Eliciting Risk Aversion in Health

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Background (1)

- Risk preferences influence behaviour.
- In health:
  - Decision to smoke/exercise/take medicines
- In health preference elicitation
  - WTP for risk reductions
  - Standard Gamble methods
- To understand/predict/measure preferences and behaviour, control for health risk preferences.

Background (2)

- Standard practice:
- Ignore health risk preferences
  - Assumes risk neutrality for health. Unrealistic?
  - Biased estimates/interpretations
- Financial proxies e.g. Holt and Laury (2002)
  - Assumes domain generality of risk preferences
- Use health risk preferences
  - Harrison (2005) review
  - Mainly self-ratings
  - DOSPERT and DOSPERT+M
  - Existing choice-based measures: theoretical implications & assumptions under-explored.
    - Eraker and Sox (1981); Breyer and Fuchs (1982); van der Pol & Ruggeri (2008); Ruggeri & van der Pol (2012) .

Eliciting risk preferences: theory

- Von Neumann Morgenstern utility of health function:

$$u(h) = \frac{h^{(1-\beta)}}{(1-\beta)} \qquad (1)$$

- Coefficient of Relative Risk Aversion in health, $CRRA_h$:

$$CRRA_h = -\frac{hu''}{u'} = \beta \qquad (2)$$

- β elicited by finding indifference between paired health lotteries:

$$ph_3^{(1-\beta)} + (1-p)h_2^{(1-\beta)} = ph_4^{(1-\beta)} + (1-p)h_1^{(1-\beta)} \qquad (3)$$

Where

- h_i is health state i, increasing in i, such that $h_1<h_2<h_3<h_4$,
- the lottery between h_1 and h_4 ="risky"
- the lottery between h_2 and h_3 ="safe"

Notice the clear links to eliciting CRRA in finance

Eliciting risk preferences: method (1)

- EQ-5D-5L health descriptions (Herdman et al, 2011)
  - Directly about health severities (not durations)
  - Unambiguously decreasing in severity from h_1 to h_4.

Minor illness (h_4 - 11121) • You would have **no problems** moving about • You would have **no problems** with self-care • You would have **no problems** carrying out your usual activities • You would experience **slight** pain and discomfort • You would experience **no** anxiety and depression	**Moderate illness** (h_3 - 12231) • You would have **no problems** moving about • You would have **slight problems** with self-care • You would have **slight problems** carrying out your usual activities • You would experience **moderate** pain and discomfort • You would experience **no** anxiety and depression
Moderately severe illness (h_2 - 12343) • You would have **no problems** moving about • You would have **slight problems** with self-care • You would have **moderate problems** carrying out your usual activities • You would experience **severe** pain and discomfort • You would experience **moderate** anxiety and depression	**Severe illness** (h_1 - 22443) • You would have **slight problems** moving about • You would have **slight problems** with self-care • You would have **severe problems** carrying out your usual activities • You would experience **severe** pain and discomfort • You would experience **moderate** anxiety and depression

Eliciting risk preferences: method (2)

- Lottery choice list, with *p* of less severe health state increasing.
- Choice list format one of many options, chosen for simplicity
- Dominance in final row

A		B	Your choice
10% chance of moderate illness 90% chance of moderately severe illness	OR	10% chance of minor illness 90% chance of severe illness	
20% chance of moderate illness 80% chance of moderately severe illness	OR	20% chance of minor illness 80% chance of severe illness	
30% chance of moderate illness 70% chance of moderately severe illness	OR	30% chance of minor illness 70% chance of severe illness	
40% chance of moderate illness 60% chance of moderately severe illness	OR	40% chance of minor illness 60% chance of severe illness	
50% chance of moderate illness 50% chance of moderately severe illness	OR	50% chance of minor illness 50% chance of severe illness	
60% chance of moderate illness 40% chance of moderately severe illness	OR	60% chance of minor illness 40% chance of severe illness	
70% chance of moderate illness 30% chance of moderately severe illness	OR	70% chance of minor illness 30% chance of severe illness	
80% chance of moderate illness 20% chance of moderately severe illness	OR	80% chance of minor illness 20% chance of severe illness	
90% chance of moderate illness 10% chance of moderately severe illness	OR	90% chance of minor illness 10% chance of severe illness	
100% chance of moderate illness	OR	100% chance of minor illness	

