Life Cycle Responses to Health Insurance Status

Florian Pelgrin[1] and Pascal St-Amour[2,3]

[1]EDHEC Business School

[2]University of Lausanne, Faculty of Business and Economics (HEC)

[3]Swiss Finance Institute

2014 Annual Health Econometrics Workshop

Discussant: Brian Ferguson
Department of Economics, University of Guelph
and
Canadian Centre for Health Economics

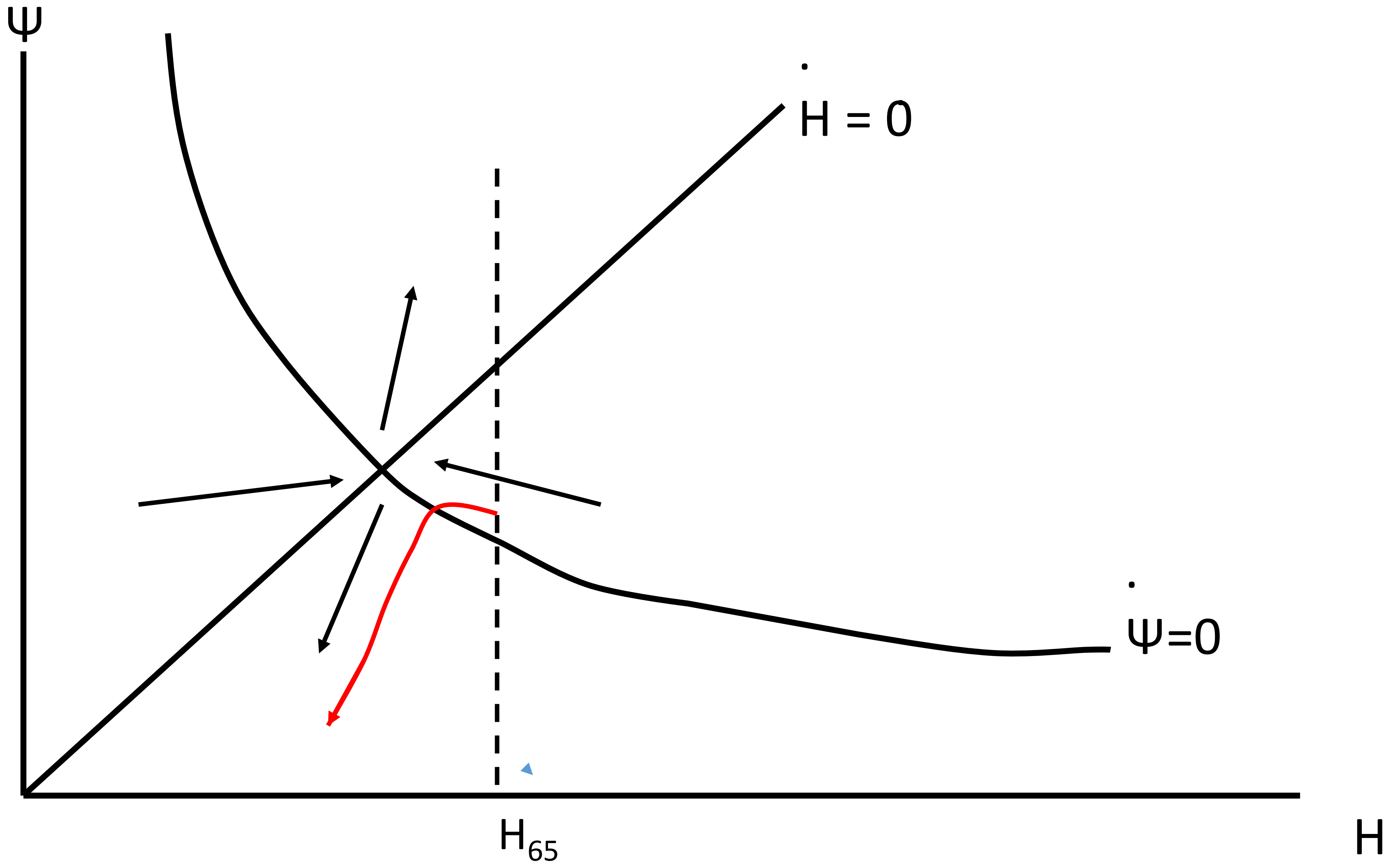
Research question: How do future changes in health insurance status affect current decisions with regards to investment in health?

Basic Structure: Two stage intertemporal Grossman model of investment in health

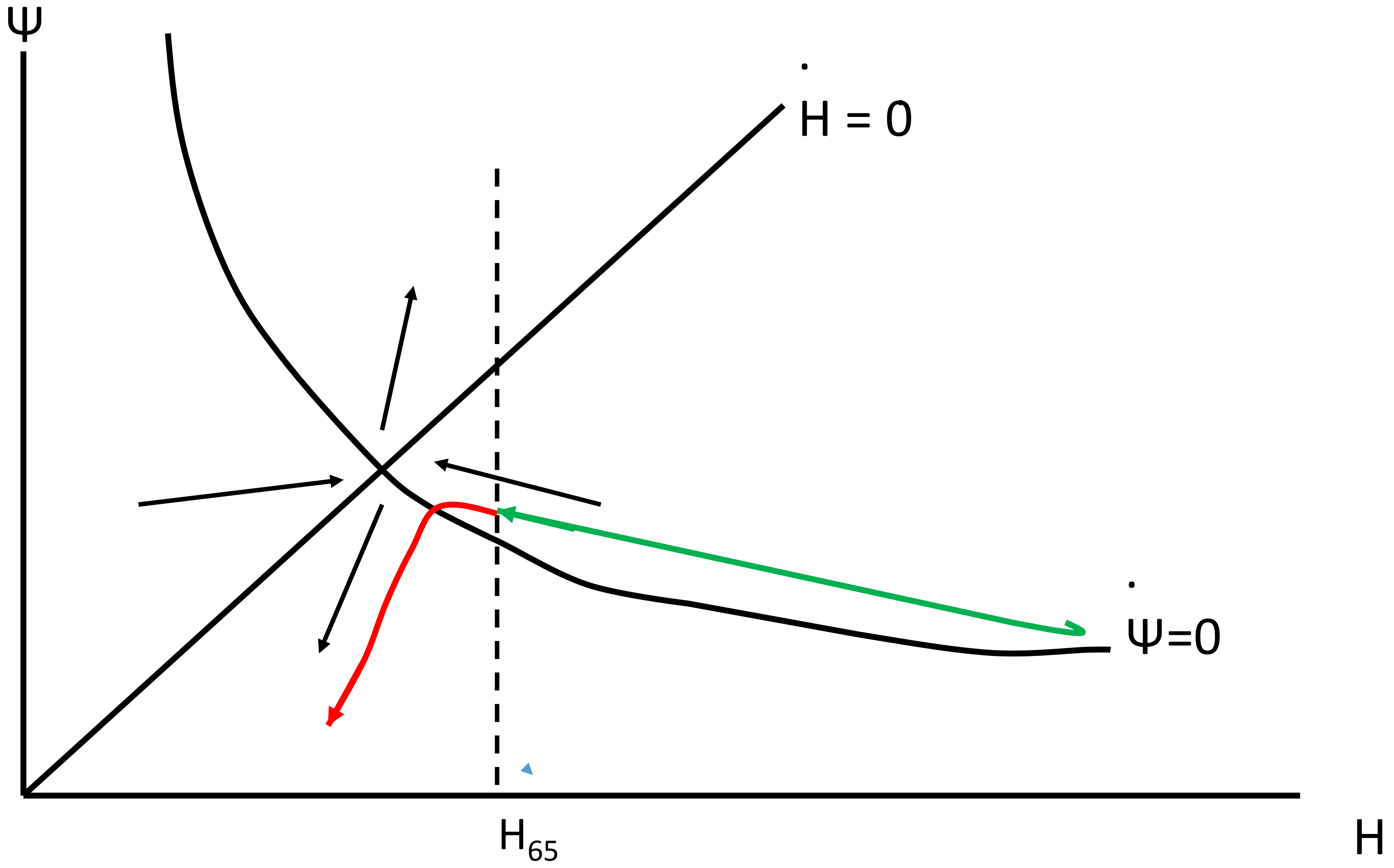
Max: $\int_{t_0}^{65} U(C,H)e^{-\rho t}\,dt + \int_{65}^{T} U(C,H)e^{-\rho t}dt$

