Liability and Unawareness

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April 2017

Introduction

- Often when an individual makes a choice (s)he does not know all of the possible consequences of his/her actions.
- This is referred to as unawareness.
- Many new acts have become available in recent years.
  - This is due to recent rapid advances in technology. Also the creation of new types of security has allowed new trades in financial markets.
  - The consequences of these acts may not be fully known.
- In liability law an injurer may be unaware that his/her actions have the potential to damage the victim's property.
- BP Deepwater Horizon, involved drilling at new depths with a complex advanced technology.
- The present paper argues that in the presence of unawareness negligence is superior to strict liability.
- This is because negligence makes information available to potential injurers, which can encourage them to take levels of care closer to the social optimum.

McAlpine versus Bercow

- On 2nd November 2012 the BBC broadcast an interview with Mr. Messham who alleged that as a child he had been abused by a senior politician in the Thatcher government.
- 4th November 2012, Sally Bercow tweeted "Why is Lord McAlpine trending? *innocent face*".
  - This was taken to imply that McAlpine was the accused in this case. (He was not.)
  - In a subsequent court case Mrs. Bercow was found liable and had to pay damages.
  - In *The Guardian*, Joshua Rozenberg, a lawyer, commented on the decision, "The judgement is one of great public interest and provides a warning to and guidance for people who use social media."
- Two features of this case are interesting.
  - The use of a new technology. In the language of decision theory a new act.
  - The courts decision revealed the potential harm of this new act.

The Concept of Unawareness

- The standard model of choice under uncertainty is subjective expected utility theory (SEU).
- SEU has been criticized on the grounds that individuals often do not know the probabilities. This has lead to a literature on ambiguity.
- It may not just be the probabilities of states which are unknown. In addition individuals may be ignorant or be unable to perceive all the possible consequences of their actions. This is referred to as *unawareness*.
- We use a model of unawareness known as Reverse Bayesianism, see Karni and Viero (2013), Karni and Viero (2015) and Karni and Viero (2016) (henceforth KV).
- KV study three types of unawareness;
  - new consequences e.g. a new disease, BSE.
  - new acts new technology, new financial instruments.
  - new act-consequence links e.g. diesel engines cause pollution.

Liability Model I

- We consider a bilateral accident model with two agents, an injurer (he) and a victim (she).
- The injurer and victim are assumed to be unaware of some aspects of the model e.g. potential harms.
- In contrast we assume the court is fully aware.
- An injurer may be unaware that his/her action can cause harm to the victim.
- The fact a case has been brought will alert the court to this possibility.
- Moreover the court deals with a number of similar cases while each injurer or victim is only involved in one case.

Liability Model II

- The injurer undertakes an activity which may cause harm or damage to the victim.
- He can reduce the damage by choosing a care level, x.
- If an accident occurs this will result in damage worth $D(1-x)$ to the victim. We assume that care reduces damage.
- The cost of care is given by $c(x), c'(x) > 0, c''(x) > 0$. This could be justified by arguing that the injurer will spend first on the most effective ways of reducing damage.
- This is different to the standard unilateral accident model since care affects the *level* of damage rather than the *probability* of damage.
- This framework allows us to use a Savage-style model of acts, states and consequences without specifying probabilities.

Model of Unawareness

- S set of states of nature.
- X set of consequences, (usually identified with monetary outcomes).
- A set of acts. An act is a function $a : S \longrightarrow X$.
- KV study three types of unawareness;
  - new consequences
  - new acts
  - new act-consequence links.
- In each case one needs to add new states to model the ex-post situation.
- It is not possible to preserve the absolute value of probabilities when the state space expands.
- KV preserve relative probabilities as much as possible.

New Links I

- New links appears to be particularly relevant for tort law.
- For instance, a product which was previously thought to be safe is in fact discovered to have harmful consequences, e.g. asbestos can cause cancer.
- Assume the injurer has a choice of two acts, f and g.
- Act g may result in damage to the victim of a monetary value D, while act f is originally believed to be safe.
- The injurer can also choose a care level $x \geqslant 0$.
- Care will reduce the damage if a loss occurs from D to $D(1-x)$ but does not affect the probability of a loss.
- Assume the cost of care is quadratic $c(x) = x^2$.

