Health Risk, Insurance and Optimal Progressive Income Taxation

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Marginal Tax Rates in the US: 2018–2025

Rate	For Unmarried Individuals, Taxable Income Over	For Married Individuals Filing Joint Returns, Taxable Income Over
10%	$0	$0
12%	$9,525	$19,050
22%	$38,700	$77,400
24%	$82,500	$165,000
32%	$157,500	$315,000
35%	$200,000	$400,000
37%	$500,000	$600,000

Tax Cuts and Jobs Act (effective 2018–2025)

- eliminates personal exemptions of $4,150 and
- doubles standard deductions
  - Single: $6,350 ⇒ $12,000
  - Married Filing Jointly: $12,700 ⇒ $24,000

How Progressive Should Income Tax Be?

Theory: Trade off between **insurance** and **incentive** effects

1. The redistribution/insurance effects:
   - Unequal initial conditions
   - Privately-uninsurable shocks (i.e., labor productivity and earnings)
2. The incentive effects:
   - Labor supply or human capital accumulation
   - Saving and investment

Common Views

1. Academic research: Less progressive
   - Conesa and Krueger (2006)
   - Heathcote, Storesletten and Violante (2017)

2. Policy practice: Less progressive
   - The US Tax Cuts and Jobs Act 2017: Trump's tax reform

The Role of Health

- Health is important source of risk and heterogeneity
  - Distinct health pattern over the lifecycle
  - Increasing health spending over the lifecycle
  - Health spending fluctuations are large (and persistent)

This Paper

1. Introduce health risk and health insurance to
   - standard incomplete markets, lifecycle model with heterogeneous agents
2. Study optimal degree of income tax progressivity
   - Ramsey (utilitarian) approach: market structure and tax instruments as given
3. Assess effects of health risk and health insurance systems
   - on optimal degree of tax progressivity

Summary

1. **Optimal** income tax is **more progressive** than current US taxes
2. Optimal tax is **more progressive** with health risk
   - Mechanism: More social insurance for the poor and low income working class
3. Welfare gains from switching to optimal tax are large
   - Over 5 percent in terms of compensating consumption
4. Optimal degree of tax progressivity depends on **health insurance system**
   - no insurance vs. ACA vs. universal public health insurance

Related Literature

1. On the optimal progressivity of income taxation:
   - Income risk: Conesa and Krueger (2006), Heathcote, Storesletten and Violante (2017)
   - Human capital: Erosa and Koreshkova (2007), Guvenen, Kuruscu and Ozkan (2014), Badel and Huggett (2015), Krueger and Ludwig (2016)
   - Housing: Chambers, Garriga and Schlagenhauf (2009)
   - Health: ?

2. Quantitative health/macroeconomics:
   - Health risk and insurance: Jeske and Kitao (2009), Pashchenko and Porapakkarm (2013) and Capatina (2015)
   - Social insurance: Kopecky and Koreshkova (2014)
   - Endogenous health and insurance: Cole, Kim and Krueger (2016), Jung and Tran (2016*a*,*b*); Jung, Tran and Chambers (2017)
   - Health risk and taxation: ?

Model

Modeling Framework

- General equilibrium, overlapping generations: age 20 to 90
- Agent heterogeneity: shocks to labor productivity and **health**
- Health as consumption and investment goods
- The US tax and transfer system:
  - Progressive income taxes
  - Public health insurance: Medicare & Medicaid
  - PAYG social security
  - Minimum consumption: Food stamp

Progressive Income Tax I

- The parametric tax function from Benabou (2002) and used in Heathcote, Storesletten and Violante (2017):

$$\tilde{\tau}\left(\tilde{y}\right) = \tilde{y} - \lambda \tilde{y}^{(1-\tau)}$$

  - $\tilde{\tau}\left(\tilde{y}\right)$: net tax revenues as a function of pre-tax income $\tilde{y}$
  - τ: a progressivity parameter governing the progressivity of a income tax system,
  - λ: a scaling parameter to balance government budget

Progressive Income Tax II

- Special cases depend on value of τ:

$$
\begin{cases}
\text{(1) \textbf{Full redistribution:} } \tilde{\tau}(\tilde{y}) = \tilde{y} - \lambda \text{ and } \tilde{\tau}'(\tilde{y}) = 1 & \text{if } \tau = 1 \\
\text{(2) \textbf{Progressive:} } \tilde{\tau}'(\tilde{y}) = 1 - \overbrace{(1-\tau)}^{<1}\lambda\tilde{y}^{(-\tau)} \text{ and } \tilde{\tau}'(\tilde{y}) > \frac{\tilde{\tau}(\tilde{y})}{\tilde{y}} & \text{if } 0 < \tau < 1 \\
\text{(3) \textbf{No-Redistribution (proport.):} } \tilde{\tau}(\tilde{y}) = \tilde{y} - \lambda\tilde{y} \text{ and } \tilde{\tau}'(\tilde{y}) = 1 - \lambda & \text{if } \tau{=}0 \\
\text{(4) \textbf{Regressive:} } \tilde{\tau}(\tilde{y}) = 1 - \overbrace{(1-\tau)}^{>1}\lambda\tilde{y}^{(-\tau)} \text{ and } \tilde{\tau}'(\tilde{y}) < \frac{\tilde{\tau}(\tilde{y})}{\tilde{y}} & \text{if } \tau < 0
\end{cases}
$$

