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STRICT LIABILITY VS NEGLIGENCE: IS ECONOMIC EFFICIENCY A RELEVANT COMPARISON CRITERION?

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Strict Liability vs Negligence:
Is Economic Efficiency a Relevant Comparison Criterion?

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Summary:

The efficiency criterion (the highest care level at the lowest accident cost) indisputably governs the comparison of performance between strict liability and negligence. This view stems from the standard accident model development in the 70's and the 80's that ensures under ideal conditions, the equivalence between regimes and assume their potential substitutability. We develop a more general accident model (under risk universe) with divergent views among the parties about the damage. It follows that efficiency is no longer a relevant criterion. liability regimes belong to specific fields: Ultra-hazardous activities for strict liability and the remaining areas of negligence.

JEL codes: D62, K13, K23, K32, Q52, Q58.

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1. Introduction

In the late nineteenth and early twentieth century onward, in Western countries, tort law evolved by including no-fault liability aside fault-based regimes. This move concerned all industrialized countries ruled either by common law or by continental law. Recall that tort liability obliges wrongdoers to repair damage, losses, prejudices, harm they cause to others. Civil fault (generically called here negligence) involves a "man-made fact", that ranges from intentional faults to faults of imprudence or negligence and may be hard and costly to prove for victims The industrialization process developed strict liability regimes and associated insurance systems (accidents at work, transport accidents in particular) that oblige compensating victims without involving the managers' (or firm owners') personal fault. Strict liability does not require a proven fault and has no exonerating effect.

Ronald Coase (Coase (1960) and Gino Calabresi (1961)) renewed the economics of tort law. A significant trend of its large fields compares strict liability regimes and negligence rule on the basis of their respective economic performance. The point is to minimize the primary accident costs (the prevention and the average expected cost of an accident), the secondary costs" (the equitable loss spreading) and the tertiary costs (the administrative costs) (Calabresi, 1977, pp. 24 ff).

As a by-product, tort law induces the potential wrongdoers to ensure the highest prevention level at the lowest accident costs. In this aim, Brown (1973), Diamond (1974a, 1974,b), Shavell (1980, 1987) or, still, Posner and Landes (1987), developed a standard or canonical accident model (CAM in the following). This model is "unilateral" when the victims cannot protect themselves from the tortfeasor's action, while it is "bilateral" when they can. The CAM considers that all parties are rational, Savage expected utility maximizers and neutral to risk. The victims' utility depends on the injurer's care effort (unilateral model) or of both (injurer and victim) (bilateral version). In the CAM, the accident probability distribution and the damage scale are common knowledge. The model shows that:

1) Under strict liability, the injurer chooses the care level that minimizes his expected accident cost. This level corresponds to the socially first-best care level.

2) Under negligence, a rational wrongdoer sets up his (her) own optimal care level to the social optimum care level as under strict liability.

3) Consequently, negligence and strict liability are equivalents (Shavell (1987)).

Economic performance is the basic criterion that allows comparing liability regimes. This basis appears as an indisputable and "natural" rule. Indeed, for all kind of following models that either complete or criticize the CAM because of its lack of realism, neither puts into question this performance rule. For instance, Shavell (1982) introduced risk-aversion utility functions and designed an insurance system that restores the basic model results. In the mid-2000s and beyond, several authors questioned the CAM's basic foundations. Teitelbaum (2007)'s pioneer paper considers that the ultra-hazardous activities are not characterized by risk, but by radical uncertainty and the wrongdoer's utility function integrates the aversion for ambiguity. Then, under uncertainty:

(a) Regardless of the regime, the socially optimal level of prevention no longer corresponds to the effective level that the wrongdoer set up.

(b) The liability regimes are no longer equivalent. Following the models, either strict liability dominates negligence or the other way around.

According to their promoters, models with radical uncertainty would better integrate the real-world's imperfections. However, even if they focus on the CAM's lack of realism, they all accept to compare strict liability and negligence comparison on the base of their respective performance. Hence, the authors agree with the CAM basic foundations and its basic results. However, each new model defines its own view about the agents' beliefs, the kind of uncertainty, etc. Each one defines the best liability regime the government should enforce, but no consensus exists among the critical models that do not put into question the legitimacy of the efficiency rule concerning the liability regimes. Consequently, even if their critics are strong, they do not challenge the internal structure of the basic model and their critics remain external to it.

The present paper considers that the efficiency criterion cannot help choosing between liability regimes. The root of this comes from the CAM adoption as benchmark. However, this model lies on very restrictive and strong assumptions. Relaxing these assumptions while remaining within the risky framework (excluding radical uncertainty) leads to the development of unparalleled liability regimes.

We develop our proof by extending the CAM on less stringent assumptions but by keeping the agent's Expected Savage Utility function and neutrality to risk. The difference with CAM is that here, ex-ante, victims and wrongdoer do not share identical damage assessment by forming his/her own evaluation. This assumption stays in line with the Bilateral Externality Models based on the benefit-cost analysis from which CAM originates. Hence, in these models each agent (polluter and victims) reveals his/her preferences to a benevolent regulator that

aggregates individual utility functions and calculates the equilibrium values (Viner (1931), Meade (1952), Baumol et Oates (1993) for instance). Then, the equilibrium solution equalizes the marginal cost of damage for the Society and the injurer's marginal benefit. In the CAM, this process involves determining the socially optimum care level. Consequently, divergent opinions about damage assessment does not involve a change in the accident model methodology based on risk. It follows that, now:

a) Under strict liability, the injurer's optimum level of care diverges from the socially first-best level of care,
b) Under negligence, potentially, several socially optimal care level may be distinguished,
c) Structurally, there is no longer equivalence between both regimes.

The main consequence is that negligence and strict liability apply to different fields as lawyers showed it for years. Strict liability should rule abnormal risky activities while negligence concerns less risky activities. Currently, Courts (or legislation) apply strict liability to agents that have engaged in the exploitation, use or treatment of abnormally hazardous activities (see Cantú (2001)). The new technologies and risks emergence lead to sudden accidents and pollution with unknown consequences. Mostly, harm arises without tortuous intention or negligence. It remains to economists to define a relevant cost-benefit methodology for each field.

