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Abstract

This paper studies an economic model of the Negligence rule and considers litigation between a defendant and a plaintiff, under the assumption that the plaintiff may not perfectly observe the defendant's action *ex post*. We consider the noiseless case as a benchmark that the plaintiff perfectly observes the defendant action *ex post*. We show in the noiseless case that the defendant surely takes care and in the noiseless case that there is no equilibrium in which the defendant surely takes care. This result implies that even if the noise is sufficiently small, the situation can not be approximated by the noiseless model. Moreover, we show that punitive damages induce the defendant to make overdeterrence.

KEYWORDS: Negligence rule, Imperfect observability, Incentive for care, Punitive damages
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1 Introduction

This paper studies an economic model of the Negligence rule. Under the Negligence rule, a (potential) victim who suffers a loss must attest to all of the following: (1) the occurrence of the damage, (2) the negligence of a (potential) injurer, and (3) a causal relationship between his negligence and the damage. This rule imposes severe burdens on the plaintiffs, and most of plaintiffs might have to take the damage lying down, since there is asymmetric information between the defendants and the plaintiffs.[1]

So far, most of the literatures on the Negligence rule have shown that the Negligence rule is desirable, *i.e.*, the Negligence rule induces the defendant to take care.[2] We explains that the defendant does not necessarily takes care. We introduce two important factors: imperfect observability and the process of litigation, incorporating pretrial negotiation. Imperfect observability means that the plaintiff cannot perfectly observe the defendant's action *ex post*. The plaintiff finds some evidence and we call the evidence a *signal*. The signal are mutually related to the defendant's action and it is noisy.

We consider the noiseless case as a benchmark that the signal perfectly informs the plaintiff of the defendant's action.[3] In the noiseless case, we get a different result from the one in the noisy case. In the noiseless case, if the plaintiff observes the "wrong" signal, she brings a suit against the defendant since the signal implies that he surely did not take care. Thus, the Negligence rule gives the defendant a stronger incentive to take care. In the noisy case, the defendant has no incentive to take care if the plaintiff always accepts the defendant offer, whose offer is equal to 0. Therefore, the plaintiff must reject the defendant's offer with some probability.

This paper is organized as follows. Section 2 constructs the model of the Negligence rule, incorporatign pretrial negotiation. In section 3, we analyzes the noiseless case as a benchmark. Section 4 investigates the noisy case, and section 5 gives the concluding remarks.

[1] For example, consider product failure. The technology of the product, as well as its production process, might be unknown to the victims.

[2] see, Brown (1973), Shavell (1983), *etc.*

[3] For example, if the manufactured goods have a simple structure, plaintiffs can easily prove the defendant's negligence. In this case, we may consider the situation as the noiseless case. For goods with a complicated structure, however, it is difficult for the plaintiffs to determine the cause of the accident, so we rather have a noisy case. Since, as a trend, the structure of goods is getting more and more complex, we regard the noiseless case just as a benchmark.

2 The Model

All actors are risk neutral: potential victims (plaintiffs) who suffer losses from accidents and potential injurers (defendants). The structure of the game is divided into two stages: a deterrence stage and a settlement stage.

In the deterrence stage, each party decides the deterrence action C or N without observing an opponent's action, where C denotes an action that a party takes care and N denotes that a party does not take care. The defendant and the plaintiff must pay the additional deterrence cost $x > 0$ and $y > 0$ respectively when they takes care. The game ends if no accident which injures the plaintiff occurs. If the accident occurs, the game reaches the next stage.

The probability with which an accident occurs depends on both parties' action and is denoted by α_{ij}, where i means the defendant's deterrence action and j means the plaintiff's deterrence action. We assume that probabilities satisfy the following inequalities:

$$\alpha_{CC} < \alpha_{CN} < \alpha_{NN}, \quad \text{and} \quad \alpha_{CC} < \alpha_{NC} < \alpha_{NN}.$$

When an accident occurs, the plaintiff suffers the damage $L > 0$ from accident. We assume that both parties know the damage.

After the plaintiff suffered the damage, she obtains some evidence which indicates the defendant's action. We call the evidence the *signal*.[4] There are two signals c and n, where c is the signal that the defendant took C, and n is that he took N. Those signals are with the noise. If the defendant chooses C, the signal c is observed by the plaintiff with a probability $1 - \varepsilon$, whereas the signal n is observed with the remaining probability $\varepsilon \in (0, 1/2)$. If the defendant chooses N, the signal n is observed by the plaintiff with a probability $1 - \varepsilon$, and the signal c is observed with the remaining probability.

