Valuing mortality risk reductions

A Global Meta-analysis of the Value of a Statistical Life (VSL) from Stated Preference studies

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Outline

1. Background – implicit/explicit VSL, methods and regulatory practises
2. Research questions
3. VSL database, screening and meta-regressions
4. Results
5. Base Value and Adjustments
6. Conclusions

1. Background

- Objections to ”Value of a Statistical Life”
- Rather use ”Value of Preventing a Fatality” or ”The value of a very small change in the mortality risk for the general population” ?
- VSL is **not** the value of an identified person’s life
- Increased use of Cost-Benefit Analysis within the European Commission, European countries, US, World Bank etc → Need for explicit VSL

Implicit vs. Explisit VSL

- Avoid valuation → Decisions still made
  → **Implicit VSL estimates**
  → Random, inconsistent values
  → Invest too much in some sectors to avoid fatalities and too little in other sectors

- **Explicit VSL estimates also differ** due to different methodological approaches across sectors (Transport, Health, Environment, Climate Change) within a country and across countries

Valuation Methods for VSL

- Hedonic Wage / Wage risk

  Revealed Preference

- Contingent Valuation and Choice Experments

  Stated Preference

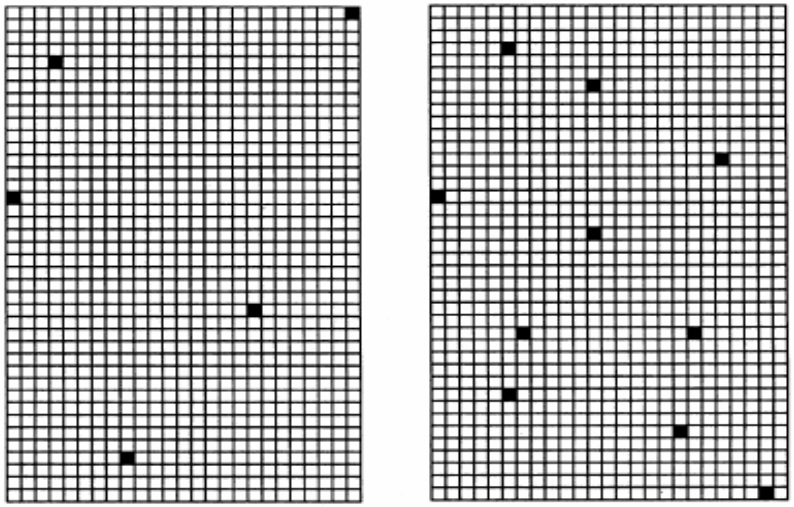
How to derive VSL from Contingent Valuation?

- **Example:**

CV survey shows:
Mean WTP = 30 US$/year per person for a mortality risk *reduction* from 3 in 100.000 to 2 in 100.000 i.e. an annual mortality risk reduction of 1:100.000.

VSL = 30 x 100.000 = 3 million US$

5 in 1000 **10 in 1000**



Regulatory Practices

- **USA**
  - Based mainly on wage-risk studies
  - VSL varies between agencies
  - OMB : 1 – 10 million US $
  - EPA: 7.5 million US $ (0.9 – 21.1)
    - DoT: 5.8 million US $
  - FDA: 5 million $, 6.5 million $; varies
  - DHS: 6.3 million $

No adjustment for age or income; Adjust for increased real income over time, latency, medical costs added.

Regulatory Practices (2)

- **Canada**
  - Based on both SP and Wage Risk studies
  - Wage risk: VSL = 7.8 million C $ (6.2- 9.9)
  - SP = 5.0 million C $ (3.4- 6.3)
  - Recommended VSL = 6.5 million C $
    (Low VSL 3.5 High Value 9.5)
  - Have applied age adjustment
    4.9 million C$ for adults aged 65+

Regulatory Practices (3)

- **UK**

  - Long tradition for SP surveys

  - Defra use VOLY to value 2-6 months loss in life expectancy for every death brought forward due to air pollution

Regulatory Practices (4)

- **EU**

  - Based on Stated Preference studies
  - EC Impact Assessment Guidelines

    VSL = 1-2 million €

    VOLY = 50.000 – 100.000 €

    ”if no more context specific estimate are available”

  - Based on EC-DG Environment (2001): “Recommended Interim Values for the Value of Preventing a Fatality in DG Environment Cost Benefit Analysis’ (2000)

