Health Risk and the Value of Life

julianreif.com/research/reif.wp.healthrisk.pdf

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Value of statistical life (VSL) plays central role in public policy

- VSL: amount that group is willing to pay to reduce a risk expected to kill 1 person
- Example: US Environmental Protection Agency (EPA)
  - Uses VSL of $10.7 (€10.2) million in cost-benefit analyses
- Example: Téhard, Detournay et al. (2020)
  - Use VSL to estimate that French value of a QALY is €150-200 thousand

The conventional model has significant shortcomings

- The conventional model has only two health states: alive and dead
- As a result, the model cannot:
  1. quantify how VSL varies with underlying health
  2. distinguish between preventive care and medical treatment

The conventional model cannot answer important questions

- Society invests less in prevention than in treatment
  - Is this inefficient?
- Should payments for a medical technology depend on a patient's condition?

We extend the conventional model to multiple health states

- There are n possible health states while alive, and one "death" state $(n+1)$
  - Health states: $\{1, 2, \ldots, n, \underbrace{n+1}_{\text{Death}}\}$
- Health shocks cause transitions from one state to another
- Quality of life and the probability of dying depend on current health state

We introduce the value of statistical illness (VSI)

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- Note: VSL is a special case of $VSI(i, j)$ where j is death

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- VSI can compare risk-reduction values across people in different health states
  - Relevant for understanding whether there is a "severity premium"
- VSI can compare values of preventing different diseases

We employ data to quantify the size of these differences

- US survey data provide individual-level information about:
  - Comorbidities
  - Mortality probabilities
  - Quality of life (used to measure QALYs)

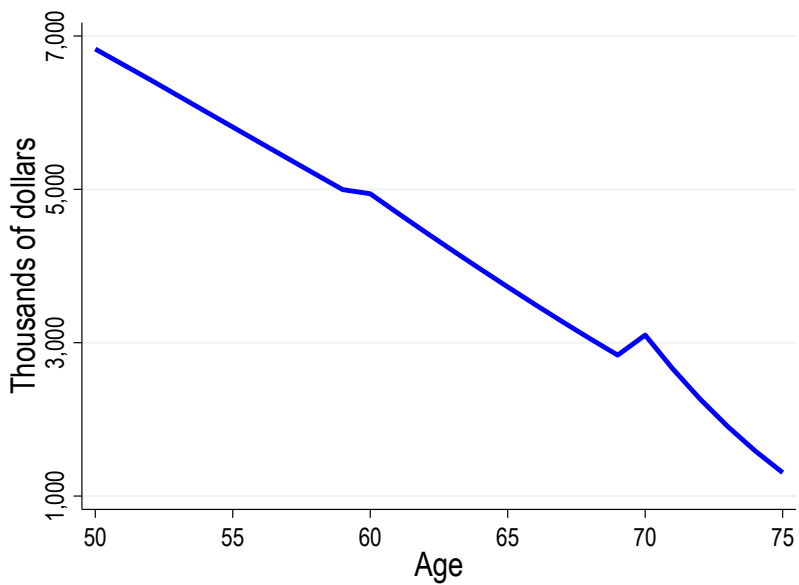
- We divide individuals into $4 \times 5 = 20$ health states
  - Number of chronic conditions: 0, 1, 2, or 3+
  - Number of impaired activities of daily living (ADLs): 0, 1, 2, 3, or 4+

Summary means at age 50 for our data

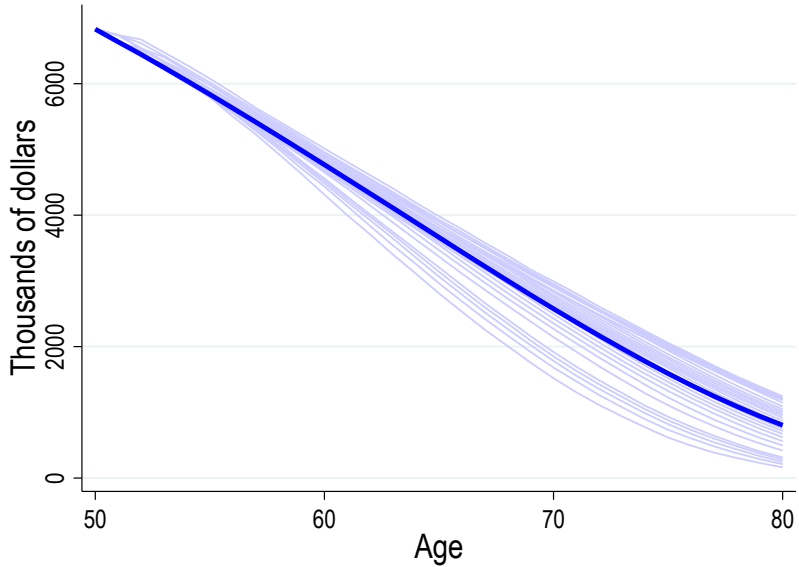
State	ADLs / CCs	Life expect. (yrs)	Health index	Spending ($)
1	0 / 0	30.9	0.88	686
2	0 / 1	28.2	0.85	866
3	0 / 2	24.6	0.81	1,145
4	0 / 3	20.5	0.77	1,487
5	0 / 4+	16.1	0.73	2,318
...	...	...	...	...
18	3+ / 2	15.7	0.62	1,105
19	3+ / 3	12.7	0.58	1,671
20	3+ / 4+	9.1	0.54	2,759

