Reference Dependent Decisions on Noncommunicable Diseases

Prevention, Treatment and Optimal Health Insurance

DONG Yaohui

Toulouse School of Economics

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NCDs and Its Consequences

- Noncommunicable Chronic Diseases (NCDs)
  - Not infectious, long duration, slow progression, non-curable (WHO, 2015)
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- Cardiovascular diseases (12% of THE), cancers (7%), chronic respiratory diseases and diabetes

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- Genetic dispositions and *lifestyles*
  - Tobacco, alcohol, unhealthy diet, inactivity
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- Genetic dispositions and lifestyles
  - Tobacco, alcohol, unhealthy diet, inactivity

- Prevention: Lower the prevalence of risk factors
  - 75% Heart disease, stroke and Type II diabetes
  - 40% Cancer
Prevention, Treatment and Moral Hazard

\[ 1 - \pi \rightarrow \text{Healthy} \]
\[ \pi \rightarrow \text{III} \]
Prevention, Treatment and Moral Hazard

(Primary) Prevention

\[ 1 - \pi \rightarrow \text{Healthy} \]

\[ \pi \rightarrow \text{Ill} \]
Prevention, Treatment and Moral Hazard

1 - \(\pi\) → Healthy

\(\pi\) → Ill

(Primary) Prevention

\[\text{Healthy} \quad \text{Ill}\]
(Primary) Prevention
– Preventive care: Vaccines, condoms

1 − π → Healthy

π → Ill
Prevention, Treatment and Moral Hazard

(Primary) Prevention

- Preventive care: Vaccines, condoms
- Preventive effort: Healthy lifestyle

1 − π → Healthy

π → Ill

Reference
Dependent
Decisions on NCDs
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Intro
NCDs
Moral Hazard
Preview
Reference
Dependent
Models
Model
Insurance
Thanks
Prevention, Treatment and Moral Hazard

(Primary) Prevention
- Preventive care: Vaccines, condoms
- Preventive effort: Healthy lifestyle

1 - \( \pi \)  Healthy
\( \pi \)  Treatment

- Preventive care: Vaccines, condoms
- Preventive effort: Healthy lifestyle
Prevention, Treatment and Moral Hazard

(Primary) Prevention
- Preventive care: Vaccines, condoms
- Preventive effort: Healthy lifestyle

Health insurance causes

1 - \( \pi \) → Healthy
\( \pi \) → Treatment
Prevention, Treatment and Moral Hazard

(Primary) Prevention
- Preventive care: Vaccines, condoms
- Preventive effort: Healthy lifestyle

Health insurance causes
Ex-ante moral hazard
Stanciole (2008)
Prevention, Treatment and Moral Hazard

(Primary) Prevention
- Preventive care: Vaccines, condoms
- Preventive effort: Healthy lifestyle

Health insurance causes
Ex-ante moral hazard
Stanciole (2008)

Ex-post moral hazard
Aron-Dine et al. (2013)
Prospect Theory (Kahneman & Tversky, 1979)
- Prevention
- Treatment
- Policy implications

Prospect Theory v.s. Expected Utility Theory (EUT) in health
- Health decisions violates EUT’s assumptions (e.g. Oliver, 2003)
- Prospect Theory performs better (e.g. Osch, 2004; Bleichrodt & Pinto, 2005)

Results preview
- Medical bankruptcy ex-post
- Deliberate engagement in risky health behaviors
- Deductible insurance: financially unfeasible
- Insurance can encourage prevention
- Inverse relationship between income and unhealthy behaviors serves as a justification of redistribution
Reference Dependence

\[ u(\cdot) \]

VNM Utility Preference
Reference Dependence

$u(W_0)$

VNM Utility Preference
Reference Dependence

VNM Utility Preference

$u(W_0)$

Reference Dependent Preference

$u(\cdot)$

$v(\cdot)$

Gain/Loss
Reference Dependence

VNM Utility Preference

Reference Dependent Preference

\[ u(W_0) \]

\[ \text{Gain/Loss} \]

\[ v(\cdot) \]
Reference Dependence

VNM Utility Preference

Reference Dependent Preference

\[ u(W_0) \]

\[ v(\cdot) \]

