The Lifetime Costs of Bad Health

Mariacristina De Nardi
UCL, Federal Reserve Bank of Chicago, and NBER

Svetlana Pashchenko
University of Georgia

Ponpoje Porapakkarm (Poe)
National Graduate Institute for Policy Studies (GRIPS)

Facing Demographic Change in
a Challenging Economic Environment

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Why bad health is bad?

#**A**. People in bad health

i. Work less + Earn less if working

ii. Face higher medical expenses

iii. Have lower life expectancy

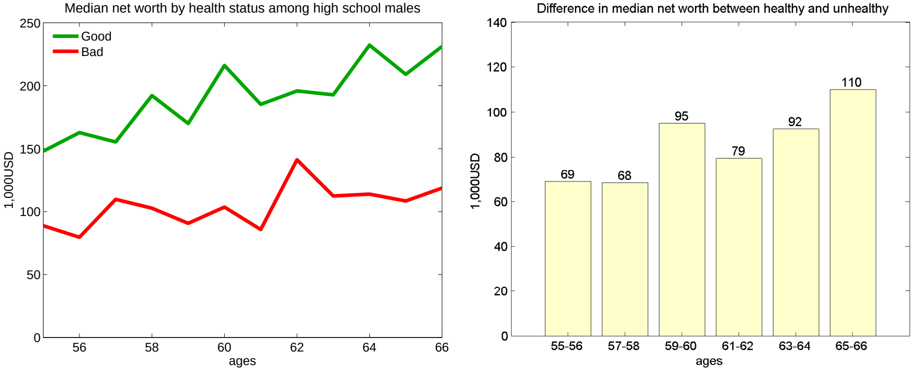
#**B**. Over the life cycle, the *accumulated* effects of bad health

- Depend on how long the sickness lasts
- Can be substantial when health is persistent and markets are incomplete

#**A** is well documented and studied while #**B** is still not

Is the *accumulated* effect important?

Wealth-health gradient among high school men (HRS: 1994-2012)



- good health $\in$ {*excellent*, *very good*, *good*}; bad health $\in$ {*fair*, *poor*}

- net worth: controlled for year effects and family sizes

▶ The difference is large even among a relatively homogeneous group

wealth change

Our stand on health and economic outcomes

How do economists think about health and economic outcomes?

Ch.1 Health is *exogenous*: health ⇒ economic outcomes

Ch.2 Health is *endogenous*: economic outcomes ⇒ health

Ch.3 People differ in *characteristics/factors affecting both their health and economic outcomes*
(eg. childhood development can affect both health outcomes and economic behaviors in adulthood)

This paper

⇒ focus on Ch.1 and 3

⇒ quantify effects of health uncertainty under incomplete markets

What we do? The big picture

1^{st} Part : Why is health status persistent?

- Document long-term dynamics of health status in the data
- Estimate a parsimonious health shock process that is consistent with the empirical facts (both cross-sectional and dynamic aspects)
- Identify two different sources of health persistence
  i. *Duration-dependence: the longer an unhealthy spell, the lower the chance of recovering*
  ii. *Fixed health type: people are different, eg. lifestyle, genes*

What we do? The big picture (cont.)

2^{nd} **Part**: How does bad health affect individuals over life cycle?

- Estimate a life cycle model augmented with the health shock that captures
  1. Effects of bad health on life expectancy and medical spending
  2. Income-health gradient
  3. wealth-health gradient
- And answer the following questions
  - i. How much is the monetary loss due to bad health over life cycle?
  - ii. Why being in good health is valuable?
  - iii. How much does health uncertainty contribute to lifetime inequality?