We assume that after the plaintiff observed either the signal c or n, parties can settle out of court without additional costs. The defendant makes an *take-it-or-leave-it offer* $\overline{s} \in [0, \infty)$. The plaintiff decides whether to accept or reject it. If the plaintiff accepts his

[4] In some cases, the signal may be observed by the plaintiff before an accident occurs. Consider the situation where an accident occurs immediately after the defendant observes the signal. Then, the plaintiff cannot change her action. Therefore, the above situation can also obtain the same result as the case where the plaintiff observes the signal after an accident occurs. In other words, if we consider the situation in which the plaintiff chooses her first action and cannot change it, then the result is tantamount to observing the signal after an accident occurs.

offer, the defendant pays $\overline{s}$ to the plaintiff and the game ends. If the plaintiff rejects it, the case goes to trial.

Litigation is costly. Let t_D (t_P) > 0 be the defendant's (plaintiff's) cost of litigating. We assume that the court is omnipotent in that it can correctly observe their action in passing judgment on a case. If the judgment is in favor of the plaintiff, she receives a fixed amount of awards $W_k,\ k \in \{C, N\}$, depending on the defendant's deterrence action and $W_C \leq W_N$. We also assume $W_C - t_P > t_D$ not to trivially analyze.

We formalize their payoffs in this game. First, consider the payoffs when an accident does not occur. If the defendant (the plaintiff) takes C, he (she) pays the deterrence cost x (y). If the defendant (the plaintiff) takes N, he (she) pays nothing, *i.e.*, his (her) payoff is equal to 0. Next, given that an accident occurred, we consider their payoff. If the plaintiff rejects the defendant's offer and the plaintiff wins the case, the defendant pays $\tau(a_D)x+(W_k+t_D)$ and the plaintiff receives $-\tau(a_P)y+W_k-t_P-L$, where $\tau(\cdot)$ is a function such that $\tau(C) = 1$ and $\tau(N) = 0$. $a_i,\ i \in \{P, D\}$ denotes the party's deterrence action, where D denotes the defendant and P denotes the plaintiff. If the plaintiff rejects the defendant's offer and the plaintiff loses, the defendant pays $\tau(a_D)x + t_D$ and the plaintiff's payoff is $-\tau(a_P)y - t_P - L$ respectively. If parties reach settlement, the defendant pays $\tau(a_D)x + \overline{s}$ and she gets $-\tau(a_P)y + \overline{s} - L$.

Which side wins is provided by the Negligence rule. The Negligence rule signifies that the defendant is liable if he fails to comply with due-care standard, which is defined by the following equation[5]:

$$x \leq (\alpha_{NC} - \alpha_{CC})L. \tag{1}$$

3 The Noiseless Case

In this section, we analyze the noiseless case ($\varepsilon = 0$) as benchmark. In this case, after the plaintiff observed the signal, she can accurately know the defendant's action. Therefore, the plaintiff observes the signal c when the defendant takes care, and she observes n when he does not take care.

[5]We call this standard the expanded Hand formula. This formulation of the negligence standard was first stated by Judge Learned Hand in United States v. Carroll Towing Co., 159F. 2d 169 (2d Cir. 1947). The Hand formula is as follows: $x < \alpha L$, where α denotes the probability of occuring an accident. In this paper, we analyze the situation in which the accident occurs even if both parties take care. Therefore, we use the extended Hand formula as $x \leq (\alpha_{NC} - \alpha_{CC})L$

We examine the condition in which there exist Perfect Bayesian equilibria where each party chooses C with the positive probability. The plaintiff's deterrence cost y may be small: for example, the consumer puts a milk pack into a refrigerator. Therefore we assume that y is small and the plaintiff takes care.[6]

Intuitively, an equilibrium in which both parties take care exists only when both x and y are not too large. The following result gives a complete characterization for the range of x which the defendant takes care.

Proposition 1. *A Perfect Bayesian equilibrium where the defendant takes care exists if and only if*

$$x \leq \alpha_{NC}(W_N + t_D). \tag{2}$$

On the equilibrium path, the defendant takes C and offers $\overline{s} = 0$. The plaintiff takes care and accepts his offer.

Proof. All proofs are provided in Appendix. ■

On the equilibrium path, both parties takes care. Hence, the defendant wins the case if it goes to trial. This implies that the defendant offers $\overline{s} = 0$, and the plaintiff accepts his offer. The incentive for the defendant to choose C have no change when W_C increases. This is because the defendant wins the case if he takes care. If W_N increases, the expected cost to deviate N for defendant raises. Therefore, the defendant strengthens the incentive to choose C. This result is the same as that of Polinsky and Rubinfeld (1988), who concluded that by positively adjusting W, the injurer has a stronger incentive to choose C under Neg.

The situation where $W_N > L$ is interpreted as "*punitive damages*". Punitive damages also give the defendant with greater deterrence cost the incentive to take care. From (2), however, the adoption of punitive damages gives the defendant the excess incentive to take care. The court must order W_N smaller than L to make only the defendant with the deterrence cost who satisfies Hand Formula take care.