The US Progressive Income Tax Function

- We model transfers explicitly (e.g., foodstamps, Medicaid)
- Use parametric function from Benabou (2002) and Heathcote, Storesletten and Violante (2017) with a non-negative tax restriction, $\tilde{\tau}(\tilde{y}) \geq 0$,

$$\tilde{\tau}(\tilde{y}) = \max\left[0,\, \tilde{y} - \lambda y^{(1-\tau)}\right]$$

The US Health Insurance System

- Private health insurance:
  - Group based health insurance (GHI)
  - Individual based health insurance (IHI)

- Public (social) health insurance:
  - Medicaid for low income
  - Medicare for retirees

- Health insurance status for workers:

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

Out-of-Pocket Health Spending

- Out-of-pocket health expenditures depend on insurance state

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

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:

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

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

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

Worker's Dynamic Optimization Problem

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

s.t.

$$\begin{aligned}
\left(1+\tau^C\right) c_j + (1+g)\, a_{j+1} + o(m_j) & \\
+1_{\{in_{j+1}=1\}} \text{prem}^{\text{IHI}}(j,h) & \\
+1_{\{in_{j+1}=2\}} \text{prem}^{\text{GHI}} &= y_j^W - tax_j + t_j^{\text{SI}}, \\
0 &\leq l_j \leq 1, \\
0 &\leq a_{j+1}, \\
h_j &= i\left(m_j, h_{j-1}, \delta^h, \epsilon_j^h\right)
\end{aligned}$$

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

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

$$\left(1+\tau^C\right) c_j + (1+g)\, a_{j+1} + \gamma^{\text{Mcare}} \times p_m^{\text{Mcare}} \times m_j + \text{prem}^{\text{Mcare}}$$

$$= R\left(a_j + t_j^{\text{Beq}}\right) - tax_j + t_j^{\text{Soc}} + t_j^{\text{SI}},$$

$$a_{j+1} \geq 0,$$

where

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

Remaining Parts

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

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

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

Health Shocks

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

$$\epsilon^h_j = \left\{0, \frac{\bar{h}^2_{j,d} - \bar{h}^1_{j,d}}{\bar{h}^1_{j,d}}, \frac{\bar{h}^3_{j,d} - \bar{h}^1_{j,d}}{\bar{h}^1_{j,d}}, \frac{\bar{h}^4_{j,d} - \bar{h}^1_{j,d}}{\bar{h}^1_{j,d}}\right\}$$

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

Human Capital

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:

$$\left[p_m^{\text{noIns}}, p_m^{\text{IHI}}, p_m^{\text{GHI}}, p_m^{\text{Maid}}, p_m^{\text{Mcare}}\right] = [1.70, 1.25, 1.10, 1.0, 0.90] \times p_m$$

More Calibration Details

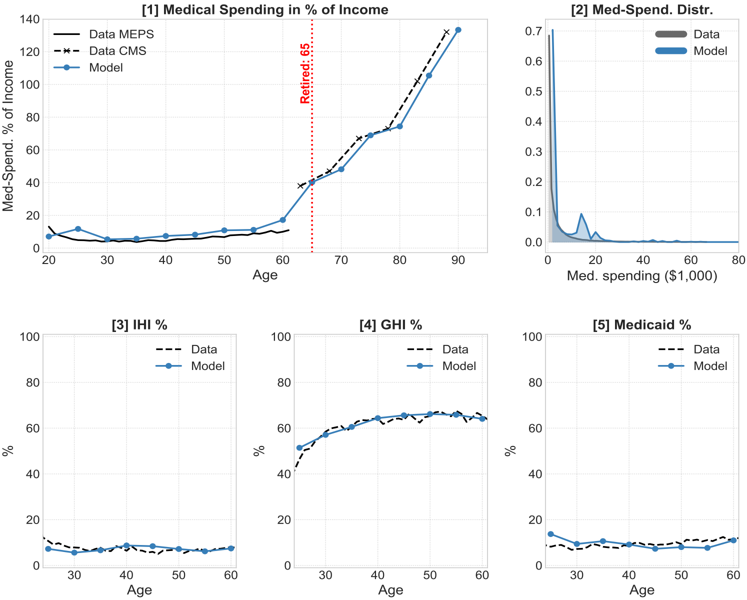
Progressive Income Tax Function

- Calibration of the Benabou (2002) tax function

$$\tilde{\tau}\left(\tilde{y}\right) = \max\left[0,\, \tilde{y} - \lambda \tilde{y}^{(1-\tau)}\right]$$

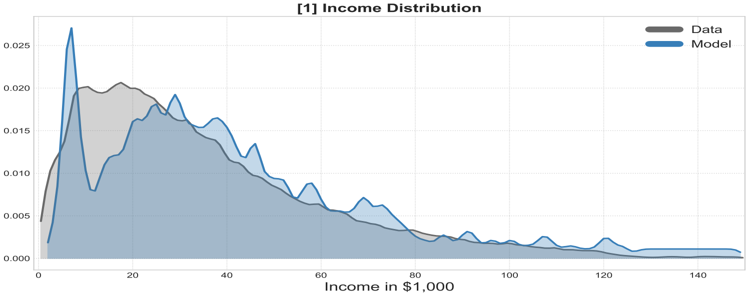
  - Progressivity level $\tau = 0.053$ as in Guner, Lopez-Daneri and Ventura (2016)
  - Scaling factor $\lambda = 1.095$ to match the relative size of the government budget

