Health Heterogeneity and the Preferences for Consumption Growth

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Introduction

- A big question in Macroeconomics is what determines savings.
  - The old are special (DeNardi, French, Jones (2015), Ameriks, Briggs, Caplin, Shapiro Tonetti (2015))
  - There is an increasing number of them.

- Two fundamental characteristics of the old
  - Their health worsens with age
  - It does so at different rate for people in different socio-economic groups Pijoan-Mas, Ríos-Rull (2014)

▷ *How do age and health shape preferences and consumption decisions?*

  - Surprisingly, little work exploring effects of health on consumption

Objective

We estimate the effect of health on the marginal utility of consumption

- We use a model where the evolution of health is itself endogenous
- But we use only the consumption Euler equation to estimate structural parameters
  - We exploit differences in consumption growth by age, education, wealth, and health groups
  - We use estimates of health transitions by age, education, and wealth.
  - We interpret them as the outcome of optimal behavior.

▷ Hence, *we do not need to know the whole health production technology.*

Conventional wisdom

The marginal utility of consumption falls when health declines

- Domeij, Johannesson (2006) and Scholz, Seshadri (2012)
  - Exploit the average joint decline of health and consumption with age
  - ▷ But age-consumption decline may be due to other reasons
    Gourinchas, Parker (2002); Aguiar, Hurst (2013)

- Finkelstein, Luttmer, Notowidigdo (2012)
  - Subjective well-being increases with health, more so for individuals with larger permanent income
  - ▷ But not necessarily related to consumption expenditure

- Koijen, Van Nieuwerburgh, Yogo (2012)
  - Households own too little long-term care insurance, too many annuities

Main findings

1. At age 65, better health gives higher marginal utility of consumption
   - You need healthy time to enjoy life
2. However, as individuals age, this difference narrows down
   - Consumption expenditure also substitutes for healthy time
   - Hence, low health may give high marginal utility of consumption
3. We provide some direct evidence of the age effect of health on consumption composition

Model: main elements

- Individuals differ in:
  - age (i), education (e), health (h), wealth (a), income (s)
- They choose
  - nonmedical expend (c), medical expend (x), health-related behaviour (y)
- Education $e \in E = \{c, h, d\}$ is predetermined.
  - (potentially) different patience β^e
  - (potentially) different income process $\pi^{e,i}(s' \mid s, h)$
  - (potentially) maybe different health technologies $\Gamma^{e,i}$
- Health stock $h \in H$ evolves stochastically $\Gamma^{e,i}(h'|h, x, y)$
  - different survival probability $\gamma^i(h)$
  - different income process $\pi^{e,i}(s' \mid s, h)$
  - different value of medical expenditure $\varepsilon^i(h)$
  - different value of non-medical expenditure $\chi^i(h)$

Preferences

Within period utility function:

$$u^i(h,c,x,y) = \chi^i(h)\,\frac{c^{1-\sigma_c}}{1-\sigma_c} - \nu_0\, y^{\nu_1} - \frac{\varepsilon^i(h)}{x^{\sigma_x}} \qquad \sigma_c, \sigma_x, \nu_0, \nu_1 > 0$$

- $\chi^i(h)$ regulates the health-dependence of u_c
  - It is the object of interest.
- We choose not to make ν_0 health-dependent: we think of y as preventive health-behavior
- $\varepsilon^i(h)$ regulates the health-dependence of u_x
  - In the main exercise we will ignore this part.
  - But extension: $\varepsilon^i(h)$ stochastic to address the role of medical expenditure uncertainty in consumption growth.

The Optimization Problem

- The Bellman equation:

$$v^{e,i}(a,h,s) = \max_{c,x,y} \Big\{ u^i(h,c,x,y) + \beta^e\, \psi^i(h) \sum_{s',h'} \Gamma^i(h' \mid h,x,y)\, \pi^{e,i}(s' \mid s,h)\ \mathbb{E}_{\varepsilon'|h'} v^{e,i+1}(a',h',s') \Big\}$$

s.t. $\quad c + x + a' = a\,(1+r)\, + s$

- The model can be solved to deliver decision rules

$$c^{e,i}(a,h,s), \quad x^{e,i}(a,h,s), \quad y^{e,i}(a,h,s)$$

The FOC

- Consumption Euler equation,

$$\chi^i(h)\, c^{-\sigma_c} = \beta^e \psi^i(h)\,(1+r) \sum_{s',h'} \Gamma^i(h' \mid h,x,y)\, \pi^{e,i}(s' \mid s,h)\, \chi^{i+1}(h')\,(c')^{-\sigma_c}$$