New Links II

- There are two possible states of nature s_2 and s_2 with respective probabilities p_1 and p_2.
- Initially the agents perceive the situation as described in the table below:

states	s_1	s_2
probabilities	p_1	p_2
f	0	0
g	0	$-D(1-x)$

- The efficient levels of care are $\tilde{x}_f = 0, \tilde{x}_g = \frac{p_2 D}{2}$.
- The efficient level of care may be implemented either by strict liability or by negligence if the court stipulates $\frac{p_2 D}{2}$ as the level of care appropriate for act g.

A New Link III

- The court (but not the agents) becomes aware that act f may also lead to damage $D(x)$.
- To model this we expand the state space.

	σ_1	σ_2	σ_3	σ_4
	q_1	q_2	q_3	q_4
f	0	0	$-D(1-x)$	$-D(1-x)$
g	0	$-D(1-x)$	0	$-D(1-x)$

- Define the degree of unawareness, δ, by $\delta = q_3 + q_4$.
- KV show that $q_1 = (1-\delta)\, p_1$, $q_2 = (1-\delta)\, p_2$, $q_3 = \delta p_1$ and $q_4 = \delta p_2$.
- If we define $E = \{\sigma_1, \sigma_2\}$ then one may see that p is the Bayesian update of q conditional on E. Hence the term "Reverse Bayesianism".

New Links and Liability Rules

- Negligence
  - The stipulated level of care for act g will remain at $\frac{p_2 D}{2}$.
  - In contrast the court will now stipulate care for act f as well. The optimal level of care for act f is $\tilde{x}_f = \frac{\delta D}{2}$.
- By announcing the stipulated care level for f, the court informs the injurer that f may also cause harm.
- Moreover the injurer can deduce both the amount and the probability of damage from the care levels stipulated by the court. This can be seen from the equations:

$$\tilde{x}_g = \frac{p_2 D}{2} \Rightarrow D = \frac{2\tilde{x}_g}{p_2}, \tag{1}$$

and

$$\tilde{x}_f = \frac{\delta D}{2} \Rightarrow \delta = \frac{2\tilde{x}_f}{D} = \frac{p_2 \tilde{x}_f}{\tilde{x}_g}. \tag{2}$$

- Under strict liability less information is revealed. The injurer will remain unaware of the possibility of damage until an accident occurs. Even then he will not become aware of the likelihood of an accident.

New Consequences I

- We consider situations where it is already known that some acts have harmful consequences.
- Now suppose that a new harmful consequence is discovered.
- For example suppose that the injurer is a mining company. Miners can be injured by rockfalls, which result in damage D.
- Suppose a new consequence is discovered. Working in the mine can lead to an industrial disease, say a specific type of cancer, T.

New Consequences II

- Initially f is considered to be a safe act, while g is potentially dangerous.

	s_1	s_2
f	0	0
g	0	D

(3)

- Suppose that a new consequence, cancer, T, is discovered. Then the state space expands as follows

	σ_1	σ_2	σ_3	σ_4	σ_5	σ_6
f	0	0	T	T	0	T
g	0	D	0	D	T	T

(4)

- Define $\delta = q_3 + ... + q_6$ to be the degree of unawareness, i.e. the total probability of the new states.
- KV show $q_1 = (1-\delta)\, p_1, q_2 = (1-\delta)\, p_2$.
- Since σ_3 is derived from splitting s_1 and σ_4 is derived from splitting s_2, we assume $\frac{q_3}{q_4} = \frac{p_1}{p_2} = \lambda$.

New Consequences III

- We assume that a different kind of care is needed to prevent cancer (T) than to prevent rockfalls (D). Let y denote the level of precautions to prevent cancer. Appropriate precautions will reduce the damage from cancer to $T(1-y)$.
- The costs of care are quadratic, $c(y) = y^2, c(x) = x^2$.

Proposition

Assume that the liability rule is negligence. The court will set the following stipulated levels of care for acts f and g respectively, $\hat{x}_f = 0, \hat{y}_f = \frac{(q_3+q_4+q_6)T}{2}, \hat{x}_g = \frac{(q_2+q_4)D}{2}$ *and* $\hat{y}_g = \frac{(q_5+q_6)T}{2}$. *The injurer may deduce that the probability of the new states, δ, satisfies*

$$\frac{2\hat{y}_f}{T} \leqslant \delta \leqslant \frac{2(\hat{y}_f + \hat{y}_g)}{T}.$$

- This may be summarised by saying that negligence converts unawareness into ambiguity.

