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A Note on Optimal Care by Wealth-Constrained Injurers

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Abstract

This paper clarifies the relationship between an injurers wealth level and his care choice by highlighting the distinction between monetary and non-monetary care. When care is non-monetary, wealth-constrained injurers generally take less than optimal care, and care is increasing in their wealth level under both strict liability and negligence. In contrast, when care is monetary, injurers may take too much or too little care under strict liability, and care is not strictly increasing in injurer wealth. Under negligence, the relationship between injurer care and wealth is similar in the two formulations. However, when litigation costs are added to the model, the relationship between injurer care and wealth becomes non-monotonic under both liability rules.

A Note on Optimal Care by Wealth-Constrained Injurers

1. Introduction

In the standard economic theory of liability, injurers choose care to minimize the

sum of their cost of care and liability (plus litigation costs, if any).[1] Ordinarily, this is

treated as an unconstrained minimization problem, but in reality, injurers have limited

assets, or wealth, with which to pay these costs. This is especially true for individual

injurers who are either uninsured or underinsured, but it is also important for firms

because, although they have more assets, they are more likely to cause large-scale

accidents. In addition, firms may be able to organize their corporate structures in ways

that shield their assets from liability (Ringleb and Wiggins, 1990).

Shavell (1986) was the first to formally analyze the incentive effects of a limit on

injurers' ability to pay damages (what he called the "judgment-proof problem"). He

showed that under strict liability, injurers will take less than optimal care as long as their

assets are less than the victim's damages. Under negligence, injurers will also take too

little care if their assets are less than a critical amount that is strictly less than the victim's

damages. Thus, Shavell concluded that negligence is preferred over strict liability when

injurers have limited ability to pay damages. Under both rules, care is strictly increasing

in the injurer's asset level.

Shavell's model, however, assumes that care is non-monetary, so its exercise does

not reduce the assets the injurer has to spend on liability. This is true, for example, of

accident settings where care involves *effort*, like being attentive while driving or clearing

snow from a sidewalk. In contrast, Beard (1990) showed that if care involves a *monetary*

expenditure, as when a railroad installs crossing gates or a manufacturer invests in

product safety, the injurer's incentives for care under strict liability are not necessarily reduced. Intuitively, the injurer may have an incentive to increase his spending on care up-front in order to lower his liability for damages later. Beard did not consider injurer care under a negligence rule.

This paper re-examines and clarifies the relationship between an injurer's asset level and his care choice. The emphasis is on a graphical analysis that provides a unified approach to the judgment-proof problem. The paper begins by developing a simplified version of Beard's model that shows the impact of including both the injurer's cost of care, and liability for damages, as part of his budget constraint. It also illustrates the difference between Shavell's and Beard's treatments of the injurer's asset constraint.

In addition, the analysis extends Beard's model in two ways. First, it shows that under a negligence rule, the Shavell and Beard formulations yield qualitatively similar results regarding the relationship between injurer assets and care (as described above). Second, the analysis incorporates litigation costs as a further component of the injurer's budget constraint. The presence of costly litigation allows injurers to avoid suits by taking enough care to lower their assets below the level that would make suits profitable for victims. As an injurer's assets increase, however, suits eventually become profitable, at which point care drops discretely (for reasons that will be made clear) under both strict liability and negligence. Litigation costs thus add another source of non-monotonicity in the relationship between injurer assets and care.

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[1] See Brown (1973), Landes and Posner (1987), and Shavell (1987).

2. The Model with Zero Litigation Costs

We first consider the case of zero litigation costs, and then extend the analysis below to allow for positive litigation costs.

