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Some Recent Developments in the Economic Analysis of Liability Law: An Introduction

by

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Abstract

This paper surveys some recent results on the economic analysis of tort law. We consider accident situations involving two risk-neutral parties. Both parties, injurers and victims, engage in actions that are profitable but affect the magnitude of possible bilateral accidents. We analyze how the injurers' and victims' action choices can be decentralized by liability rules that assign damages to the two parties to an accident according to the action levels they picked. Our focus is on situations where agents are different from each other. We demonstrate how and under which circumstances the efficient allocation of the actions can be decentralized by liability rules. Moreover, we show that liability rules which share damages are superior to negligence rules where one party bears the entire accident costs.

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I. Introduction

This paper surveys some recent results on the economic analysis of liability law. We consider accident situations involving two risk-neutral parties. Both parties, injurers and victims, engage in actions that are profitable but affect the magnitude of possible bilateral accidents. We analyze how the injurers' and victims' action choices can be decentralized by liability rules that assign damages to the two parties to an accident according to the action levels they picked. Our focus is on situations where agents are different from each other. We demonstrate how and under which circumstances the efficient allocation of the action levels can be decentralized by liability rules. Moreover, we show that liability rules which share damages are superior to negligence rules where one party bears the entire accident costs.

Accidents involving more than one party are an example of externalities. By their choices of action levels, two parties jointly determine the magnitude of a possible accident. Without any legal rules each party bears some fraction of the accident costs. Individually rational behavior then typically leads to an inefficient resource allocation. Each agent takes into account the effects of his choice on the fraction of the accident costs he incurs. He ignores the effects of his choice on the other individuals in the economy.

Tort liability may be seen an incentive device whose goal is to induce an efficient pattern of individual behavior. A liability rule allocates the entire actual damages to the two parties to an accident according to the action levels they have chosen. If the law prescribes a liability scheme, agents base their choices on the costs they incur under the rule. Accordingly, a liability rule is a mechanism that decentralizes behavior.

The problem of designing efficient liability rules has mainly been studied in models where all injurers and all victims are identical (see, e.g., Brown (1973)). In this special case, efficiency requires that all injurers engage in the same action level as well as all victims. The efficient allocation can be decentralized by a negligence rule. Such a rule holds injurers not liable if they meet the efficient due action (care) level; otherwise, injurers are strictly liable. In order not to be liable, injurers engage in the efficient due action level. Since victims bear the entire accident costs, they also pick the efficient level.

If injurers (victims) are different from each other, efficiency requires that different individuals engage in different action levels. In this more general setup, the efficient allocation can be implemented by a negligence rule using the incremental Learned Hand formulation (see, e.g., Posner (1986 p. 151-152)). Under this rule an injurer is not liable if his marginal utility from the action is greater than or equal the marginal damage that he causes; otherwise, the injurer is strictly liable.

The negligence rule using the incremental Learned Hand formulation raises two problems. First, it requires that a judge can ascertain individual preferences, a task that is typically difficult to accomplish. Once we drop the assumption that courts can ascertain utility functions, we are bound to find liability rules that depend only on the action choices of the two parties to an accident and not on their individual preferences.

Even if courts are able to discern preferences, a second problem remains. The negligence rule using the incremental Learned Hand formulation implicitly defines a personalized due action level for each injurer and thus raises problems with respect to the equal protection clause. Think as an example of the injurers' action as the speed at which motorists drive. We might wish to treat a medical doctor on his urgent way to a patient different from a tourist if both exceed the speed limit. Yet, are we willing to accept, e.g., income dependent speed limits that allow yuppies to drive faster than the unemployed? If we interpret the equal protection clause such that a law should treat everybody who does the same thing in the same way, we are again restricted to use liability rules that are only conditional on the action choices.

The problem then is to find a liability rule depending only on the action choices of the two parties to an accident that implements a reasonably efficient allocation. The literature suggests (see, e.g., Shavell (1987 p. 86 - 89)) negligence rules with an average due action level, the so called 'reasonable man standard', be applied. These rules induce all injurers to engage in the same 'reasonable' action level. This leads to an inefficiency because some injurers engage in too high while others engage in too low action compared to the social optimum. Yet, since injurers are not liable, victims bear the entire accident costs and engage in action levels that are efficient given the injurers' inefficient choice.

