Health Inequality: Role of Insurance and Technological Progress

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Disclaimer

The views expressed in this paper are those of the authors and do not necessarily reflect the views of the U.S. Census Bureau, the Agency for Healthcare Research and Quality, National Longitudinal Mortality Study, Mortality Differentials across American Communities, the National Heart, Lung, and Blood Institute, the National Cancer Institute, the National Institute on Aging, and the National Center for Health Statistics.

Summary

Motivation

- Huge inequality in health outcomes
  - Gap in Life-expectancy between top and bottom of income distribution $\approx$ 12 years (Chetty et al., 2016)
- Getting worse over time
  - From 2000 to 2014, rich gained 2.3 years vs poor gained 0.3 years (Chetty et al., 2016)
- Rich and poor have comparable health investments
  - Total health investments (including OOP, insurance and govt. programs) similar across income groups (Ales et al., 2012)
- **This paper**: Timing of investments and its interaction with technological innovation determines the outcomes

Research Questions

- What explains the increasing health inequality across income groups in the US?
- How does health insurance and medical technology affect individual's decisions on health capital investments, and outcomes such as mortality?
- What is the potential impact of policies on economic output and welfare?

Summary

- A life-cycle model where individuals choose how to invest in their health capital, examples include:
  - Purchases of private insurance
  - Timing of doctor visits
  - Medical spending
- Partial equilibrium model, estimated on insured individuals; feed in insurance prices from data

Summary

1. Model with timing explains a substantial part of the health inequality
2. Role of Technological Progress:
   - Non-uniform increase in TFP can lead to increase in inequality in Life-expectancy
3. Role of Insurance:
   - Public health insurance, funded by flat-income tax, decreases the inequality by half
4. External Validity:
   - Qualitative predictions of Medicaid and role of fixed-costs on Mortality

Contribution

1. Theoretical
   - Endogenous health-capital accumulation incorporating the *timing* of investment in a life-cycle model (Building onto: Grossman (1972), DeNardi et al (2017) and Gilleskie (1998))
   - Use continuous-time tools in health (Agarwal et al (2018))

2. Empirical
   - Put together nationally representative datasets of health, wealth, expenditures and mortality to estimate the model
   - Document the changes in life-expectancy over time using the mortality follow-up of about 9 Million individuals

Roadmap

1. Stylized Facts
2. Model: Individuals Problem
3. Results
4. External Validation: Regression Discontinuity and PSM

Data Sources

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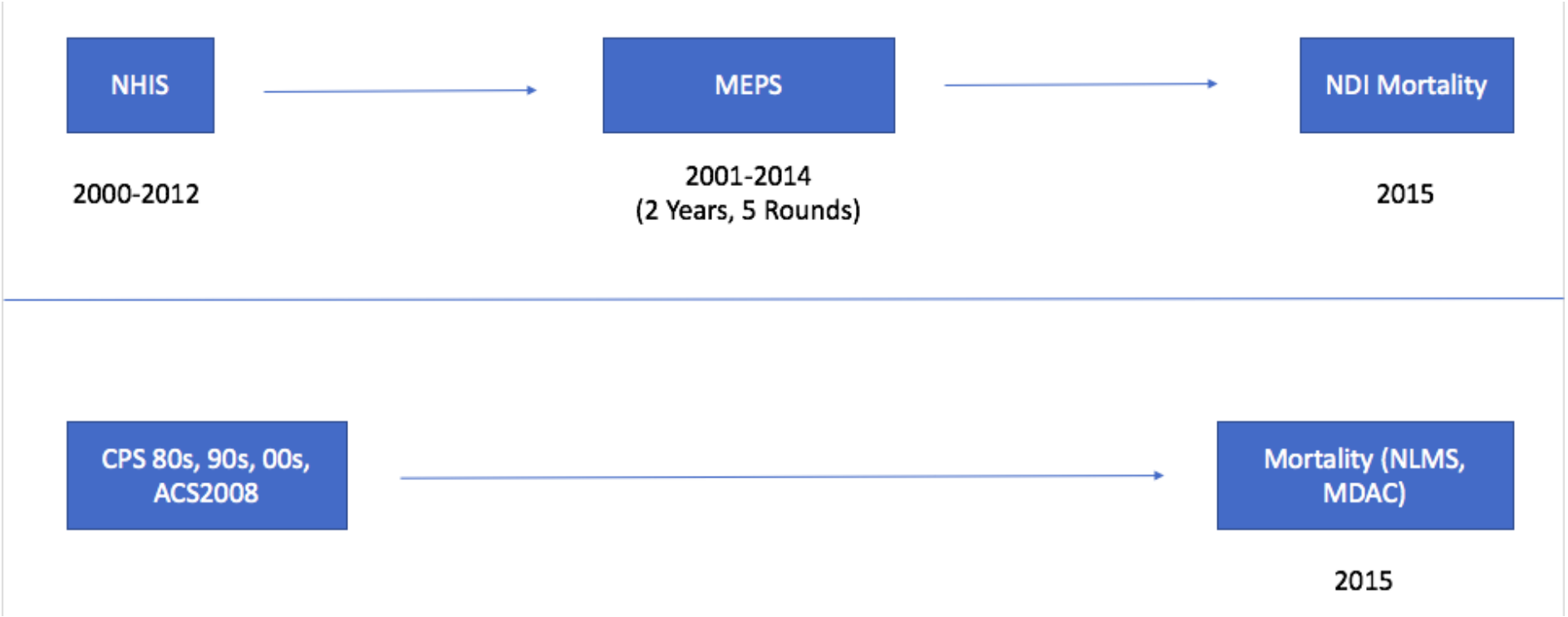

Facts

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1. Mean medical spending looks "almost" flat across income groups
2. More fraction of poor have zero medical spending but they also have very high spending
3. Visit decision of poor is more elastic to their health status compared to rich
4. Cancer related innovation is a major contributor in increased health disparities

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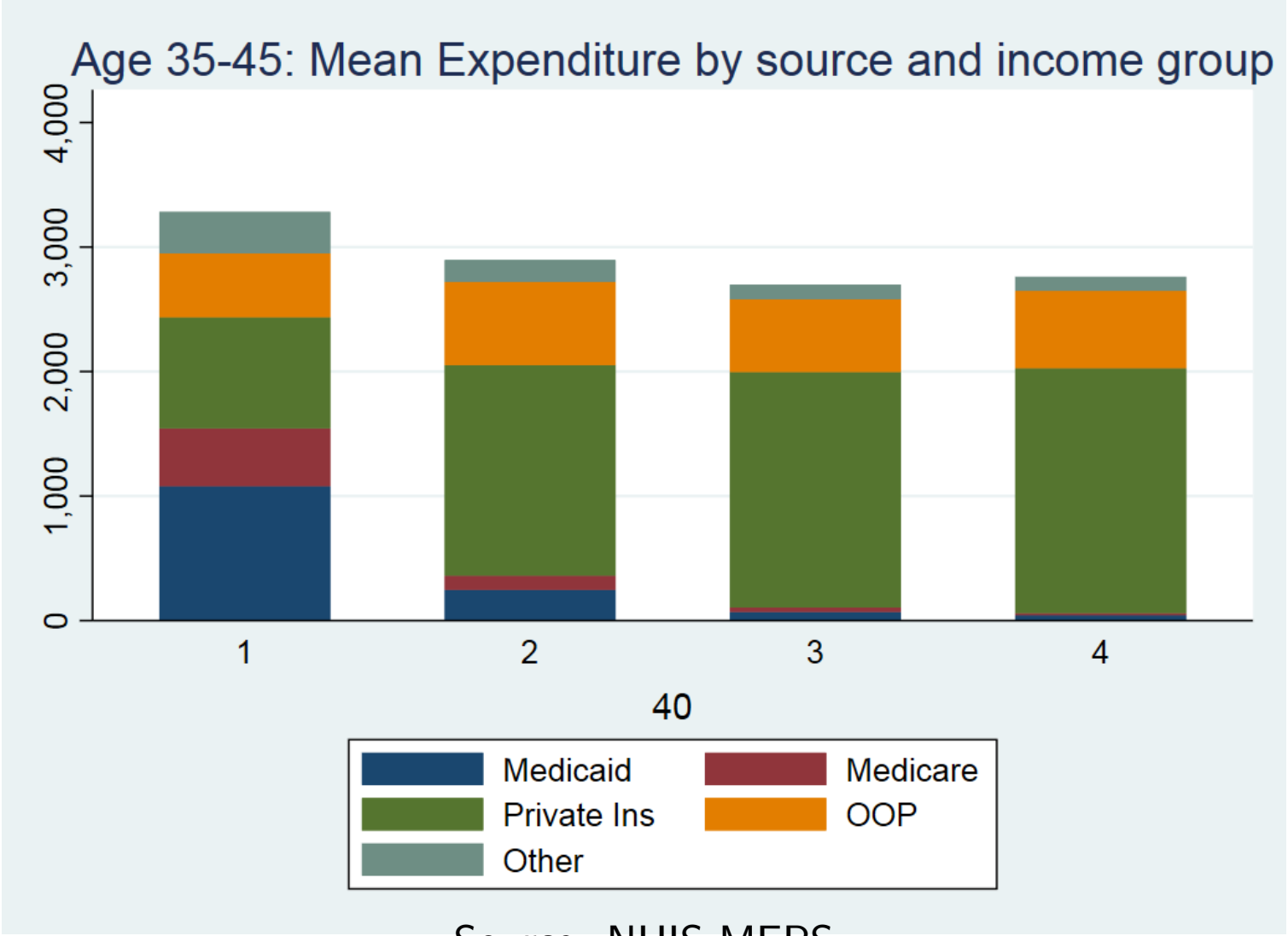
Mean Medical Expenditure: Age 35-45

Other Age Groups



Source: NHIS-MEPS

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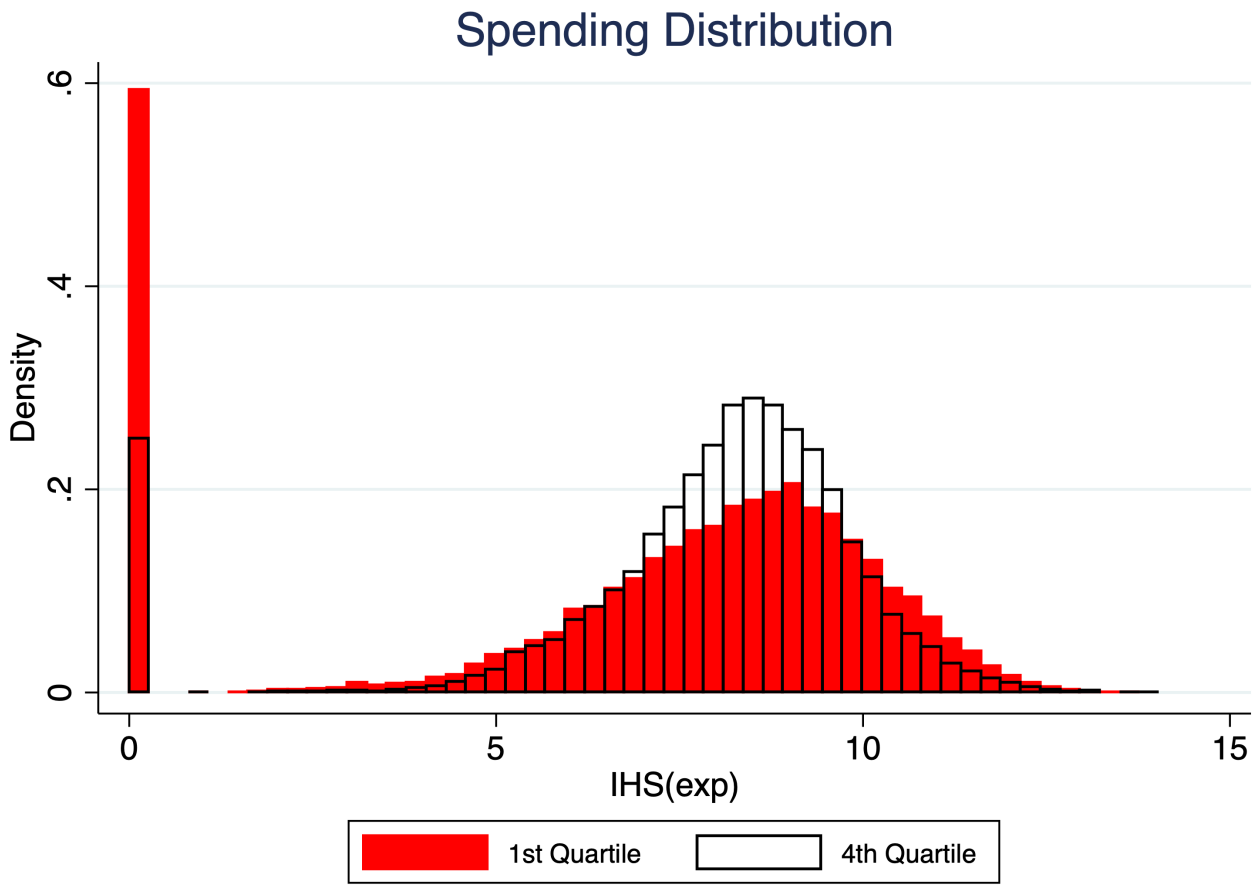
Medical Spending Distribution, Age 45-55



Notes: Inverse Hyperbolic Sine (IHS) Transformation

All Quartiles | Other Age Groups

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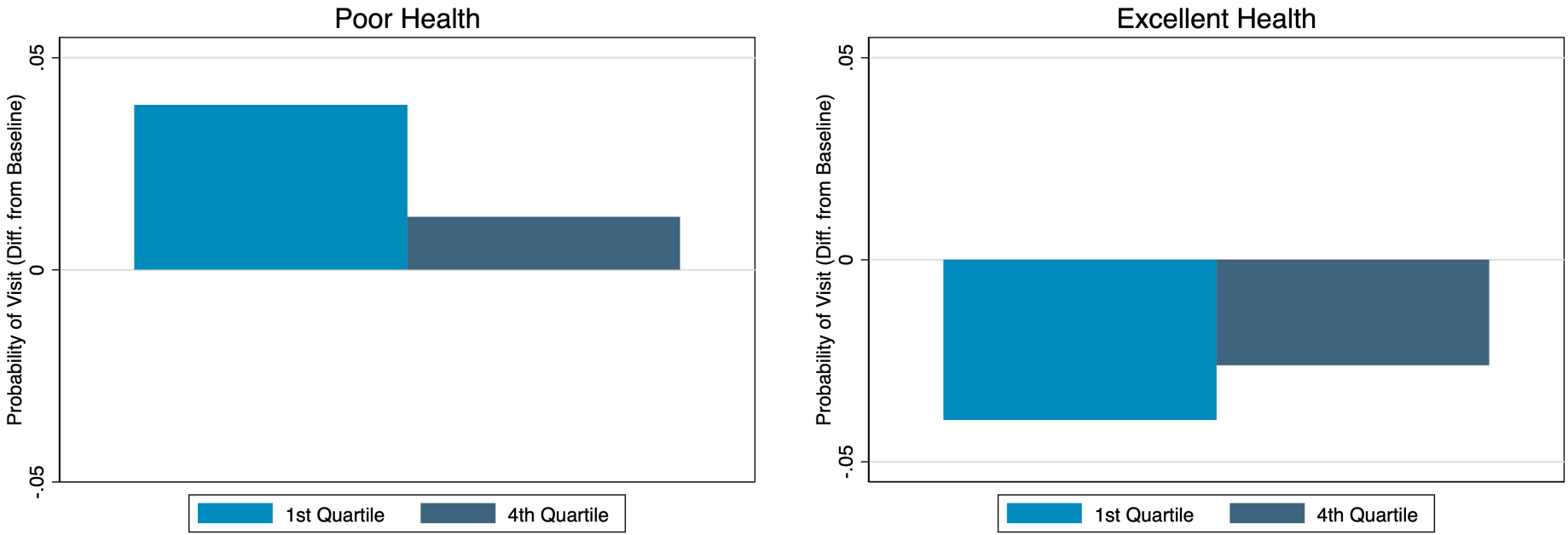
Timing of Visit by Income



Notes: Includes individual fixed effect; base set to average health in each income group regression

Rich individuals go to the doctor in a much healthier state

By Insurance | All Quartiles

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Gains in Life-expectancy: 1980s to 2000s

	0-25%	25-50%	50-75%	75-100%
Life-expectancy 1983	70.7	74.2	77.4	79.2
Total Change (1983 - 2003)	2.4	2.7	3.1	4.7
Cause of death:				
Malignant neoplasms	0.3	0.3	0.7	1.2
Heart	2.8	2.6	2.8	2.9

Life-expectancy conditional on surviving until age 20.

