Michael Schlander, Oliver Schwarz, and Ramon Schaefer:

An Update on the Economic Value of a Statistical Life Year in Europe
1. Background & Research Question
2. Material & Methods
3. Results
   - European Studies
   - [Global Studies]
   - Heterogeneity, Methods and Regions
   - Summary of Results
4. Conclusions
1

Background & Research Question
Willingness to Pay for a Quality-adjusted Life Year:

In Search of a Standard

RICHARD A. HIRTH, PhD, MICHAEL E. CHERNEW, EDWARD MILLER, MA, A. MARK FENDRICK, MD, WILLIAM G. WEISSERT, PhD

What Determines the Value of a Life?
A Meta-Analysis

A Systematic Review of Studies Eliciting Willingness-to-Pay per Quality-Adjusted Life Year: Does It Justify CE Threshold?

Khachapon Nimdet¹, Nathorn Chaiyakunapruk²,³,⁴,⁵*, Kittaya Vichansavakul¹, Surachat Ngorsuraches¹
Benchmarks for Cost Effectiveness

- **Examples of international *de facto* benchmarks:**
  - **New Zealand** (PHARMAC):
    NZ-$ 20,000 / QALY$^1$
  - **Australia** (PBAC):
    AUS-$ 42,000 / LYG to AUS-$ 76,000 / LYG$^2$
  - **England and Wales** (NICE):
    £ 20,000 – £ 30,000 / QALY
  - **United States** (some MCOs):
    US-$ 50,000 – US-$ 100,000 / QALY$^3$
  - **Canada** (proposed “grades of recommendation”):
    CAN-$ 20,000 – CAN-$ 100,000 / QALY$^4$
  - **WHO** (recommendation): 1-3 times GDP/capita / DALY$^5$

- **No scientific basis**

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$^1$C. Pritchard (2002); QALY: “quality-adjusted life year”
$^2$George et al. (2001); LYG: “life year gained”
$^3$D.M. Cutler, M. McClellan (2001);
$^4$A. Laupacis et al. (1992);
$^5$DALY: “disability-adjusted life year”
In Search of a Scientific Basis

- **Demand-Side Analyses**
  - **Health Care Programs (or Interventions):**
    social (or individual) WTP, holistic
  - **Attributes of Health Care Programs (or Interventions):**
    social (or individual) WTP, characteristics (and their interaction)
  - **Quality-Adjusted Life Years (Individual or Social WTP-Q):**
    QALY maximization hypothesis; constant proportional trade-off…

- **Supply-Side Analyses**
  - **PROs and Efficiency Frontier Approach (e.g., IQWiG):**
    flexible benchmarks, contingent on therapeutic area and rationality of prior pricing and reimbursement decisions
  - **Quality-Adjusted Life Years (Shadow Prices, e.g., York):**
    universal benchmark, (in addition to assumptions above) also contingent on rationality of health care budget
Answers Offered by [Health] Economists

- **Value of a Statistical Life Year (VSLY)**
  - **Human Capital Approach**: resting on productivity, rejected by modern welfare economics
  - **Revealed Preferences Approach**: observed human behavior (job risk or non-occupational safety)
  - **Stated Preferences Approach**: direct elicitation of preferences
    - contingent valuation (CV): direct or referendum style questions
    - discrete choice experiments (DCEs): choice alternatives, where the different goods or programs are defined by their attributes

- **Willingness-to-Pay for a QALY (WTP-Q)**
  - With adjustment for reduced average quality of life in later years, WTP-Q may be ~10% greater than VSLY (Hirth et al., 2000)
  - WTP-Q exists only if QALY maximization hypothesis is accepted and normative and empirical grounds for concern are disregarded
In Search of a Standard (Hirth et al., 2000\(^1\))

\[\text{WTP-Q: Willingness-to-Pay for a QALY}\]

\[
\begin{array}{c|c|c|c}
\text{HC} & \text{RP-S} & \text{CV} & \text{RP-JR} \\
\hline
24,777 & 93,402 & 161,305 & 428,286 \\
\end{array}
\]

\[\text{[US-}$(1997)$]\]