2.1. Strict Liability

The standard (unconstrained) economic model of accidents involves the choice of care by an injurer to minimize his cost of care plus expected liability.[2] This problem can be written

$$\text{Minimize } x+p(x)L \tag{1}$$

where x is the dollar cost of care, $p(x)$ is the probability of an accident ($p'<0, p''>0$), and L is expected liability. Under a rule of strict liability, L equals the victim's actual damages, D, which yields the efficient level of care, x^*, as the solution to

$$1+p'(x)D=0. \tag{2}$$

In Shavell's model, the injurer's assets, A, may be insufficient to cover D, so the constraint, $L=\min[D,A]$ is added to (1). If $A\geq D$, the asset limit is not binding and the injurer chooses optimal care, but if $A<D$, the injurer chooses care equal to $\tilde{x}(A)<x^*$, which is the solution to

$$1+p'(x)A=0. \tag{3}$$

It is easy to show from (3) that $\tilde{x}(A)$ is increasing in A.[3]

Beard's (1990) reformulation of this model recognized that the injurer's expenditure on care before the accident reduces his post-accident asset level to A-x. Thus, the injurer's asset constraint becomes $L=\min[D,A$-$x]$, and his problem under strict liability is properly written as

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[2] We focus on the unilateral care accident model. See Shavell (1987: Ch. 2).

Minimize $x+p(x)L$ (4)

Subject to: $L=\min[D, A-x]$

We focus on a graphical solution to this problem. To do this, we first derive the iso-cost curves associated with the objective function in (4). Totally differentiating this expression yields their slope in (L,x) space as follows:

$$\frac{\partial L}{\partial x}\Big|_{\overline{C}} = \frac{-(1+p'L)}{p} \hspace{3cm} (5)$$

The curves are thus inverted U's, with costs decreasing to the lower left, as shown in Figure 1. Also note that the peaks of the curves, corresponding to the unconstrained minimum points of the cost expression for given values of L, shift leftward as L decreases.

Figure 2 shows the injurer's care choice when $L=D$ (given by x^*) and when the asset constraint (shown by the darkened line) is binding ($\hat{x}$). In the absence of the asset constraint, the injurer therefore chooses the optimal care level under strict liability (the standard result). When the asset constraint is binding, however, it should be clear from the graph that $\hat{x}$ may be either larger or smaller than x^*, depending on the specific location of the iso-cost curves.

Formally, when $L=A-x$, the injurer minimzes

$$x+p(x)(A-x). \hspace{3cm} (6)$$

Assuming an interior solution, we obtain the first-order condition

$$-p'(x)(A-x)=1 - p(x). \hspace{3cm} (7)$$

Since $A-x<D$, $\hat{x}$ may be larger or smaller than x^*. This is essentially Beard's result, though the model differs from Beard's in that he treats the victim's actual damages, D, as

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[3] Differentiating (3) yields $\partial \tilde{x}/\partial A=-p'/p''A>0$.

a random variable which is unknown to the injurer when he makes his care choice. Our results show that variation in D across victims is not essential to derive his principal result (i.e., non-monotonicity of $\hat{x}$ in A).

The intuition for Beard's result is as follows. If the injurer spends \$1 on care, the amount he has left to pay liability is reduced by \$1, which represents an expected savings of $p(x)\times\$1$. Thus, the marginal cost of care is perceived to be $\$1-p(x)$ (as shown by the right-hand side of (7)), which is less than \$1. If this "subsidy" to care is large enough to offset the fact that the injurer's remaining assets are less than damages (i.e., $A-x<D$), then the injurer will actually spend more than x^* on care.

In contrast to the Beard formulation, in Shavell's (1986) model, $\tilde{x}$ is always less than x^*. Geometrically, this is true because the asset constraint is simply a horizontal line at $L=A$ in Figure 2. Thus, when $L=A<D$ (i.e., when the constraint is binding), the tangency of the iso-cost curve with the constraint occurs at the peak of the curve and therefore must be to the left of x^*. It is not generally possible, however, to say whether $\tilde{x}$ is larger or smaller than $\hat{x}$ for any given $A<D$.[4]

We next consider how $\hat{x}$ varies with A. First we ask whether it ever pays the injurer to intentionally exhaust his assets on care (by setting $x=A$) in order to leave himself entirely judgment-proof in the event of an accident. It turns out that this is never optimal in the model with zero litigation costs. To see this, note that at $x=A$, the left-hand side of (7) becomes $1-p(A)>0$, which implies that costs are rising. Thus, $\hat{x}<A$.[5]