Gain/Loss
Reference Dependence

$u(W_0)$

VNM Utility Preference

$u(\cdot)$

$u(W_0)$

$0$

$W_0$

$W$

$u(\cdot)$

$v(\cdot)$

Reference Dependent Preference

$v(\cdot)$

Gain/Loss

0
Timing

Pay $P$

Choose $e$

$\pi(e)$

Ill

Pay full or part of $M$

$1 - \pi(e)$

Healthy

$t = t_0$

$t = t_1$
Model Setup
Value Function for Non-Curable Diseases

- Reference point: Status quo in each period
  - Evolution of reference point across period
  - Pre- and post-diagnosis life expectancies (Rasiel, Weinfurt, & Schulman, 2005)

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  - Curable diseases
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  - Curable diseases $\rightarrow$ Pay for treatment

Reference point: Status quo in each period
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$V(h, w)$
Curable diseases $\rightarrow$ Pay for treatment
Reference point: Status quo in each period
- Evolution of reference point across period
- Pre- and post-diagnosis life expectancies (Rasiel et al., 2005)

\[ V(h, w) \]
- Curable diseases → Pay for treatment → Recover
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  - Pre- and post-diagnosis life expectancies (Rasiel et al., 2005)
- $V(h, w)$
  - Curable diseases → Pay for treatment → Recover
  - Non-curable diseases

Reference point: Status quo in each period
Model Setup
Value Function for Non-Curable Diseases

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- $V(h, w)$
  - Curable diseases → Pay for treatment → Recover
  - Non-curable diseases → Pay for survival

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  - Curable diseases → Pay for treatment → Recover
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Value Function for Non-Curable Diseases

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  - Evolution of reference point across period
  - Pre- and post-diagnosis life expectancies (Rasiel et al., 2005)
- $V(h, w)$
  - Curable diseases $\rightarrow$ Pay for treatment $\rightarrow$ Recover
  - Non-curable diseases $\rightarrow$ Pay for survival $\rightarrow$ Remain sick
Model Setup
Value Function for Non-Curable Diseases

- Reference point: Status quo in each period
  - Evolution of reference point across period
  - Pre- and post-diagnosis life expectancies (Rasiel et al., 2005)
- \( V(h, w) \)
  - Curable diseases → Pay for treatment → Recover
  - Non-curable diseases → Pay for survival → Remain sick
- NCDs cause

\( V(h, w) \)
Model Setup
Value Function for Non-Curable Diseases

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- \( V(h, w) \)
  - Curable diseases → Pay for treatment → Recover
  - Non-curable diseases → Pay for survival → Remain sick

- NCDs cause
  - Financial loss
Model Setup
Value Function for Non-Curable Diseases

- Reference point: Status quo in each period
  - Evolution of reference point across period
  - Pre- and post-diagnosis life expectancies (Rasiel et al., 2005)

- \( V(h, w) \)
  - Curable diseases \( \rightarrow \) Pay for treatment \( \rightarrow \) Recover
  - Non-curable diseases \( \rightarrow \) Pay for survival \( \rightarrow \) Remain sick

- NCDs cause
  - Financial loss
  - Permanent damage to health
Model Setup
Value Function for Non-Curable Diseases

- **Reference point:** Status quo in each period
  - Evolution of reference point across period
  - Pre- and post-diagnosis life expectancies (Rasiel et al., 2005)

\[ V(h, w) \]

- Curable diseases $\rightarrow$ Pay for treatment $\rightarrow$ Recover
- Non-curable diseases $\rightarrow$ Pay for survival $\rightarrow$ Remain sick

- **NCDs cause**
  - Financial loss
  - Permanent damage to health

- **Health dimension:** Life years
- **Wealth dimension:** Monetary terms
Timing

Pay $P$  
Choose $e$

$\pi(e)$

Ill

Pay full or part of $M$

$1 - \pi(e)$

Healthy

$t = t_0$

$t = t_1$
Treatment: Assumptions

\[ w \]

\[ h \]

