp. 203–221, 2004.

Cooter, R. and Ulen, T. Law and Economics. Pearson Addison Wesley, New York, 2004.

Daughety, A. and Reinganum, J. "Found Money? Split-Award Statutes and Settlement of Punitive Damages Cases." *American Law and Economics Review,* Vol. 5 (2003), pp. 134–394.

Dodson, S. "Assessing the Practicality and Constitutionality of Alaska's Split-Recovery Punitive Damages Statute." *Duke Law Journal,* Vol. 49 (2000), pp. 1335–1369.

Epstein, K. " Punitive Damage Reform: Allocating a Portion of the Award to the State." *The Review of Litigation,* Vol. 13 (1994), pp. 597–621.

Hughes, J. and Snyder, E. "Litigation and Settlement under the English and American Rules: Theory and Evidence." *Journal of Law and Economics* Vol. 38 (1995), pp. 225–250.

Hylton, K. "An Asymmetric-Information Model of Litigation." *International Review of Law and Economics,* Vol. 22 (2002), pp. 153–175.

Hylton, K. "Litigation Cost Allocation Rules and Compliance with the Negligence Standard." *Journal of Legal Studies,* Vol. 22 (1993), pp. 457–476.

Kahan, M. and Tuckman, B. "Special Levies on Punitive Damages: Decoupling, Agency Problems and Litigation Expenditures." *International Review of Law and Economics*, Vol. 15 (1995), pp. 175–85.

Landeo, C.M., Nikitin, M., and Babcock, L. "Split-Awards and Disputes: An Experimental Study of a Strategic Model of Litigation." Mimeo, University of Alberta, Department of Economics, and Carnegie Mellon University, Heinz School, 2004. http://www.arts.ualberta.ca/∼econweb/landeo/.

Landeo, C.M. and Nikitin, M. "Split-Award Tort Reform, Firm's Level of Care and Litigation Outcomes." Mimeo, University of Alberta, Department of Economics, 2004. http://www.arts.ualberta.ca/∼econweb/landeo/.

O'Connell, J. "Blending Reform of Tort Liability and Health Insurance: A Necessary Mix." *Cornell Law Review* Vol. 79 (1994), pp. 1303–1338.

Png, I.P.L. "Litigation, Liability, and the Incentives for Care." *Journal of Public Economics,* Vol. 34 (1987), pp. 61–85.

Polinsky, A. and Rubinfeld, D. "Aligning the Interests of Lawyers and Clients." *American Law and Economics Review* Vol. 5 (2003), pp. 165–188.

Reinganum, J. and Wilde, L. "Settlement, Litigation, and the Allocation of Litigation Costs." *Rand Journal of Economics* Vol. 17 (1986), pp. 557–566.

Schweizer, U. "Litigation and Settlement under Two-Sided Incomplete Information." *Review of Economic Studies* Vol. 56 (1989), pp. 163–178.

Sloane, L. "The Split-Award Statute: A Move Toward Effectuating the True Purpose of Punitive Damages." *Valparaiso University Law Review*, Vol. 28 (1993), pp. 473–512.

Smith, S., DeFrances, C., Langan, P., and Goersdt, J. "Special Report. Civil Justice Survey of State Courts, 1992. Tort Cases in Large Counties." Bureau of Justice Statistics, United States Department of Justice, NCJ-153177, 1995.