The paper is organized as follows. Section two presents a generic unilateral accident model in a risky environment with risk-neutral agents that includes the CAM. Section three analyzes the consequences of divergent opinions on the damage scale under strict liability, and we proceed the same in section four for negligence. A last section studies two streams of literature: the question of the Courts' erring in defining compensation and damage and the consequences of introducing uncertainty in the standard unilateral accident model.

2. A Basic generic unilateral accident model under a risky background

- Let be two representative agents, a potential tortfeasor (he), indexed by I, and a potential victim (she) indexed by V.
- The wrongdoer and the victim are Savage Expected Utility maximizers, risk neutral and $\Psi(.), \phi(.)$ are, respectively, their utility function.
- $u, u > 0$ and $v, v > 0$ are correspondingly the wealth level of the injurer and the victim.

- L_I, L_V: The injurer and victim's assessment concerning the expected damage ($L_I \gtreqless L_V$) if L is the maximum value of the harm, by assumption, $(u > L)$. This means that the injurer is never judgment-proof and can always compensate or repair the damage he is responsible as in the CAM.
- We consider two states of nature: i) the occurrence of an accident (indexed by a) and ii) the business as usual case (no accident) ($\overline{a}$), and two moments $\tau = 0,1$, i.e. an "ex-ante" (moment 0) where the agents make their choice. Then, the effective state that Nature chooses (moment 1): accident or not.
- By assumption, the injurer chooses ex-ante the care level $x, x \geq 0$. It follows that the agents' utility functions depend on x, with $\Psi(x)$ (for the injurer) and $\phi(x)$ (for the victim).
- The choice of x reduces the probability of an accident $p(x)$ with:
  $p'(x) < 0, p''(x) \geq 0, 1 - p(x)$ the probability of no accident and, $p(0) = 1$.
  A benevolent regulator calculates and provides the "official accident probability distribution.

2.1 A generic accident model in a risky environment

The CAM's theoretical roots belong to the bilateral negative externality models conceived by Viner (1931), Meade (1952), Baumol et Oates (1993). A negative externality appears when an agent undesirably influences other agents' welfare and, thus, decreases the victims' utility. This action undesirably influences the social welfare that a benevolent regulator is in charge to restore. This leads him defining an optimal emission level that equalizes the marginal cost of damage of enduring one more unit of pollutant and the producer's marginal benefit. The regulator builds the social welfare function by adding the agents' individual utility function.

The generic accident model works on a similar scheme with the difference that the negative externality is random (see Shavell (1982) or Shavell (1987) for a global presentation). For instance, Shavell (1987, p.34, fn 50) says: "*Under current assumptions, minimizing* $x + l(x)$ *(*$x + Lp(x)$ *in our notation) is equivalent to maximizing the sum of injurers' and victims' expected utilities: since parties's level of activity are taken as fixed, Exp (2.1) (i.e.* $x + Lp(x)$ *in our notation) measures the reduction from what the sum of their expected utilities would otherwise be*."

The payoff or utility functions depend on the liability regime that the regulator enforces. Briefly, strict liability holds the defendant liable for the victim's damages once the victim proves causation between the accident and the activity whatever the prevention means that the

defender settled. Negligence is engaged when the victim further proves that the defendant was at fault by not taking reasonable care to avoid the accident. Then, k will be the index corresponding to the present liability regime, $k = \{strict\ liability\ (SL),\ negligence(NR)\}$.

The agents maximize their utility functions in $\tau = 0$, considering the future period $\tau = 1$ where an accident may happen or not. The potential injurer chooses a care level x to prevent an accident occurrence according the two potential states of nature: $A = \{\overline{a}, a\}$ considering the current liability regime k, $k = \{(SL),\ (NR)\}$.

- $\phi_{\tau=0}(x|a,k)$ is the victim's utility function conditional to an accident occurrence in time 0, under the liability regime, $k = \{(SL),\ (NR)\}$ where:

(1) $\phi_{\tau=0}(x|a,k) = v - L_{V\tau=0}(k)$

$L_{V\tau=0}(k)$ is the victim's expected loss given the k liability regime after an accident occurrence.

- $\phi_{\tau=0}(x|\overline{a},k)$ is her utility function $\phi(x|\ \overline{a},k,0)$ when no accident happens:

(2) $\phi_{\tau=0}(x|\overline{a},k) = v$

Then, given the accident probability distribution, the victim's Savage expected utility function expresses as:

$$\phi_{\tau=0}(x,k) = \phi_{\tau=0}(x|\overline{a},k)\big(1 - p(x)\big) + \phi_{\tau=0}(x|a,k)p(x)$$
$$= v\big(1 - p(x)\big) + (v - L_{V\tau=0}(k))\ p(x)$$

(3) $\phi_{\tau=0}(x,k) = v - p(x)L_{V\tau=0}(k)$

By the same argument we can express the injurer's payoff:

(4) $\Psi_{\tau=0}(x,k) = u - x - p(x)L_{I\tau=0}(k)$

$L_{I\tau=0}(k)$ is the injurer's assessment of the damage cost that he may provoke. Knowing the agents' expected utility function, we can deduce the Social Expected Welfare function, $ESW_{\tau=0}(x,k)$ built by aggregating both functions:

(5) $ESW_{\tau=0}(x,k) = \phi_{\tau=0}(x,k) + \Psi_{\tau=0}(x,k) = u + v - x - p(x)(L_{I\tau=0}(k) + L_{V\tau=0}(k))$.

Note that as the agents assess differently their expected losses, it follows there is no agreement about what the ex-ante damage function should be $(L_{I\tau=0}(k) \lesseqgtr L_{V\tau=0}(k))$. Equation (5) make the generic accident model very close from the bilateral negative externality one[2].

[2] See also Mas-Colell, Whinston, and Green, (1995 chap.11).

2.2 The regulator's status

After an accident, the court assesses the injurer's potential liability, the damage scale and the value of repairs. However, the court cannot define ex-ante standards or rules except by its past case law. Consequently, a benevolent regulator cannot directly hinder in the contention between victim and wrongdoer. Ex-ante, it enforces a current liability regime, and in real world it may set standards, permits or allowance. In the theoretical world, it may aggregates the agent's preferences to determine the socially optimal prevention level as show it Newman, and Wright, (1990): "*The social welfare maximization problem is provided so that the social welfare maximizing level of care can be compared with the care taken under strict liability. A social planner would maximize a weighted average of the victim's and the principal's utility functions. This is equivalent to maximizing one party's expected utility subject to the other earning his reservation level of utility as in Shavell* (1982)". Indeed, for Shavell (1982 p.123) the regulator is « *an omniscient and benevolent dictator*" that "*solves the accident problem*". However, he disposes of no means to induce the agents to enforce the Pareto-efficient solution and the liability regimes. An insurance system should do so (Shavell (1982)).