  - Adjustments for latency, cancer and age proposed but not applied in practise

  - VOLY used mainly for sensitivity analysis

    (see e.g. CBA of CAFE)

Regulatory Practices (5)

- **Other countries**
  - **Australia:**
    - Based on SP studies
    - VSL : 3.5 mllion AUS $
    - VOLY: $ 151,000 AUS $
  - **Norway**
    - Based on SP studies
    - Dept. of Transport has a long tradition of using VSL
    - Ministry of Finance CBA Manual (2005)

      VSL and VOLY estimates based on DG-ENV (2001) recommendations

Background for this study

- No comprehensive meta-analysis (MA) of stated preference (SP) VSL studies globally
  - Both of research and policy interest
- OECD project 2008-2011, supported by the EC
- **Database** of SP studies constructed

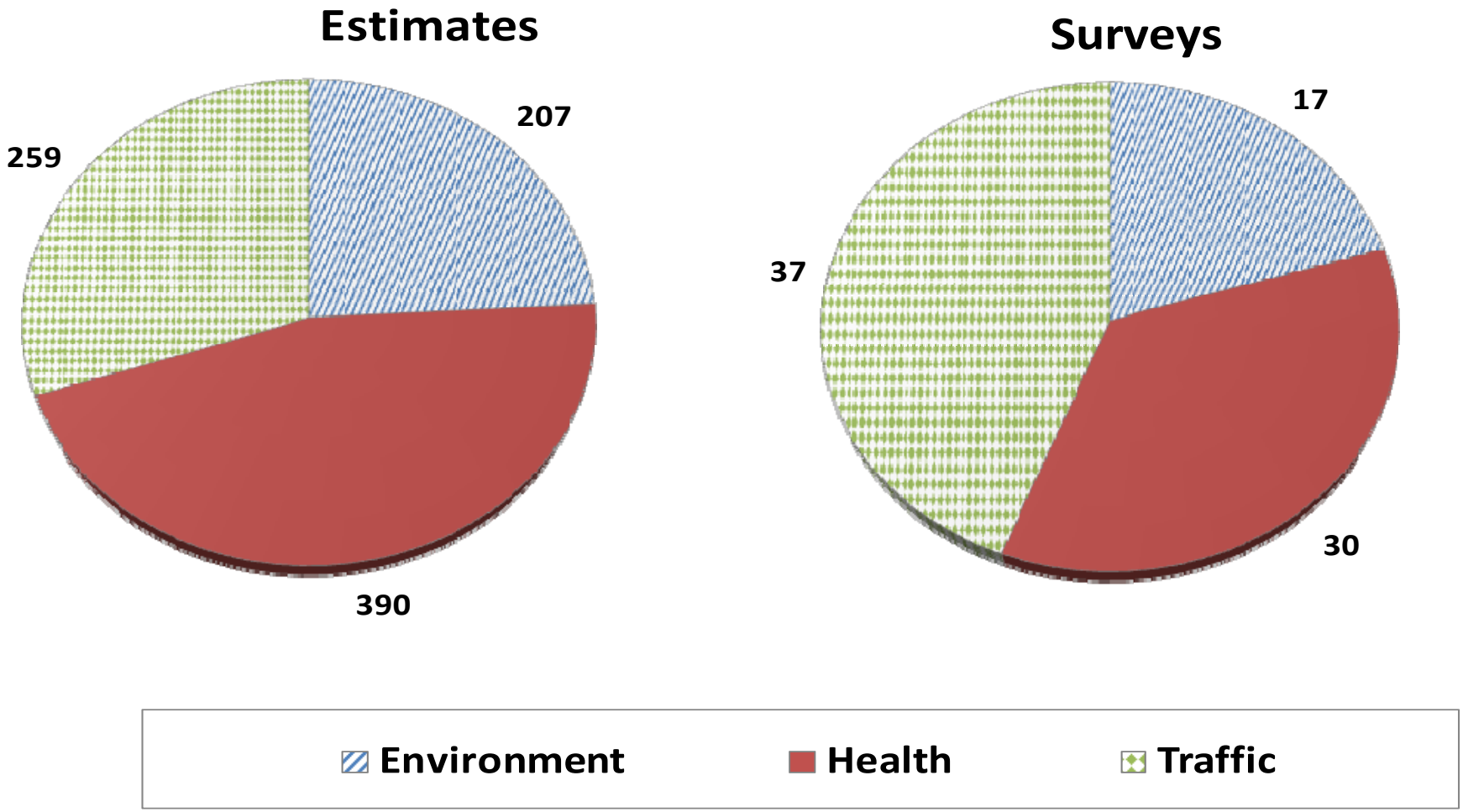
  - 850 sample mean adult VSL estimates in 38 countries around the world from SP surveys using an environmental (207), health (390) and traffic (259) risk context; from 1970-2008.
- All VSL estimates adjusted for inflation to 2005 values in respective countries currencies and converted to 2005 US $ using PPP (AIC) adjusted exchange rates

