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March 2008

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March 11, 2008

Abstract

There exist evidence that asymmetrical information do exist between litigants: not in a way supporting Bebchuk (1984)'s assumption that defendants' degree of fault is a private information, but more likely, as a result of parties' predictive power of the outcome at trial (Osborne, 1999). In this paper, we suggest an explanation which allows to reconcilie different results obtained in experimental economics. We assume that litigants assess their estimates on the plaintiff's prevailing rate at trial using a two-stage process. First, they manipulate the available information in a way consistent with the self-serving bias. Then, these priors are weighted according to the individual's attitude towards risk. The existence of these two different cognitive biases are well documented in the experimental literature. Within this framework, we study their influence in a model of litigation where the self-serving bias of one party is private information. We show that the influence of the former is consistent with the predictions of the "optimistic approach" of trials. However, we show that the existence of risk aversion and more generally non neutrality to risk, is more dramatic in the sense that it has more unpredictable effects.

JEL classification: D81, K42.

Keywords: litigation, pretrial bargaining, cognitive dissonance and self-serving bias, risk aversion.

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1 Introduction

The fact that informational imperfections introduce biases in litigants' assessment of the outcome of trial, thus entailing losses of efficiency in a dispute between two parties, is beyond debate. The issue which is still controversial in the literature is what causes the disagreement between parties which results in the pretrial bargaining impasse?

In the hunt for the most powerful theory of litigations, two prominents theories have been suggested. According to the "optimistic approach" (Priest and Klein (1984), Shavell (1982)), the failure of pretrial negotiations occurs because the plaintiff is more confident than the defendant about his own chances to win at trial - the more confident the plaintiff relative to the defendant, the more likely the trial. As a result, the optimistic model predicts that the subset of cases going to trials is not a representative sample of all tried cases but it is biased towards those for which the plaintiff has a trial win rate close to 50% (Priest and Klein (1984), Waldfogel (1995,1998)). In the "strategic approach", the existence of information asymmetries between the parties explains why disputes are sometimes inefficiently solved in front of Courts. In a seminal paper, Bebchuk (1984) assumes that the defendant has the private information concerning whether he was negligent, and shows that cases going to trial are those for which the plaintiff has the best chances to prevail[1].

The available empirical evidence is mixed. Priest and Klein (1984) and Waldfogel (1995) found evidence in favour of the prediction of a 50% prevailing rate for plaintiffs, but Hughes and Snyder (1985) and Katz (1987) conclude that it is more likely to be less than 20%. Waldfogel (1998) rejects the assumption that information asymmetries exist for cases going to trial, while Osborne (1999) finds evidence that they do exist, but interestingly not in a way supporting Bebchuk (1984)'s assumption that defendants' degree of fault is a private information. He suggests that this is actually more likely to be connected to differences between parties' predictive power of the outcome at trial. In words, litigants are neither equally skilled nor have the same ability to assess their chances to prevail at trial. Hence, we are back to the question what does explain that litigants are unequally skilled in predicting the outcome at trial?

Farmer and Pecorino (2002) investigate a promising line of research which allows to reconcile the optimistic and strategic models. They assume that litigants exhibit the self-serving bias, a form of bounded rationality that has been documented in the experimental literature. Farber and Bazerman (1987) long ago argued that neither divergent expectations nor asymmetric informations provide sufficient explanations of the existence of a disagreement in bargaining; in contrast, the existence of cognitive limits, and various forms of bounded rationality, provide the most powerful

[1] Daughety (2000) affords a complete survey of the strategic analysis of litigations.

arguments. More recently, a growing literature in the area of *behavioral law and economics* has also afforded empirical and experimental evidence for the presence of cognitive limits such as anchoring effects and optimistic or self-serving bias on behalf of individuals in civil litigations. There exist convincing proofs that cognitive biases are exhibited by both well experienced lawyers and judges (Ichino, Polo and Rettore (2003), Marinescu (2005), Rachlinski, Guthrie and Wistrich (2007), Viscusi (2001)) and more naive individuals (Babcock and Loewenstein (1997)). For example, Babcock and Loewenstein survey experimental studies showing that people display the self-serving bias, that is a systematic tendancy for individuals to interpret facts in civil litigations in a way which is favorable to themselves: given identical facts, an individual given the role of a plaintiff (defendant) will interpret those facts as more favorable for the plaintiff (respectively for the defendant). In their paper, Farmer and Pecorino (2002) introduce the self-serving bias in a model of litigations *à la* Bebchuk (1984) and analyse its incidence on the trial rate and the well-being of parties (i.e. the amount for which they settle the case). Typically, the authors[2] find that an increase in the optimistic bias of the informed party (the defendant) has an ambiguous effect on the frequency of trial and settlement demand. In contrast, an increase in plaintiff's self-serving bias (uninformed party) increases the incidence of trial but decreases his settlement proposal. Our paper departs from the work of Farmer and Pecorino regarding two main features.

First, in our paper, individuals are aware of their self-serving bias, and we assume that this is a private information. In contrast to Farmer and Pecorino, we believe that the very existence of a self-serving bias does not mean that individuals are unable to recognize their own bias, or to learn the bias of the opponents. We woud like to stress this point since it is close to an old debate in experimental economics and decision making under risk.

Early on, advocates of the Expected Utility model considered that experimental paradoxes such as the so-called Allais paradox, the certainty effect or the common ratio effect (see Hey and Lambert (1990)) essentially provide the proof that experimental subjects behave in an *irrational* way when facing with hypothetical choices of gambles, and were they confronted to what appears as irrational decisions, they would change their choices in a way consistent with the (EU) theory. But fourty years later we know that this is not true (Hey and Lambert (1990)): experimental subjects perform exactly the same decisions regarding the ranking of loteries once they are aware that their initial behavior is not consistent with the theory. As a consequence, it is very tempting to believe that the evidence discussed by Babcock and Loewenstein (1997) rather suggests that were they informed of the existence of their own optimistic bias, experimental subjects would nevertheless

[2] More precisely, Farmer and Pecorino (2002) study the consequence of both a multiplicative and an additive bias.

still continue to display this bias. We will argue that several reasons explain why we are right to believe this. The usual justification of such biases is the heuristic called by Tversky and Kahneman (1974) "comparative optimism": people are prone to underestimating the risk they are personnaly confronted with as compared to other people. In a sense, this may be seen as an over optimistic pattern of thinking, quite irrational actually. However, the literature in social psychology yields several alternative explanations pertaining to the theory of *cognitive inconsistency* or cognitive dissonance (Akerlof and Dickens (1982), Babcock and Loewenstein (1997)). Generally speaking, it seems that in most social interactions, people need to rationalize their own decisions and behavior. The basic reason is that individuals view themselves as reasonable, liable, "smart and nice people", having the sense of fairness or impartiality; at the same time, they need to maintain self-esteem. Cognitive dissonance operates when in practice inviduals are confronted with situations or obtain information that conflict with this prior. In such cases, the individual will ignore, reject or accomodate the new facts or informations, changing his posterior beliefs in a way constistent with the prior (that he/she is always a smart person). In a sense, cognitive dissonance is a theory of self-manipulation of beliefs: when having the true and objective information about the situation, individuals are prone to reinterpret the facts in a way favorable to the initial image of themselves. This reflects that people are not confortable with evidence or ideas which contradict the opinion they have on themselves.

This cognitive inconsistency seems to be a sound and constant pattern of human thinking. The interesting point concerning the analysis of litigations is that the existence of such a cognitive bias may play the role of a "moral constraint", or, as explained by Farmer and Pecorino (p 164, 2002) the role of a commitment device. On the one hand, when confronted with facts showing that it is likely that he has been negligent, the defendant will reinterpret the case as a situation where he could by no way prevent to do so, and thus he is led not to accept unfair settlement demands. On the other, a plaintiff having unclear evidence that the defendant is liable, will nevertheless file his case and will be prone to reject what he sees as an unfair settlement offer as compared to what he expects to obtain in case of trial. This way of thinking may be perfectly anticipated by both litigants, leading them to assess optimistic beliefs concerning their chances of prevaling, with the best reasons to do so. The issue of the paper is to investigate the consequence of the existence of these biases, but when an asymmetric information also exist on their size.

