Does Evidentiary Uncertainty Induce Excessive Injurer Care?

Yoon Ha Yoo
KDI School of Public Policy and Management
+82- 2- 3299- 1013
+82- 2- 968- 5072(fax)
yhy@kdischool.ac.kr

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Abstract

We derive the precise conditions under which over- or under-compliance can take place under imperfect information about the care levels chosen by both injurer and victim in a tort litigation. The conditions identified turn out to be more complicated than are usually presumed in the literature. A correct evaluation requires us to consider both the pure uncertainty effect as well as the feedback effect. Properly done, the overall effects of uncertainty on care levels are always indeterminate, depending on various factors such as costs of care, the size of expected accident loss, the degree of dispersion and bias of the judgment error distribution.

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In the tort literature, there appears some confusion about the effects of uncertainty on the incentives of potential tortfeasors to take due care. One group of researchers say that uncertainty leads to over-compliance, while others claim that the statement is not necessarily true. One good example for the former is found in the widely used textbook (Cooter and Ulen, 2000) which explicitly states that

“Evidentiary uncertainty causes potential injurers to go beyond the level of precaution that might just barely exonerate them. That is, evidentiary uncertainty will cause over-precaution relative to the efficient level of precaution.” (p. 344.)

This conclusion comes from their earlier research (Cooter and Ulen, 1986) which says,

“Therefore, in situations of evidentiary uncertainty, the level of care that minimizes the rational decisionmaker’s expected costs exceeds the legal standard, even if the legal standard is set at the efficient level of care. By exceeding the legal standard, the decisionmaker reduces the probability that a court will make a mistake and find him liable.” (p. 1090).

This conclusion appears to be shared by many other scholars. Among others, Haddock and Curran (1985), Shavell (1987), Bar-Gill (2001) make similar statements¹, and Rubinfeld (1987), Orr (1991), Edlin (1994), Bar-Gill and Ben-Shahar (2002) take it for granted as if it was a settled wisdom in a law and economics literature.

Others, however, especially Calfee and Craswell (1984), White (1988), say that evidentiary uncertainty may lead either to over- or under-compliance depending on the

¹ Strangely enough, Bar-Gill (2001) starts his argument by questioning the validity of the aforementioned proposition, but then acknowledges that it may be true by saying that;

“Nevertheless, I do not wish to base my criticism of the efficiency argument for comparative negligence on the questions raised above regarding the robustness of the ordering result. In fact, I do believe that the ordering result often holds – a belief, which is also supported by the numeric analysis section of the present study. Therefore, I proceed to show that even when the ordering result is valid evidentiary uncertainty does not establish a case for comparative negligence.”

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accident prevention technology and cost structure. Among others, White (1988), in his book review of Shavell (1987), is most explicit about this:

“... but some of the models discussed by Shavell involve situations in which several different sets of assumptions seem equally attractive. Thus, a note of caution is useful.

... Whether the care level chosen by the injurer is equal to, greater than, or less than the economically efficient care level depends on a comparison between the rate at which the probability of accidents falls with more care, and the rate at which the probability of the injurer not being held liable rises with more care, at the level of care chosen by injurer. (p.1226)

The main purpose of this paper is to clear the clouds by deriving the precise conditions under which over- or under- compliance results. A clear delineation of conditions will obviate unnecessary confusions and help sort some of the other theoretical results that crucially depends on the proposition, either in a negative or positive way. Earlier literature which questions the validity of the proposition have mainly relied on numerical examples2 and failed to provide the exact conditions to settle the issue3.

My conclusion is that it depends. In this regard, I belong to the latter camp. By explicitly identifying the underlying factors and deriving the precise conditions among them, however, I hope to persuade the many skeptics. The conditions that come out of the analysis turns out to be more complicated than are generally presumed so far in the literature. Fortunately, however, each factor identified and the relationship among them

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2 Mysteriously enough, after performing an extensive array of simulation, Craswell and Calfee (1986) in a sequel to the aforementioned paper lapse back to the old proposition of overcompliance by concluding “Our analysis shows that if the uncertainty created by the legal system is distributed normally about the optimal level of compliance, and if the uncertainty is not too large – two seemingly plausible assumptions – then the result under normal damage rules will be too much deterrence rather than too little. (p 299)” This implies that their simulation was not general enough to consider all the possible circumstances.

3 Bargill (2001) describes the situation as “When uncertainty is incorporated into the economic model of tort law, the complexity of the enriched model renders it virtually impossible to derive a general analytical solution. (p6)” and then he resorts to numerical solutions via computer simulation. As it turn out, however, the general analytical solution is not that difficult to devise, as the present study presents one.
has clear-cut economic rationales.

