Externalities: Does Law Offer Efficient Remedies?

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Externalities: Does Law Matter? I

An (hypothetical) Example:

- There is town with 150 residents. A factory has come up nearby.
- Smoke from the factory is injurious to the health of the residents.
- In the absence of any corrective measure, each resident will suffer a harm of 10 each, that is, a total harm of 500.
- However, the following corrective measures are available:
  - A smokescreen can be installed at the factory at a cost of 150; or
  - Residents can buy masks at a cost of 5 each, that is, at a total cost of 250.

Which option is the efficient choice?

Externalities: Does Law Matter? II

Now consider the following alternative legal positions:

1. The law entitles the residents to smoke-free air -, i.e., residents have the right.
2. The law allows the factory to operate but requires it to compensate the residents for the harm caused.
3. The law allows the factory to operate unhindered by the residents;
    - Perhaps the smoke is within the permissible limits of environmental regulations,
    - Or, there is no environmental regulation in place.

What would be the outcome under each of the above legal positions?

The Law and the Outcomes

- Under the First legal position, the factory can be operated only with smokescreen installed, i.e., only after incurring a cost of 150.
- Under the Second position, the factory owner has to decide whether to
  - install smokescreen, i.e., incur a cost of 150; or
  - pay the liability cost of 500; or
  - pay 5 to each resident so that they can by masks, i.e., incur a cost of 250.
- Under the Third legal position, the owners have to decide
  - whether to buy masks or not
  - Or?

Coase Theorem I

When people concerned can negotiate costlessly, the outcome has the following features:

- A social cost of 150 is incurred, regardless of the legal rule in force.
- That is, the outcome is efficient regardless of the choice of the legal rule.
- However, who bears the burden of this cost depends on the legal rule in force.

Coase Theorem: When negotiations are costless, the outcome will be efficient, regardless of the choice of the legal rules.

Costly negotiations: Suppose it costs additional 4 to the residents to negotiate a deal with one another and then with the factory owner.

Question

What would be the outcome under the third rule?

Coase Theorem II

Now, the owners have to decide

- whether to by masks at a cost of 5 each, i.e., incur a total cost of 250; or
- negotiate a deal at the cost of 3+4 each, i.e., incur a total cost of at least 350

So, they will end up buying masks. The outcome is inefficient.

Question

Does Law affect the transaction costs?

Question

In the above example

- Who is the cause of externality - the factor or the residents?
- Which rule is most efficient?

Coase Theorem III

Coase Theorem: When negotiations are costly, the outcome

- will depend on the legal rule, i.e., can/will vary across rules
- may or may not be efficient, depending on the rule in force.
- In general, liability rules are more efficient.

Liability Rules I

Let

- x be the care level (cost of care) by the injurer
- y be the care level (cost of care) by the victim
- π be the probability of an accident
  - $\pi(x, y)$
  - decreases with x
  - decreases with y
- D be the harm/loss by an accident
  - $D(x, y)$
  - decreases with x
  - decreases with y
  - initial born by the victim

Liability Rules II

- L be the expected loss of accident
  - $L(x, y) = \pi(x, y)D(x, y)$
  - decreases with x
  - decreases with y

Remark

- Role of liability rules is to reallocate loss from victim to injurer
- Liability rules decides liability based on x and y

Let ,

- s be the share of the injurer in accident loss;

$$0 \leq s(x, y) \leq 1$$

- $t(x, y) = 1 - s$ be the share of the victim in accident loss

Liability Rules III

For given levels of x and y, Expected Accident Loss is

$$\pi(x, y)D(x, y) = L(x, y)$$

Expected liability of the injurer is

$$s(x, y)\pi(x, y)D(x, y) = s(x, y)L(x, y)$$

The total cost of the injurer is

$$x + s(x, y)\pi(x, y)D(x, y) = x + s(x, y)L(x, y)$$

The total cost of the victim is

$$y + (1 - s(x, y))\pi(x, y)D(x, y) = y + (1 - s(x, y))L(x, y)$$

Efficient Care Levels I

For given levels of x and y, total (expected) accident costs are:

$$x + y + \pi(x, y)D(x, y) = x + y + L(x, y).$$

Let (x^*, y^*) uniquely solve:

$$\min_{x,y}\{x + y + L(x, y)\}, i.e.,$$

Let x^* and y^*, respectively solve:

$$1 + \frac{\partial L(x, y)}{\partial x} = 0 \quad (0.1)$$

$$1 + \frac{\partial L(x, y)}{\partial y} = 0 \quad (0.2)$$

That is, (x^*, y^*) uniquely minimizes the total (expected) accident. So, for any pair of care levels $(x, y) \neq (x^*, y^*)$

$$x + y + L(x, y) > x^* + y^* + L(x^*, y^*) \quad (0.3)$$

Rules of No Liability and Strict Liability

No Liability: For every choice of x by I and of y by V, $s(x, y) = 0$.

Proposition

If $x^* > 0$, then (x^*, y^*) is NOT a N.E. under the No Liability.