The second reason why our paper departs from the work of Farmer and Pecorino is that we assume that litigants have different degrees of risk aversion. It is well known that risk aversion provides another channel for the process of probability distorsion, which is distinct from the optimistic bias. There now exist hundred of proofs that when they have to choose between loteries with known probabilities, individuals systematically depart from the Expected Utility model regarding their way of thinking, and in contrast display a typical pattern of probabilities transformation[3] which is connected to the usual concept of risk aversion. We introduce in this paper the model proposed by Yaari (1987) which captures this salient effect. It seems a very tractable tool for the analysis of litigations in the sense that the attitude towards risk (risk aversion) is uniquely characterized through the properties of a probability distorsion function. Decidue and Wakker (2001) or Weber and Kirsner (1997) present several arguments allowing to rationalize such a probability transformation function[4] which refer to psychological attitudes which are very different from those explaining the existence of self-serving biases. In a sense, this kind of mental accounting is the way by which individuals take care of and minimize the loss, disapointment or pain they will suffer when making an error in the assessment of the outcome associated with their decision. Everything goes as if the behavior of Yaari's decision makers is based on a pessimistic criterion of decision: they focuse on the worst outcome for themselves (leaving them with the smallest level of welfare) and then assess the additional gains of satisfaction that they may experience together with their subjective likelihood of occurrence. As a result, Yaari's individuals tend to overestimate the losses and underestimate the gains they may experience.

To sum up, this paper is an attempt to reconcilie alternative theories of the pretrial bargaining impasse, and at the same time an attempt to reconcilie two theories of individual assessment of beliefs on risky events. In our framework, litigants have preferences consistent with Yaari's type and perform optimistic priors consistent with the heuristic of comparative optimism. This latter assumption reflects that they use and transform (manipulate) the objective information available on the case in a way more favorable for themselves - hence they assess different priors on the outcome of the trial. The former assumption simply means that the litigants do not have the same sensibility (aversion) towards risk, and apply a new specific transformation to their priors in order to assess their prosterior probability of prevailing at trial. For the sake of simplification, we assume that the uninformed party is risk neutral, whereas the informed one is risk averse, and that the optimistic bias of one party is private information for that party.

In this framework, we obtain results which add to those found by Farmer and Pecorino (2002): we show that changes in the optimistic bias of the uninformed litigant (defendant) have consequences similar to the predictions of the optimistic approach. We also study various shifts in the distribution of bias for the informed party (plaintiff) showing that additive ones have predictable consequences consistent with the optimistic approach, while multiplicative shifts entail

[3]This is true with regard to loteries based on a large domain of monetary payments and the complete interval of probabilities.

[4]Both in the model of Yaari and in the Rank Dependant probability model of Quiggin.

more ambiguous consequences. Finally, changes in risk aversion of the informed litigant also have an ambiguous effect, but typically different from those coming from the optimistic bias.

The paper is structured as follows. Section 2 presents a screening model of litigation where both parties display a self-serving bias. We assume that the defendant's bias is public information, whereas the plaintiff's bias is private information, with the distribution of possible values being public information. Moreover, the plaintiff is supposed to be risk averse and endowed with Yaari's preferences. Section 3 discusses two natural extensions: on the one hand, the case where plaintiff's preferences display a kind of extreme sensibility to risk (the certainty effect and the possibility effect); on the second, the situation where the defendant is the informed party. Section 4 concludes.

2 The Plaintiff as the informed party

We will modify the screening model of Bebchuk (1984) in the following manner.

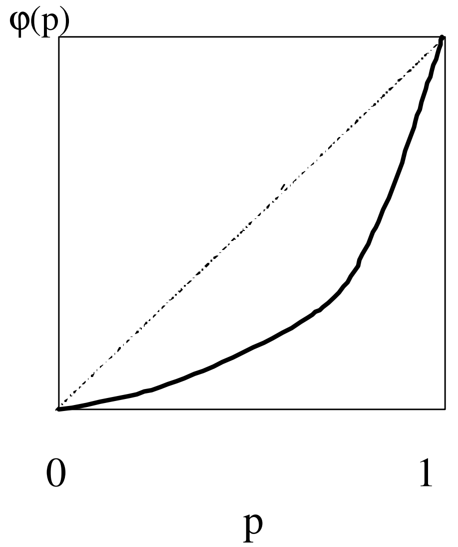
2.1 assumptions and timing of the model

We consider a plaintiff which is harmed by an accident that may be the result of negligence or wrongdoing by another party, the defendant. The loss suffered by the plaintiff in case of accident is $D > 0$ and corresponds to the dammages awarded by the Court in case the trial is in favour of the victim. The compensation D is public information. We denote p the probability that the judgment at trial be in favour of the plaintiff, and we assume that this public information.

We assume that the plaintiff has preferences which satisfy the axiomatics of Yaari's model (Yaari (1987)); thus, there exists a probability transformation (or probability weighting) function $\varphi(p)$ which is endowed with the basic properties that $\varphi : [0,1] \rightarrow [0,1]$ is unique, continuous and increasing in p, with $\varphi(0) = 0$ and $\varphi(1) = 1$. We will assume that $\varphi(p)$ is (at least twice) differentiable, with:

Assumption 1: $\forall p \in [0,1] : \varphi''(p) > 0$.

Accordingly, the plaintiff is risk averse (Yaari, 1987). The shape of the probability transformation function is displayed in the next graph:



In this setting, the satisfaction level or "anticipated utility" of the plaintiff facing a risky prospect at trial $X = (x_1, 1-p; x_2, p)$ where $x_1 < x_2$, writes:

$$E_{\varphi op}(X) \equiv (1 - \varphi(p))\, x_1 + \varphi(p)\, x_2$$

In other words, $E_{\varphi op}(X)$ is the subjectively transformed expected outcome of the prospect, since the probability of each outcome is replaced by a subjective weight of likelihood. Specifically, according to the convexity of $\varphi(p)$, the plaintiff places a weight of likelihood to the worst (best) outcome which is larger (smaller) than its probability: *i.e.* $1-\varphi(p) > 1-p$ (respectively $\varphi(p) < p$). Finally, $E_{\varphi op}(X)$ is the certainty-equivalent of the prospect X.

It is usefull to observe that according to the convexity assumption, we have:

$$\varphi'(1) > \frac{1-\varphi(p)}{1-p} > \frac{\varphi(p)}{p} > \varphi'(0)$$

or equivalently (substracting 1 to each term)

$$\varphi'(1) - 1 > \frac{p-\varphi(p)}{1-p} > \frac{\varphi(p)-p}{p} > \varphi'(0) - 1$$

hence: $\varphi'(1) > 1$ although $\varphi'(0) < 1$. Thus by continuity, we obtain the following property:

Property 1: there exists a (unique) value $q \in]0,1[$ such that $p < q \Rightarrow \varphi'(p) < 1$ but $p > q \Rightarrow \varphi'(p) > 1$.

Note that $\varphi'(p) \leq 1$ means that the risk aversion increases with the plaintiff's prior (the distorsion of the probability $p - \varphi(p)$ increases); and in contrast, $\varphi'(p) \geq 1$ means that the risk aversion decreases with the plaintiff's prior (respectively, the transformation of the probability is dampen).

