Heterogeneous and Uncertain Health Dynamics and Working Decisions of Older Adults

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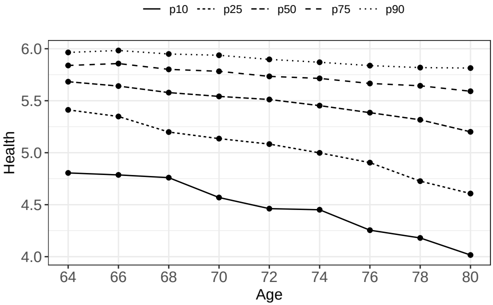
Motivation

- Population aging: number older people out of labor force per worker is rising (OECD, 2019)
    - 42 per 100 workers in 2018
    - 58 per 100 workers in 2050
- Evidence of health effects on older adults' working choices
    - Negative health shocks lead to early retirement (Kerkhofs and Lindeboom, 1997; Bound et al, 1999; Disney et al, 2006; French, 2005)
    - Changes in health affect retirement expectations of workers (McGarry, 2004)
- Mostly ignored: heterogeneity at which health deteriorates with age

Motivation

Heterogeneous health dynamics

Figure: Health percentiles with age from the Health and Retirement Study



- In my model, I find some of this variation is individidual heterogeneity in health profiles

Research questions

- Goals:
  1. To document heterogeneity of health profiles with age
  2. To measure individuals' information about their own health profiles
  3. To study its effects on working decisions of older adults
  4. To measure the effect of information from blood-base biomarkers

Data

- Health and Retirement Study (HRS)
  - Longitudinal data, collected every 2 years, running since 1992
  - Representative of individuals 50 years and older in the US
  - Includes measures of health, survival expectations, labor supply
- This analysis uses 9 waves, 1998-2014
- Construct health h_{it} by Confirmatory Factor Analysis using 11 measures
  - Better health is characterized by larger values of h_{it}
  - A decrease of 1 unit in h_{it} corresponds to one extra chronic condition

measures

Step 1: heterogeneous health dynamics

Empirical strategy

- Estimate dynamic model for health with heterogeneous levels and slopes

$$h_{it} = \rho h_{it-1} + \alpha_i + \delta_i \cdot t + \epsilon_{it}, \quad t \text{ denotes age, } \epsilon_{it} \sim N$$

Step 1: heterogeneous health dynamics

Empirical strategy

- Estimate dynamic model for health with heterogeneous levels and slopes

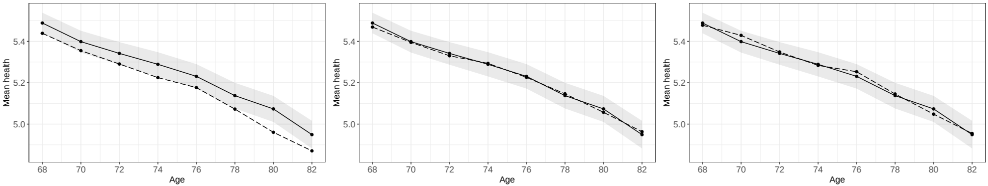
$$h_{it} = \rho h_{it-1} + \alpha_i + \delta_i \cdot t + \epsilon_{it}, \quad t \text{ denotes age}, \epsilon_{it} \sim N$$

  - Heterogeneity (α_i, δ_i) normally distributed conditional on h_{i0} (at age 50)
  - Health shocks ϵ_{it} iid normally distributed
  - Includes other strictly exogenous regressors
  - Survival equation to control for selection $S(h_{it-1})$
  - Random coefficient model estimated by MLE

Step 1: heterogeneous health dynamics

Fit under different assumptions

Figure: Mean of health with age
(solid lines: data; dotted lines: predicted values)



(a) Heterogeneous slopes without survival equation

(b) Heterogeneous slopes and survival equation

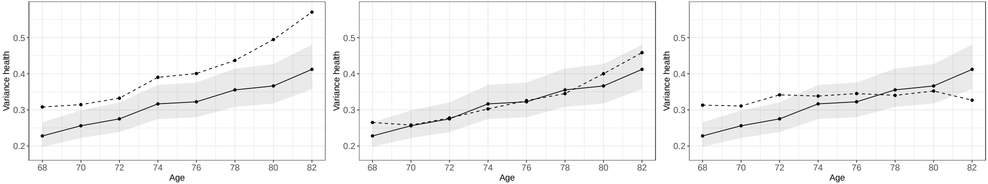
(c) Homogeneous slopes and survival equation

MLE results

Step 1: heterogeneous health dynamics

Fit under different assumptions

Figure: Variance of health with age
(solid lines: data; dotted lines: predicted values)



(a) Heterogeneous slopes without survival equation

(b) Heterogeneous slopes and survival equation

(c) Homogeneous slopes and survival equation

Step 2: uncertainty about own health dynamics with age

Model

- Unknown slope δ_i and unobserved and time-varying beliefs
- To study those beliefs, we add structure to the beliefs process

