Health Risk, Insurance and Optimal Progressive Income Taxation

Juergen Jung
Towson University

Chung Tran
Australian National University

University of Houston

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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 (labor productivity and earnings)

2. The incentive effects
   - Labor supply
   - Human capital accumulation
   - Saving/physical capital accumulation

Common Views

1. Research ⇒ optimal tax is less progressive than current US tax
   - Conesa and Krueger (2006) ⇒ optimal tax is flat (with tax free threshold)
   - Heathcote, Storesletten and Violante (2017) ⇒ optimal tax is less progressive than current US tax
2. Policy practice
   - US Tax Cuts and Jobs Act 2017 (Trump tax cuts) ⇒ more/less progressive?
   - Auerbach, Kotlikoff and Koehler (2016) ⇒ more progressive for some age groups

This Paper

1. Introduce **health risk** and **health insurance** into
   - standard incomplete markets, lifecycle model with heterogeneous agents a la Conesa and Krueger (2006)
2. Study optimal degree of income tax progressivity
   - Ramsey (utilitarian) approach: market structure and **tax instruments (polynomial form)** as given
3. Assess effects of health risk and health insurance systems
   - on optimal degree of tax progressivity

Role of Health Risk

- **Health** is important source of risk and heterogeneity
- Distinct **health status** pattern over the lifecycle (decreasing) affects
  - survival
  - labor productivity
  - life satisfaction
  - health spending
- Distinct **health spending** patterns
  - increasing over lifecycle
  - large fluctuations
  - highly skewed
  - "somewhat" persistent (Bianco and Moro 2022)
- Fairly complete ex-ante insurance is optimal in simple settings (Gruber 2022) $\Rightarrow$ opens avenue for social insurance via progressive income taxes

Results

1. Health risk + US health insurance system
   - Optimal tax **more progressive** than US tax
   - Welfare gains small ⇒ approx. 0.1% (compensating consumption)
   - **Mechanism:** More social insurance for sick/low income types generates welfare gains that counter "bad" incentive effects
2. W/o health **spending** risk ⇒ **15% flat** tax + welfare gains ⇒ Conesa and Krueger (2006)
3. Health risk + UPHI w/ coinsurance rate of:
   - **0%** ⇒ **full** insurance ⇒ **30% flat** tax ⇒ large output & welfare losses
   - **(0%, 100%)** ⇒ **partial** insurance ⇒ progressive tax ⇒ welfare gains possible ⇒ Jung and Tran (2022)
   - **100%** ⇒ **no** insurance ⇒ most progressive tax ⇒ output gains but welfare losses

Contribution to 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), Krueger and Ludwig (2016), Badel, Huggett and Luo (2020)
   - Housing: Chambers, Garriga and Schlagenhauf (2009)
   - Health: this paper!

2. Quantitative health/macroeconomics:
   - Exogenous health risk and insurance: Jeske and Kitao (2009), Pashchenko and Porapakkarm (2013); Capatina (2015), Jung and Tran (2022)
   - Exogenous disability risk and retirement: Low and Pistaferri (2015), Kitao (2014)
   - Endogenous health and insurance: Cole, Kim and Krueger (2018), Jung and Tran (2016); Jung, Tran and Chambers (2017)
   - Social insurance: Kopecky and Koreshkova (2014)
   - Health risk and taxation: this paper!

Model

Bewley with Exogenous Health States

- Overlapping Generations
- Heterogeneous agents
  - Lifespan: age 20–94
  - **Idiosyncratic shocks**: (*i*) health (*ii*) employer type (*iii*) labor
  - Exogenous health state
    - Health dependent survival + accidental bequests
    - Health dependent income profiles
    - Exogenous health spending
  - Health insurance
    - Public HI with eligibility criteria: Medicaid & Medicare
    - Choice of private HI: Individual HI & Group HI
- Markets: consumption good, capital, labor & incomplete financial markets
- Progressive income tax, Social Security, payroll taxes, min. cons. program
- General equilibrium

Health

- 5 exogenous health states $\epsilon^h \in \{1, 2, 3, 4, 5\}$
- Health expenditure $m_j\left(\vartheta, \epsilon^h\right)$ depends on age, health & education
- Health/Sick groups:

$$h\left(\epsilon^h\right) = \begin{cases} \text{healthy} & \text{if } \epsilon^h \in \{\text{excellent, very good, good}\} \\ \text{sick} & \text{if } \epsilon^h \in \{\text{fair, poor}\} \end{cases}$$