On the other hand, we assume that the plaintiff displays a self-serving bias ($\sigma > 1$), and thus has an assessement of the prior corresponding to his chances to win at trial denoted $\sigma.p$, which is larger than his true probability: in other words, the plaintiff interprets the facts of the case as more favorable for himself than they really are from an objective point of view. However, the value of σ is private information for the plaintiff and is not observable by the defendant: the defendant only knows that the plaintiff's bias is a random variable $\sigma \in [a, b]$ (with $a > 1$) distributed according to a probability function characterized by the cumulative function $G(\sigma)$ and the density $g(\sigma)$, which are public information. In what follows, σ is labelled as the type of the plaintiff. In order to rule out secondary difficulties, we introduce the following assumption:

Assumption 2: the hazard rate $\frac{G}{g}$ is increasing.

Finally, we consider here that the defendant is a risk neutral individual, but also displaying a self-serving bias denoted by $\sigma_d < 1$, which is public information; this implies that when facing the risky prospect of trial $Y = (y_1, 1-p; y_2, p)$, the defendant's expected outcome is $E(Y) \equiv (1 - \sigma_d p)y_1 + \sigma_d p y_2$.

The pretrial bargaining process has two main stages[5], following Nature's choice of the type of the plaintiff σ in $[a, b]$, and also following the plaintiff having filed his case:

- In a first stage, the defendant makes a "take-it-or-leave-it" offer to the plaintiff, denoted s, in order to reach a settlement of the case.

- In the second stage, depending on his type, the plaintiff accepts the offer (thus, the case is settled) or rejects it, in which case the parties go to trial.

We introduce the American rule in order to describe the allocation of the costs incurred by each parties at trial. We denote $C_p > 0$ the plaintiff's costs and $C_d > 0$ the defendant's costs.

Formally, the σ plaintiff's anticipated utility in case of trial corresponding to the prospect $X = (D - C_p, p; -C_p, 1-p)$, writes:

[5] Daughety et Reinganum (1994) argue that this is the more relevant assumption. First, Courts impose delays on pretrial bargaining. Then, parties chose to self-restrain the negotiations in order to lower the associated costs. We may also consider that parties often reach an agreement on the steps of the tribunal, just some minutes before the trial.

$$E_{\varphi op}(X) \equiv \varphi(\sigma p)D - C_p$$

We assume that $apD - C_p > 0$ meaning that the weakest type for the plaintiff, *i.e.* when he believes to be facing the defendant having the best chances to be seen as not liable by the Court, always has an incentive to go to trial. Nevertheless, given that the plaintiff is a risk averse individual, he will not always go to trial since for all p: $E\varphi(X) < \sigma pD - C_p$.

On the defendant side, the risky trial is a prospect denoted $Y = (-(D + C_d), p; -C_d, 1 - p)$, and the anticipated loss borne by the defendant when he faces a type p for the plaintiff at trial is:

$$E(-Y) \equiv \sigma_d pD + C_d$$

Finally we assume that $pD > C \equiv C_p + C_d$ meaning that the case to be solved is socially valuable.

2.2 the equilibrium

The (Bayesian) equilibrium is described in terms of the amount for which the parties settle, s (the equilibrium offer of the defendant to the plaintiff), and of the probability of a trial corresponding to the marginal plaintiff $\sigma(s)$, the one who is indifferent between accepting the offer or rejecting it and going to trial.

In the second stage, the plaintiff σ chooses between accepting the offer which gives him a sure gain s, and going to risky trial X, the certainty-equivalent of which is $\varphi(\sigma p)D - C_p$. As a result, the plaintiff σ accepts the offer s as soon as: $s \geq \varphi(\sigma p)D - C_p$. Otherwise, he rejects it. The marginal plaintiff $\sigma(s)$ is thus defined by the condition:

$$\varphi(\sigma(s)p)D - C_p = s \tag{1}$$

Any plaintiff having a prior more pessimistic than the marginal plaintiff (any $\sigma \leq \sigma(s)$) will also accept the offer, while any plaintiff having a more optimistic prior ($\sigma > \sigma(s)$) will go to trial.

Going back to the first stage, we can write the loss function according to which the defendant will set his best offer. With probability $G(\sigma(s))$, the defendant knows he will face a plaintiff prone to accept his offer, and thus incur the cost s to settle the case. But with probability $1 - G(\sigma(s))$, the defendant knows he will face a plaintiff more optimistic than the marginal one, and thus will have to pay the cost $\sigma_d pD + C_d$. The defendant will anounce the best offer $\hat{s} \geq 0$, which minimize the loss function:

$$L(s) = G(\sigma(s)) \times s + (1 - G(\sigma(s))) \times (\sigma_d pD + C_d) \tag{2}$$

under condition (1).

■ **Proposition 1:** *In an interior equilibrium, the offer $\hat{s}$ and the marginal plaintiff $\hat{\sigma}$ are set according to the following conditions:*

$$\begin{aligned} \hat{s} &= \varphi(\hat{\sigma}p)D - C_p & (3) \\ \left(\frac{G}{g}\right)_{|(\hat{\sigma})} &= \frac{1}{\varphi'(\hat{\sigma}p)}\left(\sigma_d - \frac{\varphi(\hat{\sigma}p)}{p} + \frac{C}{pD}\right) & (4) \end{aligned}$$

such that the probability of a trial is $\hat{\pi} = 1 - G(\hat{\sigma})$.

Proof: If $\hat{s} > 0$ and $\hat{\sigma} \in]a, b[$ are an admissible interior solution for the minimization of (2), then the First Order Condition writes as:

$$G(\hat{\sigma}) - g(\hat{\sigma}) \frac{1}{\varphi'(\hat{\sigma}p)pD}((\sigma_d p - \varphi(\hat{\sigma}p))D + C_p + C_d) = 0 \tag{5}$$

Rearranging the various terms leads to (4). Note that the Right Hand Side in (4) must be positive since the gains of the negotiation must be positive for an interior solution to exist: $\sigma_d - \frac{\varphi(\hat{\sigma}p)}{p} + \frac{C}{pD} > 0 \Leftrightarrow \hat{s} < \sigma_d pD + C_d$. Existence may be proven as in Bebchuk (1984). Under assumption 2, the Left Hand Side in (4) is increasing with σ, whereas under assumption 1 the RHS is decreasing with σ. Thus, the solution for (3)-(4), is unique and satisfies the second order condition ($L''(\hat{s}) > 0$). ■

The first LHS term in (5) is the marginal cost of the defendant's offer: raising this offer leads to an increase in the loss incured by the defendant which is equal to the probability of settlement. The second LHS term in (5) is the marginal benefit of the offer which may be split in two components. As the defendant raises his offer, some (types of) plaintiffs abandon the trial and prefer to settle their case:

- on the one hand, the effect of raising the offer on the probability of trial (which decreases), $\frac{d}{ds}(1 - G(\sigma(s)) = -g(\hat{\sigma})\frac{1}{\varphi'(\hat{\sigma}p)pD} < 0$; this term reflects the efficiency of the screening of the various plaintiff's types due to an increase in the settlement offer;

- on the other hand, the gains of the negotiation[6] for the marginal plaintiff, $(\sigma_d p - \varphi(\hat{\sigma}p))D + C >$

[6] Were the parties both risk neutral and having no self-serving bias, these gains would be reduced to the aggregate transaction costs of a trial : $C_p + C_d$. But, as the parties do not have the same perception of the risk of a trial (on the one hand, they have different priors; on the other, they do not have the same sensibility to risk) the negotiation gains are different from the transaction costs of a trial: $E(Y) - \hat{s} \neq C_p + C_d \Leftrightarrow \sigma_d p - \varphi(\hat{\sigma}p) \neq 0$.

0, since the amicable settlement of the case allows the defendant to save his judiciary costs and extract those of the plaintiff plus the value of the judgment. This second term obviously reflects the gain associated with the screening of the plaintiffs according to their type.