Generally speaking, whether an overcompliance will happen or not hinges on the cost of care, the margin of error and the size of expected accident loss. If the cost of care is relatively cheap, the margin of error is small and the size of loss is big, implying that the injurer can significantly cut his/her chance of being held liable by an extra care, it is worthwhile to take that additional care, and thereby make it more certain that he/she would not be held liable. In other words, he/she would try to guard him/herself from the unfortunate possibility of being held liable and forced to pay the damages. This would lead to an overcompliance. If, however, the cost of care is relatively expensive, the margin of error is high, and the expected loss is small -- implying that even if he/she undertakes costly extra care, it would not significantly improve the probability of not being held liable or the size of damage payment, -- he/she would rather choose to undercomply and take a chance.

This first-round effect, however, must be complemented by a second-round effect which takes into account the other party’s expected response. In general, if the victim is expected to take less care than the optimal, the injurer is likely to be induced to take more care, so that he/she can reduce the size of the remaining accident loss itself or the probability of being held liable for it. This is true even when the accident prevention technology is such that there is no inherent inter-dependence between the levels of the injurer’s care and the victim’s care. This is because the court’s measurement error breaks off the underlying technical independence and makes them mutually dependent as far as the incentive to take a cost-minimizing care is concerned.

This paper is organized as follows. In Section 1, I lay out a general setup and derive an equilibrium care under uncertainty. In Section 2, I work out the precise conditions for an over- or under-compliance to result. In doing this, I make a distinction between the pure uncertainty effect and the feedback effect. Section 3 has the conclusion.

1. The Model

In order to facilitate comparison with earlier literature, I draw heavily on Cooter and Ulen (1986). I will focus mainly on the simple negligence rule, putting aside other
rules such as negligence with a defense of contributory negligence and comparative negligence. Similar results would apply to other rules.

Let $x_1$ and $x_2$ denote the care level taken by the potential injurer and victim, respectively, with $w_1$ and $w_2$ representing the unit cost of care for each, which is assumed to be constant. The probability of accident is denoted as $p(x_1, x_2)$ and when an accident occurs, the loss is $L(x_1, x_2)$. The expected loss is then $A(x_1, x_2) = L(x_1, x_2) p(x_1, x_2)$. We assume $A_1, A_2 < 0$, meaning that additional care reduces the size of the loss and/or probability of accident. A social planner who wants to minimize the sum of the costs of care and accident loss solves the following optimization problem.

$$\min_{x_1, x_2} w_1 x_1 + w_2 x_2 + A(x_1, x_2),$$  \hspace{1cm} (1)

which yields the following first order conditions;

$$w_i + A_i(x_1^*, x_2^*) = 0, \quad i=1,2. \hspace{1cm} (2)$$

The second order conditions require $A_{ii} > 0$ and $A_{11} A_{22} - (A_{12})^2 > 0$ for an interior solution to exist. The former says that the marginal productivity of each party’s care in reducing the expected accident loss must be diminishing. The latter condition implies that the cross effects between the two must not be too large. In turn, it suggests that the first round effect of one party’s change in their care level can never be overwhelmed by the second round effect that comes from the other party’s responsive adjustments. Assuming these conditions are satisfied, let the solution values which satisfy the relationship be denoted as $(x_1^*, x_2^*)$. In the above (2), these values are plugged so that the equations in (2) hold as identities. Note that at this stage, we don’t need to impose any restrictions on the sign of $A_{ii}$. It may be negative, implying that injurer’s care and victim’s care are mutually reinforcing, and thus complementary in reducing the expected loss of accident, or positive, implying that the two are substitutable. In particular, if $A_{ii} = 0$, the two will be mutually independent. In this case, the optimum care for the injurer will be determined independently of the victim’s optimum care. Later, I will show, however, that under uncertainty, $A_{ii} = 0$ is not sufficient for the injurer’s best care to be independent of the victim’s best care$^4$. The

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$^4$ Yet, the victim’s best care is independent of the injurer’s best care if $A_{ij} = 0$. There is an asymmetry under the simple negligence rule that we are focusing in this paper. As a
stochastic nature of the injurer’s liability under imperfect information breaks off the technical independence and thus forces the injurer’s best care to be dependent on the victim’s care.

In considering the negligence rule, I will assume, following the convention, that the court set the standard of due care at the socially efficient level, $x_i^*$, ($i=1,2$), and the damages that the injurer has to pay when found liable for the accident is set at the actual loss, $L(x_1,x_2)$.

Under the simple negligence rule, the injurer will be held liable for the accident if $x_1 < x_1^*$. If it is instead $x_2 \geq x_1^*$, she will not be held liable and the loss will be completely born by the victim. It is straightforward to prove that under certainty, this simple negligence rule would generate an efficient outcome in which both the injurer and victim choose their care at the socially optimal level, and thus the proof is omitted here.