The impact of an increase in A can be found by totally differentiating (7) to obtain

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[4] When $A>D$, the constraint in Shavell ceases to bind, but it continues to be binding in the Beard formulation as long as $A<D+x$.
[5] Beard (1990) states this result as well (see his footnote 5).

$$\frac{\partial \hat{x}}{\partial A} = \frac{-p'}{p''(A-x)-2p'} > 0. \tag{8}$$

Thus, care is increasing in the injurer's assets. This is reflected in Figure 2 by a rightward shift of the tangency point as the budget constraint shifts out with increases in A. Note further from (8) that $\partial \hat{x}/\partial A < 1$. Thus, the injurer's expenditure on care rises less than dollar-for-dollar with his assets. Consequently, the injurer's liability, $\hat{L} = A - \hat{x}$, increases with A. As a result, the asset-expansion path in Figure 2 is positively sloped.

Finally, note that the injurer's total costs are increasing in A over the range where the budget constraint is binding. This follows by differentiating $\hat{C} = \hat{x} + p(\hat{x})(A - \hat{x})$ and using the Envelope Theorem to obtain

$$\frac{\partial \hat{C}}{\partial A} = p(\hat{x}) > 0. \tag{9}$$

(Costs are therefore also increasing less than dollar-for-dollar with A.) As A continues to increase, at some point the budget constraint ceases to bind and the injurer minimizes costs subject to $L=D$. When this happens, the injurer switches to the socially efficient level of care, x^*, which is independent of his level of assets. The point at which this switch occurs, denoted A_S, solves the equation

$$\hat{x} + p(\hat{x})(A_S - \hat{x}) = x^* + p(x^*)D. \tag{10}$$

Figure 3 illustrates this condition graphically. Note that at the indifference point, $\hat{x}(A_S) > x^*$.

Figure 4 shows the general relationship between injurer care and asset level, as implied by the preceding analysis. For low levels of A, we get the expected result that the injurer takes too little care, but care increases in A and eventually *overshoots* the efficient

level over some range of A. Finally, at the threshold point A_S, the asset constraint ceases to bind, and the injurer switches to the efficient level of care thereafter. The relationship between the injurer's assets and his care choice under strict liability is similar to that in Shavell, except that in his model there is no overshooting of the efficient level. The resulting non-monotonicity of care in A is therefore a consequence of the reformulated budget constraint.

2.2 Negligence

We now consider the impact of the injurer's asset limit under a negligence rule with the due standard of care set at the efficient level, x^*. The injurer can therefore avoid all liability by setting $x=x^*$, which is the optimal choice when he is not wealth-constrained.[6] When the asset constraint applies only to liability, Shavell (1986) showed that the injurer will choose optimal care, x^*, unless his asset level falls below a critical value, A', that is *strictly less* than D. For $A<A'$, the injurer chooses care equal to $\tilde{x}(A)$, the solution to (3), and is negligent. The critical value A' solves the equation[7]

$$x^* = \tilde{x}(A') + p(\tilde{x}(A'))A' \tag{11}$$

Now consider the case where A constrains both liability and care. As in Shavell's (1986) model, the injurer will choose x^* unless A falls below a critical value that is strictly less than D, at which point he switches to $\hat{x}(A)$ as defined by (7). The critical value of A, denoted A_N, is defined by the equation

$$x^* = \hat{x}(A_N) + p(\hat{x}(A_N))(A_N - \hat{x}(A_N)). \tag{12}$$

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[6] See, generally, Shavell (1987, Ch. 2).
[7] To show that $A'<D$, note that $\tilde{x} + p(\tilde{x})A$ is increasing in A (using the Envelope Theorem). The result follows from (11) and the fact that $x^* \equiv \tilde{x}(D) > \tilde{x}(A')$.