However, given that: $\sigma_d - \frac{\varphi(\hat{\sigma}p)}{p} \gtreqless 0$, it is quite surprising to find here that parties may prefer to settle their case despite that the gains of the negotiation are *smaller* than the transaction costs at trial. This is the result of two opposite effects. The first one is due to the risk aversion, which implies $\sigma p > \varphi(\sigma p)$; the second is due to the self-serving bias, as $\sigma_d < 1$. As a result, the sign of $\sigma_d p - \varphi(\hat{\sigma}p)$ is ambiguous. This means that the existence of a self-serving bias together with risk aversion introduces some ambiguity in the relationship between parties' beliefs (regarding the chances that the plaintiff prevails at trial) and the trial rate. In fact, when the plaintiff is risk neutral (for any p, we have $\varphi(p) = p$ and $\varphi'(p) = 1$), the equivalent of (4) writes: $\left(\frac{G}{g}\right)_{|(\hat{\sigma})} = \sigma_d - \hat{\sigma} + \frac{C}{pD}$ with $\sigma_d - \hat{\sigma} < 0$ as a result of the assumption on the domain of definition of individual bias, meaning that the very existence of self-serving bias tends to reduce the gain of the negotiation. This effect is the one highlithed in the usual "optimistic approach" of litigations (Priest and Klein (1984), Shavell (1982)). Optimistic litigants in the sense of parties having a self-serving bias will be biased in favor of a trial since they both overestimate their own chance to prevail in the Court. But, what occurs in this model, is that the plaintiff's risk aversion may dampen the influence of those biases and improve the gains of the negotiation. However, sometimes risk aversion may aggravate in contrast the negative influence of the self-serving bias, reducing further more the gains of the negotiation.

The effects of these two kinds of probability distorsion, optimistic bias and risk aversion, are investigated more precisely in the next paragraph.

2.3 comparative statics

Our model enlarges the representation of preferences under risk, allowing litigants to have several reasons to perform different assessments of the risk at trial. Thus, the first issue of interest is the impact on the equilibrium of a shift in risk at trial:

■ **Proposition 2:** *An increase in p:*

I) *decreases the marginal plaintiff (hence the probability of trial increases).*

II) *has an ambiguous effect on the equilibrium offer.*

Proof. I) It is easy to verify that an increase in p has a negative impact on the RHS in (4), which writes:

$$-\hat{\sigma}\left[\left(\frac{G}{g}\right)_{|(\hat{\sigma})}\times\left(\frac{\varphi''}{\varphi'}\right)_{|(\hat{\sigma}p)}+\frac{1}{\varphi'(\hat{\sigma}p)p}\left(\varphi'(\hat{\sigma}p)-\frac{\varphi(\hat{\sigma}p)}{\hat{\sigma}p}+\frac{C}{\hat{\sigma}pD}\right)\right]<0$$

since by the convexity of φ, we have $\left(\frac{\varphi''}{\varphi'}\right)_{|(\hat{\sigma}p)}>0$ and $\varphi'(\hat{\sigma}p)-\frac{\varphi(\hat{\sigma}p)}{\hat{\sigma}p}>0$. Hence (the LHS in (4) being increasing with σ) $\hat{\sigma}$ decreases with p. II) An increase in p has two effects on $\hat{s}$ in (3): a direct effect which is positive, and an indirect effect through the impact on the marginal plaintiff, which is negative; hence the ambiguity. ■

Proposition 2 adds to the existing literature in several respects. Bebchuk (1984) has shown that when the plaintiff does not observe p (i.e. the defendant's type), an upward shift in the range of p increases the settlement amount but has no effect on the rate of trial: this is because the expected value of a trial for the plaintiff increases but without any change between two any given defendants. Proposition 2 is also in contradiction with another result found by Farmer and Pecorino (1994) who have shown in the case where plaintiff's risk aversion is a private information that, as the risk borne by a plaintiff at trial decreases, then the frequency of a trial may also decrease[7]. They argue that this is the result of two opposite changes affecting the tradeoff between settling the case or going to trial: on the one hand, the contraction of the risk at trial provides the plaintiff with more incentives to go to Court; but on the other hand, the equilibrium settlement offer increases with p, thus rendering the settlement more attractive - hence the ambiguous effect on the frequency of a trial.

In contrast, our result first shows that the causality is reversed between the rate of trial and the settlement offer. Moreover, it shows that when the private information is the optimistic bias of the plaintiff, then the contraction of the risk at trial has a clearcut and intuitive (positive) effect on the trial rate. This is explained by the fact that the increase in p introduces a more than proportional decreases in risk aversion between two any given plaintiffs. But the ambiguity found on the settlement offer reflects two opposite forces: on the one hand, a direct effect which is positive, since the increase in p improve the anticipated utility of the plaintiff (all else held equal); on the other an indirect negative effect, given that the marginal plaintiff decreases.

The next results focus on the effects attached to the changes in the perception of the risk at trial experienced by each litigant, begining with:

[7] Farmer and Pecorino (1994) focus on a Mean-Preserving Contraction of risk, *i.e.* the increase in p is compensated by a decrease in D such that $\frac{dD}{dp}=-\frac{D}{p}$; it is easy to verify that our finding also extends to such a MPC, the sign being the one of:
$-\frac{1}{\varphi'(\hat{\sigma}p)}\left[\left(\frac{\varphi''(\hat{\sigma}p)}{\varphi'(\hat{\sigma}p)}\hat{\sigma}\right)\left(\sigma_d-\frac{\varphi(\hat{\sigma}p)}{p}+\frac{C}{pD}\right)+\frac{\hat{\sigma}}{p}\left(\varphi'(\hat{\sigma}p)-\frac{\varphi(\hat{\sigma}p)}{\hat{\sigma}p}\right)\right]<0$ and thus is not limited to the case of a First Stochastic Dominance Contraction of risk.

■ **Proposition 3:** *A rise in σ_d:*

I) *increases the marginal plaintiff (hence the probability of trial decreases),*

II) *increases the equilibrium offer.*

Proof. Straightforward: I) the RHS in (4) increases with σ_d - and given that the LHS in (4) increases with σ, the result is proven; II) σ_d has a positive impact on $\hat{s}$ only through the marginal plaintiff (see (3)). ■

Note that the increase in σ_d has a qualitative impact which is equivalent to a decrease in p.

Proposition 3 is in contradiction with Farmer and Pecorino (2002), who found in the case where the private information is the probability p, that the defendant's self-serving bias has an ambiguous effect both on the probability of trial and on the equilibrium offer. This suggests that the specific way the optimistic bias of a party affects the frequency of trials at equilibrium depends on the nature of the information asymmetry. It also depends on the order of play between the parties: the ambiguity concerning the role of σ_d obtained by Farmer and Pecorino (2002) disapears when the plaintiff has private information. But given that $\sigma_d < 1$, proposition 3 means literally that a rise in σ_d corresponds to the case where the defendant becomes less optimistic: as σ_d increases, the bias regarding his perception of the chances that the plaintiff prevails is reduced, and his own assessment of the likelihood of winning becomes closer to the true probability. Hence, this result is exactly the one more usually obtained in the "optimistic model", where litigants may fail to reach a settlement agreement when both parties overestimate their chances at trial: the more optimistic they are the higher the likelihood of a trial (Priest and Klein (1984), Waldfogel (1998)).