Now assume that $x_i$ is observed with an error, $e$. The error is distributed with a density function $f(e)$ which has a zero mean and a positive variance, and a cumulative distribution $F(e)$. Therefore, the injurer will be liable if $x_1 + e < x_1^*$. The probability that the injurer will be held liable is then,

$$\text{prob } (x_1 + e < x_1^*) = \text{prob } (e < x_1^* - x_1) = F(x_1^* - x_1).$$

The expected costs that a potential injurer and the victim are faced with are

$$J_1 = w_1 x_1 + A(x_1,x_2) F(x_1^* - x_1),$$
$$J_2 = w_2 x_2 + A(x_1,x_2) [1 - F(x_1^* - x_1)].$$

The first order conditions are

$$w_1 + A(x_1^* - x_1^*) F(x_1^* - x_1^*) - A(x_1^* - x_1^*) f(x_1^* - x_1^*) = 0$$

matter of fact, asymmetry is inherent in every negligence rule, for that matter.

$^5$ In fact, every liability rule – simple negligence, contributory negligence and comparative negligence rule – would result in the same efficient outcome. See Cooter and Ullen (1986) and Shavell (1987).
Again, the solution values to (6) and (7), denoted as \( x_i^s \), are plugged back above \(^6\).

2. Derivation of Conditions for Overcompliance and Undercompliance

Now we want to check whether \( x_i^s \) is greater or less than the corresponding social optimum, \( x_i^* \). Let’s take the injurer’s care first. In particular, we want to establish whether \( x_i^s \) is greater or less than \( x_i^* \), given that the victim’s care level is set at \( x_2^s \). This implies that we must evaluate equation (6) at \( (x_1^*, x_2^s) \) and see if the resulting overall sign of (6) is positive or negative\(^7\). If it is negative, we can conclude that evidentiary uncertainty causes excessive care for the injurer. If it is positive on the other hand, we have to conclude that the opposite holds.

Note that (2) is evaluated at \( (x_1^*, x_2^*) \), and (6) at \( (x_1^s, x_2^s) \). Our task, however, is to evaluate (6) at \( (x_1^*, x_2^s) \) and compare the results with those obtained in (2).

\[
\frac{\partial J_1}{\partial x_1} \bigg|_{x_1=x_1^*, x_2=x_2^s} = w_1 + A_1(x_1^*, x_2^s)F(0) - A(x_1^*, x_2^s)f(0) = ?
\]  

This cannot be done directly because we are trying to compare two disparate objects, unless we establish some sort of common reference point. Later, we will build the connecting bridge. Putting off the task for a moment, however, I rewrite equation (8) as

\[
\frac{\partial J_1}{\partial x_1} \bigg|_{x_1=x_1^*, x_2=x_2^s} = \frac{\partial J_1}{\partial x_1} \bigg|_{x_1=x_1^*, x_2=x_2^s} + [ \frac{\partial J_1}{\partial x_1} \bigg|_{x_1=x_1^*, x_2=x_2^s} - \frac{\partial J_1}{\partial x_1} \bigg|_{x_1=x_1^*, x_2=x_2^s} ].
\]  

This is an identity. But this simple transformation will simplify our task substantially. Note that the first term represents \( \frac{\partial J_1}{\partial x_1} \) evaluated at \( (x_1^*, x_2^s) \) and the

\( ^6 \) The second order condition for (6), \( A_{11}F - 2A_1f + Af' > 0 \), requires that the absolute value of \( f' \) not be too big when negative. It means that the distribution must be relatively flat if it is symmetric.

\( ^7 \) I am implicitly assuming the objective function is unimodal.
second term shows the correction that has to be made to take account the victim’s deviation from the social optimum. The first term, therefore, can be called as the pure uncertainty effect and the second term the feedback effect. In the following, I will explain the former first, and then the latter. In short, the comparison is done in two steps: first, under the assumption that the other party somehow continue to stick to the social optimum. Second, making whatever adjustment to take account of the other party’s deflection from the optimum.

