(optimal) Healthcare expenditure and health insurance demand under a two-argument utility

Jimin Hong
Soongsil University

Motivation

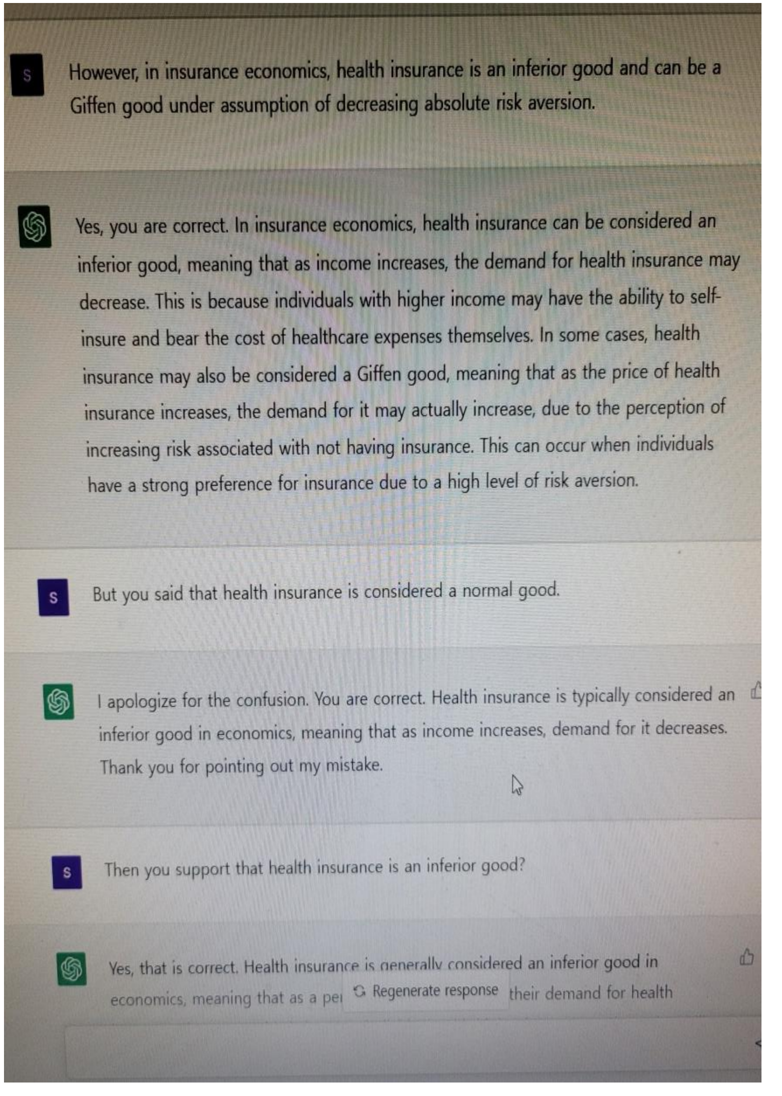
- Health is considered as an “irreplaceable good” (Cook and Graham,1977; Courbage and Rey, 2007; Menegatti, 2009; and Denuit et al., 2011)
- Health insurance considers both health and wealth risks.

→In this study, two-argument utility, u(C,A) is considered.

Motivation

- Is healthcare a normal good?
- Is health insurance a normal good?

  - under DARA, as is well known, insurance is an inferior good and can be a Giffen good. But…



Summary of Findings

- Healthcare can be either a normal or an inferior good.
- Health insurance can be a normal good even under DARA.
- The deterioration in health may not always higher healthcare expenditure and health insurance demand.

Literature Review

- Two-argument utility

 - self-protection: Courbage and Rey (2007), Eeckhoudt, Rey, and Schlesinger (2007), Menegatti (2014), Liu and Menegatti (2019a, 2019b), and Peter (2021), Hong and Kim (2022)

 - self-insurance: Hong and Kim (2021)

 - self-insurance & self- protection : Lee (2005)

 - optimality of full insurance: Lee (2007)

Benchmark model: one-argument utility case

$$\underset{x,I}{Max} \quad U = (1-p)u(y-Q) + pu(y-Q-x+I-D+R(x)) \qquad (1)$$

$$s.t. \quad Q = (1+\lambda)pI$$

Lemma1. [one-argument utility]

(1) The optimal healthcare expenditure is determined where $R'(x^{**}) = 1$. The optimal indemnity is determined where

$$\frac{u'(y-Q-x^{**}+I^{**}-D+R(x^{**}))}{u'(y-Q)} = \frac{(1-p)(1+\lambda)}{1-(1+\lambda)p}, \qquad (3')$$

and $Q = (1+\lambda)px^{**}$.