Eliciting risk preferences: calc$^{\underline{n}}$

- Recall that β elicited by finding indifference:

$$ph_3^{(1-\beta)} + (1-p)h_2^{(1-\beta)} = ph_4^{(1-\beta)} + (1-p)h_1^{(1-\beta)} \quad (3)$$

- We want to find β
- We know (from the set-up) the range of *p* within which indifference lies.
- We do not have ratio scale estimates for h_1 to h_4

Basic solution: plug in the (UK) population EuroQol scores (EuroQol, 1990; Dolan, 1997):

h_1 (severe)	h_2 (moderately severe)	h_3 (moderate)	h_4 (minor)
0.261	0.390	0.681	0.837

Experiment

- Laboratory study (Newcastle, UK)
- Convenience sample of students n=112
  - Majority reported health “better than average”
- Pen and Paper format (could be easily adapted)
- <20 minutes
- Financial risk preferences and health risk preferences were elicited. (financial followed Holt & Laury, 2002)
  - Safe: £5 or £6
  - Risky: £1 or £12

Results (1)

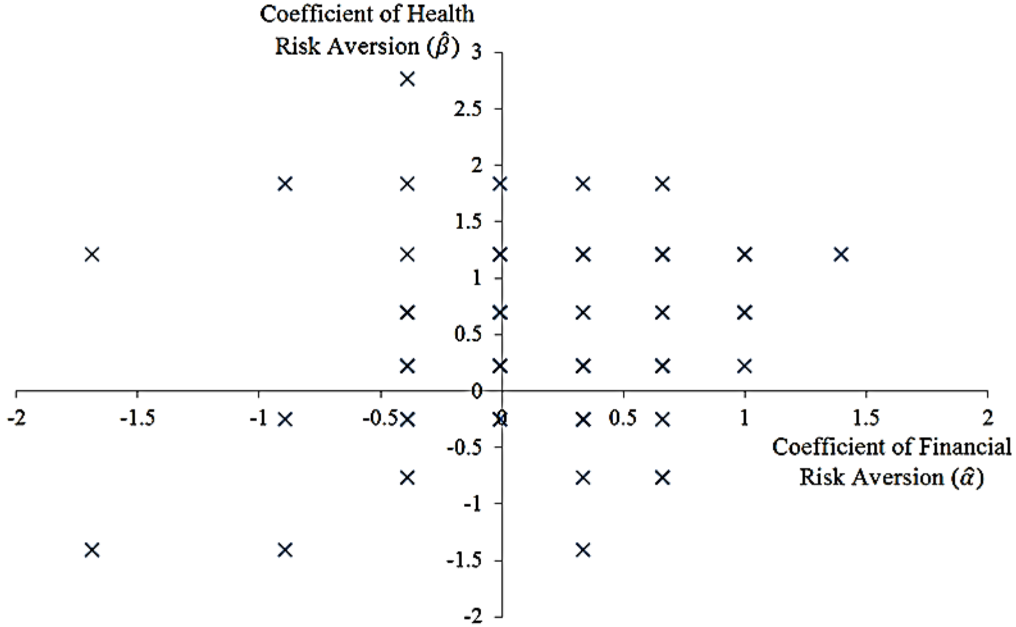
- Switch behaviour:
  - No participant switched more than once, or switched from risky to safe.
  - One participant chose all risky (could be legitimate).
  - Some evidence of switching in the middle.

Results (2)

- Risk aversion estimates (health) $\hat{\beta}$
  - Mean (n=111) = 0.402 (s.d. = 0.814)
  - Median = 0.223
  - Suggests moderately risk averse for health.
- Risk aversion estimates (money)
  - Mean = 0.168 (s.d. = 0.588)
  - Median = 0.340
  - Suggests moderately risk averse for money.

