Toulouse School of Economics

FDIR Conference, Toulouse – May 28 & 29, 2009

What is the Social Value of Preventing a Fatality?

Nicolas Treich
Laboratoire d'Economie des Ressources Naturelles (LERNA), INRA

Some questions motivating the talk

Suppose: A firm has decided to increase its expenditures in safety (e.g., by reducing workers' risk exposure, or by selling safer products)

- CSR: Is this firm more socially responsible? Should CSR rating agencies better rank/grade this firm?
- Quantifying, prioritizing: How much is safety good for society? How to compare (e.g.) an increase in safety to a decrease in CO2 emissions?
- Context effects: Should the risk type, or the population matter? (Road vs. chemical plant risk? Cars vs. cigarettes? Residents vs. workers?)

Outline

- Safety as a CSR objective
- CSR and benefit-cost analysis
- The value of a statistical life (VSL)
- The effect of the type of the risk, and of the population affected
- Discussion

Increased safety as a firms' CSR objective

- « Occupational safety and health forms an integral part of CSR and this is confirmed by its inclusion in all the major measurement and reporting guidelines and tools developed for CSR. » (UK HSE)
- The Global Reporting Initiative has safety indicators
- A recent law in France (loi NRE, requiring environmental and social reporting) includes health and safety indicators
- Several firms put forward safety objectives in their CSR reports

Example: Arcelor Mittal CSR report 2007

Corporate responsibility objectives

Commitments	Objectives
Workplace	■ Reduce safety incidents towards the goal of zero injuries ■ Exceed legally-required trade union and collective labour agreements dialogue ■ Improve levels of training and quality of programmes among employees
Environment	■ Reduce carbon intensity and energy consumption of steel production ■ Reduce water usage and emissions (dust, SOx, NOx) in steel production ■ Improve environmental management at site level through complete certification to the ISO 14001 environmental management system ■ Increase use of steel in innovative products; safe and renewable technology
Community	■ Measure total impact on society through economic development ■ Improve effectiveness of social investment practices ■ Implement highest human rights standards
Governance	■ Maintain high corporate governance standards and continuously improve shareholder dialogue
Business ethics	■ Implement the code of conduct within the Group, continuously train and raise awareness, and measure its effectiveness
Supply chain	■ Raise awareness of our own values within our supply chain; reduce environmental impacts and improve social development beyond our immediate operations

Is it CSR?

- Safer jobs/products are more attractive => better for the firm
- Large media attention to fatalities - Firms that fail to address safety problems are in danger of losing public trust
- Cappelle-Blancard and Laguna (2008) analyze stock market reaction to chemical accidents: fatalities have a significant negative impact (estimated at $160 millions per fatality); similar effect for plane crashes (Mitchell and Maloney, *JLE*, 1989)

Safety as a criterion used by rating agencies

- Major CSR rating agencies record i) accidents at plants, ii) violation of workplace safety standards, iii) instances where product deficiencies have led to litigation
- « KLD environmental social and governance ratings criteria 2009 »
- See also « Vigeo detailed rating framework » (workplace & product safety, p16 & p31)

KLD ratings criteria report

- « Concerns » (see p9 & p11 of the report):

Health and Safety. The company recently has either paid substantial fines or civil penalties for willful violations of employee health and safety standards, or it has been otherwise involved in major health and safety controversies.

Safety. The company has either paid substantial fines or civil penalties, or is involved in a major recent controversy or regulatory action, relating to the safety of its products or services.

The framework justifying CSR

- Market failure: externality, information asymmetry
- Regulatory failure: inefficient instruments/institutions, opportunistic policy-makers
- Market failure + regulatory failure => Residual inefficiency
- CSR can help reduce the residual inefficiency (or the conflict between the firm and the society, Heal, *GP*, 2005)

CSR and benefit-cost analysis (BCA)

- A key channel: Citizens (consumers, workers, investors..) demand for CSR
- Main difficulty: how can citizens give socially-efficient incentives to firms?
- A necessary condition: Citizens must be informed about firms' social impacts – role of rating agencies and governments
- BCA can be used to compute induced social benefits and costs – Example: the shadow price of carbon

