Health capital over the lifecycle: Empirical estimates using National Transfer Accounts

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Introduction

Not all kinds of human capital are *used* the same

- More knowledge increases productivity, e.g. Becker (1967), Ben-Porath (1967), Mincer (1974)
- More health increases time for production, e.g. Mushkin (1962), Grossman (1972)

Grossman Model: 40 years

Workhorse model in analyzing health demand

Extended in a number of directions

- Generalized, Muurinen (1982)
- Stochasticity, Cropper (1977)
- Longevity, Ehlrich and Chuma (1990)
- Comparative dynamic analysis, Ried (1998)

Few empirical estimates of some model parameters; estimates focus largely on elasticity

Objective

Estimate Grossman (1972) model parameters

- Minimum health stock requirement, i.e. death stock
- Health stock depreciation rates
- Initial health stock endowment

Simulate effect of various health policy experiments

Grossman model (Modified)

Individuals maximize expected lifetime utility

$$E[U] = \sum_{t=0}^{T} \beta^t U_t(c_t, H_t, l_t^C)\pi_t$$

subject to

$$\begin{gathered} l_t^S + l_t^H + l_t^W + l_t^C = 1 \\ c_t + \underline{I}_t p_t = w_t l_t^W(H_t) \\ H_t = \underline{I}_t + (1-\delta_t)H_{t-1} \end{gathered}$$

l_t^X, time devoted to $x = \{$Sick days, Health input, Work, Consumption$\}$;
c_t, consumption of numeraire good; $\underline{I}_t$ gross investments in health;
H_t, health stock; p_t, w_t, prices; β, discount factor;
π_t, survival propensity; δ_t, health stock depreciation rate;
T, optimal length of life

Literature

Much of empirical work revolves around (i) the Euler equation, or (ii) the health stock law of motion

- Estimates for health care demand elasticities
- Health proxied by subjective well-being, sick days, etc.

Little attention is given to survival probability π_t, as well as to estimating death stock $\underline{h}$ and depreciation rate δ_t

Empirical duration model

Death occurs whenever the health stock H_t is below some critical level $\underline{h}$, i.e. in order to survive

$$H_t > \underline{h} | T \geq t$$

Suppose $\underline{h}_t$ is stochastic, i.e. unobserved until when it is reached, then the hazard function may be specified as

$$\phi_t = P(H_t \leq \underline{h}_t | T \geq t)$$
$$\phi_t = P(I_t + (1 - \delta_t) H_{t-1} \leq \underline{h}_t | T \geq t)$$

With ϕ_t, other duration quantities may be calculated directly, including survival propensity π_t

Estimation

We estimate the parameters using Simulated Method of Moments:

1. For each agent, simulate $j = 5{,}000$ lifetimes
   - Fix observed π_t^D and I_t from data
   - Simulate death stock shock φe^x in $\underline{h}_t = \underline{h}\varphi e^x$
2. Choose $\{\underline{h}, \delta_t, H_0\}$
3. Calculate $H_t = I_t + (1 - \delta_t)H_{t-1}$
4. Define $1_t = 1_t(H_t > \underline{h}_t | 1_{t-1} = 1)$
5. Estimate $(1 - \phi_t)$ by averaging 1_t over j if $1_{t-1} = 1$
6. Calculate simulated $\pi_t^M = \prod_{s=0}^{t}(1 - \phi_s)$
7. Repeat (2)-(6) to minimize $(\pi_t^D - \pi_t^M)'(\pi_t^D - \pi_t^M)$

Data

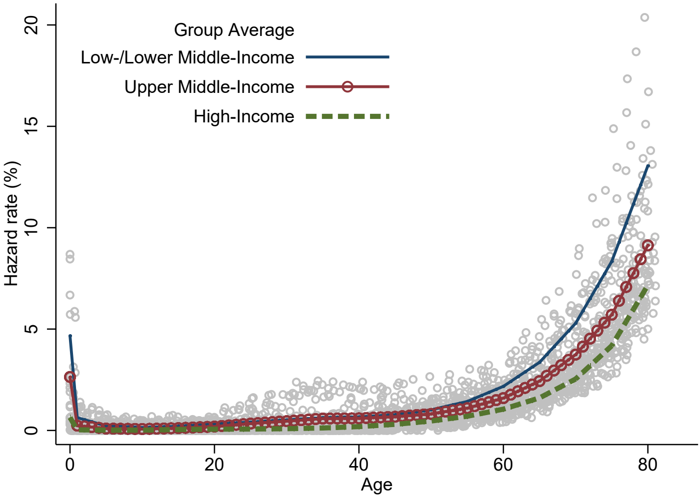
National Transfer Accounts (www.ntaccounts.org)