Negligence rules that depend only on the action levels and not on individual preferences are thus an apt device in creating incentives for the parties to an accident. In the identical individuals world they exhibit nice efficiency properties as long as risk-sharing aspects are set aside, as we will do throughout the paper. They are deemed superior to any liability rule that shares an actual damage between injurer and victim. Landes and Posner (1987 p. 82 - 84, p. 314) even call the recent U.S. movements towards sharing rules 'anomalies' that can not be justified on efficiency grounds.

In this paper we illustrate by means of a simple example that liability rules sharing accident costs are superior to negligence rules if individuals are not identical.[1] Our example takes drivers as injurers and bicyclists as victims.[2] Motorists (bicyclists) differ in the marginal utility they obtain from their driving action. In an efficient allocation a driver (a bicyclist) with high marginal utility goes faster than a driver (a bicyclist) with low marginal utility.

First we analyze how and under which circumstances we can implement the efficient allocation of speed levels. We construct a liability rule where the ex ante expected payments increase in the agents' speed levels. The rule thus shares accident costs between drivers

[1] The general results can be found in Emons and Sobel (1988) and Emons (1990). The purpose of the paper at hand is to convey the basic ideas free of mechanism design terminology.

[2] Other examples abound: The probability and/or the degree of oil spills may depend on the speed at which ships use a sea lane. How carefully ice is cleared from sidewalks and the amount of foot traffic determine the number of broken legs. The number of hunting accidents depends on the amount of hunting and hiking in a forest

and bicyclists. Agents with low marginal utility gain less from increasing their speed than agents with high marginal utility. To avoid high expected payments, an agent with low marginal utility drives slower than an agent with high marginal utility. Accordingly, we can implement the first-best speed levels by means of increasing expected payments. The liability rule is designed such that the individuals sort themselves in the desired way.

Under our liability scheme there may be situations where some agents are in expectation better off in the event of an accident than in the event of no accident. That is, some agents may ex ante expect a reward for getting into accidents. This may be seen as a shortcoming of our rule. Therefore, we tackle the question whether the negligence rule using the reasonable man standard is second-best optimal when our liability rule cannot be used due to expected rewards. Again we construct a liability scheme where the fraction of the loss that motorists bear increases with their speed level so that there is some range where accident costs are shared. This increasing liability schedule induces motorists with low marginal utility to drive slower than motorists with high marginal utility. This increases welfare relative to the negligence rule where all drivers pick the same speed.

We thus show that as soon as we leave the identical injurer/identical victim world, negligence rules are no longer efficient in providing the correct incentives. By an appropriate sharing rule we can either implement the first-best optimum or an allocation of speed levels that is superior to the negligence rule outcome.

II. An Example

Consider a place in some rural area that we will call Lawtown. Lawtown has a population of 4 inhabitants and one mainstreet. Two inhabitants possess a gas guzzler each while the other two own a racing bike each. Car driver i, $i = 1, 2$, travels at speed level x. Speed levels are normalized such that $x \in [0, 3]$. Driver #1 generates monetary utility $U_1(x) = \sqrt{x+1}$ when she drives at speed x on mainstreet and driver #2 generates monetary utility $U_2(x) = 11/2 - 9/2 \cdot 1/x$. Thus, both drivers like to drive fast and driver #2 enjoys speeding more than driver #1, i.e., $U_2'(\cdot) > U_1'(\cdot) > 0 \quad \forall x \in [0, 3]$. Analogously, bicyclist j, $j = 1, 2$, generates monetary utility $V_1(y) = \sqrt{y+1}$ and $V_2(y) = 11/2 - 9/2 \cdot 1/y$ when he pedals at speed $y \in [0, 3]$.

Now and then accidents involving one car and one bicycle at a time occur on mainstreet. Let the probability that such a bilateral accident occurs be exogenously given as $\pi = 1/6$. In case of an accident there is a monetary loss $p(x, y) = xy + c, \quad 0 \leq c \leq 9/8$. Actual damages are thus increasing in both parties' speed levels at a non-decreasing rate.

Note that bicyclists need not necessarily suffer from the loss in the absence of legal rules. Drivers, a third party, even any combination of all inhabitants of Lawtown may suffer from the loss. The damage $p(\cdot)$ constitutes a loss for the economy we analyze.