Step 2: uncertainty about own health dynamics with age

Model

- Unknown slope δ_i and unobserved and time-varying beliefs

- To study those beliefs, we add structure to the beliefs process

- Bayesian learning model for unknown slope δ_i
  - Initial beliefs $N(\hat{\delta}_{i0}, \hat{\sigma}_0^2)$ (at $t = 0$),
    - Initial bias $b = \mathbb{E}(\hat{\delta}_{i0} - \delta_i)$
    - Initial uncertainty $\lambda = \frac{\hat{\sigma}_0}{\sigma_\delta}$
  - Health h_{it} signals δ_i over time
  - Posterior beliefs $N(\hat{\delta}_{it}, \hat{\sigma}_t^2)$ with recursive updating equations

equations

Step 2: uncertainty about own health dynamics with age

Empirical Strategy

- For identification, use *Subjective Survival Expectations*
  - *What is the percentage chance you will live to be (80, 85, 90, 95 or 100) or more?* $(plive10)$

- From the model, survival expectations depend on beliefs about future health

$$\widehat{plive10}_{it} \quad = \quad f_S(h_{it}, \hat{\delta}_{it}, \hat{\sigma}_t^2, \alpha_i)$$

where beliefs $(\hat{\delta}_{it}, \hat{\sigma}_t^2)$ depend on initial bias b and uncertainty λ

descriptive

Step 2: uncertainty about own health dynamics with age

Results

- Use simulated method of moments to estimate bias b and uncertainty λ
- Allow for non-classical measurement error
- Results:
  - bias $b = -0.061 < 0$ implies **worse** beliefs about future health and **less** expected survival on average
  - $\lambda = 0.338 > 0$ is evidence of incomplete information
  - Large measurement error with mean $\mu_{merror} = 0.121$ and standard deviation $\sigma_{merror} = 0.177$
- Results are robust to rounding

Results Fit

Step 3. Working decisions

Empirical Strategy

- In any model, the working decision rule p_{it} is a function of the information set at that point, Ω_{it-1}.

- When there is heterogeneity in the health process and incomplete information, individuals beliefs $(\hat{\delta}_{it-1}, \hat{\sigma}_{t-1})$ belong to that set.

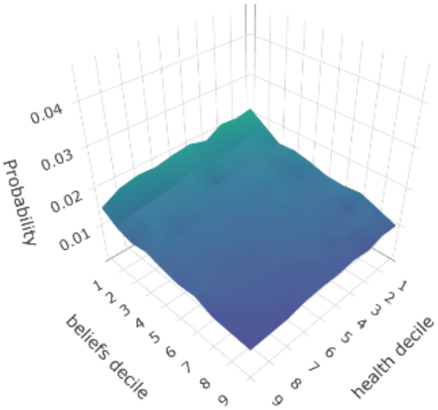
- A probit exercise shows that beliefs $\hat{\delta}_{it-1}$ do matter
  - Larger $\hat{\delta}_{it-1}$ (better expected health) implies larger probabilities of work
  - However, probit results assume a linear index and could be misspecified

- Instead, want to estimate this probability flexibly
  - Take advantage of neural networks for flexible estimation
  - Beliefs are unobserved to the econometrician
  - To deal with them, use an iterative approach based on EM algorithm

probit

Step 3: working decisions

Working individuals who believe their health will deteriorate more slowly have larger probabilities of working next period

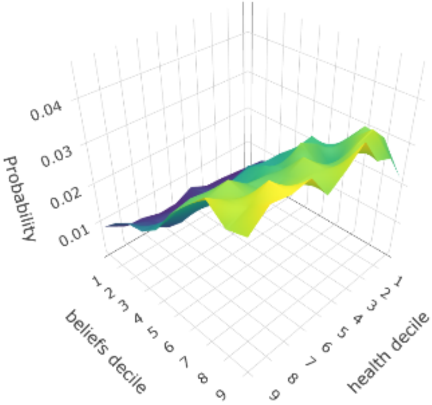


- z-axis is $\mathbb{E}\left(\frac{\partial \mathbb{P}(p_{it}=1)}{\partial \hat{\delta}_{it-1}}\right)$
- x-axis deciles of health h_{it-1}
- y-axis deciles of expected beliefs $\hat{\delta}_{it-1}$
- $age_{it} \in [52, 59]$
- Avg probability 80-90 pp

mg effect of $\hat{\delta}_{it}$ | mg effect of h_{it} | IRF

Step 3: working decisions

Non-linear effects of beliefs for younger older adults who already stopped working



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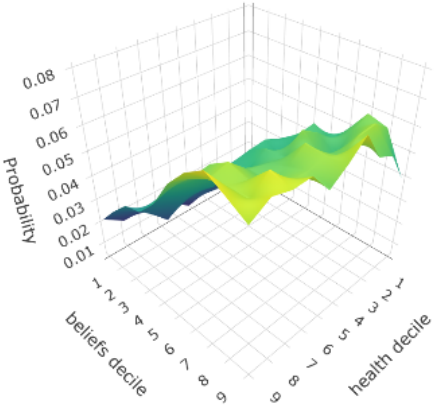
- $age_{it} \in [52, 59]$
- Avg probability 10-30 pp

mg effect of $\hat{\delta}_{it}$ | mg effect of h_{it} | IRF

Step 3: working decisions

Interaction effects for younger older adults not working



- z-axis is $\mathbb{E}\left(\frac{\partial \mathbb{P}(p_{it}=1)}{\partial h_{it-1}}\right)$
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- $age_{it} \in [52, 59]$
- Avg probability 10-30 pp

