Confidence, Optimism, and Litigation: A Litigation Model under Ambiguity

Nathalie Chappe[*]   Raphael Giraud[†]

September 30, 2014

Abstract

This paper introduces ambiguity into an otherwise standard litigation model. The aim is to take into account the plaintiff's optimism and confidence. We ask : (1) How do optimism and confidence affect (the outcomes of the) settlement? (2) How do optimism and confidence affect the level of care? (3) What are the public policy implications in terms of monitoring the level of confidence? We show that the equilibrium probability of settlement increases with the degree of optimism for all plaintiffs and increases with the level of confidence for pessimistic plaintiffs, provided plaintiffs are highly sensitive to a rise in the settlement offer is high, and that the same holds for the level of care independently of the plaintiffs' sensitivity to rises in the settlement offer. Finally, assuming the government's objective is to minimize the probability of litigation and assuming that it can manipulate the level of confidence only, we find that a clear recommendation is possible only if plaintiffs are highly sensitive to rises in the settlement offer: government intervention to raise public confidence in the judicial system is recommended only when plaintiffs are pessimistic about their chances of winning, in which case, as much as possible should be spent.

Keywords: Confidence, Ambiguity, Litigation, Behavioral Law and Economics.

JEL codes: K41, D81.

[*]CRESE, University of Franche-Comté; 45, avenue de l'observatoire, 25030 Besançon, France.
[†]LED, University Paris 8.

1   Introduction

1.1   Motivation

Public confidence is fundamental to the operation of the civil justice system. The system depends on the participation of victims. Low levels of public confidence also lead to disrespect and dissatisfaction with those responsible for administering the system. The political debate surrounding dissatisfaction has become well established over the past decade. In France, several studies[1] report a lack of public confidence in the legal system and offer several lines of action to remedy the situation. In 2011, only 55% (63% in 2008) of the French said they had confidence in the legal system. This dissatisfaction is present throughout Europe: on average, in 2010, 47% of Europeans stated they tended to trust the legal system.[2]

Standard litigation models are ill-suited to address this issue of confidence because they are based on the expected utility framework. In particular, they represent agents' beliefs about the outcome of the judgment at trial with a probability distribution. Starting with Ellsberg's seminal ideas (Ellsberg, 1961), however, a significant body of literature, reviewed e.g. in Etner, Jeleva, and Tallon (2012), has questioned the empirical and normative relevance of this assumption. The idea is that, except in very particular cases, decision-makers facing a decision problem under uncertainty do not have enough information to come up with a precise probability distribution about the events of interest. Based on the frequentist interpretation of probabilities, one main reason for this is that the decision maker does not have enough observations of the realization of the random variable at stake to be able to apply the law

---

[1] "Les Français et la justice, jugements et attente", GIP Droit et Justice, 1997 ; Conseil supérieur de la magistrature (CSM), report 2008 and "Les Français et la Justice", Le Figaro, 2011.

[2] See Eurobarometer Surveys: $http://ec.europa.eu/public\_opinion$. The same trend exists in Canada (only 5% of the public expressed a "great deal of confidence" in the criminal justice system) and in United States (29% of respondents expressed "a great deal or quite a lot of confidence" in the criminal justice system). See Confidence in justice: an international review, Hough and Robert, 2004, Home Office. Research, Development and Statistics Directorate.

of large numbers and so use the empirical frequency as a reliable estimate of the true probability distribution. This occurs in particular when the event is by nature non-repeatable.

Following Knight (1921) and the terminology now standard in this literature, when the decision-maker is able to come up with a probability distribution based on available information, we say that he is facing a decision problem under risk; in all other cases, he faces a decision problem under ambiguity. Perceived ambiguity translates into a lack of confidence in one's evaluation of the relevant probabilities. Does ambiguity matter? Should we expect new insights when taking it into consideration? What Ellsberg did was precisely to show that we should. Indeed, he showed that the most common behavior when facing ambiguity is to hang on to the known and to stay away from the unknown. This is essentially what the literature means by ambiguity aversion: people prefer betting on events about which they know the probability to betting on events with unknown probability, even though the unknown probability may turn out to be more favorable than the known probability. The theoretical literature has ever since tried to build models accommodating this behavior which is incompatible with expected utility in its subjective flavor (Savage, 1954), where the decision maker behaves under ambiguity as if he were under risk. The most famous of these models are the Multiple Prior Expected Utility model (Gilboa and Schmeidler, 1989) and the Choquet Expected Utility model (Schmeidler, 1989) (see Etner et al. (2012) for details and further references).

1.2   Contribution

The paper presents a strategic model of incentives for care and settlement under ambiguity. The injurer is engaged in an activity which entails the risk that there will be an accident imposing a loss on the victim. If an accident does occur, the parties engage in a negotiation. Geistfeld (2011) explains why ambiguity may arise in

3

such a context. He defines the concept of legal ambiguity: "...legal ambiguity refers to an unknown outcome regarding the requirements of a legal rule or body of law, as applied to a set of known facts, for which the probability cannot be confidently or reliably defined and must be estimated by decision makers." Accordingly, we introduce ambiguity about judgment for the victim.

We shall use a variant of the Choquet Expected Utility model: the NEO-additive model (Chateauneuf, Eichberger, and Grant, 2007). This model has the advantage, from an applied point of view, of providing a parametric representation of both perceived ambiguity (which can also be interpreted as the degree of confidence in one's probabilistic estimation) and attitude towards this ambiguity (aversion or love). Specifically, if we consider a (bounded) real random variable a, defined on a measurable space $(\Omega, \mathcal{A})$, the criterion to be maximized by the agent is

$$V(a) = \alpha E_\pi(u(a)) + (1 - \alpha)(\gamma \max_{\omega \in \Omega} u(a(\omega)) + (1 - \gamma) \min_{\omega \in \Omega} u(a(\omega))),$$

where u is a Bernoulli utility function, π is a probability distribution over $(\Omega, \mathcal{A})$, corresponding to the probabilistic estimation by the decision-maker of the true probability distribution, α is the degree of confidence the decision maker has in this estimation, and γ is his degree of optimism. The interpretation is that: if the decision-maker were fully confident in the prior he uses ($\alpha = 1$), he would behave as an expected utility maximizer;[3] on the other hand, if he had no confidence at all ($\alpha = 0$), he would consider himself to be facing complete uncertainty and use the Arrow-Hurwicz criterion (Arrow and Hurwicz, 1972), with optimism parameter γ.

---

[3]This in itself is a debatable assumption since beginning with Allais' paradox, it is well known that, even under risk, expected utility is not descriptively accurate. However, nearly all models of decision under ambiguity make the simplifying assumption that the only departure from expected utility comes from the presence of ambiguity.

1.3 Related literature

To the best of our knowledge, the only paper incorporating ambiguity in liability models is Teitelbaum (2007) which uses Choquet's Expected Utility theory to model the attitude toward ambiguity of a firm that is a potential injurer in a unilateral accident model with different liability rules. Teitelbaum (2007) shows that neither strict liability nor negligence are generally efficient in the presence of ambiguity. Moreover he shows that the injurer's level of care (1) decreases with his degree of optimism and increases with his degree of pessimism, and (2) decreases with ambiguity if he is optimistic and increases with ambiguity if he is pessimistic. Teitelbaum (2007) differs from our approach in several respects. First, he considers the liability design only, while we consider a more developed litigation model, since we add both uncertainty about the outcome of the trial and the possibility of settlement for the parties. Second, in our model, ambiguity is perceived by the plaintiff and bears on his probability of success in the trial, whereas in Teitelbaum (2007) ambiguity is perceived by the defendant and bears on the probability of an accident occurring.

As will be seen in the paper, one of the consequences of modeling ambiguity using the NEO-additive model in a litigation model is that the plaintiff and the defendant behave as if they had different priors for the outcome of the trial. Thus it is related to two different branches of the literature. The first is the literature on divergent expectations models of litigation. In divergent expectations theories (Landes (1971), Gould (1973), Priest and Klein (1984), Waldfogel (1998)), parties have different evaluations of the plaintiff's probability of prevailing, and cases proceed to trial when the plaintiff is sufficiently more optimistic than the defendant. The second is the literature that seeks to combine asymmetric information models à la Bebchuk (1984) and divergent expectations models by introducing a self-serving bias. For instance, Landeo, Nikitin, and Izmalkov (2012) present a strategic model of incentives for care and litigation under asymmetric information and self-serving bias, and study the

effects of caps on non-economic damages. Farmer and Pecorino (2002) focus on the self-serving bias in a model à la Bebchuk (1984) without considering the precaution stage, while Langlais (2011) generalizes this work by introducing the plaintiff's risk aversion. Thus our paper, like those of Landeo et al. (2012) and Farmer and Pecorino (2002), combines asymmetric information and divergent expectations.