Full Decomposition

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Model

Individual's Problem

Health can take 5 states: 1,2,3,4,5
How healthy you are affects:

- Flow utility from consumption
- Probability of dying
- Income
- Utility Function

$$u(c,h) = (1+\phi(h))\frac{c^{1-\gamma}-1}{1-\gamma}$$

- Mortality: Poisson intensity $\lambda^T(h)$, terminal value V^T

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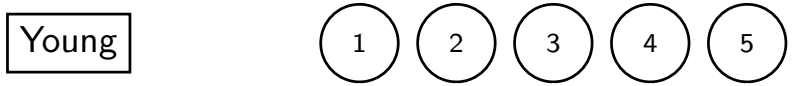
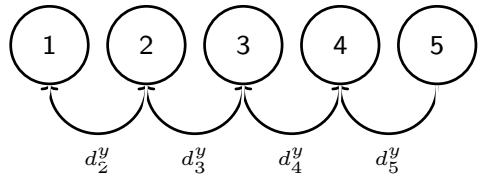
Health Evolution



Health Evolution

Young



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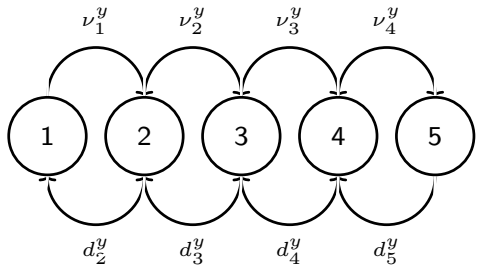

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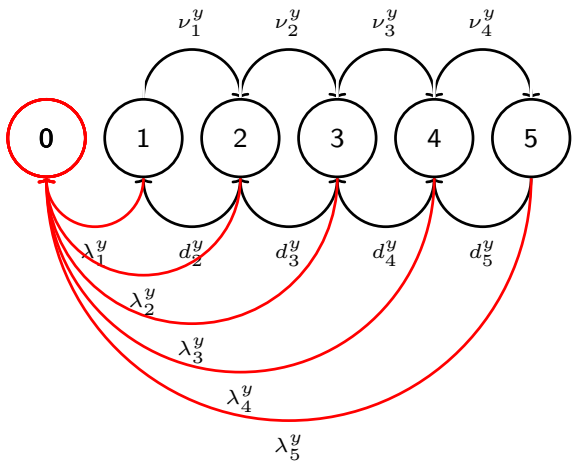

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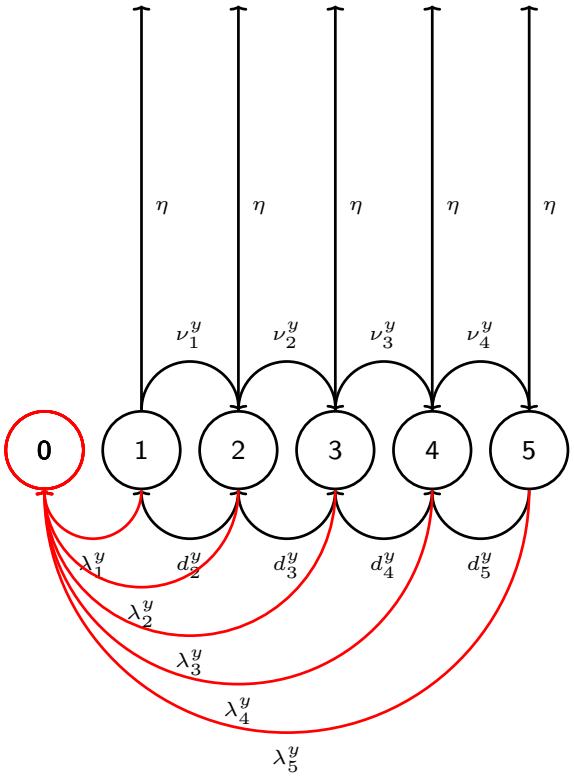

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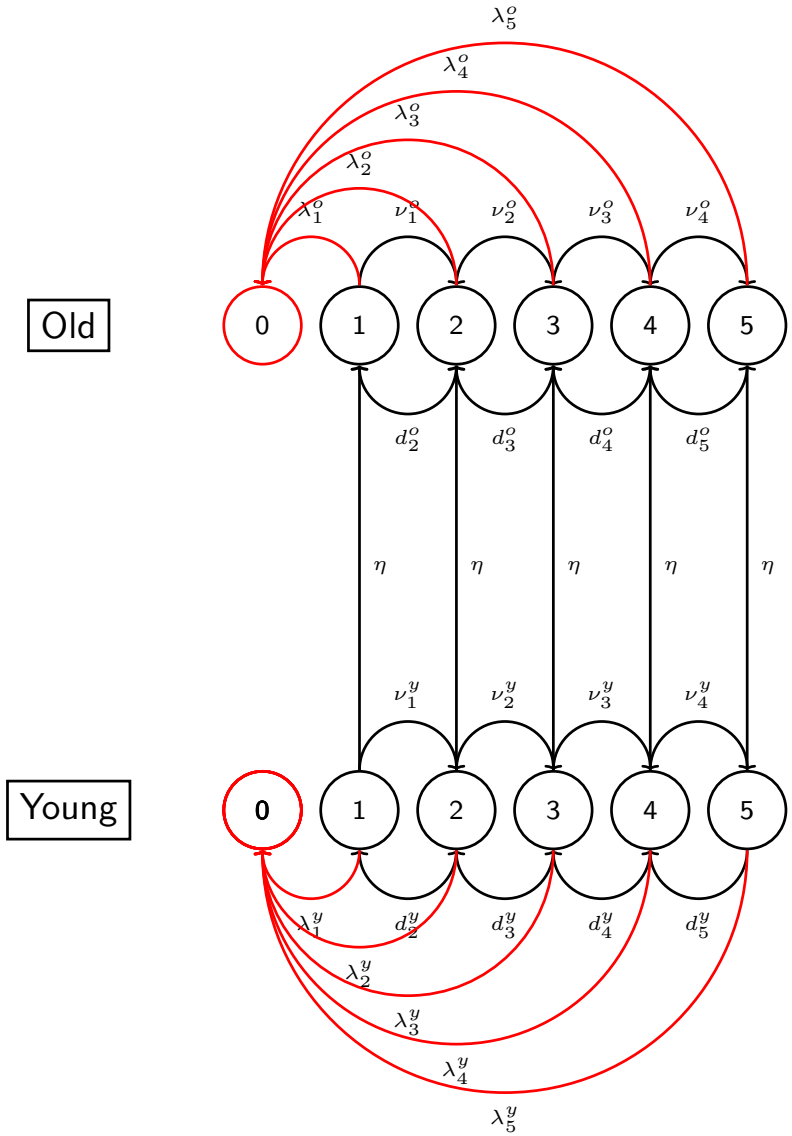

Individual's Problem

$$\begin{aligned} dw_t &= (rw_t + \theta(h)y(a,e) - c_t - p)\,dt \\ h_t &= \text{Poisson process with intensities } d(h,a), \nu \end{aligned}$$

w: Wealth
$\theta(h)$: Productivity
$y(a,e)$: Income
r: Risk free rate
p: Insurance premium
a: Age
e: Education
$d(h,a)$: Health depreciation intensity
ν: Health improvement intensity

Insurance Take-up Problem

- Individuals can decide on insurance take-up problem at random intervals (Poisson process)
- Offered a price of the premium based on their health and age
- The premium stays the same until another (random) realization of the Poisson

Insurance Take-up

Without Medical Investments

$$\rho V(w,h,\nu,a,I,p) = \max_{c}\{u(c,h) + V_w[\theta(h)y(a) + rw - c - p]\}$$

$$\underbrace{\eta[V(w,h,\nu,a+1,I,p) - V(.)]}_{\text{aging to } a+1} + \underbrace{\nu[V(w,h+1,\nu_0,a,I,p) - V(.)]}_{\text{transition to } h+1} +$$

$$\underbrace{d(h,a)[V(w,h-1,\nu_0,a,I,p) - V(.)]}_{\text{transition to } h-1} + \underbrace{\lambda^T(h,a)[V^T - V(.)]}_{\text{death}} +$$

$$\underbrace{\phi[\bar{V}(w,h,\nu,a,I',p') - V(.)]}_{\text{insurance choice}}$$

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ν: Transition intensity to a better health

Medical Care Choice

- Individuals can invest in the likelihood of transitioning to a better health
- Face a fixed cost of going to the doctor and a proportional out-of-pocket cost
- Optimally choose when to visit the doctor and how much to spend on medical care

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Medical Care Choice

Wealth evolution on Visit

$$\overbrace{w'}^{\text{Wealth after visit}} = \overbrace{w}^{\text{Wealth before visit}} - \overbrace{k(I_0)}^{\text{Fixed Cost}} - \overbrace{m(1-q(I_0))}^{\text{Out-of-pocket Cost}}$$

Health evolution on Visit

$$\nu' = \nu_0(a) + Am^{\alpha_m}$$

HJB Variational Inequality

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m: Medical Spending

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A: TFP

Private Insurance Take-up Decision, Age 25-35

Figure: Bad Health

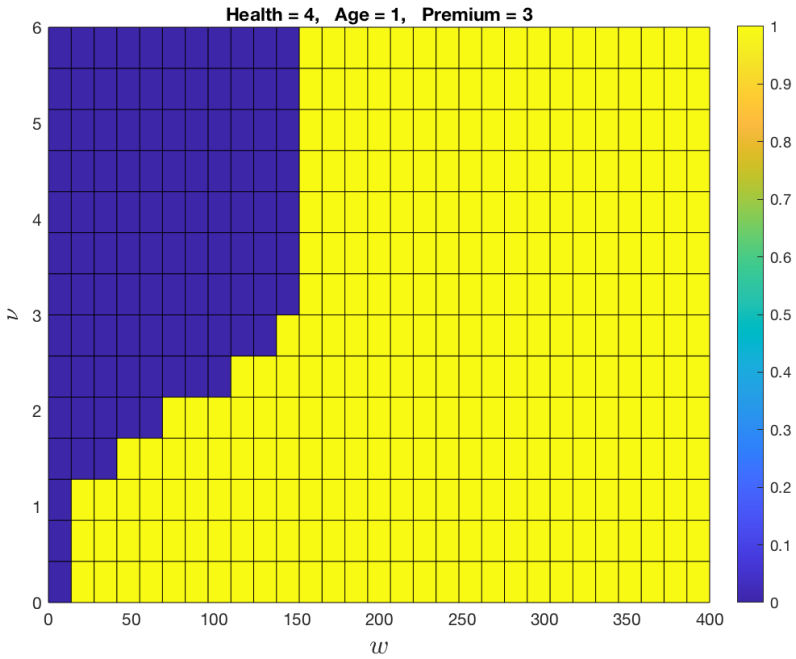
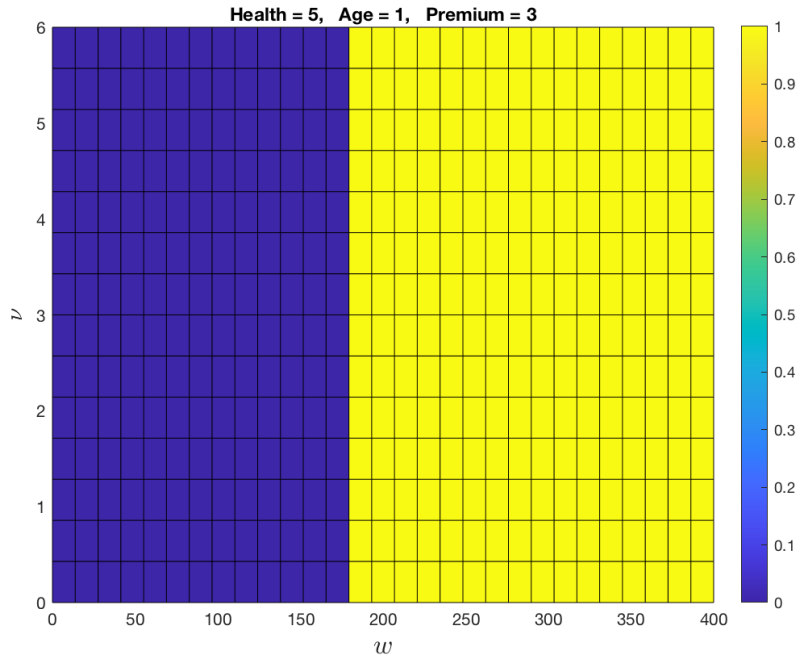