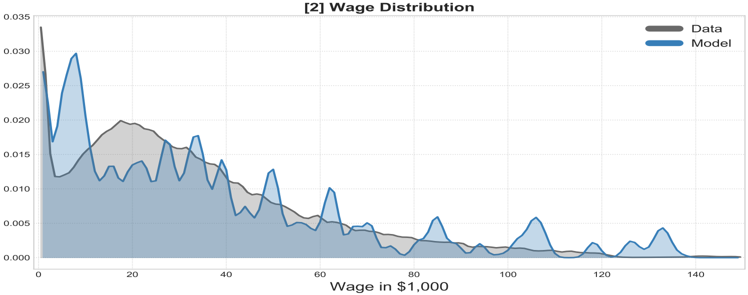
Health Expenditures and Insurance: Model vs. Data



Source: MEPS 2000-2009

Income and Wage Distribution: Model vs. Data





Source: MEPS 2000-2009

Calibration: Matched Moments

Moments	Model	Data	Source	[illegible]
- Medical exp. % HH income	17.6%	17.07%	CMS communication	[illegible]
- Workers IHI	5.6%	7.2%	MEPS 1999/2009	[illegible]
- Workers GHI	61.1%	62.2%	MEPS 1999/2009	[illegible]
- Workers Medicaid	9.6%	9.2%	MEPS 1999/2009	[illegible]
- Capital output ratio: K/Y	2.7	$2.6 - 3$	NIPA	[illegible]
- Interest rate: R	4.2%	4%	NIPA	[illegible]
- Size of Social Sec./Y	5.9%	5%	OMB 2008	[illegible]
- Size of Medicare/Y	3.1%	$2.5 - 3.1$%	U.S. Dept. of Health (2007)	[illegible]
- Medical spend. profile			MEPS 1999/2009	[illegible]
- IHI take-up profile			MEPS 1999/2009	[illegible]
- Medicaid take-up profile			MEPS 1999/2009	[illegible]
- Average labor hours			PSID 1984-2007	[illegible]
Total number of moments				[illegible]

Analysis

Experiments I

- Benchmark economy with the pre-ACA health insurance system

- Consider the progressive income tax function

$$\tilde{\tau}(\tilde{y}) = \max\left[0,\ \tilde{y} - \lambda \tilde{y}^{(1-\tau)}\right]$$

  - Social welfare function is **ex-ante lifetime utility** of newborn in stationary equilibrium implied by $\tilde{\tau}(\tilde{y},\ \lambda,\ \tau)$:

$$WF(\lambda,\ \tau) = \int V(x_{j=1}|\lambda, \tau)\, d\Lambda(x_{j=1})$$

  - Find an optimal income tax code: choose $\{\lambda, \tau\}$ to maximize the social welfare function

Experiments II

$$WF^* = \max_{\{\lambda,\ \tau\}} \int WF(\lambda,\ \tau)$$

s.t.

$$\sum_{j=1}^{J} \mu_j \int tax_j\,(\lambda, \tau, x_j)\, d\Lambda\,(x_j) = \overline{C_G} + T^{SI}\,(\lambda, \tau)$$

$$+\text{Medicaid}(\lambda, \tau) + \text{Medicare}(\lambda, \tau)$$

$$-\,\tau^{C} C\,(\lambda, \tau) - \text{Medicare Prem}(\lambda, \tau)\ ,$$

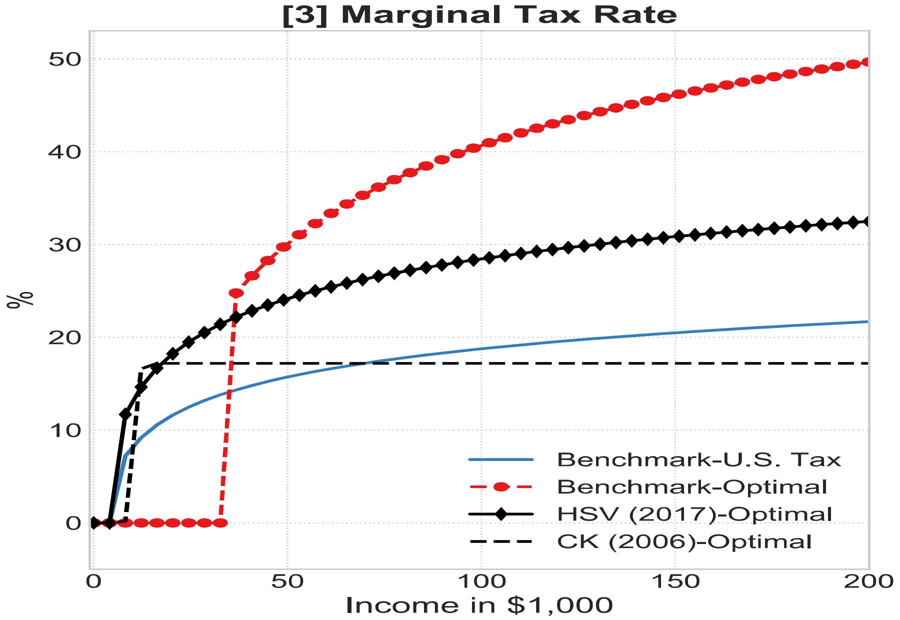
$$-\,\text{Medicare Tax}\,(\lambda, \tau)$$