This value is shown in Figure 5, while the darkened segments show the injurer's care choice as a function of A. Thus, for $A<A_N$, the injurer chooses $\hat{x}(A)$ and is found negligent, but for $A>A_N$ he meets the due standard. Note that the threshold at which the injurer switches to the efficient care level under negligence, A_N, is strictly less than the corresponding threshold under strict liability, A_S (compared Figures 4 and 5). As a consequence, the injurer's care at the switch-point takes a discrete *upward* jump under negligence (i.e., $\hat{x}(A_N)<x*$), which is in contrast to the case under strict liability where care overshot the efficient level and then declined at the threshold. Thus, as in Shavell (1986), negligence leads to efficient care over a larger range of A as compared to strict liability.

3. The Impact of Litigation Costs

In this section, we examine the impact of adding litigation costs to the preceding analysis. Thus, let c_i and c_v be the cost of trial for the injurer and victim, respectively. We first consider litigation costs in the context of strict liability, and then turn to negligence.

3.1. Strict Liability

In the standard accident model with strict liability, litigation costs have two impacts on the behavior of victims and injurers.[8] First, only victims whose damages exceed their litigation costs choose to file suit. Second, injurers adjust their care downward to account for the fact that some victims do not file suit, and upward to account for their own litigation costs when suits are filed. When the injurer is wealth-contrained, there is a third possible effect—the injurer may choose a high enough level of

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[8] See Polinsky and Rubinfeld (1988) and Hylton (1990).

care so that his remaining assets are insufficient to make a suit profitable for victims (even if their actual losses exceed their litigation costs).[9] To highlight this effect, we assume that $D>c_v$, so that in the absence of a wealth constraint for injurers, victims would always file suit.

When a victim files suit against a wealth-constrained injurer, we assume that the injurer must pay his own litigation costs before the victim receives any damages. Thus, given that care is a sunk cost at the time of a suit, the assets available to the victim are $A-x-c_i$. The victim will therefore file suit if and only if $A-x-c_i>c_v$.[10] It follows that the injurer can deter suits by choosing care such that

$$x \geq A-c_i-c_v \equiv \bar{x}(A) \tag{13}$$

In this case, the injurer's cost is simply his cost of care, x.[11]

If the injurer instead chooses care of $x<\bar{x}(A)$, he faces suits, and his costs include his expected liability plus his own litigation costs. In the absence of a wealth constraint (or when it is not binding), these costs are $D+c_i$ (i.e., $L=D$), in which case the injurer chooses x to minimize

$$x+p(x)(D+c_i) \tag{14}$$

Let x^{**} be the solution to (14). Note that $x^{**}>x^*$, which reflects the injurer's litigation costs (as noted above), but x^{**} is less than the socially optimal care level under strict liability because the injurer ignores the victim's litigation costs.

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[9] Polinsky and Rubinfeld (1988) examine a similar strategy by injurers, though in their model, a high level of care deters lawsuits by reducing the victim's damages. We ignore this possibility here by treating D as independent of care.

[10] We assume, for ease of analysis only, that the victim only brings suit when the net gain is strictly positive.

[11] The threshold $\bar{x}(A)$ thus functions like the due standard of care under a negligence rule.

When we account for the injurer's limited assets, it might be true that $A-x<D+c_i$, in which case his costs in the event of a suit are $L+c_i=A-x$.[12] The relevant budget constraint in this case is therefore $L+c_i=\min[D+c_i, A-x]$. Note that when the constraint is binding, the injurer chooses x to minimize (6), yielding $\hat{x}$ as above. In this case, the injurer's optimal care is independent of c_i. Intuitively, any increase (decrease) in c_i simply reduces (increases) L dollar-for-dollar in the range where the constraint is binding.

We can now characterize the injurer's optimal care choice for all values of A. There are several ranges. First, when $A \leq c_i+c_v$, the injurer will take no care and victims will not file suit since the injurer's assets are insufficient to cover the litigation costs. The injurer's costs over this range are zero. When $A>c_i+c_v$, the injurer can still deter suits by taking at least $\bar{x}(A)$ in care, as shown above. He will do this as long as the costs of doing so, equal to $\bar{x}(A)$, are less than the costs of taking less care and facing suits. In the range where the injurer chooses $\bar{x}(A)$, his care is increasing dollar-for-dollar with his asset level, as shown in Figure 6b.