BCA and the value of safety

- What it is the social value of preventing a fatality?
- Compute the shadow price of life using benefit-cost analysis: the value of a statistical life (VSL)

The VSL – An introductory example

- Consider a society composed of 100,000 identical individuals
- They each face a 100 in 100,000 baseline mortality risk - A project reduces the risk from 100 to 80 expected fatalities
- Each individual has a willingness to pay for the project of WTP=$500
- Therefore VSL=$2.5 million – Indeed one can collect in this society $50 million to save 20 statistical lives
- VSL= $50 million/20 = $(N \times WTP)/(N \times \Delta p)$

  $= WTP/\Delta p = 500/(20/100{,}000)$

VSL figures used by regulatory agencies

- US Office and Management Budget recommends using VSL values between $1 and $10 million
- US EPA reports a mean VSL estimate of $6.2 million (in 2000 prices)
- FDA uses a slightly lower value $5.5 million, and US DoT uses $3.3 million and US FAA $3 million (2002 prices)
- « Official values » in transport (in 2005 prices): New Zealand ($1.79 million), Norway ($2.051 million), Sweden ($1,996 million), UK (2,308 million)
- European Union DG Environment (2001) suggests to use a VSL between €1 million and €2.5 million (in 2000 prices)

Workplace safety – Wage differentials

Author(s)	Year	VSL USD Million (2000 prices)	Country
Thaler-Rosen	1975	$1.7-$1.9	US
Viscusi	1978-79	$5.5-$15.2	US
Dillingham	1977	$3.2-$6.8	US
Marin et al.	1982	$4.2	UK
Moore-Viscusi	1988	$3.2-$6.8	US
Berger-Gabriel	1991	$8.6-$10.9	US
Gegax et al.	1991	$2.7	US
Cousineau et al.	1992	$2.2-$6.8	Canada
Leigh	1995	$8.1-$16.8	US
Baranzini et al.	2001	$6.3-$8.6	Switz.
Kim	1993	$0.8	India
Liu et al.	1997	$0.2-$0.9	Taiwan

Source: Viscusi and Aldy (*JRU*, 2003, reporting about 50 VSL studies)

Road safety – Revealed & stated preferences

Table 1: Empirical estimates of the value of a statistical life in road traffic, in US$ 2005 ($\times$1000)[a]

Authors	Country	Year of data, Study type	No. of estimates[b]	Range of VSL estimates: Single	Lowest	Highest
Andersson (2005a)	Sweden	1998, RP	1	1,425		
Andersson (2007)	Sweden	1998, SP	8		3,017	15,297
Atkinson and Halvorsen (1990)	US	1986, RP	1	5,521		
Beattie et al. (1998)	UK	1996, SP	4		1,510	17,060
Bhattacharya et al. (2007)	India	2005, SP	1	150		
Blomquist (1979)	US	1972, RP	1	1,832		
Blomquist et al. (1996)	US	1991, RP	4		1,434	7,170
Carthy et al. (1999)	UK	1997, SP	4		4,528	5,893
Corso et al. (2001)	US	1999, SP	2		3,517	4,690
Desaigues and Rabl (1995)	France	1994, SP	6		1,031	23,984
Dreyfus and Viscusi (1995)	US	1987, RP	1	4,935		
Ghosh et al. (1975)	UK	1973, RP	1	1,901		
Hakes and Viscusi (2007)	US	1998, SP	5		2,396	6,404
	US	1998, RP	6		2,288	10,016
Hojman et al. (2005)	Chile	2005[c], SP	1	541		
Hultkrantz et al. (2006)	Sweden	2004, SP	2		2,192	5,781
Iragüen and Ortúzar (2004)	Chile	2002, SP	1	261		
Jara-Diaz et al. (2000)	Chile	1999, SP	1	4,555		
Jenkins et al. (2001)	US	1997, RP	9		1,350	4,867
Johannesson et al. (1996)	Sweden	1995, SP	4		5,798	6,981
Jones-Lee et al. (1985)	UK	1982, SP	1	4,981		
Kidholm (1995)	Denmark	1993, SP	3		898	1,338
Lanoie et al. (1995)	Canada	1986, SP	2		1,989	3,558
Maier et al. (1989)	Australia	1989[c], SP	6		1,853	5,114
McDaniels (1992)	US	1986, SP	3		10,131	36,418
Melinek (1974)	UK	1974[c], RP	1	881		
Persson et al. (2001)	Sweden	1998, SP	1	2,551		
Rizzi and Ortúzar (2003)	Chile	2000, SP	1	486		
Schwab Christe (1995)	Switzerland	1993, SP	1	1,094		
Vassanadumrongdee and Matsuoka (2005)	Thailand	2003, SP	2		3,208	5,458
Viscusi et al. (1990)	US	1991[c], SP	1	11,091		
Winston and Mannering (1984)	US	1980, RP	1	2,315		