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Treatment: Assumptions

\[ w \]

\[ h \]

\[ \lim_{H \to 0} \frac{\partial u}{\partial H} = +\infty, \quad \lim_{M \to 0} \frac{\partial u}{\partial M} < +\infty, \]

\[ \frac{\partial^2 u}{\partial H^2} < 0, \quad \frac{\partial^2 u}{\partial M^2} < 0. \]
Treatment: Assumptions

\[ w = \begin{cases} w(h(M)), & H(H(M)) > 0, H(H(M))'' < 0, \\
\frac{\partial u}{\partial H} > 0, \frac{\partial u}{\partial M} < 0, \\
\lim_{H \to 0} \frac{\partial u}{\partial H} = +\infty, \\
\lim_{M \to 0} \frac{\partial u}{\partial M} < +\infty, \\
\frac{\partial^2 u}{\partial H^2} < 0, \frac{\partial^2 u}{\partial M^2} < 0. \end{cases} \]
Treatment: Assumptions

\[ W(w, M) \]

\[ \frac{\partial W}{\partial h} > 0, \quad \frac{\partial W}{\partial M} < 0. \]

\[ \lim_{H \to 0} \frac{\partial W}{\partial H} = +\infty, \quad \lim_{M \to 0} \frac{\partial W}{\partial M} = +\infty, \quad \frac{\partial^2 W}{\partial H^2} < 0, \quad \frac{\partial^2 W}{\partial M^2} < 0. \]
Treatment: Assumptions

\[ w \]

\[ Y \]

\[ 0 \]

\[ h \]
Treatment: Assumptions

\[ w = Y(h, M) \]

\[ \frac{\partial w}{\partial h} > 0, \quad \frac{\partial w}{\partial M} < 0. \]

\[ \lim_{H \to 0} \frac{\partial u}{\partial H} = +\infty, \quad \lim_{M \to 0} \frac{\partial u}{\partial M} = +\infty, \quad \frac{\partial^2 u}{\partial H^2} < 0, \quad \frac{\partial^2 u}{\partial M^2} < 0. \]
Treatment: Assumptions

- $H(M)$, $H' > 0$, $H'' < 0$. 

![Diagram showing $H(M)$ as a function]
Treatment: Assumptions

- $H(M), H' > 0, H'' < 0$.

- $u(H(M), M)$

- $\frac{\partial u}{\partial H} > 0, \frac{\partial u}{\partial M} < 0$.

- $\lim_{H \to 0} \frac{\partial u}{\partial H} = +\infty, \lim_{M \to 0} \frac{\partial u}{\partial M} < +\infty$,

- $\frac{\partial^2 u}{\partial H^2} < 0, \frac{\partial^2 u}{\partial M^2} < 0$. 
Patient treatment problem:

$$\max_{M \leq Y} u(H(M), M) \quad (1)$$
Patient treatment problem:

\[
\max_{M \leq Y} u(H(M), M) \quad (1)
\]

\[
\frac{du}{dM} = \frac{\partial u}{\partial H} H'(M) + \frac{\partial u}{\partial M} = 0 \implies \frac{\partial u}{\partial H} H'(M) = -\frac{\partial u}{\partial M}
\]
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\]

Deductible \( D < Y \leq M^* \)

\[
\max_{M} u(H(M), D)
\]
Patient treatment problem:

\[
\max_{M \leq Y} u(H(M), M) \quad (1)
\]

\[
\frac{du}{dM} = \frac{\partial u}{\partial H} H'(M) + \frac{\partial u}{\partial M} = 0 \implies \\
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Deductible \( D < Y \leq M^* \)

\[
\max_{M} u(H(M), D)
\]

\[
\implies M = +\infty
\]
Prevention: Framing

Expected Utility Maximizer:

\[-K_M \pi' (e) = \alpha' (e)\]

Loss aversion v.s. Framing
Prevention: Framing

\[ \text{Sick} \quad \pi(e) \]

\[ Y - M \]

\[ 0 \quad h + H(M) \quad h \]