As Figure 6a shows, however, the injurer switches from $\bar{x}(A)$ to $\hat{x}(A)$ at A_1, where the threshold is defined by the equation

$$\bar{x}(A_1) = \hat{x}(A_1) + p(\hat{x}(A_1))(A_1 - \hat{x}(A_1)) \tag{15}$$

In the range between A_1 and A_2, the asset constraint is binding and victims file suit. Also, as Figure 6b shows, the injurer's care level drops discretely at A_1, and then rises *less than*

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[12] Note that when $x<\bar{x}(A)$, $L=A-x-c_i>0$.

dollar-for-dollar in A. The fact that $\bar{x}(A_1) > \hat{x}(A_1)$ follows immediately from (15),[13] and the fact that care rises less than dollar-for-dollar follows from (8).

The final threshold, A_2, marks the point where the injurer's asset constraint ceases to bind, and he switches from $\hat{x}$ to x^{**}. The critical value A_2 is defined by the equation

$$x^{**}+p(x^{**})(D+c_i)=\hat{x}(A_2) + p(\hat{x}(A_2))(A_2 - \hat{x}(A_2)) \tag{16}$$

At A_2, the injurer's care again drops discretely as shown in Figure 6b (the reason is the same as in the zero litigation case—see Figure 3), and thereafter is independent of A.[14]

The preceding has focused on the injurer's optimal care choice as a function of his asset level. In general, the injurer's care will not coincide with socially efficient care. Efficient care when there are no suits is given by x^* (the solution to (2)). Thus, the injurer clearly takes too little care over the range where he sets $x=0$ ($0<A<c_i +c_v$). It is also true that initially, $\bar{x} < x^*$, but it is possible that as A increases, $\bar{x}$ may eventually equal (and possibly exceed) x^*.

When A enters the range where suits are filed ($A>A_1$), the definition of efficient care changes to account for litigation costs. Social costs in this case are given by $x+p(x)(D+ c_i +c_v)$. Over the range where the asset constraint is binding ($A_1<A<A_2$), we again cannot say whether the injurer takes too much or too little care. However, when the asset constraint ceases to bind ($A>A_2$), the injurer takes too little care because, as noted above, he ignores the victim's litigation costs.

3.2. Negligence

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[13] Intuitively, the injurer now faces lawsuits so in addition to care, he faces litigation costs and liability.
[14] We have identified four ranges of injurer care as the most general case. However, we cannot rule out the possibility that the injurer will switch directly from $\bar{x}$ to x^{**} (i.e., that the range between A_1 and A_2 will not exist).

Under a negligence rule with costly litigation, the injurer can now deter lawsuits in one of two ways: by setting x equal to the due care standard, x^*,[15] or by setting $x \geq \bar{x}(A)$ as described in the discussion of strict liability. It follows immediately that the injurer will never choose $x > \min[x^*, \bar{x}(A)]$. Thus, as A increases, one possible sequence is the following. For $A < c_i + c_v$, the injurer chooses $x=0$ as described in the discussion of strict liability. Then, at $A = c_i + c_v$ he switches to $\bar{x}(A)$, which he follows up to the point where $\bar{x}(A) = x^*$, shown by A^* in Figure 7. Finally, he switches to x^* for $A > A^*$. Note that in the first two ranges, the injurer is negligent but faces no lawsuits because of his asset constraint plus the victim's litigation costs, while in the final range he faces no suits because he meets the due standard.

Figure 7 illustrates another possible sequence of choices by the injurer. As before, he chooses $x=0$ for $A < c_i + c_v$, and then switches to $\bar{x}(A)$ at $A = c_i + c_v$. However, it is possible that before he switches to the due standard, he will find it optimal to switch to $\hat{x}(A)$ (the solution to (7)) over some intermediate range of A. This range is given by $A_1 < A < A_N$ in Figure 7. Note that over this range, the injurer is negligent (because $\hat{x}(A) < x^*$), and he faces suits by victims (because $x < \bar{x}(A)$). His asset constraint nevertheless makes this strategy cheaper for the injurer compared to meeting the due standard. Once $A = A_N$, however, it becomes optimal for the injurer to switch to the due standard as described above.