3. Strict liability and divergent views on the damage scale

The CAM assumes that the victim and the injurer assess identically the damage scale. Does this mean that only one opinion prevails, for instance the injurer's one or the victim's one? Or, does this refer to an implicit ex-ante harmonization between the agent's beliefs? To deal with the point, let us analyze what happens after an accident occurrence.

In Kaplow and Shavell (1996), the injurer plays a central role by adapting the care level to the degree of his knowledge about damage. The authors compare the social value of assessing accurately a damage, and the litigants' gain by devoting resources toward proof of damages. It follows that the relationships between injurers and victims covers a large spectrum of different situations:

"*Assessment of damages is often a principal issue in litigation because the primary objective of the plaintiff usually is to collect as much as possible and that of the defendant is to pay as little as possible. Accordingly, litigants frequently devote substantial time and effort attempting to establish the level of harm. In light of this, the question naturally arises concerning the underlying social purpose of accurate determination of harm*." Kaplow and Shavell (1996, p. 191). (See also Shavell (1987)).

Whether ex-ante or ex-post, reaching unanimous agreement between the victim and the wrongdoer is a particularly difficult task (see Cozzani and Salzano (2004)). A greater precision

about damage encourages wrongdoers to supply the right care (Kaplow and Shavell (1996)). However, accuracy has no social value when damage is impossible to assess because the agents do not increase safety. For instance, drivers adopt a careful driving because the potential victims damage is unknown ex-ante.

For Kaplow and Shavell (1996), accuracy depends on the agents' available information and the resources they spend to acquire it. Then, without specific incentive to disclose the actual accident costs, the average cost remains the main criterion for choosing the prevention level regardless of the victims' assessment. If this cost is neither observable nor knowable, then, the troublemaker and the court should not to seek additional information. However, under strict liability, it is more important to know whether the wrongdoer is a priori solvent than knowing the socially optimal care. Of course, the higher the accuracy of the damage, the closer the level of prevention will be to its optimal level.

Nevertheless, it is the utmost importance for victims knowing whether the court fully considers their loss (Shavell (1987)). CAM assumes that victims raise no doubts and are certain that the repairs will be complete. Indeed, by adapting equation (3), under strict liability, the victim perfectly knows that she will not suffer any harm (as $L_{V\tau=0} = L_{V\tau=1} = 0$) (index k is omitted):

(6) $\phi_{\tau=0}(x) = v - p(x)(L_{V\tau=0} = 0) = v$

Reaching this point, remark that:

i) In the CAM, the victim knows that the injurer is never judgment-proof,

ii) All parties agree about the damage scale,

iii) Ex-ante, the victim perfectly knows that repair fully covers her losses.

Then, the CAM's structure involves that accepting points i) and ii) means implicitly validating iii). Then, iii) is much important than agreeing or disagreeing about the assessment of damage. We can establish proposition 1:

Proposition 1: *Under strict liability, with risk-neutral Savage utility maximizer agents, the sufficient and necessary condition for making equal the socially first-best level of care and the private optimal defendants' one is that the victim knows with certainty that the injurer compensate fully her losses.*

This result is independent whether both parties agree or not on the level of damage.

Proof in appendix 2.

Proposition 1 means that the equality between social and private care level in the CAM comes, first, from the victim's certainty that the injurer will always compensate her losses and,

second, that the judge estimates them at their fair value. Proposition 1 implicitly says that if the victim feels doubts about the compensation level, then the above relationship is broken.

There, in a less restrictive unilateral accident model compared to the CAM, even if the agents are risk neutral, under strict liability, the social care level diverges from the private one as corollary 1below shows it:

Corollary 1: *Under strict liability, when the victim knows that repairs may diverge from her loss, then the socially first-best level of care diverges from the private optimal injurer's care level.*

Proof: The corollary is proved in the development of the proof of proposition 1 and the following discussion completes it.

Proposition 1 and its corollary show that the CAM is a case of a more general accident model and that this does not violate the basis of the risk analysis.

i) The CAM as a specific accident model case

To show that CAM lies on restrictive assumptions, we start from the equation (5) for strict liability (we omit the index).

$$ESW_{\tau=0}(x) = \phi_{\tau=0}(x) + \Psi_{\tau=0}(x) = u + v - x - p(x)(L_{I\tau=0} + L_{V\tau=0}),$$

It is easy to see that when $L_{I\tau=0} = L_{V\tau=0} = L$ then,

$$(7)\ ESW_{\tau=0}(x) = \phi_{\tau=0}(x) + \Psi_{\tau=0}(x) = u + v - x - p(x)L$$

And obviously (see appendix 1).:

$$(8)\quad x^* = x^*(L)$$

Where x^* is the socially first best care level, and this one is equal to the optimal level that the injurer sets up, $x^* = x^0$

ii) Does the divergence of opinion open the way to radical uncertainty?

The question that remains to deal with is knowing whether different assessments by the parties ($L_{I\tau=0} \neq L_{V\tau=0}$) would violate the CAM's foundations. The answer needs a comparison with the bilateral negative externality model. In the latter, the agents' utility functions express their subjectivity. In the CAM, correspondingly, nothing indicates that, mandatorily, the parties share common values considering their utility functions ($\phi_{\tau=0}(x)$ and $\Psi_{\tau=0}(x)$). Furthermore, nothing prevents that, ex-ante, neutral-to-risk agents (victim and injurer) differently assess their losses. However, following proposition 1, the point is less about the divergence of views than about the certainty for the victim to receive less compensation than his actual losses. Kaplow and Shavell (1996) note that the victim can legitimately consider that her loss will not be fully reimbursed. The following expression takes into consideration this difference. This one appeared in the proof of proposition 1:

(9) $\phi_{\tau=0}(x) = v - p(x)(L_{V\tau=0} - d)$

Now, the victim expects that she will receive d rather than $L_{V\tau=0}$ (with $L_{V\tau=0} - d > 0$). To make easier the argument, we consider that the victim thinks in terms of a ratio $\alpha, \alpha \leq 1$ that is her expected share for her compensation. Then, the expected social welfare function becomes:

$$ESW_{\tau=0}(x) = \phi_{\tau=0}(x) + \Psi_{\tau=0}(x) = u + v - x - p(x)\big(L_{I\tau=0} + L_{V\tau=0}(1-\alpha)\big)$$

Implicitly, by supposing that the victims may form specific beliefs about her estimated level of repair could lead considering that the victim feels preference or aversion for ambiguity. This would be tantamount to implicitly introducing radical uncertainty in contradiction with the assumption of a risky universe. Indeed, similarly to the bilateral externality model, here, the parties have their own subjectivity and their evaluation is their own. The victim's assessment of the difference between her loss and her expected is a data that concerns the distribution of her payoff associated with the states of nature. Furthermore, fundamentally, this does not change the victim's utility function nature that remains neutral to risk.