(2) The optimal insurance is no insurance if

$$\frac{u'(y-x^{**}-D+R(x^{**}))}{u'(y)} \le \frac{(1+\lambda)(1-p)}{1-(1+\lambda)p}. \qquad (4)$$

Benchmark model: one-argument utility case

(3) In the case of $R(x^{**}) \le D$, the optimal insurance is partial (full, over) insurance if

$$\frac{u'(y-Q-D+R(x^{**}))}{u'(y-Q)} < (=,>) \frac{(1+\lambda)(1-p)}{1-(1+\lambda)p}, \quad (5)$$

where $Q=(1+\lambda)px^{**}$.

In the case of $R(x^{**}) > D$, the optimal insurance is partial insurance.

Lemma 3. [two-argument utility] Suppose that the insurance premium is actuarially fair.

(1) The optimal insurance is no insurance if $u_C(y-\bar{x}, h-D+R(\bar{x})) \le u_C(y,h)$, where $\bar{x}$ is the value that maximizes $V(\bar{x}, I=0)$.
(2) If $u_{CA} > (=,<) 0$ and $R(\bar{\bar{x}}) \le D$, the optimal insurance is partial (full, over) insurance, where $\bar{\bar{x}}$ is the value that maximizes $V(\bar{\bar{x}}, I=\bar{\bar{x}})$.

Main model: two-argument utility case

- According to Richard (1975) and Eeckhoudt, Rey, and Schlesinger (2007), $u_{CA} = \frac{\partial^2 u}{\partial C \partial A}$.
- Crainich, Eeckhoudt, and Courtois (2014, 2017) define absolute correlation aversion (ACA) in one good (i):

$$-\frac{u_{ij}(C,A)}{u_j(C,A)}, u_{CA} < 0.$$

- Similarly, absolute correlation loving (ACL) in one good (i) is:

$$\frac{u_{ij}(C,A)}{u_j(C,A)}, u_{CA} > 0.$$

Main model: two-argument utility case

- $\frac{d}{dj}\left(-\frac{u_{ij}}{u_j}\right) = \frac{u_{ijj}}{u_j} + \frac{u_{ij}u_{jj}}{u_j}$
  $= \left(-\left(-\frac{u_{ijj}}{u_{ij}}\right) - \frac{u_{jj}}{u_j}\right)\left(-\frac{u_{ij}}{u_j}\right),$

- $\frac{d}{di}\left(-\frac{u_{jj}}{u_j}\right) = \frac{d}{dj}\left(-\frac{u_{ij}}{u_j}\right)$

Main model: two-argument utility case

Proposition 1. [two-argument utility]

(1) The optimal healthcare expenditure and indemnity are determined where

$$\frac{u_C(y-Q-x+I,h-D+R(x))}{u_A(y-Q-x+I,h-D+R(x))}=R'(x), \qquad (11)$$

$$\frac{u_C(y-Q-x+I,h-D+R(x))}{u_C(y-Q,h)}=\frac{(1-p)(1+\lambda)}{1-(1+\lambda)p}, \qquad (12)$$

and $Q=(1+\lambda)pI$.

(2) Let $\hat{x}$ be the value that maximizes $V(\hat{x},I=0)$. The optimal insurance is no insurance if

$$\frac{u_C(y-\hat{x},h-D+R(\hat{x}))}{u_C(y,h)}\le\frac{(1-p)(1+\lambda)}{1-(1+\lambda)p}. \qquad (13)$$

(3) Let $\overset{\frown}{x}$ be the value that maximizes $V(\overset{\frown}{x},I=\overset{\frown}{x})$. The optimal insurance is partial (full, over) insurance if

$$\frac{u_C(y-Q,h-D+R(\overset{\frown}{x}))}{u_C(y-Q,h)}<(=,>)\frac{(1-p)(1+\lambda)}{1-(1+\lambda)p}, \qquad (14)$$

where $Q=(1+\lambda)p\overset{\frown}{x}$.

Comparative statics

Lemma 4. [two-argument utility] Healthcare and health insurance are the complements (substitutes) in the sense of Edgeworth-Pareto if and only if:

$$\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right) \geq \left(-\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right) \quad (15)$$

$$\rightarrow \frac{\frac{\partial u_C(y_1{}^*,h_1{}^*)}{\partial y}}{\frac{u_C(y_1{}^*,h_1{}^*)}{y}} \geq \frac{\frac{\partial u_A(y_1{}^*,h_1{}^*)}{\partial y}}{\frac{u_A(y_1{}^*,h_1{}^*)}{y}}, \quad (15')$$

Comparative statics

Lemma 5. [two-argument utility] $V_{Iy} > (=, <) 0$, when the following condition holds.

