Aging and Health Financing in the US: A General Equilibrium Analysis

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Disclaimer

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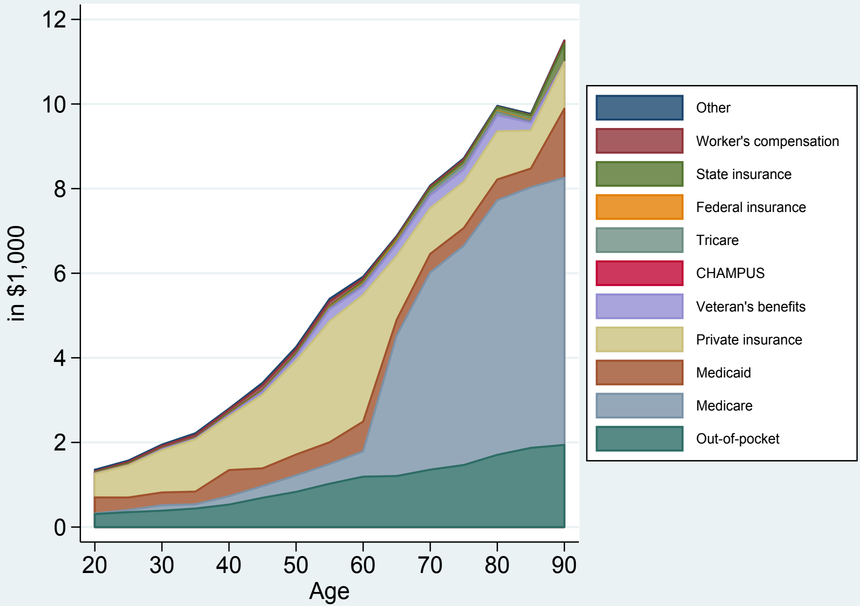
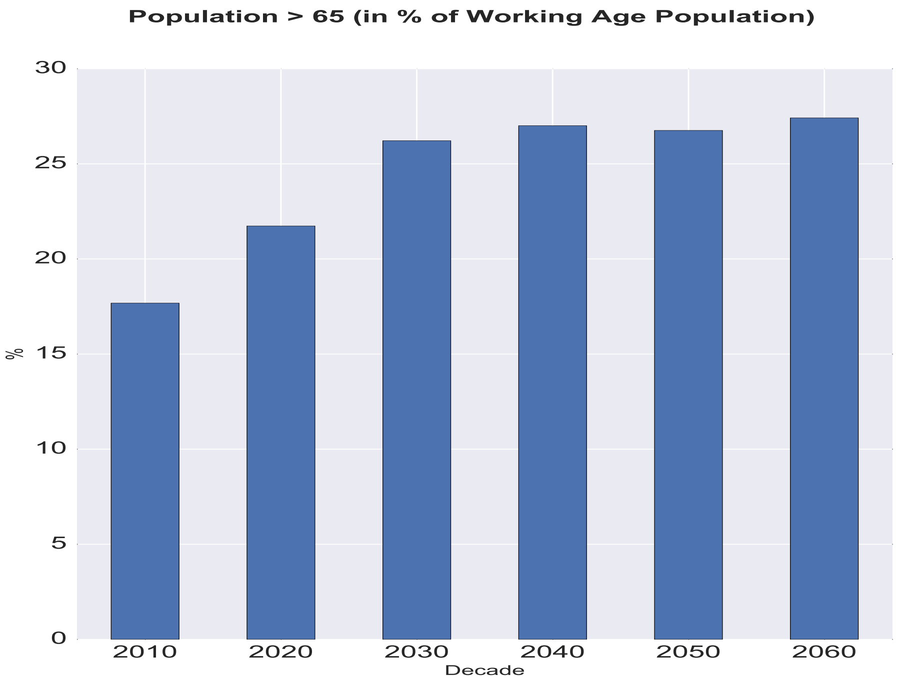
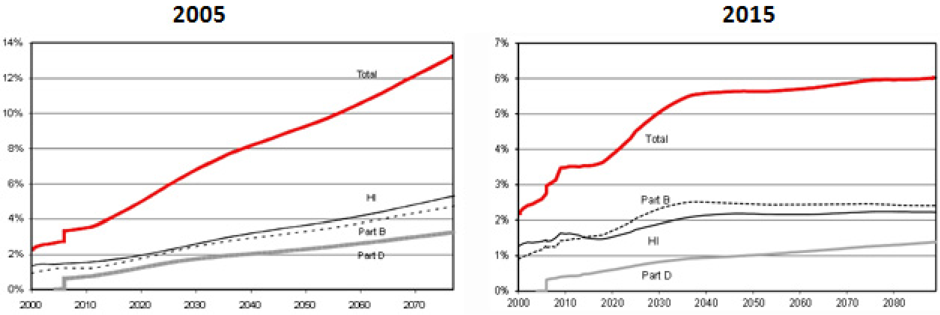
Health Spending by Financing Source



Source: MEPS 1999-2009


Population > 65 (in % of Working Age Population)
%
30
25
20
15
10
5
0
2010
2020
2030
2040
2050
2060
Decade

Medicare Expenditures As Percentage of Gross Domestic Product



Source: Boards of Trustees (2015)

Comments

- The long-term fiscal outlook in the US
  - Sensitive to assumptions about how health care spending (CBO (2014))
  - Fiscal gap between 6.1 percent and 9.0 percent of GDP (Auerbach and Gale (2013))
- CBO's projections abstract from microfoundations of health spending and financing
  - Lifecycle profiles of health-related behavior
  - Behavioral responses to demographic shift and policy reforms

This paper

1. Quantify the effects of population aging on healthcare spending and financing in US

2. Assess the implications of the ACA reform in this aging context

How?

- A Bewley-Grossman model of health capital with heterogenous agents
  - idiosyncratic income and health shocks
  - incomplete markets
- Microfoundations of health-related behavior
  - demand for medical services and health insurance
- The US institutional details:
  - Medicare and Medicaid
  - Group-based (GHI) and Individual-based insurance (IHI)
- Calibrate the model to US data before the ACA reform
  - Medical Expenditure Panel Survey
  - Population projections by CMS/OACT

Results

1. **Without ACA:** Aging leads to large increases in medical spending
   - $\uparrow$ Health expenditures $\uparrow$by 37 percent (2060 demographic structure)
   - $\uparrow$ Medicare by 50 percent
   - $\uparrow$ Insurance take-up for workers from 77 to 81 percent

2. **Introduction of ACA**
   - increases the fraction of insured workers
     - up to 99 percent
     - expansion of Medicaid and IHI
   - mitigates the increase in health expenditures
     - $\downarrow$ health expenditures by 2 percent
     - move uninsured workers into Medicaid
   - increases fiscal cost mainly via the expansion of Medicaid

Related Literature

1. Economics of aging
   - Wise (2005), Bloom, Canning and Fink (2010) and De la Croix (2013) for an overview
   - Aging and fiscal policy:
     - Deterministic: Auerbach and Kotlikoff (1987), Faruqee (2002), Kotlikoff, Smetters and Walliser (2007)
     - Stochastic: De Nardi, Imrohoroğlu and Sargent (1999), Braun and Joines (2015), Kitao (2015) and Nishiyama (2015)

2. Quantitative macroeconomics/public finance
   - Pioneers: Bewley (1986), Huggett (1993) and Aiyagari (1994)
   - Health risk and precautionary savings: Kotlikoff (1988), Levin (1995), Hubbard, Skinner and Zeldes (1995) and Palumbo (1999).
   - Large scale models with health shocks and health policy: Jeske and Kitao (2009), Pashchenko and Porapakkarm (2013), Janicki (2014), Kopecky and Koreshkova (2014), Capatina (2015)

Related Literature (cont.)