- Note: Choose $\tau \Rightarrow \lambda$ adjusts to clear government budget s.t. C_G is constant

The Optimal Income Tax System

Parameters:	[1] Benchmark	[2] Optimal Tax
+ Progressivity: τ	0.053	**0.247**
+ Scaling: λ	1.095	2.411
+ Tax break	$6,050	$36,360

The Optimal Income Tax System



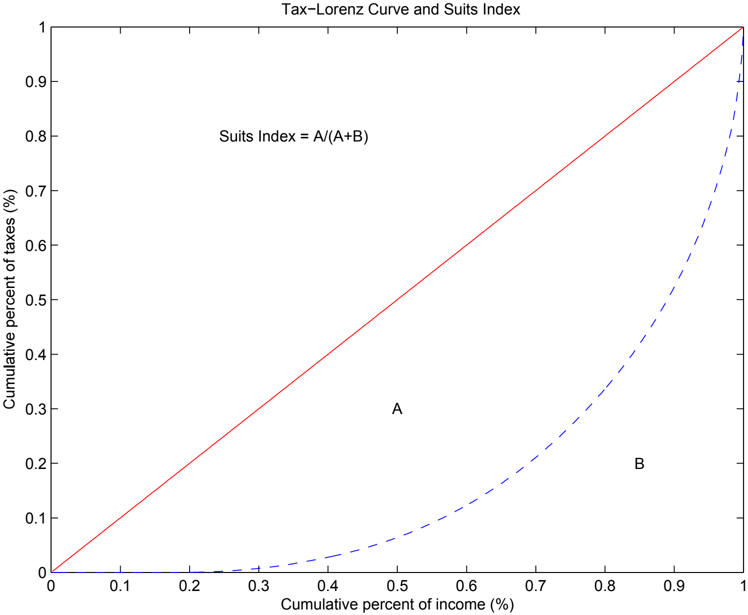
Measuring Tax Progressivity

- How to measure the level of progressivity of a income tax system?

- Tax Progressivity Index (Suits Index): Suits (1977) measures income-tax inequality
  - Lorenz-type curve measuring the degree of disproportionality between pretax income and tax contributions
  - ⇒ relative concentration curve

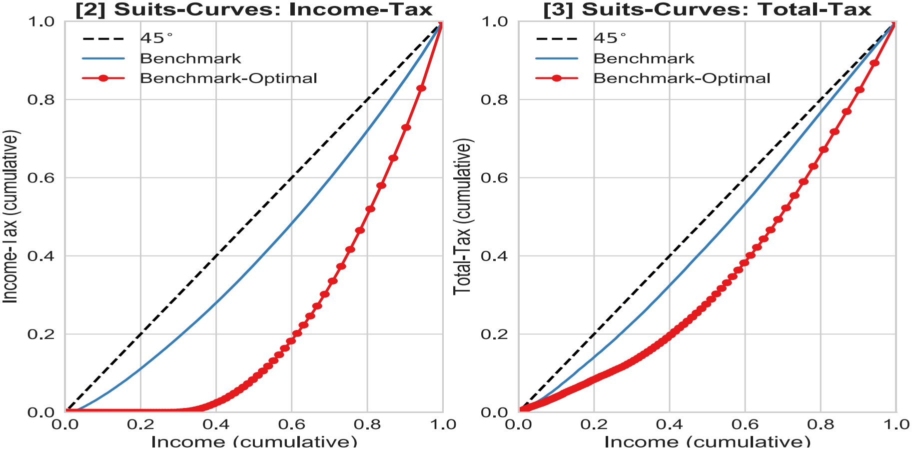
- The **Suits Index** is a "Gini coefficient" for tax contributions by income group
  - $+1$ (most progressive) ⇒ entire tax burden allocated to households of highest income bracket
  - 0 for a proportional tax
  - -1 (most regressive) ⇒ entire tax burden allocated to households of lowest income bracket

Suits Index



Tax−Lorenz Curve and Suits Index
Suits Index = A/(A+B)
A
B
Cumulative percent of taxes (%)
Cumulative percent of income (%)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