1) The Pure Uncertainty Effect

As explained above, in order to capture the pure uncertainty effect, all we have to do is to evaluate \( \frac{\partial J}{\partial x_1} \) at \((x_1^*, x_2^*)\), which is relatively simple because we can now directly compare the injurer’s care levels under the two alternative regimes without worrying about the possible deviation of the victim’s care from the optimum. Making use of the first order conditions given in (2), we can rewrite (6) evaluated at \((x_1^*, x_2^*)\) as

\[
\frac{\partial J}{\partial x_1} \bigg|_{x_1=x_1^*} = - A_1(x_1^*, x_2^*) \left[ 1 - F(0) \right] - A(x_1^*, x_2^*) f(0) \\
= \left[ 1 - F(0) \right] A(x_1^*, x_2^*) \left[ - \frac{A_1(x_1^*, x_2^*)}{f(0)} \right]
\]

The first term in the first equality is positive, but the second term is negative. Therefore, the overall sign is indeterminate, implying that any of the over-, exact- and under-compliance can occur depending on the relative magnitude of the two terms. This implies that the claim made by those early writers that uncertainty leads to excessive care does not hold even under this simplified setting.

Since \([1 - F(0)] A(x_1^*, x_2^*) > 0\), the second equality establishes the following

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8 At this juncture, it must be pointed out that some of the early writers on this issue (Cooter and Ullen (1986), Edlin (1994) for example) have not made this distinction and stopped at evaluating the first order conditions at the social optimum \((x_1^*, x_2^*)\) as if that would complete the required comparison. Bar- Gill (2002), however, questions the validity of this unjustifiable practice.

9 Some might conjecture that one simple way to justify this get-around is to assume \(A_{ij}=0\), believing that it would completely free one party’s behavior from the other’s. But it turns out that the assumption is not sufficient to do that.
relationship.

\[
\text{overcompliance} \quad \iff \quad - \frac{A^*_1}{A} < \frac{f(0)}{1 - F(0)}
\]

where \( A^*_1 = A_1(x_1^*, x_2^*) \) and \( A^* = A(x_1^*, x_2^*) \).

Note that the denominator of the left hand side is the expected accident loss when both the injurer and victim take socially optimal level of care\(^{10} \), and the numerator its change when the injurer takes one extra unit of care. Therefore, the left hand side as a whole represents the percent change in social accident loss due to the injurer's additional care. On the other hand, the denominator of the right hand side represents the probability that the injurer will be exonerated from the liability, while the numerator is its first derivative. Therefore, the right hand side as a whole represents the percent change in the probability of not being held liable, again due to the additional care by the injurer.

Simply put, the condition says that if the percentage change in his/her probability of being exonerated due to one additional care is greater than the percentage change in the accident loss, he/she will take that extra care and thus overcomply. Conversely, if the inequality is opposite, he/she will undercomply. It has the following intuitive economic interpretation.

Note that the left hand side can be interpreted as the marginal social gain from the additional precaution by the injurer, while the right hand side can be seen as the marginal private gain from the same precaution. Viewed from this perspective, the condition merely restates the well known proposition in economics that people will under-invest in activities that would generate positive externalities, and over-invest in activities that would generate negative externalities. In other words, if the expected private gain is greater than the expected social gain, the injurer will overcomply. If, instead, the private gain is smaller than the social gain, he/she will undercomply. It is

\(^{10}\) In this sense, it represents the minimum unavoidable level of accident loss from the social point of view, and therefore, has to be borne by somebody in the society even at the optimal state of affairs.
only when both are equal that the injurer takes the socially optimal level of care.

By slightly transforming the condition, we can obtain a still more intuitive explanation, this time from an individual point of view. Note that \(-A_1^* = w_1\) at the social optimum. Replacing it and multiplying both sides with \(A^*\), we have

\[
\text{overcompliance} \quad < \\
\text{undercompliance} \quad \text{if} \quad w_1 \quad > \quad \frac{f(0)}{1 - F(0)} A^*. \quad (12)
\]

The left hand side now represents the injurer’s private cost of additional precaution and the right hand, the amount of expected damage payment he/she can save by taking that extra caution. The condition thus says that if you can save more than it costs by taking an additional precaution, then you will surely take it, and it will result in an overcompliance. Conversely, if the saving you can enjoy by taking an extra precaution falls short of the cost that you have to undertake, then you will not take it, resulting in an undercompliance.

Let’s investigate the relationship a little bit more closely, delving into the underlying factors that would lead to over- or undercompliance. For this purpose, the expression (12) provides us with valuable information, identifying the four most important factors affecting the compliance result: \(w_1\), the price of care; \(1-F\), bias in judgment error; \(A^*\), the size of expected accident loss; and \(f\), the dispersion of the distribution of the judgment error.