3. Models explaining health spending within Macro frameworks:
   - Lifecycle models that analyze the determinants of rising health care cost in the US
     - Features: technological progress, economic growth and social security (Suen (2006), Hall and Jones (2007), Fonseca et al. (2013) and Zhao (2014))
   - This paper: extends our previous framework in **?**
     - a rich institutional framework and the ACA
     - altering the demographic structure in the model to mimic the process of population aging
     - the effects of aging on health care cost and health financing

The Model: Bewley - Grossman Framework

- Overlapping Generations (OLG) Model
  - Lifespan: age 20 to 90
- Heterogeneous agents
  - Idiosyncratic shocks: labor productivity and health shocks
  - Health as consumption and investment goods
    - Endogenous health spending
    - Choice of private health insurance
- Market structure: consumption goods, health care goods, capital, labor markets, and incomplete financial markets
- Fiscal policy: income tax, social security, health insurance, minimum consumption
- Dynamic stochastic general equilibrium

The Model: Preferences and Technology

- Preferences:

$$u(c,l,h) = \frac{\left(\left(c^{\eta} \times \left(1 - l - 1_{[l>0]}\bar{l}_j\right)^{1-\eta}\right)^{\kappa} \times h^{1-\kappa}\right)^{1-\sigma}}{1-\sigma}$$

- Health capital:

$$h_j = \overbrace{\phi_j m_j^{\xi}}^{\text{Investment}} + \overbrace{\left(1-\delta_j^h\right) h_{j-1}}^{\text{Trend}} + \overbrace{\epsilon_j^h}^{\text{Disturbance}}$$

- Human capital ("labor"): $e_j = e\left(\vartheta, h_j, \epsilon_j^l\right)$

- Health, labor income and employer insurance shocks:

$$\Pr\left(\epsilon_{j+1}^h | \epsilon_j^h\right) \in \Pi_j^h \text{ , } \Pr\left(\epsilon_{j+1}^l | \epsilon_j^l\right) \in \Pi_j^l \text{ and } \Pr\left(\epsilon_{j+1}^{GHI} | \epsilon_j^{GHI}\right) \in \Pi_{j,\vartheta}^{GHI}$$

The Model: Health Insurance Arrangements

- Private health insurance: group (GHI) or individual (IHI)
- Public (social) health insurance: Medicaid or Medicare
- Health insurance status:

$$in_j = \begin{cases} 0 & \text{if No insurance,} \\ 1 & \text{if Individual health insurance IHI,} \\ 2 & \text{if Group health insurance GHI,} \\ 3 & \text{if Medicaid.} \end{cases}$$

The Model: Out-of-pocket Health Spending

- Agent's out-of-pocket health expenditures depend on insurance state

$$o\left(m_j\right) = \begin{cases} p_m^{in_j} \times m_j, & \text{if } in_j = 0 \\ \rho^{in_j}\left(p_m^{in_j} \times m_j\right), & \text{if } in_j > 0 \end{cases}$$

The Model: Technology and Firms

- Final goods C production sector for price $p_C = 1$:

$$\max_{\{K,\ L\}} \{F(K, L) - qK - wL\}$$

- Medical services M production sector for price p_m:

$$\max_{\{K_m,\ L_m\}} \{p_m F_m(K_m, L_m) - qK_m - wL_m\}$$

- p_m is a base price for medical services
- Price paid by households depends on insurance state:

$$p_j^{in_j} = \left(1 + \nu^{in_j}\right) p_m$$

  - ν^{in_j} is an insurance state dependent markup factor
- Profits are redistributed to all surviving agents

The Model: Household Problem

t

- $\boldsymbol{a}$: asset
- $\boldsymbol{i}$: permanent income group
- $\boldsymbol{h}$: health capital
- $\boldsymbol{in}$: insurance

t+1

- $\boldsymbol{a'}$: asset
- $\boldsymbol{i}$: income group
- $\boldsymbol{h'}$: health capital
- $\boldsymbol{in'}$: insurance

Shocks:

- $\boldsymbol{\epsilon_t^h}$: health
- $\boldsymbol{\epsilon_t^l}$: productivity
- $\boldsymbol{\epsilon_t^{GHI}}$: group HI

Choices:

- $\boldsymbol{c}$: consumption
- $\boldsymbol{l}$: leisure
- $\boldsymbol{m}$: medical services
- $\boldsymbol{a'}$: savings
- $\boldsymbol{in'}$: insurance

Shocks:

- $\boldsymbol{\epsilon_{t+1}^h}$: health
- $\boldsymbol{\epsilon_{t+1}^l}$: productivity
- $\boldsymbol{\epsilon_{t+1}^{GHI}}$: group HI

State vector: $x_t = \{j, a, i, h, in, \epsilon^h, \epsilon^l, \epsilon^{GHI}\}$ → Choice $= \{c, l, m, a', in'\}$ → $x_{t+1} = \{j+1, a', i, h', in', \epsilon'^h, \epsilon'^l, \epsilon'^{GHI}_t\}$

Remaining Parts

- Insurance companies GHI and IHI clear zero profit condition Details
- Government budget constraint clears Details
- Pension program financed via payroll tax Details
- Accidental bequests to surviving individuals Details

A Competitive Equilibrium

1. Given the transition probability matrices and the exogeneous government policies, a competitive equilibrium is a collection of sequences of distributions of household decisions, aggregate capital stocks of physical and human capital, and market prices such that

- Agents solve the consumer problem
- The F.O.Cs of firms hold
- The budget constraints of insurances companies hold
- All markets clear
- All government programs and the general budget clear
- The distribution is stationary

Competitive Equilibrium Details

Calibration

Parameterization and Calibration

- Goal: to match U.S. data pre-ACA (before 2010)
- Data sources:
  - MEPS: labor supply, health shocks, health expenditures, coinsurance rates
  - PSID: initial asset distribution
  - CMS: demographic profiles
  - Previous studies: income process, labor shocks, aggregates

Health Capital

- Health capital accumulation:

$$h_j = \overbrace{\phi_j m_j^{\xi}}^{\text{Investment}} + \overbrace{\left(1 - \delta_j^h\right) h_{j-1}}^{\text{Trend}} + \overbrace{\epsilon_j^h}^{\text{Disturbance}}$$

- Health capital measure in MEPS: SF 12-v2

- $\delta^h \rightarrow$ MEPS$|$insured & 0-medical spenders $\rightarrow \bar{h}_j = \overbrace{\left(1 - \delta_j^h\right) \bar{h}_{j-1}}^{\text{Trend}}$

- ϵ^h and Π^h from MEPS

Calibration of Health Shocks

- MEPS data split each cohort j into 4 risk groups
- Average health capital per risk group: $\left\{\bar{h}_{j,d}^{\text{max}} > \bar{h}_{j,d}^{3} > \bar{h}_{j,d}^{2} > \bar{h}_{j,d}^{1}\right\}$
- Define shock magnitude:

$$\epsilon_j^h = \left\{0, \frac{\bar{h}_{j,d}^{3} - \bar{h}_{j,d}^{\text{max}}}{\bar{h}_{j,d}^{\text{max}}}, \frac{\bar{h}_{j,d}^{2} - \bar{h}_{j,d}^{\text{max}}}{\bar{h}_{j,d}^{\text{max}}}, \frac{\bar{h}_{j,d}^{1} - \bar{h}_{j,d}^{\text{max}}}{\bar{h}_{j,d}^{\text{max}}}\right\} \times h_m^{max}$$

- Assumption: Associate resulting health shock with risk group by age
- Non-parametric estimation of transition probabilities health shocks