VSL estimates in US$ 2005. Values transformed using purchasing power parities (PPP) and consumer price indices (CPI) from http://stats.oecd.org, 09/02/07. (For Chile and Thailand PPP and CPI from http://www.imf.org/external/data.htm were used.)
a: Many of the VSL estimates from de Blaeij et al. (2003).
b: Several studies contain more estimates that stated here. When available, "preferred" values have been used.
c: Refers to year of study rather than data, since the latter not available.

Source: Andersson and Treich (*Handbook in Transport Economics*, 2009)

Environmental externalities

- Mortality impacts often dominate benefits in BCA
- Clean Air Act: mortality risks reduction represented about 90% of the quantified benefits
- Estimated benefits of avoided skin-cancer mortality accounted for 99% of quantified benefits of Montreal Protocol (EPA Regulatory Impact Assessment)

Climate change

- Climate change may increase mortality risks (heat stress, malnutrition and vector-borne diseases)
- The World Health Organization estimates about 300,000 casualties for just a +1° warming (Stern, 2007)
- If VSL is equal to 1 million for all lives, mortality damages equal about $140 billion, that is, about **half aggregate estimates of warming damages** (IPCC, 1995, p.198)

VSL and the type of the risk

- Should one use a higher VSL for environmental risks?
- VSL usually higher for acute risks compared to latent risks, « in the range of 50-80% for a 20-year latency period » according to Pearce et al. (*OECD*, 2005)
- VSL usually higher for uncontrollable risks and small risks (Carlsson et al., *JRU*, 2004) – Cancer premium (Hammitt and Liu, *JRU*, 2003)
- A difficulty is the ambiguity over probability distributions – Should VSL be higher for ambiguous risks?

The standard VSL model (under EU)

- Let utility be U = $(1-p_0)u(w) + p_0v(w)$
- u (resp. v) is the utility if alive (resp. dead), w is wealth and p_0 is probability of death (or the baseline risk) Assume u>v, and u'>v'≥0

$$VSL = \frac{dw}{dp_0} = \frac{u(w)-v(w)}{(1-p_0)u'(w)+p_0v'(w)}$$

- Increases with w under concave utility functions (wealth effect) and increases with p_0 (« dead-anyway effect »)
- Intuition for the dead anyway effect: under u'>v', the opportunity cost of spending money is lower when the probability of death is higher

VSL under ambiguity aversion

- See Treich (JEEM, 2009)
- Let $\tilde{p}$ be a random variable, representing the ambiguous baseline risk (e.g. in the example either a 50 or 150 in 100,000 mortality risk)
- Assume ambiguity aversion (Klibanoff et al., *Econometrica*, 2005)
- Utility becomes: $W = \phi^{-1}\{E\phi\{(1-\tilde{p})u(w) + \tilde{p}v(w)\}\}$
- ø concave means ambiguity aversion
- Result: VSL increases under ambiguity aversion

VSL and the population affected

- Should one use a different VSL for different population?
- Theoretic and empirical analyses justify a positive effect of wealth, and of baseline risk (see above)
- Inverted U-shape effect of age
- Premium for children's safety (Hammitt and Haninger, *AJAE*, 2008)

Discussion: Should we use VSL as a CSR indicator?