Corollary 1. *The award W_N must be the following:*

$$W_N = \frac{\alpha_{NC} - \alpha_{CC}}{\alpha_{NC}} L - t_D$$

[6]The condition which the plaintiff takes care is provided in Appendix.

4 The Noisy Case

In this section, we analyze the noisy case, *i.e.* when the plaintiff does not perfectly observe the defendant's action *ex post*. We may think that the results in the noiseless case have no change in the noisy case if the noise ε is sufficiently small. However, we show that its inference is incorrect. As in previous section, we show that an equilibrium where the defendant takes C exists.

Proposition 2. (*i*) *A Perfect Bayesian equilibrium where the defendant takes C exists if and only if*

$$x < \alpha_{NC}(1-\varepsilon)(W_N + t_D) - \alpha_{CC}\varepsilon t_D. \tag{3}$$

On the equilibrium path, the defendant chooses C with probability λ and offers $\overline{s} = 0$. The plaintiff takes care and accepts his offer when she observes the signal c, and rejects with probability p when she observes the signal n:

$$\lambda = \frac{\alpha_{NC}(1-\varepsilon)(W_N - t_P)}{\alpha_{NC}(1-\varepsilon)(W_N - t_P) + \alpha_{CC}\varepsilon t_P}, \tag{4}$$

$$p = \frac{x}{\alpha_{NC}(1-\varepsilon)(W_N + t_D) - \alpha_{CC}\varepsilon t_D}. \tag{5}$$

(*ii*) *A Perfect Bayesian equilibrium where the defendant takes C exists if and only if*

$$\alpha_{NC}(1-\varepsilon)(W_N + t_D) - \alpha_{CC}\varepsilon t_D < x < \alpha_{NC}(W_N + t_D) + \alpha_{CC}t_D, \tag{6}$$

On the equilibrium path, the defendant chooses C with probability λ and offers $\overline{s} = 0$. The plaintiff takes care and rejects his offer with probability p when she observes the signal c and rejects when she observes the signal n.

$$\lambda = \frac{\alpha_{NC}\varepsilon(W_N - t_P)}{\alpha_{NC}\varepsilon(W_N - t_P) + \alpha_{CC}(1-\varepsilon)t_P}, \tag{7}$$

$$p = \frac{x + \alpha_{CC}\varepsilon t_D - \alpha_{NC}(1-\varepsilon)(W_N + t_D)}{\alpha_{NC}\varepsilon(W_N + t_D) - \alpha_{CC}(1-\varepsilon)t_D}. \tag{8}$$

In the noiseless case, the defendant surely takes care under the Negligence rule. However, in the noisy case, there is only the equilibrium in which the defendant takes care with probability λ. If the defendant offers $\overline{s} > 0$, the plaintiff believes that he did not take care, so that the defendant offers $\overline{s} = 0$. If the plaintiff always accepts the defendant's offer $\overline{s} = 0$, the defendant has no additional cost even if he does not take care. Therefore, the defendant has no incentive to take care. This implies that the plaintiff must reject $\overline{s} = 0$ with the positive probability.

From Proposition 2, the following result holds.

Corollary 2. *Under the Negligence rule, the defendant with the deterrence cost who satisfies Hand Formula necessarily does not take care.*

Corollary 2 implies that the defendant does not necessarily take care even if *punitivi damages* is adopted.

5 Concluding Remarks

This paper studied an economic model of the Negligence rule. We showed that under the Negligence rule, the defendant surely takes care in the noiseless case whereas the defendant takes care with some probability in the noisy case. This implies that even if the noise is sufficiently small, the situation can not be approximated by the noiseless case, and suggests to the importance of explicitly analyzing the model with imperfect observability.

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Appendix

Proof of Proposition1. We characterize a Perfect Bayesian equilibrium in the noiseless case. In the noiseless case, the plaintiff perfectly observes the defendant's deterrence action after she received the signal.

If the defendant takes care, he is not liable. Given that the defendant takes care and an accident occurs, therefore, it is optimal for him to offer $\overline{s} = 0$. If the case goes to trial, the plaintiff loses the case and she pays t_P. Therefore, the plaintiff accepts the defendant's offers $\overline{s} = 0$.

Given that the defendant does not take care and accident occurs, the defendant is liable. If the case goes to trial, the plaintiff wins the case, and the defendant incurs $W_N + t_D$, and the plaintiff receives $W_N - t_P$. Therefore, it is clearly optimal for the defendant to offer $\overline{s} = W - t_P$ and for the plaintiff to accept his offer.