- Survival probability: $\pi_j\left(h\left(\epsilon^h\right)\right)$
- Human capital: $e_j\left(\vartheta, \epsilon^n, \epsilon^h\right)$
- Health, labor income and employer insurance shocks:

$$\Pr\left(\epsilon^h_{j+1}|\epsilon^h_j\right) \in \Pi^h_j\ ,\ \Pr\left(\epsilon^n_{j+1}|\epsilon^n_j\right) \in \Pi^n_j \text{ and } \Pr\left(\epsilon^{\mathrm{GHI}}_{j+1}|\epsilon^{\mathrm{GHI}}_j, \vartheta\right) \in \Pi^{\mathrm{GHI}}_{j,\vartheta}$$

Health Insurance Arrangements

- Private health insurance: group (GHI) or individual (IHI)

- Public (social) health insurance: Medicaid or Medicare

- Health insurance status:

$$\text{in}_j = \begin{cases} 0 & \text{if no insurance} \\ 1 & \text{if private IHI} \\ 2 & \text{if private GHI} \\ 3 & \text{if public insurance} \end{cases}$$

- Coinsurance rates: $0 \leq \gamma^{\text{in}}(m) \leq 1$
- Out-of-pocket medical spending

$$o_j(m) = \begin{cases} m & \text{if in}_j = 0 \\ \gamma^{\text{in}} \times m & \text{if in}_j > 0 \end{cases}$$

- Insurance pays: $(1 - \gamma^{\text{in}}) \times m$

Technology and Firms

- Final goods production sector

$$\max_{\{K,\ N\}} \{F(K, N) - q \times K - w \times N\}$$

- Firms offering GHI subsidizes fraction ψ of premium cost

- Firm passes costs c_E to employees e.g. Jeske and Kitao (2009)

$$\widehat{w} = \left(w - 1_{\left[\epsilon^{\text{GHI}}=1\right]} \times c_E\right)$$

- Remaining share of GHI premium $\widehat{\text{prem}}^{\text{GHI}} = (1 - \psi) \times \text{prem}^{\text{GHI}}$ is tax deductible

More Details

Progressive Income Tax I

- The parametric tax function: Musgrave (1959); Kakwani (1977); Benabou (2002); Heathcote, Storesletten and Violante (2017):

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

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

Progressive Income Tax II

- Special cases depend on value of τ:

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

Progressive Income Tax Function

- We model transfers explicitly (e.g., foodstamps, Medicaid)
- Adjust parametric function with a non-negative tax restriction, $\tilde{\tau}(\tilde{y}) \geq 0$

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

Worker Problem

- State vector: $x_j = \left\{\vartheta, a_j, \text{in}_j, \epsilon_j^n, \epsilon^h, \epsilon_j^{\text{GHI}}\right\}$
- Choice set: $\mathcal{C}_j \equiv \{(c_j, \ell_j, a_{j+1}, \text{in}_{j+1}) \in R^+ \times [0,1] \times R^+ \times \{0,1,2,3\}\}$

$$V(x_j) = \max_{\mathcal{C}_j} \left\{ u(c_j, \ell_j) + \beta \overbrace{\times \pi_j\left(h\left(\epsilon^h\right)\right)}^{\text{Health surv. channel}} \times \mathbb{E}\left[V(x_{j+1}) \mid x_j\right] \right\} \text{ s.t.}$$

$$(1+\tau^c)\, c_j + a_{j+1} \overbrace{+ o_j\left(m_j\left(\epsilon^h\right)\right) +}^{\text{Health spend. channel}} \underset{\{\text{in}_{j+1}=1\}}{1 \times} \text{prem}^{\text{IHI}}\left(j, \epsilon^h\right) + \underset{\{\text{in}_{j+1}=2\}}{1 \times} \widehat{\text{prem}}_j^{\text{GHI}}$$

$$= (1+r)\, a_j + \widehat{w} \overbrace{\times e_j\left(\vartheta, \epsilon_j^n, h\left(\epsilon^h\right)\right)}^{\text{Health income channel}} (1-\ell_j) + b_j^{\text{SI}} + \left(1-\tau^{\text{Beq}}\right) b^{\text{Beq}} \quad \overbrace{-\, Tax}^{\text{Health tax channel}}$$

$$\text{Tax} = T^y\left(y_j^{\text{T}}\right) + T^{\text{SS}}\left(y_j^{\text{SS}}; \bar{y}^{\text{SS}}\right) + T^{\text{MCare}}\left(y_j^{\text{SS}}\right)$$