2. Research Questions

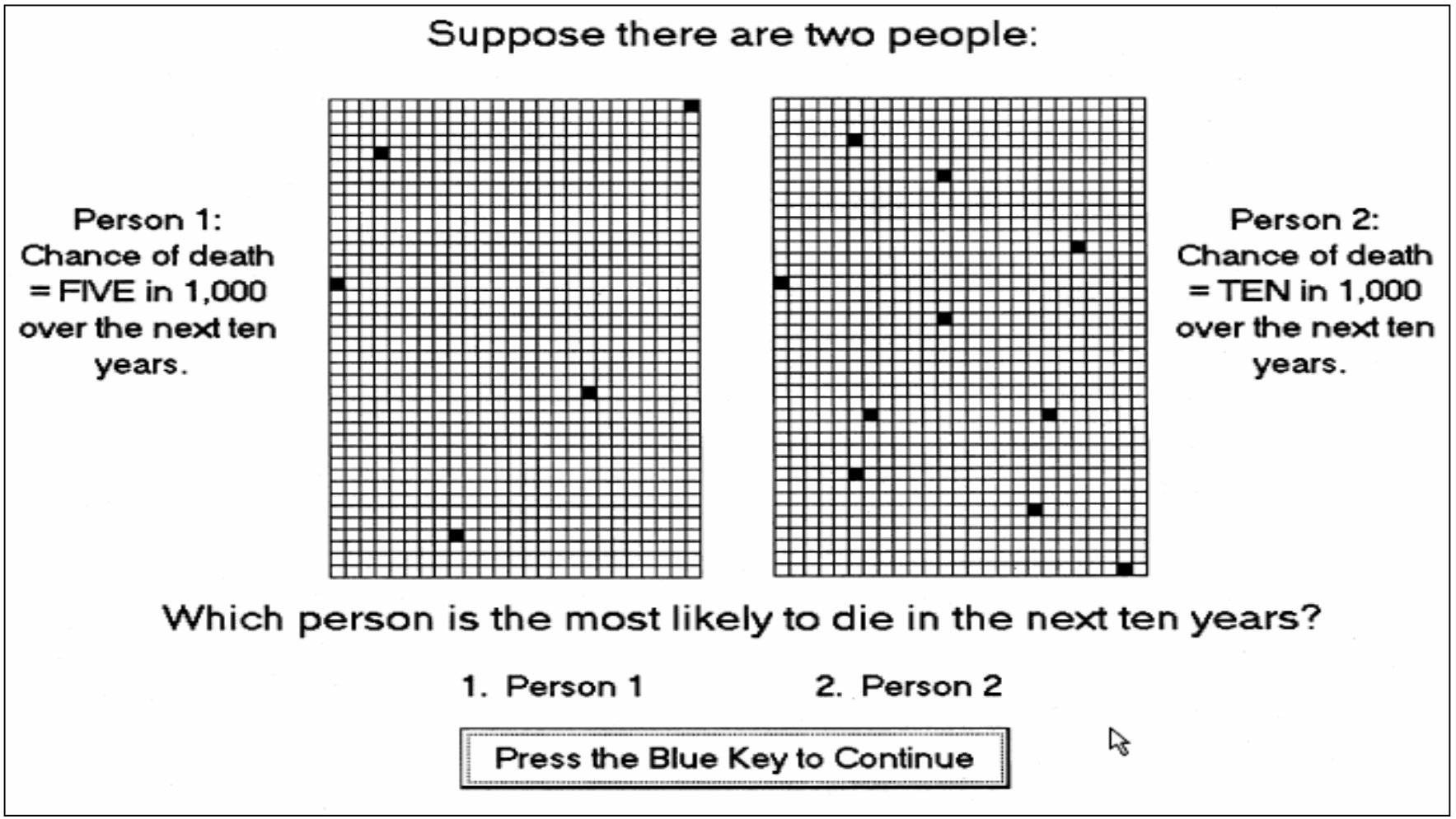
- **How do characteristics** of the population surveyed, the risk type and context, and the methodological aspects of the surveys affect mean VSL estimates derived from SP studies?