As was the case under strict liability, the injurer will not generally choose efficient care under negligence for $A < A_N$ (though $\hat{x}(A)$ may intersect the efficient care

[15] We retain the same due standard for negligence (the zero-litigation-cost optimum) even though litigation is costly. (See Hylton (1990).)

level at some A between A_1 and A_N). However, when he switches to the due standard at A_N, the first-best outcome (care of x^* and no suits) is achieved thereafter.

4. Conclusion

This paper has used a simple accident model to re-examine the impact of the injurer's budget constraint on his choice of care. The model provided a unifying framework that both clarified the relationship between the Shavell and Beard approaches to the judgment-proof problem and also extended their results. The principal conclusions of the analysis are as follows.

1. The asset constraint does not necessarily result in too little injurer care under strict liability. In his original analysis of the judgment proof problem, Shavell (1986) showed that under strict liability, injurers will take less than optimal care if their wealth is less than the damages that they cause. However, when care is monetary, injurers' wealth limits both their ability to invest in care before an accident, and to pay damages afterward (the Beard formulation). Thus, they may actually spend more than the efficient level of care in an effort to lower their liability in the event of an accident. As a result, care may be too low or too high (though it is more likely to be too high as wealth increases). Under a negligence rule, the results are qualitatively the same under both the Shavell and Beard formulations: injurers take too little care if their wealth is less than a critical value that is lower than the victims' damages, but beyond this critical value, care jumps to the efficient level.

2. Care does not increase monotonically in the injurer's wealth. In Shavell, injurers' care increases monotonically in their wealth under both strict liability and negligence (though, as noted, care does not increase continuously under negligence).

This is no longer true under the Beard formulation. The non-monotonicity of care arises for two reasons. First, under strict liability, the injurer's care overshoots the efficient level as he tries to lower his ability to pay damages ex post, but it then drops back to the efficient level when the wealth constraint ceases to bind. Second, under both strict liability and negligence, the introduction of litigation costs allows injurers to deter suits by taking enough care to lower their wealth below the victim's litigation costs. However, at the point where an injurer's wealth becomes large enough to attract suits, his care drops discretely.

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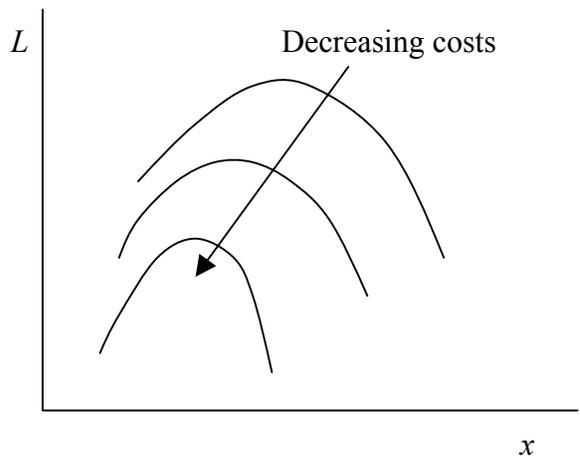
Figure 1. Injurer's iso-cost lines.
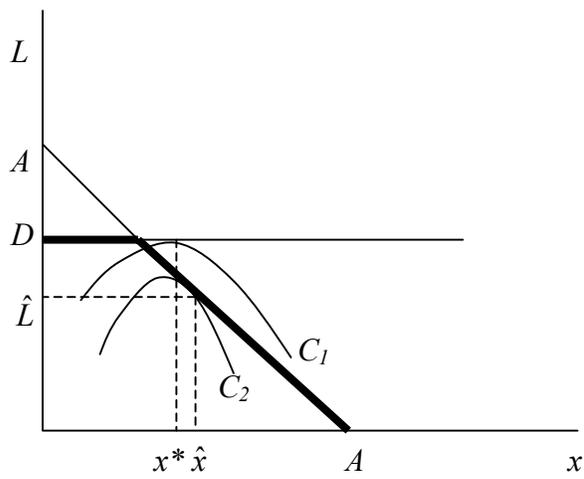
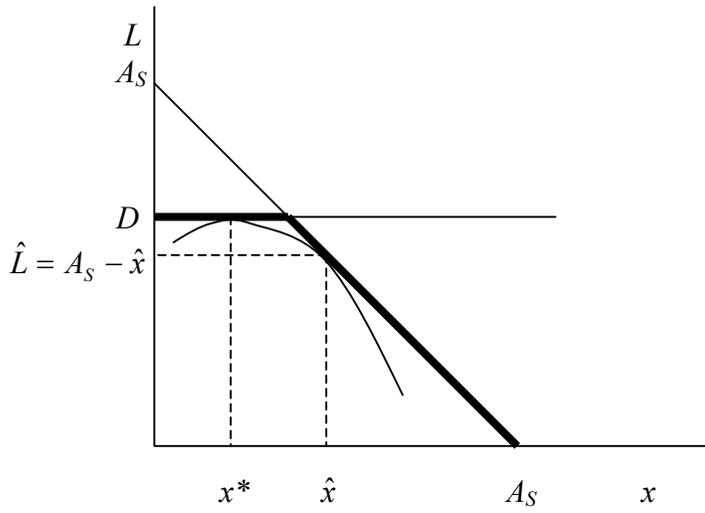Figure 2. Optimal care when asset constraint is binding.