Holding \(f(0)/[1 - F(0)]\) constant for a moment, let’s first consider the relationship between \(w_1\) and \(A(x_1^*, x_2^*)\). Note that \(w_1\) is the price of care, the opportunity cost of care taking. \(A(x_1^*, x_2^*)\) is the expected accident loss when both injurer and victim take the socially optimum amount of care. For a given \(w_1\), if \(A(x_1^*, x_2^*)\) is large, the right hand side is likely to be greater than the left hand side, thus resulting in overcompliance. In this case, the injurer takes extra precaution because the damage payment at stake is very high. This in turn implies that if the minimum unavoidable expected accident loss is still very large, either because the probability of accident is very high or the size of the accident loss itself is big, it is likely that the injurer will take extra care. On the other hand, if the minimum expected loss is small, the injurer would take a less-than-
optimum level of care because the stake involved is small. The same story can be applied to the price, given the size of the expected loss. If the price of care is cheap compared to the expected burden she would have to bear if found negligent, it would be better for her to take that extra care to be relatively freer from that burden. On the other hand, if the price of care is relatively high, it is not worthwhile to take that care. Thus she will reduce her care level below the legal standard.

Now let’s turn to \( f(0) \), which stands for the marginal change in the probability of being held liable at the socially optimal level of the injurer’s care. In the case of regular probability distributions, i.e., symmetric uni-modal distributions, this density value at the center of a distribution measures the degree of dispersion of the given distribution\(^{11}\). It would take a large value if the variance of the distribution is small and would take small value if the variance is large. A large variance in this context means that a small change in the level of care would not have a great impact on the chance of his being held negligent or non-negligent. Here again, the intuition is clear. If one unit of extra care cannot bring the injurer a corresponding quid pro quo in the form of a reduction in the expected damage payment, it is not worth taking. If, on the other hand, the distribution is highly concentrated and therefore is quite sensitive to small changes in care level, it would be better to make such an investment to cut the unhappy onus that might be imposed upon her.

Lastly, \( 1-F(0) \) term captures the effect of the bias of the judgment error. If the error is unbiased so that it is equally likely that the court holds an injurer to be negligent or non-negligent given that he/she has set his/her care exactly at the legally required level, the error distribution would be symmetric, i.e., \( F(e) = 1-F(-e) \), and \( F(0) = 1-F(0) \) would be exactly \( 1/2 \) for every distribution\(^{12}\). If the distribution is tilted more toward the negative side so that the court is more likely to hold a faithful law-abider to be negligent, \( 1-F(0) \) will be less than \( 1/2 \) or \( 1/[1-F(0)] \) greater than 2, thus making the right hand side of the inequality (10) larger. This will induce the potential injurer to take excessive precaution. In other words, if the court is known to be harsh in the sense that it would hold more to be liable than not, the injurer would take an extra precaution in order to avoid the unhappy consequence. If the court is known to be

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\(^{11}\) Or in the case of uniform distribution, it measures the margin of error.

\(^{12}\) This is a bit disconcerting since it implies that those people who have faithfully abided by the legal rules and set their care level exactly at the required level should still face the possibility of being held liable with a fifty percent chance. Yet, this is the reality from which no one can escape under imperfect information.
lenient on the contrary, in the sense that it would be more likely to set free even those somewhat negligent injurers, the potential injurer will take a somewhat relaxed attitude and will thus undercomply.

In sum, the potential injurer will be the more cautious and thus will overcomply, the cheaper the price of care, the more precise the court’s measurement of care, and the harsher the court’s decision on the care level actually taken.

The following two graphs each illustrate the representative cases of overcompliance and undercompliance. Below, the solid curves depict the expected cost under evidentiary uncertainty, with the socially optimum level of care denoted as $x_1^*$, and individual optimum as $x_1^-$.

![Figure 1](image-url) Overcompliance and Undercompliance

Panel (a) represents overcompliance and the panel (b) undercompliance. Three factors are worth noting in comparing these two diagrams. First, in panel (a), the slope of the straight line is flatter than that in panel (b), signifying that the price of care is relatively cheap. Second, the bottom point of the expected total cost curve is located...
way above in panel (a) than in panel (b), implying that the damage payments at stake is
greater in panel (a) than in panel in (b). More accurately the distance between the
$w_1x_1+A$ curve and the $w_1x_1$ line at $x_1^*$ is greater in panel (a), implying $A(x_1^*,x_2^*)$ is quite
high. Lastly, the range in which the thick curve deviates from the thin curve and the
straight line to form the expected cost curve is narrower in panel (a) than in panel (b),
suggesting that the judgment error distribution is more dispersed in panel (b). As
explained, these three factors are the key determinants that induce the potential injurer
whether to take more or less than optimum level of care under uncertainty. Note also
that these two diagrams are drawn under the implicit assumption of symmetric error
distribution. This makes the thick curve pass the mid-point of the distance between
$w_1x_1+A$ and $w_1x_1$ and makes the curve look smooth. If there is a systematic bias, the
thick curve will pass above or below the midpoint and the curve will look more wriggly
toward a certain direction.