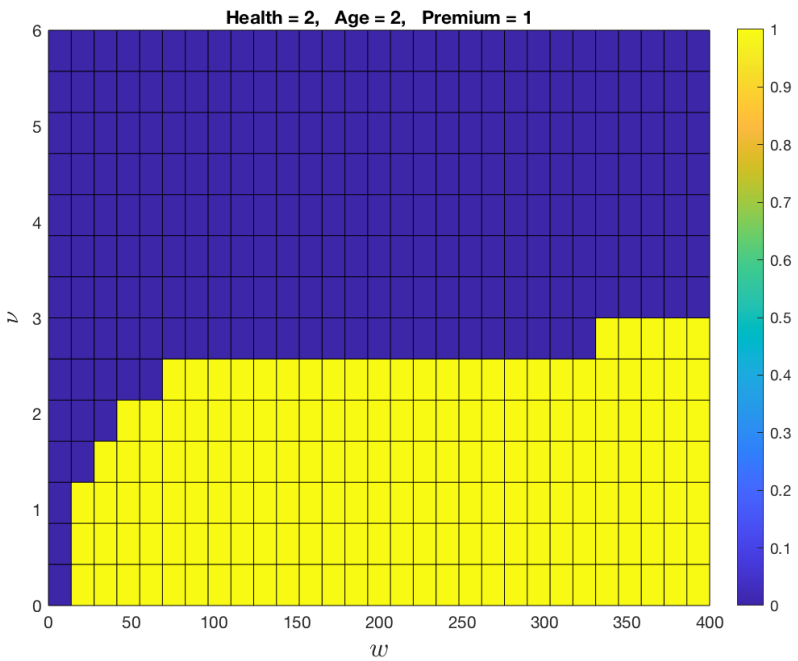
Figure: Excellent Health



Medicaid

Visit Decision, Age 35-45

Figure: Uninsured, Bad Health



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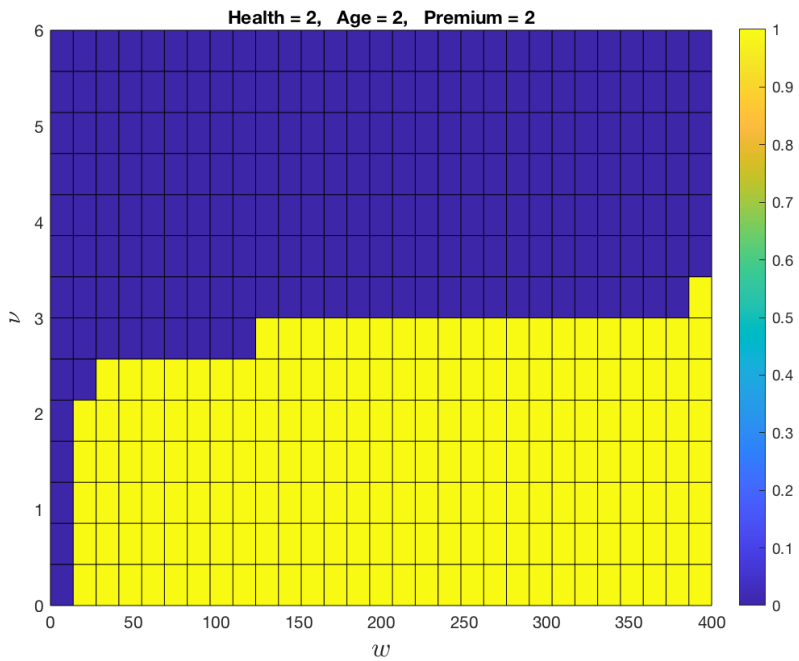

Continuation (don't go to the doctor)

Stopping (go to the doctor)

Visit Decision, Age 35-45

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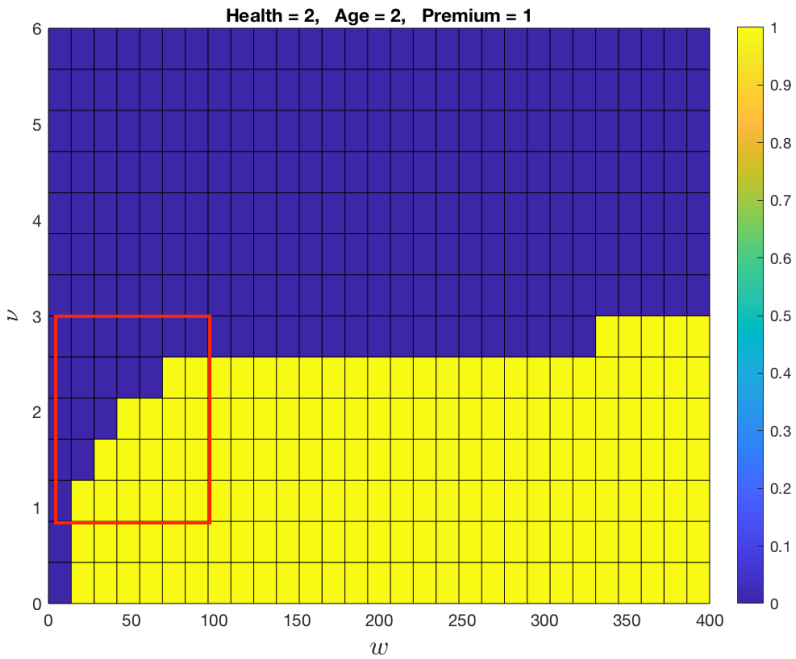

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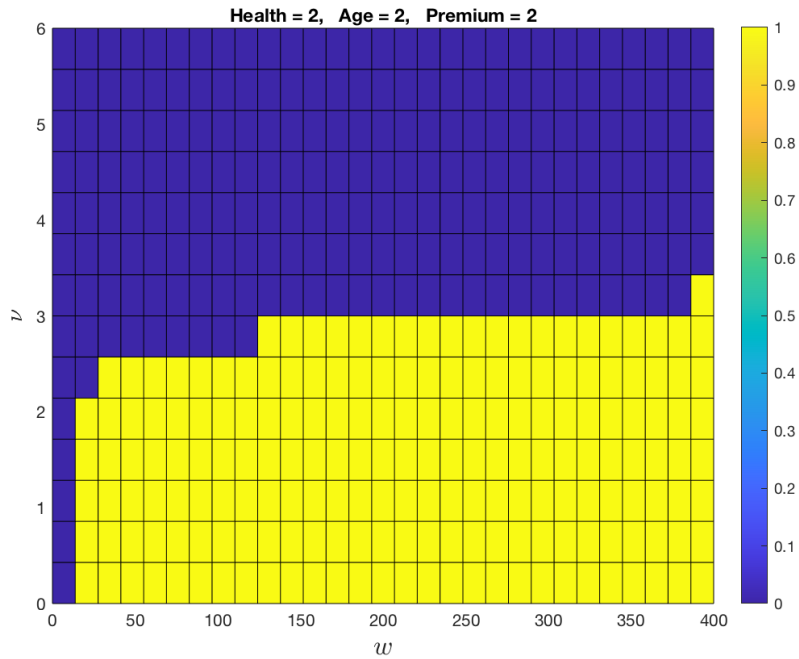

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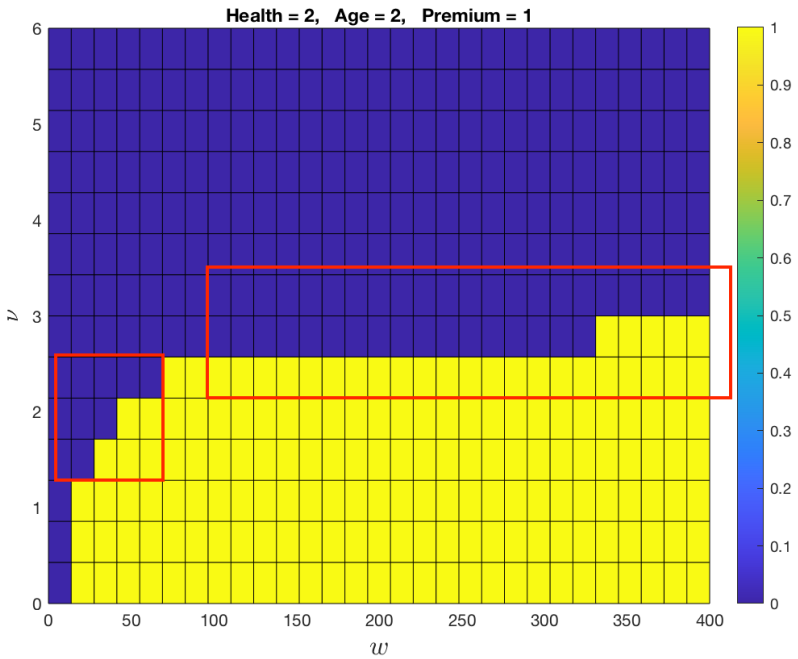

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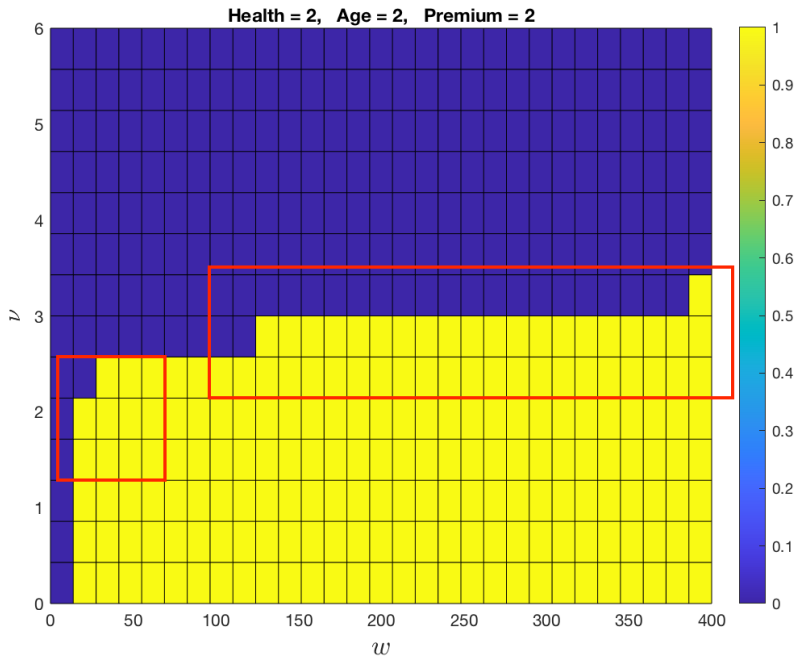

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Initial Estimation Summary

- Parameterize the functional forms to reduce the number of parameters
- Estimating some orthogonal parameters outside of the model
- Using SMM to target choices (visits, spending) and transitions (improvements and changes in health) by age and health
- Leave moments by wealth untargeted

Estimation

Initial Estimates

Table: Initial Estimates

Meaning	Parameter	Value	Std. Errors*
TFP	A	2.34	(0.007)
Elasticity w.r.to. m	α_m	0.10	(0.002)
Fixed Cost	k	0.0213	(0.00011)
Depreciation Poisson-1	d_0	0.86	(0.0007)
Depreciation Poisson-2	d_1	0.23	(0.0005)
Depreciation Poisson-2	d_2	-0.026	(0.0007)
Natural Improvement-1	n_0	0.48	(0.005)
Natural Improvement-2	n_1	-0.022	(0.0004)
Natural Improvement-3	n_2	-0.028	(0.0009)
Utility parameter-1	ϕ_0	1.26	(0.0019)
Utility parameter-2	ϕ_1	1.016	(0.00029)
Utility parameter-3	ϕ_2	0.036	(0.0054)