Consequently, the socially first-best care level and the injurer's optimal care level do not match unlikely to the CAM. Using appendix 1's notation, then the first-one writes as:

(10) $x^* = x^*\big(L_{I\tau=0} + L_{V\tau=0}(1-\alpha)\big)$

While the second is:

(11) $x^0 = x^0(L_{I\tau=0})$

We can easily check that $x^* > x^0$.

iii) CAM: Questions concerning the consequence of same assessment

How does both parties may assess identically damage? Obviously, we could consider that, ex-ante, following an unspecified process, they both agree on a given value. However, Kaplow and Shavell (1996) show that in many circumstances (most of them) this agreement cannot be reached. Then, we consider two possibilities. The first one is that both parties agree with the injurer's assessment, i.e. $(L_{I\tau=0})$, the second one, on the victim one, $(L_{V\tau=0})$.

- First, when the injurer tends to minimize the potential damages, the victim may consider that her loss that will be $(L_{V\tau=0} - d,\ d \in]0, L_{I\tau=0}\,])$, obviously, there, the injurer does not establish the socially optimum care level and $x^* > x^0$. In the opposite, if for an, the reverse is true (i.e. $L_{I\tau=0} > L_{V\tau=0}$) then $d = 0$, and $x^* = x^0$.
- Second, parties agree on the victim's evaluation $L_{V\tau=0}$. Consequently $L_{V\tau=0} - d = 0$ and $x^* = x^0$. We find again the CAM. However, nothing may explain why and how the injurer

would accept the victim's loss assessment. Indeed, generally, victims tend to overestimate them.

In conclusion, under strict liability, a generalized accident model that respect the assumption of a risky environment, does not lead to naturally establish the first-best level of care.

4. Negligence rule and divergent views: a paradoxical result

Under negligence, the wrongdoer must mandatorily compensate the victims when the Court finds him faulty, negligent or reckless. Generally, the victim bears the burden of the proof. The damage must be quantifiable, and the Court must define a causal link between the faulty behavior and the damage. Then, it fixes what the care level should have been. When the injurer is not liable, the victim suffers the loss without any compensation.

The social care level that the injurer should respect is $x^* = x^*(L_{\tau=1})$ (See appendix 1). Then, if the defendant has brought due care by determining x^0 such that, $x^0 = x^0(L_{I\tau=0}) \geq x^* = x^*(L_{\tau=1})$ after an accident occurrence, the victim may assess her loss to $L_{V\tau=1}$. When $L_{V\tau=1} > L_{\tau=1}$, i.e. the victim's evaluation is higher than the Court's one, the difference $L_{V\tau=1} - L_{\tau=1}$expresses the victim's feeling of loss. Let us systematically study this question.

4.1 The socially first-best care level under negligence

Generally, as with strict liability, the parties do not agree about their ex-ante damage assessment. The following vector $\tilde{L}_{\tau=0}$ represents the agents' ex-ante damage estimate in the absence of any information and coordination process:

$$\tilde{L}_{\tau=0} = \{L_{I\tau=0,}L_{V\tau=0}, L_{V\tau=0} - d\}$$

Where d is the victim's estimate of effective repair. After an accident, before the court judgement, the parties' estimate is:

$$\tilde{L}_{\tau=1} = \{L_{I\tau=1,}L_{V\tau=1}\}, \text{with } L_{I\tau=1} \neq L_{V\tau=1}$$

If d' is the value of repairs that the judge decides, both agents then $J_{\tau=1}$ expresses their assessed level of loss:

$$J_{\tau=1} = \begin{cases} \{L_{I\tau=1,} - d', L_{V\tau=1} - d'\}, & x < x^* \\ \{0, L_{V\tau=1}\}, & x \geq x^* \end{cases}$$

a) Then, when $x < x^*$, (Chosen care is less than the social care level) then the wrongdoer is held liable by the Court and he bears the burden of repair, i.e. d', that does not correspond to both parties' forecast. Implicitly, we consider that $L_{I\tau=1} < L_{V\tau=1}$ are the damage levels that both parties claim after an accident. The troublemaker minimizes them, while the victim raises them.

b) By the same reasoning, when $x \geq x^*$, the judge finds that the prevention measures were sufficient. It follows that $p(x^0) \leq p(x^*)$. Then, the judge may find that the amount of damages $L_{\tau=1}$ is lower or equal to $L_{I\tau=1}$, i.e. the amount of damages estimated by the troublemaker $L_{\tau=1} \in]0, L_{I\tau=1}]$. When the defendant is found free from liability, the victim bears the repairs. However, these may be higher than the judge assessed.

Then, in the absence of any consensus about the assessment of damage, how can the socially optimal level of prevention be determined ex-ante? Resorting to the fiction of the beneficent regulator leads to a paradoxical situation. As shown above, the victim is uncertain about the level of repair, then, the regulator latter should collect the agents' preferences according that $x < x^*$ or $x \geq x^*$ and this would lead to the determination of two levels of socially optimal care levels:

- $x_1^* = x^*(L_{I\tau=0} + L_{V\tau=0} - d)$ when $x < x^*$ and
- $x_2^* = x^*(L_{V\tau=0})$ when $x \geq x^*$

It is the point we are studying now.