Let’s us briefly examine the victim’s incentives to take due care under uncertainty,
this time assuming in turn that the injurer will stick to the social optimum even though
we now understand that this cannot be true in general. What is interesting here is that
unlike the injurer’s case, the victim always chooses less-than-optimal care. The
intuition is simple. The fact that the injurer always has a positive -- however small it
may be -- probability of being held liable under the simple negligence rule makes the
victim ease off on his/her part, because on average terms, part of the loss is always
shared by the injurer.

The minimization problem that a victim is faced with is

$$\text{Min}_{x_2} \quad J_2 = w_2 x_2 + A(x_1, x_2) [1 - F(x_2^*-x_1)].$$  \hspace{1cm} (13)

The first order condition is

$$\frac{\partial J_2}{\partial x_2} = w_2 + A_2(x_1^*, x_2^*)[1 - F(x_2^*-x_1)] = 0$$  \hspace{1cm} (14)

Evaluating at $x_i=x_i^*$, and making use of (2) again, we have

$$\frac{\partial J_2}{\partial x_2} \bigg|_{x_i=x_i^*} = w_2 - w_2 [1 - F(0)] = w_2 F(0) > 0$$  \hspace{1cm} (15)
So the victim will always undercomply, i.e., $x_2^s < x_2^\ast$. Note that $F(0) = 1/2$ if symmetric, making the victim's incentive to deviate from the optimum equal to $w_2/2 = A_2(x_1^\ast, x_2^\ast)/2$ which can be quite substantial: half of the victim's marginal productivity. Under no judgment error, the victim would have to bear the entire residual loss once the injurer has taken legally due care. This would have induced the victim to take the socially optimal care because otherwise his/her loss would only be larger. Under uncertainty, however, if the injurer takes his/her due care, the remaining burden for the victim is just half of the original loss, so he/she slashes off his/her care level correspondingly. This burden sharing effect makes the victim take a relaxed attitude toward the uncertainty and thereby undercomply.

Of course, it is true that there is also a positive chance that the defendant can successfully dodge the damages even when he/she knowingly choose insufficient care. But on average terms, the burden that the victim has to bear is always less than the actual loss under the regime of judgment error, and this drives the victim's undercompliance. In some sense, it is similar to the moral hazard in insurance contract. If an accident occurs, the expected loss that he/she has to bear for him/herself has been reduced through the insurance. So he/she takes a less attentive attitude to reduce the loss itself or the probability of it happening.

It is also interesting to note that the victim's incentive to undercomply depends only on the price of care, $w_2$, and the bias of judgment error, $F(0)$, but not on the dispersion of the error distribution.

2) The Feedback Effect Due to the Other Party's Deviation from the Optimum

Now we know that $x_2^s < x_2^\ast$, which prompts us to correct our early assumption that the victim will somehow stick to $x_2^\ast$. Knowing that the victim has an incentive to take less-than-optimal care, how would the injurer respond to this? To answer this question, we have to formally tackle the put-off task of evaluating (8). For this, I take a linear approximation of $A_1(x_1, x_2)$ and $A(x_1, x_2)$ in (8) around the point $(x_1^\ast, x_2^\ast)$ and evaluate them at $(x_1^\ast, x_2^s)$ 13. Taking a Taylor expansion and the required evaluation yields

13 This requires the $A(x_1, x_2)$ function to be twice-differentiable, which we assume so.
\[ A_1(x_1^*, x_2^*) = A_1(x_1^*, x_2^*) + A_{12}(x_1^*, x_2^*) \cdot (x_2^* - x_2^*) \]  
(16)

\[ A(x_1^*, x_2^*) = A(x_1^*, x_2^*) + A_2(x_1^*, x_2^*) \cdot (x_2^* - x_2^*). \]  
(17)

Substituting and simplifying gives

\[ ? = [1 - F(0)]\left[ w_1 \cdot \frac{f(0)}{1 - F(0)} A^* + \frac{A_{12}^*}{A_2^*} \left( \frac{f(0)}{F(0)} \right) F(0)A_2^*(x_2^* - x_2^*) \right]. \]  
(18)

The first term replicates what we have already seen in (10). What is new is the second term which gives the sought-for effects of the victim's deviation from the optimum. As in the above, if the second term as a whole has a positive sign, assuming the first term is neutral, the injurer will undercomply and if negative, overcomply.

Basically, from the injurer's point of view, the victim's deviation has the following two effects: first, it alters the actual size of the accident loss (from the optimal state) which must be borne by the liable party. This is captured by \( A_2^* \). If the victim's care is greater than the optimum, the resulting loss will smaller than that at the optimum, and vice versa. Second, it also alters the marginal productivity of the injurer's care in reducing the loss, which is captured by \( A_{12}^* \) term. If its sign is negative, the victim's care magnifies the marginal productivity of the injurer's care. Conversely, if the sign is positive, it dwarfs the latter.