Parameterization: Production Function

- Final goods production:

$$F(K, L) = AK^{\alpha}L^{1-\alpha}$$

- Medical services production:

$$F_m(K_m, L_m) = A_m K_m^{\alpha_m} L_m^{1-\alpha_m}$$

- Parameters from other studies

- $A = 1$ and A_m calibrated to match aggregate health spending

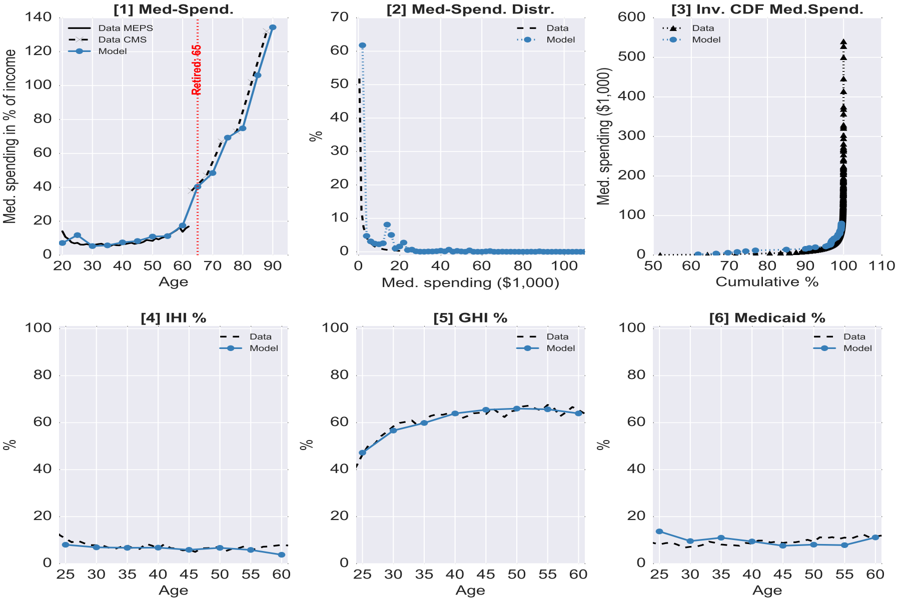
Calibration: Price of Medical Services

- Medicare/Medicaid reimbursement rates (to providers) are about 70% of private HI rates (CMS)
- Average price markup for uninsured around 60% (Brown (2006))
- Large GHI can negotiate favorable prices (Phelps (2003))
- Price vector:

$$\left[p_m^{\text{noIns}}, p_m^{\text{IHI}}, p_m^{\text{GHI}}, p_m^{\text{Maid}}, p_m^{\text{Mcare}}\right] = (1 + [0.70, 0.25, 0.10, 0.0, -0.10]) \times p_m$$

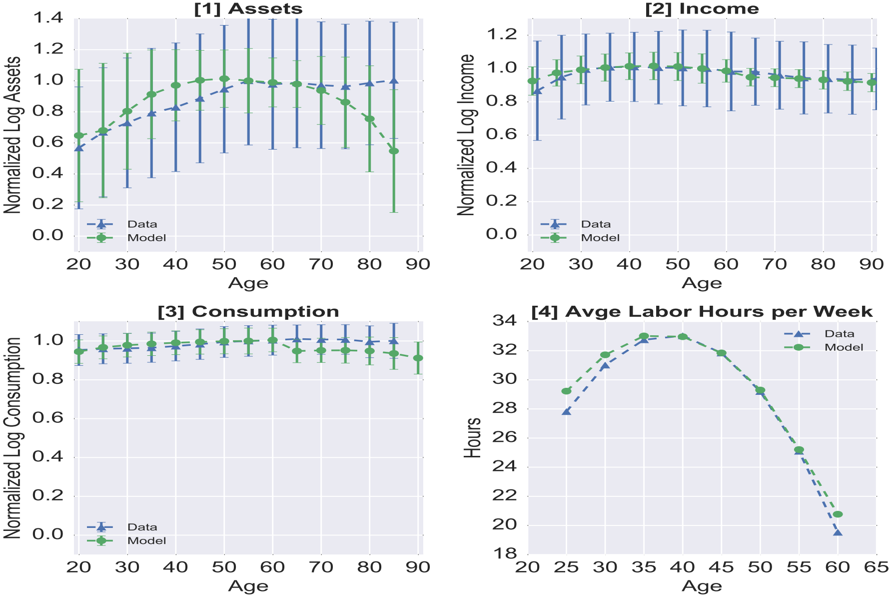
More Calibration Details

Model vs. Data

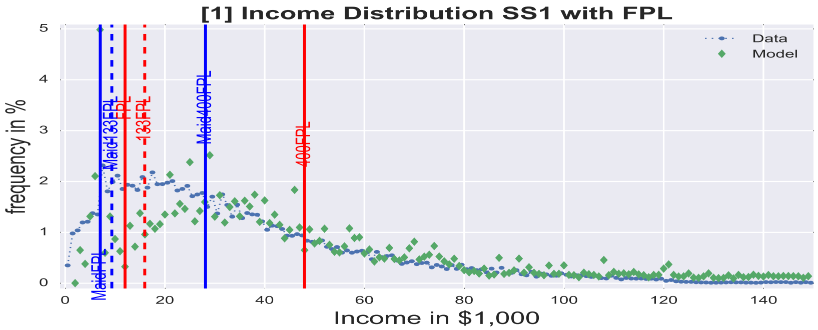


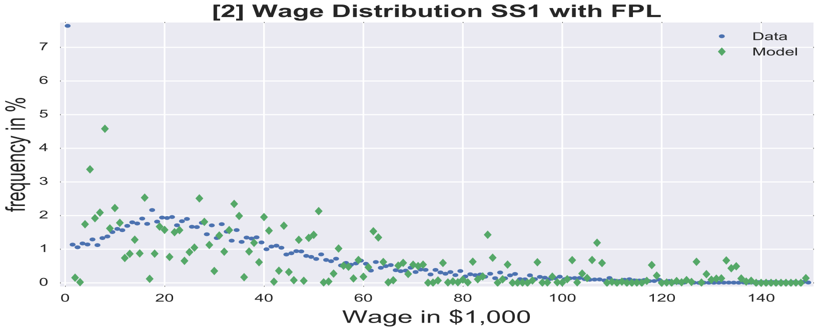
Source: MEPS 2000-2009

Model vs. Data



Source: PSID 1984-2007 and CPS 1999-2009


[1] Income Distribution SS1 with FPL
frequency in %
Income in $1,000
Data
Model
MaidFPL
Maid133FPL
FPL
133FPL
Maid400FPL
400FPL
0
1
2
3
4
5
0
20
40
60
80
100
120
140


[2] Wage Distribution SS1 with FPL
frequency in %
Wage in $1,000
Data
Model
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120
140