- **How sensitive are the results** to common methodological challenges and choices faced by the meta-analyst, especially related to procedures for quality screening of VSL estimates?

3. Database of VSL, by risk category

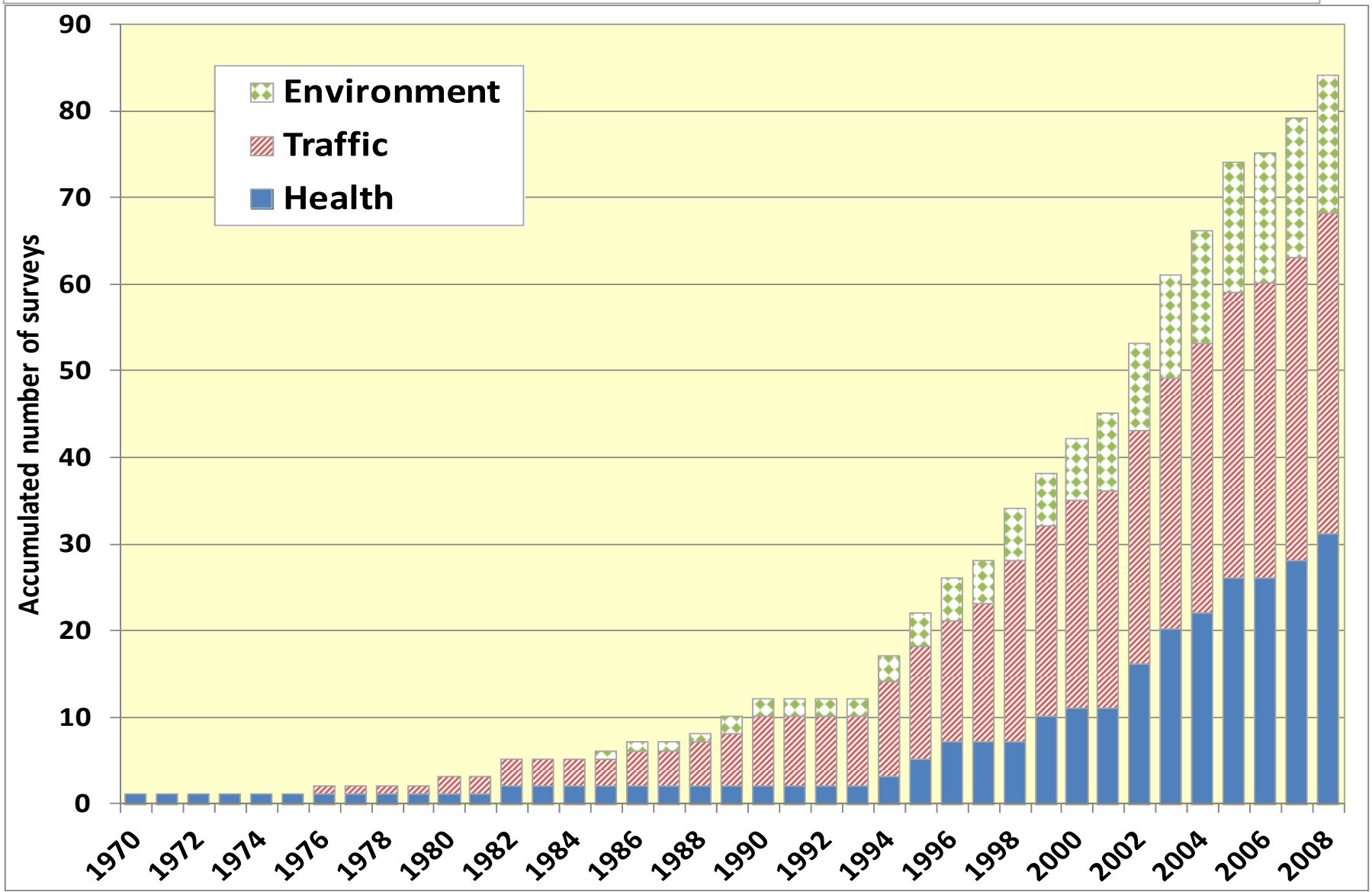


Example of risk communication and comprehension
1.000 square grid where risk changes from 10 to 5 in 1.000 over 10 years