- Optimal health expenditure

$$\chi^i(h)\, c^{-\sigma_c} = \beta^e\, \psi^i(h) \sum_{s',h'} \Gamma^i_x(h' \mid h,x,y)\, \pi^{e,i}(s' \mid s,h)\;\; v^{e,i+1}(s',h',a') - \varepsilon^i(h)\; - \sigma_x x^{-\sigma_x - 1}$$

in extension

- Optimal health behavior

$$u_y = \beta^e\, \psi^i(h) \sum_{s',h'} \Gamma^i_y(h' \mid h,x,y)\, \pi^{e,i}(s' \mid s,h)\;\; v^{e,i+1}(s',h',a')$$

Problem: Estimating the Law of Motion for Health

Need to measure *effects of health investments* on health evolution

$$\Gamma^i(h' \mid h, x, y) \quad \text{and} \quad \Gamma^i_x(h'|h, x, y) \quad \text{and} \quad \Gamma^i_y(h'|h, x, y)$$

- Very hard to measure directly due to endogeneity bias (typically one finds $\Gamma^i_x < 0$ and $\Gamma^i_y < 0$)
- In addition, a substantial part of x is not strictly health care

Our Solution

1) Use only the Euler equation of consumption
   - No need to solve the full dynamic problem
   - No need to measure $\Gamma_x^i\left(h'|h,x,y\right)$ and $\Gamma_y^i\left(h'|h,x,y\right)$

2) Replace health investments by their optimal policies
   - Take the law of motion for health

$$\Gamma^i(h' \mid h, x, y)$$

   - replace the x and y by their optimal policies

$$x^{e,i}\left(a,h,s\right) \quad \text{and} \quad y^{e,i}\left(a,h,s\right)$$

   - Then, the law of motion of health is function of the state variables:

$$\Gamma^{e,i}\left(h' \mid a,h,s\right)$$

   which is easy to estimate

Consumption growth and information about $\chi(h)$

$$\beta^e \, \psi^i(h) \, (1+r) \sum_{h'} \Gamma^{e,i}(h' \mid h, a) \, \frac{\chi^{i+1}(h')}{\chi^i(h)} \left(\frac{c^{e,i+1}(h', a')}{c^{e,i}(h, a)} \right)^{-\sigma} = 1$$

1/ If health was constant ($\Gamma^{e,i}$ diagonal), *higher consumption growth for high health* due to $\psi^i(h)$

2/ With changing health

- Changes in health affect consumption growth through $\chi^{i+1}(h')/\chi^i(h)$
- If health and consumption are complements ($\chi(h_g) > \chi(h_b)$)

  Consumption growth higher for low health
- If health and consumption are substitutes ($\chi(h_g) < \chi(h_b)$)

  Consumption growth higher for high health

3/ If health expenditure uncertainty differs across health types, a further reason for consumption growth differences

The model moment conditions

- For each agent of type (e, i, a, h):
  - The realised value of the Euler eqn. depends on the shock h'

$$f\left(e,i,a,h;h'\right) = \beta^{e}\left(1+r\right)\frac{\chi\left(h'\right)}{\chi\left(h\right)}\left(\frac{c^{e,i+1}\left(h',a^{e,i+1}\left(h,a\right)\right)}{c^{e,i}\left(h,a\right)}\right)^{-\sigma} - 1$$

  - So we can rewrite the Euler equation in expectation as:

$$\mathbb{E}_{h'|e,i,a,h}\left[f\left(e,i,a,h;h',\right)\right] = \psi^{i}(h)\sum_{h'}\Gamma^{e,i}\left(h' \mid h,a\right)f\left(e,i,a,h;h'\right) = 0$$

  - Which give one moment condition for every type

The Empirical Analog

- We have a discretized state space $\Omega \equiv E \times I \times A \times H$

  (Ω is a discrete set with M elements indexed by m)

- For each individual j we observe
  - current state $\omega_j \in \Omega$
  - realized shocks tomorrow h'_j
  - consumption chosen tomorrow

- Hence, the empirical analog of our orthogonality conditions requires to compute the average consumption growth for each type ω_j, h'_j

The Empirical Analog

- In particular:
  - For each individual type ω_j, h'_j,

$$\tilde{f}\left(\omega_j, h'_j; \theta\right) = \beta^{e_j}\ (1+r)\ \frac{\chi\left(h'_j\right)}{\chi\left(h_j\right)} \sum \mathbf{1}_{\omega_j, h'_j} \left(\frac{c'_j}{c_j}\right)^{-\sigma} - 1$$