Divide life into two stages – pre- and post-retirement

Treat each stage as an intertemporal optimization problem. Solution to the retirement stage problem takes as its H_0 the value of H at the end of the first stage: H_{65}



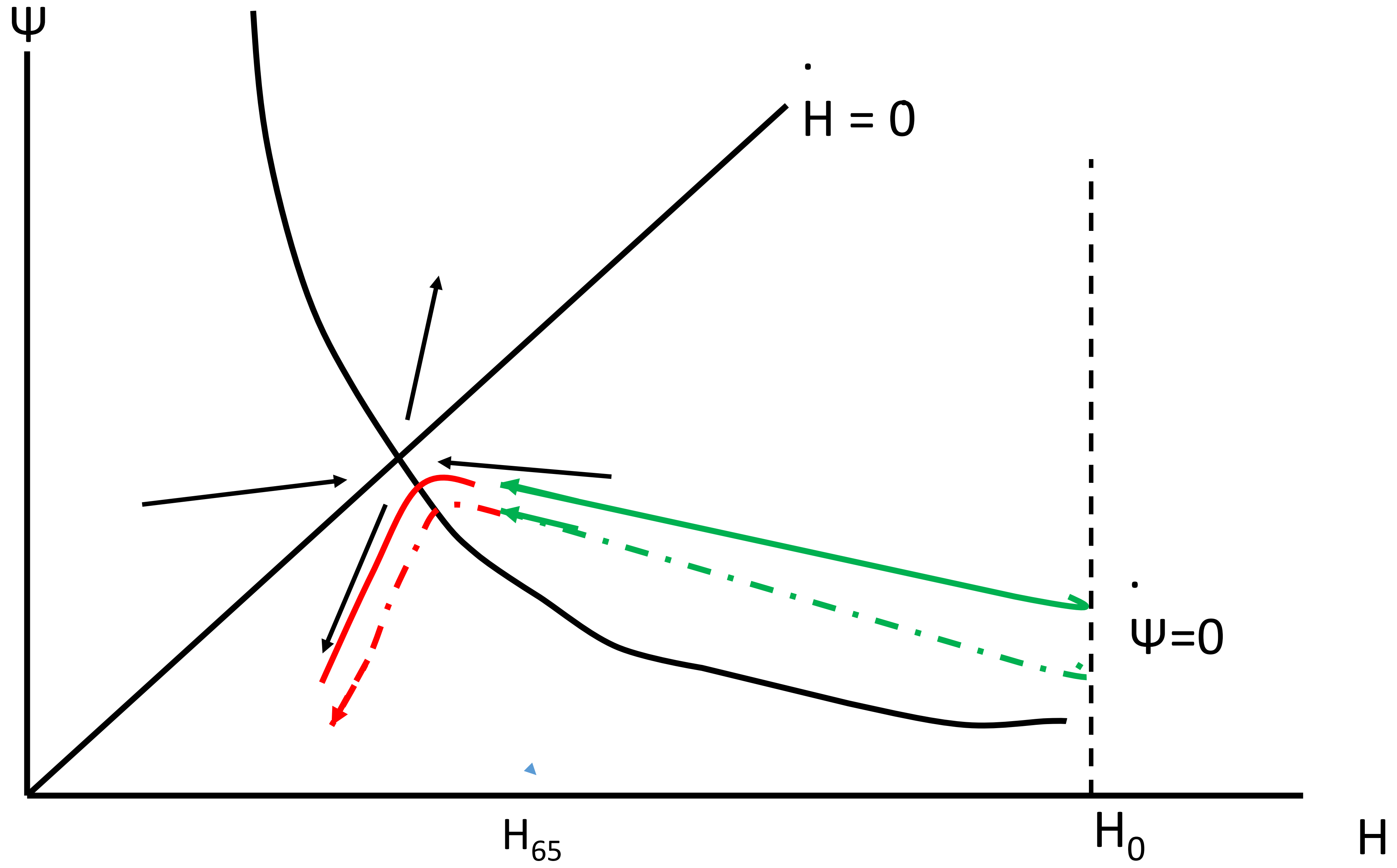
Ψ
$\dot{H} = 0$
$\dot{\Psi}=0$
H_{65}
H



ψ
$\dot{H} = 0$
$\dot{\psi}=0$
H_{65}
H

By its nature, the value of H at the end of the first stage will be the same as the value of H at the beginning of the second stage

By the transversality condition for a two-stage optimal control problem, the value of the shadow price of health at the beginning of the second stage will be the same as its value at the end of the first stage.