The next two propositions highlight how alternative changes in the relevant domain for the value of plaintiff's self-serving bias affect the equilibrium:

■ **Proposition 4:** *An additive shift to the right in the range of plaintiff's types:*

I) *implies a (less than proportional) increase in the marginal type;*

II) *increases the probability of trial;*

III) *increases the equilibrium offer.*

Proof. We define (see also Bebchuk (1984)) an additive shift to the right of the range of plaintiff's types as a t-translation of plaintiff's types, such that σ is now distributed on the interval $[a + t, b + t]$ (with $t \geqslant 0$) with the cumulative $\Gamma(\sigma)$ and the density $\gamma(\sigma)$ functions satisfying the following correspondances with the primitives $G(\sigma)$ and $g(\sigma)$:

$$\begin{aligned}\Gamma(\sigma) &= G(\sigma - t) \\ \gamma(\sigma) &= g(\sigma - t)\end{aligned}$$

In fact, these two conditions characterize a family of distribution functions which is parametrized by $t \geqslant 0$, where $t = 0$ gives us the primitives, and $t > 0$ leads to a distribution with a higher mean type but having identical higher order moments. In this case, the condition (4) may be substituted with the general formulation:

$$\left(\frac{G}{g}\right)_{|(\hat{\sigma}-t)} = \frac{1}{\varphi'(\hat{\sigma}p)}\left(\sigma_d - \frac{\varphi(\hat{\sigma}p)}{p} + \frac{C}{pD}\right) \tag{6}$$

with $\hat{\pi} = 1 - G(\hat{\sigma} - t)$ and $\hat{s}$ given by (3). I) Differentiating (6) gives:

$$\frac{d\hat{\sigma}}{dt} = \frac{1}{\Omega}\left(\frac{G}{g}\right)'_{|(\hat{\sigma}-t)}$$

with: $\Omega \equiv \left(\frac{G}{g}\right)'_{|(\hat{\sigma}-t)} + \left(\frac{G}{g}\right)_{|(\hat{\sigma}-t)} \times \left(\frac{\varphi''}{\varphi'}\right)_{|(\hat{\sigma}p)} \times p + 1 > 0$ according to the second order condition. Moreover, under assumption 2: $\left(\frac{G}{g}\right)'_{|(\hat{\sigma}-t)} > 0$, while under assumption 1: $\left(\frac{\varphi''}{\varphi'}\right)_{|(\hat{\sigma}p)} > 0$. Thus, it is obvious that $\frac{d\hat{\sigma}}{dt} > 0$ but $\frac{d\hat{\sigma}}{dt} < 1$. II) As a result, $\hat{\pi} = 1 - G(\hat{\sigma} - t)$ increases with t. III) Given that the marginal type increases with t, it is also straightforward to see that the equilibrium offer $\hat{s} = \varphi(\hat{\sigma}p)D - C_p$ also increases with t. ■

It is obvious that proposition 4 gives predictions that are close to the findings by Farmer and Pecorino (1984) who showed that an increase in the plaintiff (observable) self-serving bias both increases the likelihood of a trial and the settlement amount. This of course reflects the very definition of an additive shift to the right of the range of plaintiff's types since such a shift increases the mean type and leaves unchanged the higher order moments. Hence, everything goes as if the plaintiff, irrespective of his type, becomes more optimistic (more biased) as compared to the defendant - entailing the same effects at equilibrium as those obtained by Farmer and Pecorino.

It is also worth noticing that the results in proposition 4 are once more replicating those more usually obtained in the "optimistic model". Roughly speaking, as the range of plaintiff's possible types is additively shift to the right, then the plaintiff becomes more optimistically biased as compared with the defendant; hence the occurrence of a trial increases. This is the effect also predicted by the "optimistic model" (see Priest and Klein (1984) and Waldfogel (1998)).

However, changing our definition of the shift in the possible range of plaintiff's optimistic bias will introduce new effects in equilibrium:

■ **Proposition 5.** *A mean-preserving proportional shift in the range of plaintiff's types:*

I) *decreases the marginal type if $\hat{\sigma} < \mu$; otherwise, the effect is ambiguous;*

II) *has an ambiguous effect on the probability of trial;*

III) *decreases (increases) the equilibrium offer if the marginal type decreases (respectively, increases).*

Proof. We define (see also Bebchuk (1984)) a mean-preserving proportional shift of the distribution of plaintiff's types as the composition of an additive shift to the left (a $\mu(1-t)$-translation, with $t \geqslant 1$ and $\mu = E(\sigma)$) plus a multiplicative shift of plaintiff's types, such that σ is now distributed on the interval $[ta + \mu(1-t), tb + \mu(1-t)]$ with a cumulative $\Gamma(\sigma)$ and a density $\gamma(\sigma)$ satisfying the following correspondances with the primitives $G(\sigma)$ and $g(\sigma)$:

$$\begin{aligned} \Gamma(\sigma) &= G\left(\frac{\sigma-\mu}{t}+\mu\right) \\ \gamma(\sigma) &= \frac{1}{t} g\left(\frac{\sigma-\mu}{t}+\mu\right) \end{aligned}$$

Once more, these two conditions characterize a family of distribution functions which is parametrized by $t \geqslant 1$, where $t = 1$ gives us the primitives, and $t > 1$ gives us a new distribution with the same mean $\mu = E(\sigma)$ but which is more spread than the primitive distribution; thus it has moments of higher orders which are larger than those of the primitive. In this case, condition (4) may be now substituted with the general formulation:

$$t \times \left(\frac{G}{g}\right)_{|\left(\frac{\hat{\sigma}-\mu}{t}+\mu\right)} = \frac{1}{\varphi'(\hat{\sigma}p)}\left(\sigma_d - \frac{\varphi(\hat{\sigma}p)}{p} + \frac{C}{pD}\right) \tag{7}$$

with $\hat{\pi} = 1 - G\left(\frac{\hat{\sigma}-\mu}{t}+\mu\right)$. I) Differentiating (7) gives:

$$\frac{d\hat{\sigma}}{dt} = \frac{1}{\Omega} \times \left[\left(\frac{G}{g}\right)'_{|\left(\frac{\hat{\sigma}-\mu}{t}+\mu\right)} \times \left(\frac{\hat{\sigma}-\mu}{t}\right) - \left(\frac{G}{g}\right)_{|\left(\frac{\hat{\sigma}-\mu}{t}+\mu\right)}\right]$$

It is obvious that $\hat{\sigma} < \mu \Rightarrow \frac{d\hat{\sigma}}{dt} < 0$ although if $\hat{\sigma} > \mu$ then $\frac{d\hat{\sigma}}{dt}$ has an ambiguous sign. II) Similarly, $\hat{\pi}$ may decrease or increase with t since:

$$\frac{d\hat{\pi}}{dt} = -g\left(\frac{\hat{\sigma}-\mu}{t}+\mu\right) \times \frac{1}{t} \times \left(\frac{d\hat{\sigma}}{dt} - \frac{\hat{\sigma}-\mu}{t}\right)$$

Hence the result. III) Given the ambiguity on the marginal type, it is also straightforward to see that the equilibrium offer $\hat{s} = \varphi(\hat{\sigma}p)D - C_p$ may as well increase (if the marginal type increases) as decrease (respectively if the marginal type decreases) with t. ■

Remark that $\frac{d\hat{\sigma}}{dt}$ may equivalently be written as:

$$\frac{d\hat{\sigma}}{dt} = \frac{1}{\Omega} \times \left(\frac{G}{g}\right)_{|\left(\frac{\hat{\sigma}-\mu}{t}+\mu\right)} \times (e-1)$$

where $e = \left(\frac{G}{g}\right)' \frac{\left(\frac{\hat{\sigma}-\mu}{t}\right)}{\left(\frac{G}{g}\right)}$ is the (partial) elasticity of the rate of hazard with respect to $\left(\frac{\hat{\sigma}-\mu}{t}\right)$, evaluated at $\left(\frac{\hat{\sigma}-\mu}{t}+\mu\right)$. Hence, we have the following corollary:

Corollary 6. *A mean-preserving proportional shift in the range of plaintiff's types:*

I) *decreases the marginal type if* $e < 1$*;*

II) *increases the marginal type if* $e > 1$*.*

Proposition 5 and corollary 6 for their own give predictions concerning the effects of such shifts in the range of possible types for the plaintiff[8] which are different as compared to those of Bebchuk. For Bebchuk, the additive shift has no effect on the frequency of trial and a positive effect on the settlement offer, while the mean-preserving proportional shift increase the likelihood of a trial and has an ambiguous effect on the amount for which the parties settle. Corollary 6 shows in which way this last result may be connected to more specific restrictions concerning the distribution of plaintiff's types.