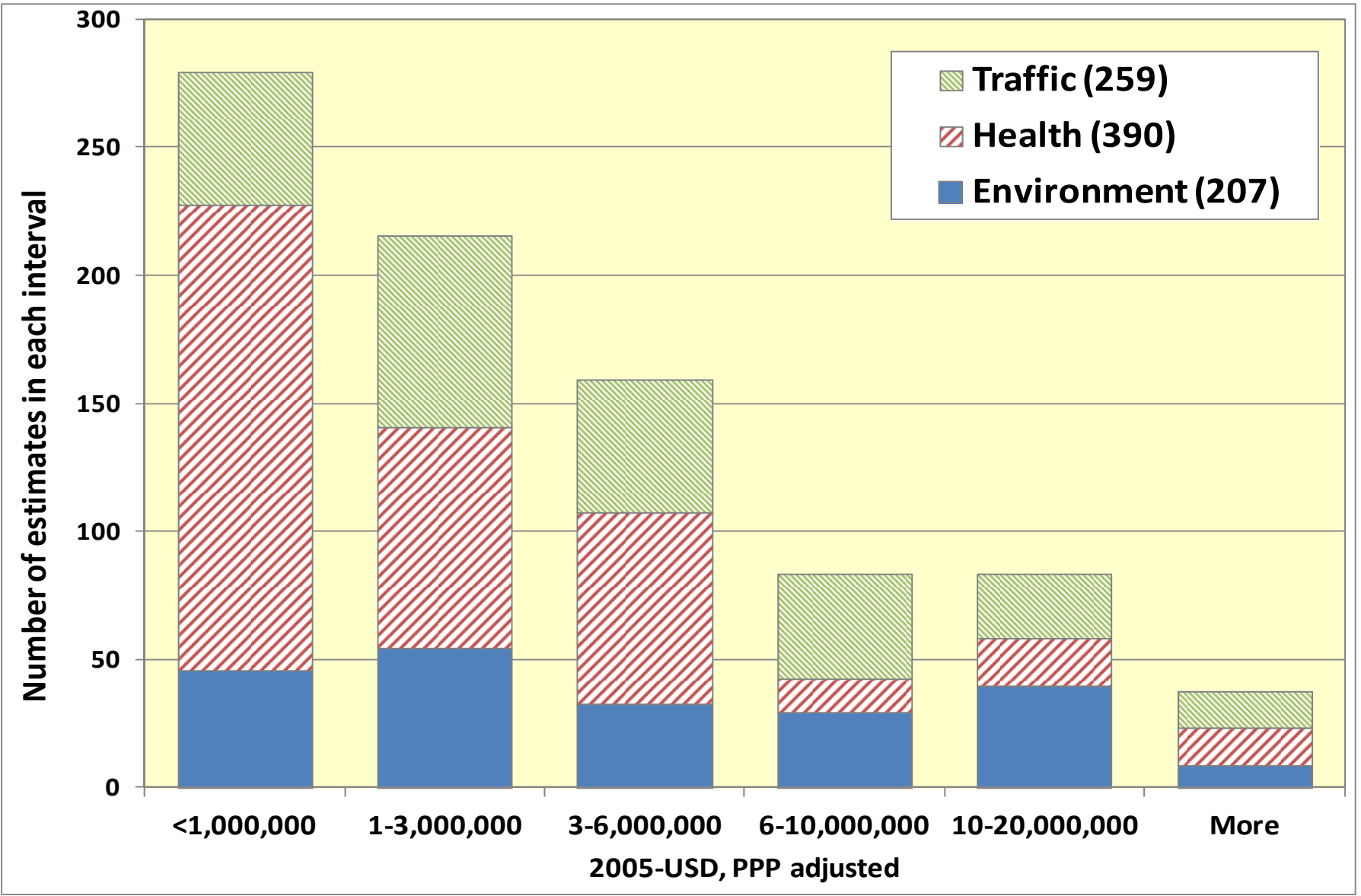


Source: Krupnick *et al.* (2002).