1.4   Results

We ask : (1) How do optimism and confidence affect the outcomes of the settlement? (2) How do optimism and confidence affect the level of care? (3) What are the public policy implications in terms of monitoring the level of confidence?

For the first two questions, we show that, provided plaintiffs are highly sensitive to a rise in the settlement offer (in a sense to be specified later), the equilibrium probability of settlement increases with the degree of optimism for all plaintiffs and increases with the level of confidence for pessimistic plaintiffs. For the second question, and independently of the plaintiffs' sensitivity to rises in the settlement offer, the level of care increases with the degree of optimism and increases with the level of confidence for pessimistic plaintiffs.[4]   For the third question, finally, assuming the government's objective is to minimize the probability of litigation, and assuming that it can only manipulate the level of confidence, we find that a clear recommendation is possible only if plaintiffs are highly sensitive to rises in the settlement offer. In that case, government intervention to raise public confidence in the judicial system is recommended only when plaintiffs are pessimistic about their chances of winning. If this is so, as much should be spent as possible.

The paper is organized as follows: in section 2, we present the model. The settlement

---

[4]The difference between these two questions is, for the case of the level of care, the envelope theorem implies that only changes in the plaintiff's behavior due to a change in optimism and confidence have an impact on the level of care; changes in the settlement offer by the plaintiff do not matter.

stage is examined in section 3, while the resulting incentives for care are studied in section 4. Finally, public policy implications are outlined in section 5. Section 6 contains concluding remarks.

2 The model

2.1 Basic notations

The model assumes one injurer and a continuum of victim types, indexed by the damages awarded in court in the event of an accident, denoted L, and distributed according to distribution F with differentiable density f and support $[\underline{L}, \bar{L}]$, such that $f(L) \neq 0$ for all $L \in (\underline{L}, \bar{L})$. This distribution is known to the defendant (based on the standard argument that the defendant is a firm that has faced a sufficient number of trials to correctly estimate the distribution). If there is an accident the defendant and plaintiff bargain over the amount of compensation that the defendant should pay the plaintiff. Litigation costs, denoted c_p for the plaintiff (victim) and c_d for the defendant (injurer), are allocated according to the American rule, which requires each party to pay for its own litigation expenses.

2.2 Decision model

The plaintiff's probability of prevailing is $\pi \in (0, 1)$. The defendant, being a firm with significant experience of trials, knows this probability. The plaintiff, on the other hand, is unsure about it. He therefore faces ambiguity. Given that if he prevails in the trial, the plaintiff is awarded L and that he is awarded nothing otherwise, and given his probability of prevailing π, applying the NEO-additive formula discussed in the introduction, his "expected" recovery is

$$V = \alpha \pi L + (1 - \alpha) \gamma L, \quad \alpha \in (0, 1), \quad \gamma \in (0, 1). \tag{1}$$

As discussed in the introduction, the parameter α may be interpreted as an indicator of the victim's confidence about his probability of prevailing, or alternatively $1 - \alpha$ is the degree of perceived ambiguity, and the parameter γ represents the level of the plaintiff's optimism.

Let us define the (confidence-and-optimism) adjusted probability of winning, denoted $\hat{\pi}$:

$$\hat{\pi} := \alpha\pi + (1 - \alpha)\gamma.$$

This probability may be interpreted as a *subjective* probability of winning, as opposed to the objective probability π. The difference between π and $\hat{\pi}$ reveals the plaintiff's optimism or pessimism. Since $\hat{\pi} < \pi$ if and only if $\gamma < \pi$, the plaintiff underestimates his probability of prevailing if and only if his optimism parameter is low. Accordingly, we introduce the following definition:

Definition 1. *We say that a plaintiff is*

- optimistic *if $\hat{\pi} > \pi$ (or equivalently $\gamma > \pi$);*

- pessimistic *if $\hat{\pi} < \pi$ (or equivalently $\gamma < \pi$);*

Optimistic plaintiffs can be viewed as ambiguity loving, while pessimistic plaintiffs can be viewed as ambiguity averse. In what follows we will sometimes use these formulations interchangeably.

Because in our model the plaintiff may be construed as having a distorted view of his probability of prevailing, hence a bias, our model may be compared to Farmer and Pecorino (2002)'s model of a self-serving bias. The difference here is threefold. First, the bias is not systematically self-serving, as the plaintiff can be either optimistic or pessimistic. Second, in our model, the bias is mixed in the sense that we combine a multiplicative and an additive bias, whereas Farmer and Pecorino (2002) consider the two cases separately. We do not consider the most general form of mixed bias,

however, as this is not the focus of our research. Third, only the plaintiff is biased in our model.

How do confidence and optimism affect $\hat{\pi}$? We find that

$$\frac{\partial \hat{\pi}}{\partial \gamma} = 1 - \alpha > 0$$

and

$$\frac{\partial \hat{\pi}}{\partial \alpha} = \pi - \gamma > 0 \text{ if and only if } \pi > \gamma.$$

Hence, while the subjective probability increases with the level of optimism (hence decreases with ambiguity aversion), its reaction to a change in perceived ambiguity is more complex: if the perceived degree of ambiguity increases, a pessimistic plaintiff becomes more pessimistic, whereas an optimistic plaintiff becomes more optimistic. The intuition is that, for an ambiguity loving individual, more ambiguity means that a high winning probability is more likely, whereas for an ambiguity averse individual it means that it is less likely.

To rule out the possibility that the plaintiff will not actually go to trial even if he gets the low payment, we assume:[5]

$$\hat{\pi}\underline{L} - c_p > 0.$$

3   Settlement

Confidence in the courts will inevitably be determined by factors other than the quality of the decision ultimately handed down, for a number of reasons. The overwhelming majority of cases in all courts do not proceed to final judgment. Confidence in the courts will obviously be enhanced if courts proactively facilitate settlement, by

---

[5]This assumption means that the plaintiff had a credible commitment to pursue the case all the way to trial. This is not necessarily true. Nalebuff (1987) incorporates a credibility constraint and shows that when the constraint is binding, the equilibrium settlement offer is higher than before.

whatever means. In this section we incorporate the possibility of settlement into our model by assuming the parties can settle the lawsuit after the victim has filed. For simplicity, we assume that settlement is free of charge.

In our settlement stage, the plaintiff has private information about the loss. The uninformed defendant makes a take-it-or-leave-it settlement offer. The settlement offer will "screen" the plaintiffs into two groups: those who accept it and those who reject it. In addition, the parties consider the plaintiff's probability of winning differently, since the plaintiff perceives ambiguity. The plaintiff considers a probability $\hat{\pi}$, whereas the defendant considers a probability π.

3.1 The Plaintiff's decision

After an accident the defendant makes the plaintiff a single "take it or leave it" settlement offer s. If the plaintiff rejects the offer, there is a trial. If the plaintiff accepts, there is a settlement at s.

The plaintiff accepts the offer if it is as least as large as the value of a trial:

$$s \geq \hat{\pi}L - c_p. \tag{2}$$

Equivalently the plaintiff accepts the offer if the damages awarded are below his acceptance threshold level:

$$L \leq \frac{s + c_p}{\hat{\pi}} := \hat{L}(s). \tag{3}$$

The probability of the plaintiff rejecting the offer s and of there being a trial is the probability that the damages awarded are higher than $\hat{L}$, i.e. $1 - F(\hat{L})$. We have:

$$\frac{\partial \hat{L}}{\partial \gamma} = -\frac{(1-\alpha)(s + c_p)}{\hat{\pi}^2} < 0 \tag{4}$$

and

$$\frac{\partial \hat{L}}{\partial \alpha} = -\frac{(\pi - \gamma)(s + c_p)}{\hat{\pi}^2} > 0 \quad \text{iff} \quad \gamma > \pi. \tag{5}$$

We can therefore state the following proposition:

Proposition 2. *All else constant (including the defendant's settlement offer), the probability of settlement is (a) decreasing in the plaintiff's degree of optimism and (b) decreasing in the plaintiff's perceived degree of ambiguity if and only if the plaintiff is optimistic. Equivalently, it is increasing with the plaintiff's level of confidence if and only if the plaintiff is optimistic.*

The first result is easy to understand: the more optimistic the victim is, the more he will reject the offer, since he believes he will prevail.