Ψ
H = 0
Ψ=0
H65
H0
H

Standard Grossman framework with a few twists:

Two state variables, Health (H) and Wealth (W)

Stochastic elements:

Two categories of stochastic shock – morbidity and mortality.

Morbidity shocks – downward shocks to health.

Enter the equation of motion for health capital.

In continuous time terms, using Merton's generalized Ito derivative:

$$dH = [\, A(t)I^{g}(H(t), I(t), \ell(t)) - \delta(t)H \,]dt \; - \; \phi(t)H(t)d\pi$$

$A(t)$ = technological progress term

$I^{g}(H(t), I(t), \ell(t))$ = gross health investment function

$\delta(t)$ = non-stochastic health depreciation term

$\phi(t)H(t)d\pi$ = stochastic health depreciation term

Mortality shocks:

Finite horizon model – T = biological upper limit to life.

Actual age at death is stochastic: $T^m \in [0,T]$

$T^m = \min \{t: \varepsilon^m = 1\}$

$\Pr\{\varepsilon_{t+1}^{m} = 1 \mid H_t\} = 1 - \exp[-\lambda^m (H_t)]$

$\lambda^m (H_t)$ is decreasing in H.

Both types of health shock, but operate through $\lambda^m(H_t)$, the force of mortality term .

Morbidity shock reduces H, increases probability of death at any moment.

Mortality shock kills.

Λ(H(t)) = probability of being alive up to period t

π(t) = probability of dying in period t.

Then, seen from t=0, the individual's problem is:

$$\text{Max} \int_0^T [\Lambda\big(H(t)\big)U\big(C(t), \ell(t)\big) + \pi(H(t))U^M\big(W(t)\big)]e^{-\rho t}dt$$

Subject to stochastic equation of motion for H

deterministic equation of motion for W,

$W_{t+1} = [W_t + Y_t(\boldsymbol{\ell}) - C_t - OOP_t\,(I_t) - \Pi_t]R$

W = financial wealth, Y = income, R = interest factor, Π = insurance premium, OOP = out of pocket payment for care.

Instantaneous budget constraint, and hence equation of motion for wealth, allow for change in earnings function on retirement, including exogenous drop in wages.

Also allows for out of pocket payments (OOP) for health care, which depend on deductibles and co-insurance payments

In any period if are alive get utility from Consumption and leisure.

If die, get utility from leaving a bequest: U^m (W)

W = accumulated wealth.

Here U^m is negative but increasing in W.

Don’t want to go, but ability to leave a bequest lessens the pain somewhat.

Nice touch.

Authors note that stochastic horizon with endogenous health-dependent death intensity is isomorphic to a fixed horizon problem with endogenous health-dependent discounting.

Merton, Optimal consumption and Portfolio Rules (JET 1971)

Another variation on standard investment in health model:

Instantaneous utility depends only on C and ℓ, not on H.

i.e. U = U(C, ℓ), not U(C, ℓ, H)

H enters only through force of mortality term, $\lambda^m (H_t)$

Not clear why this is an advantage from the theoretical point of view

In general seems reasonable that H affects utility directly and also utility to be derived from consuming non-health related commodities.

May have econometric appeal – only have to estimate effect of H through the λ function, not through both it and the utility function.

Make assumptions about functional forms, to substitute into Euler Equations:

$$I^{g}(\mathrm{H}, \mathrm{I}, \boldsymbol{\ell}) = I^{\eta I}\ell^{\eta \ell}H^{1-\eta I-\eta \ell}, \eta I, \quad \eta \ell \in (0,1)$$

$$\mathrm{U}(\mathrm{C}, \boldsymbol{\ell}) = [\mu_C C^{1-\gamma} + \quad \mu_\ell \ell^{1-\gamma}]^{\frac{1}{1-\gamma}}$$

$$U^{M}(W) = \mu_M \frac{W^{1-\gamma}}{1-\gamma}$$

$I^g(H(t), I(t), \ell(t))$ = gross health investment function

Function of current stock of health, H, Health investment goods, I, and leisure, ℓ, where leisure is measured in time units.

Argue that the joint inclusion of leisure and expenditures on health in the I^g function is innovative.

Not clear why: time input into the production of health is pretty standard in Grossman models.

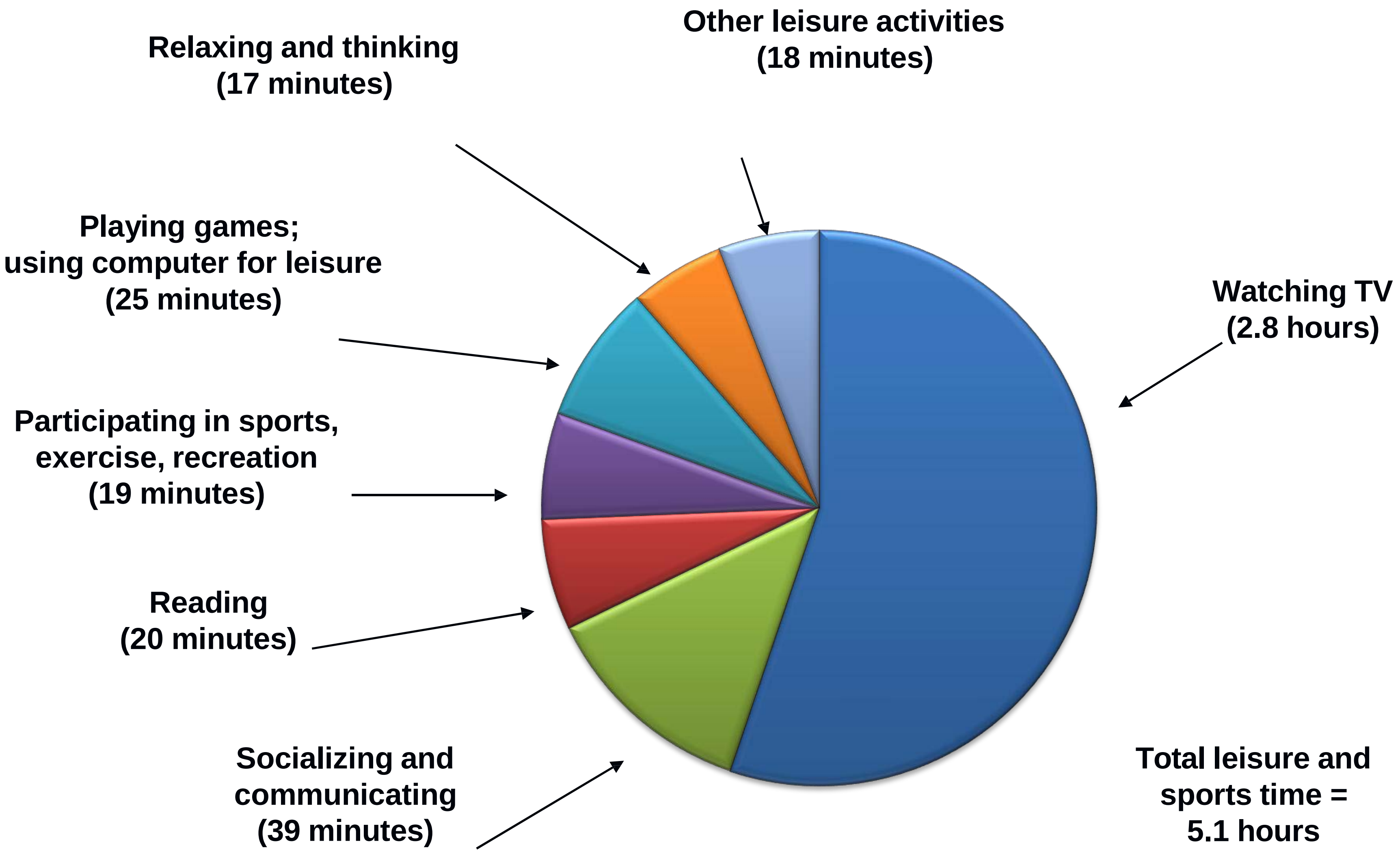
No distinction between leisure and the time input into the health production function.