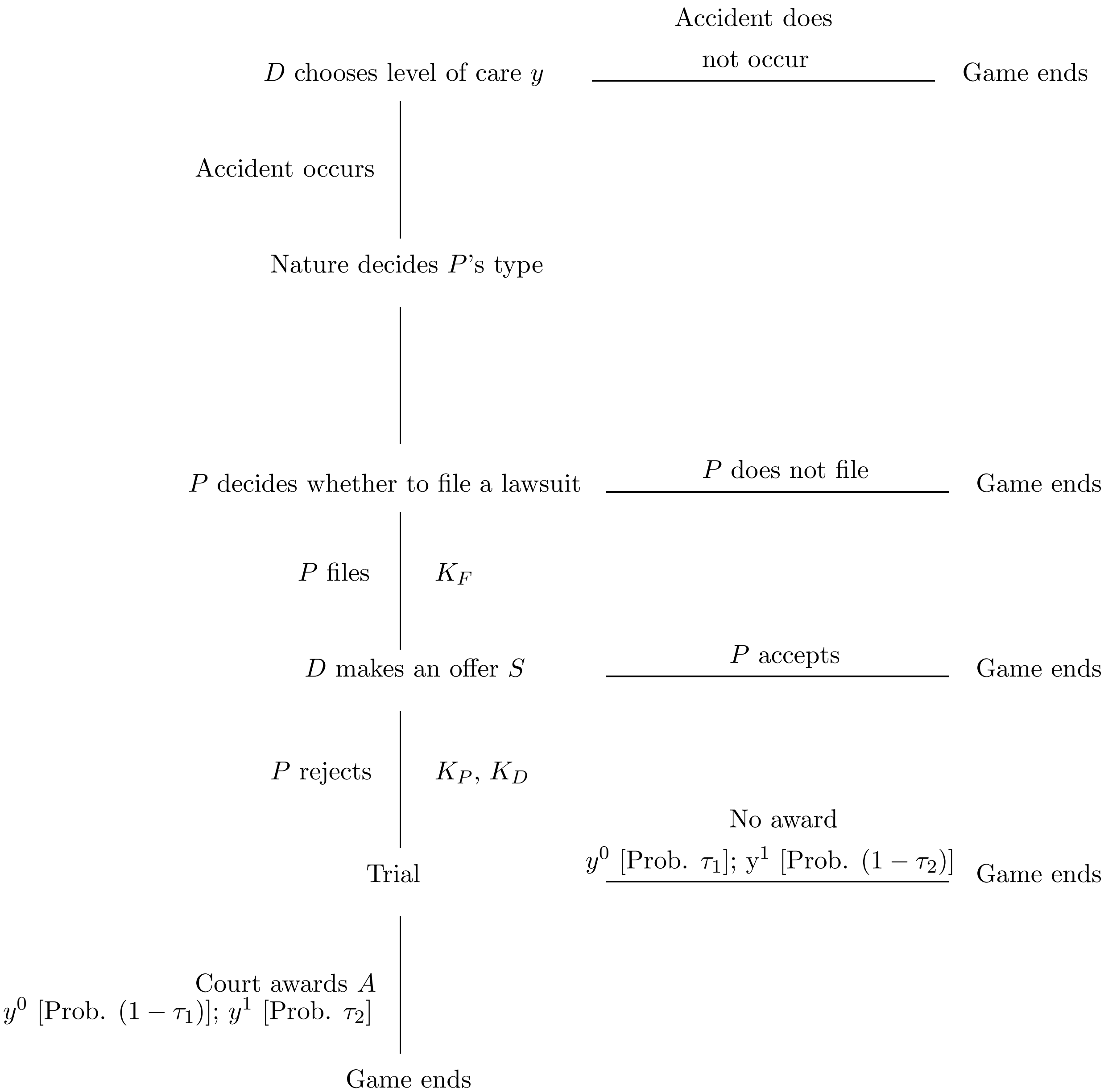
Snyder, E. and Hughes, J. "The English Rule for Allocating Legal Costs: Evidence Confronts Theory." *Journal of Law, Economics, and Organization* Vol. 6 (1990), pp. 345–380.

Stevens, C. "Split-Recovery: A Constitutional Answer to the Punitive Damage Dilemma." *Pepperdine Law Review*, Vol. 21 (1994), pp. 857–908.

Tullock, G. Trials on Trial: The Pure Theory of Legal Procedure. Columbia University Press, New York, 1980.

White, P. "The Practical Effects of Split-Recovery Statutes and their Validity as a Tool of Modern Day 'Tort Reform'." *Drake Law Review*, Vol. 50 (2002), pp. 593–610.

FIGURE 1
SEQUENCE OF EVENTS IN THE GAME



Note: D = defendant, P = plaintiff, K_F = filing costs, K_D = defendant's litigation costs, K_P = plaintiff's litigation costs, A = punitive damage award, y^1, y^2 = levels of care; τ_1, τ_2 = court's errors.