The second result is slightly more involved: if the perceived degree of ambiguity increases, a pessimistic plaintiff will want to stay away from the trial and accept the offer more often, whereas an optimistic plaintiff will want to go to trial. The idea is that, for an ambiguity loving individual, more ambiguity means that a high probability of winning is more likely, whereas for an ambiguity averse individual it means that a low winning probability is more likely.

3.2 The Defendant's Decision

The probability of trial given that there has been an accident depends on the defendant's offer as well as the plaintiff's willingness to accept a given offer.

3.2.1 The likelihood of settlement and the settlement amount

The defendant does not know the actual value of the plaintiff's damages but he does know the distribution of possible values. The defendant makes his offer to minimize

his expected post-accident costs:

$$H(s) = \int_{\hat{L}(s)}^{\bar{L}} (\pi L + c_d)\, dF(L) + F(\hat{L}(s))s, \tag{6}$$

with $s \geq 0$.

In order to present the results, we consider the following definitions. First, let

$$m(F) = \inf_{L \in (\underline{L}, \bar{L})} 1 - \frac{\varepsilon_f(L)}{\varepsilon_F(L)}.$$

Definition 3 (Distribution bounded pessimism)**.** *The plaintiff exhibits distribution bounded pessimism if $\frac{\pi}{\hat{\pi}} \leq 1 + m(F)$.*

In other words, this means that the plaintiff either cannot be pessimistic ($\frac{\pi}{\hat{\pi}} > 1$) if $m(F) < 0$ or may be pessimistic but not too much if $m(F) > 0$.

Similarly, let

$$M(F) = \sup_{L \in (\underline{L}, \bar{L})} 1 - \frac{\varepsilon_f(L)}{\varepsilon_F(L)}.$$

Then,

Definition 4 (Distribution bounded optimism)**.** *The plaintiff exhibits distribution bounded optimism if $\frac{\pi}{\hat{\pi}} \geq 1 + M(F)$.*

Again, this means that the plaintiff either cannot be optimistic ($\frac{\pi}{\hat{\pi}} < 1$) if $M(F) > 0$ or may be optimistic but not too much if $M(F) < 0$.

In the same spirit, we will be led, when stating our results, to classify the plaintiff according to the following typology.

Definition 5. *We say that a plaintiff is*

(i) *Very optimistic if $\hat{\pi} - \pi \geq \frac{c_p + c_d}{\underline{L}}$.*

(ii) *Level-headed if $\frac{c_p + c_d}{\underline{L}} - \frac{\hat{\pi}}{\underline{L}f(\underline{L})} < \hat{\pi} - \pi < \frac{c_p + c_d}{\underline{L}}$.*

12

(iii) Very pessimistic if $\hat{\pi} - \pi < \frac{c_p + c_d}{\underline{L}} - \frac{\hat{\pi}}{\underline{L}f(\underline{L})}$.

Note that a very pessimistic plaintiff in the above is indeed pessimistic according to the previous definition and a very optimistic one is optimistic.

Let s^* be the smallest solution to the defendant's problem:

$$s^* = \min \arg \min_{s \geq 0} H(s) \tag{7}$$

Thus defined, s^* is unique.

We have the following propositions.

Proposition 6. *No agreement can be reached between a very optimistic plaintiff exhibiting distribution bounded pessimism and the defendant: $s^* = 0$*

Let us comment on the proposition.

There exists a defendant's optimal settlement offer $s^* = 0$ such that trial always occurs. Observing the condition that defines a very optimistic plaintiff , we see that trial is certain whenever ambiguity is low and the plaintiff is optimistic, and whenever total costs $c_p + c_d$ are low and stakes are high.

In the standard case without ambiguity, $\pi = \hat{\pi}$ and thus 0 cannot be a solution. With ambiguity, on the other hand, we have identified conditions under which it can be a solution. In that case, there will be no settlement. Ambiguity therefore allows for the appearance of a new solution, the no settlement case, when the plaintiff is very optimistic; this is a testable prediction, that is indeed supported by experimental evidence and field studies. For instance, Babcock, Wang, and Loewenstein (1996) shows that negotiators often interpret data in a way that is consistent with what they think is fair, or better said interpret fairness in a way that favors them. In particular, one may say that they will overestimate their chances of prevailing at trial because they think their prevailing is fair. This optimistic view due to self-serving bias often leads to bargaining impasse, consistent with our findings.

13

In divergent expectations models, this would happen if the plaintiff was sufficiently more optimistic than the defendant. The condition that defines here a very optimistic plaintiff is actually exactly the condition found in the divergent expectations literature, for a damage level $\underline{L}$ (see e.g. Waldfogel, 1998, p.454). Here the defendant is assumed to know the true probability, but the condition can be interpreted similarly. Thus we generalize the results in this literature by introducing asymmetric information and showing how the condition must be modified in that case; i.e. which damage value among the possible ones must be used.

Proposition 7. *Let $L^* = \hat{L}(s^*)$, $\underline{s} = \hat{\pi}\underline{L} - c_p$, and $\bar{s} = \hat{\pi}\bar{L} - c_p$. If the plaintiff is level-headed and exhibits distribution bounded pessimism, trial may or may not occur: s^* must lie in $(\underline{s}, \bar{s})$ and satisfy*

$$F(L^*) = ((\pi - \hat{\pi})L^* + c_d + c_p)\frac{f(L^*)}{\hat{\pi}}, \tag{8}$$

and

$$(\hat{\pi} - \pi)L^* f'(L^*) + (2\hat{\pi} - \pi) f(L^*) \geq (c_p + c_d)f'(L^*). \tag{9}$$

Moreover, $s^* \in (\underline{s}, \bar{s})$ exists and is unique.

When pessimism is bounded, there is an interior solution whenever the plaintiff is level-headed. Condition (8), the first order condition, implies that marginal net benefits of increasing the offer (r.h.s.):

$$(\underbrace{\pi L^* + c_d}_{\text{total litigation costs saved}} - \underbrace{(\hat{\pi}L^* - c_p)}_{\text{total litigation gains lost}}) \underbrace{\frac{f(L^*)}{\hat{\pi}}}_{\text{marginal number of trials avoided}}$$

equal the marginal net costs (l.h.s.):

$$\underbrace{F(L^*) + s\frac{f(L^*)}{\hat{\pi}}}_{\text{marginal payment}} - \underbrace{s\frac{f(L^*)}{\hat{\pi}}}_{\text{marginal total sum received}}.$$

In other words, the defendant balances benefits and costs of increasing the settlement offer.

In our model,[6] an informational asymmetry and divergent expectations are responsible for the possible failure of parties to settle: on the one hand, the defendant's offer will be accepted by a plaintiff whose private information is sufficiently unfavorable (low L) and rejected by a plaintiff for whom this is not the case (high L). On the other hand, the plaintiff's optimism may lead him to reject some offers, since $(\pi - \hat{\pi})$ is involved in the decision.[7]

Proposition 8. *An agreement is always reached between a very pessimistic plaintiff exhibiting distribution bounded optimism and the defendant at* $s^* = \bar{s} = \hat{\pi}\bar{L} - c_p$.

3.2.2 Comparative statics

We now turn to comparative statics. In order to present the results, we need first to introduce the notion of adjusted reversed hazard rate (RHR),

$$\frac{\hat{\pi}f(L)}{\hat{\pi}F(L) + (\hat{\pi} - \pi)Lf(L)}.$$

The standard RHR measures the percentage of plaintiffs of type L among plaintiffs of type lower than L. It can thus be used to measure the percentage of plaintiffs of marginal type, i.e. the plaintiff that might react to a marginal increase or decrease of the defendant's offer. The adjusted RHR is the standard RHR whenever $\hat{\pi} = \pi$. It is smaller than the standard RHR if and only if $\hat{\pi} > \pi$, i.e. in the case of optimism. In other words, ignoring optimism implies overestimating the percentage of high types that accept the settlement offer: people who accept the offer are of a really

---

[6]See Farmer and Pecorino (2002) and Langlais (2011) for similar results about the settlement stage.