At the same time, the effects we obtain here are also different from those predicted by the "optimistic model". To see this, let us interpret such a mean-preserving proportional shift in the range of plaintiff's types as representing, from the defendant point of view, more variability in the prediction of the plaintiff's type (less precision in the assessments of the true value for the plaintiff's bias) since it corresponds to more dispersion in plaintiff's possible bias. Let us remind that Priest and Klein (1984) and Waldfogel (1998) showed that when the errors made by the litigants in predicting the outcome at trial increase, then the likelihood of a trial increases: this is because the chances are raised that plaintiff's optimistic estimate of prevailing at trial be larger than defendant's one. In the interpretation of the optimistic model suggested by Priest and Klein (1984), litigants perform unbiased estimates, or rational expectations, for their chances of prevaling at trial. In contrast and by definition, we consider here the situation where litigants have (positively, optimisticaly) biased estimates of their chances to win at trial, which are endogenously determined to the extent that they are supported by their intrinsic preferences and the perception of the risky prospect they are facing (see also Farmer and Pecorino (2002)).

[8] In the model of Bebchuk (1984) where the private information is p, it does not matter whether the informed party is the defendant or the plaintiff for the analysis of such shifts in the range of unobservable types.

In short, our results suggest that the additive expansion in the range of the unobservable possible types have perfectly predictable effects on the equilibrium, although multiplicative shifts have more imprecise consequences.

The final proposition focuses on the incidence of raises in plaintiff's risk aversion. In order to study this effect, we need to introduce some new materials. Let us first recall some basic results about comparative risk aversion in Yaari's model:

1- according to Yaari (1987), a plaintiff having a probability transformation function ψ is more risk averse than a plaintiff characterized by φ iff ψ is a positive and convex transformation of φ. This implies that (see Yaari (1987), Roëll (1987)) for all p: $\psi(p) < \varphi(p)$ - meaning that, roughly speaking, the graph of ψ is everywhere under the graph of φ, and never above.

2- moreover, since ψ and φ are both (strictly) increasing and (strictly) convex, satisfying $\psi(0) = \varphi(0) = 0$ and $\psi(1) = \varphi(1) = 1$ and finally $\forall p : \psi(p) < \varphi(p)$, then: $\psi'(0) < \varphi'(0)$ but $\psi'(1) > \varphi'(1)$. By continuity, once more we obtain the following useful property:

Property 2: if ψ is more risk averse than φ, there always exists a (unique) $Q \in]0,1[$ such that $p \geq Q \Rightarrow \psi'(p) \geqslant \varphi'(p)$, but $p \leq Q \Rightarrow \psi'(p) < \varphi'(p)$.

This property will be interpreted as follows. In the range of probabilities such that $p \leq Q$ then equivalently we have $\psi'(p) < \varphi'(p) \Leftrightarrow 1-\psi'(p) > 1-\varphi'(p)$: in other words, for probabilities smaller than the threshold Q the probability distortion[9] increases more ($(p-\psi(p))' > (p-\varphi(p))'$) for the individual ψ than for the individual φ. The reverse occurs in the domain where $p > Q$. In the following, we assume that $Q \in]a,b[$. Using this property, we obtain the following characterization:

■ **Proposition 7:** *As the plaintiff becomes more risk averse:*

I) *the marginal plaintiff increases (hence the probability of trial decreases) if $\hat{\sigma}p \leqslant Q$; otherwise the effect is ambiguous;*

II) *the equilibrium offer decreases if the marginal plaintiff decreases; otherwise, the effect is ambiguous.*

Proof. Assume that plaintiff ψ is more risk averse than plaintiff φ in the sense of Yaari-Roëll. I) There are two opposite effects on the RHS term in (4); on the one hand, the gains of the negotiation are raized all else equal since for any σ: $\left(\sigma_d - \frac{\varphi(\sigma p)}{p} + \frac{C}{pD}\right) < \left(\sigma_d - \frac{\psi(\sigma p)}{p} + \frac{C}{pD}\right)$ -

[9] It is well known that risk aversion is usually parametrized by initial wealth in the Expected Utility model. For the model of Yaari, there is no wealth effect (the marginal utility for wealth is constant). So the risk aversion/probability distortion is parametrized by the probability.

thus this first term has a positive effect on the RHS of (4). On the other hand, given that we may have $\psi'(\sigma p) \lesseqgtr \varphi'(\sigma p)$, then the effect on the efficiency of the separation among plaintiffs' types is ambiguous. Thus, the net effect on the RHS is ambiguous. When $\psi'(\hat{\sigma}p) < \varphi'(\hat{\sigma}p)$, then this second effect enhances the influence of the first one, such that the net effect on the RHS of (4) is positive. Thus a sufficient condition for the plaintiff's marginal type to increase with his risk aversion is that $\hat{\sigma}p \leqslant Q$. II) When the plaintiff becomes more risk averse, there are also two effects on the equilibrium offer: all else equal, the anticipated utility of the marginal plaintiff decreases, which allows the defendant to reduce his offer; furthermore, the type of the marginal plaintiff may increase or decrease. Hence the result. ■

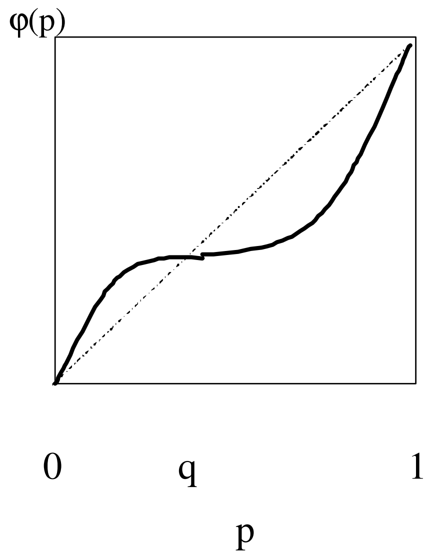
The fact that an increase in risk aversion may have an ambiguous effect on the predicted behavior of an individual is not new and has led to a lot of literature in insurance economics, portfolio choices and so on (see Ross (1981)) . However, what appears as a new result here is that the comparative statics of risk aversion depends on $\hat{\sigma}.p$, the initial prior of the marginal plaintiff and the way it affects the distorsion of probability. Consider the situation where the marginal plaintiff is weakly biased and assesses a small prior for his chances of prevailing, in the sense that $\hat{\sigma}p \leqslant Q$; then according to proposition 7, as he becomes more sensible to risk (more risk averse) such a plaintiff will be prone to settling the case as will do too some of the near-to-the-marginal-plaintiff individuals who previously prefer to go in front of the court. In contrast, when he marginal plaintiff is highly biased in the sense that $\hat{\sigma}p > Q$, then an increase in risk aversion suggests on the one hand that more plaintiffs accept to settle their case, and on the other that they become less sensible to the probability of prevaling, which implies that more plaintiffs may go to trial.

3 Extensions

We briefly sketch how the results extend to the case where the plaintiff exhibits preferences which are consistent with both the "possibility effect" and the "certainty effect". Then, we have a look at the case where the defendant is the informed party.

