Valuing mortality risk reductions in global benefit-cost analysis

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Outline

• Concept & terminology
• Review of direct estimates in LMICs
• Recommendations (in process)
  — Use direct high-quality estimates if available
  — Extrapolate from high-income country estimates, adjusting for income difference
    o As primary estimate, or “standard sensitivity analysis”
  — Extrapolation
    o 2 base values (VSL/income ratio & income level)
    o 2 income elasticities
  — Sensitivity analysis for age
    o Value proportional to life expectancy
Concept

- **Money value of reduction in mortality risk**
  - Risk change in specified period
    - Usually short-term, e.g., current year

- **Individual concept**
  - Own risk
  - Own money (or household money)

- **Rate of substitution (ratio of money to risk change)**
  - Idealization: marginal rate (infinitesimal risk change)
  - Approximation: money value per small risk change
    - Change in wealth that has same effect on wellbeing as the risk change
      - Compensating or equivalent variation
Terminology

• Rate of substitution (ratio of money to risk change)
  — Rate = ratio = change in money / change in risk

• Value per statistical life (VSL) = $ per 1 unit change in risk (probability)

• Value per standardized mortality unit (VSMU) = $ per 1/10,000 change in risk
  — = VSL • 1/10,000

• Value per micromort = $ per 1/million change in risk
  — = VSL • 1/million

• EPA expected to propose a new term; we will evaluate & may recommend it (or an alternative)
VSL = slope

Indifference curve

Wealth

VSL

Survival probability ( = 1 - risk)

0 1
VSL = slope

\[ VSL \approx \frac{WTP}{\Delta r} \]

\( \Delta r = \text{SMU} \)

WTP = VSMU

Indifference curve

Wealth

VSL

Survival probability (\( = 1 - \text{risk} \))
Total value of a change in population risk  
= sum of individual values

- Total value = sum of (individual VSL x individual risk reduction)
  \[= \sum_{i=1}^{n} (VSL_i \cdot \Delta r_i)\]

- \(\approx\) average VSL x sum of (individual risk reduction)
  \[\approx \overline{VSL} \sum_{i=1}^{n} \Delta r_i\]
  Approximation is exact if individual VSLs and risk reductions are uncorrelated

- = average VSL x expected number of lives saved
  Lives saved = deaths avoided during period
  \[= \overline{VSL} \cdot E(lives saved)\]
VSL depends on

• Individual characteristics
  — Wealth & income
    o We know something about how to adjust for this
  — Age & life expectancy
    o Conflicting evidence, we suggest crude adjustments
  — Health
  — Household size & composition

• Social or cultural characteristics
  — Preferences for allocating resources to self v. family or community

• Risk characteristics
  — Traumatic injury v. chronic disease

• Other factors?
Currency exchange rates

• Market exchange rate (MER)
  — Cost of buying goods locally in US dollars

• Purchasing power parity (PPP)
  — 1 international dollar buys the same basket of commodities in all countries

• Objective of BCA: estimate net benefits in local currency
  — Can convert to US dollars or international dollars as desired
  — Use local prices & other unit values as available

• When extrapolating unit values from high-income countries
  — Health & other non-market benefits: use PPP
  — Local goods: use PPP
  — Internationally traded goods: use MER
Recent approaches to extrapolation

<table>
<thead>
<tr>
<th>Study</th>
<th>VSL (millions)</th>
<th>Income</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD (2016)</td>
<td>$3.0</td>
<td>NA</td>
<td>Low income: 1.0</td>
</tr>
<tr>
<td></td>
<td>(2015 $)</td>
<td></td>
<td>Middle income: 0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High income: 0.8</td>
</tr>
<tr>
<td>World Bank &amp; IHME (2016)</td>
<td>$3.83</td>
<td>$37,000 (OECD GDPpc, PPP)</td>
<td>Low &amp; middle income: 1.2</td>
</tr>
<tr>
<td></td>
<td>(2011 $)</td>
<td></td>
<td>High income: 0.8</td>
</tr>
<tr>
<td>Viscusi &amp; Masterman (2017)</td>
<td>$9.6</td>
<td>$55,980 (U.S. GNIpc MER)</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>(2015 $)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masterman &amp; Viscusi (2018)</td>
<td>$9.6</td>
<td>$55,980 (U.S. GNIpc MER)</td>
<td>GNI/cap</td>
</tr>
<tr>
<td></td>
<td>(2015 $)</td>
<td></td>
<td>&lt; $8,809: 1.0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>≥ $8,809: 0.85</td>
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Direct estimates in LMICs