Couch potatoes might agree, but may cause problems for estimation.

Health also enters as an input into the gross Investment function.

Increases in H increase the MPs of I and ℓ.

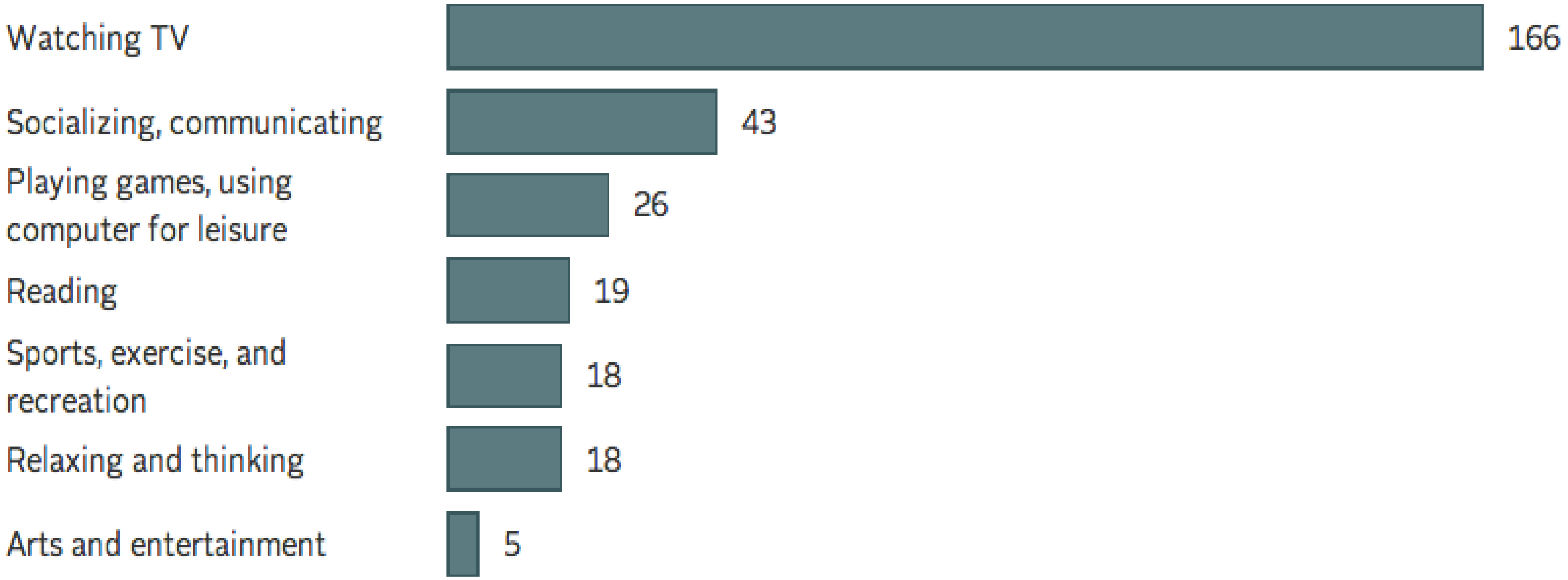
Leisure time on an average day



NOTE: Data include all persons age 15 and over. Data include all days of the week and are annual averages for

How Americans spend their leisure time

Average time spent per day, minutes (selected activities)



Source: BLS

Euler Equations for control variables (C, I, $\boldsymbol{\ell}$) and Equations of Motion for state variables (H,W) allow us to, in principle, plot out optimal trajectories for an individual's values of (C, I, $\boldsymbol{\ell}$, H, W) .

With suitable panel data could estimate these.

Problem: don't yet have panels containing all of the information we would like on interrelated health and economic variables.

Approach chosen here: Simulated Moments Estimation

Essentially an application of agent-based modelling.

Build up an artificial dataset of individuals who behave according to the equations of the model.

Pick an initial set of coefficient values.
Generate an artificial population of individuals all at t=0:
In this case, 16-year olds

Give each individual H_0 and W_0 based on true values – ideally random drawing from real world (H,W) data on individuals aged t=0.

Run the Euler equations and equations of motion ahead to generate artificial data out to t=T

Calibrate – match some characteristics of artificial data to their counterparts in real world data set.

Adjust coefficient values to bring characteristics of artificial data as close as possible to real counterparts.

When distance between real and artificial characteristics has been minimized according to some criterion function, you have your coefficient estimates.

In practice have to calibrate some parameters to the literature, estimate the others using SME.