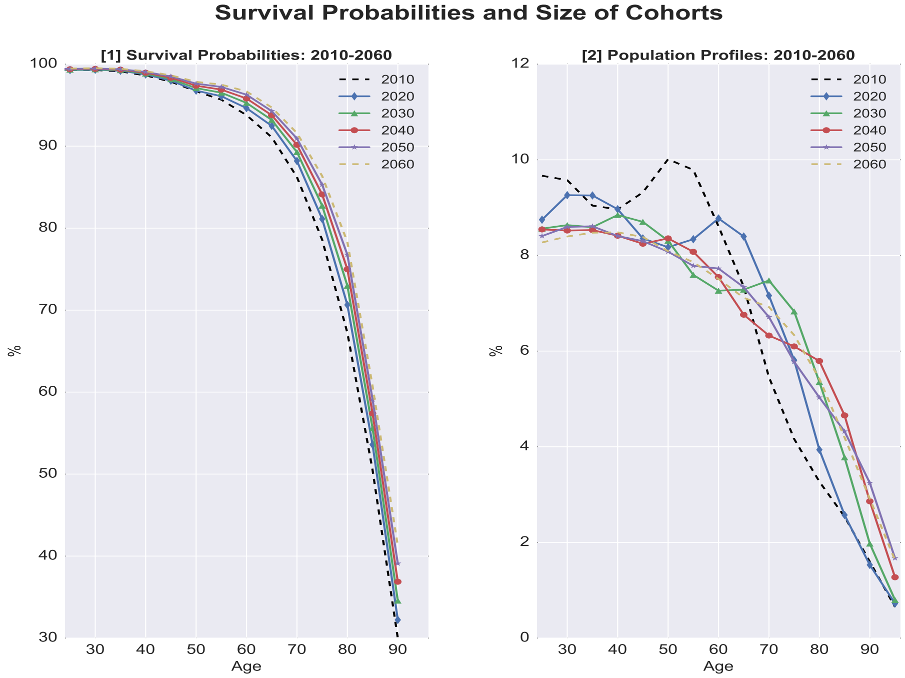
Calibration: Matched Moments

Moments	Model	Data	Source
- Medical Expenses HH Income	17.6%	17.07%	CMS communication
- Workers IHI	6.7%	7.6%	MEPS 1999/2009
- Workers IHI	62.2%	63.6%	MEPS 1999/2009
- Workers Medicaid	9.0%	9.2%	MEPS 1999/2009
- Capital Output Ratio: K/Y	2.9	$2.6 - 3$	NIPA
- Interest Rate: R	4.2%	4%	NIPA
- Size of Soc.l Security: $SocSec/Y$	5.9%	5%	OMB 2008
- $Medicare/Y$	3.1%	$2.5 - 3.1\%$	U.S. Dept of Health 2007
- Payroll Tax Social Security: τ^{Soc}	9.4%	$10 - 12\%$	IRS
- Consumption Tax: τ^{C}	5.0%	5.7%	Mendoza et al. (1994)
- Payroll Tax Medicare: τ^{Med}	2.9%	$1.5 - 2.9\%$	Soc. Sec. Update (2007)
- Total Tax Revenue/Y	21.8%	28.3%	Stephenson (1998)
- Medical spending profile		see figure	
- Medical spending distribution		see figure	
- Insurance take-up ratios		see figure	

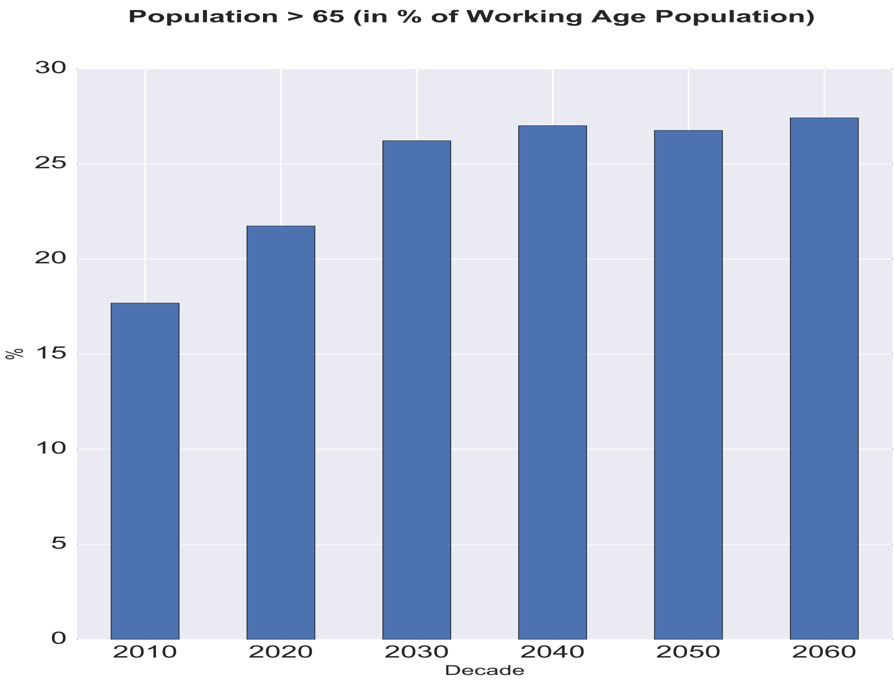
Aging

Experiments

1. Benchmark economy in 2010 $\rightarrow$fix baseline parameters
2. Change the survival probabilities to match the 10-year average demographic structure of CMS/OACT population forecasts for 2030, 2040, 2050, 2060
3. Each time fix the particular demographic structure of a given decennial and resolve (using Benchmark paras) for a new steady
4. "Updating" the age profile essentially creates a larger share of older individuals in the model by appropriately increasing individual survival probabilities
5. We do NOT solve for the transition path from 2010 to 2060!



Survival Probabilities and Size of Cohorts
[1] Survival Probabilities: 2010-2060
%
Age
2010
2020
2030
2040
2050
2060
[2] Population Profiles: 2010-2060
%
Age
2010
2020
2030
2040
2050
2060


Population > 65 (in % of Working Age Population)
30
25
20
15
10
5
0
%
2010
2020
2030
2040
2050
2060
Decade

Aging: Medicare and Social Security

- Balanced budget condition (no debt in model)
- Medicare and Social Security will grow if fraction of old increases $\rightarrow$ needs to be financed
- Assumption:
  - Fix Medicare payroll tax at benchmark level of 2.9%
    $\rightarrow$ Medicare is part of the overall gov't budget constraint
    $\rightarrow$ adjust τ_C to cover the extra Medicare spending
  - Social security is self-financing (by assumption) $\rightarrow$ increase τ_{SS}

Aging: Medicare and Social Security

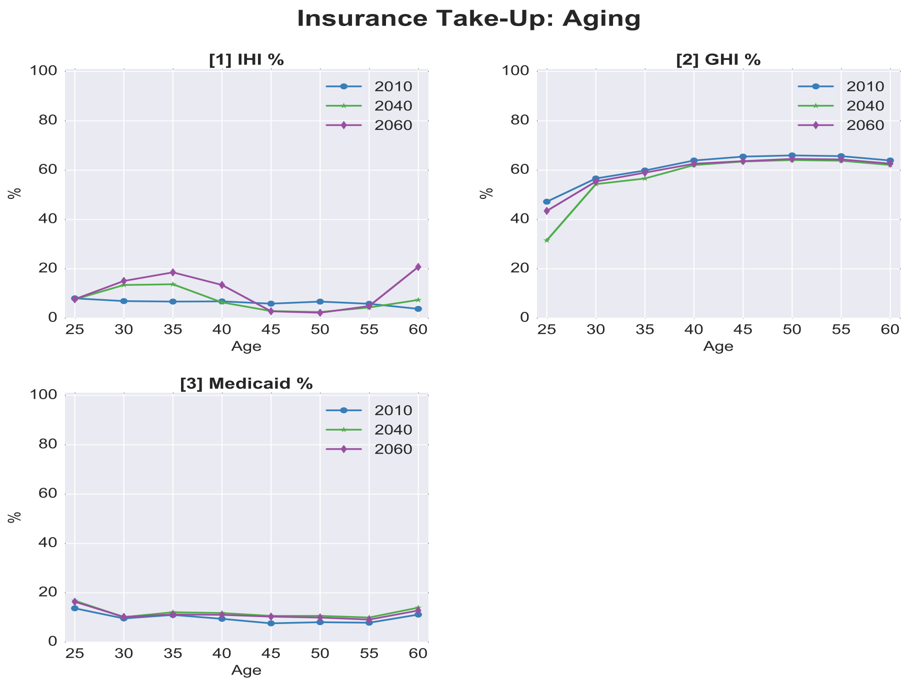
	2010	2020	2030	2040	2050	2060
Medicare in %:	17.68	21.74	26.21	27.01	26.76	27.42
Cons. tax: τ^C %	5.00	7.21	10.59	12.10	12.08	12.43
Soc. sec. tax: τ_{SS} %	9.38	12.19	15.61	16.23	16.04	16.58
Medicare tax: τ_{Med} %	2.90	2.90	2.90	2.90	2.90	2.90

Aging: Effect on Workers

- The fraction of insured workers is fairly constant at around 81 percent
- IHI share ↑
  - Premiums of IHI generally fall around 4 percent when compared to the benchmark
  - 2040 is different: With loss of the higher risk working age population (those over 55), the IHI market shrinks as the lower risk population chooses to exit the market decreasing both the participation and premium in the IHI market
- GHI share ↓
  - Increased premiums in GHI market around 2040 → drop in coverage to 76
  - The shrinking of the worker risk sharing pool causes an increase in GHI premiums
- Medicaid ↑