4.2 The socially first-best care level under negligence

Under negligence, the injurer's effective payoff function expresses as:

$$\Psi_{\tau=0}(x) = \begin{cases} u - x - L_{I\tau=0}p(x) & if\ x < x^* \\ u - x & if\ x \geq x^* \end{cases} \quad (12)$$

While the victim's expected utility function is:

$$\phi_{\tau=0}(x) = \begin{cases} v - (L_{V\tau=0} - d)p(x) & if\ x < x^*,\ (a) \\ v - L_{V\tau=0}p(x) & if\ x \geq x^*,\ (b) \end{cases} \quad (13)$$

Equation (a) in (13) expresses that the victim forecasts that the Court and herself differently assess damage. As under strict liability, even if the Court involves the injurer in liability, the victim feels doubts about her effective compensation level. Equation (13b) means that if the injurer is not liable, the victim will bear the full loss that she assesses to $L_{V\tau=0}$. Now the expected welfare function becomes:

$$ESW_{\tau=0}(x) = \begin{cases} v + u - x - p(x)(L_{I\tau=0} + (L_{V\tau=0} - d)) & if\ x < x^* \\ v + u - x - L_{V\tau=0}p(x) & if\ x \geq x^* \end{cases} \quad (14)$$

Solving this program leads considering two cases following that $x < x^*$ or that $x \geq x^*$. Hence, when $x < x^*$, the socially first-best care level is $x_1^* = x^*\big(L_{I\tau=0} + (L_{V\tau=0} - d)\big)$ and when $x \geq x^*$, it is $x_2^* = x^*(L_{V\tau=0})$, obviously $x_1^* \neq x_2^*$ or still (see appendix 1):

$$x_v^* = \begin{cases} x_1^* = x^*\big(L_{I\tau=0} + (L_{V\tau=0} - d)\big) & if\ x < x^* \\ x_2^* = x^*(L_{V\tau=0}) & if\ x \geq x^* \end{cases} \quad (15)$$

Indeed, if the court exonerates the injurer from any liability, the victim bears the reparations burden then her assessment of the loss defines the first-best care level.

4.2.1 Negligence rule and CAM

If the CAM determines a unique socially first best care level it is because the consensus between the defendant and the victim extends from the level of the damage to the level of compensation, i.e. $L_{V\tau=0} = L_{I\tau=0} = L = d$. From this, it results that the expected social welfare function writes as:

$$(16) \quad ESW_{\tau=0}(x) = \begin{cases} v + u - x - p(x)L \; if \; x < x^* \; (a') \\ v + u - x - p(x)\, L \qquad if \; x \geq x^* \; (b') \end{cases}$$

It follows that the socially first-best care level is unequivocally determined. One must be aware that this issue comes from the adoption of several implicit assumptions that we recall in literal terms.

i) Ex-ante, both agents agree on the level of damage (L here).

ii) The victim expects that the court will compensate exactly her losses, $L = d$,

iii) There is a perfect compliance between the victim's damage assessment and the Court's one, i.e. $L_{V\tau=0} = L$. The victim never over or underestimate her losses compared to the court's assessment. This particular strong assumption concerns only a few kinds of accidents, for instance cars accidents where billion of accidents in one Century all over the World may have designed a schedule. However, for other hazardous activities, the convergence between the views of all parties is only casual or the result of a strong assumption which is the case with the CAM.

4.2.2 Choosing a socially optimal care level with divergent assessments

If we consider only i) and ii) without iii) (in 3.1.3) then $L_{V\tau=0} - d = 0$. Hence, whatever its level, the victim knows that her loss will be compensated. However, this does not prevent her to have her own specific assessment concerning the level of damage, i.e. $L_{V\tau=0}$ Consequently, if the court considers that the defendant has complied to the socially first best level of care, the victim bears the weight of the loss that she estimates to $L_{V\tau=0}$. Then, the social welfare function becomes:

$$(17) \quad ESW_{\tau=0}(x) = \begin{cases} v + u - x - p(x)L_{I\tau=0} & if \; x < x^* \\ v + u - x - L_{V\tau=0}p(x) & if \; x \geq x^* \end{cases}$$

This situation stems from the fact that the social welfare function is formed from the aggregation of the individual expected utility functions. Consequently, the solutions are the following (see appendix 1):

$$(18) \quad x_v^* = \begin{cases} x_1^* = x^*(L_{I\tau=0}) & if\ x < x^* \\ x_2^* = x^*(L_{V\tau=0}) & if\ x \geq x^* \end{cases}$$

Considering (18) the injurer may set up three possible levels of care if we add his optimal own level $x^0 = x^0(L_{I\tau=0})$. These correspond to the following set: $\{x^0, x_1^*, x_2^*\}$. Then, what level should he choose? In the CAM, the injurer does not raise this question because he naturally settles $x^0 = x^0(L)$ that corresponds to the socially first-best care level (because $x^0 = x^* = x^0(L)$).

In our global approach, considering $\{x^0, x_1^*, x_2^*\}$, it appears that the injurer should make a choice between these values. This choice depends on his level of knowledge. Consequently, how could the injurer get information about the prevention level to choose the best one for him. To answer the question, we will consider, first, the fiction of the rational and benevolent regulator that inform the concerned agents, second, the no-information case, and third, the setting of standards and norms by the regulator.

a) The regulator calculates the social care and informs the agents

To deal with this point assume that the injurer must shift towards the socially first-best levels of prevention x_1^* or x_2^* when he knows the social level of care $x_v^*, v = 1,2$ with, $x^0 + p(x^0)L_{I\tau=0} > x_v^*, v = 1,2$.

Reaching this step, the question to solve consists in knowing how to choose between both values. When the injurer chooses x_1^* rather than x_2^* (because $x_1^* < x_2^*$), this means that he thinks that the judge will consider that the socially first-best care level is x_1^*. However, nothing prevents thinking that the judge could make another choice and favor x_2^*.

Conclusion 1: Knowing x_1^* and x_2^* does not prevent the injurer to be involved in liability if he chooses x_1^* (if $x_1^* < x_2^*$). Then, the only strategy that avoids it is choosing x_2^*, i.e. fully comply with the victim's assessment. However, it may happen that the victim over-assesses her losses in such a way that:

$$u - x_1^* - p(x_1^*)\big(L_{I\tau=0} + (L_{V\tau=0} - d)\big) > u - x_2^*$$

Putting otherwise, the injurer expected profit is higher by complying with x_1^* (and taking the risk to pay $L_{I\tau=0} + (L_{V\tau=0} - d)$) rather than complying to x_2^*. This result directly comes from the neutrality to risk assumption: the probability of an accident $p(x_1^*)$ is sufficiently low to ensure that $\Psi_{\tau=0}(x_1^*) > \Psi_{\tau=0}(x_2^*)$.