[7]This term $\pi - \hat{\pi}$ does not appear in the traditional AI models. For example in Bebchuk (1984), where the asymmetry bears on the plaintiff's probability of prevailing, the first order condition is written (proposition 1, p. 408): $1 - F(q^*) = \frac{C_p + C_d}{W}f(q^*)$ where, in Bebchuk's notations, $1 - F$ is the likelihood of settlement, W the judgment, and q the marginal plaintiff's type. However, a similar term appears in Farmer and Pecorino (2002).

low type; whenever the damages are not too small, optimism will lead to trial. Let us denote T the reverse of the adjusted RHR, i.e.

$$T(L) = \frac{F(L)}{f(L)} + \left(1 - \frac{\pi}{\hat{\pi}}\right) L.$$

Note that, under the standard differentiability assumptions, the adjusted RHR is decreasing (T is increasing) if and only if the plaintiff exhibits distribution bounded pessimism, and increasing if and only if the plaintiff exhibits distribution bounded optimism.

The following proposition describes the effects of changing the parties' litigation costs, the level of optimism and the level of confidence about the settlement amount.

Proposition 9. *Assume the plaintiff is level-headed, and exhibits distribution bounded pessimism. Then both the optimal settlement offer and the equilibrium probability of settlement are:*

- *increasing in the defendant's litigation costs;*

- *decreasing in the plaintiff's litigation costs if and only if $T'(L^*) > 1$*

- *increasing in the plaintiff's degree of optimism if and only if the absolute value of the elasticity of the adjusted RHR (i.e. the elasticity of T) w.r.t. L is larger than 1 at L^*, $\varepsilon_{T/L}(L^*) > 1$ and*

- *decreasing in the plaintiff's degree of ambiguity (increasing in the plaintiff's level of confidence) if and only if $\varepsilon_{T/L}(L^*) > 1$ and the plaintiff is pessimistic.*

Let us discuss these results. We have phrased the proposition so that the conditions under which the comparative statics results match the intuition are apparent. The effect of the defendant's costs on the settlement offer indeed matches the intuition unconditionally: if they rise, the incentive to settle is stronger for the defendant, so he will offer a higher settlement. As for the plaintiff's characteristics (his costs,

16

ambiguity attitude and confidence), intuition says that: a fall in the plaintiff's costs or a rise in his subjective probability of winning (through which ambiguity aversion and confidence operate) have two effects: on the one hand, the incentive to settle is weaker for the plaintiff, and this translates into a smaller threshold type $\hat{L}(s)$; on the other hand, the surplus to be shared as a result of the negotiation shrinks, as can be seen noting equation (8) can be rewritten in the following way.

$$T(L^*) = \frac{c_p + c_d}{\hat{\pi}}. \tag{10}$$

The defendant's reaction to the first effect is to raise his offer, while his reaction to the second is more ambiguous: he could decide either that the stakes are too low anyway and he should give up trying to obtain a settlement that will anyway procure very little benefit, and thus lower his offer, or try to earn a bigger share of the stakes (as measured by $\frac{f(L^*)}{\hat{\pi}}$) by raising his offer. The first effect may be the most intuitive but one needs to take into account the second one too. Which effect dominates depends on the relative magnitude of the first effect which is given by the derivative of T, for the costs, or the elasticity of T, for the subjective probability.[8] In order to illustrate the propositions, let us examine an example.

Example 10. *Assume that F is uniform. Then*

$$T(L) = \left(2 - \frac{\pi}{\hat{\pi}}\right) L - \underline{L},$$

---

[8]Although the intuition is the same, the technical difference between these two cases can be understood by rewriting condition (10) as follows:

$$\hat{\pi} T \left(\frac{s^* + c_p}{\hat{\pi}} \right) - c_p = c_d.$$

This shows that the costs affect this condition in an additive way, hence its marginal effect is in absolute terms, hence the derivative, while the subjective probability affects the condition in a multiplicative way, hence its marginal effect is in relative terms, hence the elasticity.

hence the assumption that $T'(L^*) > 0$ implies that $2 > \frac{\pi}{\hat{\pi}}$. Therefore,

$$s^* = \frac{(\pi - \hat{\pi})c_p + \hat{\pi}c_d + \hat{\pi}^2 \underline{L}}{2\hat{\pi} - \pi}.$$

In the absence of ambiguity $s^* = \pi\underline{L} + c_d$. Thus, with a uniform distribution the plaintiff's costs affect the settlement offer if and only if ambiguity affects it. We see that s^* is decreasing with c_p if and only if $\pi < \hat{\pi}$, i.e. if and only if $T'(L) > 1$. Moreover, the elasticity of T is

$$\varepsilon_{T/L}(L^*) = \frac{\left(2 - \frac{\pi}{\hat{\pi}}\right)L^*}{\left(2 - \frac{\pi}{\hat{\pi}}\right)L^* - \underline{L}} = \frac{c_p + c_d + \hat{\pi}\underline{L}}{c_p + c_d} > 1$$

whenever $\underline{L} > 0$. Hence s^* behaves in the intuitive way.

4 The defendant's level of care

For each victim type, the injurer's care level x affects the probability of an accident occurring $q(x)$, with $q'(x) < 0$ and $q''(x) > 0$. We assume that liability is strict. Introducing a negligence rule would change nothing to our result Given that there has been an accident, the probability of trial is the probability that the plaintiff will reject the defendant's offer: $1 - F(\hat{L}(s^*))$.

The post-accident cost borne by the defendant is his incentive to take care. The defendant chooses his level of care x to minimize the sum of his care costs and his expected accident costs: $x + q(x)H^*$, where H^* is given by

$$H^* = H(s^*) = F[\hat{L}(s^*)]s^* + \int_{\hat{L}(s^*)}^{\bar{L}} \pi L + c_d \, dF(L). \tag{11}$$

The optimal level x^* satisfies: $1 + q'(x^*)H^* = 0$.

When the plaintif is very optimistic and exhibits distribution bounded pessimism,

$s^* = 0$, so $H^* = \pi E(L) + c_d$. In that case, $1 + q'(x^*)H^* = 0$ implies that

$$q'(x^*) = -\frac{1}{\pi E(L) + c_d}.$$

It is then dependent on α and γ only through the conditions guaranteeing that the plaintif is very optimistic and exhibits distribution bounded pessimism.

When the plaintif is level-headed and exhibits distribution bounded pessimism, by the implicit function theorem and because of the assumption about q, the signs of $\frac{\partial x^*}{\partial \gamma}$ and $\frac{\partial x^*}{\partial \alpha}$ are the same as the signs of $\frac{\partial H^*}{\partial \gamma}$ and $\frac{\partial H^*}{\partial \alpha}$ respectively. Moreover, since the defendant's offer minimizes H^*, and s^* is an interior solution, the first order condition holds, so that, by the envelope theorem, changes in the optimal offer s^* can be ignored in assessing the effects of α and γ on the incentive for care. Therefore,

$$\frac{\partial H^*}{\partial \gamma} = \frac{\partial H}{\partial \gamma} = \frac{\partial \hat{L}}{\partial \gamma}[s^* - c_d - \pi L^*] = \frac{\partial \hat{L}}{\partial \gamma}((\hat{\pi} - \pi)L^* - c_p - c_d). \qquad (12)$$

and

$$\frac{\partial H^*}{\partial \alpha} = \frac{\partial H}{\partial \alpha} = \frac{\partial \hat{L}}{\partial \alpha}[s^* - c_d - \pi L^*] = \frac{\partial \hat{L}}{\partial \alpha}((\hat{\pi} - \pi)L^* - c_p - c_d). \qquad (13)$$

According to the FOC, $(\hat{\pi} - \pi)L^* - c_p - c_d < 0$. This leads to the following proposition:

Proposition 11. *If the plaintiff is level-headed and exhibits distribution bounded pessimism, then the level of care is:*

- *increasing in the level of optimism,*

- *increasing in the level of confidence (decreasing in perceived ambiguity) if and only if $\gamma < \pi$, i.e. if and only if the plaintiff is pessimistic.*

Since the probability of an accident decreases with the level of care, the effect of confidence and optimism follows accordingly.