Results (3)

- Scatterplot coefficients in health and finance shows no clear relationship:



- Simple OLS regression of health on financial estimates with robust S.E. => coeff = 0.275, p=0.10
- Effect size and lack of significance robust to demographics.

Assumptions

- To calculate and interpret the coefficient of health risk aversion ($\hat{\beta}$) we assumed:
  - Health can be measured on a continuous increasing cardinal scale
  - Utility can be defined directly over health *u(h)*
  - VNM axioms of EUT hold.
- Also (and problematically):
  - EuroQoL scores are a measure of *h*
  - BUT
    - These are a measure of value or utility, not of *h*.
    - This changes the interpretation of $\hat{\beta}$.

Reinterpreting $\hat{\beta}$ (1)

- If the input scores represent the individual's own value function:
  - $\hat{\beta}$ is the "probabilistic risk aversion" or "gambling aversion"
  - Additional curvature of *u(h)* over the value function *v(h)*

Reinterpreting $\hat{\beta}$ (2)

- If the input scores represent the population's average utility function $u^*(h)$:
  - $\hat{\beta}$ is the individual's risk aversion *relative to the average member of the population*
  - Additional curvature of *u(h)* after controlling for average curvature of utility function in the population.
  - Reflects heterogeneity between individuals.

Reinterpreting $\hat{\beta}$ (3)

- Overall,
  - If we assume that *v(h)* is linear, and/or population *u*(h)* is linear, then the elicited coefficient is directly comparable to the CRRA in finance.
  - Otherwise, interpretation needs to take account of the curvature already captured in the measures of *h*.

Summary

- We provided a new way to control for health risk preferences.
- Choice based, underpinned by utility theory.
- We demonstrated the method to be tractable (but we are not wedded to our current implementation).
- We outlined the assumptions required for interpreting the coefficient as comparable to financial CRRA.
- We explain how to interpret it when these assumptions do not hold.

Thank you.

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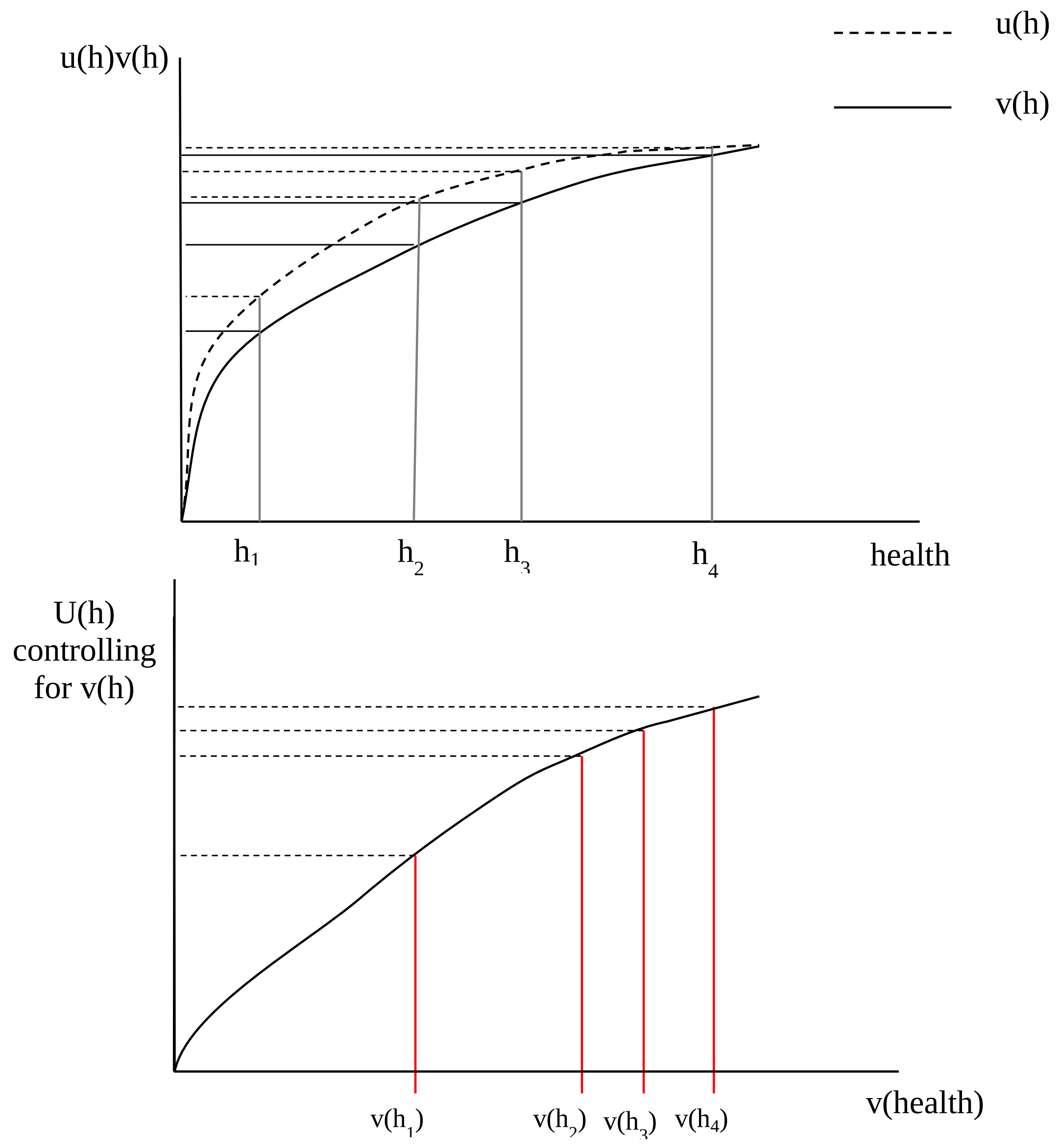
Verbal instructions