Expected Utility Maximizer:

\[ -K_M \pi'(e) = \alpha'(e) \]

Loss aversion v.s. Framing 11 / 16
Prevention: Framing

\[ Y = \bar{h} - h + H(M) \]

\[ 1 - \pi(e) \]

\[ \bar{h} \]

\[ h \]

\[ w \]

\[ Y \]

\[ Y - M \]

Sick

\[ \pi(e) \]

Healthy

\[ V(h, w) = \gamma h + w \]

Effort cost:

\[ K M \pi'(e) = \alpha'(e) \]

Expected Utility Maximizer:

\[ -K M \pi'(e) = \alpha'(e) \]
Prevention: Framing

\[ Y = \pi(e) \]

\[ Y - M = \pi(e) \]

\[ 1 - \pi(e) \]

\[ h + H(M) \]

\[ \bar{h} \]

\[ V(h, w) = \gamma h + w \alpha(e) \]

\[ K M \pi'(e) = \alpha'(e) \]

Expected Utility Maximizer:

\[ -K M \pi'(e) = \alpha'(e) \]

Loss aversion v.s. Framing
Prevention: Framing

\[ Y - M \]

\[ Y \]

\[ 1 - \pi(e) \]

\[ \pi'(e) \leq 0 \]
Prevention: Framing

\[
\begin{align*}
\text{Healthy} & : \pi'(e) \leq 0 \\
\text{Sick} & : \pi(e) \\
\text{Ref} & : 1 - \pi(e)
\end{align*}
\]

\[
V(h, w) = \gamma h + \alpha(e) \text{ effort cost: } (\lambda - 1)(2\pi - 1)K \pi'(e) = \alpha'(e)
\]

Expected Utility Maximizer:
\[
-\lambda h \pi'(e) = \alpha'(e)
\]

Loss aversion v.s. Framing
Prevention: Framing

\[ V(h, w) = \gamma h + w \alpha(e) \]

\[ \pi'(e) \leq 0 \]

Gain ↓ and loss ↑
Prevention: Framing

\[ V(h, w) = \gamma h + w \]

\[ \alpha(e) \text{ effort cost:} \]

\[ \pi'(e) \leq 0 \]

\[ \text{Gain } \downarrow \text{ and loss } \uparrow \]

\[ \text{Loss aversion v.s. Framing} \]
Prevention: Framing

\[ Y - M \]

\[ Y \]

\[ \pi(e) \]

\[ \pi'(e) \leq 0 \]

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\[ V(h, w) = \gamma h + w \]

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Prevention: Framing

\[ V(h, w) = \gamma h + w \]

- \( \pi'(e) \leq 0 \)
- Gain ↓ and loss ↑
- \( \alpha(e) \) effort cost:
  \[ (\lambda - 1)(2\pi - 1)K_M \pi'(e) = \alpha'(e) \]
- Expected Utility Maximizer:
  \[ -K_M \pi'(e) = \alpha'(e) \]
Prevention: Framing

\[ Y - M < 0 \]

\[ \pi'(e) \leq 0 \]

Gain ↓ and loss ↑

\[ V(h, w) = \gamma h + w \]

\[ \alpha(e) \text{ effort cost:} \]

\[ (\lambda - 1)(2\pi - 1)K_M \pi'(e) = \alpha'(e) \]

Expected Utility Maximizer:

\[ -K_M \pi'(e) = \alpha'(e) \]

Loss aversion v.s. Framing
Prevention Across Income Groups

Proposition

1. \( Y > M^* \quad \Rightarrow \quad \text{the same level of prevention} \quad \frac{\partial e}{\partial Y} = 0 \).

2. \( Y \leq M^* \), \( \frac{\partial e}{\partial Y} \leq 0 \quad \iff \quad 1 - \gamma H'(M) \leq 0 \)

For the poor, if \( \frac{\partial e}{\partial Y} \geq 0 \)
Prevention Across Income Groups

Proposition

1. $Y > M^*$ $\Rightarrow$ the same level of prevention $\frac{\partial e}{\partial Y} = 0$.

