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Confidence, Optimism and Litigation: A Litigation Model under Ambiguity

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Abstract

This paper introduces ambiguity into an otherwise standard litigation model. The aim is to take into account optimism and confidence on the plaintiff side. We examine the following questions : 1) How optimism and confidence affect the outcomes of the settlement stage? 2) How optimism and confidence affect the level of care? 3) As a result what are the public policy implications in terms of monitoring the level of confidence? We show that the equilibrium probability of settlement is increasing in the degree of optimism for every plaintiffs and increasing in the level of confidence for pessimistic plaintiffs, provided the sensitivity of plaintiffs to a rise in the settlement offer is high, and that the same holds for the level of care independently of the sensitivity of plaintiffs to rises in the settlement offer. Finally, assuming the objective of the government 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 in the case of a high sensitivity of plaintiffs 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 and in that case, as much as possible should be spent.

Keywords: Confidence, Ambiguity, Litigation, behavioral law and economics.

JEL codes: K41, D81.

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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] provide the finding of a lack of confidence on the part of the population with respect to the legal system and offer several lines of action to remedy the situation. In 2011, 55% (63% in 2008) of French say they have confidence in justice. This dissatisfaction is present in all European Countries: on average, in 2010, 47% of Europeans state they tend to trust the legal system[2]. Standard litigation models are ill-suited to address this confidence problem, 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 literature, reviewed e.g. in Etner, Jeleva, and Tallon (2012), has questioned the empirical as well as 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 on 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 of large numbers and thus use the empirical frequency as a reliable estimate of the true probability distribution. This occurs in particular when the event is by nature unique, non repeatable.

Following Knight (1921) and the terminology now standard in this literature, when the decision maker, based on available information, is able to come up with a proba-

[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.

bility distribution, 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, however? Should we expect new insights when taking it into consideration? What Ellsberg did is 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 what the literature essentially means by ambiguity aversion: people prefer betting on events the probability of which they know 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 carries the risk that there is an accident which imposes a loss on the victim. If an accident occurs, the parties engage in a negotiation. Geistfeld (2011) explains why ambiguity may arise in such 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 (that 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 $(\Omega, \mathcal{A})$, which corresponds 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 the following: 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 as facing complete uncertainty and use the Arrow-Hurwicz criterion (Arrow and Hurwicz, 1972), with optimism parameter γ.

1.3 Related Literature

To our knowledge, the only paper incorporating ambiguity in liability models is the contribution of Teitelbaum (2007) who 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 is 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 only the liability design, while we consider a more developed litigation model, since we add both uncertainty on 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 accident.

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 a different prior for the outcome of the trial. Thus it is related

[3]This in itself is a debatable assumption since beginning with the 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.

to two different branches of the literature. The first is the literature on divergent expectations models of litigation. In the 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 model by the introduction of 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 risk aversion of the plaintiff. Thus our paper, as those of Landeo et al. (2012) and Farmer and Pecorino (2002), combines asymmetric information and divergent expectations.

1.4 Results

We examine the following questions : 1) How optimism and confidence affect the outcomes of the settlement stage? 2) How optimism and confidence affect the level of care? 3) As a result what are the public policy implications in terms of monitoring the level of confidence?

Regarding the first two questions, we show that, provided the sensitivity of plaintiffs to a rise in the settlement offer is high (in a sense to be specified later), the equilibrium probability of settlement is increasing in the degree of optimism for every plaintiffs and increasing in the level of confidence for pessimistic plaintiffs. Regarding the second question, and independently of the sensitivity of plaintiffs to rises in the settlement offer, the level of care is increasing in the degree of optimism and increasing in the level of confidence for pessimistic plaintiffs.[4] Regarding the third question, finally, assuming the objective of the government 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 in the case of a high sensitivity of plaintiffs to rises in the settlement offer. In that case, government intervention to

[4] The difference between these two questions is that for the level of care, the envelope theorem implies that the 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.

raise public confidence in the judicial system is recommended only when plaintiffs are pessimistic about their chances of winning. In that case, as much as possible should be spent.