Data

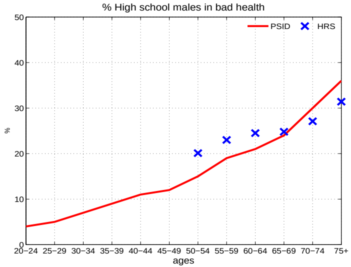
1. Health and Retirement Study (HRS: 1994-2012)
2. Panel Study of Income Dynamics (PSID)
   - Annual data (1984-1997); bi-annual (1997-2012)
3. Medical Expenditure Panel Survel (MEPS: 1999-2011)

Outline of the presentation

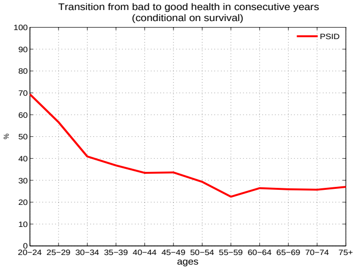
- Health process estimation
- Life-cycle model
- Model estimation *(MSM)*
- Results

Health status data (PSID)

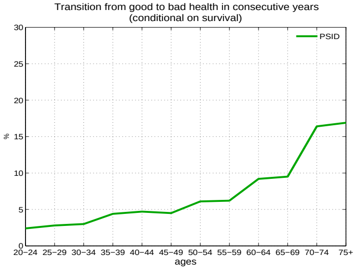
Panel A: % unhealthy people by ages



Panel B1: % transition *bad* → *good*



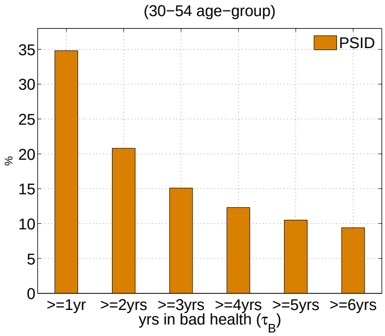
Panel B2: % transition *good* → *bad*



Dynamics of health status data (PSID)

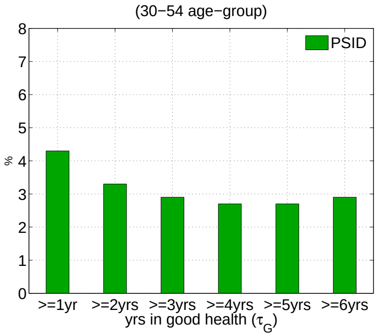
Duration-dependent profile by health status (30-54 years old)

Panel C1: % Transition from bad to good health



Long duration-dependence

Panel C2: % Transition from good to bad health



Not much duration-dependence

sample No DI

Health shock process

Conditional on surviving to the next period,

- Probability to be *healthy* if unhealthy for τ_B yrs: $\pi_i^{\overrightarrow{BG}}(\tau_B|age)$

$$logit\left(\pi_i^{\overrightarrow{BG}}(\tau_B|age)\right) = \underbrace{\left(a_1^B \mathbf{1}_{\{\tau_B=1\}} + a_2^B \mathbf{1}_{\{\tau_B\geq 2\}}\right)}_{\text{duration dependence}} + \left(b_1^B age + b_2^B age^2\right) + \underbrace{\eta_i}_{\text{health type}}$$

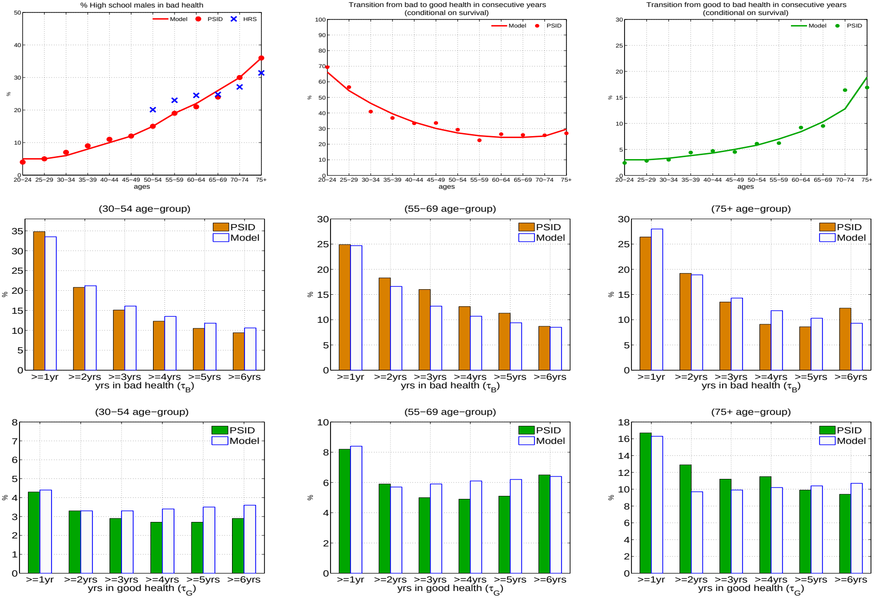
- Probability to be *unhealthy* if healthy for τ_G yrs: $\pi_i^{\overrightarrow{GB}}(\tau_G|age)$