Accumulated surveys, by risk category



VSL histogram, by risk category



Screening of VSL estimates

- Motivation: Differences in quality of studies, reduce heterogeneity, increase precision for policy

- Screening criteria; Exclude estimate if:
  - No reporting of the risk change valued
  - WTA estimates
  - Small samples (< 100 and 200)
  - Unrepresentative samples (e.g. commuters)
  - Surveys showing no internal and/or external scope
  - Not using a survey developed by Krupnick et al
  - Authors recommending exclusion

First level screening

4. Methods and data analysis

- Meta-regression:

$$\mathrm{lnvsl}_{si} = \beta_0 + \beta_1 \mathrm{lngdp}_{si} + \sum_k \beta_k X_{si}(k) + \varepsilon_{si}$$

- OLS, weighted by inverse of estimates in each survey
- Cluster option to estimate robust standard errors
- For a subset: weighted by precision of estimates
- Regressions using different screening criteria

Variable	Description	Sign
Lnvsl	Log of sample mean VSL in PPP-adjusted USD 2005 - dependent variable	
Risk valuation context variables:		
Lnrchrisk	Log of change in mortality risk on an annual basis per 1000	**0**
Public	1 if public good; 0 if private (the individual asked or her household).	+/-
Envir	1 if environment-related risk change; 0 if health-related.	**?**
Traffic	1 if traffic-related risk change; 0 if health-related.	**?**
Latent	1 if risk change occurs after a certain time; 0 if immediate.	-
Cancerrisk	1 if reference to cancer risk in survey; 0 if not.	+
Household	1 if WTP is stated on behalf the household; 0 if individual asked.	+
Methodological variables:		
Noexplan	1 if no good explanation of the risk change was used; 0 if otherwise.	**+/?**
Turnbull	1 if WTP was estimated using Turnbull; 0 parametric method.	-
Income and survey year:		
Lngdp	Log of mean GDP/capita, USD 2005, PPP-adjusted based on AIC.*	+
Lnyear	Log of year of data collection, adjusted to start at earliest survey in1970.	+/-

4. Results – first level screening

	Model I	Model II	Model III	Model IV	Model V
lngdp	0.768***	0.841***	0.882***	0.850***	0.783***
	(0.205)	(0.193)	(0.184)	(0.186)	(0.193)
lnchrisk	-0.450***	-0.528***	-0.552***	-0.572***	-0.577***
	(0.0940)	(0.103)	(0.101)	(0.0826)	(0.0849)
turnbull	-0.948	-0.384	-0.109	0.0160	-0.0774
	(0.825)	(0.653)	(0.630)	(0.654)	(0.677)
envir		-1.097***	-0.433	-0.650*	-0.606*
		(0.352)	(0.275)	(0.348)	(0.335)
traffic		-0.310	-0.0814	-0.126	-0.288
		(0.278)	(0.308)	(0.267)	(0.231)
public			-1.002***	-0.917***	-0.913***
			(0.260)	(0.263)	(0.249)
household			-0.0198	0.0154	0.0159
			(0.277)	(0.232)	(0.225)
cancerrisk				0.407	0.475
				(0.314)	(0.308)
latent				-0.369	-0.326
				(0.381)	(0.371)
noexplan					0.668***
					(0.214)
Constant	2.882	1.784	1.205	1.319	1.846
	(2.422)	(2.313)	(2.230)	(2.263)	(2.366)
Estimates	405	405	405	405	405
R-squared	0.720	0.767	0.806	0.817	0.833
Root mean squared error	0.886	0.810	0.740	0.721	0.691

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4. Results – scope sensitivity

	No scope		Internal or External		Internal & External	
	Model I	Model II	Model III	Model IV	Model V	Model VI
lngdp	0.753***	0.811***	0.692**	0.745**	0.249	0.336**
	(0.174)	(0.116)	(0.318)	(0.293)	(0.158)	(0.134)
lnchrisk	-0.475***	-0.608***	-0.443***	-0.551***	-0.290***	-0.245
	(0.0814)	(0.0895)	(0.114)	(0.102)	(0.0573)	(0.135)
turnbull	-1.982***	-0.714**	0.600	0.850	-0.705*	-0.476
	(0.435)	(0.333)	(0.903)	(0.866)	(0.370)	(0.299)
envir		-0.0285		-0.241		0.130
		(0.222)		(0.355)		(0.294)
traffic		-0.360		-0.179		-0.190
		(0.215)		(0.385)		(0.197)
public		-0.999***		-0.768**		-0.0143
		(0.244)		(0.312)		(0.331)
household		0.512*		-0.486		0.0845
		(0.243)		(0.358)		(0.332)
cancerrisk		0.0965		0.484		0.0188
		(0.299)		(0.311)		(0.125)
latent		1.186***		-0.384		-0.695**
		(0.338)		(0.293)		(0.245)
noexplan		0.648**		1.051***		
		(0.227)		(0.291)		
Constant	3.032*	1.162	3.556	2.366	9.395***	9.192***
	(1.521)	(1.402)	(3.623)	(3.439)	(1.572)	(1.659)
Estimates	108	108	297	297	79	79
R-squared	0.898	0.952	0.629	0.775	0.637	0.756
Root mean squared error	0.545	0.386	0.971	0.765	0.528	0.451