Denote the drivers' speed levels by $X = (x_1, x_2)$ and the bicyclists' speed levels by $Y = (y_1, y_2)$. Social (utilitarian) welfare is taken to be the sum of the monetary utilities minus the expected losses

$$W(X, Y) = \sum_i U_i(x_i) + \sum_j V_j(y_j) - \sum_i \sum_j \pi p(x_i, y_j).$$

In the welfare maximizing allocation $X^* = (0, 3)$, $Y^* = (0, 3)$ each agent's marginal utility from speeding equals the marginal expected damage he thereby causes. Since driver #1 (bicyclist #1) enjoys speeding less than driver #2 (bicyclist #2), we have $x_1^* < x_2^*$ ($y_1^* <$

y_2^*). Efficiency requires that driver #1 (bicyclist #1) drives slower than driver #2 (bicyclist #2).

In the absence of legal rules each individual maximizes the utility out of its respective speed minus the expected accident costs it has to bear. If the bicyclists incur the entire damages, all car drivers obviously go as fast as possible. If some third party, say, a tourist visiting Lawtown, suffers from the loss, both all drivers and all bicyclists travel at maximum speed. Consequently, there is typically a need for a mechanism that decentralizes the speed choices in an efficient way.[3]

III. Decentralizing the Speed Choice by Liability Rules

Let us now analyze how allocations of the speed levels (X, Y) may be decentralized by liability rules.[4] A liability rule apportions an actual loss to the driver and the bicyclist. We will identify a liability rule by the part of the loss $l(x, y)$ the driver bears. Under the liability scheme $l(\cdot)$ the bicyclist bears $p(x, y) - l(x, y)$. Accordingly, we confine our attention to liability rules where a loss is entirely split up between the driver and the bicyclist.

We say that the liability rule $l(\cdot)$ implements speed levels $(\tilde{X}, \tilde{Y}) = \big((\tilde{x}_1, \tilde{x}_2), (\tilde{y}_1, \tilde{y}_2)\big)$ if and only if $(\tilde{X}, \tilde{Y})$ is a Nash-equilibrium to the game in which each party simultaneously

[3] We have formalized the externality problem in terms of action levels. Parts of the literature (see, e.g., Shavell (1987)) deal with the case where x and y denote care levels. The injurers' utility $a(x)$, the victims' utility $b(y)$, and the harm $t(x, y)$ decrease with care. In this case let $U(x) \equiv a(3 - x)$, $V(y) \equiv b(3 - y)$, and $p(x, y) \equiv t(3 - x, 3 - y)$ and work with $U(\cdot)$, $V(\cdot)$, and $p(\cdot)$ instead of $a(\cdot)$, $b(\cdot)$, and $t(\cdot)$. Accordingly, an increase in care corresponds to a reduction in the action (speed) level, the lowest care level corresponds to the highest action level etc. Thus, by the above transformation all of our results immediately apply to models set up in terms of care instead of action.

[4] Note that we rule out any ex ante bargaining to internalize the externality. That is, Volume III of the Journal of Law & Economics has not yet arrived in Lawtown.

picks speed levels and pays damages according to the rule $l(\cdot)$. Formally, $(\tilde{X}, \tilde{Y})$ satisfy

$$\tilde{x}_i \in \arg\max_{x \in [0,3]} U_i(x) - \sum\nolimits_j \pi l(x, \tilde{y}_j) \quad i = 1,2 \quad \text{and}$$

$$\tilde{y}_j \in \arg\max_{y \in [0,3]} V_j(y) - \sum\nolimits_i \pi \big[p(\tilde{x}_i, y) - l(\tilde{x}_i, y)\big] \quad j = 1,2.$$

Given, e.g., the bicyclists choice of $\tilde{Y}$, each driver picks $\tilde{x}_i$ so as to maximize the utility out of her speeding minus the expected payments she incurs under the rule $l(\cdot)$. In the sequel we will refer to this difference as an agent's payoff.

The literature suggests to decentralize the first-best optimum (X^*, Y^*) by the following negligence rule using the incremental Learned Hand formulation (see, e.g., Posner (1986 p. 151 - 152))

$$\mathrm{l}(U_1'(x), U_2'(x), p_x(x, y_1^*), p_x(x, y_2^*), x, y) = \begin{cases} 0, & \text{if } U_i'(x) \geq \sum_j \pi p_x(x, y_j^*); \\ p(x,y), & \text{otherwise,} \end{cases}$$

where $p_x(\cdot)$ denotes the partial derivative of $p(\cdot)$ with respect to x.