$$logit\left(\pi_i^{\overrightarrow{GB}}(\tau_G|age)\right) = \left(a_1^G \mathbf{1}_{\{\tau_G=1\}} + a_2^G \mathbf{1}_{\{\tau_G\geq 2\}}\right) + \left(b_1^G age + b_2^G age^2\right) + b_3^G \times \eta_i$$

$\eta_i \sim$ *uniform distribution over 5 points symmetric around zero*

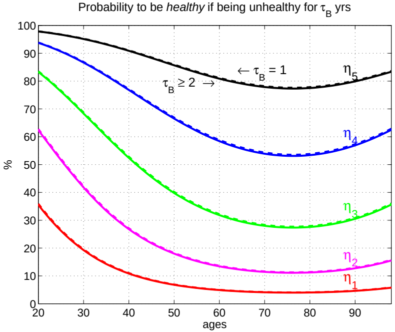
▸ surv prob

Dynamics of health status: model vs PSID



Estimated health shock process

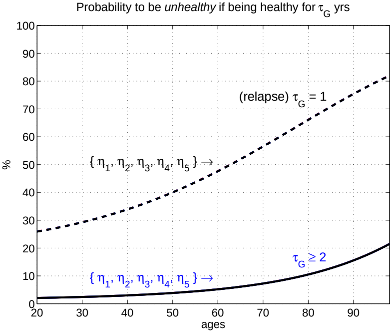
bad⇒good



$$logit\left(\pi_i^{\overrightarrow{BG}}(\tau_B|age)\right) = \underbrace{\left(a_1^B \mathbf{1}_{\{\tau_B=1\}} + a_2^B \mathbf{1}_{\{\tau_B\geq 2\}}\right)}_{a_1^B \approx a_2^B} + \left(b_1^B age + b_2^B age^2\right) + \eta_i$$

→ Most of duration dependence is due to fixed health type

good⇒bad

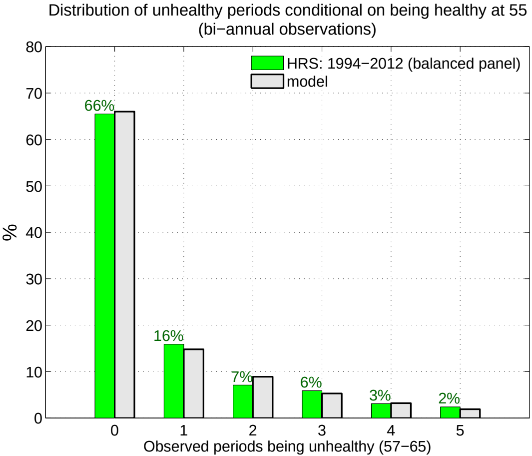


$$logit\left(\pi_i^{\overrightarrow{GB}}(\tau_G|age)\right) = \left(a_1^G \mathbf{1}_{\{\tau_G=1\}} + a_2^G \mathbf{1}_{\{\tau_G\geq 2\}}\right) + \left(b_1^G age + b_2^G age^2\right) + \underbrace{b_3^G}_{\approx 0} \eta_i$$

→ No effect of fixed health type

Distribution of unhealthy periods between 57-65: Model vs HRS

(Additional validation)



HRS: balanced panel of *healthy* individuals at 55 (N=828 individuals)

How should we think about health type?

