Doctoral course
Climate Economics for Engineers

Valuation of human life

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Damages to humans

It is particularly difficult to put a price
on the damage to human lives

Pricing human life is unavoidable

Investment (CHF millions)	# deaths
0	5
4	3
10	1

How to measure lives lost ?

- Number of lives

- Years of life = Σ lives × remaining life expectancy

- Quality adjusted life years (QALY)

- Disability adjusted life years (DALY)

- 'Values' based on willingness to pay

Willingness to pay for reducing the risk of a fatal accident

Example 1:

Policy measure for risk reduction from

    4 cases per 10,000 inhabitants to

    3 cases per 10,000 inhabitants

Risk reduction: 1 case per 10,000 Inhabitants = **0.0001**

Individual **willingness to pay** (WTP) for that policy measure, which saves
1 life among 10,000 inhabitants = **100 €**.

WTP for prevented (statistical) fatality:
100 €/0.0001 = **1 Million €**   or   10,000 × 100 € = **1 Million €**

"Value of a statistical life"

- It is important to remember that this is not an amount the population (or the people surveyed) would be willing to spend to save the life a determined person (hence: "statistical life")

- It would be more accurate to call this "the value of goods and services the population would accept to give up in exchange for a small reduction of the probability of occurrence of a fatal event for a member of the population"

- This is expressed as a "value of life" for simplicity … and rapid calculation

Methods

- Estimate the income a dead person would have earned over her remaining lifetime *(damage function approach, "replacement cost")*

- Interview a sample of persons about their WTP for lifesaving programs *(contingent valuation)*

- Infer WTP from amounts spent by people to reduce their risk of fatal accident *(revealed preferences)*

- Use court rulings of compensation for lost life, particularly when they have a popular jury (next slide)

- Infer WTP from amounts spent by public authorities to reduce the risk of fatal accidents *(revealed preferences)*

Do not use court rulings!

The compensation granted depends on personality of victim and circumstances of death

Post Nation

A man was shot and killed by police. A jury gave his family $4.

In a move that the family's attorney said was doubly surprising, the jury gave money to the losing party: $4 — a dollar for funeral costs, which was about $11,000, and another for each of Hill's three young children, ages 13, 10 and 7.

https://www.washingtonpost.com/news/post-nation/wp/2018/06/02/a-man-was-shot-and-killed-by-police-a-jury-gave-his-family-4/

Inferring WTP from public protection measures

- One expects public authorities to make reasoned choices reflecting the preferences of their population

- In fact, when they apply cost-benefit analysis, they use value-of-life estimates provided by experts!

- Hence, these choices must be excluded from the sample of life-saving measures used to infer (public) WTP

- A common problem of all methods (survey, revealed preferences, etc.) are the very small probabilities; no one is good at handling small probabilities

Resources spent to save lives and avoid injuries in transportation (million CHF)

Context	Health endpoint	Mean value
RT	Death	5.078
	Invalidity	1.704
	Severe injury	0.179
	Moderate injury	0.027
	Minor injury	0.002
PT	Death	34.249
	Invalidity	11.494
	Severe injury	1.208
	Moderate injury	0.184
	Minor injury	0.012
AP	Death	12.266
NP	Death	11.451

Note: RT: Road traffic; PT: Public transport; AP: Air pollution; NP: Noise pollution.

Kägi, W., et al. (2015). Monetarisierung des statistischen Lebens im Strassenverkehr. Schweizerischen Verbands der Strassen- und Verkehrsfachleute (VSS), Tab. 5, p.30

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How much is a life-year worth to the (US) authorities?

The following table shows some government health and safety programs, along with estimates of each program's annual cost and benefit. Each benefit is expressed in **life-years**, or the additional years of life people can expect to enjoy as a result of the program.

Existing programs	Estimated annual cost (2004 dollars)	Estimated annual life-years saved	Cost per life-year saved
Ban asbestos in brake blocks	$ 407,498	10.8	$ 37,731
Control radionuclide emissions at elemental phosphorus plants	3,688,269	0.5184	
Ban asbestos in automatic transmission components	28,900	0.000333	
Control arsenic emissions at glass manufacturing plants	6,254,690	3.563	
Prevent releases of carcinogenic chloroform at pulp mills	38,630,000	0.0003048	$ 126,738,845,100
Totals	$49,009,357	14.8820378	

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Cost per life-year of life-saving intervention

Intervention	Cost/life-year (US $)
Fatal injury reduction	
Mandatory seat belt use and child restraint law	98
Smoke detectors in aeroplane lavatories	30 000
Widen shoulders on rural two-lane roads to five feet versus two feet	120 000
Seat belts for passengers in school buses	2 800 000
Flammability standard for children's clothing size 7-14	15 000 000
Toxin control	
Reduced lead content of gasoline from 1.1 to 0.1 grams per leaded gallon	50
Ban asbestos in brake blocks	29 000
Benzene emission control at pharmaceutical manufacturing plants	460 000
Ban asbestos in thread, yarn, etc.	34 000 000
Radionuclide emission control at coal-fired industrial boilers	260 000 000
Health care	
Measles, mumps and rubella immunization for children	50
Beta-blockers for myocardial infarction survivors	850
Postsurgical chemotherapy for premenopausal women with breast cancer	18 000
Annual mammography for women aged 55-64 years	110 000
Sickle cell screening for newborns	65 000 000