  - Hence, the empiricial moment condition for every type $\omega_m \in \Omega$ is

$$\tilde{g}_m\left(\text{data}; \theta\right) = \sum_j \mathbf{1}_{(\omega_j = \omega_m)} \psi^{i_j}\left(h_j\right) \sum_{h_l \in H} \mathbf{1}_{(h'_j = h_l)} \Gamma^{e_j, i_j}\left(h'_j | h_j, a_j\right)\ \tilde{f}\left(\omega_j, h'_j; \theta\right)$$

- Minimize the weighted quadratic loss function

$$\tilde{Q}_J(\text{data}; \theta) = \frac{1}{2} \tilde{g}\left(\text{data}; \theta\right)' W \tilde{g}\left(\text{data}; \theta\right)$$

Data

- PSID 1999-2013
- Why: it has good data on
  a) non-durable consumption and services
  b) oop med expenditures *(drugs, doctors, hospital, nursing homes, insurance)*
  c) Wealth *(household total net worth)* and health *(self-rated)*
- Use HRS estimates of
  - Survival probabilities, $\psi^i(h)$
  - Health transitions, $\Gamma^{e,i}(h' \mid h, a)$

  Pijoan-Mas, Rios-Rull (2014)

Preliminary Estimations

- Sample selection:
  - Households aged 65-85 $\rightarrow$ No need to deal with earnings uncertainty
  - Headed by males
  - We lump together married and non-married
- (equivalized) consumption growth observations: 2,809
- Moment conditions
  - age group i (4) $\in$\{65-69, 70-74, 75-79, 80+\}
  - education e (3) $\in \{c, h, d\}$
  - health h (2) $\in$ \{good, bad\}
  - wealth a (5) : wealth quintiles

  ▷ 120 (= 4 $\times$ 3 $\times$ 2 $\times$ 5) moment conditions

Preliminary Estimations

- We pose a simple parametric structure for the age-dependence of the health modifier

$$\chi^i(h) = \chi_a(h) + \chi_b(h) \times i$$

  where
  - $\chi_a(h)$: health modifier by health status at age 50
  - $\chi_b(h)$: change of health modifier with age

- We pose two identifying restrictions
  - $\chi_a(h_g) = 1$
  - $\chi_b(h_g) = 0$

- Hence, we have a maximum of 6 parameters to identify
  - $\chi_a(h_g)$, $\chi_a(h_g)$
  - β_c, β_h, β_d
  - σ_c

Results – Men, 65+ only, time-varying χ

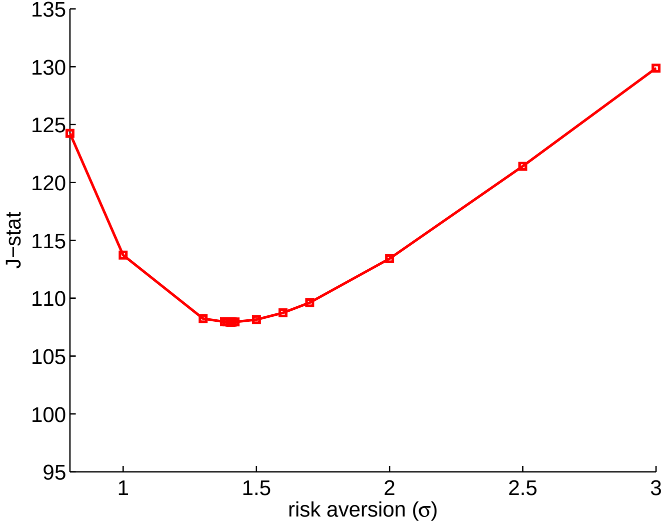
- common β

Results across different σ, (with $r = 2\%$, Consumption (ndc_s1_v1))

	$\sigma = 0.8$		$\sigma = 1$		$\sigma = 1.5$	
β	0.9953	(.0037)	0.9832	(.0045)	0.9455	(.0064)
$\chi_a(b)$	0.7816	(.0402)	0.7869	(.0491)	0.7854	(.0733)
$\chi_b(b)$	0.0024	(.0044)	0.0023	(.0053)	0.0038	(.0076)
J stat (*p*-value)	124.25	(.2211)	113.72	(.4632)	108.15	(.6115)
	$\sigma = 2$		$\sigma = 2.5$		$\sigma = 3$	
β	0.8989	(.0084)	0.8447	(.0102)	0.8447	(.0116)
$\chi_a(b)$	0.7776	(.1007)	0.7694	(.1314)	0.7694	(.1674)
$\chi_b(b)$	0.0063	(.0100)	0.0094	(.0124)	0.0094	(.0150)
J stat (*p*-value)	113.42	(.4712)	121.41	(.2776)	129.88	(.1324)