19

5 Volume of Litigation and Public Policy Implications

Assume that the government's objective is to maximize a utilitarian social welfare function, i.e. the sum of "expected" utilities. However, in our setting where the objective probability of the plaintiff winning the trial may differ from the subjective one, two potential social welfare functions may be considered. The *actual* utilitarian social welfare function uses only the objective probability, and is therefore the standard SWF. After some algebra it can be written:

$$W_A = -q(x^*)(E(L) + (1 - F(L^*))(c_p + c_d)) - x^*,$$

where $E(L)$ is the expected loss. On the other hand, the *perceived* welfare function uses the actual, subjective, beliefs of the plaintiff, and after some computations can be shown to be equal to:

$$W_S = -q(x^*)\left(E(L) + (1 - F(L^*))(c_p + c_d) + \int_{L^*}^{\bar{L}}(\pi - \hat{\pi})L\,\mathrm{d}F\right) - x^*.$$

A benevolent social planner will aim at maximizing W_A. How does manipulating the degree of confidence contribute to this objective? The answer is given in the next two propositions.

Proposition 12. *If the representative plaintiff is very optimistic and exhibits distribution bounded pessimism, then the actual social welfare is independent of the degree of confidence.*

Let

$$\delta(L) = \begin{cases} s^* & \text{if } \underline{L} \le L \le L^* \\ \pi L - c_p & \text{if } L^* < L \le \bar{L}. \end{cases}$$

$\delta(L)$ is the objective ex interim expected outcome of the litigation process, just after the settlement stage: plaintiffs that went to trial are expected to earn $\pi L - c_p$, while plaintiffs that didn't will earn s^* for sure. For a plaintiff of type L, the ex interim objective expected surplus is the difference between the objective ex interim expected outcome of the litigation process and L. The average ex interim objective expected surplus is thus

$$E(\delta(L) - L) = \int_{\underline{L}}^{L^*} s^* - L \, dF(L) + \int_{L^*}^{\bar{L}} \pi L - c_p - L \, dF(L).$$

Then

Proposition 13. *Assume the representative plaintiff is level-headed and exhibits distribution bounded pessimism. Then:*

- *Assume $E(\delta(L) - L) \leq 0$. Then the objective social welfare is*

  - *increasing in the degree of confidence (decreasing in perceived ambiguity) if the plaintiff is pessimistic ($\pi > \gamma$) and $\varepsilon_{T/L}(L^*) > 1$.*

  - *decreasing in the degree of confidence (decreasing in perceived ambiguity) if the plaintiff is optimistic ($\pi < \gamma$) and $\varepsilon_{T/L}(L^*) > 1$.*

- *Assume $E(\delta(L) - L) \geq 0$. Then the objective social welfare is*

  - *decreasing in the degree of confidence (decreasing in perceived ambiguity) if the plaintiff is pessimistic ($\pi > \gamma$) and $\varepsilon_{T/L}(L^*) < 1$.*

  - *increasing in the degree of confidence (decreasing in perceived ambiguity) if the plaintiff is optimistic ($\pi < \gamma$) and $\varepsilon_{T/L}(L^*) < 1$.*

In all other cases, the effect of α on the objective social welfare is ambiguous.

The second term of $E(\delta(L) - L)$ is always negative because due to uncertainty and the litigation cost the plaintiff can never be expected to make up for his initial loss

ex ante. Thus, if $E(\delta(L) - L) > 0$, it must be because $\int_{\underline{L}}^{L^*} s^* - L\, dF(L) > 0$. Since $s^* - L^* < 0$, for $\int_{\underline{L}}^{L^*} s^* - L\, dF(L)$ to be positive, the absolute value of this quantity must be small enough. Formally, we have, after integrating by parts,

$$E(\delta(L) - L) > 0 \iff |s^* - L^*| < \frac{\int_{\underline{L}}^{L^*} F(L)dL + \int_{L^*}^{\bar{L}} \pi L - c_p - L\, dF(L)}{F(L^*)},$$

which is the case case if s^* is large enough. Therefore, the most frequent, "natural" case is that $E(\delta(L) - L) \leq 0$, but if the equilibrium settlement amount is large enough it can become positive.

To interpret the proposition, let us focus on the latter case.

Consider first the probability of going to trial, $1 - F(L^*)$. By Proposition 9, we know that if the plaintiff is pessimistic and highly sensitive to a rise in the settlement offer, if the degree of confidence increases, this probability decreases. This increases actual social welfare.

Consider now the precaution side: as shown before, if plaintiffs are pessimistic, the equilibrium level of care is increasing with the level of confidence, and so a rise in α will increase x^*, which decreases actual social welfare, and decrease $q(x^*)$, which increases social welfare. Whichever effect dominates in the social welfare actually depends on what is to gain by avoiding a trial. Hence the role of $E(\delta(L) - L)$, that is recorded in the following formula (see the proof of the proposition in the appendix):

$$\frac{\partial W_A}{\partial \alpha} = q(x^*)f(L^*)\frac{dL^*}{d\alpha}(c_p + c_d) + \frac{\partial x^*}{\partial \alpha}q'(x^*)\left(E(\delta(L) - L)\right).$$

If $E(\delta(L) - L) < 0$, since $q'(x^) < 0$, the total effect is a rise in social welfare. Indeed, if the expected gain from litigation is negative, avoiding it by raising the level of precaution is good for welfare. Finally, since the litigation and precaution side of social welfare react in the same direction to a rise in confidence, the total effect is unambiguous and is a rise in social welfare. The total effect is ambiguous, a priori.

However, if $E(\delta(L) - L) \geq 0$, s^* is large, so that the litigation side dominates. The reverse holds when plaintiffs are optimistic, since all the effects on each side are reversed.

If $E(\delta(L) - L) \leq 0$, the litigation side and the precaution side do not go in the same direction ambiguity of the effect remains; therefore to resolve the ambiguity of the sign to the total effect, we must consider the combinations of pessimism/optimism and sensitivity that are polar to the ones considered before. These are the cases considered in the proposition.

Proposition 14. *If the representative plaintiff is very optimistic and exhibits distribution bounded pessimism, then the subjective social welfare is decreasing in the degree of confidence.*

If the plaintiff is optimistic, he likes ambiguity, thus if perceived ambiguity decreases, the plaintiff will be (subjectively) worse off, and thus subjective social welfare will decrease.

Let

$$\hat{\delta}(L) = \begin{cases} s^* & \text{if } \underline{L} \leq L \leq L^* \\ \hat{\pi}L - c_p & \text{if } L^* < L \leq \bar{L} \end{cases}$$

be the subjective ex interim expected outcome of the litigation process, just after the settlement stage: plaintiffs that went to trial expect to earn $\hat{\pi}L - c_p$, while plaintiffs that didn't will earn s^* for sure. For a plaintiff of type L, the ex interim subjective expected surplus is the difference between the subjective ex interim expected outcome of the litigation process and L. The average ex interim subjective expected surplus is thus

$$E(\hat{\delta}(L) - L) = \int_{\underline{L}}^{L^*} s^* - L \, dF(L) + \int_{L^*}^{\bar{L}} \hat{\pi}L - c_p - L \, dF(L).$$

We have the following proposition.

23

Proposition 15. *Assume the representative plaintiff is level-headed and exhibits distribution bounded pessimism. Then, if $E(\hat{\delta}(L) - L) \leq 0$, the subjective social welfare is*

- *increasing in the degree of confidence (decreasing in perceived ambiguity) if the plaintiff is pessimistic ($\pi > \gamma$) and $\varepsilon_{T/L}(L^*) > 1$.*

- *decreasing in the degree of confidence (decreasing in perceived ambiguity) if the plaintiff is optimistic ($\pi < \gamma$) and $\varepsilon_{T/L}(L^*) > 1$.*

In all other cases, the effect of α on the subjective social welfare is ambiguous.

As can be seen, the effect of a rise in confidence on the subjective welfare is the same as the effect on the actual welfare for the most frequent case of a negative ex interim subjective expected surplus. The interpretation of the precaution side of welfare is the same, but the interpretation of the litigation side is a bit more involved. Indeed, we have:

$$
\frac{\partial W_S}{\partial \alpha} = q(x^*)f(L^*)\left(\frac{\partial L^*}{\partial \alpha}\hat{\pi}\frac{F(L^*)}{f(L^*)} + (\pi - \gamma)\int_{L^*}^{\bar{L}} L\,dF(L)\right) - \frac{\partial x^*}{\partial \alpha}(q'(x^*)E(L - \hat{\delta}(L))).
$$

If we consider the first term as the litigation side term, it turns out that it sign is not determined in an unambiguous way because the conditions of sensitivity and pessimism of the plaintiff affect its components in a different way. Specifically, the term $\pi - \gamma)\int_{L^*}^{\bar{L}} L\,dF(L)$ is not affected by sensitivity. This introduces an extra degree of liberty. Now, if it doesn't affect the interpretation in the case of of a negative ex interim subjective expected surplus, this extra degree of liberty leads to an unsolvable ambiguity problem in the case of a of a positive ex interim subjective expected surplus.