- Accounting framework consistent with UN System of National Accounts that provides estimates of how much is produced, consumed, and shared at each age
- Currently estimated in 70+ economies; estimates for 36 economies used in this study
- Estimates for both private and public consumption; Normalized by average labor income of prime-age workers

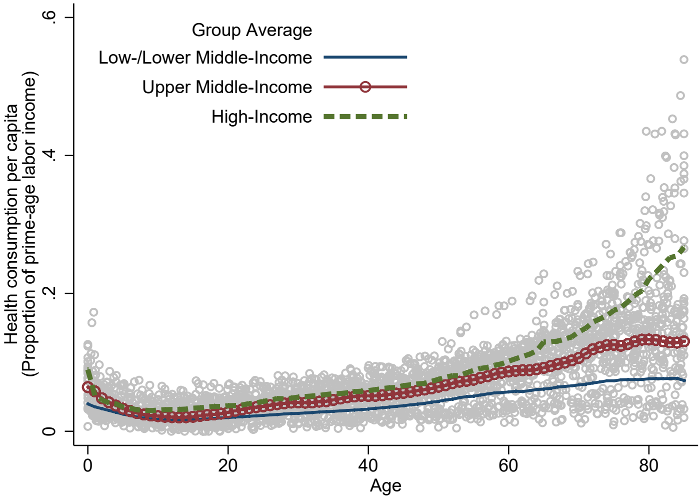
UN Life tables

- Provide survivorship at 0, 1, 5, 10, ..., 85
- Missing observations are linearly interpolated

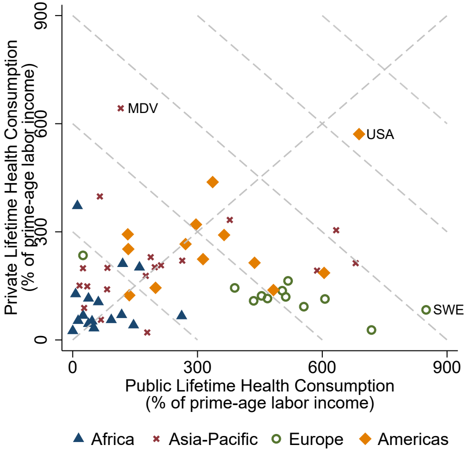
Health over the lifecycle



Health *consumption* over the lifecycle



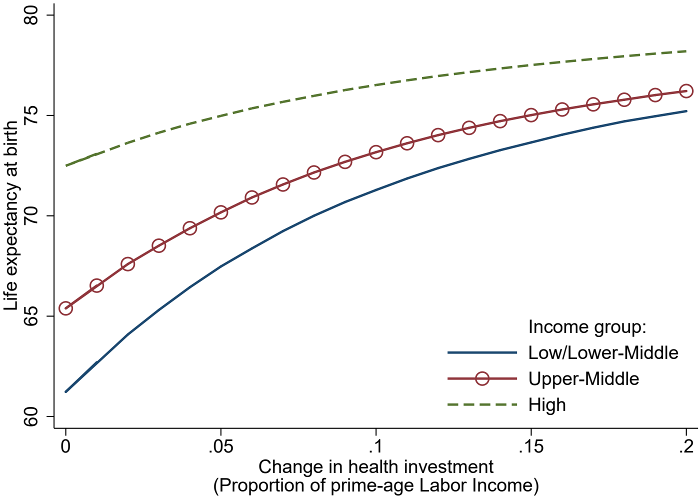
Health consumption by sector over the lifecycle