3.1 the "possibility effect" and the "certainty effect"

As previously recalled in the introduction, the empirical tests of the alternative theories of litigations have provided different estimates of the plaintiff's prevailing rate at trial. Priest and Klein (1984) and Waldfogel (1995,1998) concluded on $p = 50\%$. In contrast, Hughes and Snyder (1985) or Katz (1987) found that it more likely that $p \in [10\%, 20\%]$, depending on the nature of the civil litigation and on the fee-shifting rule. The figure of 50% is also suggested more recently by studies focusing on courts specialized in labor conflicts and/or dismissal law in Europe (Ichino, Polo and Rettore (2003), Marinescu (2005)), but other studies (Munoz-Perez and Serverin (2005) or Serverin (2000)) found that the prevailing rate of salaries in the case of Tribunal des Prud'hommes (a French juridiction specialized in labor conflicts) is less than 40%. In our setting where the attitude towards risk is captured by the properties of a probability transformation function, such a variability found in the empirical estimates for p is not inocuous. The reason is that another characteristic pattern of probability transformation exhibited in the experimental literature corresponds to the one represented in the next graph (Tversky and Fox (1995), Tversky and Kahneman (1992), Tversky and Wakker (1995)):



In other words, most experimental subjects are prone to overestimating small probabilities, and at the same time they underestimate the large ones[10]. Typically, for the representative probability weighting function, there exists a probability q (close to .3 in Tversky and Fox (1995)) for which the probability function satisfies $\varphi(q) = q$, and is concave (convex) for any $p < q$ (any $p > q$ respectively). As a result, individuals overreact to a given change in probabilities both in the neighborhood of 0 and 1, as compared to the same change for intermediate probabilities. In the

[10] As shown by Tversky and Kahneman (1992) such a shape for the probability transformation is the most relevant to explain why individuals display risk averse choices when confronted with a large probability of gain or a small probability of loss, and that at the same time they reveal risk-seeking attitudes when they face a low probability of gain or a large probability of loss.

limit, there are two cases for which individuals display an infinite sensibility to a change in the probability (*i.e.* for which $\varphi' \to \infty$): on the one hand, at the top of the interval of probabilities - this is the *certainty effect*, meaning that events associated to probabilities close to 1 are seen as sure event; on the other, at the bottom of the interval: this is the *possibility effect*, meaning that events with very small probability, close to 0, are understood as impossible events.

Such a pattern of behavior may be captured in the Yaari's model with a new assumption replacing assumption 1:

Assumption 3: $\exists q$, unique, with $a < q < b$, such that $\varphi(q) = q$ and satisfying $\forall p \in [0, q]$: $\varphi''(p) < 0$ and $\forall p \in [q, 1] : \varphi''(p) > 0$.

implying that plaintiffs do not have a constant attitude towards risk - they may be locally risk averse or risk-seeking depending on the risk they are facing. Accordingly, property 1 is replaced with:

Property 3[11]:

- in the interval $[0, q]$, the probability transformation function φ satisfies: $\varphi'(0) > 1$ although: $\varphi'(q) < 1$. By continuity, there exists a (unique) $q_0 \in]0, q[$ such that $p \leqslant q_0 \Rightarrow \varphi'(p) \geq 1$, but $p \geqslant q_0 \Rightarrow \varphi'(p) \leq 1$.

- in the interval $[q, 1]$, we have now: $\varphi'(1) > 1$ and by continuity, there exists a (once more, unique) $q_1 \in]q, 1[$ such that $p \geq q_1 \Rightarrow \varphi'(p) \geq 1$, but $p \leq q_1 \Rightarrow \varphi'(p) \leq 1$.

In the following, we assume that $q_0 > a$ and $q_1 < b$. In this case, it is obvious that condition (4) still holds, but the second order requirement would need to be more closely investigated: under assumption 3, several (local) extrema may be obtained given that the RHS in (4) is no longer monotonic in σ. Some may not be minima, and a multiplicity of (local) equilibria may occur: those satisfying $L''(s) > 0$. Thus in such a case the global minimum is by definition found by comparing the values obtained for $L(s)$ at these local minima. Anyway, proposition 1 is still relevant. As a result, proposition 3, 4, and 5 are still obtained. In contrast, the results of proposition 2 and 7 must be reassessed as explained in the next propositions. First, we study the impact of a change in p.

■ **Proposition 8:** *An increase in p:*

I) *decreases the marginal plaintiff and increases the probability of trial if* $\hat{\sigma}p > q$.

[11] The "possibility effect" is connected with the condition: $\varphi'(0) > 1 > \varphi'(q)$, while the "certainty effect" is reflected by: $\varphi'(1) > 1 > \varphi'(q)$.

II) *may increase or decrease the marginal plaintiff and the probability of trial if* $\hat{\sigma}p < q$.

III) *increases the equilibrium offer if the marginal plaintiff increases; otherwise it has an ambiguous effect on the equilibrium offer.*

Proof. As for proposition 2, the effect on the marginal type depends on the sign of:

$$-\hat{\sigma}\left[\left(\frac{G}{g}\right)_{|(\hat{\sigma})} \times \left(\frac{\varphi''}{\varphi'}\right)_{|(\hat{\sigma}p)} + \frac{1}{\varphi'(\hat{\sigma}p)p}\left(\varphi'(\hat{\sigma}p) - \frac{\varphi(\hat{\sigma}p)}{\hat{\sigma}p} + \frac{C}{\hat{\sigma}pD}\right)\right]$$

I) When we focus on the domain of probabilities where φ is convex, this term is negative since the bracketed term is positive as in proposition 2. II) In the area of probabilities where φ is concave, we have $\left(\frac{\varphi''}{\varphi'}\right)_{|(\hat{\sigma}p)} < 0$ and $\varphi'(\hat{\sigma}p) - \frac{\varphi(\hat{\sigma}p)}{\hat{\sigma}p} < 0$ but $\varphi'(\hat{\sigma}p) - \frac{\varphi(\hat{\sigma}p)}{\hat{\sigma}p} + \frac{C}{\hat{\sigma}pD} \gtrless 0$, implying that the sign of the bracketed term is ambiguous; thus the impact of an increase in p on the RHS of (4) may be now positive or still negative. III) The proof is the same as in proposition 2. ■

Now we investigate the impact on the equilibrium when the plaintiff experiences larger distorsion in his probability transformation function, defined in the following sense: we will say that plaintiff ψ exhibits more probability distorsion than plaintiff φ if:

- there exists a unique q satisfying: $\varphi(q) = q = \psi(q)$,

- in the interval $[q, b]$, ψ is more convex (more risk averse in the sense of Yaari-Roëll) than φ; this implies now $p > \varphi(p) > \psi(p)$,

- in the interval $[a, q]$, ψ is more concave (more risk seeking in the sense of Yaari-Roëll) than φ; this implies $p < \varphi(p) < \psi(p)$.

As a result, we have:

Property 4: there always exist two probabilities q_0 and q_1, with $0 < q_0 < q < q_1 < 1$ such that:

- for any $p \in]0, q[$: if $p \leqslant q_0 \Rightarrow \psi'(p) > \varphi'(p)$, but if $p \geqslant q_0 \Rightarrow \psi'(p) < \varphi'(p)$.

- for any $p \in]q, 1[$: if $p \geq q_1 \Rightarrow \psi'(p) < \varphi'(p)$, but if $p \leq q_1 \Rightarrow \psi'(p) > \varphi'(p)$.

In the following, we assume without loss of generality that $q_0 > a$ and $q_1 < b$.

■ **Proposition 9:** *As the plaintiff exhibits more probability distorsion:*

I) *the marginal plaintiff increases (hence the probability of trial decreases) if* $\hat{\sigma}p \in [q, q_1]$*, but decreases (hence the probability of trial increases) if* $\hat{\sigma}p \in [q_0, q]$; finally the effect is ambiguous if $\hat{\sigma}p \in [a, q_0] \cup [q_1, b]$.

II) *the equilibrium offer decreases if the marginal plaintiff decreases; otherwise, the effect is ambiguous.*

The proof is similar to the one in proposition 7.