Summary of Estimates

- Fixed cost per visit: \$213
- Ages 25-35, the expected duration before going to a worse health state: 1 year and 3 months
- Ages 65-75, the expected duration before going to a worse health state: 9 months
- Ages 25-35, the expected duration before going to a better health state without investments: 2 years
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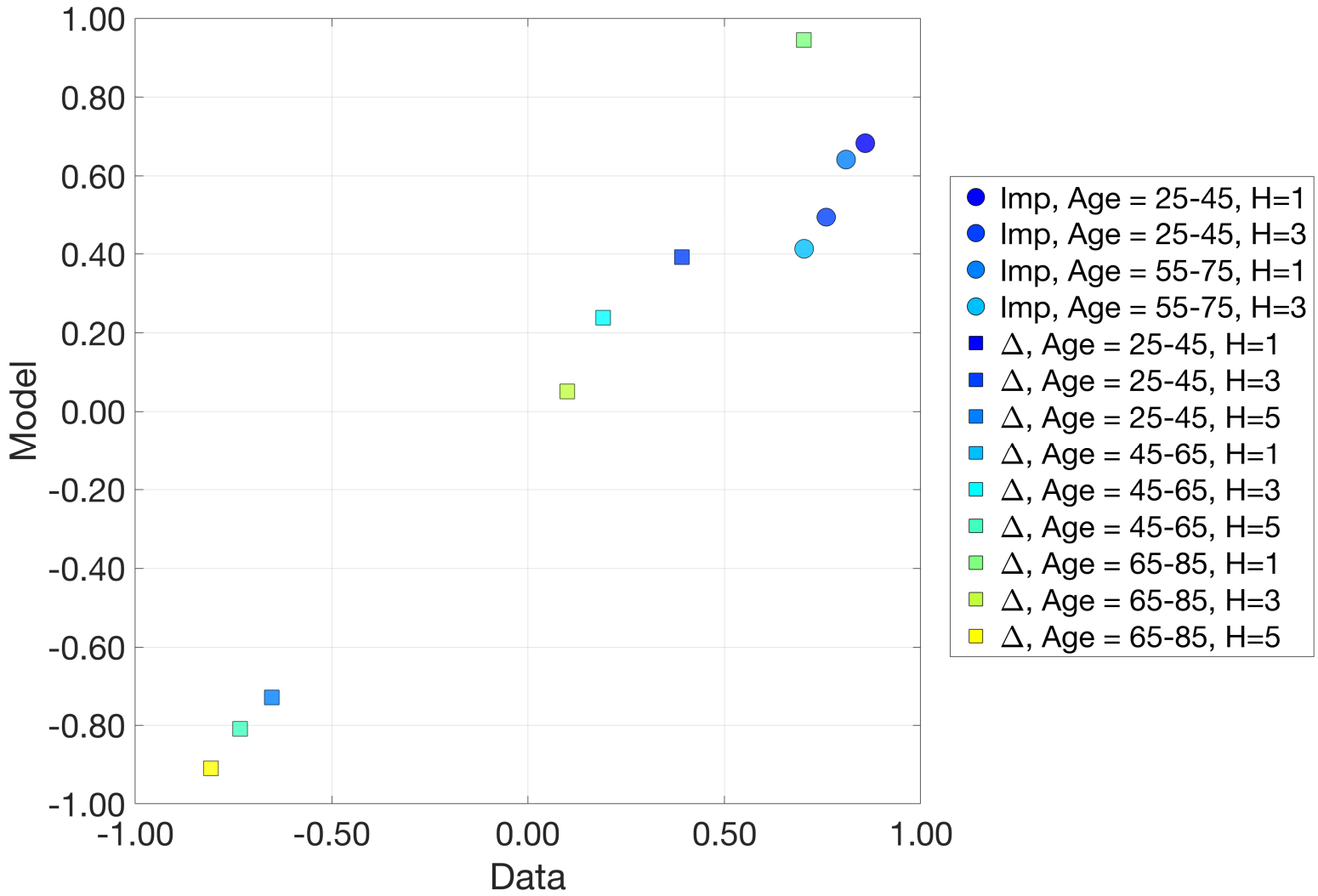
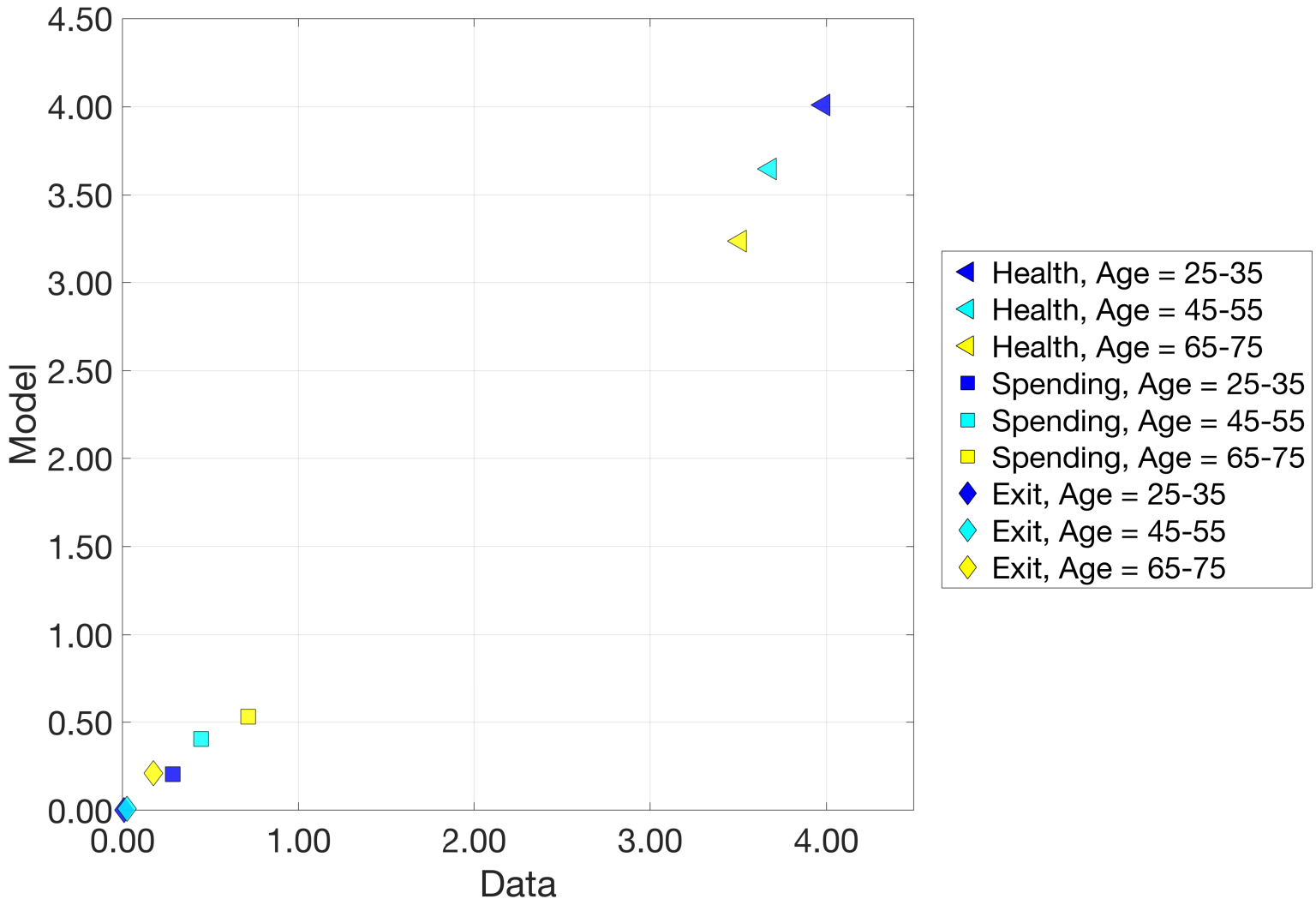
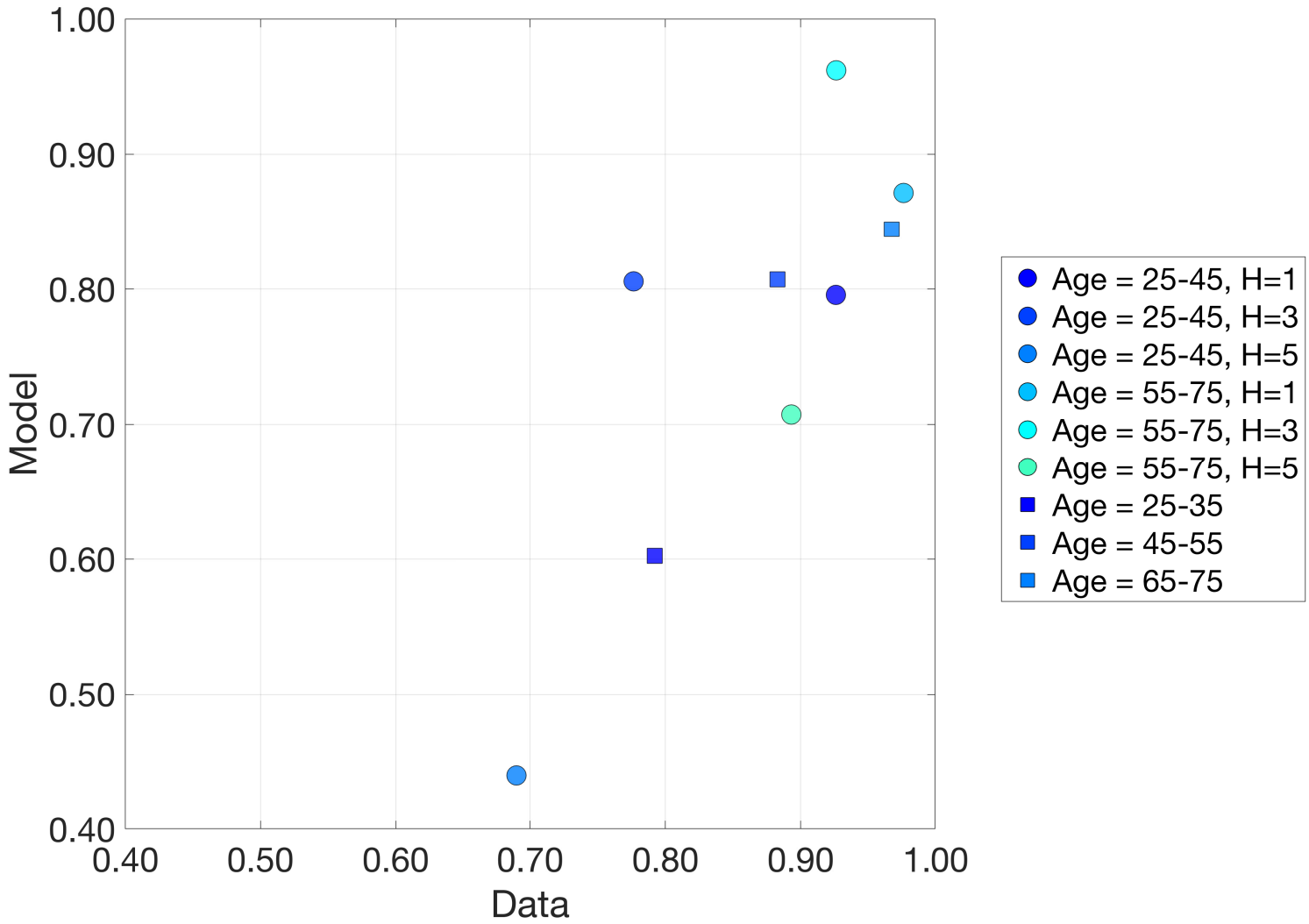
Model Fit: Health Transitions



Model Fit: Health, Spending and Mortality over Age



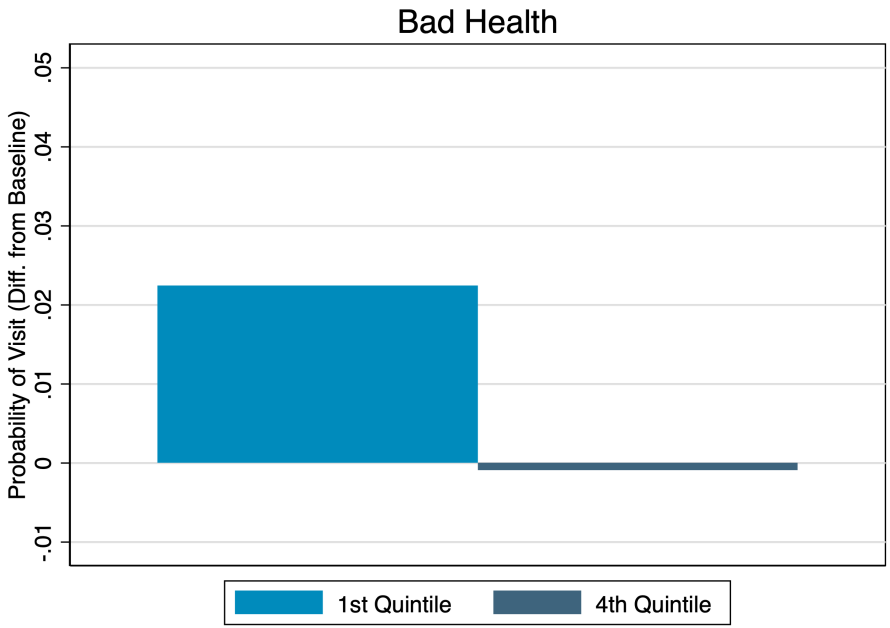
Model Fit: Visit Decisions

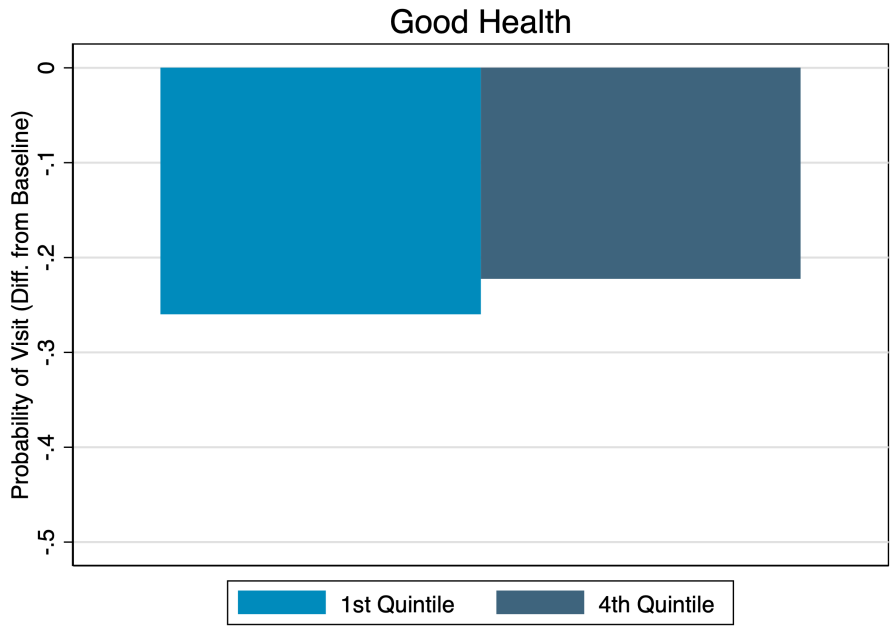


Summary of Model Fit

- We match the levels and differences in changes in health, average spending and health over age
- We are off in levels but match the differences in improvements and visit by age
- We are off in levels and differences in visit by health

Timing of Visit by Wealth





Lower wealth individuals have a highly elastic visit decision

Untargeted: Health-care Spending by Health and Wealth

Table: Model: Age 35-45

	Spending by Health and Wealth				
	H1	H2	H3	H4	H5
W1	0.58	0.62	0.56	0.41	0.19
W2	0.80	0.79	0.78	0.72	0.37
W3	0.55	0.59	0.57	0.45	0.27
W4	0.76	0.78	0.57	0.31	0.21

Table: Data: Age 35-45

	Spending by Health and Wealth				
	H1	H2	H3	H4	H5
W1	0.60	0.33	0.21	0.17	0.12
W2	0.73	0.41	0.25	0.18	0.13
W3	0.77	0.47	0.29	0.21	0.15
W4	0.74	0.46	0.32	0.24	0.18

Fixing health, wealthy spend more on their health over the next year thus transitioning to a better health with a higher probability

Untargeted: Exit by Health and Wealth

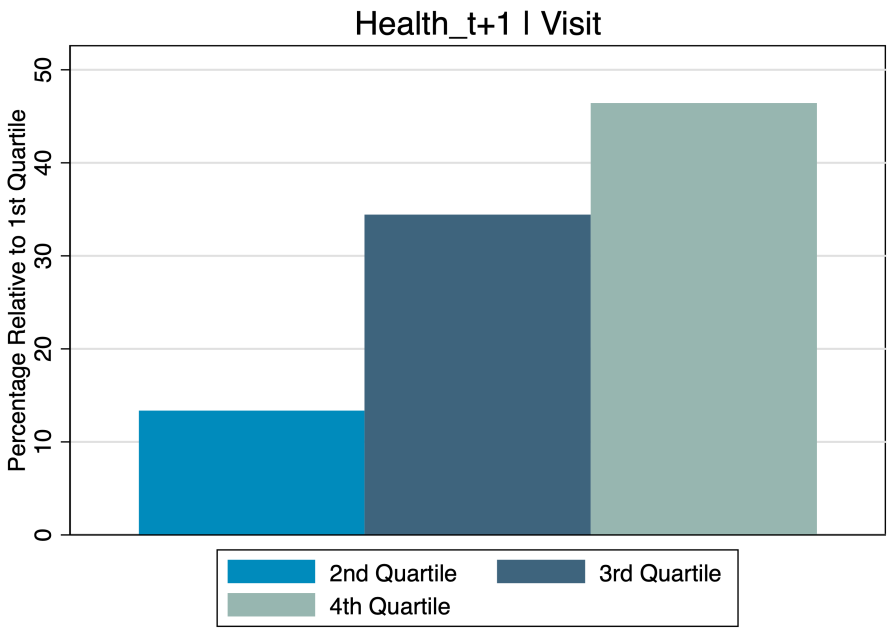
Table: Model: Age 35-45

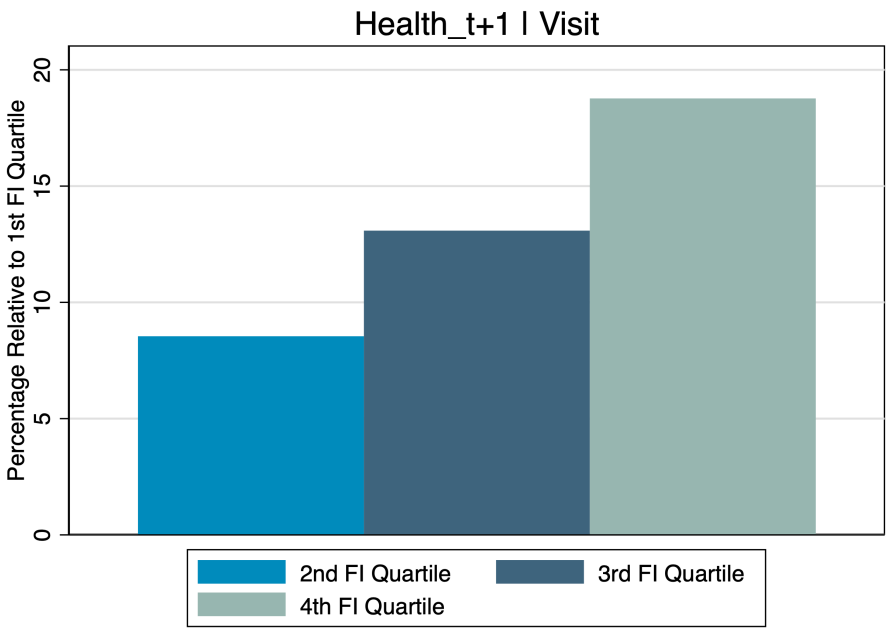
	Exit by Health and Wealth				
	H1	H2	H3	H4	H5
W1	3.1	1.6	0.8	0.4	0.2
W2	3.2	1.8	0.7	0.4	0.2
W3	3.1	1.1	0.7	0.2	0.2
W4	2.7	1.5	0.7	0.3	0.2

