Valuing nonfatal health risk:
Inferring monetary values from QALYs

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Outline

• Components of value of nonfatal risk
• QALYs as a measure of utility (preferences)
• Relationship between WTP and QALYs
  — In theory
  — Stated-preference estimates
Three components of value

- **Financial effects**
  - Medical expenses, lost income
    - Part born by individual, household, etc.
      - Impoverishment
    - Part born by government, insurance firms, etc.

- **Lost productivity (non-market); time cost of medical care**
  - Effects on individual
  - Effects on household members

- **Pure utility loss (e.g., pain & suffering)**
  - Few empirical estimates relative to diversity of nonfatal health outcomes

- **Components may interact**
  - In principle, should estimate monetary value to individual incorporating all three components
  - Supplement with effects on other parties
Inferring monetary value of utility from QALYs

• QALYs are (arguably) a measure of utility loss
  — Reasonably easy to estimate
  — Estimate monetary value as a function of QALYs?

• What about DALYs?
  — DALYs measure health, not wellbeing
  — Empirically, may be good proxy for QALYs

• QALYs as a measure of preferences for own health
  — Preferences must satisfy several conditions
    o Reasonable on average?
    o Often violated
Quality-adjusted life years

\[ QALYs = qt \quad \text{Constant health} \]

\[ QALYs = \sum_{i=1}^{N} q_i t_i \quad \text{Time-varying health} \]

• \( q = "\text{Health-related quality of life}" \) (HRQL)
  - \( q \leq 1 \)
    - \( q = 1 \) (full health)
      - Age dependence?
    - \( q = 0 \) (equivalent to dead)
      - \( q < 0 \) worse than dead

• \( t = \text{duration} \)
Key assumptions

\[ QALYs = qt \]

\[ QALYs = \sum_{i=1}^{N} q_i t_i \]

• \( q \) (health-related quality of life)
  — Independent of duration
    o If 40 yrs good health \( \sim \) 30 yrs excellent health
    o Then 4 yrs good health \( \sim \) 3 yrs excellent health
  — Independent of previous & succeeding states

• \( t \) (duration)
  — Utility is proportional to \( t \)
    o (or to present value of \( t \))
  — Risk neutral over lotteries on duration
    o 50/50 chance of 0 or 2 days sick \( \sim \) 1 day sick for sure
McNeil et al. (1981), "Speech and Survival: Tradeoffs between Quality and Quantity of Life in Laryngeal Cancer," NEJM

Violates:
- risk neutrality
- q independent of T
## Empirical evidence on risk posture (%)

<table>
<thead>
<tr>
<th>Study</th>
<th>Methodological Design</th>
<th>N</th>
<th>RN</th>
<th>RA</th>
<th>RS</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>Pliskin, Shepard, Weinstein (1980)</td>
<td>10 Harvard health faculty, 1 qx</td>
<td>10</td>
<td>40</td>
<td>20</td>
<td>40</td>
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<tr>
<td>Corso &amp; Hammitt (2001) US</td>
<td>4 binary choices</td>
<td>865</td>
<td>0</td>
<td>14</td>
<td>11</td>
<td>75</td>
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<td></td>
<td>5 binary choices</td>
<td>610</td>
<td>0</td>
<td>13</td>
<td>9</td>
<td>78</td>
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<tr>
<td>Nielsen et al. (2010)</td>
<td>3 pairwise choices to survival curve (same life expectancy)</td>
<td>129</td>
<td>6</td>
<td>22</td>
<td>23</td>
<td>49</td>
</tr>
<tr>
<td>Hammitt &amp; Tunçel (2015)</td>
<td>3 pairwise choices to survival curve (same life expectancy)</td>
<td>1024</td>
<td>23</td>
<td>14</td>
<td>16</td>
<td>47</td>
</tr>
</tbody>
</table>
WTP per QALY

• If
  — Individual preferences for own health are consistent with QALYs
  — Value of additional wealth is larger if one survives than dies (i.e., as bequest)

• Then
  — Marginal WTP per QALY is a decreasing function of QALYs
  — WTP / QALY decrease with QALYs
Eliciting WTP to reduce nonfatal risk

- Two stated-preference studies
  - US internet panels
  - WTP to reduce risk by 1 / 10,000 to 3 / 10,000
    - Per meal or per year
- Acute illness (1, 3, 7 days) from food contaminants
  - Described symptoms, elicited HRQL
- Chronic illness (1 month, 1 year, rest of life) from environmental pollution
  - Described illness using health-state classification system (EQ-5D) which predicts HRQL

- Results:
  - WTP increases with QALY gain, at sharply decreasing rate
  - WTP per QALY decreases with QALY gain
Regression results

<table>
<thead>
<tr>
<th></th>
<th>Acute</th>
<th>Chronic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log risk reduction</td>
<td>0.52 ***</td>
<td>1.01 ***</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.23)</td>
</tr>
<tr>
<td>Log HRQL loss</td>
<td>0.20 ***</td>
<td>0.34 ***</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Log duration</td>
<td>0.11 **</td>
<td>0.13 ***</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>N</td>
<td>4851</td>
<td>2343</td>
</tr>
</tbody>
</table>

***, ** denote significantly different from zero at 1 and 5%, respectively
## Elicited & implied values ($)

<table>
<thead>
<tr>
<th>$\Delta q$</th>
<th>$t$</th>
<th>WTP</th>
<th>Value / case</th>
<th>Value / QALY</th>
<th>Implied WTP</th>
<th>Value / case</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>1 day</td>
<td>1.36</td>
<td>6,800</td>
<td>24,800,000</td>
<td>0.03</td>
<td>132</td>
</tr>
<tr>
<td>0.9</td>
<td>1 day</td>
<td>2.10</td>
<td>10,500</td>
<td>4,250,000</td>
<td>0.24</td>
<td>1,180</td>
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<tr>
<td>0.1</td>
<td>7 days</td>
<td>1.67</td>
<td>8,300</td>
<td>4,350,000</td>
<td>0.18</td>
<td>921</td>
</tr>
<tr>
<td>0.9</td>
<td>7 days</td>
<td>2.57</td>
<td>12,900</td>
<td>745,000</td>
<td>1.66</td>
<td>8,290</td>
</tr>
<tr>
<td>0.1</td>
<td>1 month</td>
<td>79</td>
<td>524,000</td>
<td>62,900,000</td>
<td>0.60</td>
<td>4,000</td>
</tr>
<tr>
<td>0.9</td>
<td>1 month</td>
<td>170</td>
<td>1,140,000</td>
<td>15,100,000</td>
<td>5.40</td>
<td>36,000</td>
</tr>
<tr>
<td>0.1</td>
<td>40 yrs</td>
<td>165</td>
<td>1,100,000</td>
<td>275,000</td>
<td>168</td>
<td>1,118,000</td>
</tr>
<tr>
<td>0.9</td>
<td>40 yrs</td>
<td>357</td>
<td>2,380,000</td>
<td>66,200</td>
<td>1,510</td>
<td>10,060,000</td>
</tr>
</tbody>
</table>

Implied values: VSL = $9.3m, r = 3%, LE = 40 yrs → WTP / QALY = 480k

Values per case plausible for severe, not for milder cases?
Conclusions

- WTP not proportional to QALYs
  - Increasing but strongly concave function of QALYs
- Can WTP be reliably predicted using a more elaborate function of severity, duration (and context)?
  - Different values for different QALYs?
- Should we force consistency (constant value per QALY)?