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For the poor, if $\frac{\partial e}{\partial Y} \geq 0$

- Medical bankruptcy
Proposition

1. \( Y > M^* \implies \text{the same level of prevention} \quad \frac{\partial e}{\partial Y} = 0. \)

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For the poor, if \( \frac{\partial e}{\partial Y} \geq 0 \)

- Medical bankruptcy
- Poorer health
Prevention Across Income Groups

Proposition

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For the poor, if $\frac{\partial e}{\partial Y} \geq 0$

- Medical bankruptcy
- Poorer health
- Less healthy lifestyles
Behavioral welfare analysis is challenging
Optimal Health Insurance

- Behavioral welfare analysis is challenging
- Different utility functions ex-ante and ex-post
Optimal Health Insurance

- Behavioral welfare analysis is challenging
- Different utility functions ex-ante and ex-post
- Assumptions
  - Utilitarian welfare function: Ex-post utility function
Optimal Health Insurance

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- Different utility functions ex-ante and ex-post
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  - Wellbeing of the longevous: 0
Optimal Health Insurance

- Behavioral welfare analysis is challenging
- Different utility functions ex-ante and ex-post
- Assumptions
  - Utilitarian welfare function: Ex-post utility function
  - Wellbeing of the longevous: 0
- Welfare without insurance

\[
W = \int_{Y}^{\breve{Y}} (1 - \pi(e(Y))) \times 0dF(Y) + \int_{Y}^{\breve{Y}} \pi(e(Y))u(H(M_1(Y)), \zeta(Y))dF(Y)
\]
Purely Redistributive Insurance

- Insurance premium in the beginning of \( t_0 \)
- Reference point changes
  \[
P(Y) = Y - M^*
\]
- Assume \( E[Y] \geq M^* \), transfer in \( t_0 \)
Purely Redistributive Insurance

- Insurance premium in the beginning of $t_0$
- Reference point changes
  - $P(Y) = Y - M^*$
- Assume $\mathbb{E}[Y] \geq M^*$, transfer in $t_0$
  - $W^I = (1 - \pi(e_0)) \cdot 0 + \pi(e_0) \int_{Y} \bar{u}(H(M^*), M^*) dF(Y) = \pi(e_0)u(H(M^*), M^*)$
Purely Redistributive Insurance

- Insurance premium in the beginning of $t_0$
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- $P(Y) = Y - M^*$
- Assume $E[Y] \geq M^*$, transfer in $t_0$
- $W^I = (1 - \pi(e_0)) \cdot 0 + \pi(e_0) \int_Y u(H(M^*), M^*)dF(Y) = \pi(e_0)u(H(M^*), M^*)$

Proposition

$$1 - \gamma H'(M) \geq 0 \implies W^I \geq W.$$
### Ex-ante Moral Hazard

<table>
<thead>
<tr>
<th>Insurance</th>
<th>Effects on Prevention</th>
</tr>
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<tbody>
<tr>
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<td>−</td>
</tr>
<tr>
<td>Coinsurance</td>
<td>+/−</td>
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- Coinsurance could encourage prevention
## Ex-ante Moral Hazard

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- Coinsurance could encourage prevention
- Even when preventive efforts are unobservable
Thank You

DONG Yaohui
Toulouse School of Economics
21, Allée de Brienne
31015 Toulouse, France
+33 (0)6 28 56 74 82
yaohui.dong@tse-fr.eu
Inconsistent predictions by EUT
Inconsistent predictions by EUT

- Treatment choices 

Example 1

Evidence in health decision making

- Gambles with years of life (Verhoef et al., 1994)
- Health insurance decisions (Marquis & Holmer, 1996)
Reference dependent preference

Violation of EUT

Inconsistent predictions by EUT
- Treatment choices (Example 1)
- Health state valuations (Example 2)
Reference dependent preference
Violation of EUT

- Inconsistent predictions by EUT
  - Treatment choices  
  - Health state valuations
- Reference dependence (Kahneman & Tversky, 1979)
Reference dependent preference
Violation of EUT

