Environment Center
Charles University
in Prague

Health Impacts Due to Smoking Valuation of Premature Cancer Mortality

(A summary of cancer risk valuation in the Czech Republic)

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Benefit valuation of morbidity

< Three welfare components >

COI=Cost-Of-Illness (Rice et al., 1966)

1. **Direct (resource) costs** i.e. medical treatment costs paid by the health service (or covered by insurance), and any other personal out-of-pocket expenses (US EPA COI Handbook, 2002)
2. **Indirect (opportunity) costs -** the cost in terms of lost productivity due to sickness (work time loss, cost of absenteeism, friction costs measured by concept of replacement (Koopmanschap et al. 1995)

BUT: COI does not include goods that are outside of market (e.g. pain, suffer, inconveniences) → a lower bound of the welfare estimate

Dis-utility

3. welfare loss due to inconvenience, suffer, or pain

Review of COI studies on lung cancer: medical treatment costs

Author	country	approach	viewpoint	discounting	Medical treatment cosi in national currencies					€2005 in exchange rate	
					Currency	lung cancer	NSLC	SCLC	%NSCLC	lung cancer	NSLC/SCLC
Koopmanschap (1994)	Netherlands	incidence prevalence	not specified	no	NLG 1988	10,126			n.a.	6,846	
Evans et al. (1995)	Canada	incidence	GOV	no	CAD 1988	21,003	19,782	25,988	90%*	20,907	20,309
Berthelot et al. (2000)	Canada	incidence	GOV	no	CAD 1995		24,828	41,178	90%*		21,434
Wolstenholme Whynes (1999)	UK	incidence	Hospital	yes (6%)	GBP 1993		6,150	5,668	90%		12,179
Weissflog et al. (2001)	Germany	prevalence	Sickness fund	no	DM 1996	32,415			n.a.	18,703	
Serup-Hansen et al. (2003)	Denmark	incidence	?	yes (3%)	DKK 2002	143 685			n.a.	20,173	
Braud et al. (2003)	France	incidence	Hospital	no	Euro 2001	12,518	13,969	7,369	90%*	13,637	14,499
Chouaid et al. (2004)	France	incidence	Healthcare payment	no	USD 1999		24,242	26,009	79%		23,189
Vergnenegre et al. (2004)	France	incidence	Healthcare payment	no	Euro 1999		24,984	24,759	90%*		28,431
Dedes et al. (2004)	Switzerland		Health service expenses	?	Euro 1999		19,212	20,992	89%		22,105
Abal Arca et al. (2006)	Spain	incidence	?	?	Euro 2003	4,643	5,070	3,692	74%	4,835	4,906
our study (2008)	Czech Republic	incidence	GOV	yes (1%)	CZK 2007	176,600			n.a.	6,221	

Source: Ščasný, Máca, Melichar, 2008 (EC DROPS project)

Review of COI studies on lung cancer: medical costs plus loss of productivity

Author	country	approach	discounting	€2005 by exchange rate		
				medical treatment	loss of productivity	total
Weissflog et al. (2001)	Germany	prevalence	no	18,703	151,327	170,031
Serup-Hansen et al. (2003)	Denmark	incidence	yes (3%)	20,173	35,608	55,781
our study (2008)	Czech R	incidence	yes (3%)	6,221	33,746	39,967
our study (2008)	Czech R	incidence	yes (1%)	6,221	38,043	44,264
our study (2008)	Czech R	incidence	no	6,221	40,580	46,800

Source: Ščasný, Máca, Melichar, 2008 (EC DROPS project)

Mortality valuation in economics

Ideally, the effects on mortality risk can be characterised as shifts in individual (population) survival curves.

Mortality risk can be measured in terms of

- „postponed“ deaths → **VSL =Value of a Statistical Life**
- increased remaining LE → **VOLY =Value of a (Statistical) Life Year**

$$VSL = \frac{\partial WTP}{\partial R}$$

- defined as the marginal rate of substitution between **wealth** and (unconditional) **mortality risk** in a defined time period
- **marginal value of reducing the risk of dying**, defined as marginal value that the individual is willing to trade for her income

Mortality valuation in economics

- VSL refers to an anonymous death
  „…A VSL of €3 million does not imply that a person would be willing to pay €3 million to avoid certain death or that he or she would be willing to accept certain death if paid €3 million. *People may* ***lack the financial resources*** *to pay €3 million to eliminate the certainty of death, and similarly they may be quite* ***unwilling to face the risk of certain death*** *even for compensation amounts much greater than €3 million. The VSL tradeoff rate is reflective of the terms of trade involving very small risks and does not generalize to these larger risk situations.“ (Viscusi 2009:106)*

- If each person in a population of **1 million** paid **3 Euro** to reduce his or her chance of dying this year by **one in million**, a total of **3 million Euro** would be paid, and **one fewer death** would be expected to occur in this year.