Proposition

The rule of No Liability is efficient if $x^* = 0$. That is, if care is unilateral and only V can take care.

Strict Liability: For every choice of x by I and of y by V, $s(x, y) = 1$.

Proposition

If $y^* > 0$, then (x^*, y^*) is NOT a N.E. under the Strict Liability.

Proposition

The rule of Strict Liability is efficient if $y^* = 0$. That is, if care is unilateral and only I can take care.

Rule of Negligence

Under Rule of Negligence:

- There is a due care standard for I, say at $\bar{x}$
- That is, the injurer is liable if and only if $x < \bar{x}$.
- If $x < \bar{x}$, I has to compensate V, fully

Assume $\bar{x} = x^*$.

Definition

Rule of Negligence:

$$\begin{aligned} x \geq x^* &\Rightarrow s(x, y) = 0 \\ x < x^* &\Rightarrow s(x, y) = 1 \end{aligned}$$

Outcome Under Rule of Negligence I

Proposition

(x^*, y^*) is N.E. under the Rule of Negligence.

Proof: Under the Rule of Negligence, $s(x^*, y^*) = 0$. Now, suppose the victim has opted for y^*. So,

- if the injurer opts for x^*, his total cost is $x^* + s(x^*, y^*)L(x^*, y^*) = x^*$, and
- if he opts for some $x < x^*$ his total cost is

$$\begin{aligned} x + s(x, y^*)D(x, y^*)\pi(x, y^*) &= x + s(x, y^*)L(x, y^*) \\ &= x + L(x, y^*) \end{aligned}$$

since $s(x, y^*) = 1$

Outcome Under Rule of Negligence II

Injurer will choose $x < x^*$ over x^*, only if

$$\begin{aligned} x + L(x, y^*) &< x^*, i.e., \text{only if} \\ x + y^* + L(x, y^*) &< x^* + y^*, i.e., \text{only if} \\ x + y^* + L(x, y^*) &< x^* + y^* + L(x^*, y^*) \end{aligned} \tag{0.4}$$

But, (0.4) cannot be true in view of the fact that

$$(x \neq x^*) \Rightarrow x + y^* + L(x, y^*) > x^* + y^* + L(x^*, y^*)$$

That is, for the injurer choice of x^* is better than choice on any $x < x^*$.

Next, consider a choice of $x > x^*$ by the injurer (assuming that the victim is still spending y^* on care).

Outcome Under Rule of Negligence III

Note that when $x > x^*$

$$x + s(x, y^*)L(x, y^*) = x + s^* L(x, y^*) = x$$

So, injurer will choose $x > x^*$ only if

$$x \quad < \quad x^*$$

which is a contradiction. So, we have proved that:

- If the victim opts for y^*, the injurer will opt for x^*
- Similarly, we can prove that if the injurer opts for x^*, the victim will opt for y^*
- (x^*, y^*) is a N.E.

Outcome Under Rule of Negligence IV

Proposition

(x^*, y^*) *is a* unique *N.E. under the Rule of Negligence.*

Proof: Let $(\bar{x}, \bar{y})$ be a (any) N.E. under the Rule of Negligence.

Note that $(\bar{x}, \bar{y})$ be a N.E. means $\bar{x} > x^*$ cannot be true. (Why?). So, there are two possible cases.

Case 1: $\bar{x} = x^*$. Now, $(\bar{x}, \bar{y})$ is a N.E., and $\bar{x} = x^*$ together mean $\bar{y} = y^*$. That is,

$$(\bar{x}, \bar{y}) = (x^*, y^*).$$

Case 2: $\bar{x} < x^*$.

Outcome Under Rule of Negligence V

Now $(\bar{x}, \bar{y})$ is a N.E. implies that

$$\begin{aligned} \bar{x} + \bar{s}(\bar{x}, \bar{y})L(\bar{x}, \bar{y}) &\leq x^* + s(x^*, \bar{y})L(x^*, \bar{y}), i.e., \\ \bar{x} + L(\bar{x}, \bar{y}) &\leq x^* \end{aligned} \tag{0.5}$$

$(\bar{x}, \bar{y})$ be a N.E. also implies that

$$\begin{aligned} \bar{y} + (1 - \bar{s}(\bar{x}, \bar{y}))L(\bar{x}, \bar{y}) &\leq y^* + s(\bar{x}, y^*)L(\bar{x}, y^*), i.e., \\ \bar{y} &\leq y^*. \end{aligned} \tag{0.6}$$

But (0.5) and (0.6) together imply

$$\begin{aligned} \bar{x} + \bar{y} + L(\bar{x}, \bar{y}) &\leq x^* + y^*, i.e., \\ \bar{x} + \bar{y} + L(\bar{x}, \bar{y}) &\leq x^* + y^* + L(x^*, y^*), \end{aligned} \tag{0.7}$$

which is a contradiction, since $\bar{x} < x^*$. That is, when $\bar{x} < x^*$,

$(\bar{x}, \bar{y})$ CANNOT be a N.E.