Calibrated Values

parameter	value	parameter	value	parameter	value	parameter	value
T	100	κ	-37				
ε^m	2.5	λ_2^s	50	ξ^s	4.9		
A_0	1.5	g^A	0.004	η_I	0.20	η	0.40
ψ	0.200	Π	0.0413	Π^M	0.0167		
P_0^I	1.8522	g^P	0.008	D_0	0.0100	g^D	0.008
Y^R	0.1476	τ	0.0145	R^f	1.04		
β	0.9656	μ_c	0.3333	μ	0.6667	μ_m	0.0200
$W_{\min}$	0.05	$W_{\max}$	4	$H_{\min}$	0.1	$H_{\max}$	3
$C_{\min}$	0.05	$C_{\max}$	1	$I_{\min}$	0	$I_{\max}$	1
$£_{\min}$	0.05	$£_{\max}$	1				
K_W	10	K_H	10	K_Y	30		

Table 7: Estimated parameter values

parameter	value	(standard error)	parameter	value	(standard error)
δ_0	0.0166	(0.0072)	g^{δ}	0.0154	(0.0062)
φ_0	0.0658	(0.0215)	g^{φ}	0.0157	(0.0046)
λ_0^m	0.0061	(0.0020)	λ_1^m	0.0091	(0.0044)
λ_0^s	0.2621	(0.1347)	λ_1^s	5.1022	(1.2468)
γ	3.4005	(1.4523)			

Notes: Estimated parameters based on SME estimator (26).

Dealing with individual lifetime trajectories of state and control variables.

Seems natural to match simulated data time-paths to real data time-paths

Two immediate problems:

(1) Path calibration has consistency problems.

(2) Don’t have a long panel containing all of the requisite variables to use as the basis for calibration.

Alternative to path calibration: moment calibration.

Generate selected moments of the distribution of variables of interest from the artificial trajectories and compare them with moments from actual data.

Here generate artificial longitudinal data sets, calculate age-specific means of key variables over five year age intervals from 20 to 80.

Five-year means of:

C, I, Out of Pocket (OOP) health expenditures, Leisure, Health, and Wealth.

In the absence of panel data containing all of these variables, compare the age-specific means from artificial data sets with means of data from cross-section surveys. (The authors test for cohort effects.)

Have to draw each mean for matching from a different data set.

Variables	Data (2010, 2011), and explanations
W	Survey of Consumer Finances (SCF), Federal Reserve Bank. Financial assets held.
H	National Health Interview Survey (NHIS), Center for Disease Control. Self-reported health status (phstat) where Poor=0.10, Fair=0.825, Good=1.55, Very good=2.275, Excellent=3.0.
S	National Vital Statistics System (NVSS), Center for Disease Control. Survival rates
I	Medical Expenditures Survey (MEPS), Agency for Health Research and Quality. Total health services mean expenses per person with expense and distribution of expenses by source of payment.
OOP	Medical Expenditures Survey (MEPS), Agency for Health Research and Quality. Out-of-pocket health services mean expenses per person with expense and distribution of expenses by source of payment.
	American Time Use Survey (ATUS), Bureau of Labor Statistics. Share of usual hours not worked per week, 1-uhrsworkt/40
C	Consumer Expenditures Survey (CEX), Bureau of Labor Statistics. Non-durables consumption, net of health expenditures and vehicle purchases = 4*(totex4pq - healthpq - vehicle)

Initial (i.e. t=0) population:

Ideally would like to draw H_0, W_0 with replacement from real world joint distribution $f(H,W,\varepsilon)$.

Here: “we initialize the simulation by taking 100 draws (without replacement) from the observed distribution over health and wealth at age 16, such that this sample is representative of the general population at the beginning of adult age. We then simulate 500 trajectories from the initial grid along the optimal path. This procedure is therefore equivalent to simulating 50’000 individual life cycles from which the 5-year moments are computed.”

Presumably individual distributions, $h(H_{16}, \varepsilon_H)$, $w(W_{16}, \varepsilon_W)$, not a joint distribution $f(H_{16}, W_{16}, \varepsilon)$

Given estimated parameters, insert details of broad types of insurance into First Order Conditions to generate simulated paths for different lifetime insurance combinations.

Denoted Y,O: Younger, Older (over 65)

PM = Private, Medicare
NM = None, Medicare
NN = None, None
PN = Private, None
PP = Private, Private

Table 4: Insurance plans, net effects and restrictions

(a) Statuses and net effects

Status: young	Status: old			Net effects
	Insured		Uninsured	
	Medicare	Private		
Insured				
- Private	PM	PP	PN	Insured old
Uninsured	NM		NN	Insured old
Net effects	Insured young		Insured young	

(b) OOP's, premia, and income

plan x	$OOP_t^x(I_t)$	Π_t^x	$Y_t^x(\ell_t)$
PM	$P_t^I I_t - \mathbb{1}_D(1-\psi)(P_t^I I_t - D_t)$	$\Pi\left[1-\mathbb{1}_R(1-\pi)\right]$	$\mathbb{1}_R Y^R + (1-\tau)w_t(1-\ell_t)$
PP	$P_t^I I_t - \mathbb{1}_D(1-\psi)(P_t^I I_t - D_t)$	Π	$\mathbb{1}_R Y^R + w_t(1-\ell_t)$
PN	$P_t^I I_t - (1-\mathbb{1}_R)\mathbb{1}_D(1-\psi)(P_t^I I_t - D_t)$	$(1-\mathbb{1}_R)\Pi$	$\mathbb{1}_R Y^R + w_t(1-\ell_t)$
NM	$P_t^I I_t - \mathbb{1}_R\mathbb{1}_D(1-\psi)(P_t^I I_t - D_t)$	$\mathbb{1}_R \Pi\pi$	$\mathbb{1}_R Y^R + (1-\tau)w_t(1-\ell_t)$
NN	$P_t^I I_t$	0	$\mathbb{1}_R Y^R + w_t(1-\ell_t)$

Notes: Insurance plans: (N)o insurance, (P)rivate insurance, and (M)edicare. Indicators: $\mathbb{1}_X = \mathbb{1}_{x=P,M}$ (Insured), $\mathbb{1}_M = \mathbb{1}_{x=M}$ (Medicare), $\mathbb{1}_D = \mathbb{1}_{P_t^I I_t > D_t}$ (Deductible reached), $\mathbb{1}_R = \mathbb{1}_{t\geq 65}$ (Retired).

US, 2013, Under 65:

84.7% of population had any health insurance

65.8% had private health insurance

24.5% had Government health insurance

15.3% uninsured

US, 2013, 65 and Over:
98.4% had any health insurance
54% had private health insurance
93.6% had government health insurance
1.6% uninsured

4.8% had private health insurance only (Snowbirds?)