In case of an accident a driver is not deemed liable if her marginal utility from speeding is not less than the marginal expected damage that she thereby causes; otherwise, the driver is strictly liable, i.e., she has to pay for the entire damage. Suppose bicyclists pick Y^*. Given the discontinuous negligence rule, it is an optimal strategy for driver i to choose the socially efficient speed x_i^* generating the highest utility among those speed levels that involve no damage payments *for her*. Given the drivers' behavior, bicyclists bear, willy-nilly, the entire accident costs. That is, when choosing his speed bicyclist j takes into account all of the adverse effects of his behavior and accordingly picks the socially optimal level y_j^*. Thus, the negligence rule using the incremental Learned Hand formulation decentralizes the first-best optimum (X^*, Y^*).

The negligence rule using the incremental Learned Hand formulation requires that in case of an accident a judge can ascertain each driver's utility function, a task that is typically difficult to accomplish. Once we drop the assumption that courts can ascertain individual preferences, we are bound to use liability rules that depend on the speed levels of the two parties to an accident and not on their utility functions.

Even if courts are able to discern preferences, a second problem remains. The negligence rule using the incremental Learned Hand formulation implicitly defines different due speed levels for different drivers. In our example it allows driver #2 to drive up to 3 without being liable whereas driver #1 is strictly liable if her speed exceeds 0. Landes and Posner (1987, p. 121 - 131) and Shavell (1987, p. 73 - 104) suggest the use of individualized due speed levels wherever possible to achieve economic efficiency. They do not discuss the problems that arise with respect to the equal protection clause.[5]

Once we drop the assumption that courts can ascertain each driver's utility function, we are restricted to use liability rules of the form $l(x, y)$ that depend only on the measurable drivers' and bicyclists' speed levels. Note that any such liability rule equally applies to all individuals and thus raises no problems regarding the equal protection clause.

In this situation of incomplete information the literature suggests (see, e.g., Diamond (1974), Posner (1986, p. 151 - 152), Shavell (1987, p. 86 - 89)) and courts tend to apply a negligence rule using the reasonable man/woman standard. Take some average (in legal parlance 'reasonable') driver and determine her socially optimal speed level that we will denote by $\hat{x}$. In our example let $\hat{x} = 3/2$. Define $\hat{x}$ as the due speed level of the negligence rule

$$l(x, y) = \begin{cases} 0, & \text{if } x \leq 3/2; \\ p(x, y), & \text{otherwise.} \end{cases}$$

Suppose under this negligence rule bicyclists pick $Y = (0, 3)$. Then it is an optimal strategy for both drivers to choose the speed $\hat{x} = 3/2$ that generates the highest utility

[5] Perhaps the major problem with individually tailored legal standards is not the constitutional one of equal protection so much as the tradition of what counts as a relevant difference when applying the principle that like cases should be treated alike.

among all speed levels which involve no damage payments. This causes an inefficiency because driver #1 drives too fast while driver #2 drives too slow compared to the social optimum. Nevertheless, since all drivers pick the due speed level they are not liable and bicyclists bear the entire accident costs. That is, the bicyclists take into account all of the adverse effects of their behavior. Accordingly, they pick the speed levels $Y = (0, 3)$ that are efficient given the drivers' inefficient choice.

So far the state of the art in the literature. The social optimum can be implemented by the negligence rule using the incremental Learned Hand formulation that depends on individual utility functions. If a scheme that depends on preferences cannot be employed, the negligence rule using the reasonable man standard should be applied. Under this rule all drivers choose the same (inefficient) due speed level. Yet cyclists pick speed levels that are efficient given the motorists' inefficient choice. In what follows we will analyze whether we can implement the first-best optimum by a liability rule that depends on speed levels and not on preferences. Moreover, we will scrutinize the efficiency properties of the reasonable man rule.

Let us now try to decentralize the social optimum (X^*, Y^*) with a liability rule of the form $l(x, y)$.[6] Consider first the case $c = 3/4$ so that in the social optimum total expected damages $\sum_i \sum_j \pi p(x_i^*, y_j^*) = 2$.