- Less misleading terms
  VPF = value of preventing fatality (Jones-Lee 2004)
  'micromort' (Howard 1984; Cameron 2010)

Mortality valuation in policy evaluation

VSL used in BCA

- US EPA, European Commission, OECD, many countries
- VOLY used for air quality context (Desaigues et al. 2012), but VSL generally recommended to use in BCA (USEPA SAB 2008; Pearce et al. 2006)

VSL estimates

- estimated from **a risk-wage differential** (job injuries) or **expenditures on safety** (safer cars, helmets, fire alarms, etc.)
- elicited preferences within **a stated preference study** to get WTP for dR within specific context and/or for specific population

Alberini and Ščasný (2011; 2013)

1. Does the VSL vary with ***the cause of death***, *including cancer*?

2. Does ***the mode of provision*** of the risk reduction (public program v. private good) influence the VSL?

3. Are differences in VSL for different causes of death explained away by ***perceptions*** (dread, controllability, exposure and salience of the risk?

4. After characteristics of the risk and perceptions are accounted for, ***does "cause of death" still matter***?

Alberini and Ščasný (2011; 2013)

- Discrete choice experiment, with 5 attributes and 3 alternatives

Attribute	No. levels	Levels
Context (cause of death)	3	Cancer
		Road traffic accidents
		Respiratory illnesses
Private good or public program	2	Private good (no other beneficiaries);
		Nationwide public program (other beneficiaries)
Latency	4	0, 2, 5, 10 years
Size of the risk reduction	4	2, 3, 5, 7 in 10,000 over 5 years
(One-time) Cost to the respondent	4	200, 500, 1,000, 2,000 euro (Italy)
		3,200, 8,000, 16,000, 32,000 CZK (Czech Republic)

- We ask for reducing risk of a respondent (adult) and his/her own child
- Stated preference survey in the Czech Republic (n=1,506) and Italy (n=1,906) in 2008; parents with at least one child younger than 18

Alberini and Ščasný (2011; 2013)
Example of choice card

Comparison 2. Let us now consider two more interventions that reduce the probability of dying for a person your age, gender, health status and preventive actions, which is currently equal to 57 in 10.000 over 5 years. These interventions are described below.

Characteristics	Intervention C	Intervention D
Cause of death	Road-traffic accidents	Respiratory illnesses
Type of initiative	Government program	individual preventive action
Other beneficiaries of the reduction in the probability of dying?	Other adults	No
Reduction in the probability of dying	1 in 10.000 in 5 years	1 in 10.000 in 5 years
When does the reduction in the probability of dying begin?	In 2 years	Immediately
Total cost to your household	300 euro	500 euro

2. Which intervention would you choose, intervention C, intervention D, or neither?

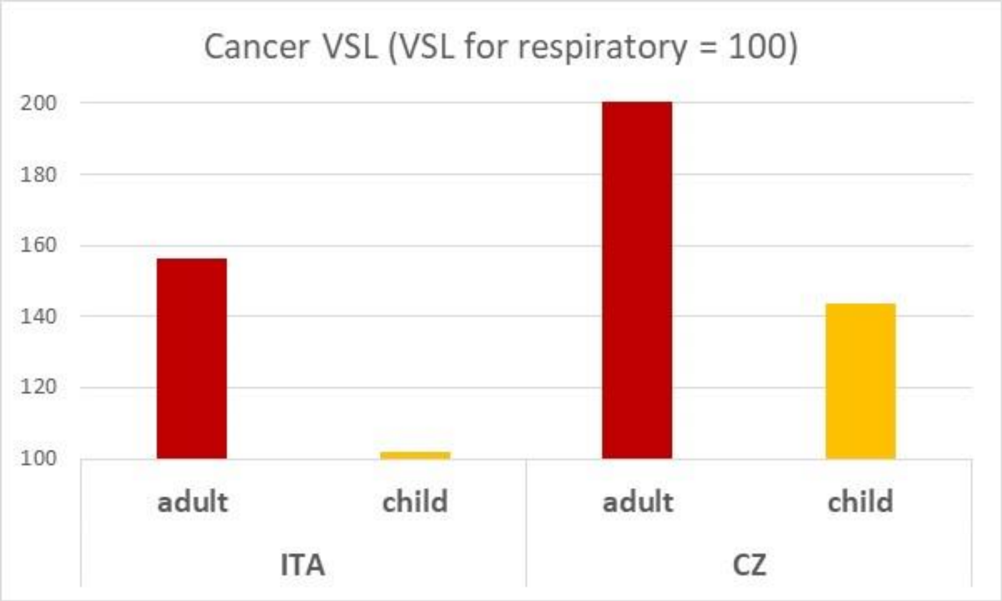
☐ Intervention C ☐ Intervention D ☐ Neither intervention (I would pay nothing and obtain no reduction in the probability of dying)

