Law and Economics Tort Law - Bilateral Care

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### Overview



#### Sequential Care





# Summary

- When victims can take precautions, strict liability does not implement efficient care.
  - Does not provide incentives for the victim to take precautions.
- In fact, when victims can take precautions, the model is almost *symmetric*.
  - NL and SL are two extreme cases of constant liability. No constant liability rule can implement the first-best.
- Negligence rule works because it plays a dual role:
  - Injurer takes care to avoid liability.
  - Victim takes care because is liable in equilibrium.

### The Bilateral Care Model

- x: investment in precaution by injurer.
- y: investment in precaution by the victim.
- *a*: accident in {0,1}
- $p(x, y) := \Pr(a = 1 | x, y)$ . Probability of accident.
- D: dollar losses suffered by the victim.
- Let  $D(x, y) = E_{x,y}[D|a = 1]$

# Example: Hunters and Joggers

- Hunter chooses precautions:
  - clear shot,
  - how far from the road, etc.

- Jogger chooses precautions:
  - Wear orange vest.
  - Not go far from main roads, etc.

# Probability of Accident

• We assume diminishing returns:  $p_{yy} > 0$  and  $p_{xx} > 0$ .

#### Definition

Precautions are *strategic substitutes* if  $p_{xy} > 0$ 

#### Definition

Precautions are *strategic complements* if  $p_{xy} < 0$ 

### Social Problem

$$\min_{x,y} \quad E_{x,y}[x+y+aD] \quad = \quad \min_{x,y} \quad x+y+p(x,y)\cdot D(x,y)$$

Let the (unique, interior) solution to this problem be (x\*, y\*).
FOC:

$$1 + p_x(x^*, y^*)D(x^*, y^*) + p(x^*, y^*)D_x(x^*, y^*) = 0$$
  

$$1 + p_y(x^*, y^*)D(x^*, y^*) + p(x^*, y^*)D_y(x^*, y^*) = 0$$

• To simplify analysis: deterministic damage D (given accident).

## **Decentralized Problem**

• Problem of the injurer:

$$\min_{x} \quad x + p(x, y) \cdot \psi$$

• Problem of the victim:

$$\min_{y} \quad y + p(x, y) \cdot (D - \psi)$$

• Equilibrium will depend on the liability rule  $\psi(x, y)$ .

### Implementation

#### Definition

We say that a Liability Rule  $\psi$  *implements* a level of care (x, y) if (x, y) is an equilibrium given  $\psi$ .

# No Liability

 $\psi(x,y)=0$ 

- The injurer chooses  $\hat{x} = 0$ .
- Given this, the Victim's problem is:

$$\min_{y} \quad y + p(x, y) \cdot D$$

FOC:

$$1+p_y(0,y)\cdot D=0$$

• Notice that:

$$p_y(0, \hat{y}) = -\frac{1}{D} = p_y(x^*, y^*)$$

When precautions are strategic complements, p<sub>y</sub>(x\*, ŷ) < p<sub>y</sub>(0, ŷ) = p<sub>y</sub>(x\*, y\*)
So, ŷ < y\*.</li>

# Strict Liability

 $\psi(x,y)=D$ 

- The victim chooses  $\hat{y} = 0$ .
- Given this, the Injurer's problem is:

$$\min_{x} \quad x + p(x,0) \cdot D$$

• The first order condition is:

$$1+p_x(x,0)D=0$$

# General Constant Liability

#### Claim

There is no constant  $\psi$  that achieves efficiency.

- For the injurer to be efficiently careful, his cost from the accident  $\psi$  should be equal to D.
- For the victim to be efficiently careful, the same is true:  $D \psi = D$ .

What if what the injurer pays is not transferred to the victim?