- *“Option A will always be between the moderate and moderately severe illnesses. Option B will always be between the severe and minor illnesses. The chances of the illnesses will change as you go down the table, with the chance of the least severe illness (minor or moderate illness) getting bigger and bigger. You need to think about which of the options you would prefer to face in each row of the following table. You will choose by writing A for option A or B for option B in each row of the table.”*

Figure A2: Comparison of utility and value functions



USING VALUES OF *h* (*v(h)*) IN PLACE OF *h*

The researcher estimates $\hat{\beta}$ from the equality

$$p_a v(h_2)^{(1-\widehat{\beta})} + (1 - p_a)v(h_3)^{(1-\widehat{\beta})} = p_b v(h_1)^{(1-\widehat{\beta})} + (1 - p_b)v(h_4)^{(1-\widehat{\beta})}$$

Letting $v(h_i) = h_i^{(1-\theta)}$ with θ reflecting the concavity of the value function, the equality becomes

$$v(h_i)^{(1-\widehat{\beta})} = \left(h_i{}^{(1-\theta)}\right)^{(1-\widehat{\beta})} = h_i{}^{(1-\beta)}$$

which implies

$$\beta = \hat{\beta} + \theta - \hat{\beta}\theta$$

hence

$$\hat{\beta} = \frac{\beta-\theta}{1-\theta} = \frac{(1-\theta)-(1-\beta)}{(1-\theta)}$$

USING POPULATION UTILIIES OF *h* (*u*(h)*) IN PLACE OF *h*

The researcher estimates $\hat{\beta}$ from the equality

$$p\left(\left((1-\beta^*)u^*(h_2)\right)^{\frac{(1-\beta)}{(1-\beta^*)}}\right)+(1-p)\left(\left((1-\beta^*)u^*(h_3)\right)^{\frac{(1-\beta)}{(1-\beta^*)}}\right)=$$

$$p\left(\left((1-\beta^*)u^*(h_1)\right)^{\frac{(1-\beta)}{(1-\beta^*)}}\right)+(1-p)\left(\left((1-\beta^*)u^*(h_4)\right)^{\frac{(1-\beta)}{(1-\beta^*)}}\right)$$

hence

$$\hat{\beta}=\frac{(1-\beta^*)-(1-\beta)}{(1-\beta^*)}$$