- *Model:* People with bad health type experience multiple periods being unhealthy
- *HRS:* Characteristics of people by #periods being unhealthy

# unhealthy periods (57-65)	% $\eta_1 + \eta_2$ (model)	% smoking	BMI*	% parent alive		parents' educ (yrs)	
				father	mother	father	mother
0-1	26.9	23.2	27	21.2	49.5	10	12
2-3	39.7	25.9	28	20.2	46.7	9	10
4-5	71.1	43.5	30	15.2	36.9	8	8

Individuals are healthy at 55

* BMI=body mass index (median)

Outline

- Health process estimation
- Life-cycle model
- Model estimation *(MSM)*
- Results

Key mechanisms

- The observed correlation between health and life-cycle outcomes is generated by two mechanisms

1 Causal effects of bad health:

   a. Decreases productivity and increases disutility from work
   b. Increases OOP medical spending
   c. Lowers life expectancy

2 Composition effect:

   - Fixed and heterogenous health types (η_i)
   - Fixed and heterogenous patience (β_i)
   - η_i and β_i can be correlated.

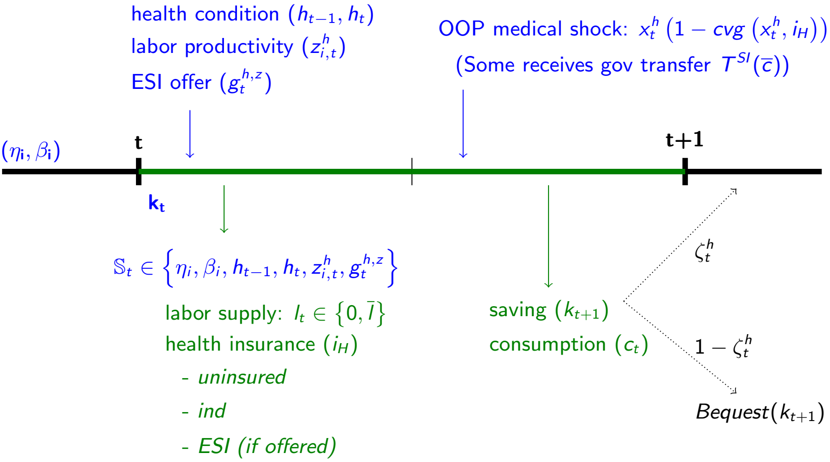
Life-cycle model

- 20-64→work, 65-99→retired
  - health type: $\eta_i \in \{\eta_1, ..., \eta_5\}$ and discount factor: $\beta_i \in \{\beta_{low}, \beta_{high}\}$

    $$0 \leq Pr(\beta_j|\eta_m) \leq 1; j \in \{low, high\}, m \in \{1, 2, ..., 5\}$$

- People face productivity, health, medical expenses, and survival uncertainty
- Retired people receive Social Security benefits and are covered by Medicare

A working-age individual



$$u(c_t, l_t, h_t) = \frac{c_t^{1-\rho}}{1-\rho} - \phi_W \mathbf{1}_{\{l_t>0\}} - \phi_B \mathbf{1}_{\{h_t=B, l_t>0\}} + \bar{\mathbf{b}}$$

▸ HH prob

Outline

- Health process estimation
- Life-cycle model
- Model estimation *(MSM)*
  - wealth profile
  - employment profile + average labor income profile
- Results

Model parameters taken/estimated outside model

Parameters taken/estimated outside model

parameters		sources
Survival probability by health:	ζ_t^h	HRS (extrapolation from 20 to 50)
Health transition probability:	$\pi_{i,t}^{\overrightarrow{BG}}(\tau_B)$, $\pi_{i,t}^{\overrightarrow{GB}}(\tau_G)$	PSID
Labor productivity shock:	$z_{i,t}^h$	PSID
Health-dependent medical expenses:	x_t^h	MEPS
ESI offer probability (logit) :	$g_t^{h,z}$	MEPS
Insurance coverage:	$cvg(x_t^h, i_H)$	MEPS
Risk aversion:	$\rho = 3.0$	common values $\in [1, 5]$