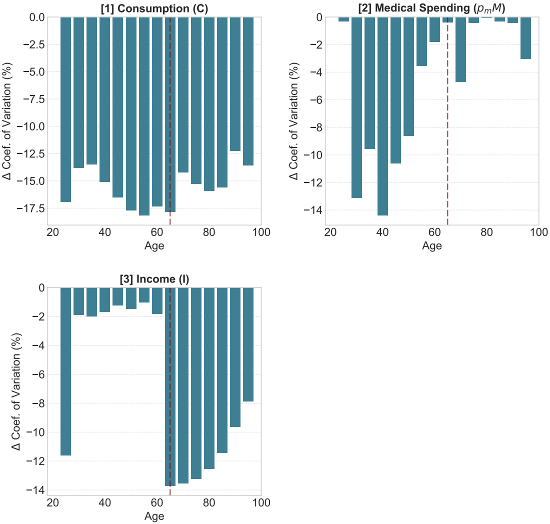
Suit Index: Benchmark vs Optimal



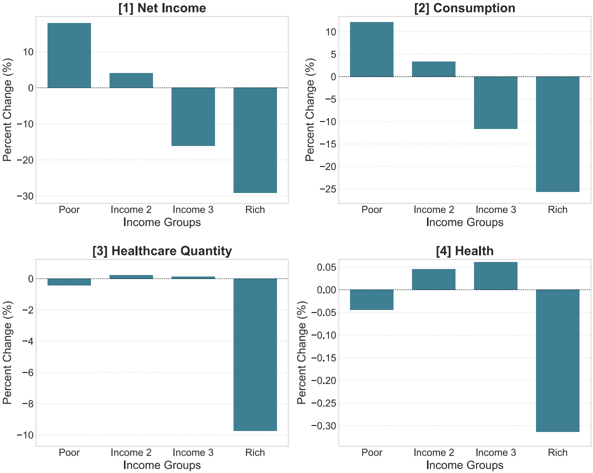
Aggregate Variables: Benchmark vs. Optimal

	[0] Benchmark: US Tax	[1] Optimal Tax
Output (GDP)	100	94.34
Capital (K_c)	100	93.55
Capital (K_m)	100	99.28
Weekly hours worked	29.40	29.03
Non- Med. Cons. (C)	100	93.13
Med. consumption (M)	100	99.42
Med. spending ($p_m M$)	100	100.46
Workers insured (%)	78.59	75.55
Medicaid (%)	9.56	6.19
Gini (Total income)	0.44	0.41
Gini (Net income)	0.38	0.31
Suits index (Income tax)	0.17	0.53
Welfare (CEV):	0	+5.64
• Income Group 1 (Low)	0	+20.85
• Income Group 2	0	+11.89
• Income Group 3	0	−9.11
• Income Group 4 (High)	0	−31.84

Changes due to Optimal Tax Progressivity



Changes due to Optimal Tax Progressivity

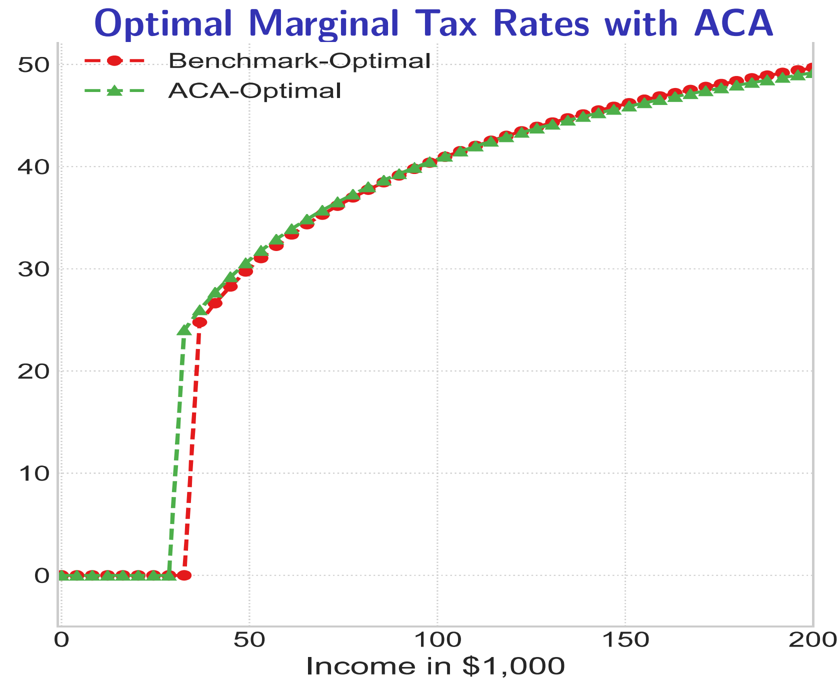


The Role of Health Insurance

- Redistribution/social insurance embedded in the health insurance system
- How does the design of the health insurance system affect the optimal income tax system?
  - The shape of the progressive tax function
  - The optimal progressive level
- Two alternative health insurance systems:
  1. Obamacare (ACA)
  2. Universal public health insurance (UPHI)

The Optimal Tax System after ACA

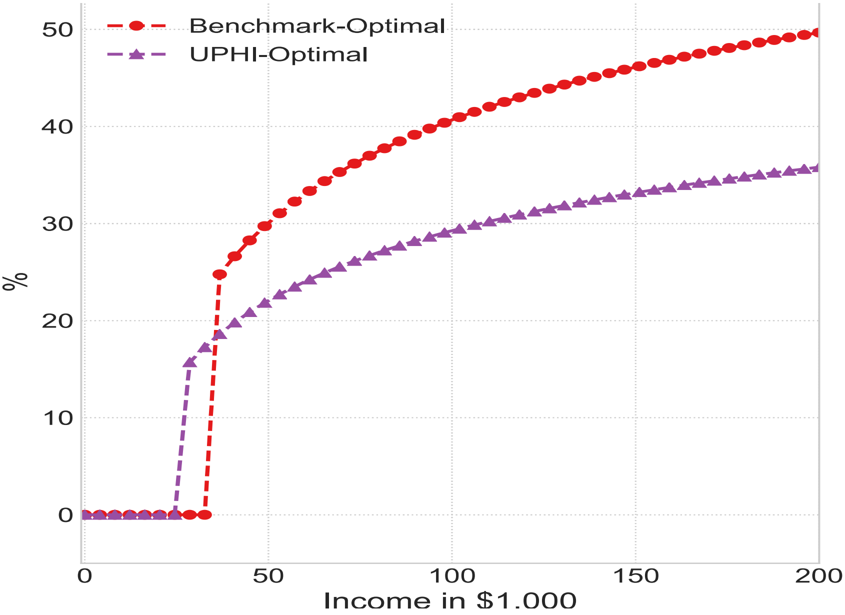
Parameters	[1] Opt. Tax - Bench.	[2] Opt. Tax - ACA
Progressivity (τ)	0.247	0.222
Scaling (λ)	2.411	2.118
Tax break	$\$36,360$	$\$30,300$