mg effect of $\hat{\delta}_{it}$ | mg effect of h_{it} | IRF

Step 4: information experiment

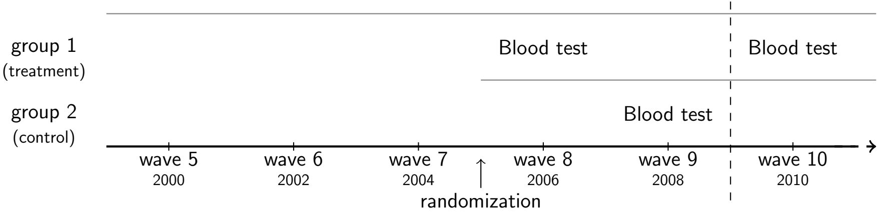
Biomarkers as signals of δ_i

- So far, results show
  - Beliefs matter for working decisions
  - Beliefs are biased
  - Health is a weak signal
- Can we provide information to correct beliefs? And affect working decisions?
- Blood-based biomarkers introduced in 2006
  - Some results are informed back: blood glucose, HDL and total cholesterol
    These results provide *information about health*
  - Info collected and provided to a random half of the sample, every other wave
    Hence, we have *exogenous source of variation*

Step 4: information experiment

Collection of biomarkers

Figure: Timing of the biomarker collection and information experiment



Step 4: information experiment

Collection of biomarkers

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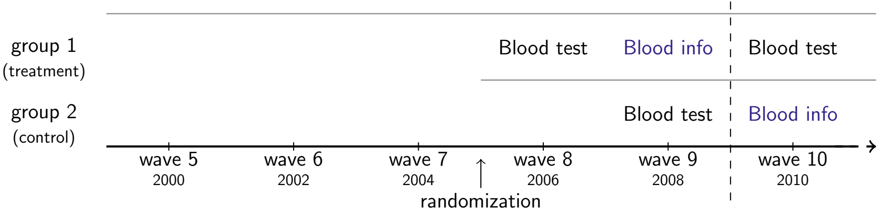

Step 4: information experiment

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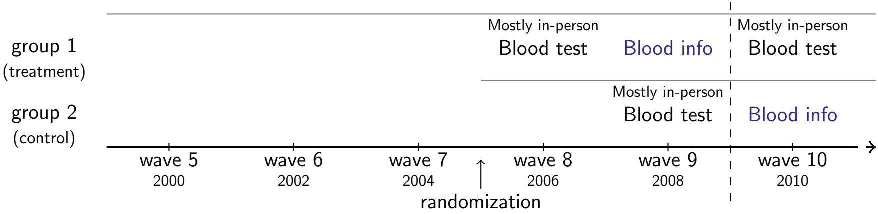

Step 4: information experiment

Collection of biomarkers

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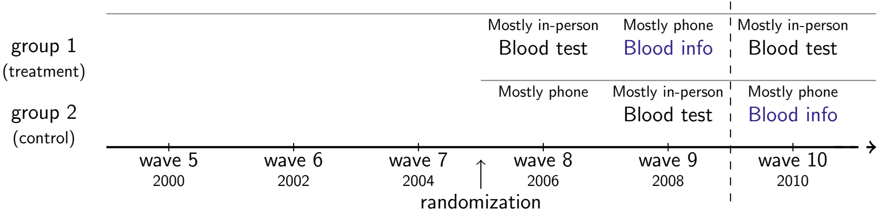

Step 4: information experiment

Collection of biomarkers

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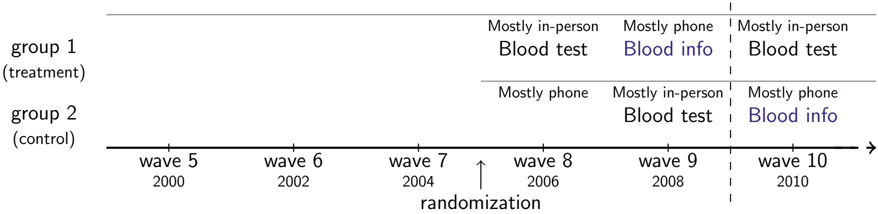

- DD waves 7 and 8: mode collection effects (in-person)
- DD waves 7 and 9: information effect - mode collection effects (in-person)

Step 4: information experiment

Collection of biomarkers

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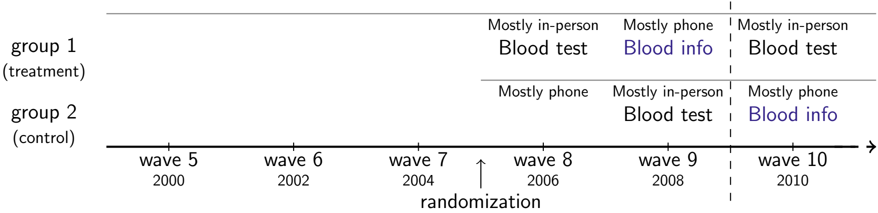

- DD waves 7 and 8: mode collection effects (in-person)
- DD waves 7 and 9: information effect - mode collection effects (in-person)
- Two variables:
  - Survival expectations $plive10$ i.e. effects on beliefs
  - Working decision p i.e. effects on outcomes

Step 4: information experiment

Biomarker results from a data perspective

- Overall results
  - Survival expectations $plive10$: 1.36 pp not significant
  - Working decision p: 0.02 pp not significant
- Larger effects for college graduates
  - Survival expectations $plive10$: 5.12 pp significant at 5%
  - Working decision p: 0.04 pp not significant

DD results DD bad results

Summary

- Evidence of heterogeneity in health dynamics
- Individuals are uncertain and have negatively biased in beliefs about health changes with age
- Expecting a worse health profile is associated with lower probability of work, in particular, for younger adults (50s) not working
- Eliminating initial bias in beliefs would increase participation by more than 2 pp
- Cholesterol and glucose information has small effects on expectations, but no work effects

Thank you!