The general public policy implication is thus that, if an objective-welfare-oriented government believes that the sensitivity of marginal types to an increase in the

settlement offer is strong, and equilibrium level of settlement is relatively high (in other words, there are relatively few trials already), and believes that the expected social gains from the litigation process are negative, it should spend nothing on raising confidence if plaintiffs are optimistic, and as much as possible if plaintiffs are pessimistic and vice-versa if it believes that the expected social gains from the litigation process are positive. In turn, if a subjective-welfare-oriented government believes that the sensitivity of marginal types to an increase in the settlement offer is strong, and equilibrium level of settlement is relatively high (in other words, there are relatively few trials already), and believes that the plaintiffs agents believe that expected social gains from the litigation process are negative, it should spend nothing on raising confidence if plaintiffs are optimistic.

The question whether plaintiffs are optimistic or pessimistic is answered in the literature on self-serving bias. Several studies have explored the degree to which individual litigants appear to skew their expectations about trial in a manner that favors their own case (Babcock, Loewenstein, Issacharoff, and Camerer (1995)). Babcock and Loewenstein (1997) have provided evidence that self-serving biases are also present when the extent of damages (rather than liability) serves as a source of potential disagreement. These studies suggest that subjects exhibit self-serving bias (optimism) and that this cognitive bias increases the likehood of trial. There is a systematic tendency for an individual to interpret facts in ways which are favorable to him.[9] Babcock, Loewenstein, and Issacharoff (1997) and Jolls and Sunstein (2006) explore legal procedures (damages caps, split-awards tort reform) that may de-bias litigants' optimism.

---

[9]Lawyers are also subject to such a bias (Goodman-Delahunty, Granhag, Hartwig, and Loftus (2010)).

25

6 Conclusion

Our work contributes to the theoretical literature on liability and litigation by providing the first assessment of the effects of ambiguity (through a NEO-additive model) on incentives to settle and incentives to exercise care. Ambiguity corresponds to an agent's lack of confidence in his belief about the probability of uncertain events (here the probability of prevailing), while optimism and pessimism correspond to an agent over weighting the best and worst outcomes (here to receive damages or not), respectively. Our framework encompasses two sources of failure of settlement: asymmetric information about the loss/damages and divergent expectations about the probability that the plaintiff will prevail. Furthermore, we provide public policy findings. Our main contributions are as follows.

Regarding the settlement stage, our results indicate that: (i) the defendant's settlement offer increases with the plaintiff's level of optimism while the probability of settlement decreases with the plaintiff's level of optimism; (ii) the defendant's settlement offer increases with the plaintiff's level of confidence while the probability of settlement decreases with the plaintiff's level of confidence if and only if the plaintiff is pessimistic. These results hold provided the elasticity of the marginal plaintiff in equilibrium to a rise in the settlement offer is greater than one. Our results are consistent with those of Farmer and Pecorino (2002) and Langlais (2011) except that we find an additional solution where the settlement offer is zero and all plaintiffs go to trial and that for the interior solution we identified an additional condition about the elasticity of plaintiffs to a rise in the settlement offer.

For the liability stage, we show that the level of care chosen by the defendant increases with the plaintiff's level of optimism and increases with the plaintiff's level of confidence if an only if the plaintiff is pessimistic.

Finally, previous results allow us to assess the effects of confidence on the volume of litigation. If plaintiffs are pessimistic and highly sensitive to a rise in the settlement

26

offer, an increase in the level of confidence will increase the defendant's settlement offer and decrease the probability that the plaintiff will reject the offer; and will increase the level of care, thus will decrease the probability of accident. Hence globally an increase in the level of confidence will reduce the volume of litigation. In that case, public authorities have to invest in public policies aimed at increasing confidence. If plaintiffs are optimistic and highly sensitive to a rise in the settlement offer, the results are reversed. An increase in the level of confidence will increase the volume of litigation. In that case, our results suggest not to invest in public policies aimed at increasing confidence. If plaintiffs' sensitivity to a rise in the settlement offer is low, then an increase in the level of confidence will have an ambiguous effect since the impact on the settlement stage is reversed. Public authorities have to be careful, since an increase in confidence may have counter intuitive effects. Empirical works show that people tend to be optimistic which leads us to minimize the role of policies aimed at increasing confidence.

Natural extensions of this paper include introducing ambiguity for the defendant. This may take two forms. First, we may treat him much as we treated the plaintiff and assume that he also perceives ambiguity on the plaintiff's probability of prevailing and behave according to the NEO-additive model. This would imply replacing π in the defendant's loss function by the relevant confidence-and-optimism-adjusted subjective probability. Second, if instead of interpreting F as the objective distribution of plaintiffs, we interpret it as the defendants subjective beliefs about the plaintiff's type, then, we may introduce ambiguity about this distribution.

A   Proofs

A.1   Propositions 6, 7 and 8

Let $\underline{s} := \hat{\pi}\underline{L} - c_p$ and $\bar{s} = \hat{\pi}\bar{L} - c_p$. Let us first show that without loss of generality we may assume that the solutions to the minimization of H lie in the interval $[\underline{s}, \bar{s}]$. Indeed, if $s \le \underline{s}$, then $\hat{L}(s) \le \underline{L}$, and therefore no plaintiff will agree to settle. Hence, the expected loss of the defendant is always $\pi E(L) + c_d$.

There the defendant is indifferent between any offer in $[0, \underline{s}]$, so we may restrict attention to $[\underline{s}, +\infty)$. Similarly, if $s \ge \bar{L}$, then $H(s) = s$, hence its minimum on $[\bar{s}, +\infty)$ must be at $\bar{s}$, so again we may restrict our attention to $[\underline{s}, \bar{s}]$.

The problem is therefore now

$$
\begin{aligned}
\min_{s} \quad & H(s) \\
\text{s.t.} \quad & s \le \hat{\pi}\bar{L} - c_p \quad (\lambda) \\
& s \ge \hat{\pi}\underline{L} - c_p \quad (\mu)
\end{aligned}
\tag{14}
$$

where $\lambda \le 0$ and $\mu \le 0$ are the Kuhn-Tucker multipliers. The first order conditions are thus

(C1) $(s^* - \pi L^* - c_d)f(L^*)\frac{\partial \hat{L}}{\partial s}(s^*) + F(L^*) = \lambda - \mu,$

(C2) $\lambda(\hat{\pi}\bar{L} - c_p - s) = 0,$

(C3) $\mu(s - \hat{\pi}\underline{L} + c_p) = 0.$

Recall now that

$$
T(L) = \frac{F(L)}{f(L)} + \left(1 - \frac{\pi}{\hat{\pi}}\right)L
$$

and note that since $\frac{\partial \hat{L}}{\partial s}(s) = \frac{1}{\hat{\pi}}$ for all s, we have:

$$
H'(s) = \frac{(\hat{\pi} - \pi)\hat{L}(s) - c_p - c_d}{\hat{\pi}}f(\hat{L}(s)) + F(\hat{L}(s)),
$$

28

so that

$$H'(s) \geq 0 \iff T(\hat{L}(s)) \geq \frac{c_p + c_d}{\hat{\pi}}.$$

Assume now that the plaintiff exhibits distribution bounded pessimism, i.e. T is increasing.

Consider first the case of a very optimistic plaintif, i.e., rearranging the defining condition:

$$c_p + c_d \leq (\hat{\pi} - \pi)\underline{L}.$$

Since $F(\underline{L}) = 0$ and $f(\underline{L}) > 0$, this is actually equivalent also to $\frac{c_p + c_d}{\hat{\pi}} \leq T(\underline{L})$, and, to $H'(\underline{s}) \geq 0$. Since T is increasing,

$$\frac{c_p + c_d}{\hat{\pi}} \leq T(\underline{L}) < T(L)$$

for all $L > \underline{L}$, hence $H'(s) > 0$ for all $s > \underline{s}$, so that $\underline{s}$ must be the minimum in $[\underline{s}, \bar{s}]$, and therefore $s^* = 0$.

Assume now that the plaintiff is level-headed. This implies that $s \in (\underline{s}, \bar{s})$, thus $\lambda = \mu = 0$ and therefore

$$(s^* - \pi L^* - c_d)f(L^*)\frac{\partial \hat{L}}{\partial s}(s^*) + F(L^*) = 0$$

which, when rearranged and plugging in the value of s^* as a function of L^*, is condition (8). Then existence of s^* is guaranteed by the continuity of H', the fact that $H'(\underline{s}) < 0$ and $H'(\bar{s}) > 0$.