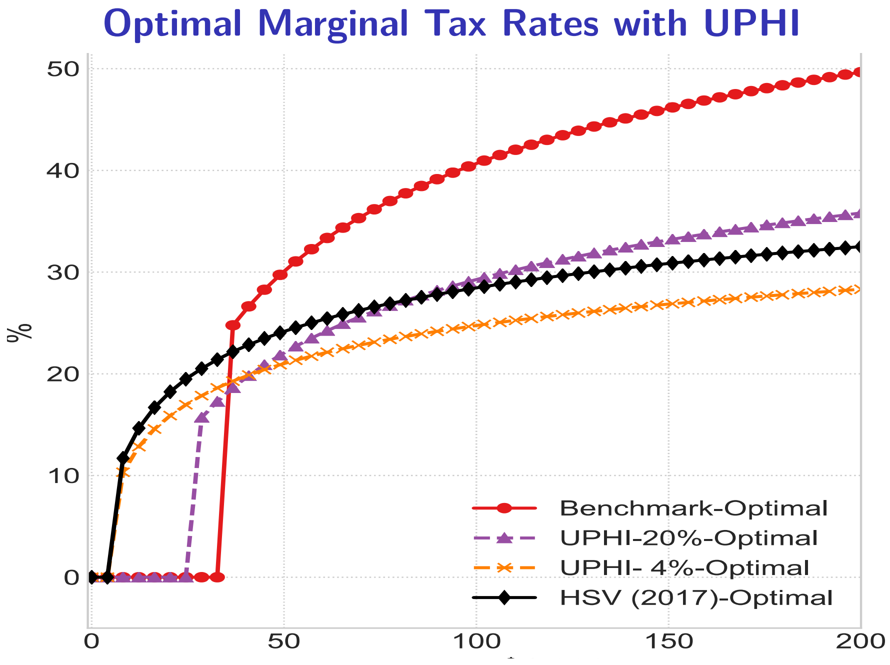

Optimal Marginal Tax Rates with ACA
Benchmark-Optimal
ACA-Optimal
0
10
20
30
40
50
0
50
100
150
200
Income in $1,000

The Optimal Tax System with UPHI

	[1] Bench.	[3.1] UPHI $\rho = 0.2$	[3.2] UPHI $\rho = 0.04$
Progressivity (τ)	0.247	0.140	0.07
Scaling (λ)	2.411	2.118	1.117
Tax break	\$36,360	\$26,260	\$6,061

Optimal Marginal Tax Rates with UPHI ($\rho = 0.2$)





Optimal Marginal Tax Rates with UPHI
%
50
40
30
20
10
0
0
50
100
150
200
Benchmark-Optimal
UPHI-20%-Optimal
UPHI- 4%-Optimal
HSV (2017)-Optimal

Two Extreme Cases

1. **No health risk**: Health capital accumulation

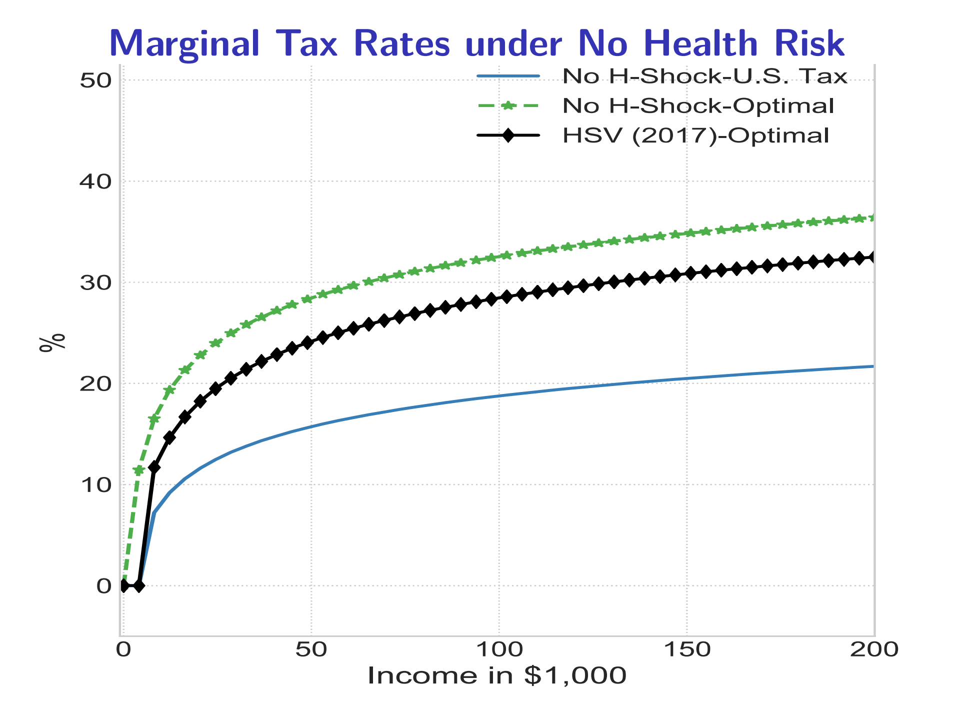
$$h_j = \overbrace{\phi_j m_j^{\xi}}^{\text{Investment}} + \overbrace{\left(1-\delta_j^h\right) h_{j-1}}^{\text{Trend}}$$