Alberini and Ščasný (2011)
VSL estimates

in Euro 2008 PPS	CHILD		ADULT		Child premium
	VSL, mill.€	s.e. (VSL)	VSL, mill.€	s.e. (VSL)	%
ITALY					
any of the three causes	**4.67**	0.30	**4.03**	0.26	**16%**
Respiratory	**4.70**	0.30	**3.41**	0.22	**38%**
Cancer	**4.79**	0.34	**5.33**	0.35	**-10%**
Road traffic acc.	**3.97**	0.31	**2.83**	0.23	**40%**
CZECH REPUBLIC					
any of the three causes	**1.46**	0.13	**1.08**	0.12	**35%**
Respiratory	**1.36**	0.14	**0.86**	0.12	**57%**
Cancer	**1.95**	0.18	**1.83**	0.18	**7%**
Road traffic acc.	**1.12**	0.13	**0.71**	0.13	**56%**

Alberini and Ščasný (2011) Results

- People re prepared to pay more if the risk reduction is delivered by **a public program** – the premium is approx. €1.8–2 mil. (child) and €1.1–1.3 mil. (adult) in Italy, and €0.8 mil. (child) and not signif. in Czech Rep.
- People are also prepared to pay more for reducing **cancer risk** – VSL for cancer is 60 and 100 % larger than VSL for respiratory diseases in adults, the difference is smaller or zero for reducing risk in children



Risks and risk perception: ‘Dreaded’ risks

- Cancer is associated with suffering and pain, and is **highly dreaded** (Starr, 1969, Fischhoff et al., 1978; Slovic, 1987)
  - Respondents **favoured programs** that reduce cancer mostly in **risk-risk trade-off studies** (Jones-Lee et al., 1985; Mendeloff and Kaplan, 1989; McDaniels et al., 1992; Savage, 1993, and Tolley et al., 1994; van Houtven et al., 2008)
  - **cancer ‘premium’** (Revesz 1999; Rowe et al. 1995; US EPA 2000; EC DG ENVI 2001 CBA Guide), but US EPA (2010) and recently EC do not apply the differential in policy appraisal
- Stated-preference studies: Is there a VSL ‘premium’?
  - ***little evidence*** about “premium” while WTP/VSL directly derived (Hammitt and Liu, 2004; Hammitt and Haninger, 2010; Chestnut et al., 2012)
  - **modest cancer “discounts”** (Tsuge et al., 2005; Adamowicz et al., 2011). *Low baseline risks* may offset the effect of dread. Chilton et al. (2006) separate effects of contextless baseline risks and dread effects for various risks.
  - **large variations** across causes (Alberini and Scasny, 2011; 2013)

Alberini and Ščasný (2013, survey in Italy)

Are differences in VSL for different causes of death explained away by ***perceptions*** (dread, controllability, exposure and salience) of the risk? After they are accounted for, ***does "cause of death" still matter***?

