Valuing Risk Reductions to Human Health

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Delivering Healthy Water Economics Workshop

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Economic Assessment
  - role
  - ‘economic’ characteristics of a risk

(Monetary) Valuation Framework/Classification for (recreational) Waterborne Risks

Methods for Identifying ‘value’ (VSL; VOLY)

Issues to consider in the valuation of risk reductions in (recreational) water environments
THE NEED FOR AN ECONOMIC ASSESSMENT OF WATER RISKS

- Humans face a wide range of potentially adverse health effects when using (recreational) water environments (WHO, 2003)

- Monetary values for reducing risks are widely applied in other policy sectors (transport; crime; environment), allowing a quantification of the health benefits of improvements in environmental quality/safety.

- Large literature on mortality (fatal) risk valuation, some studies on morbidity (non-fatal) risks

- No water-specific values to date to compete a full “Impact Pathway” Assessment
EXAMPLE IMPACT PATHWAY

Four steps:
1. emission
2. dispersion of the emission
3. estimation of impacts (dose-response functions)
4. valuation of impacts avoided

Figure 2: The impact pathway approach.
ECONOMIC CHARACTERISTICS OF RISKS

- Fatal/Non-Fatal
- Acute/Chronic
- Timing of risk reduction
- Vary across risks

- Value the policy outcome (risk/hazard reduction & its impact on health) to the individual/society concerned, not the policy itself
## Characteristics of Different Water Borne Risks

<table>
<thead>
<tr>
<th>Risk</th>
<th>Outcome</th>
<th>Fatal</th>
<th>Non-Fatal</th>
<th>Acute</th>
<th>Chronic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drowning</td>
<td>Death</td>
<td>✓</td>
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<tr>
<td>UVR</td>
<td>Sunburn, heatstroke, Cataracts, Cancer</td>
<td>✓</td>
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<td>Faecal contamination</td>
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<td>Free-living organisms</td>
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</table>
ECONOMIC CHARACTERISTICS OF RISKS

- Valuation is based in expected utility and decision making under risk theory (one period)

\[ U(p, w) = (1 - p)u_a(w) + pu_d(w) \] (1)

\[ U(p', w) = (1 - p')u_a(w) + p'u_d(w) \] (2)

(2) – (1) value/change in utility from the risk reduction
METHODS FOR IDENTIFYING “VALUE” (1)

1. HUMAN CAPITAL APPROACH

- Up until 1980’s
- Discounted value of average lifetime earnings
  “The money value of a man” Dublin (1930)
  - “the value of a wage-earner”
  - depreciation of a machine

- Max GDP and not necessarily welfare
- ex post valuation
METHODS FOR IDENTIFYING “VALUE” (2)

2. AVOIDED COSTS

- Proxy for benefits
- Measure direct and indirect costs of mortality/morbidity (e.g. medical expenses, lost productivity)

- Do not capture non-monetary costs, such as pain and suffering
- Not based on individual’s preferences, inferior to estimates derived from theoretically correct measures of economic benefit (e.g. willingness-to-pay)
3. WTP–BASED MEASURES (VSL, VOLY)

- **Value of a Statistical Life (VSL)**
  

  A one–period reduction in the risk of death

- **Value Of a Life Year Lost (VOLY)**
  
  *Johanesson et al.* (1997); *Jones–Lee* (1989)

  An ongoing and sustained reduction in the risk of death

**NB:** Both can be shown to *increase average life expectancy*
VALUE OF A STATISTICAL LIFE (VSL)

Example

- Group of 10,000 individuals
- Individual risk change equal to 1/10,000 in the forthcoming period
- Reduce the expected number of fatalities with one

- Average willingness-to-pay = £100
- \[ VSL = \frac{WTP}{\Delta p} = \frac{100 \text{ £}}{1/10,000} = 1 \text{M} \text{ £} \]
- NOT an identified life
VALUE OF A STATISTICAL LIFE (VSL) (2)

- **Theoretical issue**

- **Initial LE**

  \[(1) \quad LE = (1-p_{40}) + (1-p_{40})(1-p_{41}) + \ldots\]

  Change \(LE \rightarrow LE_X\)

- \(X\): an absolute risk reduction \(\delta(\delta \in (-p, 0))\) in the *first period* hazard rate after which the hazard rates return to their previous level

  \[(2) \quad LE = (1-p_{40} + \delta) + (1-p_{40} + \delta)(1-p_{41}) + \delta \in (-p_{40}, 0)\]
Best point estimate for US is $4m (meta-analyses, wage risk)

EU consensus value 1.4m Euro for traffic accidents and 1m Euro for premature death related to air pollution

Danish air pollution study (Andersen et al, 2004)
80% of external damage (health) value = avoidance of premature deaths; 20% other impacts
VALUE OF A LIFE YEAR LOST (VOLY) (1)

A particular gain in life expectancy can be generated by various changes in the survival curve (e.g. on-going risk reductions over a lifetime).

Example

- VOLY valuation: Directly ask for the value of a change in life expectancy “WTP for a 1 month gain in LE?”

- A gain in life expectancy is not a precise description of a good
- It is NOT an “Add-on” to the end of life
VALUE OF A LIFE YEAR LOST (VOLY) (2)

- **Theoretical issue**

- **Initial LE**

\[ LE = (1 - \rho_{40}) + (1 - \rho_{40}) (1 - \rho_{41}) + \ldots \]

Change \( LE \rightarrow LE_X \)

- \( X \): a permanent constant *relative* risk reduction \( kp(k \in (-1,0)) \) in hazard rates

\[ LE = (1 - (\rho_{40} (1 + k)) + (1 - \rho_{40} (1 + k)(1 - \rho_{41}) (1 + k)) \ldots, + k \in (-1,0) \]
# POSSIBLE TAXONOMY/ECONOMIC VALUATION FRAMEWORK FOR WATERBORNE RISKS

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Note: VSL and VSI indicate specific measures for valuation.
ISSUES TO CONSIDER IN THE VALUATION OF WATER RISKS

A ‘one size fits all’ VSL/VOLY or a suite of measures?

1. Would you expect VSL/VOLY to be given the same numerical value across different sectors?
   - Traffic
   - Environment
   - Crime
   - Water (Recreation)

2. Would you expect VSL to be given the same numerical value across different countries/regions/age groups (children, elderly)?

3. Do ‘premia’ exist (e.g. cancer: dread, morbidity). Would latency impacts counter this?
ISSUES cont.

- Impact of other contextual features?

3. How does baseline risk (personal exposure) affect value? Is there a ‘dread’/’baseline risk tradeoff?

4. Do other contextual features affect values?
   (Voluntariness; Severity; Controllability; Public exposure; Immediacy; Personal knowledge; Expert knowledge)
Outstanding theoretical considerations w.r.t VOLY

5. Should the fact that the VOLY is not fully theoretically specified yet matter, given it might be the most appropriate measure in many cases (VSL may underestimate benefits)?
CONCLUSIONS

- Economic valuation would allow a full impact pathways assessment of water-bourn risks

- Waterborne risks have differing characteristics, suggesting both VSL and VOLY measures

- WTP-based (public preferences)

- Many conceptual, empirical and ethical issues to consider in their implementation