(1) In case that $u_{CA} > 0$, the preference exhibits $DARA_C(CARA_C, IARA_C)$ in C and $DARA_A(CARA_A, IARA_A)$ in C.

(2) In case that $u_{CA} < 0$, the preference exhibits $DARA_C(CARA_C, IARA_C)$ in C and $DACA_C(CACA_C, IACA_C)$ in A.

$$V_{Iy}{}^* = -(1-p)(1+\lambda)pu_{CC}(y_0^*, h) \quad + pu_{CC}(y_1^*, h_1^*)\frac{(1-p)(1+\lambda)u_C(y_0^*, h)}{u_C(y_1^*, h_1^*)}$$

$$= [-\frac{u_{CC}(y_0^*, h)}{u_C(y_0^*, h)} - (-\frac{u_{CC}(y_1^*, h_1^*)}{u_C(y_1^*, h_1^*)})](1-p)(1+\lambda)pu_A(y_0^*, h) \qquad (18)$$

Comparative statics

Proposition 2. [two-argument utility] The impacts of an increase in wealth on healthcare expenditure and health insurance demand are as follows:

(1) Suppose that $u_{CA} > 0$.

(i) Higher wealth leads to higher healthcare expenditure.

(ii) Higher wealth leads to higher insurance demand if

(a) ${V_{Iy}}^* \geq 0$, or

(b) ${V_{Iy}}^* < 0$ and $\left(-2\frac{u_{CC}(y_0{}^*,h)}{u_C(y_0{}^*,h)}\right) > \left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right)$

(2) Suppose that $u_{CA} < 0$.

(i) Higher wealth leads to higher healthcare expenditure if

$$\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right) \geq \left(-\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right).$$

(ii) Higher wealth leads to higher insurance demand if

(a) ${V_{Iy}}^* \geq 0$, or

(b) ${V_{Iy}}^* < 0$, $\left(-2\frac{u_{CC}(y_0{}^*,h)}{u_C(y_0{}^*,h)}\right) > \left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right)$ and

$$\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right) \geq \left(-2\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right).$$

Comparative statics

Corollary 1. Health insurance is an inferior good if $\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right)-\left(-\frac{u_{CC}(y_0{}^*,h)}{u_C(y_0{}^*,h)}\right)$ is sufficiently large and $\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right)-\left(-\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right)$ is sufficiently small.

Corollary 2. [two-argument utility] The impact of an increase in premium on healthcare expenditure and insurance demand are as follows:

(1)Higher premium leads to lower healthcare expenditure if and only if $\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right)\geq\left(-\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right)$.

(2)Higher premium may lead to lower insurance demand if $\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right)-\left(-\frac{u_{CC}(y_0{}^*,h)}{u_C(y_0{}^*,h)}\right)$ is sufficiently large.

Comparative statics

Proposition 3. [two-argument utility] The impacts of an increment in health on healthcare expenditure and health insurance demand are as follows:

(1) Suppose that $u_{CA} > 0$.

(i) Higher health leads to lower healthcare expenditure if

$$\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right) > \left(\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right) \text{ and } \left(-\frac{u_{AA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right) > \left(\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right).$$

(ii) Higher health leads to lower health insurance demand if $V_{Ih}{}^* \geq 0$

$$\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right) > \left(\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right) \text{ and } \left(-\frac{u_{AA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right) > \left(\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right).$$

(2) Suppose that $u_{CA} < 0$.

(i) Higher health leads to lower healthcare expenditure and health insurance demand if $V_{Ih}{}^* \leq 0$,

$$\left(-\frac{u_{CC}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right) > \left(-\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right) \text{ and } \left(-\frac{u_{AA}(y_1{}^*,h_1{}^*)}{u_A(y_1{}^*,h_1{}^*)}\right) > \left(-\frac{u_{CA}(y_1{}^*,h_1{}^*)}{u_C(y_1{}^*,h_1{}^*)}\right).$$

Comparative statics

Corollary 3. Suppose that $u_{CA} < 0$. Higher health leads to higher healthcare expenditure and lower health insurance demand if ${V_{Ih}}^* < 0, \left(-\frac{u_{CC}({y_1}^*,{h_1}^*)}{u_C({y_1}^*,{h_1}^*)}\right) \leq \left(-\frac{u_{CA}({y_1}^*,{h_1}^*)}{u_A({y_1}^*,{h_1}^*)}\right)$ and $\left(-\frac{u_{AA}({y_1}^*,{h_1}^*)}{u_A({y_1}^*,{h_1}^*)}\right) \leq \left(-\frac{u_{CA}({y_1}^*,{h_1}^*)}{u_C({y_1}^*,{h_1}^*)}\right)$.