Conclusion 2: It is obvious that, here spontaneously, the injurer will not naturally implement the level of care that maximizes his expected payoff taking account his own assessment of damage. He will choose $x_v^*, v = 1,2$ as a second best by considering that the Court may involve him in liability.

Conclusion 3: Because of the existence of two potential social care levels under negligence, no structural bridge exists with the strict liability regime as with the CAM.

b) The no-standard case

When the regulator does not create a standard, the injurer could implement the amount $x^0(L_{I\tau=0})$ that corresponds to his own evaluation. However, he also could increase x to lessen the probability of an accident and the risk to be involved in liability. There are few chances that this level could meet this level that helps him escaping from liability.

c) The regulator defines standards

Now, the regulator may impose either x_1^* or x_2^*, and consequently, in case of an accident, the Court will refer to this level as the level of due care. Then, if the regulator enforces x_v^*, $v = 1,2$, as a social norm, the injurer must check whether this level insures him a positive payoff (i.e. $\Psi_{\tau=0}(x_v^*) > 0$).

If $\Psi_{\tau=0}(x_v^*) \leq 0$, then the injurer has the choice to resign because he cannot comply with it, or to choose the highest level of care $x', x' > 0$, such that:

$\Psi_{\tau=0}(x') > 0$ and $\Psi_{\tau=0}(x') = u - x' - p(x')(L_{v\tau=0}) > u - x_v^*$ with $x' < x_v^*$

($L_{v\tau=0}$ is the level of care corresponding to x_v^*, where $L_{v\tau=0} = \{L_{I\tau=0} + (L_{V\tau=0} - d), L_{V\tau=0}\}$).

In this situation, the injurer accepts to act as if he was under strict liability. However, he may attempt mitigating the effect of an accident by increasing the level of care from x^0, the optimal level of care corresponding to his damage assessment, i.e. $x^0 = x^0(L_{I\tau=0})$ to x' where, $x_v^* > x' > x^0(L_{I\tau=0})$. As in ii), here still, the criteria that could help defining the level of care that the injurer settles are lacking. Then, in case of an accident, he runs the risk to compensate the victim because the prevention level is insufficient compared to the required social one.

As a conclusion concerning negligence, none of the three above conjectures show that the injurer naturally installs the socially first best level of care. The Court plays an essential role in defining the social care level, but this is done afterwards, and, for a lot of kind of accident, it is difficult for the tortfeasor to determine ex-ante this level.

5. A review of literature on the courts' errs and the assumption of radical uncertainty

5.1 Discussion: Negligence rule and the role of the court

Coase 1960's analysis made aware lawyers and economists that compensation should respect the social optimum. This requires that the judge could be able to balance costs and benefits of the compensation rule. Coase followed the Judge Learned Hand's opinion that appeared in U.S. v. Carroll Towing Co.[3]. This law case was the first that explicitly referred to cost-benefit analysis in assigning tort liability. The question is how the Court may dispose of enough information to determine the socially first-best level of care that both minimizes the risk of accident and ensure the highest welfare. This question is different from what the literature deals with under the name of "courts' errs". Indeed, the authors assume that the courts do not have enough means to reveal the real social cost of damages and, as a result, "err" by "mistaking" in their assessment. Agents who are aware of this possibility will tend either to invest too much in the prevention or, on the contrary, to underinvest. Taking up the presentation made by Arlen (1999), we can distinguish three sources of errors made by courts.

(a) The first comes from determining negligence and was highlighted by Calfee and Craswell (1984); Craswell and Calfee, (1986) as well by Shavell, (1987, pp. 79-83, 93-97). Knowing that Courts may make error, the injurer may think that if he does not comply with the socially first-best care level, he has a chance to escape to liability. Then, he could be tempted to supply less than the expected due care. Furthermore, even he fully fulfills his care duty the court could mistake, and he is induced to supply more than required. In our representation, the doubt does not come from the court's erring but from the uncertainty of how the judge will assess the real damage considering that no consensus among the agents exist.

(b) Our model is concerned by the role of causation rules question as described by Grady (1983) and above all Kahan (1989) when he analyzes situations where uncertainty affects the knowledge of the optimal level of care: "*Consequently, injurers exercising a certain level of care might not know whether they will be found negligent or not, either because they are not certain about the level of due care or because they are not certain what level of care they will be found to have exercised*" Kahan (1989, p.437). Hence, when they are certain about the level of due care, injurers, when they fail to comply with this level become liable for the cost of all the additional accidents they caused. However, uncertainty about the level of care involves that the injurers supply less safety than the known due care. Kahan takes the example of the owner of a cricket

[3] 1159 F.2d 169 (2d Cir. 1947).

field that is uncertain about the legal height of the fence. When the owner is uncertain about the due care he should supply, i.e. the "right" height, he is induced to under-size the protection level. Typically, our model shows that the lack of consensus about the damage, leads the injurer to face uncertainty about the level of care he should set.

Indeed, if, naturally, he is induced to apply $x^0(L_{I\tau=0})$, but if he knows that a higher standard, for instance, x_1^* will free him from any liability, he will be induced to choose x_1^* and supply the corresponding care level (i.e. here because the level of damage is higher $(L_{I\tau=0} + L_{V\tau=0} - d > L_{I\tau=0})$). This if and only if, he is certain about it. However, in the opposite, if for instance, they are three equally probable care level as x^0, x_1^* and x_2^*, he will be uncertain about its level and he will tend to undersize it. This level corresponds to the care level associated to the potential damages included in the interval:

$]L_{I\tau=0}, L_{I\tau=0} + L_{V\tau=0} - d\,[$, where $x_1^0 \in]x^0(L_{I\tau=0}), x_1^*(L_{I\tau=0} + L_{V\tau=0} - d)\,[$

The uncertainty about the level of damage involves uncertainty about the social care level.