Aging: Effect on Workers

	2010	2020	2030	2040	2050	2060
IHI in %:	6.43	13.06	10.71	7.39	10.04	10.70
GHI in %:	61.02	62.56	60.05	56.96	59.29	59.27
Medicaid in %:	9.78	10.20	11.56	12.01	11.39	11.42
Workers Insured %:	77.23	85.81	82.33	76.36	80.71	81.39



Insurance Take-Up: Aging
[1] IHI %
[2] GHI %
[3] Medicaid %
2010
2040
2060
%
Age
0
20
40
60
80
100
25
30
35
40
45
50
55
60

Aging: Health Expenditures

- Retirees face larger health shocks
- More retirees $\rightarrow$ more medical spending
- However, aging causes private insurance premiums$\downarrow$ as individuals become healthier $\rightarrow$ longer optimization horizon

Aging: Health Expenditures

	2010	2020	2030	2040	2050	2060
Med. quantity: M	100.00	118.28	131.61	138.26	141.15	144.13
Med. spend.: $p_m M$	100.00	114.58	125.73	132.31	134.35	136.95
M. sp.: no Ins	100.00	69.87	80.90	100.27	85.66	84.96
M. sp.: IHI	100.00	170.05	131.16	98.14	131.46	134.75
M. sp.: GHI	100.00	106.41	98.16	95.45	99.84	100.56
M. sp.: Maid	100.00	110.78	118.26	121.58	119.21	120.93
M. sp.: Old	100.00	132.48	166.84	181.55	184.92	190.45

Aging: Aggregate Variables

- Average worker is older $\rightarrow$ earning a higher level of labor income
- Decrease in workers $\rightarrow$restricts the supply of labor $\rightarrow$ wages$\uparrow$
- Older households hold more assets/capital which increases the supply of capital $\rightarrow$ interest rates$\downarrow$
- Shift funds from general household consumption into the consumption of medical services
- Medical sector grows

Aging: Aggregate Variables

	2010	2020	2030	2040	2050	2060
GDP:	100.00	105.50	101.73	101.20	103.86	105.27
Output: Y_c	100.00	103.75	97.68	96.17	98.79	99.99
Output: $p_m Y_m$	100.00	118.50	131.88	138.58	141.55	144.60
Capital: K_c	100.00	105.58	99.64	98.31	101.50	103.14
Capital: K_m	100.00	120.59	134.53	141.66	145.43	149.15
Health capital: H	100.00	110.06	111.48	110.85	112.55	114.44
Human capital: HK_c	100.00	102.87	96.73	95.14	97.48	98.47
Human capital: HK_m	100.00	117.48	130.59	137.09	139.68	142.40
Consumption: C	100.00	104.18	97.30	95.17	97.33	97.90
Med. quantity: M	100.00	118.28	131.61	138.26	141.15	144.13

Aging and the ACA

Implementation of ACA

- **Medicaid Expansion:** eligibility threshold to 133 percent of the FPL and remove asset test
- **Subsidies:** Income is between 133 and 400 percent of the FPL are eligible to buy health insurance through insurance exchanges at subsidized rates according to

$$sub_j = \begin{cases} \max\left(0, \text{prem}_j^{\text{IHI}} - 0.03\tilde{y}_j\right) \text{ if } 1.33 \text{ FPL}_{\text{Maid}} \leq \tilde{y}_j < 1.5 \text{ FPL}_{\text{Maid}} \\ \max\left(0, \text{prem}_j^{\text{IHI}} - 0.04\tilde{y}_j\right) \text{ if } 1.5 \text{ FPL}_{\text{Maid}} \leq \tilde{y}_j < 2.0 \text{ FPL}_{\text{Maid}} \\ \max\left(0, \text{prem}_j^{\text{IHI}} - 0.06\tilde{y}_j\right) \text{ if } 2.0 \text{ FPL}_{\text{Maid}} \leq \tilde{y}_j < 2.5 \text{ FPL}_{\text{Maid}} \\ \max\left(0, \text{prem}_j^{\text{IHI}} - 0.08\tilde{y}_j\right) \text{ if } 2.5 \text{ FPL}_{\text{Maid}} \leq \tilde{y}_j < 3.0 \text{ FPL}_{\text{Maid}} \\ \max\left(0, \text{prem}_j^{\text{IHI}} - 0.095\tilde{y}_j\right) \text{ if } 3.0 \text{ FPL}_{\text{Maid}} \leq \tilde{y}_j < 4.0 \text{ FPL}_{\text{Maid}} \end{cases}$$

- **Penalties:**

$$penalty_j = 1_{[ins_{j+1}=0]} \times 0.025 \times \tilde{y}_j,$$

Implementation of ACA (cont.)

- **Screening:** Restrictions on the price setting and screening procedures of IHI insurance companies
- **Financing**: New payroll taxes for individuals with incomes higher than \$200,000 per year

- New household budget constraint with the ACA:

$$
\begin{aligned}
& \left(1+\tau^{C}\right) c_j + (1+g)\, a_{j+1} + o^{W}\left(m_j\right) \\
& + 1_{\{in_{j+1}=1\}} \text{prem}^{\text{IHI}} + 1_{\{in_{j+1}=2\}} \text{prem}^{\text{GHI}} \\
= \quad & y_j + t_j^{\text{SI}} - tax_j - 1_{\{in_{j+1}=0\}} penalty_j + 1_{\{in_{j+1}=1\}} subsidy_j - tax_j^{\text{ACA}}
\end{aligned}
$$

Aging and the ACA

	2010	ACA -2020	2030	2040	2050	2060
GDP:	100.00	104.15	100.44	100.10	102.69	104.08
Health capital: H	100.00	110.22	111.63	110.99	112.68	114.57
Consumption: C	100.00	101.44	94.62	92.69	94.79	95.35
Med. quantity: M	100.00	120.37	133.37	139.90	142.86	145.79
Med. spend.: $p_m M$	100.00	113.20	123.63	129.09	131.92	134.52
M. sp.: no Ins	100.00	17.10	18.45	18.41	18.56	18.88
M. sp.: IHI	100.00	209.54	191.74	189.41	195.26	195.35
M. sp.: GHI	100.00	106.48	99.65	98.75	101.46	101.87
M. sp.: Maid	100.00	202.12	196.87	196.91	201.43	204.96
M. sp.: Old	100.00	132.49	166.86	181.62	185.00	190.51

Aging and the ACA - 2

	2010	ACA -2020	2030	2040	2050	2060
IHI in %:	6.43	21.71	21.14	20.98	21.05	20.94
GHI in %:	61.02	61.70	61.18	61.11	61.13	60.93
Medicaid in %:	9.78	16.10	16.92	17.12	16.99	17.20
Workers Insured %:	77.23	99.52	99.24	99.22	99.17	99.07
Medicare in %:	17.68	21.74	26.21	27.01	26.76	27.42
Cons. tax: τ^C %	5.00	7.68	11.16	12.68	12.60	12.87
Soc. sec. tax: τ_{SS} %	9.38	12.25	15.69	16.35	16.14	16.70
Medicare tax: τ_{Med} %	2.90	2.90	2.90	2.90	2.90	2.90
Payroll tax: τ^V %	0.00	1.33	1.38	1.38	1.36	1.36

Net Effect of ACA in different Periods

- Isolate the net effects of the ACA reform different age profiles

(Table: Aging & ACA in year t) - (Table: Aging-only in t)

Net Effect of ACA: Medicare and Social Security

- ACA increases the social security tax
- Medical spending of the old increases slightly due to ACA