With this on hand, let's examine \( F(0)A_2^*(x_2^* - x_2^*) \) first, ignoring the bracket for a moment. \( A_2^*(x_2^* - x_2^*) \) is the change in the expected accident loss induced by the victim's deviation. It will be negative if the victim's care level is greater than the optimum, and positive if the victim's care is smaller than the optimum. Since the analysis in the previous subsection suggests that the victim is likely to undercomply, it implies that the loss is now larger. Multiplying it with \( F(0) \) then gives the change in the expected damage payment conditional on the injurer's being found liable.

Now let's investigate the inside of the bracket which determines the direction of the injurer's response. If the inside is positive, the overall sign of the second term except \( (x_2^* - x_2^*) \) will be negative, making the whole term have an opposite sign to that of \( (x_2^* - x_2^*) \).

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\[ ^{14} \text{This is only tentative and not necessarily true any longer, because we have to consider, here also, the possible feedback effect that would come from the injurer's side.} \]
This will make the injurer’s care and victim’s care move toward the same direction, generating an ‘over to over’ or ‘under to under’ pair. On the other hand, if the inside of the bracket is negative, it will cause the two party’s care to move toward opposite directions each other, yielding an ‘over to under’ or ‘under to over’ pair. As will be seen shortly, the bracket is more likely to be negative than positive, which, combined with the victim’s implied undercompliance, suggest that the injurer is more likely to overcomply, as far as the feedback effect is concerned.

The first term inside the bracket stands for the percent change in the victim’s marginal productivity due to the injurer’s additional care, and the second term represents the percent change in the probability that the injurer will be held liable. The second term is invariably negative because an injurer’s additional care always reduces his/her probability of being held liable. Therefore, the whole bracket will be negative once the first term is non-positive, i.e., $A_{12} \geq 0$. It can be positive only when the first term is positive and the absolute value of the first term exceeds that of the second term.

Let’s start with the case of $A_{12} = 0$. In this case, the inside of bracket is left only with the second term, $-f(0)/F(0)$, whose sign is negative. Therefore, the injurer will overcomply. The intuition is that given that the victim took a less-than-optimal care, the expected loss is now made bigger by that deficiency. In this case, the injurer is better off taking greater care to cut his/her probability of being held liable, -- this is the $f(0)$ effect -- even if the victim’s deviation has made no dent on the productivity of his/her additional care, i.e., $A_{12} = 0$.

If $A_{12} > 0$, the above tendency is reinforced. In this case, the victim’s smaller care has made the marginal productivity of the injurer’s care larger ($A_{12} > 0$). This gives an additional impetus for the injurer to take extra care. By taking that extra care, the injurer can now reduce the size of the expected loss itself as well as the probability of her being held liable.

Finally, consider the case of $A_{12} < 0$. Under $A_{12} < 0$, the victim’s under-care not only

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15 This is comforting from a policy point of view because the victim’s shortfall is expected to be filled by the injurer’s excess, thus containing the social loss within a certain boundary. But this is not always so. In an extreme case, it is still possible that the two may go hand in hand in one direction, aggravating the situation.
makes the remaining loss size bigger but also renders the injurer’s care to be less potent in its loss-reducing power. Rendered to be less powerful, the injurer now has to be more cautious in wielding her weapons. Mathematically, $A_{12}<0$ makes the first term inside the bracket positive. But the second term is negative. Therefore, the injurer will take extra care only when the negative second term overwhelms the positive first term. If, on the contrary, the first positive term dominates, the injurer will also undercomply in response to the victim’s undercompliance.

Note that even with $A_{12}=0$, the technical independence between the two cares does not allow the injurer to completely disregard the victim’s care. Notwithstanding the technical independence, the injurer still has to consider the victim’s possible reaction in determining his/her equilibrium care under uncertainty. Under perfect information, the injurer’s optimal care does not depend on the victim’s care: the F term does not appear in the injurer’s minimization problem, because the probability is given as either 1 or 0 in a discontinuous fashion. Under uncertainty, however, the injurer has a positive probability of being held liable under all circumstances, and therefore, her expected damage payment is always affected by the victim’s behavior, however minute it may be.