Condition (9) is the necessary second order condition:

$$f'(L^*)(s^* - \pi L^* - c_d)\frac{\partial \hat{L}}{\partial s}(s^*) + f(L^*)(2 - \pi\frac{\partial \hat{L}}{\partial s}(s^*)) \geq 0$$

rearranged with the value of s^* as a function of L^*. Since T is increasing, a unique

s^* satisfying (8) exists and is a minimum, because differentiating T and using the FOC yields the sufficient second order condition.

Finally, assume that the plaintiff exhibits distribution bounded optimism, i.e. T is decreasing. If the plaintiff is very pessimistic, then rearranging the defining condition yields

$$c_p + c_d \geq (\hat{\pi} - \pi)\bar{L} + \frac{\hat{\pi}}{f(\bar{L})}.$$

This is also equivalent to $\frac{c_p + c_d}{\hat{\pi}} \geq T(\bar{L})$, so that if this condition holds and T is decreasing, then $H'(\bar{s}) \leq 0$ and $H'(s) < 0$ for all $s < \bar{s}$, so that the minimum must lie at $\bar{s}$.

A.2 Proposition 9

Since $T'(L^*) > 0$, by the implicit function theorem, we have, on an appropriate open subset of the set of parameters:

$$\begin{aligned}
\frac{\partial s^*}{\partial c_d} &= \frac{1}{T'(L^*)} \\
\frac{\partial s^*}{\partial c_p} &= \frac{1 - T'(L^*)}{T'(L^*)} \\
\frac{\partial s^*}{\partial \hat{\pi}} &= \frac{1}{\hat{\pi}} \frac{(s^* + c_p)T'(L^*) - (c_p + c_d)}{T'(L^*)}
\end{aligned}$$

Thus, $\frac{\partial s^*}{\partial c_d} > 0$, $\frac{\partial s^*}{\partial c_p} < 0$ if and only if $T'(L^*) > 1$ and

$$\begin{aligned}
\frac{\partial s^*}{\partial \hat{\pi}} > 0 \quad &\Longleftrightarrow \quad \frac{(s^* + c_p)T'(L^*)}{\hat{\pi}} > \frac{(c_p + c_d)}{\hat{\pi}} \\
&\Longleftrightarrow \quad L^* T'(L^*) > T(L^*) \\
&\Longleftrightarrow \quad \varepsilon_{T/L}(L^*) > 1.
\end{aligned}$$

Results for $\frac{\partial s^*}{\partial \alpha}$, $\frac{\partial s^*}{\partial \gamma}$, $\frac{\partial F(L^*)}{\partial \alpha}$ and $\frac{\partial F(L^*)}{\partial \gamma}$ follow using the chain rule.

B Propositions 12, 13, 14 and 15

We have

$$\frac{\partial W_A}{\partial \alpha} = q(x^*)f(L^*)\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}(c_p + c_d) - \frac{\partial x^*}{\partial \alpha}(q'(x^*)(E(L) + (1 - F(L^*))(c_p + c_d)) + 1).$$

Since x^* is the optimal level of care, it satisfies: $1 + q'(x^*)H^* = 0$. When the representative plaintif is very optimistic and DARHR holds, $s^* = 0$, $L^* = \underline{L}$ and $H^* = \pi E(L) + c_d$, so that x^* is independent of α, so we have

$$\frac{\partial W_A}{\partial \alpha} = 0,$$

proving Proposition 12.

If the representative plaintiff is level-headed and DARHR holds, then

$$\frac{\partial W_A}{\partial \alpha} = q(x^*)f(L^*)\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}(c_p + c_d) - \frac{\partial x^*}{\partial \alpha}(q'(x^*)(E(L) + (1 - F(L^*))(c_p + c_d) - H^*)),$$

with

$$H^* = F(L^*)(\hat{\pi}L^* - c_p) + \int_{L^*}^{\bar{L}} \pi L + c_d \, dF(L)$$

$$= F(L^*)\hat{\pi}L^* + \int_{L^*}^{\bar{L}} \pi L \, dF(L) + (1 - F(L^*))(c_p + c_d) - c_p.$$

Thus,

31

$$\frac{\partial W_A}{\partial \alpha} = q(x^*)f(L^*)\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}(c_p + c_d) - \frac{\partial x^*}{\partial \alpha}\left(q'(x^*)\left(E(L) - F(L^*)\hat{\pi}L^* - \int_{L^*}^{\bar{L}}\pi L\, dF(L) + c_p.\right)\right)$$

$$= q(x^*)f(L^*)\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}(c_p + c_d) - \frac{\partial x^*}{\partial \alpha}\left(q'(x^*)\left(\int_{\underline{L}}^{L^*} L - s^*\, dF(L) + \int_{L^*}^{\bar{L}}(1 - \pi)L + c_p\, dF(L).\right)\right)$$

$$= q(x^*)f(L^*)\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}(c_p + c_d) - \frac{\partial x^*}{\partial \alpha}q'(x^*)\left(E(L - \delta(L))\right)$$

From this and previous results we can deduce the sign of $\frac{\partial W_A}{\partial \alpha}$ in several cases (see tables 4 and 2).

Table 1: Objective social welfare in the case of negative average ex interim objective surplus

	$\pi > \gamma$		$\pi < \gamma$	
	$\varepsilon_T > 1$	$\varepsilon_T < 1$	$\varepsilon_T > 1$	$\varepsilon_T < 1$
$q(x^*)f(L^*)\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}$	+	−	−	+
$\frac{\partial x*}{\partial \alpha}$	+	+	−	−
$q'(x^*)(E(L) + (1 - F(L^*))(c_p + c_d) + 1)$	−	−	−	−
$\frac{\partial x*}{\partial \alpha}(q'(x^*)(E(L) + (1 - F(L^*))(c_p + c_d) + 1))$	−	−	+	+
$\frac{\partial W_A}{\partial \alpha}$	+	?	−	?

For proposition 14, note that in the case considered, $L^* = \underline{L}$ and x^* is independent of α, therefore

$$\frac{\partial W_S}{\partial \alpha} = q(x^*)E(L)\frac{\partial \hat{\pi}}{\partial \alpha}.$$

Now, if the plaintiff is very optimistic, $\hat{\pi} - \pi \geq \frac{c_p + c_d}{\underline{L}} > 0$, therefore in particular it is optimistic. Thus $\frac{\partial \hat{\pi}}{\partial \alpha} < 0$ and $\frac{\partial W_S}{\partial \alpha} < 0$.

Table 2: Objective social welfare in the case of nonnegative average ex interim objective surplus

	$\pi > \gamma$		$\pi < \gamma$	
	$\varepsilon_T > 1$	$\varepsilon_T < 1$	$\varepsilon_T > 1$	$\varepsilon_T < 1$
$q(x^*)f(L^*)\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}$	$+$	$-$	$-$	$+$
$\frac{\partial x*}{\partial\alpha}$	$+$	$+$	$-$	$-$
$q'(x^*)(E(L)+(1-F(L^*))(c_p+c_d)+1)$	$+$	$+$	$+$	$+$
$\frac{\partial x*}{\partial\alpha}(q'(x^*)(E(L)+(1-F(L^*))(c_p+c_d)+1))$	$+$	$+$	$-$	$-$
$\frac{\partial W_A}{\partial\alpha}$	?	$-$	?	$+$

For proposition 15, we have:

$$\frac{\partial W_S}{\partial\alpha} = q(x^*)f(L^*)\left(\frac{\partial L^*}{\partial\alpha}\left((c_p+c_d+(\pi-\hat\pi)L^*)+\frac{\partial\hat\pi}{\partial\alpha}\int_{L^*}^{\bar L} L\,dF(L)\right)\right.$$
$$\left.-\frac{\partial x^*}{\partial\alpha}\left(q'(x^*)\left(E(L)+(1-F(L^*))(c_p+c_d)+\int_{L^*}^{\bar L}(\pi-\hat\pi)L\,\mathrm{d}F\right)+1\right)\right),$$

thus, again using the fact that x^* is optimal,

$$\frac{\partial W_S}{\partial\alpha} = q(x^*)f(L^*)\left(\frac{\partial L^*}{\partial\alpha}\left(c_p+c_d+(\pi-\hat\pi)L^*\right)+(\pi-\gamma)\int_{L^*}^{\bar L} L\,dF(L)\right)$$
$$-\frac{\partial x^*}{\partial\alpha}\left(q'(x^*)\left(E(L)+(1-F(L^*))(c_p+c_d)+\int_{L^*}^{\bar L}(\pi-\hat\pi)L\,\mathrm{d}F-H^*\right)\right).$$