(c) The third factor concerns the victims' doubts about their repair level compared to losses. Cooter (1984) noted that courts may inaccurately assess the victims' damage and knowing which regime provide a better information is at stake (Shavell (1987, pp.131-32), Kaplow and Shavell (1996), Fees and Wohlschlegel (2006), Lando (2018). Without entering the details of these discussions note that, for some, neglect would encourage victims to seek more information (Cooter (1984), Lando (2018), while for others, both regimes are equivalent (Kaplow and Shavell (1996)). In fact, for our purposes, these analyses tend to show that, exa-ante, the victims cannot know with certainty their potential loss level. It is only the search for ex-post information, and therefore the intensity of this search, that would determine the superiority of one regime over the other. Grady's (2018) analysis of the US courts responsible for determining liability and damages shows that juries tend to "forgive" troublemakers more than victims could expect regarding the fault regime. This approach reinforces the issue of victims' distrust in relation to the accuracy assessment of their losses.

5.2 The impact of radical uncertainty

From the mid-2000s, several works challenged the canonical model by introducing radical uncertainty. This change implies that the agents form non-homogeneous beliefs about

the level of fundamental variables (accident probability distribution, for example) and affect their utility function. These either integrates preference/aversion to ambiguity or sophisticated shapes of aversion for risk. In particular, the pioneering works of Bigus (2006), Teitelbaum (2007) opened a real Pandora's Box that seriously questioned the basic model foundations. The most famous paper, the Teitelbaum (2007)'s one, assumes that the injurer's assessment of the accident cost departs from the social cost. The injurer is a Choquet Expected Utility maximizer (CEU) this means that he expresses his ambiguous and optimistic/pessimistic views about an "official" probability distribution of risk, while the victim is supposed to be neutral to risk. The CEU is also called Neo-capacity utility function. This function comes from the ambiguity theory reformulation made by Chateauneuf, Eichberger, and Grant (2007) among others. Here, the injurer allocates specific weights to extreme events that involve distinguishing a maximum and a minimum utility level plus a utility expectation. These weights express his degree of aversion/preference for ambiguity and its degree of optimism/pessimism. The main issue is that the injurer's first-best level of care is not socially optimal, and this breaks the equivalence between strict liability and negligence rule. Indeed, the injurer's level of care decreases with ambiguity if he feels optimistic and decreases with his optimism degree. The relationship varies in the opposite with decreasing ambiguity and pessimism. As pessimism leads to more precaution, negligence rule seems superior to strict liability.

However, the Teitelbaum's scheme structurally differs from the canonical model. Indeed, Teitelbaum considers that the social accident cost is independent from the agents' preferences and the impossibility to enforce the socially first best level of care comes from the discrepancy between this level and the injurer's optimal care level[4]. The social welfare function is not built from the aggregation of the parties' preferences as in the CAM.

Langlais (2012) Franzoni (2013) and Franzoni (2015) consider a social welfare function built from the injurer and the victim's preferences. For Franzoni, the agents' utility functions come from Klibanof and al. (2005)'s model (smooth ambiguity). He does not consider ambiguity aversion as a cognitive bias, but a genuine component of welfare as Ellsberg (1961): "*ambiguity aversion is taken as a rational response to scientific uncertainty. In other words, I do not consider ambiguity aversion as a "cognitive bias" but a genuine component of welfare, to be factored into the efficiency quest*" Franzoni (2015 p.5).

[4] See Teitelbaum (1987, fn 27, p. 446) and also Mondello (2012) and Lampach and Spaeter (2016).

Then, ambiguity aversion is not a mistake that agents should correct once they note it. The agents (victims and injurer) form (prior) beliefs about the probability of harm. The ambiguity degree is captured by the variance of the prior beliefs of the agents. The parties may feel different degrees of ambiguity (i.e. their prior distributions about the probability of harm differ). Consequently, the model consists in minimizing the social accident loss, that includes the expenditure in prevention, expected harm, and the uncertainty premium of the parties. Then, under strict liability, ambiguity induces the defendant to take greater precautions if, and only if, such precautions reduce the spreading of prior beliefs (together with the mean probability of harm). Negligence leads to raise the standard of care, but only in situations where investing in care has the power to reduce the perceived ambiguity. Moreover, strict liability dominates negligence. However, under very restrictive conditions: the injurer feels both a lower degree of risk aversion and a lower degree of ambiguity aversion, than the victim, and the injurer's assessment of the likelihood of harm is less ambiguous.

Chakravarty and Kelsey (2016) analyze the welfare implications of tort rules in a bilateral accident model where both injurer and victim, each Neo-capacity utility maximizers, invest in care. Both agents derive utility from an unobservable action, which may lead to the accident. When the agents only choose the level of care, under negligence, ambiguity-averse agents are more likely to choose the optimal amount of care. Second, when agents choose care and the unobservable action, they propose a system of negligence, plus punitive damages which give optimal level of both care and unobserved action by injurers and victims.

Langlais (2012) also keeps the aggregation of agents' preferences. He shows that Knight's uncertainty leads to a socially inefficient level of care and he considers a global non-insurable risk where the polluters invest in reducing risk technologies. Compared to victims, the polluter feels a lesser degree of risk aversion and ambiguity. Then, his estimate of the prejudice likelihood also corresponds to a lower ambiguity degree. Langlais' model is based on supposed pessimistic and risk-averse agents. Agents are maximizers Rank Dependent Expected Utility, he is close to Bigus (2005)'s work. He shows that the required security level is higher than in a neutral to risk economy and that no liability regime is significantly efficient.

In conclusion, all of these critical representations retain the ideal of comparing liability regimes following their economic efficiency as in the CAM. They do not put into question the efficiency criterion because they go on considering that liability regimes are substitutable.

6. Methodological consequences of structural divergent assessment between parties: Some conclusions

What would have been the theoretical consequences of comparing liability regimes by using a more general framework than the CAM? This paper shows that, whatever the regime, when the parties diverge about the damage assessment, the socially optimal and the private care do not match anymore. Regarding strict liability, when the victims are unsure about the level of repair, the required socially first best care level is higher than with the CAM framework. Under negligence, as under strict liability, victims may not only fear that their losses will not be fully covered and, but also, they will have to support the full repair burden if the injurer is found free from any liability.

Furthermore, under negligence, the system generates at least two potential socially first-best care levels. Consequently, both regimes can no longer be compared on the basis of each other's performance that structurally cannot match. This impossibility stems from the specific features of each regime: the victims' attitude, the regulator's role, and the court action are also specific to each regime.