Appendix

Data and preliminaries

Health measures

- Chronic conditions: high blood pressure, heart attack, diabetes, stroke, lung disease, arthritis, cancer
- Self reported health: excellent, very good, good, fair, poor
- Body mass index
- Eyesight in general, at a distance, and up close: excellent, very good, good, fair, poor and legally blind
- Hearing: excellent, ... poor
- Pain: no pain, mild, moderate and severe pain
- ADLs mobility: walk 1 block, several blocks, across room, climb 1 flight of stairs, several flight of stairs
- ADLs large muscles: push or pull large object, sit for 2 hours, get up from chair, stoop kneel or crouch
- Other ADLs: carry 10 lbs, reach arms

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Data and preliminaries

Confirmatory Factor Analysis results

Measure of health	Intercept	Loading	R-squared
Number of chronic conditions$^{(a)}$	0	1	0.29
Self-assessed health	8.188	-1.027	0.44
Body mass index	37.278	-1.812	0.05
Eyesight in general	5.710	-0.549	0.15
Eyesight at a distance	5.177	-0.502	0.13
Eyesight up close	5.465	-0.523	0.13
Hearing	4.830	-0.424	0.08
Pain	4.792	-0.802	0.36
Difficulties in ADLs regarding mobility	9.398	-1.598	0.64
Difficulties in ADLs of large muscles	8.964	-1.475	0.63
Difficulties in other ADLs	3.812	-0.654	0.50

Note: (a) The first measure corresponds to 7 minus the number of chronic conditions, hence, larger values represent better health. For this variable, the intercept and loading are fixed to 0 and 1, respectively. All other coefficients are significant at 1%.

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Step 1: heterogeneous health dynamics

MLE results on health and survival

	Symbol	Coefficient	Pvalue
Persistence	ρ	0.223	0.000
Mean* of α_i	μ_α	0.955	0.000
Mean* of δ_i	μ_δ	-0.057	0.018
SD of α_i	σ_α	0.235	0.000
SD of δ_i	σ_δ	0.043	0.000
$Corr(\alpha_i, \delta_i)$	ϕ	-0.033	0.714
SD of health shocks	σ_ϵ	0.266	0.000
Survival dependence on health	γ	0.583	0.001
Controls		Yes	
N alive observations		8,901	
N dead observations		112	
N individuals		1,671	
-Log likelihood		3,027.6	

Hence, evidence of slope heterogeneity

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Step 1: heterogeneous health dynamics

MLE results: health equation

back

	Heterogeneous slopes without survival eq		Heterogeneous slopes with survival eq		Homogeneous slopes with survival eq	
	Coefficient (1)	Pvalue (2)	Coefficient (3)	Pvalue (4)	Coefficient (5)	Pvalue (6)
ρ	0.225	0.000	0.223	0.000	0.366	0.000
τ	0.001	0.087	0.001	0.119	0.001	0.108
μ_α	0.968	0.000	0.955	0.000	0.781	0.000
$\nu_{\alpha female}$	-0.029	0.132	-0.029	0.131	-0.024	0.163
$\nu_{\alpha white}$	0.026	0.338	0.027	0.335	0.018	0.458
$\nu_{\alpha hispanic}$	0.004	0.909	0.005	0.889	-0.001	0.973
$\nu_{\alpha less\_HS}$	-0.134	0.000	-0.134	0.000	-0.120	0.000
ω_α	0.599	0.000	0.603	0.000	0.492	0.000
μ_δ	-0.060	0.012	-0.057	0.018	-0.051	0.000
$\nu_{\delta female}$	0.006	0.146	0.006	0.136	0.005	0.198
$\nu_{\delta white}$	0.015	0.007	0.015	0.008	0.013	0.011
$\nu_{\delta hispanic}$	0.010	0.196	0.010	0.199	0.006	0.390
$\nu_{\delta less\_HS}$	-0.003	0.677	-0.003	0.624	0.001	0.896
ω_δ	0.000	0.956	0.000	0.962		
σ_α	0.235	0.000	0.235	0.000	0.212	0.000
σ_δ	0.042	0.000	0.043	0.000		
ϕ	-0.030	0.741	-0.033	0.714		
σ_ϵ	0.266	0.000	0.266	0.000	0.285	0.000