Stochastic processes estimated outside the model

- Health-dependent labor income process $\left(z_t^h\right)$

$$z_{i,t}^{h} = \lambda_t^{h} + \gamma_i + y_{i,t}$$
$$y_{i,t} = \rho_y y_{i,t-1} + \varepsilon_{i,t}; \quad \varepsilon_{i,t} \sim iid\ N\left(0, \sigma_\varepsilon^2\right)$$

  - From PSID: $\rho_y = 0.9275,\ \sigma_\varepsilon^2 = 0.0209,\ \sigma_\gamma^2 = 0.042$
  - λ_t^h is used to match average labor income among healthy and unhealthy workers

Parameters estimated inside model

parameters	value					targets
$\{\beta_{low}, \beta_{high}\}$	$\{0.904, 0.995\}$					"
$Pr(\beta_{low}\|\eta_i)$	η_1	η_2	η_3	η_4	η_5	net wealth profiles by health (PSID)
	0.89	0.81	0.66	0.36	0.12	
consumption floor: $\overline{c}$	\$3,593 (or \$5,484 in 2010)					"
value of life: $\overline{\mathbf{b}}$	$\frac{\overline{c}^{1-\rho}}{1-\rho}$					positive utility flow

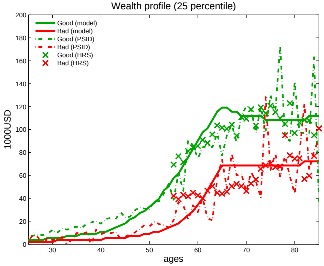
* η_1 *has the lowest probability to recover*

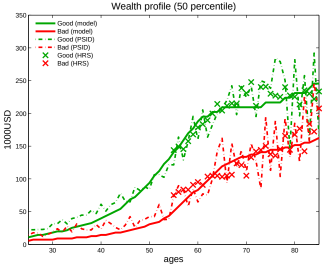
- Compensation for adding 1 death among 10,000 adults: 6.0*M USD*

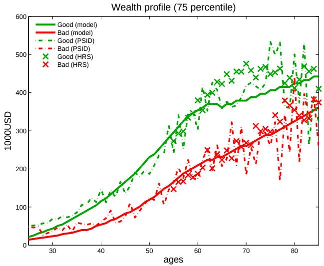
  (Empirical *Value of Statistical Life = 2-9M USD*)

Targeted moments: model vs PSID

- Wealth profiles by health status







model fit

Results

R0. The importance of compositional difference between the heathy and unhealthy

R1. The monetary cost of bad health during the working period

R2. The value of being in good health

R3. The contribution of health to lifetime inequality

R0. The importance of compositional difference

Wealth difference between healthy and unhealthy people at ages 60-64.

Wealth difference by health	PSID	Baseline	No (β_{low}, η_i) correlation
25^{th} pct	41,225	54,157	**32,497**
50^{th} pct	97,142	101,094	**39,715**
75^{th} pct	156,824	146,225	**70,404**

R0. - No correlation between types and patience misses health-wealth gradient

- Income-health gradient does not imply wealth-health gradient

details

R1. The monetary cost of bad health

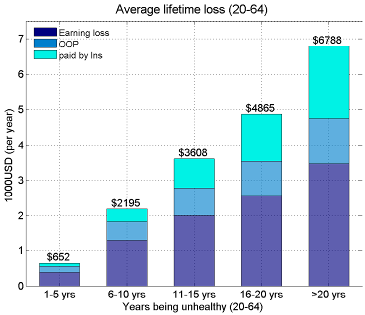
Exp#1:

- Everyone always draws good health
- Consider those surviving to age 64 in baseline
- Monetary costs_{it} of bad health =

$$\textit{earnings loss}_{it} + \textit{medical costs}_{it} \quad \textit{(during 20 to 64)}$$