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Research Questions

- **Demand-Side Perspective**: What Can We Learn About the Economic Value of a Statistical Life Year (“VSLY”) from Empirical Studies Reporting Original Data on the Value of a Statistical Life (“VSL”) over the Last Two Decades (1995-2015)?
  - Methodology of empirical studies over the last two decades
  - Heterogeneity of estimates, by method and by area of origin
  - No adjustment for health-related quality of life;
    no attempt to derive WTP-Q estimates from VSLY estimates
  - No specific review of the Quality-Adjusted Life Year literature

- **Two levels of analysis**
  - European data
  - Worldwide data
Materials & Methods
Systematic Literature Search

**Databases:**

EconBiz and EconLit (German and English); January 1995 – December 2015

Supplementary search in published reviews and meta-analyses

**Search Terms:**

Value of Life, Statistical Life, Value of a Statistical Life, Value of a Life Year, Value of a Statistical Life Year, Value of a Quality-Adjusted Life Year (QALY)

**VSL Estimates:**

After elimination of duplicates, extracting the reported value of (a statistical) life (VSL) for each experimental setting studied,

using the base case VSL if reported by the authors; otherwise calculating the mean VSL when various methods were employed on the same dataset
Study Eligibility Criteria

- **Report VSL(Y) based on an original data analysis**
  - Reports clearly state currency and year of VSL(Y) estimates
  - No reviews or meta-analyses
  - No specific review of WTP-Q (“value of a QALY”) literature

- **Data sources and methods used specified**
  - HC; SP/CV; SP/DCE; RP and type of risk (WR, non-occupational)
  - Characteristics of study population (time of survey; respondent selection criteria, age, male/female; white/blue collar, …)
  - Identification of national origin of data

- **European subset**
  - Data originating from a European setting
Literature Search: European Studies

Studies identified (n = 3,452)
EconBiz = 2,480
EconLit = 972

Studies excluded after screening (n = 3,288)
Duplicates = 1,469
Title/Abstract = 1,375
No Primary Data = 424

Studies included after reference search in reviews and meta-analyses (n = 37)

Studies retrieved for full text review (n = 154)
plus Reference Search = 37

Studies excluded after assessment for eligibility criteria (n = 71)

Non-European studies (n = 79)

Relevant studies included in the literature review
European studies: n = 41

Unique VSL estimates: n = 49
Literature Search: Global Results

Studies identified (n = 3,452)
- EconBiz = 2,480
- EconLit = 972

Studies excluded after screening (n = 3,268)
-Duplicates = 1,499
- Title/Abstract = 1,375
- No Primary Data = 424

Studies included after reference search in reviews and meta-analyses (n = 37)

Studies retrieved for full text review (n = 154)
- plus Reference Search = 37

Studies excluded after assessment for eligibility criteria (n = 71)

Relevant studies included in the literature review (n = 120)
Extracting Data from Study Reports

Data extracted for analysis included the following:

- VSL (base case or mean, and range, for each experimental setting)
- Country and Year (for origin of data and for publication)
- Method: HC; WTP: SP (CV / DCE), RP (WR / non-occupational safety); cross-sectional / longitudinal / panel data analysis
- Population studied (size; blue-collar / white-collar; male/female ratio)
- Mean age of study population
- Type of risk / risk reduction / fatality risk (mean, min/max)
- Currency (and year); average annual income

Additional data sources used for analysis:

- Life expectancy (by year, sex, and age): WHO Life Tables
- GDP / capita (by year): World Bank
- CPI, PPPs, exchange rates: World Bank
Computing the VSLY from Reported VSL Data

Abbreviated calculation procedures:

- VSL (base case or mean for each experimental setting) from study
- Currency reconversion from US-$ (or else) to LCU (exchange rates)
- VSL inflated to year 2014 using country-specific CPIs
- GDP / capita from year of data generation, inflated as VSL
- Conversion of LCU values for 2014 to Euro (PPPs)

VSLY computation:

- Calculation separately for men and women,
  Residual Life Expectancy data from WHO Life Tables by Country
- Base case discount rate 3% (for sensitivity analyses, 0% - 10%)
- Formulas: \( VSLY = \frac{VSL \cdot (1 + r)^{t-1} \cdot r}{(1 + r)^t - 1} \) or (for \( r = 0\% \)): \( VSLY = \frac{VSL}{t} \)
- Calculating VSLY average (and range, if data were available), weighted by study population sex ratio
Database for Analysis

- **European data:**
  - 41 studies,
    yielding a total of 49 unique VSL estimates
  - **Regional origin of studies yielding VSL estimates:**
    Sweden (13),
    United Kingdom (4);
    France, Germany, Norway, Switzerland (3 each);
    Italy, Netherlands (2 each);
    Austria, Czech Republic, Denmark, Netherlands, Poland (1 each);
    plus three comparative international studies
    (reporting VSL for more than one country each)

- **Methodological basis of estimates:**
  HC, 0; RP/WR, 11; SP/DCE, 11; SP/CV, 27
3

Results

- European Studies
- [Global Studies]
- Heterogeneity, Methods and Regions
- Summary of Results
## Overall European Results:

### Mean and Median VSL and VSLY

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>95% Confidence Intervals (nonparametric bootstraps)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>VSL</td>
<td>€ 4,721,286</td>
<td>€ 2,940,381</td>
</tr>
<tr>
<td>VSLY</td>
<td>€ 209,424</td>
<td>€ 127,307</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>95% Confidence Intervals (nonparametric bootstraps)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
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<tr>
<td>VSL</td>
<td>€ 3,428,516</td>
<td>€ 2,727,662</td>
</tr>
<tr>
<td>VSLY</td>
<td>€ 158,448</td>
<td>€ 136,147</td>
</tr>
</tbody>
</table>
European Results

Median VSL Estimates by Method

[1,000 Euro (2014)]

- RP/WR
- SP/CV
- SP/DCE
European Results

Median VSLY Estimates by Method

[1,000 Euro (2014)]
## European Results

### Revealed Preference Studies (Wage Risk)

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Median</th>
<th>25% Percentile</th>
<th>75% Percentile</th>
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</thead>
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<tr>
<td>All RP/WR Studies</td>
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<tr>
<td>VSL</td>
<td>€ 8,436,298</td>
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<td>€ 2,192,626</td>
<td>€ 7,340,022</td>
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<tr>
<td>VSLY</td>
<td>€ 376,493</td>
<td>€ 231,422</td>
<td>€ 100,058</td>
<td>€ 334,954</td>
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</table>
## European Results

### Revealed Preference Studies (Wage Risk)

<table>
<thead>
<tr>
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<th>75% Percentile</th>
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</thead>
<tbody>
<tr>
<td>All RP/WR Studies</td>
<td></td>
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</tr>
<tr>
<td>VSLY</td>
<td>€ 376,493</td>
<td>€ 231,422</td>
<td>€ 100,058</td>
<td>€ 334,954</td>
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<tr>
<td>Scenario Analysis (1):</td>
<td></td>
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</tr>
<tr>
<td>excluding Spengler (2004) and Schaffner and Spengler (2005)</td>
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<tr>
<td>VSLY</td>
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<tr>
<td>excluding Sandy and Elliott (1996)</td>
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<tr>
<td>VSLY</td>
<td>€ 214,642</td>
<td>€ 243,222</td>
<td>€ 100,058</td>
<td>€ 334,954</td>
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</table>
European Results

Revealed Preference Studies (Wage Risk)

VSLY by Study

[1,000 Euro (2014)]

UK

CHE

DEU (cs)

DEU (lg)

DEU (lg)

DEU (lg)

POL

UK

TUR
## European Results

### Stated Preference Studies (CV, DCE)

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Median</th>
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<th>75% Percentile</th>
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</thead>
<tbody>
<tr>
<td>VSL (CV)</td>
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<td>€ 2,978,677</td>
<td>€ 2,319,086</td>
<td>€ 3,942,348</td>
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<td>VSLY (CV)</td>
<td>€ 147,053</td>
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<td>VSL (DCE)</td>
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<td>€ 195,448</td>
<td>€ 187,857</td>
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<td>€ 296,563</td>
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**European Results**