- There is a need for a transparent methodology backing up CSR indicators
- There is a need to compare different CSR actions: compute « monetary equivalents »
- There is a longstanding theoretic and empirical literature on the social value of preventing a fatality: VSL figures are well-grounded and well-documented
- But some difficulties remain

Difficulty #1: VSL is controversial

- The VSL term can be misunderstood; people may feel offended by the idea of placing a dollars value on a human life (life is « priceless »)

- The use of VSL has been controversial in policy-making – Two illustrations:

- US OMB issued a memorendum advising agencies against adjusting VSL for age

- The European Union (2000) states that « it is not recommended that [VSL] values be changed according to the income of the population affected »

Difficulty #2: Characterizing market & regulatory failure(s)

- Within the BCA framework, CSR justification depends on the existence of *both* a market and a regulatory failure
- The VSL literature (based on the hedonic price approach) usually assume well-functioning markets
- Which market failures?
- Evidence of workers' awareness of many job hazards - High rates of workers' turnover in the US (« 1/3 of all manufaturing quit rates in the US stem from workers' learning about job risks », Viscusi, *Regulation*, 1994)
- However, worplace and product safety are heavily regulated
- Is CSR justified in the first place? Under which conditions is CSR « superior » to regulation?

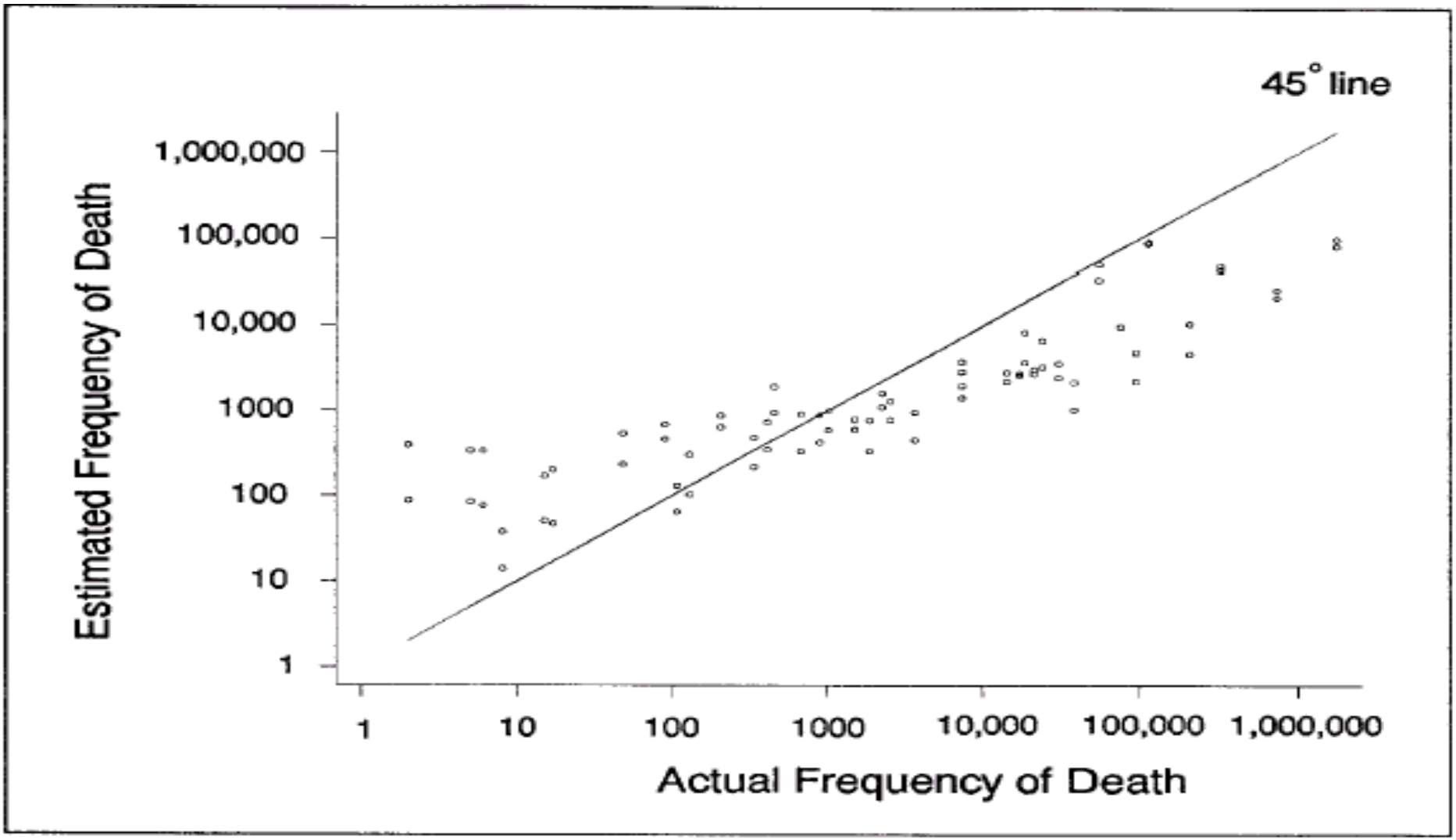
A provocative example: Cigarettes

- Externalities (social cost of health expenditures, passive smoking) alone would justify only a tax of 40c$ per pack (Chaloupka and Warner, 1998) – which represents only about a half of observed tax of 76c$ (Gruber, 2001)
- Higher contribution of smokers to the pension system (smokers life expectancy is about 6 years lower than nonsmokers, Cutler et al., 2001) which may offset negative externalities
- People seem to overestimate, and not understimate, risk of smoking (Viscusi, *JPE*, 1990)
- Regressive (excise tax affects more low income groups) – it would be more efficient to tax other goods
- Therefore, the justification for CSR is not clear (using our standard BCA framework)

Difficulty #3: Citizens' risks perceptions

- Large literature in cognitive psychology about citizens' biased perceptions and decisions in face of risks (Kahneman, Slovic, Tversky)
- Citizens overstimate small mortality risks and underestimate large mortality risks (Fishhoff)
- Citizens hold different beliefs than experts (Slovic, 2000), over-react to bad news (mad cow disease, swine flu), and are too emotional (Lowenstein, 2008)
- Citizens may need not give « good » incentives to firms in the context of mortality risks (controversial argument)