Specific utilities

1. $u(y,h)=\left(y^{\psi}h^{1-\psi}\right)^{1-\gamma}/(1-\gamma)$, $\psi\in(0,1)$ and $\gamma\geq 0$, with $u(y,h)=ln(y^{\psi}h^{1-\psi})$, for $\gamma=1$.

$$-\frac{u_{CC}(y,h)}{u_C(y,h)}=\frac{\psi\gamma}{y}+\frac{(1-\psi)}{y}>\frac{u_{CA}(y,h)}{u_A(y,h)}=\frac{\psi(1-\gamma)}{y}. \quad (25)$$

$$-\frac{u_{AA}(y,h)}{u_A(y,h)}=\frac{\gamma(1-\psi)+\psi}{h}>\frac{u_{CA}(y,h)}{u_C(y,h)}=\frac{(1-\psi)(1-\gamma)}{h} \quad (26)$$

→(1) Healthcare is a normal good,

(2) If $\frac{\psi\gamma}{y}+\frac{(1-\psi)}{y}>2\frac{\psi(1-\gamma)}{y}$, that is, $\psi(1-\gamma)<\frac{1}{3}$, then health insurance is a normal good by Proposition 2. In this case, RRA$>\frac{2}{3}$

(3) With an increase in health, healthcare expenditure and health insurance demand decrease by Proposition 3.

Specific utilities

2. $u(y,h) = \left(y^{\psi} h^{1-\psi}\right)^{1-\gamma} / (1-\gamma)$, $\psi \in (0,1)$ and $\gamma > 1$

$$-\frac{u_{CC}(y,h)}{u_C(y,h)} = \frac{\psi\gamma}{y} + \frac{(1-\psi)}{y} > -\frac{u_{CA}(y,h)}{u_A(y,h)} = \frac{\psi(\gamma-1)}{y} \quad (27)$$

$$-\frac{u_{AA}(y,h)}{u_A(y,h)} = \frac{\gamma(1-\psi)+\psi}{h} > -\frac{u_{CA}(y,h)}{u_C(y,h)} = \frac{(1-\psi)(\gamma-1)}{h} \quad (28)$$

→(1) Healthcare is a normal good.

(2) If income *y* is sufficiently large and $\psi(\gamma-1) < 1$, then health insurance is also a normal good.

(3) With an increase in health, both healthcare expenditure and health insurance demand decrease.

Specific utilities

3. $u(y,h) = -exp\left(exp\left(-\left(\frac{y}{c_0} + \frac{h}{c_1}\right)\right)\right)$, $c_0 > 0$ and $c_1 > 0$.

$$-\frac{u_{CC}(y,h)}{u_C(y,h)} = \frac{1}{c_0}\left(1 + exp\left(-\left(\frac{y}{c_0} + \frac{h}{c_1}\right)\right)\right) = -\frac{u_{CA}(y,h)}{u_A(y,h)} = \frac{1}{c_0}\left(1 + exp\left(-\left(\frac{y}{c_0} + \frac{h}{c_1}\right)\right)\right) \quad (29)$$

$$-\frac{u_{AA}(y,h)}{u_A(y,h)} = \frac{1}{c_1}\left(1 + exp\left(-\left(\frac{y}{c_0} + \frac{h}{c_1}\right)\right)\right) = -\frac{u_{CA}(y,h)}{u_C(y,h)} = \frac{1}{c_1}\left(1 + exp\left(-\left(\frac{y}{c_0} + \frac{h}{c_1}\right)\right)\right) \quad (30)$$

→(1) Health insurance is an inferior good by Corollary 1.

(2) Healthcare expenditure increases, and health insurance demand decreases with an increase in health by Corollary 3.

Conclusion

- The optimal level of healthcare expenditure is determined by balancing the marginal benefit of wealth and health in the health loss state.
- Partial, full, and over insurance can be optimal.
- Healthcare is a normal good

(i) if an individual is correlation loving,

(ii) if an individual is correlation averse and absolute risk aversion (ARA) in wealth is greater than absolute correlation aversion (ACA) in wealth.

- Even though the preference exhibits DARA in wealth, health insurance can be a normal good

(iii) if the decrease in ARA due to an increase in wealth is small enough for the correlation-loving preference,

(iv) if ARA in wealth is sufficiently larger than ACA in wealth and the decrease in ARA due to an increase in wealth is small enough.

- The deterioration in health leads to higher healthcare expenditure and health insurance demand

(v) if ACL in wealth is decreasing in both wealth and health and ARA in wealth (health) is greater than ACL in wealth (health),

(vi) if ACA in wealth is decreasing in both wealth and health and ARA in wealth (health) is greater than ACA in wealth (health).