More Details

Retiree Problem

- State vector: $x_j = \left\{\vartheta, a_j, \epsilon^h\right\}$
- Choice set: $\mathcal{C}_j \equiv \{(c_j, a_{j+1}) \in R^+ \times R^+\}$

$$V(x_j) = \max_{\mathcal{C}_j} \left\{ u(c_j) + \beta \overbrace{\times \pi_j \left(h\left(\epsilon^h\right)\right)}^{\text{Health surv. channel}} \times \mathbb{E}\left[V(x_{j+1}) \,|\, x_j\right] \right\} \text{s.t.}$$

$$(1+\tau^c)\, c_j + a_{j+1} \overbrace{+ o_j\left(m_j\left(\epsilon^h\right)\right)}^{\text{Health spending channel}} + \text{prem}^{\text{MCare}}$$

$$= (1+r)\, a_j + b_j^{\text{SS}} + b_j^{\text{SI}} + \left(1-\tau^{\text{Beq}}\right) b^{\text{Beq}} \overbrace{- T^y\left(y_j^{\text{T}}\right)}^{\text{Health tax channel}}$$

More Details

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
- 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
  - Previous studies: income process, labor shocks, aggregates

More Calibration Details

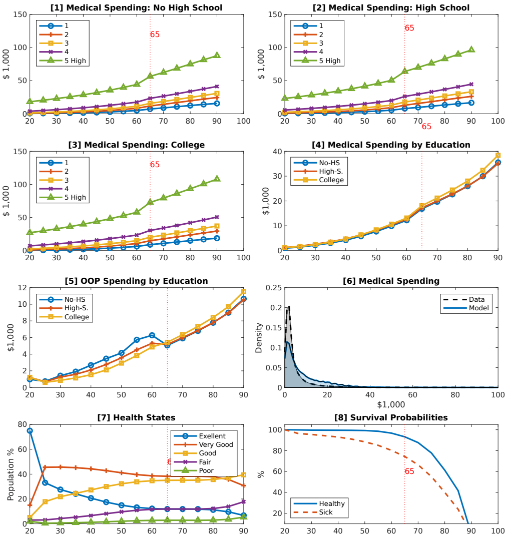


Figure 1: **Exogenous health state process and health spending**

Exogenous Parameters

Calibrated Parameters

Parameters	Values	Calibration targets	Model gener. moments	Data	Sources
Discount factor β	0.995	$\frac{K}{Y}$	3	3	Standard value
Pop. adjust. rate n	0.01	Fraction of pop 65+	17.5%	17.5%	US Census 2010
Fixed time cost labor $\bar{n}_j$	$[0.05, 0.17]$	Labor part.by age	Pan1,Fig.2		MEPS 1999–2009
Pref. cons. vs. leisure η	0.272	Avge. worker hours	Pan2,Fig.2		MEPS 1999–2009
GHI prem. scaling ϕ^{GHI}	0.75	GHI take-up at 25	Pan4,Fig.2		MEPS 1999–2009
Tax scaling para. λ	1.016	Clear govt.BC$\Rightarrow C_G/Y$	15%	15–17%	BEA 2009
Pension scaling Ψ^{ϑ}	$[0.32, 0.38]$	Size of Pension$/Y$	5%	4.8%	SSA (2010)
Medicaid asset test $\bar{a}^{\mathrm{MAid}}$	$\$75,000$	40–64 on Medicaid	Pan6,Fig.2		MEPS 1999–2009
Medicaid inc. test $\bar{y}^{\mathrm{MAid}}$	$\$5,500$	20–39 on Medicaid	Pan6,Fig.2		MEPS 1999–2009
Consumption floor $c_{\min}$	$\$2,500$	Frac. net-assets<\$5k	20%	20%	Jeske and Kitao (2009)