Step 1: heterogeneous health dynamics

MLE results: survival equation

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	Heterogeneous slopes without survival eq		Heterogeneous slopes with survival eq		Homogeneous slopes with survival eq	
	Coefficient (1)	Pvalue (2)	Coefficient (3)	Pvalue (4)	Coefficient (5)	Pvalue (6)
γ			0.583	0.001	0.640	0.000
ι_1			-0.277	0.334	-0.422	0.125
ι_2			0.044	0.986		
ι_3			0.029	0.306	0.036	0.287
ι_4			0.241	0.601		
θ_0			0.529	0.326	0.514	0.336
θ_1			-0.178	0.136	-0.193	0.092
$\theta_{2female}$			0.259	0.002	0.255	0.002
θ_{2white}			0.019	0.847	0.029	0.758
$\theta_{2hispanic}$			0.317	0.079	0.311	0.078
θ_{2less_HS}			-0.106	0.305	-0.114	0.267
N alive observations	8,901		8,901		8,901	
N dead observations	0		112		112	
N individuals	1,671		1,671		1,671	
-LL	2,498.6		3,027.6		3,067.6	

Step 2: uncertainty about own health dynamics with age

Bayes' updating equations

Posterior variance

$$\frac{1}{\hat{\sigma}_t^2} = \frac{1}{\hat{\sigma}_{t-1}^2} + \frac{t^2}{\sigma_\epsilon^2}$$

Posterior mean

$$\begin{aligned} \frac{\hat{\delta}_{it}}{\hat{\sigma}_t^2} &= \frac{\hat{\delta}_{it-1}}{\hat{\sigma}_{t-1}^2} + \frac{(h_{it} - \rho h_{it-1} - \alpha_i)t}{\sigma_\epsilon^2} \\ \Leftrightarrow \hat{\delta}_{it} &= \hat{\delta}_{it-1} + K_t(\lambda, \sigma_\epsilon^2) \cdot \hat{\zeta}_{it} \end{aligned}$$

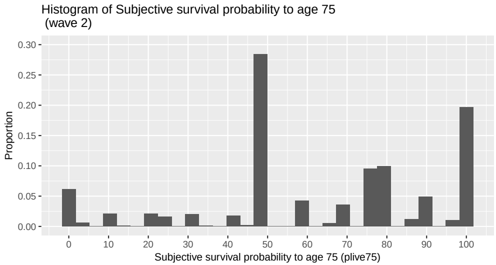
where

- $\hat{\zeta}_{it}$ is the perceived innovation in health, $\hat{\zeta}_{it} \equiv h_{it} - \mathbb{E}(h_{it}|\Omega_{it-1})$
- $K_t(\lambda = 0, \sigma_\epsilon^2) = 0$, $\frac{\partial K_t}{\partial \lambda} > 0$, and $\frac{\partial K_t}{\partial \sigma_\epsilon^2} < 0$

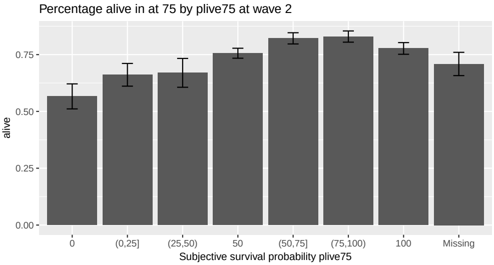
back

Step 2: uncertainty about own health dynamics with age

Subjective survival probabilities in the HRS



(a) Histogram of plive75 (wave 2, $age \leq 65$)



(b) Percentage alive at 75 by plive75 at wave 2

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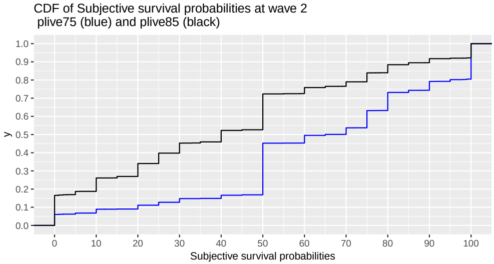
Step 2: uncertainty about own health dynamics with age

Subjective survival probabilities in the HRS (cont.)

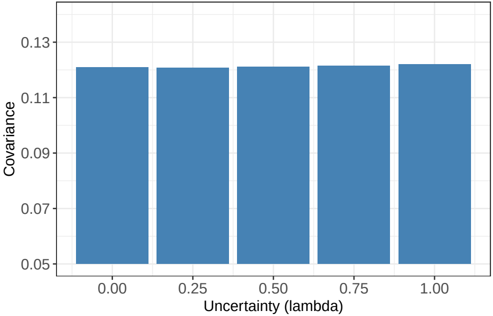


(a) Cumulative distribution of plive75 and plive85 (wave 2, $age \leq 75$)

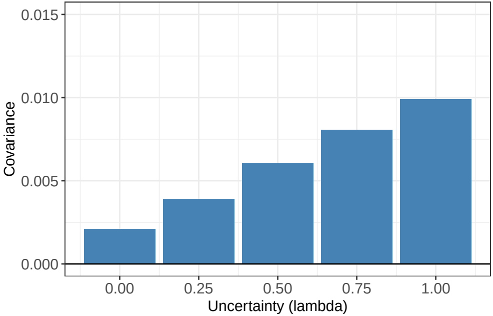
back

Step 2: uncertainty about own health dynamics with age

Simulated covariance moments of Survival Expectations as function of uncertainty λ