Picking the right σ

- Men, 65+ only, χ age dependent



Results – Men, 65+ only, time-varying χ

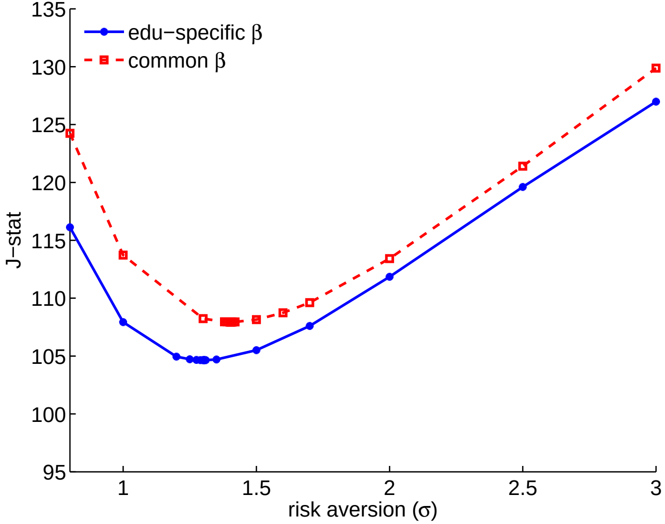
- education-specific β

Results across different σ, (with $r = 2\%$, Consumption (ndc_s1_v1))

	$\sigma = 0.8$		$\sigma = 1$		$\sigma = 1.5$	
β^d	1.0143	(.0078)	1.0023	(.0094)	0.9642	(.0133)
β^h	0.9940	(.0050)	0.9815	(.0061)	0.9416	(.0089)
β^c	0.9859	(.0057)	0.9743	(.0071)	0.9396	(.0108)
$\chi_a(b)$	0.7918	(.0407)	0.7979	(.0499)	0.7992	(.0747)
$\chi_b(b)$	0.0006	(.0044)	0.0004	(.0053)	0.0018	(.0076)
J stat (*p*-value)	116.13	(.3507)	107.93	(.5647)	105.50	(.6294)
	$\sigma = 2$		$\sigma = 2.5$		$\sigma = 3$	
β^d	0.9173	(.0166)	0.8639	(.0194)	0.8056	(.0216)
β^h	0.8910	(.0116)	0.8321	(.0141)	0.7672	(.0161)
β^c	0.8988	(.0147)	0.8537	(.0186)	0.8053	(.0221)
$\chi_a(b)$	0.7921	(.1021)	0.7835	(.1324)	0.7846	(.1674)
$\chi_b(b)$	0.0044	(.0100)	0.0079	(.0124)	0.0114	(.0150)
J stat (*p*-value)	111.84	(.4597)	119.61	(.2716)	126.98	(.1425)

Picking the right σ

- Men, 65+ only, χ age dependent



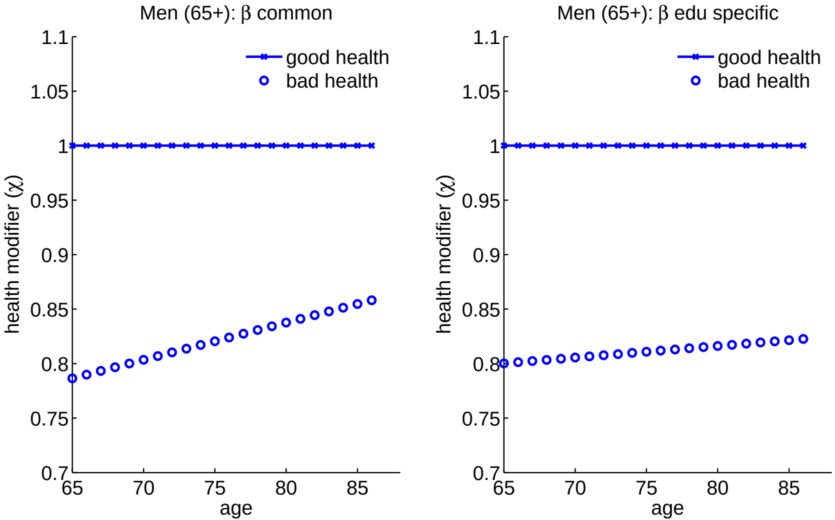
with the right σ (Men, 65+ only)

Results, (with $r = 2\%$, Consumption (ndc_s1_v1))