Consider a liability rule $l(\cdot)$ that gives rise to the following expected payments for drivers given that bicyclist pick Y^*. See Figure 1.

insert **Figure 1** about here

The expected payments $\sum_j \pi l(\cdot, y_j^*)$ are 0 at speed level 0 and 1 over the interval $(0, 3]$. Since both drivers like to drive fast, only the speed levels 0 and 3 can be payoff maximizing choices. Consider driver #1. If she picks speed 0, her payoff $U_1(0) - \sum_j \pi l(0, y_j^*) = 1$.

[6] The following argument is based on Emons and Sobel (1988).

If she picks speed 3, her payoff $U_1(3) - \sum_j \pi l(3, y_j^*) = 1$. That is, under our liability rule $l(\cdot)$ driver #1 is indifferent between the speed levels 0 and 3. Accordingly, she picks speed 0. If driver #1 switches from 0 to 3, her utility increases by 1 monetary unit. We have constructed the liability rule $l(\cdot)$ such that expected payments increase by the same amount. Therefore, driver #1 chooses speed level 0.

Consider now driver #2. If she picks speed 0, her payoff $U_2(0) - \sum_j \pi l(0, y_j^*) =$ "$-\infty$". If she picks speed 3, her expected payoff $U_2(3) - \sum_j \pi l(3, y_j^*) = 3$. Consequently, driver #2 picks speed 3. Driver #2 has higher marginal utility than driver #1. That is, she gains more from the switch from speed 0 to speed 3 than motorist #1. Since the increase in expected payments is constructed such that driver #1 is indifferent between the two alternatives, driver #2 strictly prefers speed 3 to speed 0. Thus, our liability scheme $l(\cdot)$ gives rise to increasing expected payments that induce motorists to sort themselves in the desired way.

Next consider bicyclists. Given that drivers pick X^*, our liability rule gives rise to the following expected payments for bicyclists. See Figure 2.

insert **Figure 2** about here

The expected payments $\sum_i \pi[p(x_i^*, \cdot) - l(x_i^*, \cdot)]$ are 0 at speed 0 and 1 over the interval $(0, 3]$. That is, the switch from speed 0 to speed 3 increases expected payments for bicyclists by 1. A similar argument as above demonstrates that bicyclists pick Y^* under our liability scheme. Thus, our liability rule $l(\cdot)$ implements the first-best allocation (X^*, Y^*).

Note that $\sum_j \pi l(x_i^*, y_j^*) + \sum_i \pi[p(x_i^*, y_j^*) - l(x_i^*, y_j^*)] = 2$. That is, we have allocated the entire (expected) damages to the agents and do not require nanny state to finance our liability rule.

Next we have to find the values of $l(x_i^*, y_j^*)$, $i, j = 1, 2$, that give rise to the above derived expected payments. Such values always exist. For example, the numbers $l(x_1^*, y_1^*) =$

$l(x_1^*, y_2^*) = 0$, $l(x_2^*, y_1^*) = 3/2$, and $l(x_2^*, y_2^*) = 9/2$ do the job for us. Note that when motorist #2 and bicyclist #1 have an accident, the driver has to pay 3/2 although the actual damage is only 3/4. That is, driver #2 has to pay punitive damages. The reason why we must employ punitive damages is as follows. Driver #1 has to pay no expected damages. Therefore, $l(x_1^*, y_1^*) = l(x_1^*, y_2^*) = 0$. Accordingly, if driver #1 and bicyclist #1 have an accident, the bicyclist has to pay for the entire damages of 3/4. However, bicyclist #1 has to pay expected damages of 0. Therefore, driver #2 has to pay punitive damages for an accident with bicyclist #1 so that the latter ends up paying expected damages of 0.

It is thus punitive damages that allow us in general to implement the first-best allocation. Consequently, Posner's (1986, p. 176 - 177) 'powerful reasons' not to allow for punitive damages as a general rule in tort cases no longer apply in the more general framework we consider. See Shavell (1987, p. 159 - 163) for a discussion of other situations where punitive damages may be efficient.[7]

Next consider the case $c = 0$ so that in the social optimum (X^*, Y^*) total expected damages $\sum_i \sum_j \pi p(x_i^*, y_j^*) = 3/2$. Construct expected damages for drivers as in the first case. Notice that now we have used up 2/3 of total expected damages to screen drivers. To sort bicyclists, their expected payments have to increase by one unit. To provide these increasing expected payments and to balance our mechanism, we therefore have for speed 0 expected payments $\sum_i \pi[p(x_i^*, 0) - l(x_i^*, 0)] = -1/2$ and for speed 3 expected payments $\sum_i \pi[p(x_i^*, 3) - l(x_i^*, 3)] = 1/2$. This liability rule implements the first-best allocation (X^*, Y^*) as does the rule in the first case. However, because in the second case total expected damages are 'small', we have to use expected rewards to implement the first-best.