Robust st.errors in parenth.
*** p<0.01, ** p<0.05, * p<0.1

4. Results – Main variables

- Most robust variables explaining variation in VSL are GDP/capita & risk change
  - Income elasticity 0.7-0.9

    (0.3-0.4 for subset passing scope tests),
- Private risk change gives higher VSL
- Environmental risk gives lower VSL than health risks
- No proper risk explanation gives higher VSL
- Mixed evidence re. latency, cancer and other variables. No clear relationship with age

4. Results – screening etc

- Explanatory power increases with tighter screening criteria → heterogeneity reduced
- Scope sensitive data → VSL less sensitive to risk
- Results are fairly robust to different models, weighting procedures, trimming etc.

5. Base Value and Adjustment

- Navrud & Lindhjem (2011) derive a base VSL range for EU- 27
  - **1.25-5.25 (2005-USD), best esimate: USD 3.5 million**

- For individual countries : Use Unit Value Benefit Transfer with adjustment for income differences (GDP pr. capita) and income elasticity of 0.7 - 0.9 (sensitivity analysis 0.3-0.4)

- When should the base value be adjusted?

Adjustments to base values (I)

Adjustment factor	Recommendation
Population Characteristics	
Income	No adjustment *within* a country or group of countries the policy analysis is conducted for (due to equity concerns). For transfers *between* countries, VSL should be adjusted with the difference in GDP per capita to the power of an income elasticity of VSL of 0.8, with a sensitivity analysis using 0.4.
Age	No adjustment for adults due to inconclusive evidence. Adjust if regulation is targeted on reducing children´s risk. VSL for children should be a factor of 1.5 – 2.0 higher than adult VSL.
Health status of population and background risk	No adjustment (due to limited evidence)

Adjustments to base values (II)

Adjustment factor	Recommendation
Risk Characteristics	
Timing of risk (Latency)	No adjustment. As a sensitivity analysis, adjust downwards if the regulation is targeted on risks with significant latency periods.
Risk Perception (source or cause)	No adjustment (due to inconclusive evidence). Sensitivity analysis for lower values in the environment sector than in health and traffic.
Cancer or Dread (Morbidity prior to death)	No adjustment if regulation is targeted on cancer risks and/or risks that are dreaded due to morbidity prior to death. Morbidity costs prior to death should be added separately.
Magnitude of risk change	No adjustment. However, since the magnitude of the risk change clearly affects the VSL, a sensitivity analysis based on VSL calculated from a risk change similar in magnitude to the policy context should be conducted. A risk change of 1 in 10,000 annually is suggested for calculating a VSL base value.

Adjustments to base values (III)

Adjustment factor	Recommendation
Other adjustments	
Altruism and Public vs. Private risk	No adjustment (due to limited evidence and unresolved issues). Use “Private risk” to calculate a VSL base value. Provide illustrative adjustments in sensitivity analysis.
Discount for hypothetical bias in SP studies	No adjustment (due to limited evidence)
Correction for inflation	Adjustment based on the national CPI
Correction for increased real income over time	Adjust VSL with same percentage as the percentage increase in GDP per capita.

6. Conclusion

- Solid database to draw research and policy implications
- Some evidence that VSL should be adjusted in policy assessments
- For some variables, more research needed
- Results from MA must be balanced against other evidence in the literature
- Database made public to enable further analyses, updates and periodic revisions of VSL

Thank you

OECD Website for data and reports:

www.oecd.org/env/policies/vsl

Lindhjem, Navrud, Braathen and Biausque (2011)
Forthcoming in *Risk Analysis*

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