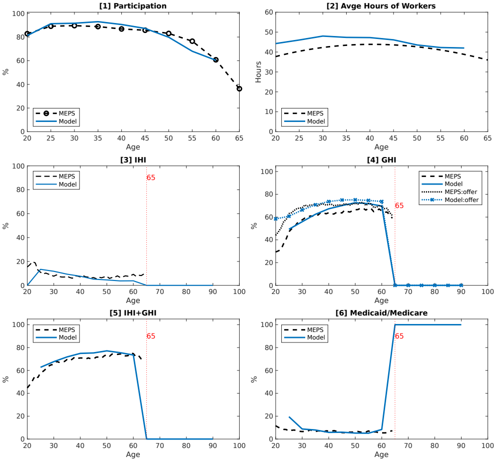


Figure 2: **Calibration Targets: Labor market and insurance percentages**

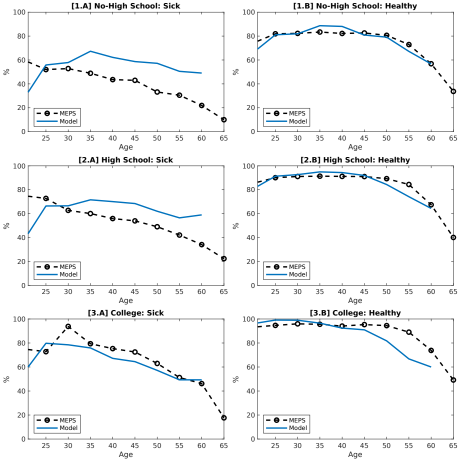


Figure 3: **Model Performance: Labor participation by educ & health**

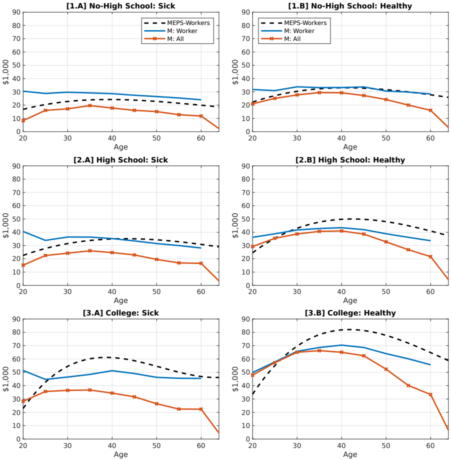


Figure 4: **Model performance: Labor income by education & health**

Model Performance (not targets)

Moments	Model	Data	Sources
Medical expens./Y	16.5%	15.2%	NHEA (2020*b*)
Gini medical spend.	0.56	0.60	MEPS 1999–2009
Gini gross income	0.40	0.46	MEPS 1999–2009
Gini labor income	0.55	0.54	MEPS 1999–2009
Gini assets	0.58	0.69	PSID 1999–2009
Interest rate: r	5.9%	5.2 – 5.9%	Gomme, Ravikumar and Rupert (2011)
Size of Medicare/Y	5.5%	4.4% (3.47%)	NHEA (2020*a*)
Size of Medicaid/Y	0.68%	1.7% (2.65%)	NHEA (2020*a*)

Analysis

Experiments I

- Benchmark economy w/ **pre-ACA HI** + **income tax function**

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

- Maximize **ex-ante lifetime utility** of newborn in stationary equilibrium implied by $\tilde{\tau}\left(\tilde{y}, \lambda,\ \tau\right)$

$$WF^{*} = \max_{\{\lambda,\ \tau\}} \int V\left(x_{j=1} | \lambda, \tau\right) d\Lambda\left(x_{j=1}\right)\ s.t.$$

$$\sum_{j=1}^{J} \mu_j \int tax_j\left(\lambda, \tau, x_j\right) d\Lambda\left(x_j\right) + \tau^{C} C\left(\lambda, \tau\right) + \text{MCare Prem}(\lambda, \tau) + \text{MCare Tax}(\lambda, \tau)$$

$$= \overline{C_G} + T^{SI}\left(\lambda, \tau\right) + \text{Medicaid}(\lambda, \tau) + \text{Medicare}(\lambda, \tau)$$