- If a risk reducing program is **perceived effective,** VSL will get larger (about €0.5 mil. for each point), and the difference is twice larger for public program than for a private initiative
- **Baseline risk** does not have effect on VSL
- **Exposure** (lives in a high pollution area, smokes, cancer runs in her family, etc.), risk is **more common**, and **experience** (a relative, spouse, close friend have cancer, has had to go to emergency room) are all increasing WTP and hence VSL. **Sensitivity** (e.g. have cancer) does not change VSL.
- 56% are highly **dreaded to get cancer** – VSL is getting larger by €0.3 mil. for each point in dread risk perception, plus €0.4 mil. if highly dreaded

Alberini & Ščasný, 2013, survey in Italy

	(F) coeff	t stat
$\alpha 1$	-0.0774	-1.705
$\alpha 2$ (cancer)	**0.0476**	**3.425**
$\alpha 3$ (road traffic)	**-0.0607**	**-4.784**
$\alpha 4$ (PUBLIC)	0.0969	3.787
$\alpha 5$ PUBEFF	0.0247	5.025
$\alpha 6$ PRIVEFF	0.0124	1.928
$\alpha 8$ ln(BRISK)	-0.0003	-0.039
$\alpha 9$ EXPOSURE	0.0177	1.726
$\alpha 10$ MORECOMM	0.0161	1.479
$\alpha 11$ SENSITIVITY	-0.0049	-0.288
$\alpha 12$ EXPERIENCE	0.0215	1.766
$\alpha 13$ DREAD	**0.0161**	**2.662**
$\alpha 14$ HIDREAD	**0.0201**	**1.388**
β	-0.0005	-16.646
δ	-0.015	-2.017
N	6970	
log L	-6282.04	

the effect of the label does not disappear!

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The benefits of avoiding cancer (or dying from cancer): Evidence from a four- country study

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ABSTRACT

We use stated-preference methods to estimate the cancer Value per Statistical Life (VSL) and Value per Statistical Case (VSCC) from a representative sample of 45–60-year olds in four countries in Europe. We ask respondents to report information about their willingness to pay for health risk reductions that are different from those used in earlier valuation work because they are comprised of two probabilities—that of getting cancer, and that of dying from it (conditional on getting it in the first place). The product of these two probabilities is the unconditional cancer mortality risk. Our hypothetical risk reductions also include two severity-related attributes—quality-of-life impacts and pain. The results show that respondents did appear to have an intuitive grasp of compound probabilities, and took into account each component of the unconditional cancer mortality risk when answering the valuation questions. We estimate the cancer VSL to be between approximately € 2 and 5.950 million, depending on whether the (unconditional) mortality risk was reduced by lowering the chance of getting cancer, increasing the chance of surviving cancer, or both. The VSCC is estimated to be up to € 0.578 million euro, and its magnitude depends on the initial (conditional) cancer mortality and on the improvement in survival. The survey responses show that our measures of cancer severity—impacts on daily activities and pain—have little or no effect on the WTP to reduce the adverse health risks.

Alberini and Ščasný (JHE 2018)

- Question: interest in isolating **the morbidity component** of the VSL from the "pure" mortality value, as in Gentry and Viscusi (2016)

- Our objectives: we wish to elicit willingness to pay figures that are useful and **appropriate for policy analyses** of environmental (carcinogen) regulations.
  - Some policy analyses quantify **the cancer deaths** avoided by a policy, while others rely on risk assessments that predict **lifetime excess cancer risks** associated with the current and improved environmental exposures.
  - This suggests that there are two key metrics of interest for policy analysis purposes—**the cancer VSL** and **the Value of a Statistical Case of Cancer (VSCC)**.

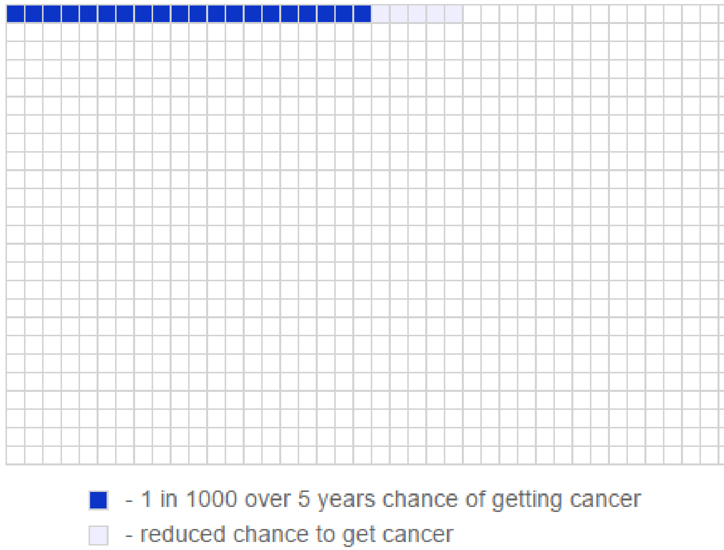
- Second, we wish to see if **the quality-of-life and pain impacts** of cancer affect risk valuation, as in Cameron and DeShazo(2013), McDonald et al. (2016) and Hammitt and Haninger (2017), and, if so, what the magnitude of their effect is compared to that from cancer risk or mortality risk alone.