Figure 4: Life cycle health

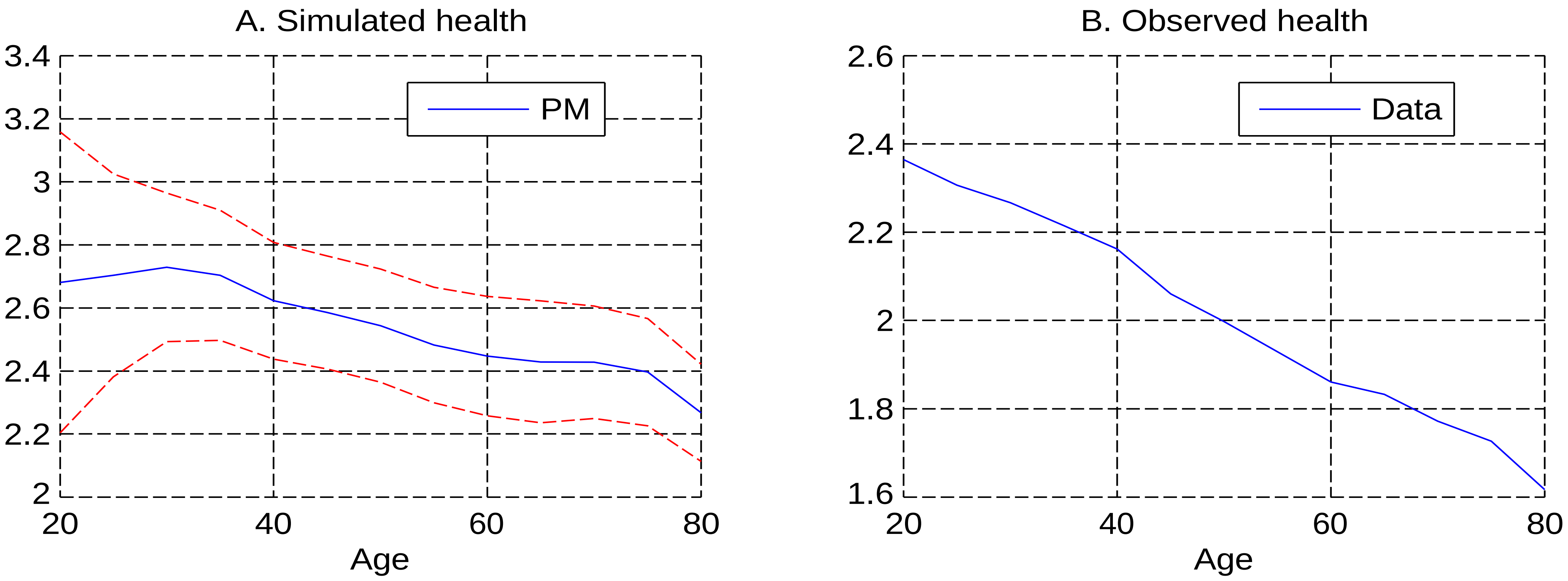


Figure 4: Life cycle health

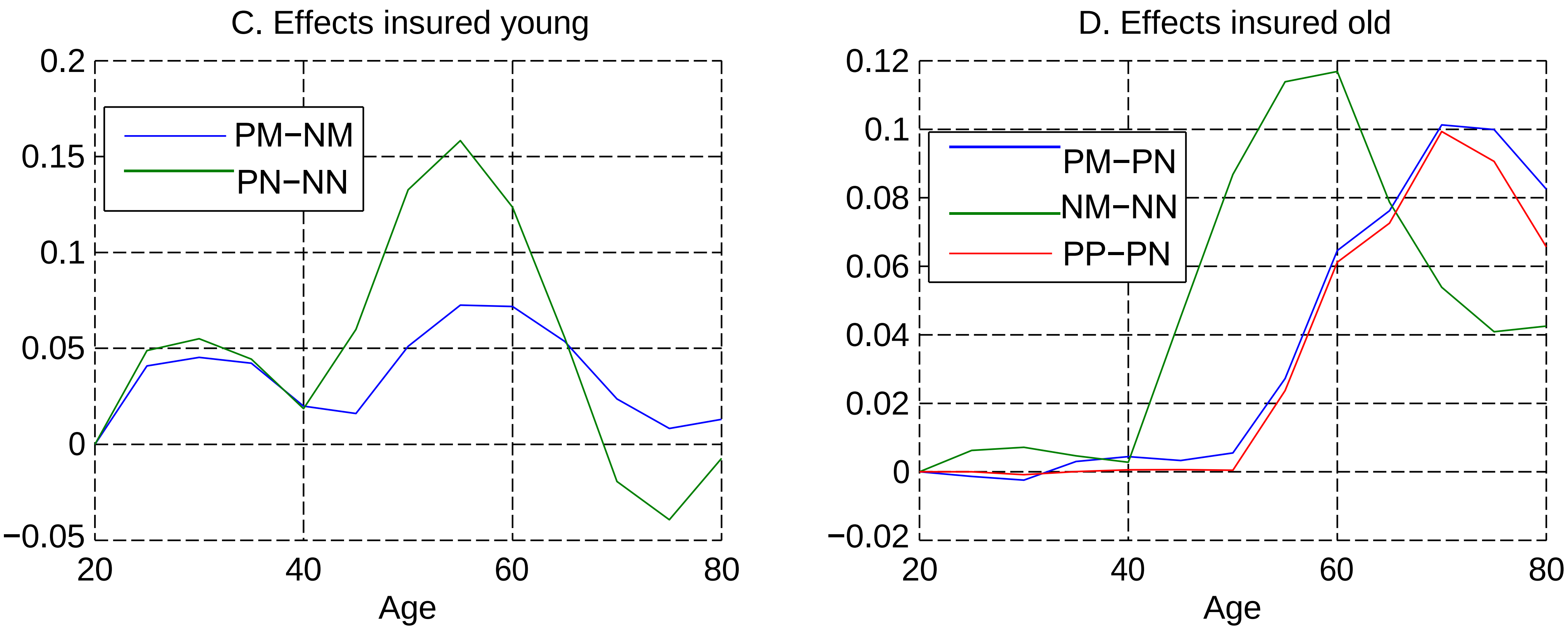


Figure 5: Life cycle health investment