Net Effect of ACA: Medicare and Social Security

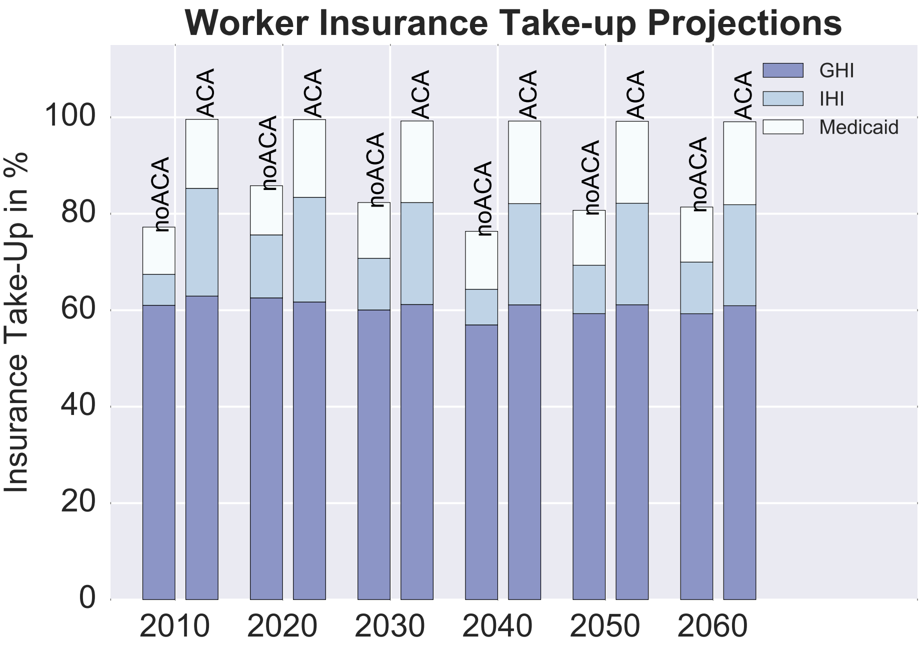
	%Δ ACA - 2020	2030	2040	2050	2060
%Δ : M. sp.: Old	0.01	0.01	0.04	0.04	0.03
%Δ : Cons. tax: τ^C %	0.47	0.57	0.58	0.52	0.44
%Δ : Soc. sec. tax: τ_{SS} %	0.07	0.08	0.11	0.10	0.11
%Δ : Medicare tax: τ_{Med} %	0.0	0.0	0.0	0.0	0.0
%Δ : Payroll tax: τ^V %	1.33	1.38	1.38	1.36	1.36

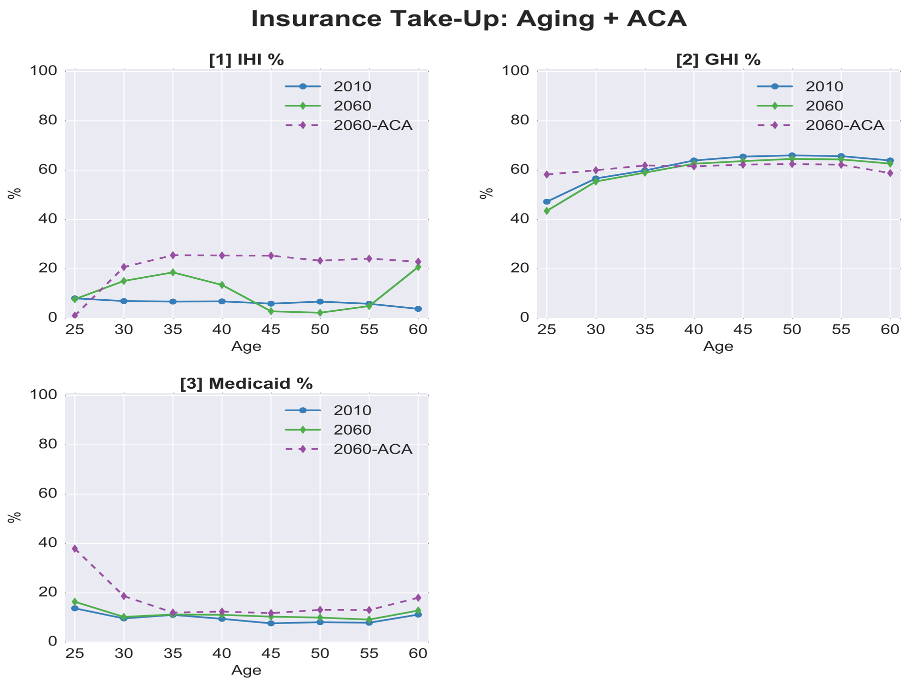
Net Effect of ACA: Effect on Workers

- Net impact of the ACA reform is a 18 percent rise in worker insurance take-up
- Driven almost entirely by increase in Medicaid and IHI participation
- GHI is relatively stable around 60 percent
- ACA 'prevents' the drop in GHI in 2040 (without ACA)

Net Effect of ACA: Effect on Workers

	%Δ ACA - 2020	2030	2040	2050	2060
%Δ : IHI in %:	8.65	10.42	13.60	11.02	10.24
%Δ : GHI in %:	-0.85	1.13	**4.16**	1.84	1.66
%Δ : Medicaid in %:	5.91	5.36	5.11	5.60	5.78
%Δ : Workers Insured %:	13.71	16.91	22.86	18.46	17.68


Worker Insurance Take-up Projections
Insurance Take-Up in %
0
20
40
60
80
100
2010
2020
2030
2040
2050
2060
noACA
ACA
GHI
IHI
Medicaid


Insurance Take-Up: Aging + ACA
[1] IHI %
[2] GHI %
[3] Medicaid %
2010
2060
2060-ACA
%
Age
0
20
40
60
80
100
25
30
35
40
45
50
55
60

Net Effect of ACA in different Periods

- Level variables are normalized:

$$\frac{(\text{Table: Aging \& ACA in year } t) \text{ - } (\text{Table: Aging-only in } t\ )}{(\text{Table: Aging-only in year } t\ )} \times 100$$

Net Effect of ACA: Health Expenditures

- Aggregate health spending drops by a small percentage
- Uninsured individuals into insurance markets where prices paid for medical services are lower
- Substantial increase in spending from both Medicaid and IHI participants
- Increase in IHI $\rightarrow$ shifts in spending types within IHI
  - Subsidies $\rightarrow$ cause high risk types to enter into IHI
  - IHI premiums increase about 20 percent
- Total number of uninsured workers is much lower under the ACA
- As the population ages, the ability of the ACA to insure additional workers diminishes
  - With older age structure more individuals are covered by Medicare $\rightarrow$limits the net effect of ACA

Net Effect of ACA: Health Expenditures

	2020	2030	2040	2050	2060
Med. quantity: M	1.77	1.34	1.18	1.21	1.15
Med. spend.: $p_m M$	-1.20	-1.66	-2.43	-1.81	-1.78
M. sp.: no Ins	-75.53	-77.20	-81.63	-78.33	-77.78
M. sp.: IHI	23.22	46.19	92.99	48.53	44.97
M. sp.: GHI	0.07	1.51	3.45	1.62	1.30
M. sp.: Maid	82.46	66.48	61.96	68.97	69.49
M. sp.: Old	0.01	0.01	0.04	0.04	0.03
$p_m M/$ GDP %	0.01	-0.06	-0.23	-0.11	-0.11

Net Effect of ACA: Aggregate Variables

- ACA causes GDP $\downarrow$
  - Higher taxes: τ_C,τ_V
  - Sector re-allocations:
    - Capital in non-medical sector $\downarrow$ 1 percent
    - Capital in the medical sector $\uparrow$ 2 percent
- Also $\tau_C\uparrow$ so that $M\uparrow$ and $C\downarrow\rightarrow$ distortion
- Overall health $H\uparrow$

Net Effect of ACA: Aggregate Variables

	2020	2030	2040	2050	2060
GDP:	-1.29	-1.27	-1.09	-1.12	-1.14
Health capital: H	0.15	0.13	0.12	0.12	0.12
Consumption: C	-2.63	-2.75	-2.61	-2.61	-2.60
Med. quantity: M	1.77	1.34	1.18	1.21	1.15