**Stated Preference Studies (CV)**

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<td>3</td>
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<td>SWE</td>
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<td>26</td>
<td>FRA</td>
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<tr>
<td>27</td>
<td>SWE</td>
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</tbody>
</table>

**VSLY by Study**

[1,000 Euro (2014)]
European Results

Stated Preference Studies (DCE)

VSLY by Study

[1,000 Euro (2014)]
### European Results

#### Panel vs. Cross-Sectional Analysis

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Mean</th>
<th>Median</th>
<th>25% Percentile</th>
<th>75% Percentile</th>
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<tbody>
<tr>
<td><strong>cross-sectional analysis</strong></td>
<td>€ 213,676</td>
<td>€ 158,753</td>
<td>€ 99,125</td>
<td>€ 204,121</td>
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<tr>
<td><strong>panel data analysis</strong></td>
<td>€ 183,913</td>
<td>€ 143,614</td>
<td>€ 100,058</td>
<td>€ 296,563</td>
</tr>
</tbody>
</table>
Panel vs. Cross-Sectional Analysis

- **Cross Analysis**
  - Values range from 0 to 400
  - Excludes outside values

- **Panel Analysis**
  - Values range from 0 to 300
European Results

Median VSL Estimates by Region

Northern Europe
United Kingdom
Continental Europe

n=18  n=6  n=25

[1,000 Euro (2014)]
European Results

Median VSLY Estimates by Region

- Northern Europe: n=18
- United Kingdom: n=6
- Continental Europe: n=25

[1,000 Euro (2014)]
## European Results

### Median VSL / VSLY by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Mean</th>
<th>Median</th>
<th>25% Percentile</th>
<th>75% Percentile</th>
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</thead>
<tbody>
<tr>
<td><strong>Continental Europe</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSL</td>
<td>€ 3,831,291</td>
<td>€ 3,235,183</td>
<td>€ 2,192,626</td>
<td>€ 5,319,627</td>
</tr>
<tr>
<td>VSLY</td>
<td>€ 170,241</td>
<td>€ 158,448</td>
<td>€ 94,601</td>
<td>€ 231,422</td>
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<tr>
<td><strong>United Kingdom</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSL</td>
<td>€ 10,273,115</td>
<td>€ 2,244,332</td>
<td>€ 1,964,914</td>
<td>€ 5,848,654</td>
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<tr>
<td>VSLY</td>
<td>€ 469,957</td>
<td>€ 117,956</td>
<td>€ 102,472</td>
<td>€ 255,023</td>
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<tr>
<td><strong>Northern Europe (including Denmark)</strong></td>
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<td></td>
</tr>
<tr>
<td>VSL</td>
<td>€ 4,106,781</td>
<td>€ 3,754,427</td>
<td>€ 2,978,677</td>
<td>€ 4,197,741</td>
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<tr>
<td>VSLY</td>
<td>€ 177,000</td>
<td>€ 161,052</td>
<td>€ 124,020</td>
<td>€ 189,478</td>
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</tbody>
</table>
European Results

VSLY / GDP/capita (by region)

Continental Europe

Northern Europe

United Kingdom

excludes outside values
## European Results

### VSLY / GDP/capita (by region)

<table>
<thead>
<tr>
<th>Region</th>
<th>Mean</th>
<th>Median</th>
<th>25% Percentile</th>
<th>75% Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continental Europe</td>
<td>5.74</td>
<td>4.75</td>
<td>2.66</td>
<td>7.56</td>
</tr>
<tr>
<td>Northern Europe</td>
<td>5.92</td>
<td>5.79</td>
<td>4.04</td>
<td>6.43</td>
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<tr>
<td>United Kingdom</td>
<td>26.00</td>
<td>4.51</td>
<td>3.32</td>
<td>8.67</td>
</tr>
<tr>
<td>Europe (overall)</td>
<td>8.29</td>
<td>5.10</td>
<td>3.37</td>
<td>7.01</td>
</tr>
</tbody>
</table>
European Results