Table: Data: Age 35-45

	Exit by Health and Wealth				
	H1	H2	H3	H4	H5
W1	4.8	1.5	0.7	0.3	0.2
W2	5.4	1.3	0.5	0.2	0.1
W3	4.0	1.0	0.5	0.4	0.3
W4	3.1	1.4	0.3	0.3	0.2

$\text{Health}_{t+1}|$ Visit





Source: NHIS-MEPS
Notes: Regress: Health_{t+1} - Health_t on Health_t, Age, Age^2; base set to family income (Data) or wealth (Model) poor

Results

Results

	Wealth Quartiles			
	W1	W2	W3	W4
Life-Expectancy	68.09	69.87	73.82	74.24
Mean Spending 35-45	0.53	0.68	0.40	0.40
Mean Spending 45-55	0.71	0.59	0.43	0.63
Mean Spending 55-65	0.55	0.85	0.52	0.92
100 x Mortality 35-45	0.11	0.11	0.05	0.04
100 x Mortality 45-55	0.38	0.20	0.16	0.13
100 x Mortality 55-65	2.13	1.74	0.71	0.82

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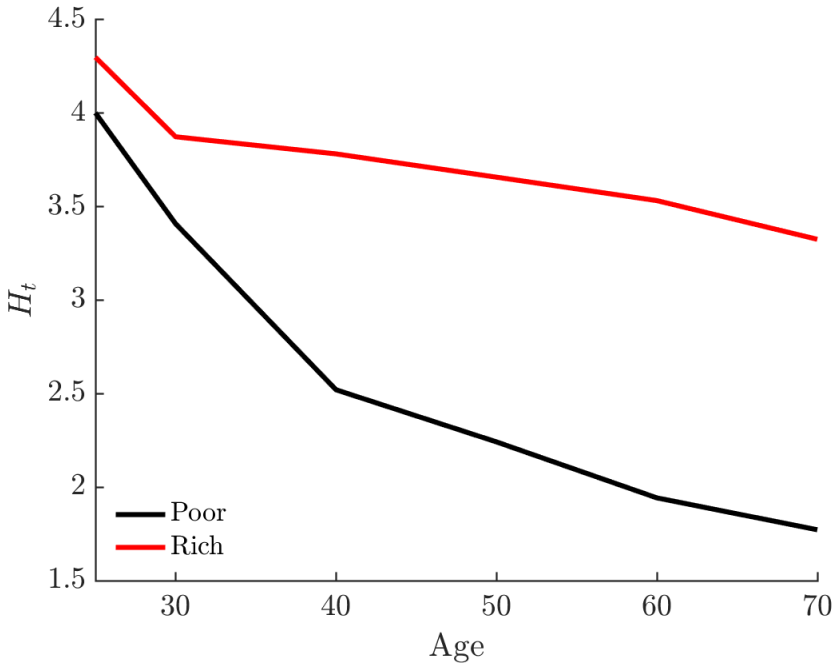
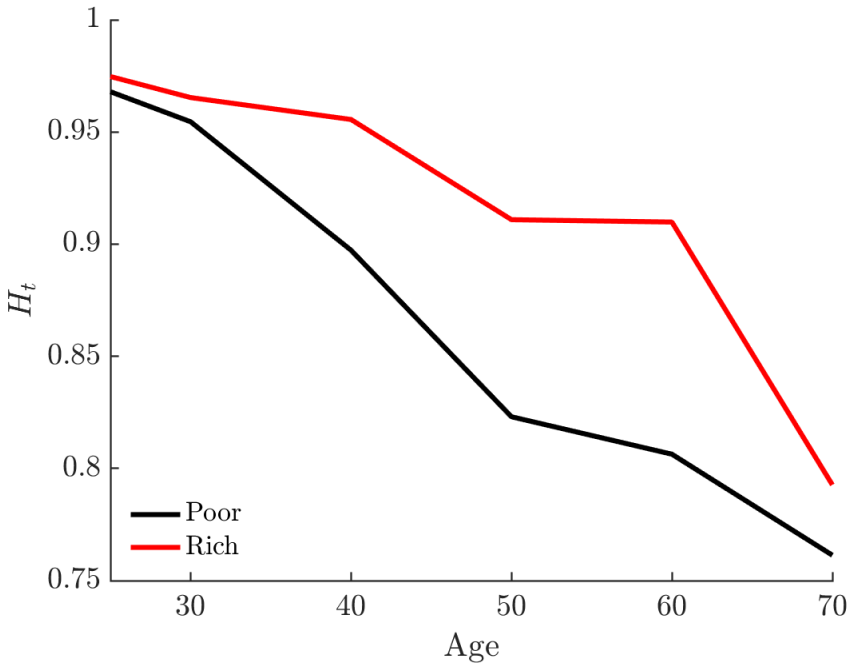
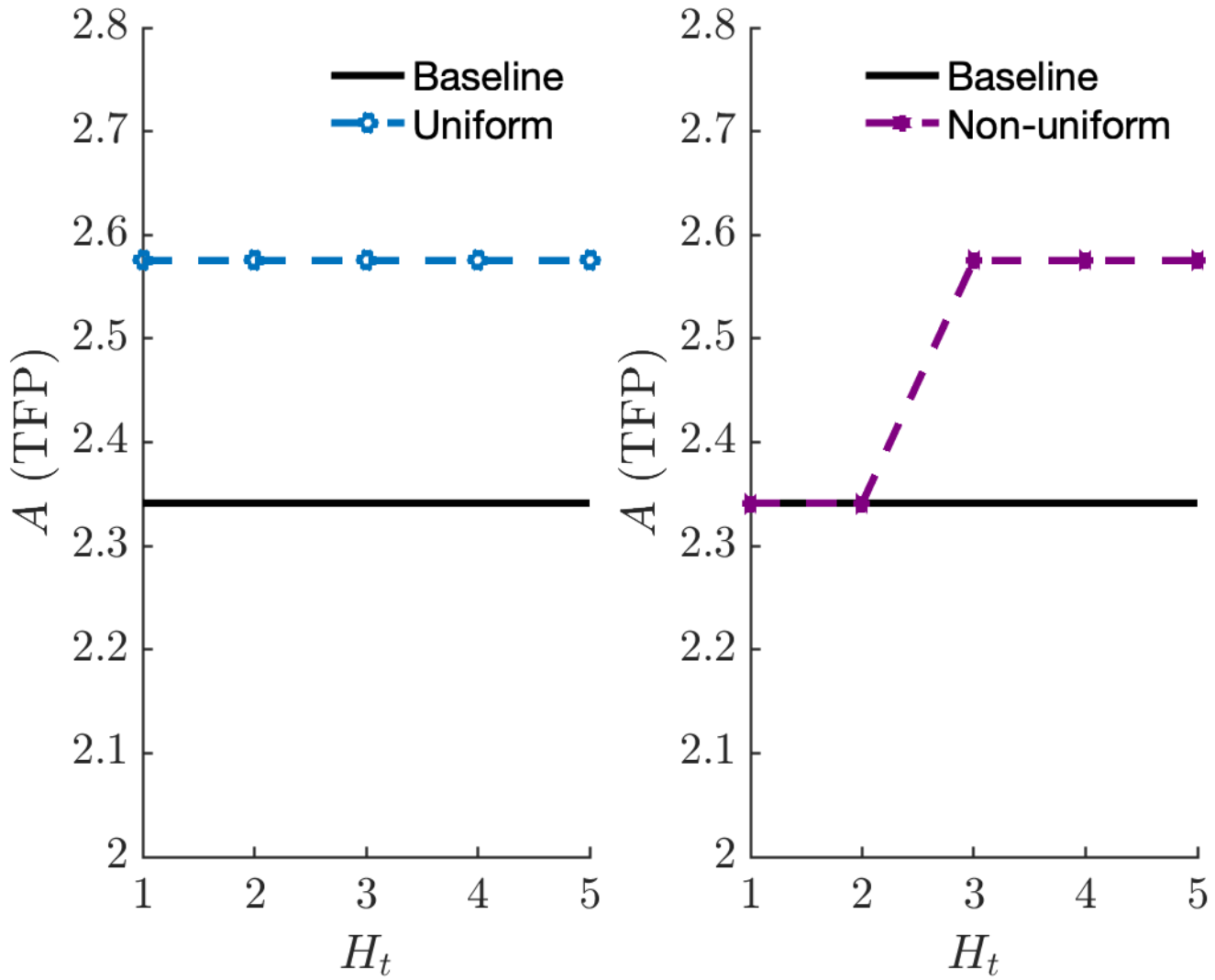
Health over the Life-Cycle





Role of Technological Progress

1. Uniform (across health states) increase increase in TFP (10%)
2. Non-uniform (across health states) increase increase in TFP (10%)



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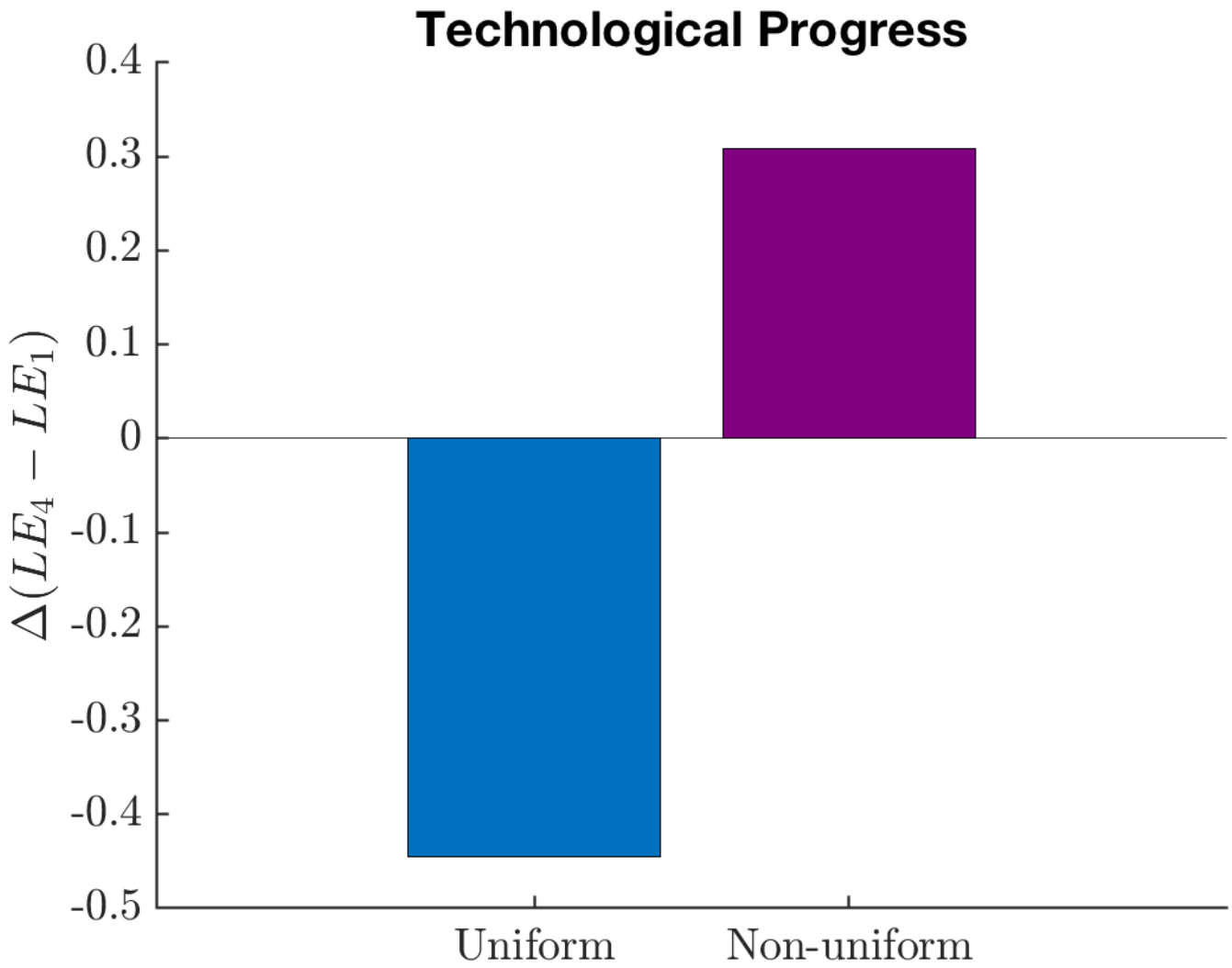
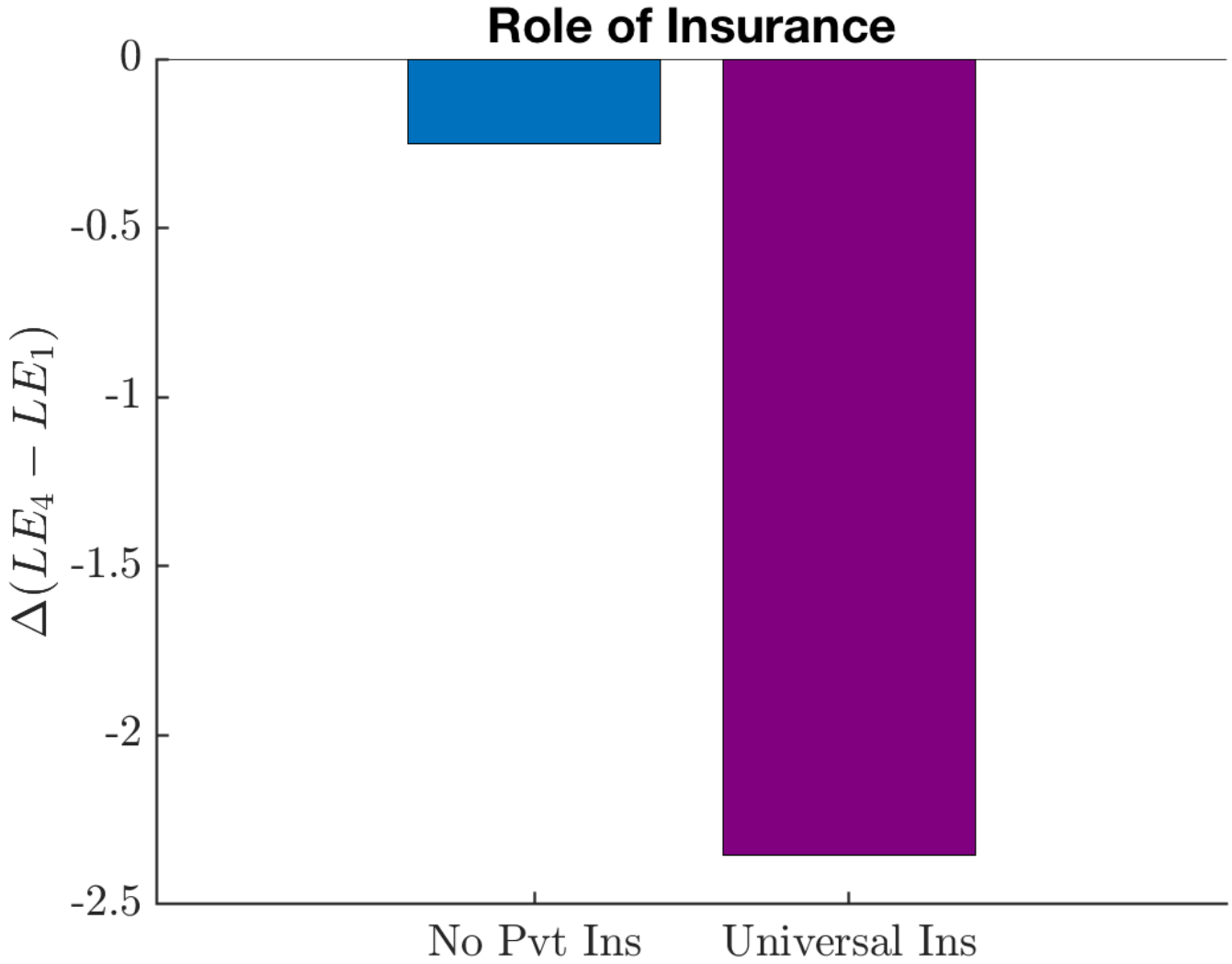