R1. The monetary cost of bad health

- Average loss (per year) over 20-64

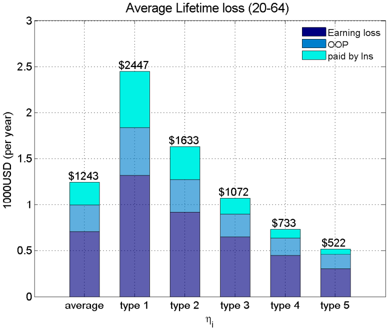


avg labor income=$36,105

- Increases steeply with the number of unhealthy years
- Health insurance covers a non-trivial portion of the cost
- Earning loss is much larger than OOP medical loss

R1. The monetary cost of bad health

- Average loss (per year) over 20-64



avg labor income=$36,105

- Varies a lot by health type

R1. The monetary loss due to bad health

- Distribution of lifetime cost of bad health

	% of total		
	top 5%	top 10%	top 20%
earning loss + total medical loss	28%	46 %	71%
earning loss + OOP loss	27%	45 %	72%

- Highly concentrated

R2. The value of being in good health (20-64)

Exp#2:

- Increase the probability of being in good health by 1% from period t to $t+1$
- Calculate willingness to pay to move from the baseline to the experiment above (among people aged 20-64)

R2. The value of being in good health (20-64)

- Sources of the gains
  1. Allow one channel through which health affects individuals
  2. Recompute the remaining gain

	$\eta_1 - \eta_5$	η_1	η_3	η_5
Baseline economy	\$3,828	\$5,113	\$3,506	\$3,026
(% of avg labor inc)	*(10.6%)*	*(14.1%)*	*(9.7%)*	*(8.4%)*
Dollar value when only one channel exists				
- Survival channel	86%	81%	86%	93%
- Labor market channel	18%	26%	16%	9%
- Medical expenses channel	2%	3%	2%	1%

% is a fraction of willingness to pay in the baseline

- Survival channel contributes most to the value of being healthy

by assets

R3. Lifetime inequality due to health

- Everyone always draws good health till death

Case 1. Fix age of death as in Baseline $\Rightarrow$ exclude survival channel

Case 2. Allow age of death to increase $\Rightarrow$ include survival channel

- Define *Lifetime utility*

$$U_i = \sum_{t=20}^{\text{age of death}+1} \beta_i^{t-20}\Big(u(c_t, l_t, h_t)\times\mathbf{1}_{alive_t} + Beq_t \times (1-\mathbf{1}_{alive_t})\Big)$$

- Variation of U_i due to health $= \left(1 - \frac{V(\hat{U}_i)}{V(U_i^B)}\right) \times 100\%$

$$\begin{aligned} \hat{U}_i &= \text{lifetime utility from } R3 \\ U_i^B &= \text{lifetime utility from Baseline} \end{aligned}$$

R3. Lifetime inequality due to health

Case 1. Exclude survival channels (fixing age of death as in Baseline)

Variation of lifetime utility due to health

	β_{low}	β_{high}
all η_i	7.35%	0.22%
$\Rightarrow \{\eta_1, \eta_2\}$	9.5%	0.7%
$\Rightarrow \{\eta_3, \eta_4, \eta_5\}$	2.6%	0.0%

* *η_1, η_2 have lower probability to recover*

Case 2. Include survival channels (allowing age of death to increase)

Variation of lifetime utility due to health

	β_{low}	β_{high}
all η_i	42.5%	12.8%
$\Rightarrow \{\eta_1, \eta_2\}$	47.5%	20.2%
$\Rightarrow \{\eta_3, \eta_4, \eta_5\}$	33.3%	9.9%

- Health affects lifetime ineq. mostly through survival channel
- Health affects lifetime ineq. more among those with bad health type (η_1, η_2)

Conclusions

- We quantify the effects of health in a life-cycle model that matches
  (1) Long-run health dynamics
  (2) Income-health gradient
  (3) Wealth-health gradient
- Health type: important for capture (1)
- Compositional difference btw. the healthy and unhealthy: important for (3)
- Implications
  i. Lifetime costs of bad health are highly concentrated
  ii. The earning losses due to bad health are the largest component of OOP losses
  iii. The most valuable aspect of being healthy is a longer life expectancy
  iv Health affects lifetime inequality mostly through survival ch.