Source: Learning to live with Health Economics, edited by H. Zöllner, G. Stoddart and C. Selby Smith, WHO Regional Office for Europe, Copenhagen, 2003. Data from Tengs et al. (1995)

Coûts de traitements pour sauver des vies

Novartis bat les pronostics, porté par le médicament le plus cher du monde

PHARMA La récente mise sur le marché d'une thérapie vendue plus de 2 millions de dollars a soutenu la croissance du géant pharmaceutique bâlois. Sa division dédiée aux traitements hors brevet fait elle aussi mieux que prévu, grâce aux biosimilaires

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C'est une maladie héréditaire. L'amyotrophie spinale provoque une atrophie des muscles, qui selon sa forme peut s'avérer mortelle chez les enfants. Un traitement existe, sous forme de thérapie génique. Mais deux conditions doivent être réunies pour son succès: il faut l'administrer aux bébés avant leurs 2 ans; et réunir les plus de 2,2 millions de dollars qu'il coûte. Si Novartis bat tous les pronostics sur ses résultats trimestriels publiés mardi, c'est en partie grâce à ce traitement, le Zolgensma, considéré comme le médicament le plus cher du monde.

Le chiffre d'affaires du géant pharmaceutique bâlois a progressé de 10% à 12,2 milliards de dollars entre juillet et septembre, de 13% à taux de change constant. Soit avec «un confortable» demi-milliard de plus qu'escompté par les analystes, écrit Cre-dit Suisse dans une note. Sur neuf mois, la croissance est de 5% (9% hors variations de change). Le groupe a ainsi amélioré sa marge opérationnelle (core) de 2 points de pourcentage, pour atteindre 30,4% du chiffre d'affaires net, se félicite le groupe dans un communiqué.

Performant dans l'innovation et les copies

Approuvé ce printemps aux Etats-Unis, le Zolgensma s'est vendu pour 160 millions de dollars, au lieu des 98 millions estimés, note Bank of America Merrill Lynch. Il a soutenu la progression de la division dédiée aux médicaments innovants. Celle-ci a gagné 15% à taux de change constant, à près de 10 milliards, +11% à 27,8 milliards sur neuf mois. «Cela prouve que le groupe a conservé sa capacité d'innovation», commente de son côté Michael Nawrath de la Banque cantonale de Zurich.

Dans le même temps, la filiale dédiée aux traitements dont le brevet a expiré, Sandoz, a aussi battu les pronostics. Son chiffre d'affaires affiche une hausse de 5% à 2,5 milliards de dollars, «soit 6,4% au-dessus de nos estimations», observe Vontobel. Et ce, en dépit de la pression continue sur les prix des génériques aux Etats-Unis.

Si Sandoz a pu générer de la croissance au dernier trimestre, c'est essentiellement grâce aux biosimilaires, ces répliques meilleur marché de traitements biologiques (développés à partir de cellules vivantes) dont le brevet a expiré. «La division a profité du lancement de trois de ces produits en Europe, couvrant des domaines porteurs comme l'oncologie, la rhumatologie, l'hypertension et d'autres maladies auto-immunes», souligne Michael Nawrath.

Même meilleur marché et destinés à un nombre plus restreint de patients, les biosimilaires peuvent devenir des blockbusters, avec des ventes de l'ordre du milliard, en raison de la cherté des traitements originaux, contrairement aux génériques. De nouvelles mises sur le marché sont attendues dans ce segment l'an prochain, notamment aux Etats-Unis, poursuit l'expert.

Le groupe mise résolument sur les revenus plutôt que sur les volumes, avec des traitements plus pointus et ciblés, destinés à un nombre plus restreint mais vendus à un prix plus élevé. Il a relevé ses objectifs pour 2019: alors qu'il tablait sur une progression des ventes entre 5 et 9%, il vise désormais le haut de cette fourchette.

Mardi l'action Novartis a gagné 0,95%, alors que le SMI a progressé de 0,26%. ◼

Estimated values of a statistical life

1.5 to 4.5 million USD$_{2005}$	adults in OECD, based on 2012 meta-analysis of 800 estimations by OECD
3.6 million USD$_{2005}$	adults in EU27, based on 2012 meta-analysis of 800 estimations by OECD
3 million €	used in France since 2013 for the CBA of public policies (up from 1.5 mio € in 2001)
0.5 to 5 million USD$_{2010}$	Nigeria to USA, Parry et al. (2014) for IMF
1.5 mio USD 0.3 mio USD 0.1 mio USD	in high-income countries in middle-income countries in lowest-income countries in AR1 and AR2 of IPCC
1.0 mio USD	for all countries, in AR3ff of IPCC

Value of statistical life: recommended value for WTP to reduce accident and health risks in Switzerland

- Accepted value was 5 million CHF between 2009 and 2017

- New estimate derived by Ecoplan (2016) from OECD (2005) reference value by taking into account relative GDP per capita and inflation

- New value from 2018: 6.5 million CHF

Ecoplan (2016). Empfehlungen zur Festlegung der Zahlungsbereitschaft für die Verminderung des Unfall- und Gesundheitsrisikos (value of statistical life). Bundesamt für Raumentwicklung ARE und Beratungsstelle für Unfallverhütung bfu. Bern.