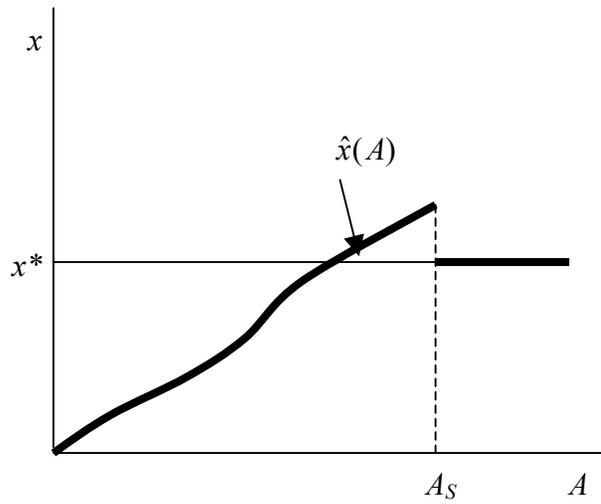Figure 3. Asset level at which injurer is indifferent between x^* and $\hat{x}$.

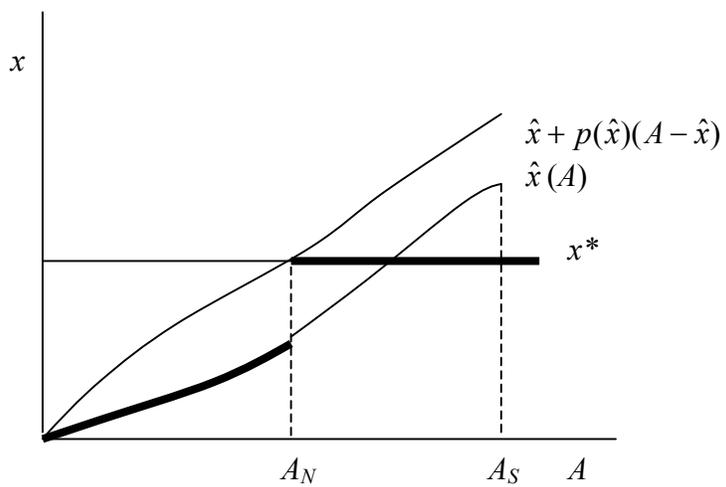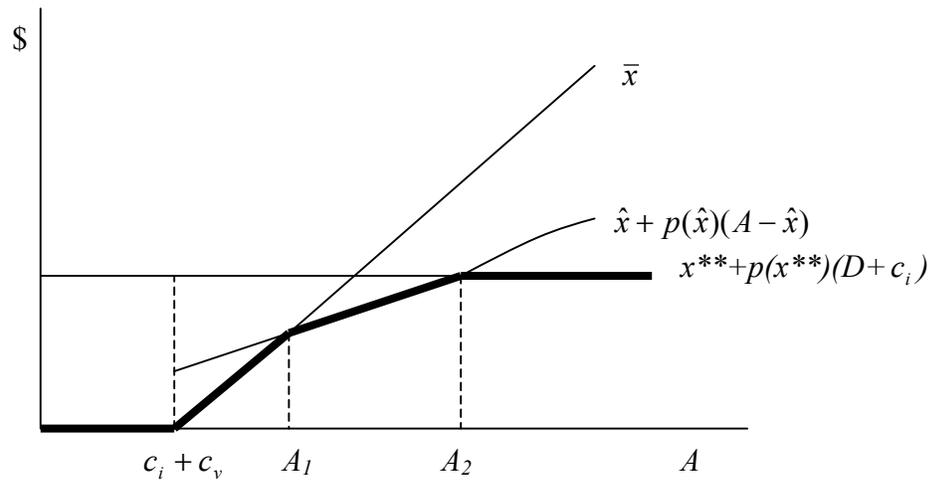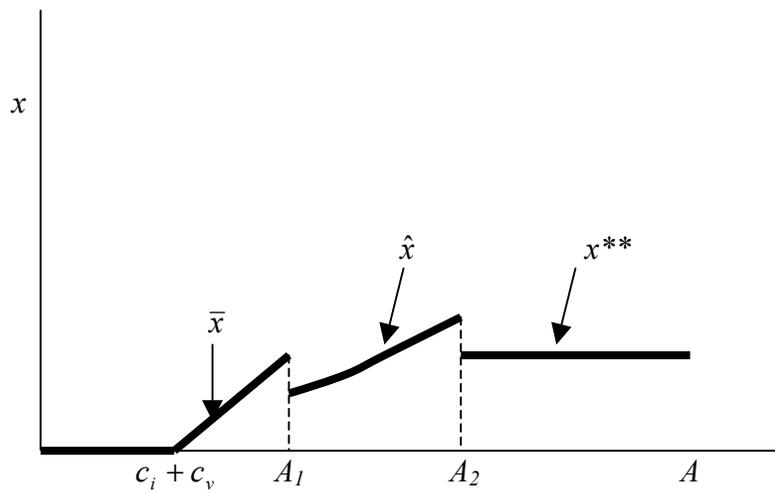Figure 4. Relationship between injurer care and asset level under strict liability.