Conclusion

1. Construct a heterogeneous agents macro-model with health as a durable good
2. Account for lifecycle patterns of health expenditures and private insurance take up rates
3. Quantify the macroeconomic and distributional effects of aging and the ACA

Extensions

1. Relax some assumptions
   - Endogenize survival probability $\rightarrow$ affects assets accumulation
2. Additional experiments
   - Push Medicare eligibility to 66, 67, etc.
   - Increase/decrease public insurance eligibility in current US system

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Supplementary Material

Worker's Dynamic Optimization Problem

$$
\begin{aligned}
V(x_j) \;&=\; \max_{\{c_j, l_j, m_j, a_{j+1}, in_{j+1}\}} \left\{ u(c_j, h_j, l_j) + \beta \pi_j E\left[V(x_{j+1}) \mid \varepsilon_j^l, \varepsilon_j^h, \varepsilon_j^{GHI} \right] \right\} \\
& \quad s.t. \qquad (1)
\end{aligned}
$$

$$
\begin{aligned}
& \left(1+\tau^C\right) c_j + (1+g)\, a_{j+1} + o(m_j) + 1_{\{in_{j+1}=1\}} \mathrm{prem}^{\mathrm{IHI}}(j,h) + 1_{\{in_{j+1}=} \\
=\; & y_j^W - tax_j + t_j^{\mathrm{SI}}, \\
0 \;\leq\; & a_{j+1},\; 0 \leq l_j \leq 1,
\end{aligned}
$$

$$h_j = i\left(m_j, h_{j-1}, \delta^h, \epsilon_j^h\right)$$

Worker's Dynamic Optimization Problem

$$
\begin{aligned}
y_j^W &= e\left(\vartheta, h_j, \varepsilon_j^l\right) \times l_j \times w + R\left(a_j + t^{\text{Beq}}\right) + \text{profits}, \\
tax_j &= \tilde{\tau}\left(\tilde{y}_j^W\right) + tax_j^{SS} + tax_j^{\text{Mcare}}, \\
\tilde{y}_j^W &= y_j^W - a_j - t^{\text{Beq}} - 1_{[in_{j+1}=2]}\text{prem}^{\text{GHI}} - 0.5\left(tax_j^{SS} + tax_j^{\text{Med}}\right), \\
tax_j^{SS} &= \tau^{\text{Soc}} \times \min\left(\bar{y}_{ss},\ e\left(\vartheta, h_j, \varepsilon_j^l\right) \times l_j \times w - 1_{[in_{j+1}=2]}\text{prem}^{\text{GHI}}\right), \\
tax_j^{\text{Mcare}} &= \tau^{\text{Mcare}} \times \left(e\left(\vartheta, h_j, \varepsilon_j^l\right) \times l_j \times w - 1_{[in_{j+1}=2]}\text{prem}^{\text{GHI}}\right), \\
t_j^{\text{SI}} &= \max\left[0,\ \underline{c} + o\left(m_j\right) + tax_j - y_j^W\right].
\end{aligned}
$$

Retiree's Dynamic Optimization Problem

$$V(x_j) = \max_{\{c_j, m_j, a_{j+1}\}} \left\{ u(c_j, h_j) + \beta \pi_j E\left[V(x_{j+1}) \mid \varepsilon_j^h \right] \right\} \quad (2)$$

$$s.t.$$

$$\left(1+\tau^C\right) c_j + (1+g)\, a_{j+1} + \gamma^{\text{Mcare}} \times p_m^{\text{Mcare}} \times m_j + \text{prem}^{\text{Mcare}}$$
$$= R\left(a_j + t_j^{\text{Beq}}\right) - tax_j + t_j^{\text{Soc}} + t_j^{\text{SI}},$$
$$a_{j+1} \geq 0,$$

where

$$tax_j = \tilde{\tau}\left(\tilde{y}_j^R\right),$$
$$\tilde{y}_j^R = t_j^{\text{Soc}} + r \times \left(a_j + t_j^{\text{Beq}}\right) + \text{profits},$$
$$t_j^{\text{SI}} = \max\left[0, \underline{c} + \gamma^{\text{Mcare}} \times p_m^{\text{Mcare}} \times m_j + tax_j - R\left(a_j + t_j^{\text{Beq}}\right) - t_j^{\text{Soc}}\right]$$

Back to Worker Problem

Insurance Sector

$$\left(1+\omega_{j,h}^{\mathrm{IHI}}\right)\sum_{j=2}^{J_1}\mu_j\int\left[1_{\left[in_j\left(x_j\right)=1\right]}\left(1-\rho^{\mathrm{IHI}}\right)p_m^{\mathrm{IHI}}m_{j,h}\left(x_{j,h}\right)\right]d\Lambda\left(x_{j,h}\right)$$

$$= \quad R\sum_{j=1}^{J_1-1}\mu_j\int\left(1_{\left[in_{j,h}\left(x_{j,h}\right)=1\right]}\mathrm{prem}^{\mathrm{IHI}}\left(j,h\right)\right)d\Lambda\left(x_{j,h}\right)$$

$$\left(1+\omega^{\mathrm{GHI}}\right)\sum_{j=2}^{J_1}\mu_j\int\left[1_{\left[in_j\left(x_j\right)=2\right]}\left(1-\rho^{\mathrm{GHI}}\right)p_m^{\mathrm{GHI}}m_j\left(x_j\right)\right]d\Lambda\left(x_j\right)$$

$$= \quad R\sum_{j=1}^{J_1-1}\mu_j\int\left(1_{\left[in_j\left(x_j\right)=2\right]}\mathrm{prem}^{\mathrm{GHI}}\right)d\Lambda\left(x_j\right),$$

Back to Remaining Parts

Government Budget

$$G + T^{\mathsf{SI}} + T^{Med} = \sum_{j=1}^{J} \mu_j \int \left[\tau^C c\left(x_j\right) + tax_j\left(x_j\right)\right] d\Lambda\left(x_j\right),$$

where

$$T^{\mathsf{SI}} = \sum_{j=1}^{J} \mu_j \int t_j^{\mathsf{SI}}\left(x_j\right) d\Lambda\left(x_j\right)$$

$$T^{\mathsf{Med}} = \sum_{j=1}^{J} \mu_j \int \left(1 - \rho^{Med}\right) p_m^{Med} m_j\left(x_j\right) d\Lambda\left(x_j\right) - \sum_{j=1}^{J} \mu_j \int prem^{Med}\left(x_j\right) d\Lambda\left(x_j\right)$$

Pensions and Bequests

- Pensions:

$$\sum_{j=J_1+1}^{J} \mu_j \int t_j^{\text{Soc}}\left(x_j\right) d\Lambda\left(x_j\right)$$

$$= \sum_{j=1}^{J_1} \mu_j \int \tau^{\text{Soc}} \times \left(e_j\left(x_j\right) \times l_j\left(x_j\right) \times w\right) d\Lambda\left(x_j\right)$$

- Accidental Bequests:

$$\sum_{j=1}^{J_1} \mu_j \int t_j^{\text{Beq}}\left(x_j\right) d\Lambda\left(x_j\right) = \sum_{j=1}^{J} \int \tilde{\mu}_j a_j\left(x_j\right) d\Lambda\left(x_j\right)$$

Back to Remaining Parts

Competitive Equilibrium Definition

- Given $\left\{\Pi_j^l, \Pi_j^h, \Pi_{j,\vartheta}^{\mathrm{GHI}}\right\}_{j=1}^J$, $\{\pi_j\}_{j=1}^J$ and
- $\left\{tax\left(x_j\right), \tau^C, \mathrm{prem}^R, \tau^{SS}, \tau^{\mathrm{Med}}\right\}_{j=1}^J$,

a competitive equilibrium is a collection of sequences of:

- distributions $\{\mu_j, \Lambda_j\left(x_j\right)\}_{j=1}^J$
- individual household decisions $\{c_j\left(x_j\right), l_j\left(x_j\right), a_{j+1}\left(x_j\right), m_j\left(x_j\right), in_{j+1}\left(x_j\right)\}_{j=1}^J$
- aggregate stocks of capital and labor $\{K, L, K_m, L_m\}$
- factor prices $\{w, q, R, p_m\}$
- markups $\left\{\omega^{\mathrm{IHI}}, \omega^{\mathrm{GHI}}, \nu^{in}\right\}$ and
- insurance premiums $\left\{\mathrm{prem}^{\mathrm{GHI}}, \mathrm{prem}^{\mathrm{IHI}}\left(j, h\right)\right\}_{j=1}^J$

such that:

Competitive Equilibrium Definition (cont.)