The necessity to use expected rewards to implement the first-best may be seen as a

[7] Extending the rule $l(\cdot)$ over the entire domain $[0, 3] \times [0, 3]$ is a straightforward computational task. See Emons and Sobel (1988).

shortcoming of our liability rule. For example, a driver who expects rewards for getting into accidents might try to increase the probability of accidents by, e.g., parking her vehicle right in the midst of mainstreet; or type #1 bicyclists from elsewhere might decide to move to Lawtown because, besides having fun riding the bicycle, they expect a reward from having accidents.[8]

It might thus be argued that our liability rule does a nice job as long as total expected damages are 'large' so that expected rewards need not be used. Nevertheless, if total expected damages are 'small' so that expected rewards are employed, we can forget about the rule because it creates too many new incentive problems.[9]

The question then arises: Is the negligence rule using the reasonable man standard second-best optimal under those circumstances where our liability rule cannot be used due to expected rewards? The answer is no. We will construct a liability rule that implements a more efficient allocation of speed levels than the negligence rule using the reasonable man standard does.[10]

Recall that under the negligence rule using the reasonable man standard both drivers pick the due speed level $\hat{x} = 3/2$, i.e., driver #1 drives too fast while driver #2 drives too slow compared to the social optimum. We now exploit the following nice property of the negligence rule. Since drivers are not liable at the due speed level, bicyclists bear the entire accident costs. That is, they pick speed levels that are efficient given the drivers' inefficient choice. Accordingly, by the envelope theorem, any small change in the bicyclists' speed levels has no first-order effect on overall welfare. All we have to do is to implement

[8] Notice that in the first case bicyclist #1 gets an *actual* reward of $3/4$ when he has an accident with driver #2. However, he has to pay damages of $3/4$ when he has an accident with driver #1. Overall then, ex ante he *expects* to pay damages of 0. In the second case bicyclist #1 ex ante *expects* to get a reward of $1/2$. It is thus expected rewards and not actual rewards that might lead to new incentive problems.

[9] See Emons and Sobel (1988) for a necessary and sufficient condition for implementing without expected rewards.

[10] The argument follows Emons (1990).

a welfare increasing allocation of the drivers' speed levels that results in a small change of the bicyclists' choices.

Since driver #1 drives too fast, we can increase welfare by lowering her speed by some small $\delta > 0$ while driver #2 sticks to $\hat{x}$. This is accomplished by the following liability rule. Drivers are not liable over the interval $[0, \hat{x} - \delta]$, they pay a small amount over the interval $(\hat{x} - \delta, \hat{x}]$, and are strictly liable otherwise. The small amount is constructed as follows. Driver #1, the marginal utility underdog, prefers $\hat{x} - \delta$ in order not to be liable while driver #2 is happier to stick to $\hat{x}$ and pay the (small) bill. Given the drivers' behavior, bicyclists no longer pay for the entire damages and increase their speed levels accordingly. Yet, the rule is constructed such that this increase is small and thus has no first-order effect on welfare. Consequently, a liability rule that makes drivers bear a positive amount of the accident costs improves welfare relative to a negligence rule using the reasonable man standard.[11]

Let us finally discuss the informational requirements of the different liability rules. Our rules require that a planner knows the preferences of each type of agent and the damage technology. The planner need not know which particular individual is of what type. The reasonable man rule has the same informational requirements. To determine the reasonable man standard, i.e., the reasonably efficient due action level, a planner needs to know the preferences of each type of agent and the harm function $p(\cdot)$. See Shavell (1987, p. 86-89). The incremental Learned Hand rule has the strongest informational requirements. A judge need not only know the preferences of each type of injurer; he must also ascertain which particular injurer is of what type. Moreover, the judge needs to know the preferences of each type of victim and the damage technology $p(\cdot)$ in order to compute Y^*. Then he can check whether $U_i'(x) < (\geq) \sum_j p_x(x, y_j^*)$, i.e., whether the injurer is strictly liable or not liable.

[11] Notice that for this argument we need not allow for punitive damages.