- Inconsistent predictions by EUT
  - Treatment choices
  - Health state valuations
- Reference dependence (Kahneman & Tversky, 1979)
  - Framing: Reference point plays a key role in decision making
Reference dependent preference

Violation of EUT

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  - Health state valuations (Example 2)

- Reference dependence (Kahneman & Tversky, 1979)
  - Framing: Reference point plays a key role in decision making
  - Loss aversion: Greater aversion to losses than appreciation of gains
Reference dependent preference
Violations of EUT

- Inconsistent predictions by EUT
  - Treatment choices (Example 1)
  - Health state valuations (Example 2)

- Reference dependence (Kahneman & Tversky, 1979)
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References
Reference dependent preference
Violation of EUT

- Inconsistent predictions by EUT
  - Treatment choices  Example 1
  - Health state valuations  Example 2

- Reference dependence (Kahneman & Tversky, 1979)
  - Framing: Reference point plays a key role in decision making
  - Loss aversion: Greater aversion to losses than appreciation of gains
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  - “Best available description of how people evaluate risk” (Barberis, 2013)
Reference dependent preference
Violation of EUT

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- Evidence in health decision making
  - Gambles with years of life (Verhoef et al., 1994)
  - Health insurance decisions (Marquis & Holmer, 1996)
### Choice reversals in treatment for lung cancer

<table>
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<th>Treatment</th>
<th>Die in treatment</th>
<th>LE on success</th>
<th>LE avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery (58%)</td>
<td>10%</td>
<td>6.8 years</td>
<td>6.1</td>
</tr>
<tr>
<td>Radiation (42%)</td>
<td>0</td>
<td>4.7</td>
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**Table:** Mortality Framed Choices

<table>
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<tr>
<th>Treatment</th>
<th>Survive in treatment</th>
<th>LE on success</th>
<th>LE avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery (75%)</td>
<td>90%</td>
<td>6.8 years</td>
<td>6.1</td>
</tr>
<tr>
<td>Radiation (25%)</td>
<td>100%</td>
<td>4.7</td>
<td>4.7</td>
</tr>
</tbody>
</table>

**Table:** Survival Framed Choices
Violation of EUT
Health States Valuation

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Healthy</th>
<th>Asthma at 40</th>
<th>Death at 40</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>80</td>
<td>(x)</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>95</td>
<td>0</td>
<td>5</td>
<td>100</td>
</tr>
</tbody>
</table>

\[80 \times 1 + x \times u(\text{Asthma}) = 95 \times 1 + 5 \times 0 \implies u(\text{Asthma}) = \frac{x}{15}\]

**Table:** Veil of ignorance approach (VEI)

<table>
<thead>
<tr>
<th>Dose</th>
<th>Healthy</th>
<th>Asthma</th>
<th>Death</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(p)</td>
<td>0</td>
<td>1-(p)</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

\[p \times 1 + (1 - p) \times 0 = 1 \times u(\text{Asthma}) \implies u(\text{Asthma}) = p\]

**Table:** Standard Gamble Approach (SG)
Violations of EUT
Pinto-Prades and Abellán-Perpiñán (2005)

<table>
<thead>
<tr>
<th>Health State</th>
<th>VEI</th>
<th>SG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restricted in participation in major aspect of life</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Unable to live independently</td>
<td>0.29</td>
<td>0.47</td>
</tr>
<tr>
<td>Need assistance for basic activities</td>
<td>-0.15</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table:** Median valuations of each health state
Empirical Support for Prospect Theory

**Figure:** Certainty Equivalent Method

- CE > expected value of the gamble $\implies$ risk aversion
- Long duration $\implies$ risk aversion; short duration $\implies$ risk seeking
Message Framing

- “Message framing” in cancer care
  - Gain framed: emphasizes the benefits of taking the action
  - Good things that will happen and the bad things that will be avoided
  - Loss framed: emphasizes the costs of inaction
  - Bad things that will happen and good things that will not happen
  - Risk seeking in loss:
    - Detective treatment
    - Loss framed is more persuasive
  - Risk averse in gains:
    - Preventive actions
    - Gain framed is more persuasive