Role of Insurance

Two experiments:

1. We take away the insurance choice
2. Give everyone a public health insurance financed by a flat 15% income tax along with 30% cost sharing

Role of Insurance



External Validation

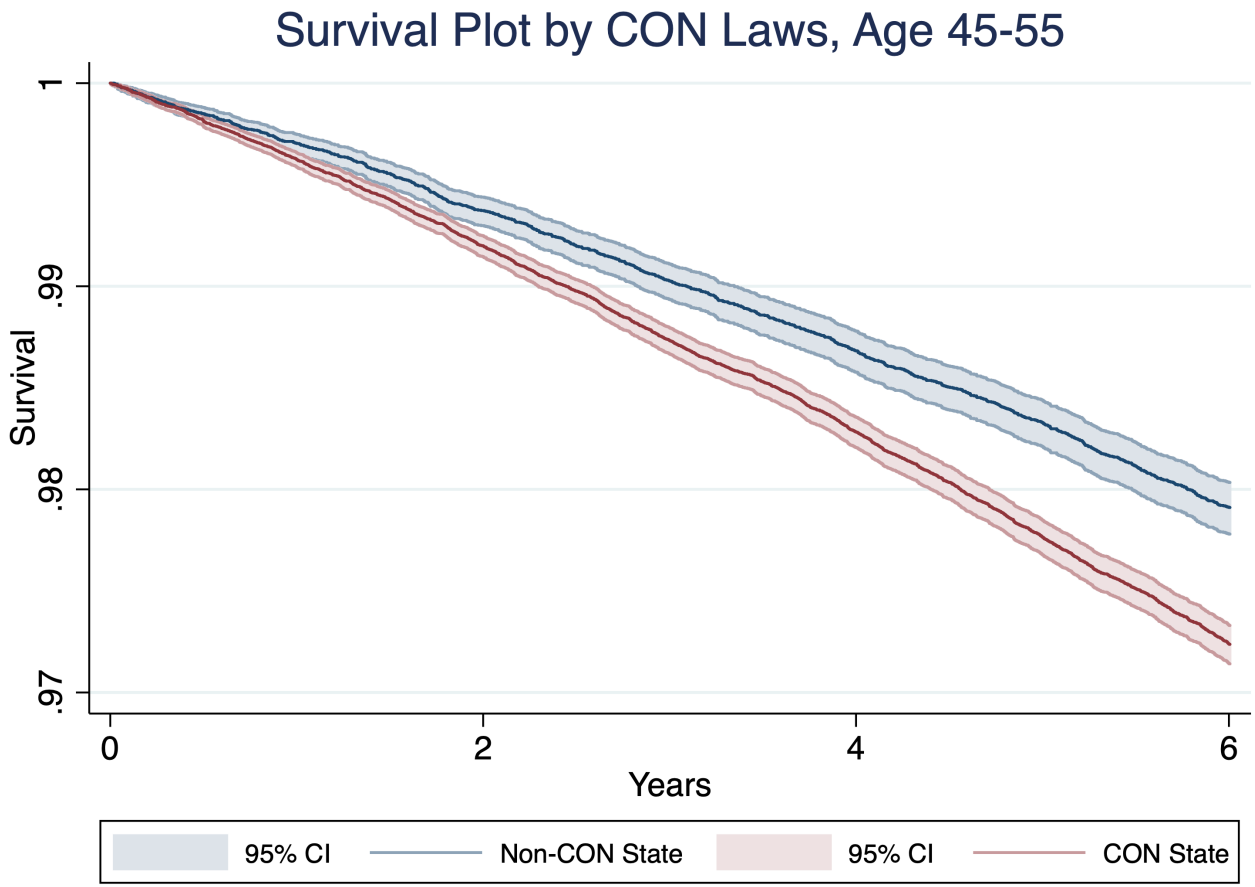
Reduced-form Estimates PSM RD

Table: Effect of Insurance on Mortality

	Logit6a	PSM_6a	Logit6b	PSM_6b	Logit6c	PSM_6c	RD6c
1 if Medicaid	0.0141***		0.0135***		0.0139***		-0.0952***
	[0.0013]		[0.0011]		[0.0008]		[0.0253]
1 if Private Insurance	-0.0052***	-0.0054***	-0.0026***	-0.0035***	-0.0016***	-0.0018***	
	[0.0008]	[0.0012]	[0.0007]	[0.0010]	[0.0006]	[0.0007]	
Adjusted Income	-0.0005***		-0.0008***		-0.0007***		
	[0.0002]		[0.0001]		[0.0001]		
Age	0.0040***		0.0033***		0.0020***		
	[0.0002]		[0.0002]		[0.0002]		
Female	-0.0132***		-0.0107***		-0.0062***		
	[0.0005]		[0.0005]		[0.0004]		
1 if Medicare	0.0121***		0.0133***		0.0145***		
	[0.0010]		[0.0009]		[0.0007]		
Observations	301327	282423	365109	335939	443521	407441	39642
Baseline		0.0231***		0.0157***		0.0121***	
		[0.0007]		[0.0002]		[0.0002]	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard Errors are in brackets.

Survival Plot: CON vs Non-CON States, Age 45-55



Notes:

Summary

1. Timing of the investments explain a substantial part of the health inequality
2. Role of Technological Progress:
   - Rich have gained a year in life-expectancy due to cancer-related medical innovations while poor have gained only 3.5 months
   - Non-uniform increase in TFP can lead to increase in inequality in Life-expectancy
3. Role of Insurance:
   - Public health insurance, funded by flat-income tax, goes a long way in decreasing the inequality by half

Ongoing Steps

1. Insurance premium determined in equilibrium from dynamic take-up problem
2. Estimating the version with disability/ Medicare and Medicaid
3. Using CON laws variation across states on visit decisions and outcomes
4. Simulated Medicaid eligibility across states and over time on visit and outcomes
5. Role of bad behavior, such as smoking

Thanks!

Insurance Firm's Value

Insurance Firm's Value

$$\rho F(w,h,\nu,a,I,p) = p + \underbrace{\eta[F(w,h,\nu,a+1,I,p) - F(.)]}_{\text{aging to } a+1} +$$

$$\underbrace{\nu[F(w,h+1,\nu_0,a,I,p) - F(.)]}_{\text{transition to } h+1} + \underbrace{d(h,a)[F(w,h-1,\nu_0,a,I,p) - F(.)]}_{\text{transition to } h-1} +$$

$$\underbrace{\lambda^T(h,a)[0 - F(.)]}_{\text{death}} + \underbrace{\phi[\bar{F}(w,h,\nu,a,I',p') - F(.)]}_{\text{insurance choice from individual's problem}}$$

$$\bar{F}(w,h,\nu,a,I',p') = \begin{cases} 0, \text{ if } I^* = 0 \\ F(w,h,\nu,a,I,p(h,a)) \text{ if } I^* = 1 \end{cases}$$

$$\lim_{\tau \to 1} F(.) = -mq(I) + F(w',h',\nu',a,I,p)$$

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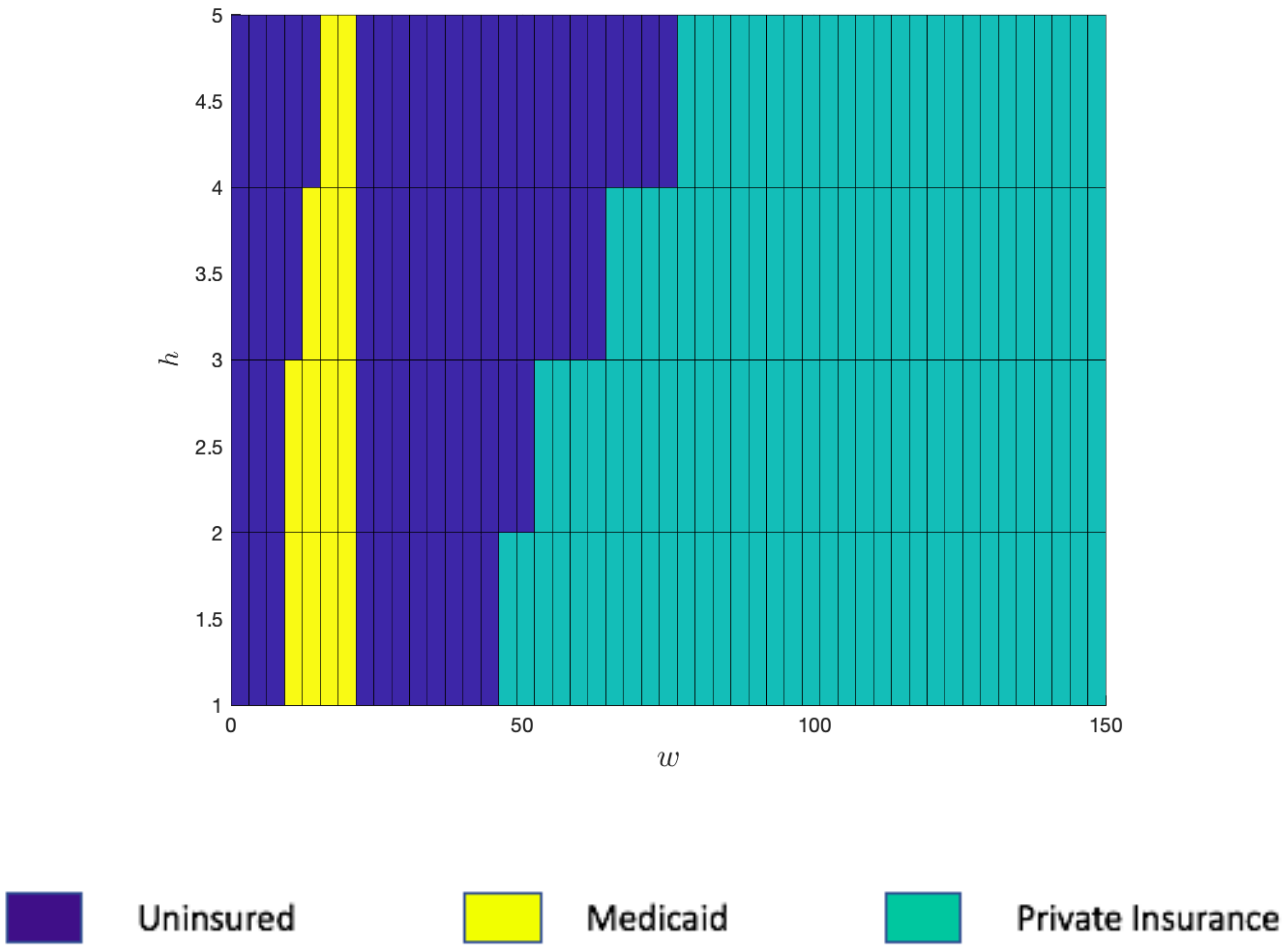
Medicaid + Private Insurance Take-up

Figure: Medicaid + Private Insurance Take-up



Functional Forms

Assumptions (1)

- Equal depreciation across health states:
  $d(5,a) = d(4,a) = d(3,a) = d(2,a) = d(a)$
- Depreciation over age: Power function

$$d(a) = d_0 + d_1 age + d_2 age^2$$

- Natural improvement by age: Power function

$$\nu_0(a) = n_0 + n_1 age + n_2 age^2$$

Assumptions (2)

- Utility cost of health: Power function

$$\phi(h) \quad = \quad \phi_0 + \phi_1 h + \phi_2 h^2$$

Assumptions (3)

- Proportional mortality across health states over age:

$$\lambda(h,a) = \begin{cases} \lambda(h,6)/F_{25-35} \text{ if age } \in \{25-35\} \\ \lambda(h,6)/F_{35-45} \text{ if age } \in \{35-45\} \\ \lambda(h,6)/F_{45-55} \text{ if age } \in \{45-55\} \\ \lambda(h,6)/F_{55-65} \text{ if age } \in \{55-65\} \\ \lambda(h,6)/F_{65-75} \text{ if age } \in \{65-75\} \end{cases} \quad (1)$$

Back

Estimation

Set Outside of the Model

Table: Set Outside of the Model

Parameter	Meaning	Value
ρ	Discount rate	0.06
r	Interest Rate	0.05
γ	Risk Aversion	1.5
T	Exit Age	85
s	Initial Age	25

Back

Estimated Outside of the Model

Table: Estimated Outside of the Model

Meaning	Parameter	Value
Mortality Poisson, Age 75-85, h $= 1$	$\lambda(1,6)$	0.116
Mortality Poisson, Age 75-85, h $= 2$	$\lambda(2,6)$	0.024
Mortality Poisson, Age 75-85, h $= 3$	$\lambda(3,6)$	0.0127
Mortality Poisson, Age 75-85, h $= 4$	$\lambda(4,6)$	0.0057
Mortality Poisson, Age 75-85, h $= 5$	$\lambda(5,6)$	0.00325
Survival Factor, Age 65-75	F_{65-75}	1.56
Survival Factor, Age 55-65	F_{55-65}	4.16
Survival Factor, Age 45-55	F_{45-55}	20.6
Survival Factor, Age 35-45	F_{35-45}	22.6
Survival Factor, Age 25-35	F_{25-35}	22.6
Productivity by Health	$\theta(h)$	(1, 1.03, 1.03, 1.04, 1.04)
Income by Education and Age ($10,000)	$y(a)$	(taken from data)
Insurance Premium	p	0.4
OOP Fraction	$q(I_0)$	0.3
Aging Poisson, all ages	η	$\frac{1}{10}$
Joint distribution health and wealth, age 25	$f(h_0, w_0)$	(taken from data)

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Income by Education and Age ($10,000)	$y(e)$	(taken from data)
Insurance Premium	p	[illegible]
OOP Fraction	[illegible]	[illegible]
Aging Poisson, all ages	[illegible]	[illegible]
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Back