2. **No health insurance**: Remove the health insurance system (Self insurance only)
   - Out-of-pocket health expenditure

$$o\left(m_j\right) = p_m \times m_j,$$

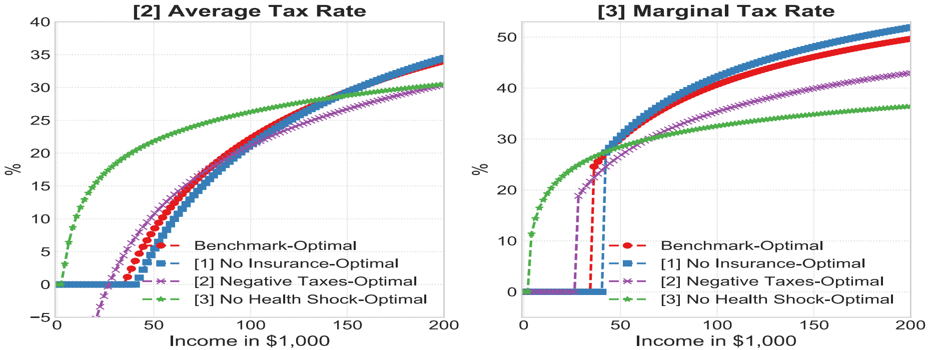
The Optimal Tax System No Health Risk and No HI

	[1] Bench.	[2] No Health Risk	[3] No HI
Progressivity (τ)	0.247	0.085	0.266
Scaling (λ)	2.411	1.090	1.117
Tax break	$\$36,360$	$\$4,041$	$\$42,425$



Marginal Tax Rates under No Health Risk
No H-Shock-U.S. Tax
No H-Shock-Optimal
HSV (2017)-Optimal
%
50
40
30
20
10
0
0
50
100
150
200
Income in $1,000

Average and Marginal Tax Rates



Sensitivity Analysis I

[1] Opt. Benchmark

	$\sigma = 2$	$\sigma = 3$	$\sigma = 4$
Progr. (τ)	0.186	0.247	xxx
Scaling (λ)	1.891	2.411	xxx
Tax break	$32,324	$36,360	$xxx

[2] Opt. UPHI: $\rho = 0.2$

	$\sigma = 2$	$\sigma = 3$	$\sigma = 4$
Progr. (τ)	0.121	0.140	0.145
Scaling (λ)	1.447	2.118	1.593
Tax break	$22,223	$26,260	$26,263

[3] Opt. No Health Shock

	$\sigma = 2$	$\sigma = 3$	$\sigma = 4$
Progr. (τ)	0.037	0.085	0.110
Scaling (λ)	0.905	1.090	1.188
Tax break	$2,021	$4,041	$6,062

Sensitivity Analysis II

- Endogenize survival probability following Suen (2006)

$$\pi_j(h) = 1 - \frac{1}{\exp\left(haz1_j \times \left(\frac{h_j}{h_{\max}}\right)^{haz2_j}\right)}$$

$$v(c,l,h) = u(c,l,h) + b$$

- Medical spending leisure cost to make medical demand less price elastic

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

[1] Opt. Benchmark

	Basic	**Endog. Surv**	**Elast. m-spend↓**	**H-productivity↑**
Progr. (τ)	0.247	0.193	0.180	0.251
Scaling (λ)	2.411	1.933	1.838	2.505
Tax break	$\$36,360$	$\$32,324$	$\$30,304$	$\$38,384$

[2] Opt. UPHI: $\rho = 0.2$

	Basic	**Endog. Surv**	**Elast. m-spend↓**	**H-productivity↑**
Progr. (τ)	0.140	0.110	0.108	0.061
Scaling (λ)	2.118	1.382	1.367	1.076
Tax break	$\$26,260$	$\$20,202$	$\$18,182$	$\$4,041$

[3] Opt. No Health Shock

	Basic	**Endog. Survival**	**Elast. m-spend↓**	**H-productivity↑**
Progr. (τ)	0.085	xxx	0.073	0.017
Scaling (λ)	1.090	xxx	1.019	0.727
Tax break	$\$4,041$	$xxx	$\$2,021$	$1