Given that both parties' strategy in litigation stage and the plaintiff takes care, the expected cost for the defendant is equal to x if he takes care. On the other hand, the expected cost for the defendant is equal to $\alpha_{NC}(W_N + t_D)$ if he does not take care. Therefore, the defendant takes care if and only if (2) holds. Give that both parties' strategy in litigation stage and the defendant takes care, her payoff is equal to $-y - \alpha_{CC}L$ when the plaintiff takes care. When the plaintiff does not take care, her payoff is equal to $-\alpha_{CN}L$. Therefore, the plaintiff takes care if and only if

$$y \leq (\alpha_{CN} - \alpha_{CC})L.$$

■

Proof of Proposition2. Under the Negligence rule, the defendant wins the case if he takes care. Therefore, the plaintiff believes that the defendant does not take care if the defendant's offer is not equal to 0. Give that the plaintiff takes care and is offered $\overline{s} = 0$, her belief is the following when she observes the signal c and n respectively:

$$\mu\ (C, c, 0) = \frac{\lambda\alpha_{CC}(1-\varepsilon)}{\lambda\alpha_{CC}(1-\varepsilon) + (1-\lambda)\alpha_{NC}\varepsilon} \equiv \mu^c, \tag{9}$$

$$\mu\ (C, n, 0) = \frac{\lambda\alpha_{CC}\varepsilon}{\lambda\alpha_{CC}\varepsilon + (1-\lambda)\alpha_{NC}(1-\varepsilon)} \equiv \mu^n, \tag{10}$$

where λ is the probability with which the defendant takes care. These beliefs imply that the plaintiff's inference that the defendant took care is relatively high when she observes the signal c, and her inference that the defendant did not care is relatively high when she observes the signal n. Therefore, we consider the following case in litigation stage: (i) $(A,\ (1-p)[A] + pR)$, (ii) $((1-p)[A] + p[R],\ R)$, (iii) $(A,\ A)$, (iv) $(A,\ R)$, (v) $((1-p)[A]+p[R],\ (1-p)[A]+p[R])$, (vi) $(R,\ R)$, where the first component of parenthesis is the plaintiff's action when she observes the signal c, the second component is her action when she observes the signal n, and p is the probability with which the plaintiff rejects the defendant's offer. A means the plaintiff "Accept" the defendant's offer and R means "Rejects" it.

We show that only the case (i) and (ii) become a Perfect Bayesian equilibrium in which the defendant takes care. If the plaintiff always accepts the defendant's offer, it is obvious that the defendant have no incentive to take care. Therefore, the case (iii) is no Perfect Bayesian equilibrium. In the case (iv), the plaintiff must have the belief $\mu^c = 1$ and

$$\mu^n \leq \frac{\lambda \alpha_{CC} \varepsilon}{\lambda \alpha_{CC} \varepsilon + (1-\lambda)\alpha_{NC}(1-\varepsilon)}.$$

This implies that the defendant takes care with the probability

$$\frac{\alpha_{NC}\varepsilon(W_N - t_P)}{\alpha_{NC}\varepsilon(W_N - t_P) + \alpha_{CC}(1-\varepsilon)t_P} \leq \lambda \leq 1$$

The defendant becomes indifference between C and N, *i.e.*, $x = \alpha_{NC}(1-\varepsilon)(W_N + t_D) - \alpha_{CC}\varepsilon t_D$. This is knife-edge case and we regard this case as no Perfect Bayesian equilibrium. The case (v) implies that the signal has no worth and (v) is no Perfect Bayesian equilibrium. It is easy to proof that the case (vi) is knife-edge case and no Perfect Bayesian equilibrium.

(i) We show behavioral strategies of both parties in litigation stage.

The plaintiff must accept the defendant's offer such that he become indifferent between taking care and no care when she observes the signal n:

$$x + \varepsilon \alpha_{CC} p t_D = \alpha_{NC}(1-\varepsilon)p(W_N + t_D).$$

Therefore, the plaintiff rejects the defendant's offer with the probability p, which holds (5), and the defendant's deterrence cost holds (3).

The defendant must be indifferent between the plaintiff accepts and rejects the offer:

$$0 = -\mu^n t_P + (1-\mu^n)(W_N - t_P). \tag{11}$$

From (10) and (11), the defendant takes care with the probability λ, which holds (4).

(ii) As in (i), the plaintiff offers $\overline{s} = 0$ in equilibrium. The plaintiff must accept the defendant's offer such that he become indifferent between taking care and no care:

$$x + \alpha_{CC}(1-\varepsilon)p t_D + \alpha_{CC}\varepsilon t_D = \alpha_{NC}\varepsilon p(W_N + t_D) + \alpha_{NC}(1-\varepsilon)(W_N + t_D),$$

Therefore, the plaintiff rejects the defendant's offer with the probability p, which holds (8), and then the defendant's deterrence cost holds (6).

The defendant must be indifferent between the plaintiff accepts and rejects the offer:

$$0 = -\mu^c t_P + (1-\mu^c)(W_N - t_P). \tag{12}$$

From (9) and (12), the defendant takes care with the probability λ, which holds (7).

■