• Searched for studies conducted in LMICs
  — General adult population
    o Probabilistic (not convenience) sample
    o WTP to reduce own risk
  — Data collected in past 20 years (1997 – present)
  — Written in English

• 25 studies
  — 8 revealed preference (wage differential)
  — 17 stated preference studies (18 estimates)
    o 9 of 18 tested whether willingness to pay increases with risk reduction
    o 5 of 9 found a statistically significant increase
25 studies, 15 countries
VSL / GNIpc vs. GNIpc (not adjusted to common year)
Values in LMICs vs US, OECD

- **Baseline values**
  
<table>
<thead>
<tr>
<th>Source</th>
<th>VSL</th>
<th>GNI per cap</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>US (DHHS)</td>
<td>$9.3 million</td>
<td>$56,150</td>
<td>170</td>
</tr>
<tr>
<td>OECD</td>
<td>$3.0 million</td>
<td>$30,600</td>
<td>100</td>
</tr>
</tbody>
</table>

- **LMIC estimates**
  
  - 25 values, ratios from 4 to 700
  
  - Exclude ratios
    - > 170 (US ratio)
    - < 20 (VSL > expected future consumption)
  
  - Yields 14 ratios, from 22 to 108
    - Income elasticities when extrapolating from
      - US: 1.1 to 2.1; median = 1.5
      - OECD: 1.5 to 1.8; median = 1.7
Recommendations (in process)

- If high-quality direct estimates exist, use them
  - Requires multiple high-quality studies
- Otherwise (or as sensitivity analysis) extrapolate from high-quality estimates (in high-income country)
  - Adjust for income, using GNI per capita as measure
    - GNI per capita is broad measure, available for all countries
    - PPP (value of risk reduction relative to other costs of living)
  - Base values (2)
    - VSL / GNIpc = 170 at GNIpc = $56k (2015 PPP)
    - VSL / GNIpc = 100 at GNIpc = $56k, 30k?
  - Income elasticities (2)
    - Income elasticity = 1.0 & something > 1
    - Bound result to VSL / GNI per capita ≥ 20
Rationale: base value
(expressed as VSL / GNI per capita; 2015 international dollars)

- US government guidance (HHS)
  - Central value: $9 million → VSL/GNIpc = 170
    - Based on wage-differential estimates (with good risk data) & stated-preference estimates (that satisfy validity test)
    - HHS (wage-differential & stated-preference): $9.3 million
    - DOT (wage differential): $9.6 million
    - EPA (old wage-differential & stated-preference): $9.7 million
  - Low value: VSL/GNIpc = 100 (OECD)
    - At US (55k) or OECD (30k) income?

- Why US values?
  - Based on many high-quality studies, numerous reviews
  - Larger than most other high-income countries
    - Treat central US value as high estimate for high-income countries
Rationale: income elasticity

- **Ratio of VSL to income probably increasing with income**
  - Share of income required for basic necessities lower at higher income
  - → income elasticity > 1

- **Wellbeing from living > value of consumption (probably)**
  - VSLY > consumption \(\approx\) GNIpc
  - VSL > present value of future consumption \(\approx 20 \times\) GNIpc

- **Direct estimates (median GNIpc \(\sim\) $9,400)**
  - Exclude ratios > 170 and < 20
  - Of remaining 14, income elasticity:
    - From US: 1.1 – 2.1
    - From OECD: 1.5 – 1.8
Adjustment for age

- Estimates suggest
  - VSL increases then decreases with age
  - May be ~ 2x higher for children than adults
- Recommendation: if policy disproportionately affects young or old, add sensitivity analysis using constant VSLY
- VSLY = VSL / life expectancy at mean adult age
  - Consistent with using VSL for mean-age adult
- Value of reducing mortality risk inversely proportional to life expectancy
  - Alternative (divide VSL by present value of discounted future life years) yields results between recommendation and using same VSL for all ages
- For children, newborns, fetal mortality
  - No special recommendation, conduct sensitivity analysis
Suggestions?

- Thanks!