(a) $Cov(plive10, h)$



(b) $Cov(\Delta plive10, \Delta h)$

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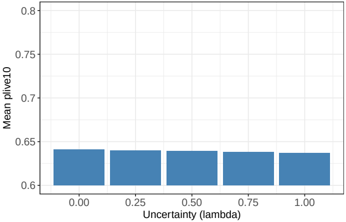
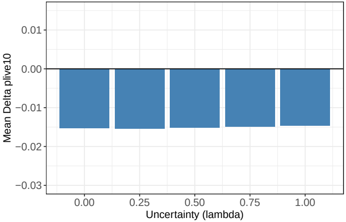
Step 2: uncertainty about own health dynamics with age

Simulated moments of Survival Expectations as function of uncertainty λ

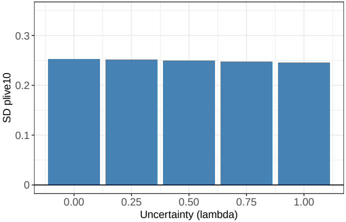
back



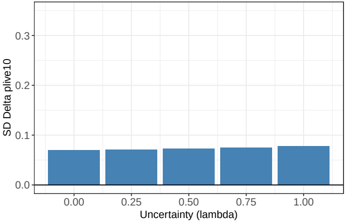
(a) Mean $plive10$



(b) Mean $\Delta plive10$



(c) SD $plive10$



(d) SD $\Delta plive10$

Step 2: uncertainty about own health dynamics with age

Identification with subjective **survival rates**

We could identify λ with panel data on expectations about **survival rates**

$$
\begin{aligned}
bsr_{it} &= \mathbb{P}(S_{it+3} = 1 | S_{it+2} = 1, \Omega_{it}) \\
bsr_{it+1} &= \mathbb{P}(S_{it+3} = 1 | S_{it+2} = 1, \Omega_{it+1})
\end{aligned}
$$

Then,

$$
\Delta_w \Phi^{-1} bsr_{it+1} = \underbrace{\rho(h_{it+1} - \rho h_{it} - \alpha_i - \hat{\delta}_{it}(t+1))}_{\text{due to persistence } \rho} + \underbrace{(t+2)(\hat{\delta}_{it+1} - \hat{\delta}_{it})}_{\text{due to learning } \lambda}
$$

And

$$
\Rightarrow Cov(\Delta_w \Phi^{-1} bsr_{it+1}, \Delta h_{it+1}) = C_t(\lambda) \cdot Var(\Delta h_{it+1})
$$

where $C_t(\lambda)$ is increasing in λ back

Step 2: uncertainty about own health dynamics with age

Results

	Symbol	Coefficient	Lower bound	Upper bound
Bias	b	-0.061	-0.061	-0.060
Uncertainty	λ	0.338	0.336	0.340
Mean of measurement error	μ_{merror}	0.121	0.118	0.123
SD of measurement error	σ_{merror}	0.177	0.176	0.177

Note: The simulation includes non-classical measurement error $\nu_{it} \sim N(\mu_{merror}, \sigma^2_{merror})$ with observed values are $max\{min\{plive10_{it} + \nu_{it}, 1\}, 0\}$. Standard errors clustered at the individual level

back

Step 2: uncertainty about own health dynamics with age

SMM fit

$\approx$ Target moments

	Data moment	SE	Simulated moment
$\mathbb{E}(plive10)$	0.531	(0.00011)	0.538
$\mathbb{E}(plive10^2)$	0.371	(0.00012)	0.357
$\mathbb{E}(plive10 \cdot h)$	2.890	(0.00065)	2.957
$\mathbb{E}(\Delta plive10)$	-0.013	(0.00002)	-0.014
$\mathbb{E}((\Delta plive10)^2)$	0.070	(0.00003)	0.066
$\mathbb{E}(\Delta plive10 \Delta h)$	0.007	(0.00002)	0.007

Note: same sample used for estimation

Other moments

	Data moment	SE	Simulated moment
$\mathbb{E}(plive75)$	0.702	(0.00017)	0.806
$\mathbb{E}(plive75^2)$	0.556	(0.00021)	0.687
$\mathbb{E}(plive75 \cdot h)$	3.886	(0.00101)	4.469
$\mathbb{E}(\Delta plive75)$	-0.001	(0.00010)	0.018
$\mathbb{E}((\Delta plive75)^2)$	0.054	(0.00008)	0.042
$\mathbb{E}(\Delta plive75 \Delta h)$	0.006	(0.00005)	0.003

Note: subsample used for estimation that is also under 65 years old, $N = 1,247$ individuals

back

Step 3: working decisions

In a model with heterogeneous and uncertain health dynamics

p_{it} labor participation, c_{it} consumption

$$V_t(\Omega_{it-1}) = \max_{p_{it},c_{it}} \Bigg\{ \mathbb{E}\Bigg(\overbrace{U(p_{it}, c_{it}, h_{it}, p_{it-1})}^{\text{flow utility}} \Bigg| \Omega_{it-1} \Bigg) + \beta \mathbb{E}\Bigg(\underbrace{S_{it+1}}_{\text{survival}} V_{t+1}(\Omega_{it}) + (1 - S_{it+1}) \underbrace{B(a_{it})}_{\text{bequest}} \Bigg| \Omega_{it-1}, p_{it}, c_{it} \Bigg) \Bigg\}$$

st.