State 1 has 0 ADLs and 0 chronic conditions (healthy)
Health index measures quality of life and ranges from 0 to 1

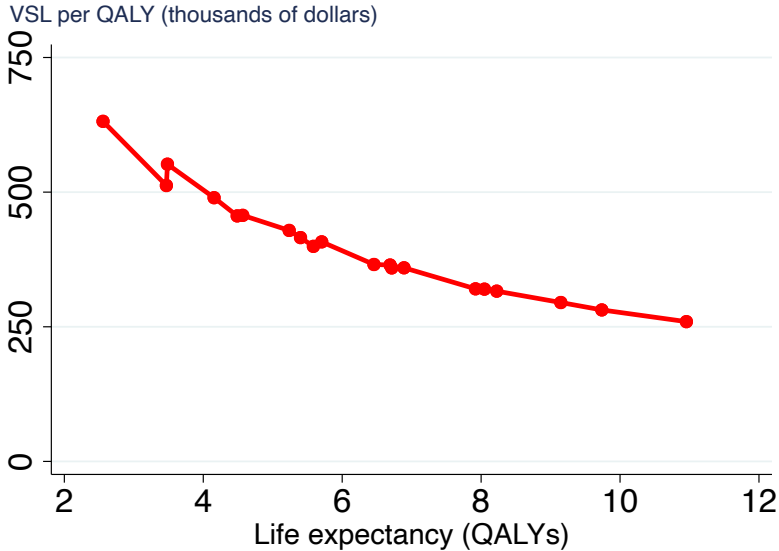
Example: VSL for person with health shocks at ages 60 and 70



VSL for a population of individuals



Average value of a QALY at age 70, by health state



Discussion

Why do people invest so little in preventive care?

- Health care systems invest little in prevention (Pryor and Volpp 2018)
- Workplace wellness programs are ineffective (Jones, Molitor, and Reif 2019; Reif et al. 2020)
- Our study provides a rational explanation for these previous findings
- Other factors may also contribute:
  - Market inefficiencies
  - Suboptimal decisions by consumers

Providing special reimbursements for diseases is controversial

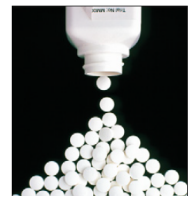
THE LANCET
Volume 376, Issue 9739, 7–13 August 2010, Pages 389

Editorial

New £50 million cancer fund already intellectually bankrupt

Addressing an audience in 415 BC, Euphemus of Athens proclaimed that "for a man who is a tyrant or for a city that has an empire, nothing is irrational that is advantageous". The UK Government's announcement of a £50 million fund for unapproved cancer drugs—a very modern triumph of political expediency over rationality—shows that Euphemus's line of reasoning is still a popular one with some politicians.

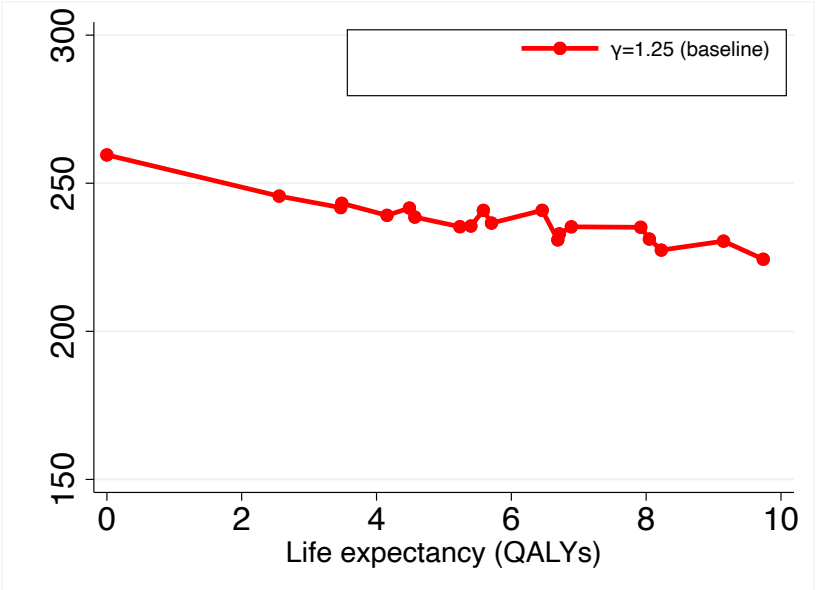
But while Lansley's maths might not add up, his political instincts are certainly well honed. On July 27, a new report into the extent and causes of international variations in drug use, by the National Cancer Director Mike Richards, provided a timely opportunity to regain the political initiative. The report compared treatment for various diseases in 14 developed countries. The UK ranked highly



The End

Appendix

VSI per QALY at age 70 (thousands of dollars)



Quality-adjusted life-years (QALYs)

- QALYs are used worldwide to measure benefits of medical care and safety
- EQ-5D questionnaire provides the "quality" input, q, for calculating QALYs
- Let D_i denote expected number of QALYs in state i:

$$D_i = \mathbb{E}\left[\int_0^T \underbrace{e^{-\rho t}\, S(t)}_{\text{Discounting}}\, q_{Y_t}(t)\, dt \,\middle|\, Y_0 = i\right]$$

where $q_{Y_t} \leq 1$ and $q = 1$ indexes perfect health

Average annual out-of-pocket spending, by age