Targeted Moments

Moment	Data	Model
Fraction Visit, Poor Health Age 55-75	0.97	0.80
Fraction Visit, Average Health Age 55-75	0.92	0.80
Fraction Visit, Excellent Health Age 55-75	0.89	0.43
Fraction Visit, Poor Health Age 25-45	0.92	0.87
Fraction Visit, Average Health Age 25-45	0.77	0.96
Fraction Visit, Excellent Health Age 25-45	0.69	0.70
Improvement Poor Health, Age 55-75	0.79	0.68
Improvement Average Health, Age 55-75	0.70	0.50
Improvement Poor Health, Age 25-45	0.86	0.64
Improvement Average Health, Age 25-45	0.75	0.41
Change in Health, Poor Health, Age 25-45	1.07	1.16
Change in Health, Average Health, Age 25-45	0.39	0.39
Change in Health, Excellent Health, Age 25-45	-0.65	-0.72
Change in Health, Poor Health, Age 45-65	0.80	1.09
Change in Health, Average Health, Age 45-65	0.20	0.23
Change in Health, Excellent Health, Age 45-65	-0.72	-0.80
Change in Health, Poor Health, Age 65-85	0.72	0.94
Change in Health, Average Health, Age 65-85	0.10	0.05
Change in Health, Excellent Health, Age 65-85	-0.80	-0.90
Average Spending, Age 25-35	0.28	0.20
Average Spending, Age 45-55	0.44	0.40
Average Spending, Age 65-75	0.71	0.53
Average Health, Age 45-55	3.68	3.64
Average Health Age 25-35/Average Health, Age 45-55	1.08	1.09
Average Health Age 65-75/Average Health, Age 45-55	0.95	0.88
Fraction Visit, Age 25-35	0.79	0.60
Fraction Visit, Age 45-55	0.88	0.80
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Back

Targeted Moments

Moment	Data	Model
Fraction Visit, Poor Health Age 55-75	0.97	0.80
Fraction Visit, Average Health Age 55-75	0.92	0.80
Fraction Visit, Excellent Health Age 55-75	0.89	0.43
Fraction Visit, Poor Health Age 25-45	0.92	0.87
Fraction Visit, Average Health Age 25-45	0.77	0.96
Fraction Visit, Excellent Health Age 25-45	0.69	0.70
Improvement Poor Health, Age 55-75	0.79	0.68
Improvement Average Health, Age 55-75	0.70	0.50
Improvement Poor Health, Age 25-45	0.86	0.64
Improvement Average Health, Age 25-45	0.75	0.41
Change in Health, Poor Health, Age 25-45	1.07	1.16
Change in Health, Average Health, Age 25-45	0.39	0.39
Change in Health, Excellent Health, Age 25-45	-0.65	-0.72
Change in Health, Poor Health, Age 45-65	0.80	1.09
Change in Health, Average Health, Age 45-65	0.20	0.23
Change in Health, Excellent Health, Age 45-65	-0.72	-0.80
Change in Health, Poor Health, Age 65-85	0.72	0.94
Change in Health, Average Health, Age 65-85	0.10	0.05
Change in Health, Excellent Health, Age 65-85	-0.80	-0.90
Average Spending, Age 25-35	0.28	0.20
Average Spending, Age 45-55	0.44	0.40
Average Spending, Age 65-75	0.71	0.53
Average Health, Age 45-55	3.68	3.64
Average Health Age 25-35/Average Health, Age 45-55	1.08	1.09
Average Health Age 65-75/Average Health, Age 45-55	0.95	0.88
Fraction Visit, Age 25-35	0.79	0.60
Fraction Visit, Age 45-55	0.88	0.80
Fraction Visit, Age 65-75	0.96	0.84

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HJBVI

$$\min\Big\{\rho V(w,h,\nu,a) - \max_{c}\{u(c,h) - V_w[\theta(h)y(a) + rw - c - p]\} -$$
$$\eta[V(w,h,\nu,a+1) - V(w,h,\nu,a)] - \nu[V(w,h+1,\nu_0,a) - V(w,h,\nu,a)] -$$
$$d(h,a)[V(w,h-1,\nu_0,a) - V(w,h,\nu,a)] - \lambda^T(h,a)[V^T - V(w,h,\nu,a)],$$
$$V(w,h,\nu,a) - V^*(w',h,\nu',a)\Big\} = 0$$

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Gains in Life-expectancy: 1980s to 2000s

	0-25%	25-50%	50-75%	75-100%
Life-expectancy 1983	70.7	74.2	77.4	79.2
Total Change (1983 - 2003)	2.4	2.7	3.1	4.7
By cause of death:				
Accident	0.1	0.1	0.2	0.2
Other	-1.1	-0.6	-0.6	-0.2
Malignant neoplasms	0.3	0.3	0.7	1.2
Cerebrovascular	0.4	0.2	0.2	0.4
Diabetes	-0.2	-0.1	-0.0	-0.1
Heart	2.8	2.6	2.8	2.9
Respiratory	-0.0	0.1	-0.1	0.2
Unknown	-0.0	-0.0	-0.0	0.0
By age group:				
20-50	-0.1	0.3	0.0	0.5
50-80	2.2	1.7	2.4	3.3
80+	0.2	0.7	0.7	0.9

Life-expectancy conditional on surviving until age 20.

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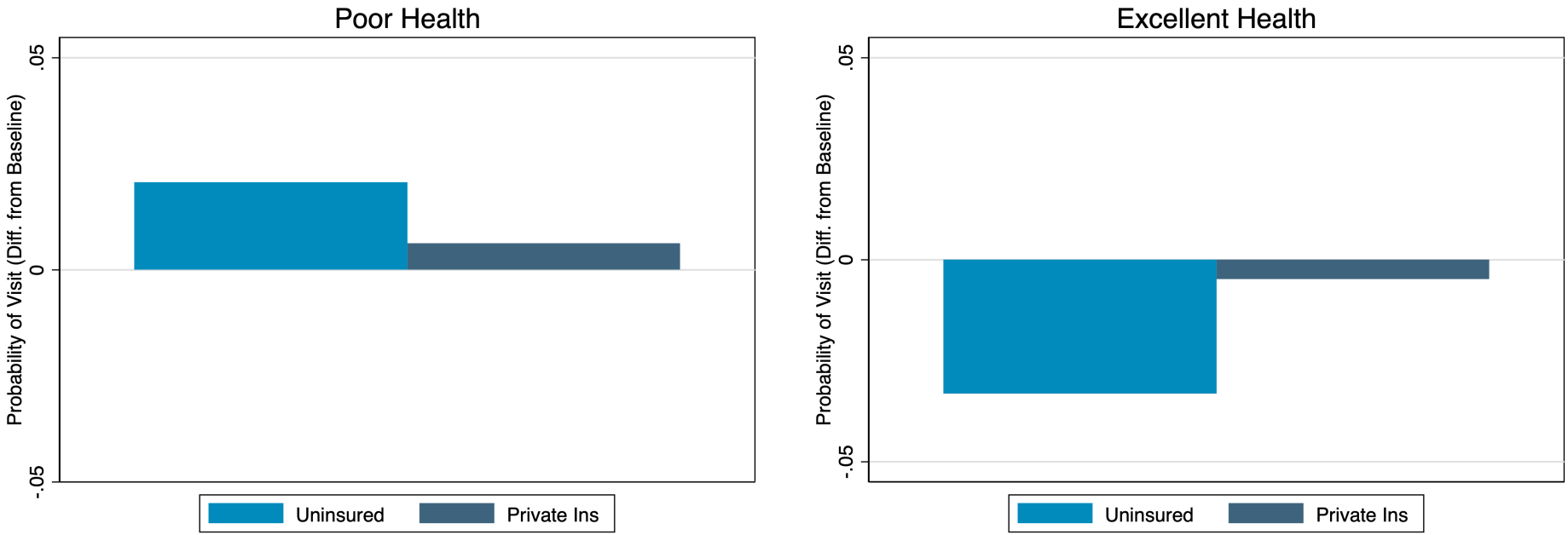
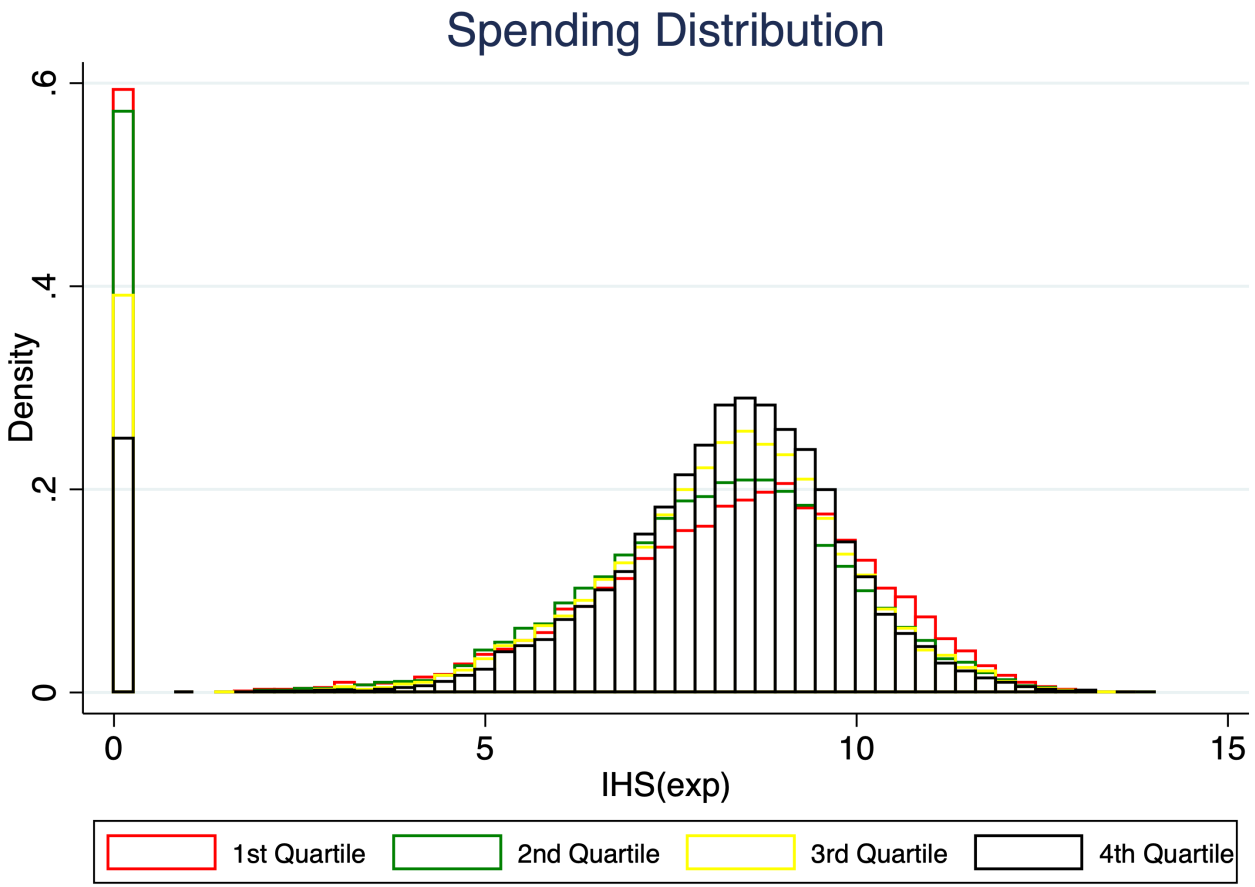
Timing of Visit by Insurance



Notes: Includes individual fixed effect; base set to average health in each income group regression

Back Other Age Groups

Medical Spending Distribution, Age 45-55



Notes: Inverse Hyperbolic Sine (IHS) Transformation

Back Other Age Groups

Initial Estimates

Table: Initial Estimates: Targeted Moments

Moment	Meaning	Parameter	Value	Std. Errors^{+}
Change in health, average health 25-35	TFP	A	2.34	(0.007)
Spending by bad health, age 55-65	Elasticity w.r.to. m	α_m	0.10	(0.002)
Fraction Visit Average Health 45-55	Fixed Cost	k	0.0213	(0.000012)
Expenditure 35-45/Expenditure 55-55	Depreciation Poisson	d_0	0.86	(0.0007)
Fraction Visit 35-45/Fraction Visit 55-55	Depreciation Poisson Age	d_1	0.23	(0.0004)
Fraction Visit 35-45/Fraction Visit 55-55	Depreciation Poisson Age^2	d_2	-0.026	(0.0007)
Improvement bad health 25-35	Natural Improvement	n_0	0.48	(0.001)
Improvement bad health 45-55	Natural Improvement-2	n_1	-0.022	(0.0004)
Improvement bad health 55-65	Natural Improvement-3	n_2	-0.028	(0.0009)
Improvement poor health 45-55	Utility parameter-1	ϕ_0	1.26	(0.0019)
Spending by bad health, age 45-55	Utility parameter-2	ϕ_1	1.016	(0.00029)
Spending by average health, age 45-55	Utility parameter-3	ϕ_2	0.036	(0.0054)

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Individual's Problem.

- Long-term Disability: Poisson parameter $\eta(h)$, absorbing state value V^D; Medicare pays $\bar{m}$ continually

$$\eta(h) = \begin{cases} \eta_L \text{ if } h \geq h^D_{high} \\ \eta_H \text{ if } h_{exit} < h < h^D_{high} \\ \eta_{exit} \text{ if } h = h_{exit} \end{cases} \tag{2}$$

$$\eta_L < \eta_H < \eta_{exit}$$

Disability Stage

For without exit and utility from health

$$\rho V^D(w) = \max_c \{u(c) + V_w^D[y^D + rw - c]\} \tag{3}$$

Standard Guess and Verify argument gives,

$$V^D(w) = \frac{(y^D + rw)^{1-\gamma}}{r(1-\gamma)} \left(\frac{\rho - r(1-\gamma)}{r\gamma} \right)^{-\gamma} \tag{4}$$

Disability Stage.