# Strict Liability Without Victim Compensation

$$\psi^I = D, \ \psi^V = 0.$$

• Problem of the injurer:

$$\min_{x} \quad x + p(x, y) \cdot D$$

• Problem of the victim:

$$\min_{y} \quad y + p(x,y) \cdot (D-0)$$

### Negligence

$$\psi(x,y,D) = \mathbb{1}_{\{x < \bar{x}\}} \cdot D$$

• This rule achieves efficiency.

# Contributory Negligence

- Negligence Rule focuses on precautions taken by the Injurer.
- Contributory Negligence focuses on the precautions taken by the Victim.
  - Negligence with Contributory Negligence:

$$\psi(x, y, D) = \mathbb{1}_{x < \bar{x}} \cdot \mathbb{1}_{\{y \ge \bar{y}\}} \cdot D.$$

• Strict Liability with Contributory Negligence:

$$\psi(x,y,D) = \mathbb{1}_{\{y \geq \bar{y}\}} \cdot D.$$

## Negligence with Contributory Negligence

$$\psi(x,y) = \mathbb{1}_{x < \bar{x}} \cdot \mathbb{1}_{\{y \ge \bar{y}\}} \cdot D.$$

- We want to show that  $(x^*, y^*)$  is a NE when thresholds are optimal  $\bar{x} = x^*$  and  $\bar{y} = y^*$ .
  - Fixing  $y^*$ , the problem of the injurer is:

$$\min_{x} \quad x + p(x, y^*) \cdot \underbrace{\psi(x, y^*, D)}_{1_{\{x < x^*\}} \cdot D}$$

- Looks like Negligence. Best response is  $x^*$ .
- Fixing  $x^*$ , the problem of the victim is:

$$\min_{y} \quad y + p(x^*, y) \cdot [D - \underbrace{\psi(x^*, y, D)}_{0}]$$

• Looks like No Liability. Best response is  $y^*$ .

# Strict Liability with Contributory Negligence

$$\psi(x,y) = \mathbb{1}_{x < \bar{x}} \cdot \mathbb{1}_{\{y \ge \bar{y}\}} \cdot D.$$

• (x\*, y\*) is a NE.

• Fixing  $y^*$ , the problem of the injurer is:

$$\min_{x} \quad x + p(x, y^*) \cdot \underbrace{\psi(x, y^*, D)}_{D}$$

• Looks like Strict Liability. Best response is  $x^*$ .

• Fixing  $x^*$ , the problem of the victim is:

$$\min_{y} \quad y + p(x^*, y) \cdot [D - \underbrace{\psi(x^*, y, D)}_{\mathbf{1}_{\{y < y^*\}} \cdot D}]$$

• Looks like the problem of the injurer under Negligence. Best response is *y*\*.

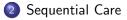
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# Advantages of Contributory Negligence

- When both parties choose care simultaneously, in equilibrium, they act as if the other party was behaving optimally.
- Deviations don't change the actions of the other party.
- When parties choose care in sequence, deviations might affect the incentives for the other party to perform due care.
- The advantage of Contributory Negligence is *off the equilibrium path* in sequential care.

### Overview

#### 1) The Bilateral Care Model







### Sequential Care

- Agents choose care in sequence. Second mover observes level of care by the first mover.
- Any liability rule that implements efficiency for simultaneous decision will do so for sequential ones.
- For simultaneous decisions, we wanted that the efficient care is an equilibrium outcome of the game.
- Now we want a stronger condition to be satisfied: efficient care on and off the equilibrium path.
- Two cases:
  - Injurer moves first.
  - Victim moves first.

### Injurer Moves First

 The efficient thing to do is, in general, not y\*. Let y\*(x) be the social best response. I.e., the solution to

$$\min_{y} \quad y + p(x, y) \cdot D$$

• If victim observes that the injurer didn't meet (x < x\*) the due standard, the problem becomes:

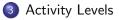
$$\min_{y} \quad y + p(x, y) \cdot (D - \psi(x, y))$$

• Let  $\tilde{y}(x)$  and  $\tilde{x}(y)$  the best response functions.