(a) $\{c_j(x_j), l_l(x_j), a_{j+1}(x_j), m_j(x_j), in_{j+1}(x_j)\}_{j=1}^{J}$ solves the consumer problem

(b) the firm first order conditions hold:

$$
\begin{aligned}
w &= F_L(K, L) = p_m F_{m,L}(K_m, L_m) \\
q &= F_K(K, L) = p_m F_{m,K}(K_m, L_m) \\
R &= q + 1 - \delta
\end{aligned}
$$

(c) markets clear

Competitive Equilibrium Definition (cont.)

$$
\begin{aligned}
K + K_m &= \sum_{j=1}^{J} \mu_j \int \left(a\left(x_j\right)\right) d\Lambda\left(x_j\right) + \sum_{j=1j}^{J} \int \tilde{\mu}_j a_j\left(x_j\right) d\Lambda\left(x_j\right) \\
&+ \sum_{j=1}^{J_1-1} \mu_j \int \left(1_{\left[in_{j+1}=2\right]}\left(x_j\right) \times \mathrm{prem}^{\mathrm{IHI}}\left(j,h\right)\right) d\Lambda\left(x_j\right) \\
&+ \sum_{j=1}^{J_1-1} \mu_j \int \left(1_{\left[in_{j+1}=3\right]}\left(x_j\right) \times \mathrm{prem}^{\mathrm{GHI}}\right) d\Lambda\left(x_j\right)
\end{aligned}
$$

$$
\begin{aligned}
T^{\mathrm{Beq}} &= \sum_{j=1j}^{J} \int \tilde{\mu}_j a_j\left(x_j\right) d\Lambda\left(x_j\right) \\
L + L_m &= \sum_{j=1}^{J_1} \mu_j \int e_j(x_j) l_j\left(x_j\right) d\Lambda\left(x_j\right)
\end{aligned}
$$

Competitive Equilibrium Definition (cont.)

(d) the aggregate resource constraint holds

$$G+(1+g)\,S+\sum_{j=1}^{J}\mu_j\int\left(c\left(x_j\right)+p_m^{in_j\left(x_j\right)}m\left(x_j\right)\right)d\Lambda\left(x_j\right)+\mathrm{Profit}^M=Y+(1-\delta)\,K$$

(e) the government programs clear

(f) the budget conditions of the insurance companies hold, and

(g) the distribution is stationary

$$\left(\mu_{j+1},\Lambda\left(x_{j+1}\right)\right)=T_{\mu,\Lambda}\left(\mu_j,\Lambda\left(x_j\right)\right),$$

where $T_{\mu,\Lambda}$ is a one period transition operator

Back to Competitive Equilibrium

Human Capital Formation

- Human capital:

$$e = e_j\left(\vartheta, h_j, \epsilon^l\right) = \epsilon^l \times \left(\overline{wage}_{j,\vartheta}\right)^{\chi} \times \left(\exp\left(\frac{h_j - \overline{h}_{j,\vartheta}}{\overline{h}_{j,\vartheta}}\right)\right)^{1-\chi}$$

- $\overline{wage}_{j,\vartheta}$ from MEPS
- ϵ^l and Π^l from prior studies using Tauchen (1986) procedure

Back to Health Shock

Calibration: Group Insurance Offers

- Offer shock: $\epsilon^{GHI} = \{0, 1\}$ where
  - 0 indicates no offer and
  - 1 indicates a group insurance offer
- MEPS variables OFFER31X, OFFER42X, and OFFER53X
- Probability of a GHI offer is highly correlated with income
- $\Pi^h_{j,\vartheta}$ with elements $\Pr\left(\epsilon^{\text{GHI}}_{j+1} | \epsilon^{\text{GHI}}_{j}, \vartheta\right)$
- ϑ indicates permanent income group

Calibration: Coinsurance Rates

- Coinsurance rates from MEPS
- Premiums clear insurance constraints
- Markup profits of GHI are zero
- Markup profits of IHI are calibrated to match IHI take up rate
- IHI profits used to cross-subsidize GHI

Calibration: Pension Payments

- L is average/aggregate effective human capital and
- $w \times L$ average wage income
- Pension payments: $t^{\text{Soc}}(\vartheta) = \Psi(\vartheta) \times w \times L$
- where $\Psi(\vartheta)$ is replacement rate that determines the size of pension payments
- Total pension amount to 4.1 percent of GDP

Calibration: Public Health Insurance

- Premium for medicare at 2.11% of GDP (Jeske and Kitao (2009))
- Coinsurance rates for Medicare and Medicaid from MEPS
- Calibrated: Medicaid eligibility FPL_{Maid} at 60% of FPL to match % on Medicaid
- Calibrated: Asset test for Medicaid to match Medicaid take-up profile

Calibration: Taxes

- Gouveia and Strauss (1994) for federal progressive income tax

$$\tilde{\tau}(\tilde{y}) = a_0 \left[\tilde{y} - \left(\tilde{y}^{-a_1} + a_2\right)^{-1/a_1}\right]$$

- Medicare tax is 2.9%
- Social security tax is 9%
- Consumption tax is 5%

External Parameters

Parameters:		Explanation/Source:
- Periods working	$J_1 = 9$	
- Periods retired	$J_2 = 6$	
- Population growth rate	$n = 1.2\%$	CMS 2010
- Years modeled	$years = 75$	from age 20 to 95
- Total factor productivity	$A = 1$	Normalization
- Capital share in production	$\alpha = 0.33$	KydlandPescott1982
- Capital in medical services production	$\alpha_m = 0.26$	Donahoe (2000)
- Capital depreciation	$\delta = 10\%$	KydlandPescott1982
- Health depreciation	$\delta_{h,j} = [0.6\% - 2.13\%]$	MEPS 1999/2009
- Survival probabilities	π_j	CMS 2010
- Health Shocks	see appendix	MEPS 1999/2009
- Health transition prob.	see appendix	MEPS 1999/2009
- Productivity shocks	see appendix	MEPS 1999/2009
- Productivity transition prob.	see appendix	MEPS 1999/2009
- Group insurance transition prob.	see appendix	MEPS 1999/2009

Calibrated Parameters

Parameters:		Explanation/Source:
- Relative risk aversion	$\sigma = 3.0$	to match $\frac{K}{Y}$ and R
- Prefs c vs. l	$\eta = 0.43$	to match labor supply and $\frac{p \times M}{Y}$
- Disutility of health spending	$\eta_m = 1.5$	to match health capital profile
- Prefs c, l vs. health	$\kappa = 0.89$	to match labor supply and $\frac{p \times M}{Y}$
- Discount factor	$\beta = 1.0$	to match $\frac{K}{Y}$ and R
- Health production productivity	$\phi_j \in [0.7 - 0.99]$	to match spending profile
- TFP in medical production	$A_m = 0.4$	to match $\frac{p \times M}{Y}$
- Production parameter of health	$\xi = 0.175$	to match $\frac{p \times M}{Y}$
- effective labor production	$\chi = 0.26$	to match labor supply
- Health productivity	$\theta = 1$	used for sensitivity analysis
- Pension replacement rate	$\Psi = 40\%$	to match τ^{soc}
- Residual Gov't spending	$\Delta_C = 12.0\%$	to match size of tax revenue
- Minimum health state	$h_{\min} = 0.01$	to match health spending
- Internal parameters		

Back to Calibration