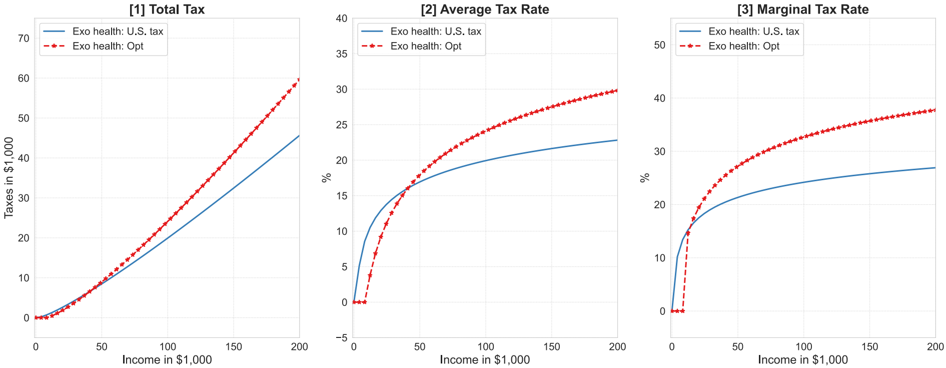
- Note: Choose τ & let λ adjust to clear gov't budget w/ constant C_G

The Optimal Income Tax System

Parameters:	[1] Benchmark	[2] Optimal Tax
+ Progressivity: τ	0.053	**0.113**
+ Scaling: λ	1.017	1.277
+ Tax break	\$1,402	\$8,810

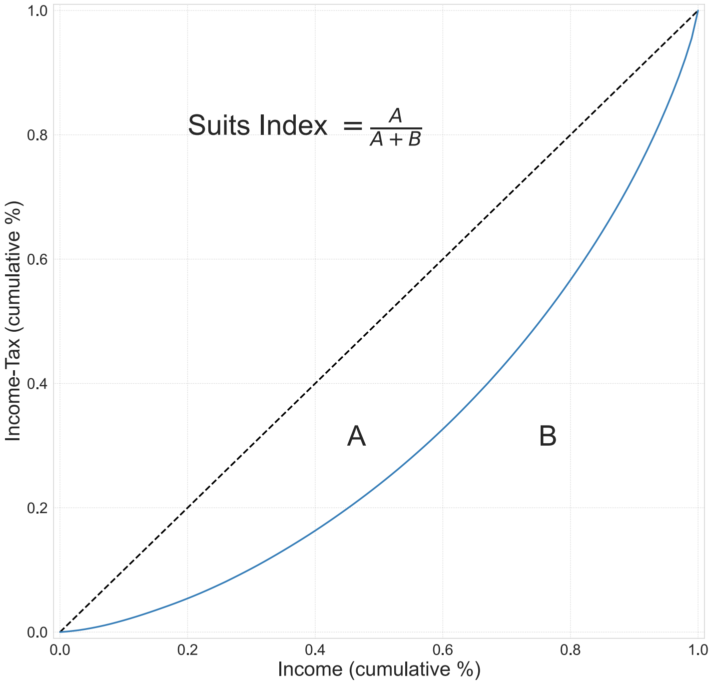
- Choice of τ^{US} based on Guner, Kaygusuz and Ventura (2014)
- Conesa and Krueger (2006) $\Rightarrow$ Prop. tax 17.2% with \$9,400 deduction

The Optimal Income Tax System



Measuring Tax Progressivity

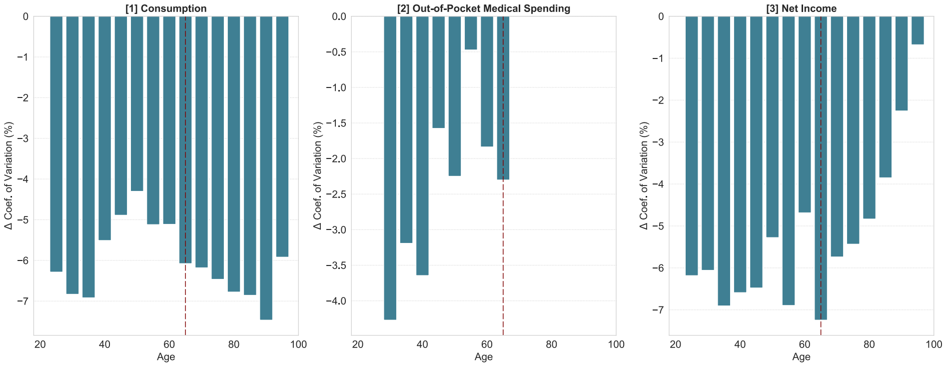
- Tax Progressivity Index (Suits Index): Suits (1977) measures income-tax inequality
  - Lorenz-type curve measuring proportionality of pretax income and tax contributions
  - Relative concentration curve
- The **Suits Index** is a "Gini coefficient" for tax contributions by income group
  - $+1$ (most progressive) $\Rightarrow$ entire tax burden allocated to households of highest income bracket
  - 0 (proportional tax)
  - -1 (most regressive) $\Rightarrow$ entire tax burden allocated to households of lowest income bracket