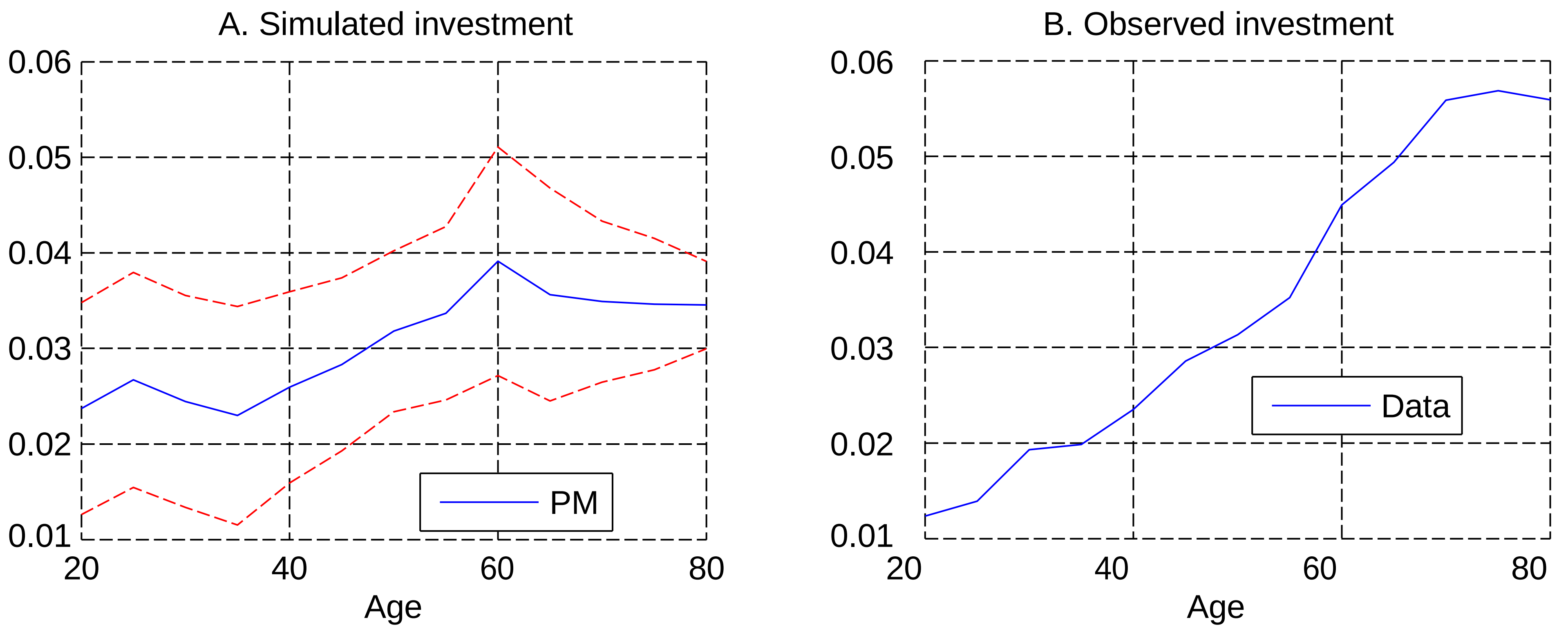


Figure 5: Life cycle health investment

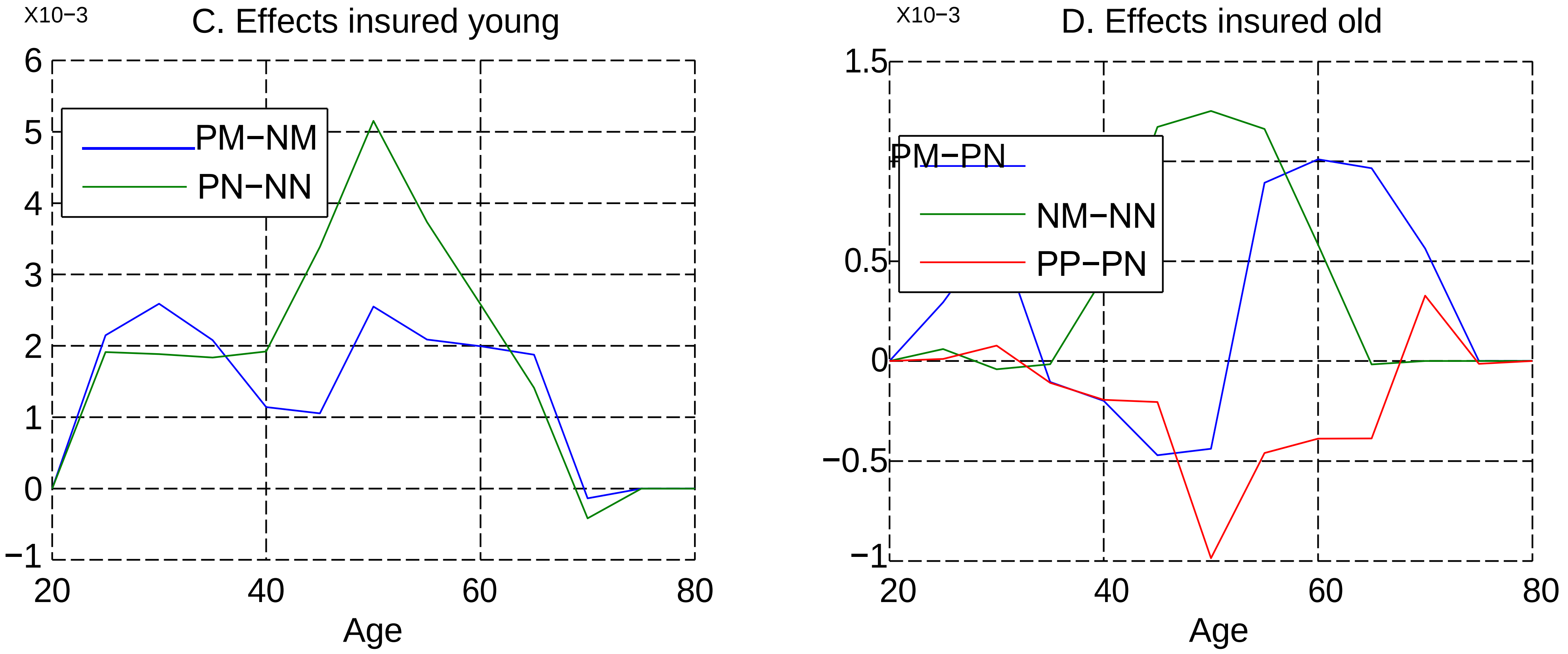


Figure 6: Life cycle out-of-pocket health expenditures