VSLY / GDP/capita (by method: RP vs. SP)

excludes outside values
European Results

VSLY / GDP/capita (by method: c-s vs. panel)

- Cross-sectional analysis
- Panel data analysis

VSLY - GDP - Ratio

excludes outside values
**European Results**

**VSLY / GDP/capita** (by method)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
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<th>75% Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revealed Preferences</strong></td>
<td>18.82</td>
<td>8.67</td>
<td>3.25</td>
<td>10.87</td>
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<tr>
<td><strong>Stated Preferences</strong></td>
<td>5.24</td>
<td>5.09</td>
<td>3.37</td>
<td>6.39</td>
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</table>

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Median</th>
<th>25% Percentile</th>
<th>75% Percentile</th>
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</thead>
<tbody>
<tr>
<td><em>cross-sectional</em></td>
<td>8.71</td>
<td>5.15</td>
<td>3.65</td>
<td>6.62</td>
</tr>
<tr>
<td><em>panel data</em></td>
<td>5.73</td>
<td>4.66</td>
<td>3.25</td>
<td>8.67</td>
</tr>
</tbody>
</table>
European Results

Sensitivity Analysis (VSLY)

Combined Impact of Discount Rate and Uncertainty

![Graph showing the combined impact of discount rate and uncertainty on VSLY. The graph includes lines for median, 25% percentile, and 75% percentile, with axes for VSLY on the y-axis and discount rate on the x-axis.](image)
European Results

Sensitivity Analysis (VSLY)
Combined Impact of Discount Rate and Uncertainty

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>1%</th>
<th>2%</th>
<th>3%</th>
<th>4%</th>
<th>5%</th>
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</thead>
<tbody>
<tr>
<td>25% Percentile</td>
<td>76,340</td>
<td>87,808</td>
<td>100,058</td>
<td>115,935</td>
<td>130,039</td>
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<td>Median</td>
<td>117,431</td>
<td>139,552</td>
<td>158,448</td>
<td>182,008</td>
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<td>75% Percentile</td>
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<td>199,136</td>
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<td>265,792</td>
<td>301,918</td>
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</table>

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Summary and Conclusions

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<th>VSLY</th>
<th>Indirect Measurement</th>
<th>Direct Measurement</th>
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<tbody>
<tr>
<td>Method Study</td>
<td></td>
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<tr>
<td>Schlander et al. (2017):</td>
<td>n.a.</td>
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<td>1995-2015</td>
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<td>Hirth et al. (2000):</td>
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</tr>
<tr>
<td>1969-1997</td>
<td>€ 97,800</td>
<td>€ 168,900</td>
</tr>
</tbody>
</table>

All VSLY expressed in Euro (2014); Hirth et al. (2000) data were transformed from US-$ (1997) using CPI, PPP, and a WTP-Q transformation factor of 1.1.
Summary – Europe

- Database: 41 studies, yielding 49 unique European estimates
- Median VSLY = 158,448 € [2014]
- 95% confidence interval, 136,147 € - 180,750 € (nonparametric bootstrapping)
- Median VSLY = 5.10 times GDP / capita
- WTP-Q > VSLY (transformation factor reportedly around ~1.1)
- Large heterogeneity between studies, which in part may be explained by different methodological approaches and by different regional sources of data (significant in the worldwide dataset only)
- Nevertheless, VSLY >> currently accepted benchmarks for cost effectiveness (among health economists and the HTA community)
Implications

Currently used benchmarks for cost effectiveness (WTP-Q) appear to be much lower than empirical willingness-to-pay for a life year (or “VSLY”) in other sectors of life.

However:

- Policy implications will be influenced by the type of health care system in question; an NHS with a politically determined health budget may respond differently than a bottom-up financed system.
- We have no intention to suggest a new benchmark for WTP-Q.
- Among other concerns, there are data which suggest that the conversion of length and quality of life, as it is inherent in the conventional QALY model, may be flawed.
- We believe there are compelling reasons to reject a universal WTP-Q benchmark on both normative and empirical grounds.
Thank You for Your Attention!

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