- Budget constraint, with assets $a_{it} = a(\Omega_{it-1}, p_{it}, c_{it}, h_{it}, w_{it})$
- Health process $h_{it} = \rho h_{it-1} + \alpha_i + \delta_i \cdot t + \epsilon_{it}$ heterogeneity
- Beliefs about δ_i following $N(\hat{\delta}_{it}, \hat{\sigma}_t^2)$ incomplete information
  defined by updating equations

Step 3: working decisions

In a model with heterogeneous and uncertain health dynamics

Information set

$$\Omega_{it-1} \quad = \quad \{t, p_{it-1}, a_{it-1}, w_{it-1}, h_{it-1}, \hat{\delta}_{it-1}, \hat{\sigma}^2_{t-1}, \alpha_i\}$$

Policy rule for working decision

$$p_{it} \quad = \quad p(t, p_{it-1}, a_{it-1}, w_{it-1}, h_{it-1}, \hat{\delta}_{it-1}, \hat{\sigma}^2_{t-1}, \alpha_i)$$

- Survival expectations $plive10_{it}$ help us identify $\hat{\delta}_{it}$ and $\hat{\sigma}^2_t$
- Conditional on Ω_{it-1}, $plive10_{it}$ do not play a role on decisions p_{it}

Step 3: working decisions

Probit results on $\mathbb{P}(p_{it} = 1|\Omega_{it-1})$

back

		(1)		(2)		(3)	
		coeff	se	coeff	se	coeff	se
age	t	-0.20***	(0.016)	-0.08***	(0.003)	-0.19***	(0.016)
lagged work	p_{it-1}	2.03***	(0.018)	2.03***	(0.019)	2.03***	(0.019)
lagged health	h_{it-1}	0.17***	(0.024)	0.26***	(0.033)	0.18***	(0.046)
heterogeneous intercept	α_i	0.24***	(0.036)	0.07	(0.046)	0.24***	(0.075)
beliefs mean	$\hat{\delta}_{it-1}$	1.93***	(0.249)			1.90***	(0.499)
beliefs var	$\hat{\sigma}^2_{t-1}/\sigma^2_{\delta}$	-13.85***	(2.048)			-13.33***	(2.102)
survival expectations	$plive10_{it}$			0.11***	(0.031)	0.01	(0.043)
Controls	other vars Ω_{it-1}	Yes		Yes		Yes	
N individuals		14,969		14,718		14,718	
N observations		58,040		55,592		55,592	

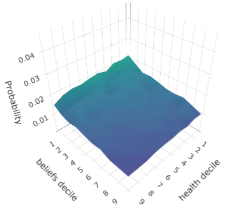
Note: Standard errors are clustered at the individual level.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

- Beliefs are unobserved to econometrician and hence are integrated out
- Beliefs matter: larger $\hat{\delta}_{it}$ implies larger probabilities of work
- Survival expectations $plive10_{it}$ do not matter once we control for beliefs

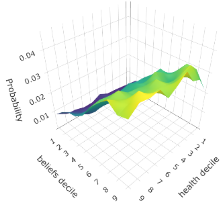
Step 3: working decisions

NN results: average marginal effects of beliefs $\hat{\delta}_{it-1}$ on labor participation p_{it}

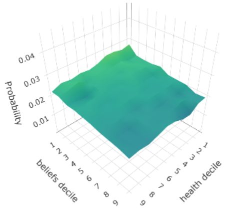
back



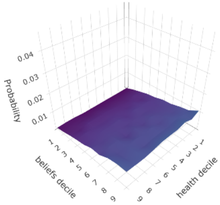
(a) $p_{it-1} = 1$ and $age_{it} \in [52, 59]$



(b) $p_{it-1} = 0$ and $age_{it} \in [52, 59]$



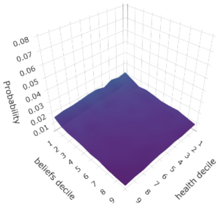
(c) $p_{it-1} = 1$ and $age_{it} \in [66, 75]$



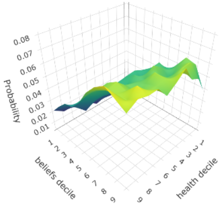
(d) $p_{it-1} = 0$ and $age_{it} \in [66, 75]$

Step 3: working decisions

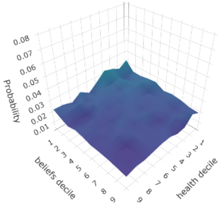
NN results: average marginal effects of health h_{it-1} on labor participation p_{it} back



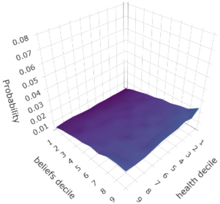
(a) $p_{it-1} = 1$ and $age_{it} \in [52, 59]$



(b) $p_{it-1} = 0$ and $age_{it} \in [52, 59]$



(c) $p_{it-1} = 1$ and $age_{it} \in [66, 75]$



(d) $p_{it-1} = 0$ and $age_{it} \in [66, 75]$

Step 3: working decisions

Result: Eliminating bias in beliefs would **increase** probability of work

(2) Effect of eliminating initial negative bias b on $\mathbb{P}(p_{it} = 1|\Omega_{it-1})$