The paper is organized as follows: in section 2, we present the model. The settlement 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 case of 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 number of trials sufficient to correctly estimate it). 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 a 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 optimism or pessimism of the plaintiff. 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 $\gamma < \pi$);*

Note that optimistic plaintiffs can be viewed as ambiguity loving, while pessimistic plaintiffs can be viewed as ambiguity averse. In the sequel we will sometimes use these formulations alternatively.

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, the bias 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: additive bias and multiplicative bias. 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 is increasing in the level of optimism (hence decreasing 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 more chances to have a high probability of winning, whereas for an ambiguity averse individual it means more chances to have a low probability of winning.

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 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 and those who reject. In addition parties consider different plaintiff's probability of winning, since 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:

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

[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.

Equivalently the plaintiff accepts the offer if the damages awarded are no more than his acceptance threshold level:

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

The probability that the plaintiff rejects the offer s and that there is a trial is the probability that his damages 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. *The probability that the plaintiff rejects the settlement offer is increasing with his degree of optimism γ. It is decreasing in the perceived degree of ambiguity (or equivalently increasing in the 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 subtle: 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 more chances to have a high probability of winning, whereas for an ambiguity averse individual it means more chances to have a low probability of winning.

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 realized value of the plaintiff's damages but she does know the distribution of possible values. The defendant makes her offer to minimize her 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 $s \geq 0$. More precisely, since it makes no economic sense to offer more than what is really needed, we shall define the solution s^* to the problem of the defendant as:

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

Thus defined, s^* is unique.

In order to present the results, we need first to introduce the adjusted reverse hazard rate (RHR),

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

The standard RHR measures the percentage of plaintiffs of type L among plaintiffs of type lower than L. 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, not taking into account optimism implies overestimating the percentage of high types that accept the settlement offer: people who accept the offer are of a really low type; as soon as the damages are not too small optimism will lead to trial. Let us denote T the reverse of the adjusted RHR, i.e.

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

We consider the following assumption:

Assumption 1 (Decreasing Adjusted Reversed Hazard Rate (DARHR))**.** *T is an increasing function on $[\underline{L}, \bar{L}]$.*

Moreover, we consider the following assumptions on the total litigation costs:

Assumption 2 (Low Costs (LC))**.** $c_p + c_d \leq (\hat{\pi} - \pi)\underline{L}$.

Assumption 3 (Intermediate Costs (IC))**.** $(\hat{\pi} - \pi)\underline{L} < c_p + c_d < (\hat{\pi} - \pi)\bar{L} + \frac{\hat{\pi}}{f(\bar{L})}$.

We have the following proposition:

Proposition 3. *Let s^* be the solution to the defendant's problem as defined by equation 7, $L^* = \hat{L}(s^*)$, $\underline{s} = \hat{\pi}\underline{L} - c_p$ and $\bar{s} = \hat{\pi}\bar{L} - c_p$.*
Assume the adjusted RHR is decreasing. Then,

1. *if (LC) holds, then $s^* = 0$: all plaintiffs go to trial.*

2. if (IC) holds, then s^* must lie in $(\underline{s}, \bar{s})$ and satisfy

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

which is equivalent to

$$T(L^*) = \frac{c_p + c_d}{\hat{\pi}}, \tag{9}$$

and

$$(\hat{\pi} - \pi)L^* f'(L^*) + (2\hat{\pi} - \pi)\, f(L^*) \geq (c_p + c_d)f'(L^*). \tag{10}$$

which, whenever (8) holds, is equivalent to

$$T'(L^*) \geq 0.$$

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

Let us comment the proposition.
First, there exists a defendant's optimal settlement offer $s^* = 0$ such that trial always occurs. 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. In that case there will be no settlement. Ambiguity allows therefore for the appearance of a new solution, the no settlement case, when costs are very low; this is a testable prediction. Differentiating the condition on total costs, we see that it is all the more likely that there will be no settlement if:

- total costs $c_p + c_d$ are low;
- stakes are high;
- the plaintiff is optimistic (actually if he is pessimistic, this solution cannot arise);
- Ambiguity is low and the plaintiff optimistic.