IV. Conclusions

In this paper we have shown that negligence rules are not efficient in providing the correct incentives if individuals are non-identical. By a sharing rule we can either implement the first-best optimum or an allocation of speed levels that gives rise to higher welfare than a negligence rule does.

Our results have the following implications. First, it is punitive damages that allow us in general to implement the first-best. Second, if total expected damages are 'large', we can implement the efficient allocation with a sharing rule without relying on rules that raise the knotty conflict of efficiency versus equal protection. Third, the negligence rule using the reasonable man standard is never optimal. We can always implement a superior allocation of speed levels by a sharing rule that does not employ punitive damages.

Overall then, we find that the recent movement in the U.S. towards sharing rules can be justified on efficiency grounds without relying on risk-sharing aspects.

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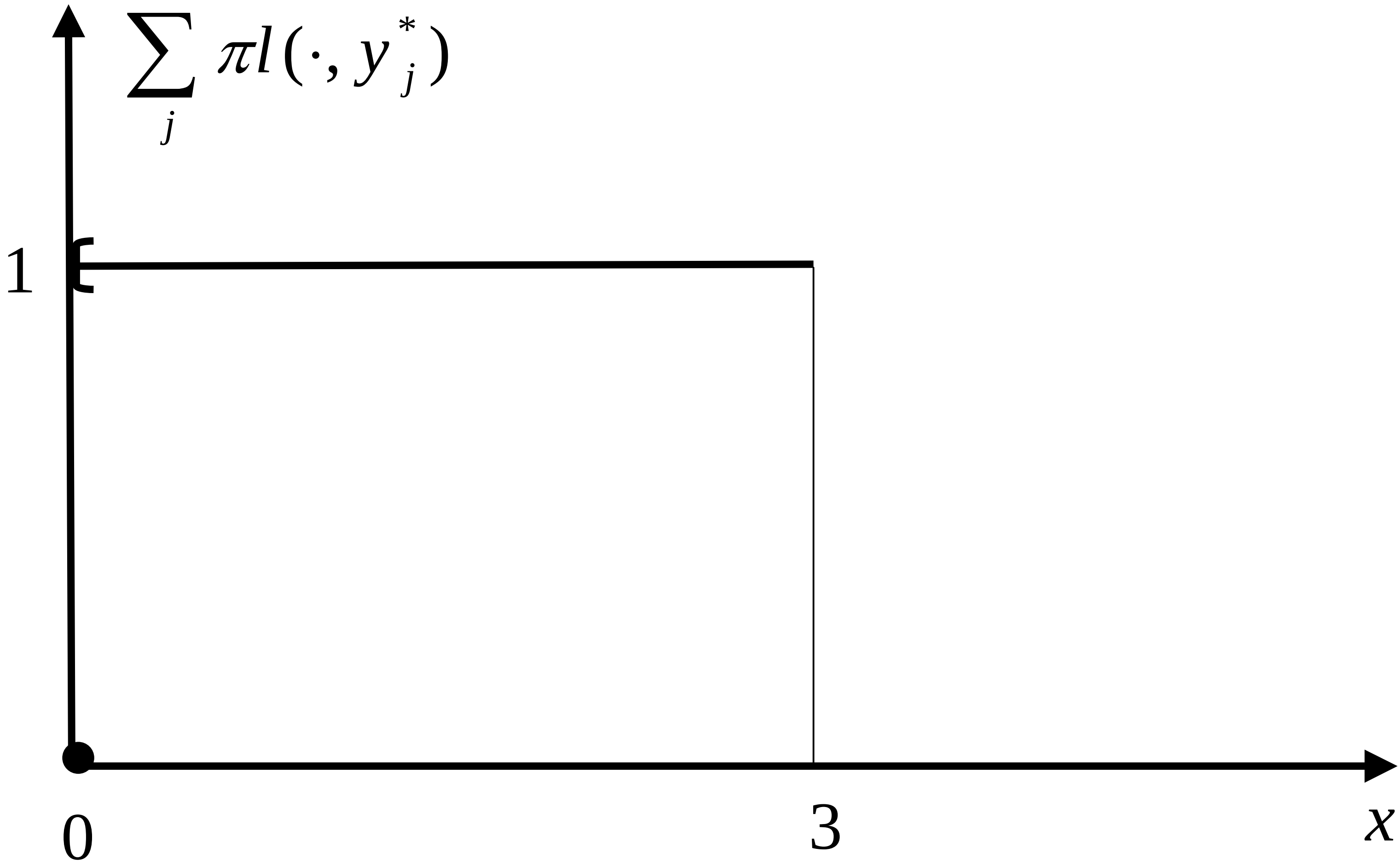
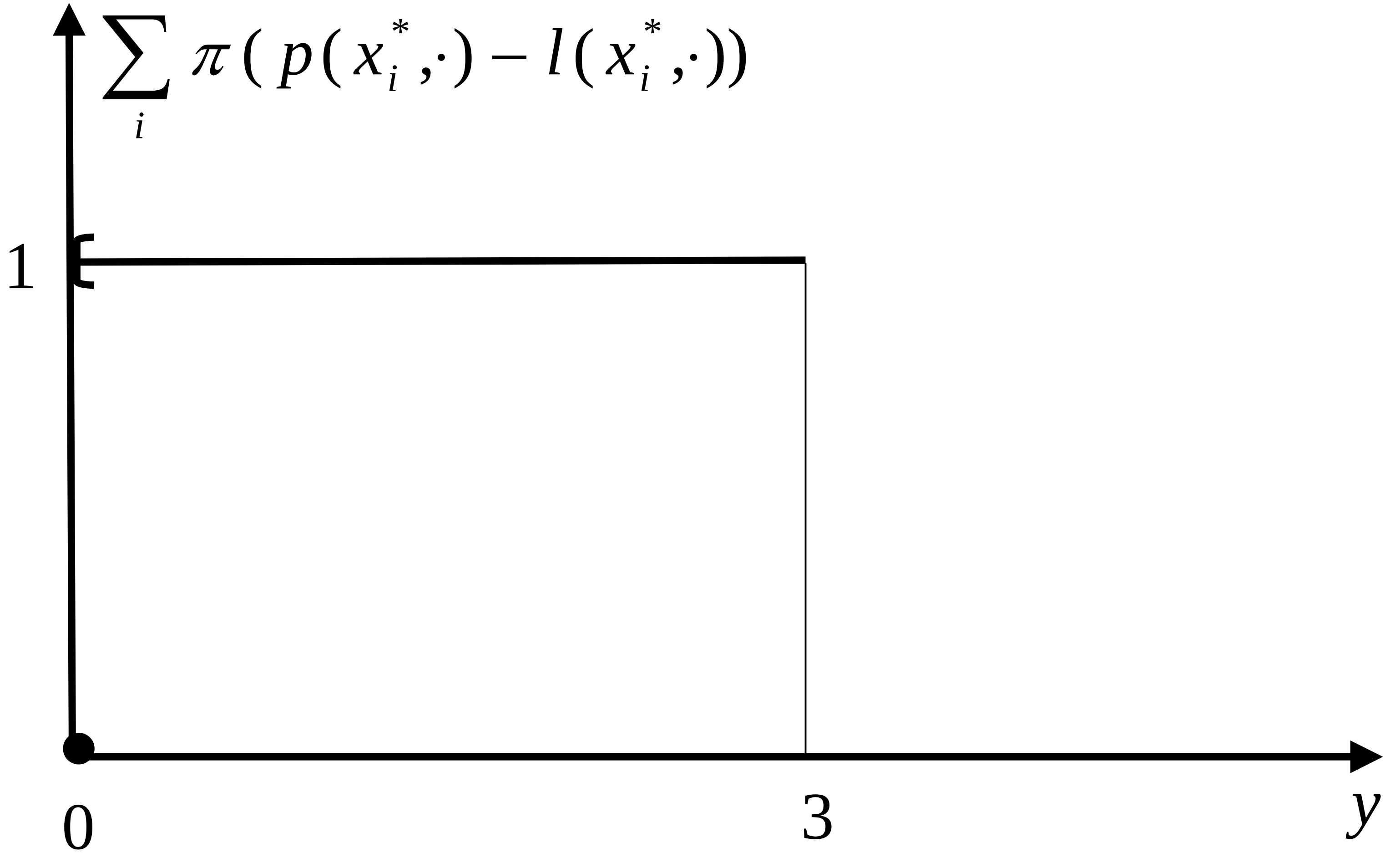


$\sum_j \pi l(\cdot, y_j^*)$
1
0
3
x


$\sum_i \pi(p(x_i^*,\cdot) - l(x_i^*,\cdot))$
1
0
3
y