Grossman parameter estimates

	Full Sample	Income group		
		Low	Middle	High
H_0	7.328	7.440	7.319	7.285
	(0.082)	(0.046)	(0.114)	(0.215)
$\underline{h}$	0.990	1.016	0.999	0.979
	(0.012)	(0.006)	(0.011)	(0.028)
δ_{10}	-0.046	-0.017	-0.030	-0.098
	(0.004)	(0.003)	(0.003)	(0.009)
δ_{20}	0.003	0.000	0.004	-0.014
	(0.004)	(0.004)	(0.005)	(0.014)
δ_{30}	0.004	0.017	0.010	0.022
	(0.004)	(0.003)	(0.002)	(0.010)
δ_{40}	0.036	0.013	0.016	0.047
	(0.005)	(0.003)	(0.005)	(0.007)
δ_{50}	0.028	0.013	0.037	0.045
	(0.006)	(0.002)	(0.008)	(0.009)
δ_{60}	0.035	0.041	0.028	0.045
	(0.011)	(0.003)	(0.008)	(0.011)
δ_{70}	0.057	0.059	0.058	0.050
	(0.005)	(0.005)	(0.006)	(0.007)
δ_{80}	0.075	0.056	0.076	0.104
	(0.006)	(0.003)	(0.008)	(0.008)
$\chi^2_{\delta_{10}=\ldots=\delta_{80}}(7)$	3357.59	3125.92	2319.26	4606.16
$\overline{\delta}_t = T^{-1}\sum\delta_t$	0.024	0.023	0.025	0.025
	(0.001)	(<0.001)	(0.001)	(0.001)
$Pseudo - R^2$	0.71	0.76	0.77	0.94
N	2916	648	891	1377
Countries	36	8	11	17

Health catch-up



Policy experiments

Interventions

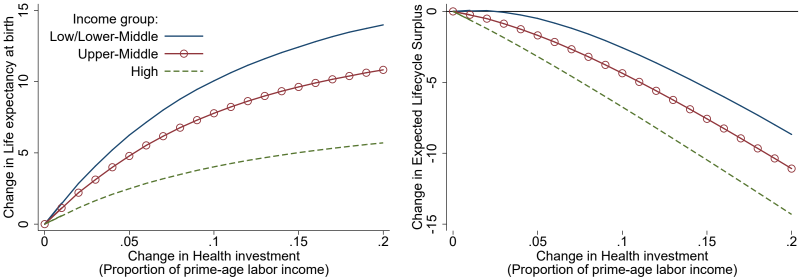
- Uniform increase in health consumption
- One-time increase at specific age
- Uniform increase from birth to specific age

Outcomes

- Life expectancy: $\sum_0^T \tilde{\pi}_t$
- Expected lifecycle surplus: $\sum_0^T \tilde{\pi}_t(YL_t - C_t)$

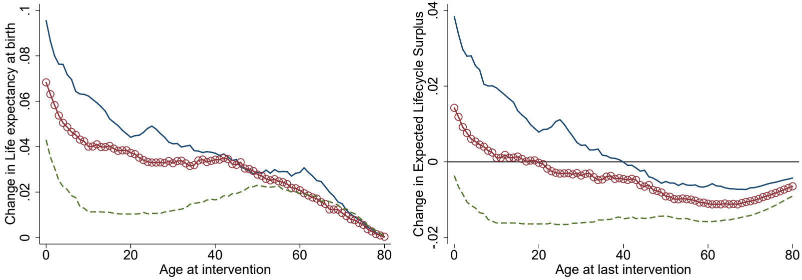
Policy experiments: Scenario 1

Uniform increase in health consumption



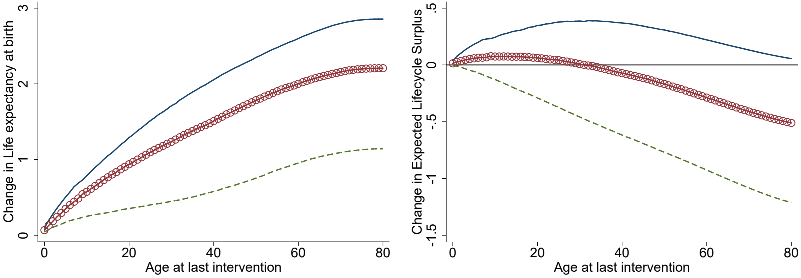
Policy experiments: Scenario 2

One-time increase in health consumption at specific age



Policy experiments: Scenario 3

Uniform increase in health consumption from birth to specific age



Conclusion

- Confirm Grossman's (1972) conjecture of increasing health depreciation rates with age
- Bonus from investing in health early in the lifecycle
- Policy experiment: Additional health investments do not necessarily increase material measure of well-being
- Caveat: Estimates are based on representative agent, i.e. average consumer