Note that the low costs condition (Assumption 2) can also be interpreted as a condition on the degree of optimism of the plaintiff: $\hat{\pi} - \pi \geq \frac{c_p + c_d}{\underline{L}}$. In other words, all plaintiffs go to trial if they are sufficiently optimistic. In divergent expectations models, this would happen if the plaintiff is sufficiently more optimistic than the defendant. This is actually the condition found in the divergent expectations literature, for a damage level $\underline{L}$. 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.

Second, there is an interior solution whenever costs are neither too high nor too low, and the adjusted reverse hazard rate (RHR),

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

is decreasing, as this is equivalent to T being increasing. Condition (8), the first order condition, implies that marginal net benefits of increasing the offer (r.h.s.):

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

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]

3.2.2 Comparative statics

We now turn to comparative statics.

[6]See Farmer and Pecorino (2002) and Langlais (2011) for similar results concerning 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).

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

Proposition 4. *Assume IC and DARHR. Then, the optimal settlement offer is*

- *increasing with the defendant's litigation costs* c_d.
- *decreasing in the plaintiff's litigation costs* c_p *if and only if* $T'(L^*) > 1$.

Moreover, under the necessary and sufficient condition that 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^*, $\varepsilon_{T/L}(L^*) > 1$, *the optimal settlement offer is*

- *increasing in the plaintiff's level of optimism.*
- *increasing in the level of confidence (decreasing in the level of ambiguity) if and only if 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 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 larger settlement. As for the characteristics of the plaintiff (his costs, ambiguity attitude and confidence), the intuition for the result is the following: a fall in the plaintiff's costs or a rise in his subjective probability of winning (through which ambiguity aversion and confidence operate) has 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 from the l.h.s. of (9). The reaction of the defendant 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 provide for a very small benefit anyway, 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 effects 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. Although the intuition is the same, the technical difference between these two cases can be understood by rewriting condition (9) as follows:

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

This shows that the costs affects this condition in an additive way, hence its marginal effect is in absolute terms, hence the derivative, while the subjective probability enters the condition in a multiplicative way, hence its marginal effect is in relative terms, hence the elasticity.
As the probability that the plaintiff will reject the offer is $1-F(L^*)$, it is straightforward, by changing the direction of the variation, to deduce from the previous proposition the way the parameters affect it.

Proposition 5. *Assume IC and DARHR. Then, the probability that the plaintiff will reject the offer is:*

- *decreasing with the defendant's litigation costs c_d.*
- *increasing in the plaintiff's litigation costs c_p if and only if $T'(L^*)>1$.*

Moreover, under the necessary and sufficient condition that 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^*: $\varepsilon_{T/L}(L^*)>1$, the probability that the plaintiff will reject the offer is:

- *decreasing in the plaintiff's level of optimism.*
- *decreasing in the level of confidence (decreasing in the level of ambiguity) if and only if the level of optimism is low enough: $\pi>\gamma$.*

In order to illustrate the propositions, let us examine an example.

Example 6. *Assume that F is uniform. Then*

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

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

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

Note that 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 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 accident $q(x)$, with $q'(x) < 0$ and $q''(x) > 0$. We assume that liability is strict. Given that there has been an accident, the probability of trial is the probability that the plaintiff rejects 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: $1 + q'(x^*)H^* = 0$.

Under the Low Costs assumption (and DARHR), $s^* = 0$, so that $H^* = \pi E(L) + c_d$. 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 that guarantee that LC and DARHR are satisfied.

If the DARHR and Moderate Costs assumption hold, by the implicit function theorem and because of the assumption on 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,

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

and

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

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

Proposition 7. *Assume IC and DARHR. 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 accident probability is decreasing in the level of precaution, the effect of confidence and optimism follows accordingly.

5 Volume of Litigation and Public Policy Implications

Assume that the government's objective is to minimize the social costs of litigation. This may be done by reducing the volume of litigation. The volume of litigation is proportional to the equilibrium probability of trial, equal to the product of the probability of suing by the accident probability:

$$\lambda = (1 - F(L^*))q(x^*).$$

Now, λ depends, besides the costs, on optimism and confidence. It is not very likely that the government can easily affect the optimism, since this is a psychological parameter; however, the government may affect confidence by spending on ways to raise the public knowledge of the legal system, so that plaintiff may form more accurate priors. This is why we will focus on the dependence of λ on α. Grouping together the previous results, we have the following proposition:

Proposition 8. *Assume DARHR and IC hold. Then, λ is:*

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

In all other cases, the effect of α on λ is ambiguous.