The general conclusion of this paragraph is that, once we allow for the probability transformation function to capture the inversed-S shape displayed in experimental studies, then the results in comparative statics become less clear-cut. Not surprisingly, changes in p have similar effects to those of proposition 2 over the range where φ is convex. Obviously, the same result occurs comparing propositions 7 and 9. In contrast, where the probability weighting function is concave, both the increase in plaintiff's prevailing rate and the increase of distorstion on probabilities have imprecise effects.

3.2 the Defendant as the informed party

In this paragraph, we assume that the plaintiff's bias $\sigma_p(>1)$ is public information, σ_d the (risk neutral) defendant's bias is private information, but the plaintiff knows only that the defendant's self-serving bias is a random variable denoted $\sigma \in [c,d]$ where $c>0$, $d<1$, with a distribution described by the cumulative function $H(\sigma)$ and the density $h(\sigma)$. The negotiation game has also two main stages, after where Nature choses the type of the defendant σ and after where the plaintiff filed his case:

- In a first stage, the plaintiff makes a one-shot demand to the defendant, S, in order to reach a amicable settlement of the case.

- In the second stage, depending on his type, the defendant accepts the demand (thus, the case is settled) or rejects it, in which case parties go to trial.

Arguments similar to the ones previously developped show that for any demand S, the marginal defendant $\sigma(S)$ is indifferent between settling the case or going to trial, such that: $S=\sigma(S)pD+C_d$. The plaintiff anticipates that any defendant $\sigma \geqslant \sigma(S)$ will prefer to settle the case, whereas any defendant $\sigma < \sigma(S)$ will go to trial. Knowing this, it is possible to write the plaintiff's benefit function given that he is a risk averse individual[12]:

$$B(S)=\varphi(1-H(\sigma(S)))\times S+(1-\varphi(1-H(\sigma(S))))\times(\varphi(\sigma_p p)D-C_p) \tag{8}$$

This is to be maximized by the plaintiff in order to determine his best demand for an amicable solution of the case. It can be shown that an interior solution corresponds now to a demand S^*

[12] Basically, Yaari's decision makers give ranked evaluations of the prospects they face, implying that the general benefit function is:

$$B(S)=\begin{cases} (1-\varphi(H(\sigma(S))))\times S+\varphi(H(\sigma(S)))\times(\varphi(\sigma_p p)D-C_p) & \text{if } S<E(X) \\ \varphi(1-H(\sigma(S)))\times S+(1-\varphi(1-H(\sigma(S))))\times(\varphi(\sigma_p p)D-C_p) & \text{if } S>E(X) \end{cases}$$

However, $S<E\varphi(X)$ is not a correct conjecture for an interior separating equilibrium to arise here.

and a marginal defendant σ^* which are set according to the following conditions:

$$S^* = \sigma^* pD + C_d \tag{9}$$

$$\frac{\varphi(1-H(\sigma^*))}{h(\sigma^*)} = \varphi'(1-H(\sigma^*)) \times \left(\sigma^* - \frac{\varphi(\sigma_p p)}{p} + \frac{C}{pD}\right) \tag{10}$$

with a probability of trial $\pi^* = H(\sigma^*)$. We verify that (10) requires that the bracketed term in the RHS must be positive $\sigma^* - \frac{\varphi(\sigma_p p)}{p} + \frac{C}{pD} > 0$ for an interior solution to hold[13].

It is possible to show that as the plaintiff becomes more risk averse, then we also have the same kind of ambiguity that the one found previously, both for the impact on the marginal defendant or for the equilibrium demand. This is easily explained; remark that the LHS in (10) may be written as:

$$\frac{\varphi(1-H(\sigma^*))}{h(\sigma^*)} = \frac{1-H(\sigma^*)}{h(\sigma^*)} \times \frac{\varphi(1-H(\sigma^*))}{1-H(\sigma^*)}$$

On the one hand, the convexity of φ implies that $\frac{\varphi(1-H(\sigma^*))}{1-H(\sigma^*)} < 1$, and thus: $\frac{\varphi(1-H(\sigma^*))}{h(\sigma^*)} < \frac{1-H(\sigma^*)}{h(\sigma^*)}$; hence as the plaintiff becomes more risk averse, the LHS in (10) decreases. On the other hand, according to the properties of φ, we may have: $\varphi'(1-H(\sigma^*)) \gtreqless 1$: thus, the RHS may be raised or lowered - as a result, when the plaintiff becomes more risk averse, the net effect on the marginal type of the defendant is not defined on a priori grounds.

The same (qualitative) results as previously obtained also arise when p increases: the marginal defendant decreases (the probability of trial thus increases), but the effect on the equilibrium demand is ambiguous. Finally, we have the following new result:

■ **Proposition 10:** *An increases in* σ_p:

I) *decreases the marginal defendant (the probability of trial increases);*

II) *decreases the equilibrium demand.*

Proof. I) Straightforward since the RHS in (10) is decreasing in σ_p. As shown by (9), S^* depends on σ_p only through the effect on σ^*. ■

Part I) is essentially similar to the one of Farmer and Pecorino (2002), suggesting that the case with the defendant as the informed party is the dual of the case developped in section 2[14].

[13] In equibrium, it must be that $\hat{S} > \varphi(\sigma_p p)D - C_p$. Remark also that under assumption 1, the RHS in (10) is increasing in σ; but under assumption 1 and 2, the LHS is not monotonic in σ. Thus, the main difference with the case of the informed Plaintiff is that we may obtain now several (local) extrema not all being maxima; nevertheless a multiplicity of (local) equilibria may occur: those satisfying $B''(S) < 0$.

[14] See Daughety and Reinganum (1994) for such an analysis of the duality.

4 Conclusion

There is a longlasting debate in experimental economics concerning the relevant interpretation for the growing evidence that people proceed to probabilities transformation or manipulation in a way not consistent with rational inference and bayesian updating rules. On the one hand, for psychologists this reflects a kind of bounded rationality due to the presence of cognitive dissonance or inconsistency, revealing that people use heuristics rather than sophisticated processes for the assessment of their priors. On the other hand, other researches in social sciences argue that the systematic departure from bayesian inference exhibited in experimental situations does not necessarily rule out any explanation consistent with the theory of procedural rationality. Apart from probability manipulations reflecting human cognitive limits, it is also well documented that individuals display both a risk averse or risk seeking attitude. Specifically, such attitudes are commonly understood as rational ways of reasoning in face of a known risk. These two explanations are more complementary than rival, and they may be reconcilied; this paper is a proposal in this spirit. Regarding the outcome associated to a risky event, we have assumed that individuals assess their beliefs using a two-stage process. First, when objectively given to individuals, the probabilities may undergo a first "psychological" process of updating, according to which they pass a test of internal concistency with more general beliefs sustained by the individual. Once these new priors are obtained, they are weighted according to the risk of the situation and the preferences (attitude) towards risk of the individual.

Two main conclusions may be drawn. The first one is that the assumption of risk aversion (and *a fortiori* the more general one according to which individuals have an inversed S-shape probability weighting function), seems to have more dramatic consequences than the self-serving bias assumption. This must be understood in the sense that changes in the former are less predictable than shifts in the latter, which are generally intuitive and consistent with those of the optimistic theory of litigations. The results often depend on the risk assessment at trial performed by the marginal plaintiff, namely $\hat{\sigma}p$, and thus it appears that the analysis is very sensible both to the specific value of the self-serving bias, and to the specific shape of the probability transformation function. A large value of $\hat{\sigma}$ will translate into an intermediate probability p towards the domain of large values of probabilities. A small value of $\hat{\sigma}$ may lead to the opposite effect. In a way, and this is the second conclusion, reconciling the optimistic and strategic theories of litigations also requires that behavioral law and economics design a new agenda of research and move towards more quantitative analysis.

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