Figure 5. Injurer's care choice under negligence.

(a)

(b)

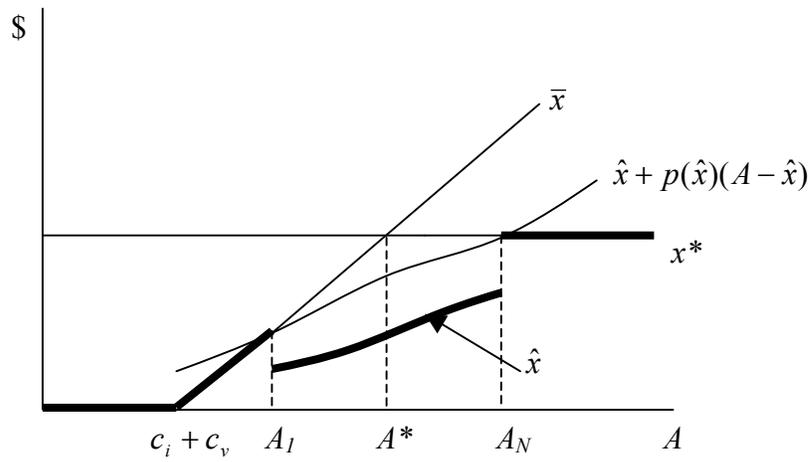Figure 6. Injurer's total costs (a) and care (b) under strict liability when litigation is costly

Figure 7. Injurer care under negligence when litigation is costly.