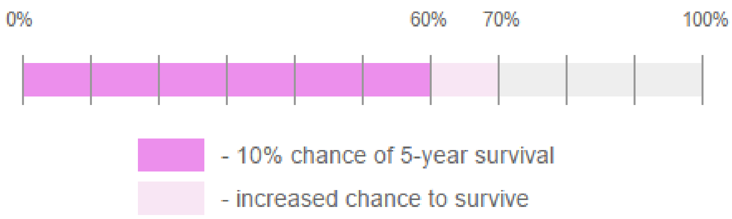
Alberini and Ščasný (JHE 2018)

- Standard approach to get VSL: **WTP for changes in <u>unconditional</u> risk of dying**
- Our approach: we decompose the (unconditional) risk of dying from cancer into the product of two probabilities: **that of getting cancer (R)**, and **that of dying from it conditional on getting it in the first place (S)**. The product is the **unconditional cancer mortality risk.**
  - *to test whether i) respondents are processing the two risks correctly, and ii) the WTP is strictly proportional to the unconditional cancer mortality risk reduction*
- A sequence of **single-bounded dichotomous choice valuation tasks**
- A survey conducted in Czech Rep., Italy, Netherlands, and the United Kingdom (n=2,414), with respondents sampled from 45-60 adult population
- A study prepared for *European Chemicals Agency* in 2014

Alberini and Ščasný (JHE 2018)
Example of choice card

	The current situation	Option A (reduced risks)
Chance of getting cancer over 5 years	25 in 1 000	20 in 1 000
Chance of 5-year survival (if you get cancer)	60 %	70 %
Effects on everyday activities (if you get cancer)	Unable to work	Unable to work
Pain (if you get cancer)	Mild pain	Mild pain
Annual cost for each of the next 5 years (total in parentheses)	£ 0 (in total £ 0)	£ 210 (in total £ 1050)
Which would you choose?	The current situation	Option A (reduced risks)





Alberini and Ščasný (JHE 2018)
Research design

- 32 blocks with 7 choice set in each; the full factorial design
- **QoL** and **pain** always the same for alternative and SQ, but change over the choice cards
- structure of the blocks

	Blocks 1-16	Blocks 17-32
First 3 choice cards	$\Delta S=0$, only $\Delta R\neq 0$	$\Delta R=0$, only $\Delta S\neq 0$
Choice cards 4-7	ΔS, ΔR both varied	ΔS, ΔR both varied

where S is conditional survival; R is (unconditional) risk of getting a cancer

- **unconditional risk of dying, M** = $(M0 - M1) = [R_0*(1-S_0)] - [R_1*(1-S_1)]$

$$\Delta M = \Delta R*(1-S_0) + R_0*\Delta S - \Delta R*\Delta S$$

if $\Delta R=0 \rightarrow \Delta M = R_0*\Delta S$

if $\Delta S=0 \rightarrow \Delta M = \Delta R*(1-S_0)$

Alberini and Ščasný (JHE 2018)
Estimating the VSL -- The Model

$$WTP_{ij}^{*} = \alpha + \mathbf{QOL}_{ij}\boldsymbol{\beta} + PAIN_{ij}\gamma + \Delta MORT\ RISK_{ij}\delta + \varepsilon_{ij}$$

Latent WTP

Reduction in the unconditional risk of dying from cancer

Cancer VSL

Alberini and Ščasný (JHE 2018)
The Model (cont'd)

But

$$\Delta MORT\ RISK = \Delta R \cdot (1 - S_0) + R_0 \cdot \Delta S - \Delta R \cdot \Delta S$$

Where

ΔR=reduction in the risk of cancer

R_0=baseline risk of cancer

ΔS=increase in the chance of surviving cancer

S_0=baseline chance of surviving cancer

So…

$$WTP_{ij}^{*} = \ldots + \delta \cdot [\Delta R \cdot (1 - S_0) + R_0 \cdot \Delta S - \Delta R \cdot \Delta S] + \varepsilon_{ij}$$