To interpret the proposition, recall that $\varepsilon_{T/L}$ measures the sensitivity of marginal types to an increase in the settlement offer. Consider first the litigation side of the trial probability. If plaintiffs are pessimistic, *ceteris paribus* a rise in confidence should lead to a rise in the trial probability. However, the defendant will try to prevent this by raising his offer. If the sensitivity of plaintiffs to this move is high, this will have a strong effect, and counterbalance the first effect, so that the volume of litigation decreases. The reverse prediction holds for optimistic plaintiffs. Consider now the precaution side: as shown before, if plaintiffs are optimistic the equilibrium level of care is increasing with the level of confidence, so that a rise in α will decrease the probability of accident, and hence the trial probability. The reverse holds when plaintiffs are pessimistic. In both cases the precaution side reinforces the litigation side. In other cases (i.e. when the sensitivity of marginal types to an increase in the settlement offer is low) the litigation side and the precaution side go in opposite directions, hence the final effect is ambiguous.

The general public policy implication is thus that if the government believes that the sensitivity of marginal types to an increase in the settlement offer is strong, it should spend nothing in raising confidence if plaintiffs are optimistic, and as much as possible if plaintiffs are pessimistic.

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.[8] Babcock, Loewenstein, and Issacharoff (1997) and Jolls and Sunstein (2006) explore law procedures (damages caps, split-awards tort reform) that may de-bias litigants optimism.

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

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 for settle and incentives for 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 contribution are as follows.

Regarding the settlement stage, our results indicate that: i) the defendant's settlement offer is increasing in the plaintiff's level of optimism while the probability of settlement is decreasing in the plaintiff's level of optimism; ii) the defendant's settlement offer is increasing in the plaintiff's level of confidence while the probability of settlement is decreasing in 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 the is greater than one. Our results are consistent with those of Farmer and Pecorino (2002) and Langlais (2011) excepted 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 .

Regarding the liability stage, we show that the level of care chosen by the defendant is increasing in the plaintiff's level of optimism and increasing in 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 the sensitivity of plaintiffs to a rise in the settlement offer is high, 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 decrease the volume of litigation. In that case, public authorities have to invest in public policies aimed at increasing confidence. If plaintiffs are optimistic and the sensitivity of plaintiffs to a rise in the settlement offer is high, 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 the sensitivity of plaintiffs to a rise in the settlement offer is low, then an increase of the level of confidence will have an ambiguous effect since the impact on the settlement stage are 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 lead 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 in a similar way 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 type of the plaintiff, then, we may introduce ambiguity about this distribution.

7 Appendix

Proof of Proposition 3

Proof. Let $\underline{s} := \hat{\pi}\underline{L} - c_p$ and $\bar{s} = \hat{\pi}\bar{L} - c_p$. Let us first show that we may without lost of generality assume that the solutions to the minimization of H lie in the interval $[\underline{s}, \bar{s}]$. Indeed, if $s \leq \underline{s}$, then $\hat{L}(s) \leq \underline{L}$, 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 the attention to $[\underline{s}, +\infty)$. Similarly, if $s \geq \bar{L}$, 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

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

where $\lambda \leq 0$ and $\mu \leq 0$ 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) $\mu(s - \hat{\pi}\underline{L} + c_p) = 0$.

Assume now that the adjusted RHR is decreasing, i.e. T is increasing.
Consider first the case of LC, i.e.:

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

Since $F(\underline{L}) = 0$ and $f(\underline{L})$, this is actually equivalent also to $\frac{c_p + c_d}{\hat{\pi}} \leq T(\underline{L})$, and, since $\frac{\partial \hat{L}}{\partial s}(\underline{s}) = \frac{1}{\hat{\pi}}$, 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 IC holds. 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 (10) 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. □

Proof of proposition 4

Proof. 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

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

□

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