Thus, it follows that economic efficiency is not a relevant criterion that helps to choose between liability regimes conversely to the restrictive CAM that assumes that strict liability and negligence regimes are perfect substitutes. This gave the direction followed by most comparative contributions. The efficiency criterion remains the main evaluation factor to choose among regimes. This view is misleading because each liability regime applies to different risky activities.

Then, this paper's main conclusion is that the relaxation of the assumption of the same evaluation between parties leads to considerable changes in the fields of the comparison of liability regimes. The most noticeable issue is that liability based on fault (negligence) and on lack of fault (strict liability) are not substitutes but complementary regimes. Strict liability and the rule of negligence smear to different areas. Strict liability concerns ultra-hazardous activities that involve huge harm for victims and for which the owners' or managers' liability is time-demanding and costly to prove (accidents at work, road accidents, heavy industry, energy, sea pollution, etc.). Negligence applies to activities with limited risk. This result is known by jurists and legislators since the end of the nineteenth century and the beginning of the twentieth. Jurisprudence and legislation tend to confirm this situation. Rather than attempting to test which regime works better than the other, one avenue of research concerns the conditions for improving the application of these regimes in the areas to which they apply.

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Appendix 1

A generic calculus

Let A, B two real positive numbers such that $A > B$. Consider the two following functions, that we call "expected cost functions":

- $v(x) = x + p(x)A$ and $v(x) = x + p(x)B$
- $p(x)$ is a probability density with $p'(x) < 0$ and $p''(x) > 0$, this means that the derivative $p'(x)$ is an increasing function.
- From the first order condition, we get x^A and x^B that we assume to be positive such that:

$$p'(x^A) = -\frac{1}{A}$$
$$p'(x^B) = -\frac{1}{B}$$

It follows that $x^A > x^B$. Indeed, as $A > B$, $\frac{1}{A} < \frac{1}{B}$ and, obviously,

$p'(x^A) = -\frac{1}{A} > p'(x^B) = -\frac{1}{B}$,

then, as $p'(x)$ is increasing, then,

$$x^A > x^B$$

This methodology and this result are generic in our paper. Then, we will write the solutions as:

$$x^A = x^A(A) \text{ and } x^B = x^B(B)$$

Appendix 2

Proof of Proposition 1

This demonstration complements Shavell (1982), it is carried out in two stages. First, we prove the necessity, then the sufficiency. Before, note that $L_{\tau=1}$ is the court's assessment of the damage and d the compensation level, it requires to the defendant, with $L_{\tau=1} = d'$.

a) Necessity

To prove necessity, consider that, after an accident, the judge assesses to an amount $L_{\tau=1}$ the cost of an accident. As the victim considers this cost equal to t $L_{V\tau=1}$t with $L_{V\tau=1} \neq L_{\tau=1}$, then, clearly, judge and victim disagree.

i) Consider, however, that ex-ante, the victim believes that the judge's assessment's fits with her own that would compensate her fully:
$L_{V\tau=0} = d$.
Then, ex-ante, her expected utility function would be:
$\phi_{\tau=0}(x) = v - p(x)(L_{V\tau=0} - d) = v - p(x)0 = v$
Consequently, considering that the injurer's utility remains unchanged, the expected social welfare function is:
$$EW_{\tau=0}(x) = \max_{x \geq 0}\{\Psi_{\tau=0}(x) + \phi_{\tau=0}(x)\} = u + v - x - p(x)L_{I\tau=0}$$

The equilibrium condition corresponds to the *standard* model where:

$x^* = x^*(L_{I\tau=0})$ and, $x^0 = x^0(L_{I\tau=0})$ with $x^* = x^0$ (see appendix 1).

ii) Now consider that, **ex-ante,** the victim knows that the judge and she will not agree about the value of the damage: $L_{V\tau=1} \neq L_{\tau=1}$. She assesses the level of compensation to $L_{\tau=1} = d$. Then, her expected utility function becomes:

$$\phi_{\tau=0}(x) = v - p(x)(L_{V\tau=0} - d)$$

And, the social welfare function expresses as:

$$EW_{\tau=0}(x) = \max_{x\geq 0}\{\Psi_{\tau=0}(x) + \phi_{\tau=0}(x)\} = u + v - x - p(x)\big(L_{I\tau=0} + (L_{V\tau=0} - d)\big)$$

It follows that the socially optimal prevention, x^* is:

$$x^* = x^*\big(L_{I\tau=0} + (L_{V\tau=0} - d)\big)$$

As the optimal level of prevention of the troublemaker is $x^0 = x^0(L_{I\tau=0})$, it follows that $x^* \neq x^0$. As $L_{I\tau=0} + (L_{V\tau=0} - d) > L_{I\tau=0}$ because by assumption $(L_{V\tau=0} - d) > 0$, then in accordance with Appendix 1, $x^* > x^0$.

Then, by i) and ii) the necessary condition is proved.

b) Sufficiency

Here victim and injurer disagree about the ex-ante level of damage $L_{V\tau=0} \neq L_{I\tau=0}$, furthermore the victim knows that the expected loss differs from the real one $L_{V\tau=1} \neq L_{\tau=1}$. However, as she knows that the court forces the injurer to compensate fully the damage, then:

$$\forall L_{\tau=1} > 0, L_{\tau=1} = L_{V\tau=1} \text{ and } \exists d' > 0: L_{\tau=1} = d', \text{then } L_{V\tau=1} = d'$$

Consequently, as in i) in a) above, the victim feels confident that her expected utility remains constant before and after an accident:

$$\phi_{\tau=0}(x) = v - p(x)(L_{V\tau=0} - d) = v - p(x)0 = v$$

This result is independent from the existence of a divergence in view between injurer and victim. Indeed, we could get the same result considering that both views converge i.e. $L_{V\tau=0} = L_{I\tau=0} = L$ as in the CAM.
Obviously, as before,

$$EW_{\tau=0}(x) = \max_{x\geq 0}\{\Psi_{\tau=0}(x) + \phi_{\tau=0}(x)\} = u + v - x - p(x)L_{I\tau=0}$$

And $x^* = x^*(L_{I\tau=0})$, $x^0 = x^0(L_{I\tau=0})$ with $x^* = x^0$.
Consequently, we only needed to show that, ex-ante, the victim's belief in a full compensation is sufficient to induce her considering that her expected utility function will stay at a constant level. This is independent from her divergent or convergent view with the injurer about the damage costs.

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