### Overview

The Bilateral Care Model

2 Sequential Care



#### 4 Cause-in-Fact

## Bilateral Care with Activity Level

- x: investment in precaution by injurer.
- $q \in [0, 1]$ : activity level of injurer.
- y: investment in precaution by the victim.
- $r \in [0, 1]$ : activity level of the victim.
- *a*: accident in {0,1}
- $q \cdot r \cdot p(x, y) := \Pr(a = 1 | x, y, q, r)$ . Probability of accident.
- D: deterministic dollar losses suffered by the victim in case of accident.

## Example: Hunters and Joggers

- Both hunter and jogger choose activity level
  - Frequency interpretation.
  - Heterogeneity interpretation.

### Social Problem

$$\max_{x,y,q,r} \quad u(q) + v(r) - qx - ry - q \cdot r \cdot p(x,y) \cdot D$$

### • FOC:

• 
$$[q]:$$
  $u'(q^*) - r^* \cdot p(x^*, y^*) \cdot D = 0$   
•  $[r]:$   $v'(r^*) - q^* \cdot p(x^*, y^*) \cdot D = 0$   
•  $[x]:$   $q^* - q^* \cdot r^* \cdot p_x(x^*, y^*) \cdot D = 0$   
•  $[y]:$   $r^* - q^* \cdot r^* \cdot p_y(x^*, y^*) \cdot D = 0$ 

# Observability

- Like before, we assume that Liability Rule can depend on (x, y), but not on (q, r).
- With the frequency interpretation, this might be due to impossibility to observe frequency.
- What about the heterogeneity interpretation?

# Impossibility of Implementing the First Best

#### Claim

There is no liability rule that implements the efficient levels of care and activity.

- If ψ(x\*, y\*) < D, the injurer would take an inefficiently high level of activity.</li>
- If \u03c6(x^\*, y^\*) > 0, the victim would take an inefficiently high level of activity.

# Combination of Liability and Pigouvian Taxes

Efficiency can recovered if liability is combined with other tools that affect incentives.

- For example, a negligence rule with a Pigovian tax for the injurers.
- If injurer takes due precautions and actions, victim does it too because faces internalizes all costs in equilibrium.
- Injurer takes due precautions to avoid liability (negligence).
- How can we ensure the injurer chooses the right activity level?

# Combination of Liability and Pigouvian Taxes

• Problem of the injurer (given optimal precautions  $x^*$ )

$$\max_{q} \qquad u(q) - q[x^* + \tau]$$
• Setting  $\tau = r^* \rho(x^*, y^*) D$  recovers efficiency!

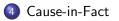
• How we concile the fact that activity level cannot be incorporated in the liability function, but we can charge a tax?

### Overview

The Bilateral Care Model

2 Sequential Care





- Golf driving range next to a parking lot.
  - x height of the safe net.
  - $z \sim F$  height of the ball. (given, support in [0, 1]).
  - D damage caused if z > x (deterministic).

- Cost of the net is c(x).
- Efficient net size solves:

$$\min_{x} \quad c(x) + \underbrace{P(z > x)}_{(1 - F(x))} \cdot D$$

• Solution  $x^*$ .

- Cause-in-fact: injurer is only liable if damage would not have happend had he taken due precautions.
- In terms of the model: liability is a function of z instead of x.

$$\psi(z,D) = \mathbb{1}_{\{z < \bar{x}\}} \cdot D$$

- Consider optimal threshold  $\bar{x} = x^*$ .
- This rule implements efficient care.

• Problem of the injurer:

$$\min_{x} \quad c(x) + \underbrace{\Pr(z \in (x, x^*))}_{(F(x^*) - F(x))} \cdot D$$

• Solution:  $x^*$ .

- Like Negligence, Negligence with Cause-in-Fact implements the efficient care.
- Advantages over negligence?
  - 1. The cost function for the injurer is continuous.
- Negligence with Cause-in-Fact is arguably more costly to implement (at least in the example).