Mortality Risk Perceptions

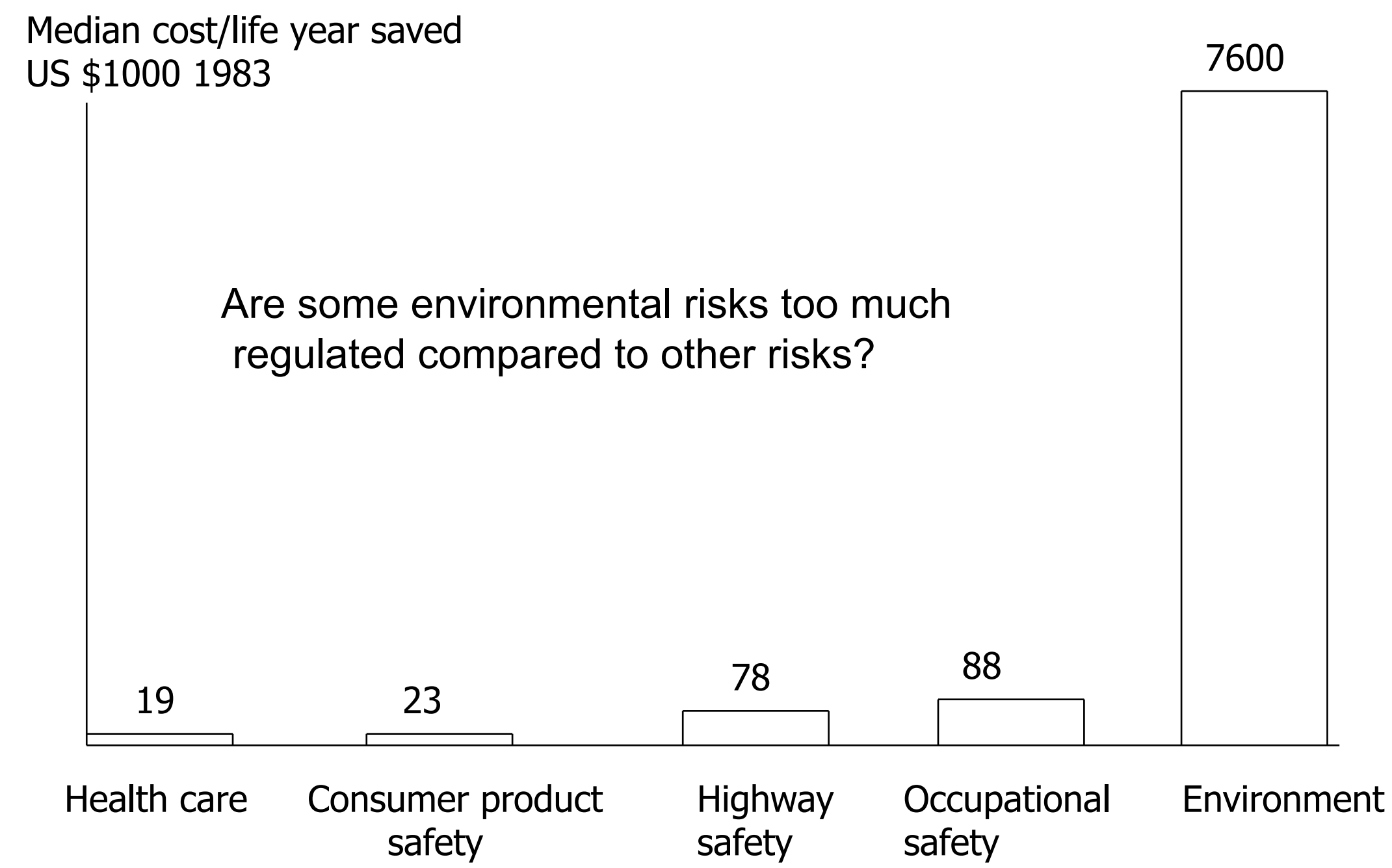


ANNEX

Cost per life-saved of US public programs

Programs (Agency)	Estimated cost per avoided death – US $ Million ($1990)
Underground construction standards (OSHA)	0.1
Auto passive restraint/ seat belt standards (NHTSA)	0.1
Auto fuel-system integrity standard (NHTSA)	0.5
Crane suspended personnel platform (OSHA)	0.7
Children's sleepwear flammability ban (CPSC)	0.8
Low altitude windshear equipment (FAA)	1.3
Arsenic/copper smelter (EPA)	2.7
Grain dust explosion prevention standards (OSHA-S)	2.8
Ethylene dibromide drinking water standard (EPA)	5.7
Arsenic emission standards for glass plants (EPA)	13.5
Ethylene oxide (OSHA)	20.5
Uranium mill tailings (EPA)	31.7
Abestos ban (EPA)	110.7
Diethylstillbestrol cattlefeed ban (FDA)	124.8
Dichloropropane drinking water standard (EPA)	653.0
Hazardous waste land disposal ban (EPA)	4,190.4

Source: Sunstein (2001, *Risk and Reason*)



Source: Tengs et al. (1995), Tengs and Graham (1996)

Conservative Risk Assessment

- **Treatment of scientific uncertainty**: US EPA uses 95% percentile of probability distribution for each uncertain parameter– overestimates by 5000 times the excess risk of cancer due to dioxin (Belzer, 1991)
- **Worst-case scenario** for individual risk-susceptibility: US EPA considers a « virtual » individual with maximal ingestion rates, maximal exposure duration and minimal body weight
- **Margins of safety**: US EPA considers blowup factor of 10 to account for extrapolation of animal studies (Viscusi, 1998) – see also UK Health and Safety Executive in industrial safety regulation
- **Linear dose-response models** – no safe threshold, or no « hormesis » effect (low dose stimulates desirable effects; Calabrese and Baldwin, 2003)