New Acts I

- Initially the injurer may choose between two acts f and g. Each of them may potentially cause harm D. The original conceivable state space is:

	p_1	p_2	p_3	p_4
	σ_1	σ_2	σ_3	σ_4
f	0	0	$D(1-x)$	$D(1-x)$
g	0	$D(1-x)$	0	$D(1-x)$

(5)

- The efficient levels of care are $\tilde{x}_f = \frac{(p_3+p_4)D}{2}, \tilde{x}_g = \frac{(p_2+p_4)D}{2}$.
- Assume that the court sets stipulated care at the efficient levels. Then the injurer can deduce the level of damage since $D = \frac{2\tilde{x}_g}{p_2+p_4}$.

New Acts II

- Suppose now a new act h is discovered. Then we obtain a larger conceivable state space:

	$\hat{\sigma}_1$	$\hat{\sigma}_2$	$\hat{\sigma}_3$	$\hat{\sigma}_4$	$\hat{\sigma}_5$	$\hat{\sigma}_6$	$\hat{\sigma}_7$	$\hat{\sigma}_8$
	q_1	q_2	q_3	q_4	q_5	q_6	q_7	q_8
f	0	0	$D(1-x)$	$D(1-x)$	0	0	$D(1-x)$	$D(1-x)$
g	0	$D(1-x)$	0	$D(1-x)$	0	$D(1-x)$	0	$D(1-x)$
h	0	0	0	0	$D(1-x)$	$D(1-x)$	$D(1-x)$	$D(1-x)$

- Define $\delta = q_5 + q_6 + q_7 + q_8$ to be the total probability of harm with act h. As before δ can be viewed as a measure of unawareness.
- KV show that there are the following relations between the new and old probabilities,

$$q_1 = (1-\delta)\, p_1, q_2 = (1-\delta)\, p_2, q_3 = (1-\delta)\, p_3, q_4 = (1-\delta)\, p_4,$$
$$q_5 = \delta p_1, q_6 = \delta p_2, q_7 = \delta p_3, q_8 = \delta p_4. \quad (6)$$

New Acts III

- After act, h, is discovered, the efficient care levels for acts f and g are unchanged.
- Assuming that the court is fully informed, it will set care for h at the efficient level, which is

$$\hat{x}_h = \frac{(q_5 + q_6 + q_7 + q_8)\, D}{2} = \frac{\delta D}{2}.$$

- The injurer may deduce the probability of harm from the stipulated care levels announced by the court since

$$\delta = \frac{2\hat{x}_h}{D}.$$

- Thus under negligence the injurer becomes aware that the new act is potentially harmful and can find the probability of damage. The level of harm, D, may be deduced from the care levels announced for the original acts.
- In contrast strict liability reveals no information until a case comes to court. Even then it will not be possible to infer the likelihood of damage.

Extensions

- More general model, n states, m acts, non-linear relation between precaution and consequences.
- Law is applied to many situations were people may be unaware of the consequences of their actions.
- Unawareness in criminal law.
  - An individual may be unaware that an act (s)he undertakes is a crime.
  - tweeting a joke about a bomb at an airport.
- Contract Law Agents may be prevented from performing contracted acts.
- Dynamic models of Unawareness. Karni and Viero (2016)
- New Liability rules In Chakravarty and Kelsey (2015) we argued that ambiguity could be exploited to give both agents an incentive to make the correct choice of unobservable activity levels.

Conclusion: Negligence versus Strict Liability

- When there is unawareness negligence has the advantage that it reveals more information about potential harms.
- In an earlier paper Chakravarty and Kelsey (2015) we argued that negligence is superior to strict liability because it is more robust to ambiguity seeking behaviour.
- Strict liability is less costly for the court to implement.
- Strict liability has the advantage of providing injurers with an incentive to undertake research into potential harms.
- Contributory Negligence May be useful when the victim is unaware of the consequences of his/her actions.
  - Is the injurer or the victim more likely to be affected by unawareness?
- Other liability rules.
  - Negligence with Defence of contributory negligence.
  - Comparative negligence.
  - May be useful because they reveal information about desirable care levels for both the injurer and the victim.

Chakravarty, S., and D. Kelsey (2015): "Ambiguity and Accident Law," *Journal of Mathematical Economics*, 56, 1–8.

Karni, E., and M.-L. Viero (2013): "Reverse Bayesianism: A Choice-Based Theory of Growing Awareness," *American Economic Review*, 103, 2790–2810.

——— (2015): "Probabilistic Sophistication and Reverse Bayesianism," *Journal of Risk and Uncertainty*, 50, 189–208.

——— (2016): "Awareness of Unawareness: A Theory of Decision Making in the Face of Ignorance," *working paper, Queens University*.