The overall effect of uncertainty on the injurer’s care level is obtained by combining these two effects, the pure uncertainty effect and the feedback effect. Since each term has no definite sign, we have to conclude that the overall effect is uncertain. In particular, as far as the pure uncertainty effect is concerned, there is nothing to say about the possible directions apriori: it depends on many underlying factors as explained above: the cost of care, the expected loss size, the dispersion and bias of the distribution. With regard to the feedback effect, we may be able to be relatively a bit more definite because we can say that the victim is likely to undercomply, and, as a consequence, the injurer is likely to respond to it with an overcompliance. Therefore, if we ignore the direct effect, the statement mentioned at the outset that the injurer will overcomply has some relevance. But it must pointed out that in this case, the reason for the overcompliance comes not from the injurer’s own initiative to keep his/her destiny safe and secure but from his/her response to the victim’s likely undercompliance, which has been so far largely ignored in the literature.

It is also worth noting that the whole expression (18) taken together is couched in terms of an weighted average: the probability of being exonerated and probability of being held liable, with each probability multiplied by the possible benefits and costs in
each incidence. In this regard, the earlier writer's practice of considering only the first term is seriously flawed in the sense that they have inadvertently dropped the second term out, and thus leaving the average incomplete.

Now I turn to the victim's response to the injurer's care. Following the same procedure as we have done with the injurer's care, we obtain the following victim's first order condition which is evaluated at \((x_1^*, x_2^*)\)

\[
\frac{\partial J_2}{\partial x_2} \bigg|_{x_1=x_1^*, x_2=x_2^*} = w_2 F(x_1^* - x_1^t) + A_{21}^t (x_1^* - x_1^t)[1 - F(x_1^* - x_1^t)].
\] (19)

The first term is quite similar to what we had earlier in (13), except that the inside of \(F\) is now \((x_1^* - x_1^s)\) instead of 0. So we may still call the first term as the pure uncertainty effect, and the second term as the feedback effect\(^{16}\). The first term replicates the similar result we had earlier that the victim will undercomply under uncertainty. Of course, the degree of undercompliance will be slightly altered because of the injurer's deviation from the social optimum: if the injurer overcomplies, the value of \(F\) will become smaller, implying the remaining probability that the victim should take the responsibility gets larger. This induces the victim to take a slightly bigger precaution than in (13), but still less than the optimum as long as \(F>0\). If the injurer undercomplies, the opposite holds.

Here again, the feedback effect depends on the signs of \(A_{21}\) and \((x_1^* - x_1^s)\). If both have the same sign, it will lead to the victim's undercompliance, but if both have opposite signs, overcompliance. Finally if \(A_{12}=0\), the feedback effect disappears. The reason why this feedback effect is simpler than in the case of the injurer is that the probability of the victim being held liable, \(1-F\), is not a variable controlled by the victim but by the injurer under the current simple negligence rule. As in the earlier case, the feedback effect doesn't depend on the dispersion of the error distribution.

The overall effect on the victim's care is obtained by combining these two effects together. If the first term dominates, it will lead to the victim's undercompliance. If instead, the second term dominates, the overall effect is uncertain. There is some reason to believe that the first term is more likely to overwhelm the second term. This

\(^{16}\) To be precise, we might have applied the same Taylor expansion to the \(F\) term as well. But this is not necessary for our current purpose.
is because of the second order condition, $A_{11}A_{22} - (A_{12})^2 > 0$, which requires that the direct effect of one party’s care must be greater than the cross effect. This implies that the victim is likely to undercomply in most circumstances under uncertainty.

If we accept the judgment error as an unavoidable facts of life, this deficiency of care on the part of victim poses a serious social problem because it implies that society has to suffer from a sub-optimally large amount of accident loss under the simple negligence rule. This may partly explain the historical evolution in which the legal doctrine governing a tort system gradually switched from the simple negligence rule to contributory negligence rule. For what the contributory negligence rule pronounces is that the victim must not complacently sit there with a less-than-optimal care and allow the accident to happen, to that when the accident takes place, he/she just collect the damages. Unless the victim proves that he/she also was not negligent, he/she cannot claim the damages. It can be shown that the victim’s one-sided mal-incentive to take a sub-optimal care is partly cured under the contributory negligence rule.

3. Conclusion

We have derived the exact conditions for over- or undercompliance of potential injurers under uncertainty in a negligent tort case and investigated the economic rationales behind the conditions. The analysis delineates clear and intuitive conditions under which over and under compliance can result. Unlike the much touted claim that uncertainty will invariably lead to excessive care, our analysis shows that both over and under-compliance can happen. This implies that some of the earlier results which hinges on this proposition must be reexamined. The method developed in this paper can also be fruitfully utilized in investigating the relationships among various other negligence rules under uncertainty.

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17 See Yoo (2003).
References


Edlin, A.S., "Efficient Standards of Due Care: Should Courts Find More Parties Negligent under Comparative Negligence?" Int'l Rev. of Law and Econ. vol. 14, 1994, 21-34.