For the version with exit and utility from health,

$$\rho V^D(w, h^D) = \max_c \{u(c, h^D) + V_w^D[y^D + rw - c]\} + \lambda^D(V^T - V^D) \quad (5)$$

$$V^D(w, h^D) = \frac{(y^D + rw)^{1-\gamma}}{r(1-\gamma)} \left(\frac{(\rho + \lambda^D) - r(1-\gamma)}{r\gamma} \right)^{-\gamma} + \left(\frac{1}{\rho + \lambda^D} \right) \left(\omega \frac{{h^D}^{1-\sigma}}{1-\sigma} + \lambda^D V^T \right) \quad (6)$$

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Mean Medical Expenditure: Age 25-35

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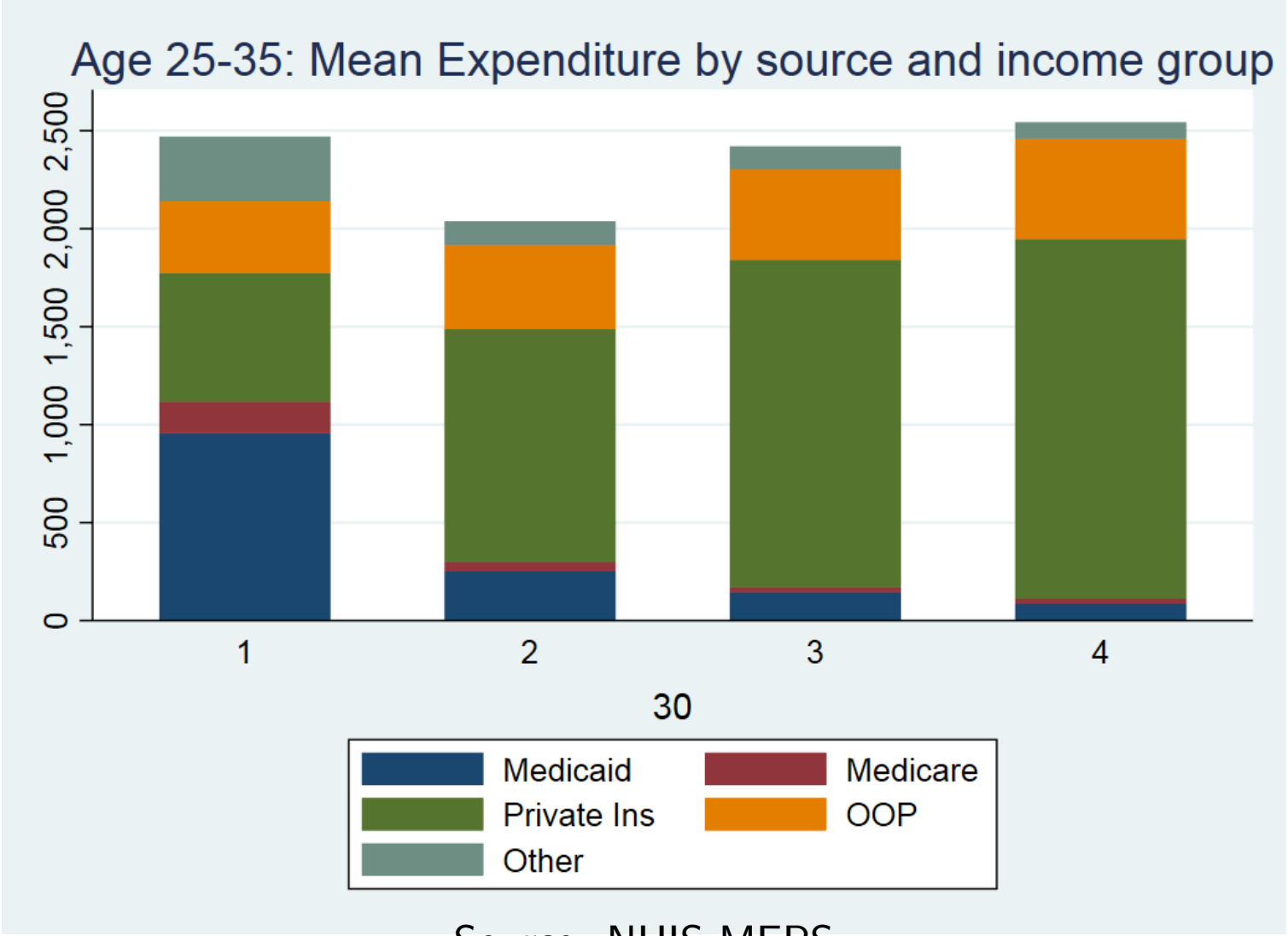
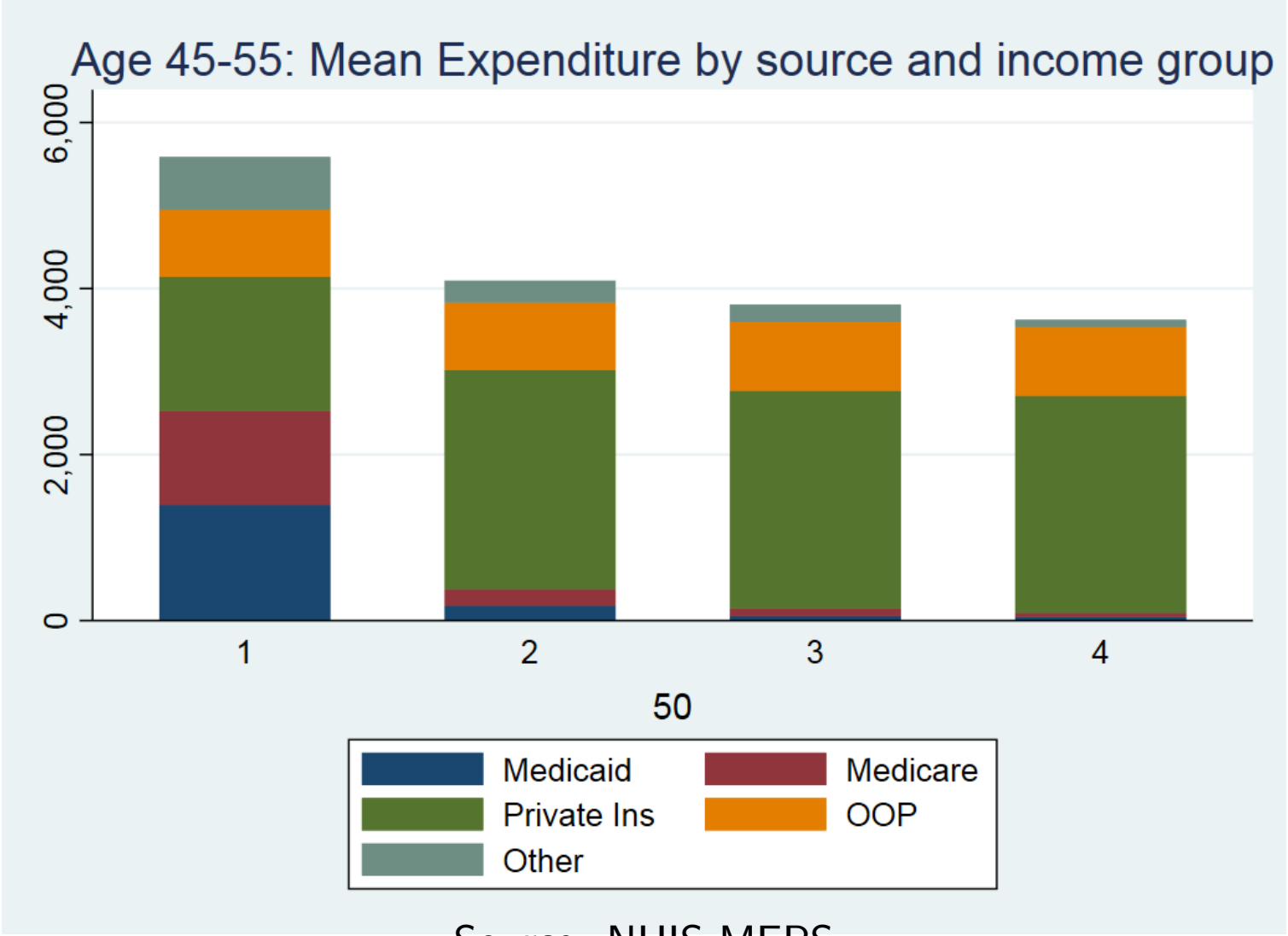


Source: NHIS-MEPS

Mean Medical Expenditure: Age 45-55

Back



Source: NHIS-MEPS

Mean Medical Expenditure: Age 55-65

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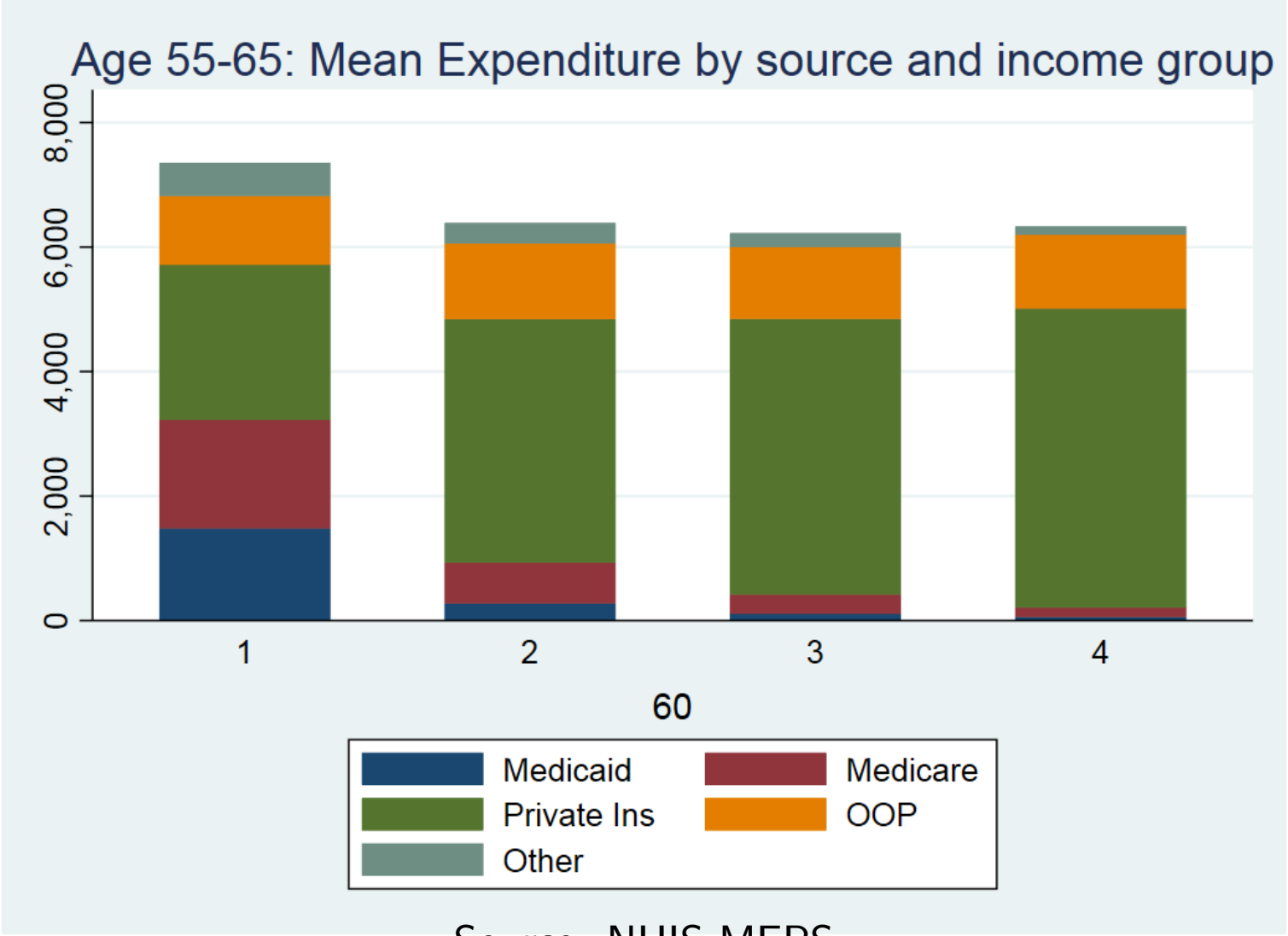

Source: NHIS-MEPS

Mean Medical Expenditure: Age 65-75

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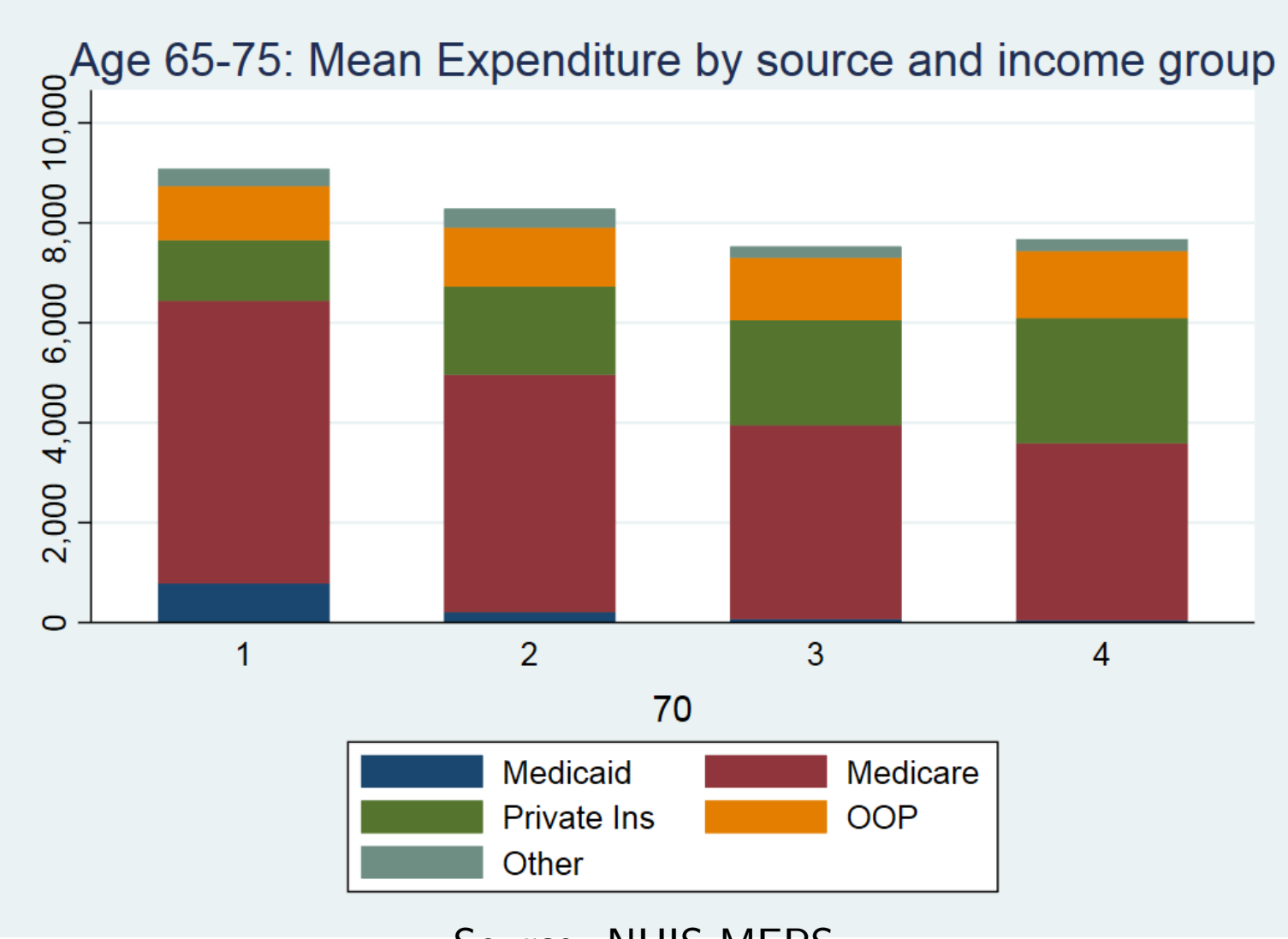

Source: NHIS-MEPS