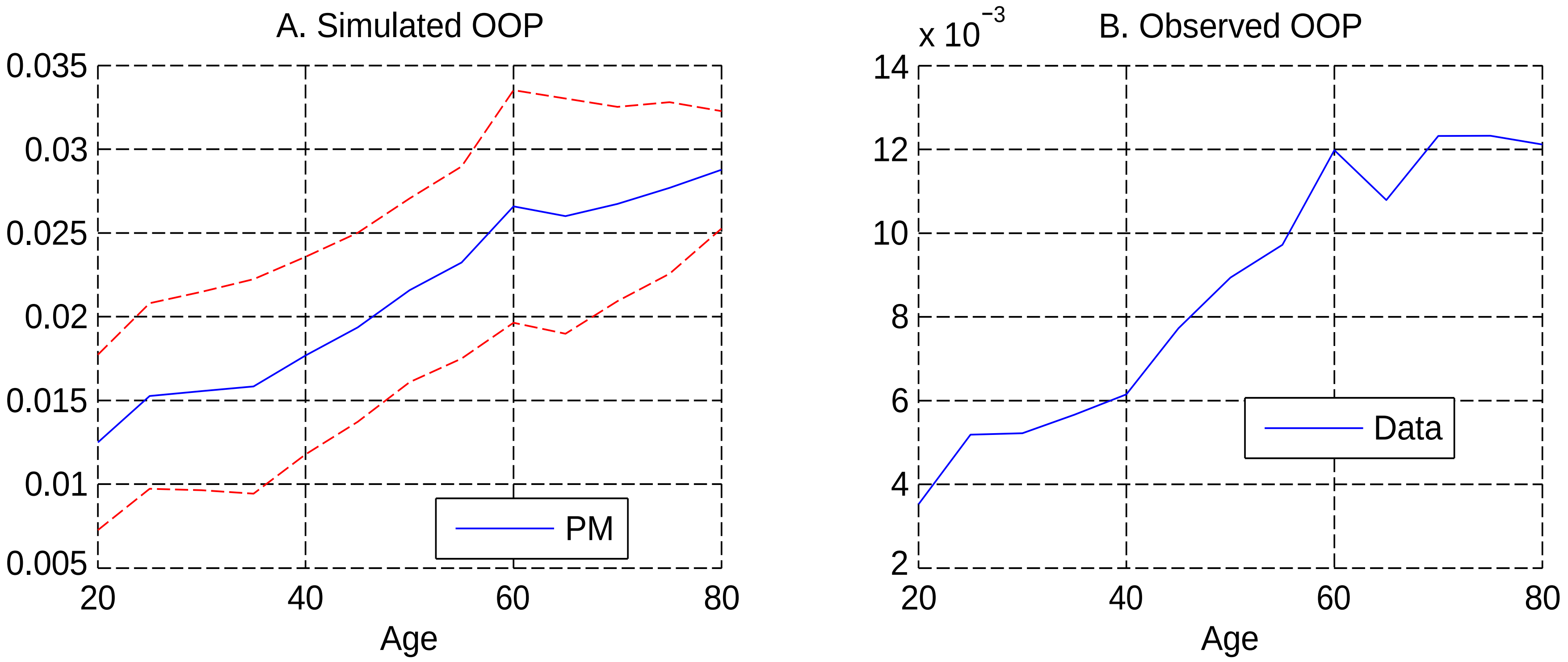


Figure 7: Life cycle healthy leisure

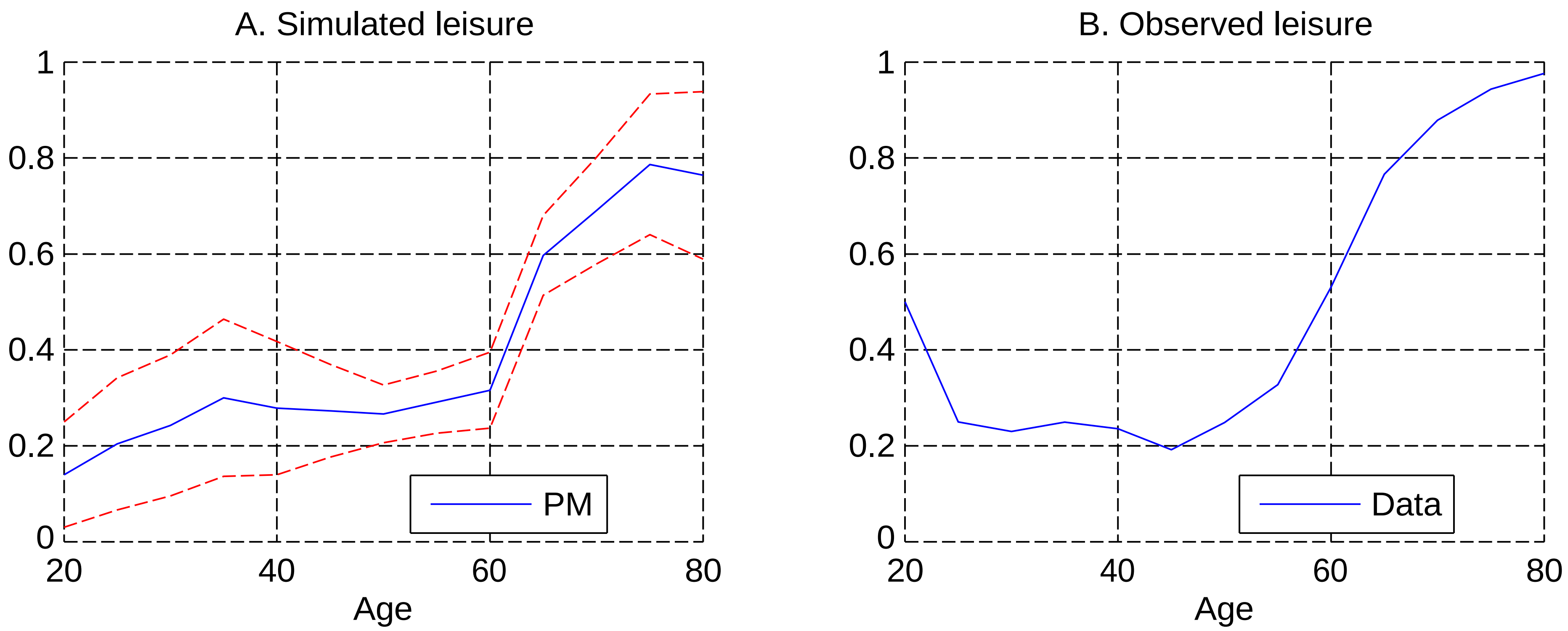


Figure 8: Life cycle wealth