Again, using the definition of H^*, the second term can be rearranged.

$$\frac{\partial x^*}{\partial \alpha}\left(q'(x^*)\left(E(L) + (1-F(L^*))(c_p+c_d) + \int_{L^*}^{\bar{L}}(\pi-\hat{\pi})L\,\mathrm{d}F - H^*\right)\right)$$

$$= \frac{\partial x^*}{\partial \alpha}\left(q'(x^*)\left(E(L) + (1-F(L^*))(c_p+c_d) + \int_{L^*}^{\bar{L}}(\pi-\hat{\pi})L\,\mathrm{d}F\right.\right.$$

$$\left.\left. - F(L^*)(\hat{\pi}L^* - c_p) - \int_{L^*}^{\bar{L}}\pi L + c_d\,dF(L).\right)\right)$$

$$= \frac{\partial x^*}{\partial \alpha}\left(q'(x^*)\left(E(L) + c_p - \int_{L^*}^{\bar{L}}\hat{\pi}L\,\mathrm{d}F - F(L^*)\hat{\pi}L^*\right)\right)$$

$$= \frac{\partial x^*}{\partial \alpha}\left(q'(x^*)\left(E(L-\hat{\delta}(L))\right)\right)$$

Thus, using the FOC of the defendant's minimization problem,

$$\frac{\partial W_S}{\partial \alpha} = q(x^*)f(L^*)\left(\frac{\partial L^*}{\partial \alpha}\hat{\pi}\frac{F(L^*)}{f(L^*)} + (\pi-\gamma)\int_{L^*}^{\bar{L}}L\,dF(L)\right) - \frac{\partial x^*}{\partial \alpha}(q'(x^*)E(L-\hat{\delta}(L)).$$

From this and previous results, we get the proposition (see tables below).

Table 3: Subjective social welfare in the case of negative average ex interim subjective surplus

	$\pi > \gamma$		$\pi < \gamma$	
	$\varepsilon_T > 1$	$\varepsilon_T < 1$	$\varepsilon_T > 1$	$\varepsilon_T < 1$
$\frac{\mathrm{d}L^*}{\mathrm{d}\alpha}\hat{\pi}\frac{F(L^*)}{f(L^*)}$	+	−	−	+
$(\pi-\gamma)\int_{L^*}^{\bar{L}}L\,dF(L)$	+	+	−	−
$q(x^*)f(L^*)\left(\frac{\partial L^*}{\partial \alpha}\hat{\pi}\frac{F(L^*)}{f(L^*)} + (\pi-\gamma)\int_{L^*}^{\bar{L}}L\,dF(L)\right)$	+	?	−	?
$\frac{\partial x*}{\partial \alpha}$	+	+	−	−
$q'(x^*)(E(L) + (1-F(L^*))(c_p+c_d) + 1)$	+	+	+	+
$\frac{\partial x*}{\partial \alpha}(q'(x^*)(E(L) + (1-F(L^*))(c_p+c_d) + 1))$	+	+	−	−
$\frac{\partial W_S}{\partial \alpha}$	+	?	−	?

Table 4: Subjective social welfare in the case of nonnegative average ex interim subjective surplus

	$\pi > \gamma$		$\pi < \gamma$	
	$\varepsilon_T > 1$	$\varepsilon_T < 1$	$\varepsilon_T > 1$	$\varepsilon_T < 1$
$\frac{dL^*}{d\alpha}\hat{\pi}\frac{F(L^*)}{f(L^*)}$	+	−	−	+
$(\pi - \gamma)\int_{L^*}^{\bar{L}} L\, dF(L)$	+	+	−	−
$q(x^*)f(L^*)\left(\frac{\partial L^*}{\partial\alpha}\hat{\pi}\frac{F(L^*)}{f(L^*)} + (\pi - \gamma)\int_{L^*}^{\bar{L}} L\, dF(L)\right)$	+	?	−	?
$\frac{\partial x*}{\partial\alpha}$	+	+	−	−
$q'(x^*)(E(L) + (1 - F(L^*))(c_p + c_d) + 1)$	−	−	−	−
$\frac{\partial x*}{\partial\alpha}(q'(x^*)(E(L) + (1 - F(L^*))(c_p + c_d) + 1))$	−	−	+	+
$\frac{\partial W_S}{\partial\alpha}$	?	?	?	?

References

Arrow, K. and L. Hurwicz (1972). An optimality criterion for decision-making under ignorance. In C. F. Carter and J. Ford (Eds.), *Uncertainty and Expectations in Economics*. Oxford, England: Basil Blackwell & Mott Ltd.

Babcock, L. and G. Loewenstein (1997). Explaining bargaining impasse: The role of self-serving biases. *The Journal of Economic Perspectives 11*(1), 109–126.

Babcock, L., G. Loewenstein, and S. Issacharoff (1997). Creating convergence: Debiasing biased litigants. *Law & Social Inquiry 22*(4), 913–925.

Babcock, L., G. Loewenstein, S. Issacharoff, and C. Camerer (1995). Biased judgments of fairness in bargaining. *The American Economic Review 85*(5), 1337–1343.

Babcock, L., X. Wang, and G. Loewenstein (1996). Choosing the wrong pond: Social comparisons in negotiations that reflect a self-serving bias. *The Quarterly Journal of Economics*, 1–19.

Bebchuk, L. (1984). Litigation and settlement under imperfect information. *The RAND Journal of Economics*, 404–415.

Chateauneuf, A., J. Eichberger, and S. Grant (2007). Choice under uncertainty with the best and worst in mind: Neo-additive capacities. *Journal of Economic Theory 137*(1), 538–567.

Ellsberg, D. (1961). Risk, ambiguity, and the savage axioms. *Quartely Journal of Economics 75*, 643–669.

Etner, J., M. Jeleva, and J. Tallon (2012). Decision theory under ambiguity. *Journal of Economic Surveys 26*(2), 234–270.

Farmer, A. and P. Pecorino (2002). Pretrial bargaining with self-serving bias and asymmetric information. *Journal of Economic Behavior & Organization 48*(2), 163–176.

Geistfeld, M. (2011). Legal ambiguity, liability insurance, and tort reform. *DePaul Law Review 60*, 539–572.

Gilboa, I. and D. Schmeidler (1989). Maxmin expected utility with a non-unique prior. *J Math Econ 18*, 141–153.

Goodman-Delahunty, J., P. A. Granhag, M. Hartwig, and E. F. Loftus (2010). *Psychology, Public Policy, and Law 16*(2), 133–157.

Gould, J. (1973). Economics of legal conflicts, the. *J. Legal Stud. 2*, 279.

Jolls, C. and C. R. Sunstein (2006). Debiasing through law. *The Journal of Legal Studies 35*(1), 199–242.

Knight, F. H. (1921). *Risk, Uncertainty and Profit*. Boston, New York: Houghton Mifflin Company.

Landeo, C., M. Nikitin, and S. Izmalkov (2012). Incentives for care, litigation, and tort reform under self-serving bias. *Forthcoming in Thomas Miceli and Mathew Baker (eds.), The Research Handbook on Economic Models of Law, Forthcoming*.

Landes, W. (1971). Economic analysis of the courts, an. *JL & econ. 14*, 61.

Langlais, E. (2011). Litigations and the pretrial negotiation impasse: The role of cognitive biases. Technical report, Mimeo.

Nalebuff, B. (1987). Credible pretrial negotiation. *The RAND Journal of Economics*, 198–210.

Priest, G. and B. Klein (1984). The selection of disputes for litigation. *The Journal of Legal Studies 13*(1), 1–55.

Savage, L. J. (1954). *The Foundations of Statistics.* New York: Wiley.

Schmeidler, D. (1989). Subjective probability and expected utility without additivity. *Econometrica 57*, 571– 587.

Teitelbaum, J. (2007). A unilateral accident model under ambiguity. *The Journal of Legal Studies 36*, 2.

Waldfogel, J. (1998). Reconciling asymmetric information and divergent expectations theories of litigation*. *The Journal of Law and Economics 41*(2), 451–476.