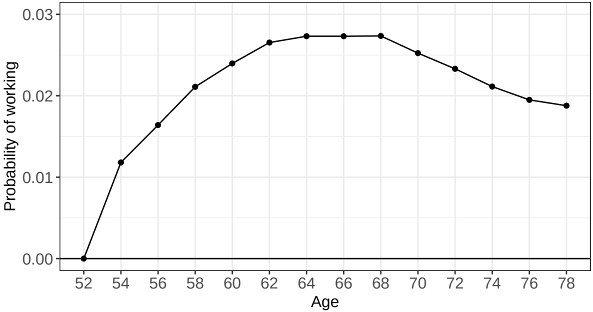


Figure: Impulse response function to eliminate initial bias b

back

Step 3: working decisions

NN impulse response functions to a reduction in bias $\hat{\delta}_{it} - \delta_i$

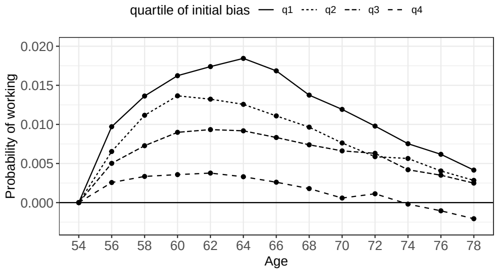


Figure: Bias reduced in half, by quartile of bias

At 54, p_{it} has mean 0.73 and sd 0.44
At 66, p_{it} has mean 0.34 and sd 0.47
At 78, p_{it} has mean 0.11 and sd 0.31

Bias at 54 goes between -0.16 to 0.12, with a mean and median of -0.059 back

Step 4: information experiment

DD results

		Survival expectations ($plive10_{iw}$)			Work choice (p_{iw})		
		All	Less college	College	All	Less college	College
group 1	d_{g_i}	-0.47	-0.24	-1.38	0.00	0.01	-0.01
wave 6	d_{w6}	-1.42***	-1.21**	-2.09**	-0.07***	-0.07***	-0.09***
wave 7	d_{w7}	-1.50***	-1.44***	-1.72**	-0.12***	-0.12***	-0.12***
wave 8	d_{w8}	-6.41***	-6.12***	-7.37***	-0.16***	-0.16***	-0.19***
wave 9	d_{w9}	-3.57***	-3.22***	-4.70***	-0.20***	-0.20***	-0.22***
group 1, wave 6	$d_{g_i} \cdot d_{w6}$	0.28	-0.06	1.37	0.01	0.00	0.02
group 1, wave 7	$d_{g_i} \cdot d_{w7}$	-0.27	-0.24	-0.33	0.01	0.01	0.01
group 1, wave 8	$d_{g_i} \cdot d_{w8}$ (a)	1.77**	1.29	3.31***	0.01	0.00	0.03
group 1, wave 9	$d_{g_i} \cdot d_{w9}$ (b)	-0.42	-1.12	1.82	0.01	0.01	0.00
Constant		53.97***	52.42***	58.96***	0.49***	0.45***	0.61***
Observations		41,930	31,815	10,115	41,923	31,810	10,113
R-squared		0.004	0.004	0.005	0.021	0.021	0.022
Interview mode effect (a)		1.77**	1.29	3.31**	0.01	0.00	0.03
Information effect (a)+(b)		1.36	1.65	5.12**	0.02	0.01	0.04

$$y_{iw} = \beta_0 + \beta_1 d_{g_i} + \beta_{2w} d_w + \beta_{3w} d_{g_i} \cdot d_w + \epsilon_{iw}$$

back

Step 4: biomarkers as signals of δ_i

Reduced-form results distinguishing bad vs good test results

back

		Survival expectations $plive10_{iw}$	Working decisions p_{iw}
group 1	d_{g_i}	-0.39	-0.01
group 1, bad results	d_{b_i}	-0.37	0.04**
wave 6	d_{w6}	-1.42***	-0.07***
wave 7	d_{w7}	-1.50***	-0.12***
wave 8	d_{w8}	-6.41***	-0.16***
wave 9	d_{w9}	-3.57***	-0.20***
group 1, wave 6	$d_{g_i} \cdot d_{w6}$	0.58	0.01
group 1, wave 7	$d_{g_i} \cdot d_{w7}$	0.15	0.02*
group 1, wave 8	$d_{g_i} \cdot d_{w8}$	2.23***	0.02*
group 1, wave 9	$d_{g_i} \cdot d_{w9}$	-0.05	0.02
group 1, bad results, wave 6	$d_{g_i} \cdot d_{b_i} \cdot d_{w6}$	-1.25	-0.01
group 1, bad results, wave 7	$d_{g_i} \cdot d_{b_i} \cdot d_{w7}$	-1.75*	-0.04**
group 1, bad results, wave 8	$d_{g_i} \cdot d_{b_i} \cdot d_{w8}$	-1.94*	-0.05***
group 1, bad results, wave 9	$d_{g_i} \cdot d_{b_i} \cdot d_{w9}$	-1.56	-0.03
Constant		53.97***	0.49***
Observations		41,930	41,923
% of group 1 individuals with bad results		12.29	12.30