Alberini and Ščasný (JHE 2018)
Estimating the VSL

$$WTP_{ij}^{*} = \ldots + \underset{\text{VSL}}{\delta} \cdot [\underbrace{\Delta R \cdot (1 - S_0)} + \underbrace{R_0 \cdot \Delta S - \Delta R \cdot \Delta S}] + \varepsilon_{ij}$$

Only this if choice cards 1-3, blocks 1-16

Only this if choice cards 1-3, blocks 17-32

Alberini and Ščasný (JHE 2018)
Estimating the VSCC

$$WTP_{ij}^{*} = \ldots + \delta \cdot [\Delta R \cdot (1 - S_0) + R_0 \cdot \Delta S - \Delta R \cdot \Delta S] + \varepsilon_{ij}$$

So…

$$VSCC = \frac{\partial WTP^*}{\partial \Delta R} = \delta(1 - S_0) - \delta \Delta S$$

The VSCC declines with the size of the improvement in the chance of survival

If $\Delta S=0$ (choice cards 1-3, blocks 1-16), then $VSCC=VSL \times (1-S_0)$

Alberini and Ščasný (JHE 2018)
Estimation details

- We don’t observe the actual WTP
- We only have yes/no responses to each choice card
- Probit model – RHS is augmented with COST
- Random effects probit to allow for correlated responses
- In earlier slides, QoL and Pain are additive—in alternate specifications, they can be entered as interactions with the reduction in the risk of dying
- Country fixed effects always included

Key Results – t stats in parentheses

	(A): Blocks 1-16 **Choice cards 1-3** **Only ΔR≠0** Nobs: 3483	(B): **Blocks 17-32** **Choice cards 1-3** ΔS≠0 Nobs: 3759	(C): **All blocks,** **all choice cards** Nobs: 16873
QOL=1 dummy	-0.1343 (-1.067)	0.1625 (1.269)	-0.0486 (-1.175)
QOL=2 dummy	0.0026 (0.018)	0.1762 (1.107)	-0.0892 (-1.918)
QOL=3 dummy	-0.1701 (-1.148)	0.1357 (0.827)	-0.1756 (-4.083)
Moderate pain dummy	0.1246 (1.311)	0.0867 (0.977)	0.0190 (0.620)
ΔMORTRISK	15023.027 (8.070)	6136.54 (10.175)	5324.53 (30.271)
Cost	-0.00265 (-9.223)	-0.00325 (-7.938)	-0.00249 (-25.181)
Implied VSL (mill. PPP euro)	**5.676** (s.e. 0.866)	**1.887** (s.e. 0.284)	**2.144** (0.102)
Implied VSCC (mill. PPP euro)	**0.551** (s.e. 0.084)	n/a	**Varies with ΔS**

Alberini and Ščasný (JHE 2018)
VSCC from all choice cards, all blocks, in million PPP Euro, s.e. in parentheses

VSL	2.140 (0.102)
VSCC	
ΔS=No change	**0.208** (0.035)
ΔS=5% at 5 years	**0.177** (0.025)
ΔS=10% at 5 years	**0.147** (0.021)
ΔS=20% at 5 years	**0.093** (0.032)

Alberini and Ščasný (JHE 2018) Results summary

- **The cancer VSL is €2–6 mil.**, depending on whether the (unconditional) mortality risk was reduced by lowering the chance of getting cancer, increasing the chance of surviving cancer, or both – the difference is the "design-induced" range.
- **The VSCC is up to €0.58 mil.** and its value depend on the 5-year survival rate after diagnosis – the larger survival, the smaller value of VSCC is (it converges to 0 with survival approaching to 1).
- Our measures of **cancer severity** – impacts on daily activities and pain – have no effect on the WTP to reducer health risk
- Robustness checks:
  - VSL estimate is €3.9 mil. if we assume WTP is lognormal.
  - If we decompose ΔM into three components depending on whether S, R, or both changed, we reject the three coefficients are equal, with VSL bw €2.4–5 mil.

Conclusions

- Several **VSL studies** for the Czech Republic
- **Child premium** for respiratory / road traffic accidents, not for cancers
- **Cancer premium**, even after controlling for risk perception
- **Design-induced VSLs**, depending on ΔS, ΔR, or both
- **VSCC estimate** that is one order of magnitude lower than VSL, and declines with the survival rate
- **Benefit transfer** to derive VSL or other benefit estimates from other localae to a study site
- Ongoing work in OECD+EC on health impact valuation, and Harvard's BCA Guidelines (https://sites.sph.harvard.edu/bcaguidelines/methods-and-cases/)