Conclusion

1. Health risks and insurance systems are important
2. Riskier environments result in higher optimal income tax progressivity (more redistribution/insurance is needed)
3. The US income tax system should be more progressive
4. Introduction of ACA reduces optimal progressivity
5. Medicare for all would reduce optimal progressivity substantially

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Supplementary Material

Worker's Dynamic Optimization Problem

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

$s.t.$

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

$$0 \leq a_{j+1},\ 0 \leq l_j \leq 1,$$

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

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

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

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

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

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

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

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

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

Back to Remaining Parts

Pensions and Bequests

- Pensions:

$$\begin{aligned}
& \sum_{j=J_1+1}^{J} \mu_j \int t_j^{\text{Soc}}(x_j)\, d\Lambda(x_j) \\
= & \sum_{j=1}^{J_1} \mu_j \int \tau^{\text{Soc}} \times (e_j(x_j) \times l_j(x_j) \times w)\, d\Lambda(x_j)
\end{aligned}$$

- Accidental Bequests:

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

Back to Remaining Parts

Government Budget

$$
\begin{aligned}
& C_G + T^{SI} + \sum_{j=2}^{J_1} \mu_j \int 1_{[in_j(x_j)=3]} \left(1 - \rho^{\text{MAid}}\right) p_m^{\text{MAid}} m_j\left(x_j\right) d\Lambda\left(x_j\right) \\
& + \sum_{j=J_1+1}^{J} \mu_j \int \left(1 - \rho^{R}\right) p_m^{R} m_j\left(x_j\right) d\Lambda\left(x_j\right) \\
= \; & \sum_{j=1}^{J} \mu_j \int \left[\tau^{C} c\left(x_j\right) + tax_j\left(x_j\right)\right] d\Lambda\left(x_j\right) \\
& + \sum_{j=J_1+1}^{J} \mu_j \int \text{prem}^{R}\left(x_j\right) d\Lambda\left(x_j\right) + \sum_{j=1}^{J_1} \mu_j \int tax_j^{\text{Med}} d\Lambda\left(x_j\right)
\end{aligned}
$$

Back to Remaining Parts

Competitive Equilibrium Definition I

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

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 $\left\{\omega^{\text{IHI}}, \omega^{\text{GHI}}, \nu^{in}\right\}$ and
- insurance premiums $\left\{\text{prem}^{\text{GHI}}, \text{prem}^{\text{IHI}}\left(j, h\right)\right\}_{j=1}^J$

such that:

Competitive Equilibrium Definition II

(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 III

$$K + K_m = \sum_{j=1}^{J} \mu_j \int (a(x_j))\, d\Lambda(x_j) + \sum_{j=1j}^{J} \int \tilde{\mu}_j a_j(x_j)\, d\Lambda(x_j)$$

$$T^{\text{Beq}} = \sum_{j=1j}^{J} \int \tilde{\mu}_j a_j(x_j)\, d\Lambda(x_j)$$

$$L + L_m = \sum_{j=1}^{J_1} \mu_j \int e_j(x_j) l_j(x_j)\, d\Lambda(x_j)$$

$$\sum_{j=1}^{J} \mu_j \int (m(x_j))\, d\Lambda(x_j) = F_m(K_m, N_m),$$

Competitive Equilibrium Definition IV

(d) the aggregate resource constraint holds

$$C_G + (1+g)\,S + \sum_{j=1}^{J} \mu_j \int c\,(x_j)\,d\Lambda\,(x_j) = Y + (1-\delta)\,K$$

(e) the government programs clear

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

(g) the distribution is stationary

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

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

Back to Remaining Parts

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

$$\tilde{\tau}\left(\tilde{y}\right) = \lambda\left[\tilde{y} - \left(\tilde{y}^{-\tau_1} + \tau_2\right)^{-1/\tau_1}\right]$$

- 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 med. services prod.	$\alpha_m = 0.26$	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:	Nr.M.
- Relative risk aversion	$\sigma = 3.0$	to match $\frac{K}{Y}$ and R	1
- Pref. cons. leisure	$\eta = 0.43$	to match labor supply and $\frac{p \times M}{Y}$	1
- Pref c and l vs. h	$\kappa = 0.75$	to match labor supply and $\frac{p \times M}{Y}$	1
- Discount factor	$\beta = 1.0$	to match $\frac{K}{Y}$ and R	1
- GHI markup profits	$\omega^{\text{GHI}} = 0$	to match GHI take-up	1
- IHI markup profits	$\omega_{j,h} \in [0.6 - 1.5]$	to match spending profile	8
- Health production productivity	$\phi_j \in [0.2 - 0.45]$	to match spending profile	15
- TFP in medical production	$A_m = 0.4$	to match $\frac{p \times M}{Y}$	1
- Production parameter of health	$\xi = 0.26$	to match $\frac{p \times M}{Y}$	1
- Effective labor services production	$\chi = 0.85$	to match labor supply	1
- Health productivity	$\theta = 1.0$	used for sensitivity analysis	1
- Pension replacement rate	$\Psi = 40\%$	to match τ^{soc}	1
- Fixed time cost of labor	$\bar{l}_j \in [0.0 - 0.7]$	to match average work hours	9
- Minimum health state	$h_{\min} = 0.01$	to match health spending	1
- Asset test level	$\bar{a}_{Maid} = \$150,000$	to match Medicaid take-up	1
-Total Nr. of paras			44

Back to Calibration