	β common		β edu specific	
	σ=1.405		σ=1.303	
β^d	0.9534	–	0.9804	(0.0118)
β^h	0.9534	(0.0060)	0.9587	(0.0078)
β^c	0.9534	–	0.9542	(0.0093)
$\chi_a(g)$ (good)	1.	–	1.	–
$\chi_a(b)$ (bad)	0.7864	(0.0685)	0.8002	(0.0646)
$\chi_b(g)$ (good)	0.	–	0.	–
$\chi_b(b)$ (bad)	0.0034	(0.0072)	0.0011	(0.0067)
J stat (p-value)	107.94	(0.6168)	104.65	(0.6517)

Health modifier across age

- Men, 65+ only



Uncertainty in health expenditure (Extension)

- Consumption growth differences between health types can be different because they face different uncertainty in health expenditures
- Two different strategies to account for this possibility:
  1/ $\varepsilon^i(h)$ is zero and x is stochastic and dependent on e, i, a, h.
  2/ $\varepsilon^i(h)$ is stochastic, independent of $e, a \rightarrow$ endogeneous choices make x to be related to a, and e.
- We extend the estimation strategy and distinguish the average consumption growth for individuals $(e, i, a, h; h)$ that differ in ε'
- We consider two equal probability levels for ε': high and low
- We identify an individual's ε' differently depending on the model:
  1/ Whether x' is above or below the median conditional on $(e, i, a, h; h')$
  2/ Whether x'/c' is above or below the median conditional on $(e, i, a, h; h')$

Results – Men, 65+ only, time-varying χ

- common β

Results across different σ, (with $r = 2\%$, σ=1.405, Consumption (ndc_s1_v1))

	No exp shock		xp shock		ratio shock	
β	0.9534	(.0060)	0.9554	(.0060)	0.9558	(.0061)
$\chi_a(b)$	0.7864	(.0685)	0.8272	(.0699)	0.8426	(.0725)
$\chi_b(b)$	0.0034	(.0072)	-0.0010	(.0072)	-0.0018	(.0072)
J stat (p-value)	104.65	(0.6517)	110.33	(.5536)	114.74	(.4366)

Consumption Composition

Idea

- We use the PSID waves of 2005, 2007, 2009, 2011
  - Richer data on consumption items than years 1999+

    It aggregates to 70% of NIPA, better than CEX, Attanasio, Pistaferri (2013)

- We build three consumption series
  - c, non-durable consumption and services
  - c_s, consumption expenditures that substitutes healthy time

    (*food home, food delivered, household repairs, bus, taxis, other transport*)
  - c_c, consumption expenditures that complement healthy time

    (*food out, trips, recreation*)

- Explore effects of health at different ages on the budget shares
  - c_s/c
  - c_c/c

Consumption Composition

Results

	c_s/c (%) Estimates	S.E.	c_c/c (%) Estimates	S.E.
$50 \leq age \leq 59$	31.3	(0.67)	11.6	(0.56)
$60 \leq age \leq 69$	33.8	(0.81)	12.3	(0.68)
$70 \leq age \leq 85$	34.7	(0.77)	12.6	(0.65)
$(50 \leq age \leq 59) \times h_{good}$	-0.10	(0.67)	2.63	(0.56)
$(60 \leq age \leq 69) \times h_{good}$	-1.58	(0.81)	2.81	(0.68)
$(70 \leq age \leq 85) \times h_{good}$	-1.99	(0.78)	4.59	(0.65)
$(50 \leq age \leq 59) \times h_{exc}, h_{vg}$	-1.39	(0.67)	4.56	(0.56)
$(60 \leq age \leq 69) \times h_{exc}, h_{vg}$	-3.73	(0.89)	5.83	(0.75)
$(70 \leq age \leq 85) \times h_{exc}, h_{vg}$	-3.60	(0.98)	6.20	(0.82)
working	-2.11	(0.46)	0.86	(0.39)
married	-2.26	(0.44)	-1.80	(0.37)
college	-1.29	(0.39)	5.54	(0.33)
wealth (milion $)	-0.06	(0.17)	0.92	(0.15)

Note: Missing category: h_{fair}, h_{poor}; Number obs: 6,103

Consumption Composition

Summary

- Individuals in good health
  - Spend more in goods that complement healthy time
  - Spend less in goods that substitute for healthy time
  - The difference is bigger for older groups
  - ▷ The difference between good and bad health implies different things at different ages

Conclusion

- We use consumption Euler equations to estimate the effect of health on the marginal utility of consumption
- We find that
  1. At age 65, better health gives higher marginal utility of consumption
     - You need healthy time to enjoy life
  2. At later ages, the difference narrows down: lower health gives higher marginal utility of consumption
     - Consumption expenditure substitutes for healthy time
  3. Health differences imply differences in consumption patterns that are different at different ages