Suits Index $= \frac{A}{A+B}$
A
B
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Income-Tax (cumulative %)
Income (cumulative %)

	[1] Benchmark	[2] Opt. progr. τ^*
Output (*GDP*)	100	93.37
Capital	100	90.77
Non-med. consumption	100	93.25
Labor part. rate	67.14	69.21
Weekly hours worked	100	93.92
Workers IHI (%)	7.8%	10.17%
Workers GHI (%)	63.8%	65.7%
Workers Medicaid (%)	8.8%	5.8%
Avge. IHI Prem.	100	90.11
Avge. GHI Prem.	100	90.30
Interest rate (%)	5.9%	6.16%
Wage	100.00	98.48
Gini (Net income)	0.35	0.32
Gini (OOP health expenditure)	0.55	0.54
Suits index (Income tax)	0.12	0.22
Tax progressivity (τ)	**0.053**	**0.113**
Scaling parameter (λ)	1.02	1.28
Tax break threshold	$1,402	$8,810
Welfare (CEV):	0	$+0.10$
• Income group 1 (sick)	0	$+1.82$
• Income group 2 (sick)	0	$+0.72$
• Income group 2 (healthy)	0	$+1.16$
• Income group 3 (healthy)	0	-2.58

Change in Coefficients of Variation



Worker without Health Spending Risk

- State vector: $x_j = \left\{\vartheta, a_j, \text{in}_j, \epsilon_j^n, \epsilon^h, \epsilon_j^{\text{GHI}}\right\}$
- Choice set: $\mathcal{C}_j \equiv \{(c_j, \ell_j, a_{j+1}, \text{in}_{j+1}) \in R^+ \times [0,1] \times R^+ \times \{0,1,2,3\}\}$

$$V(x_j) = \max_{\mathcal{C}_j} \left\{ u(c_j, \ell_j) + \beta \overbrace{\times \pi_j\left(h\left(\epsilon^h\right)\right)}^{\text{Health surv. channel}} \times \mathbb{E}\left[V(x_{j+1}) \mid x_j\right] \right\} \text{ s.t.}$$

$$(1+\tau^c)\, c_j + a_{j+1} \overbrace{\cancel{+\, oop_j\left(m_j\left(\epsilon^h\right)\right) +}}^{\text{Health spend. channel}} \cancel{\underset{\{\text{in}_{j+1}=1\}}{1\times} \text{prem}^{\text{IHI}}\left(j, \epsilon^h\right)} + \cancel{\underset{\{\text{in}_{j+1}=2\}}{1\times} \text{prem}_j^{\text{GHI}}}$$

$$= (1+r)\, a_j + \widehat{w} \overbrace{\times e_j\left(\vartheta, \epsilon_j^n, h\left(\epsilon^h\right)\right)}^{\text{Health income channel}} (1-\ell_j) + b_j^{\text{SI}} + \left(1-\tau^{\text{Beq}}\right) b^{\text{Beq}} \overbrace{-\text{Tax}}^{\text{Health tax channel}}$$

$$\text{Tax} = T^y\left(y_j^{\text{T}}\left(\cancel{m_j\left(\epsilon^h\right)}, h\left(\epsilon^h\right)\right)\right) + T^{\text{SS}}\left(y_j^{\text{SS}}; \bar{y}^{\text{SS}}\right) + T^{\text{MCare}}\left(y_j^{\text{SS}}\right)$$

Retiree without Health Spending Risk

- State vector: $x_j = \left\{\vartheta, a_j, \epsilon^h\right\}$
- Choice set: $\mathcal{C}_j \equiv \{(c_j, a_{j+1}) \in R^+ \times R^+\}$

$$V(x_j) = \max_{\mathcal{C}_j} \left\{ u(c_j) + \beta \overbrace{\times \pi_j \left(h\left(\epsilon^h\right)\right)}^{\text{Health surv. channel}} \times \mathbb{E}\left[V(x_{j+1}) \,|\, x_j\right] \right\}$$

s.t.

$$(1+\tau^c)\, c_j + a_{j+1} \cancel{\overbrace{+ o_j \left(m_j\left(\epsilon^h\right)\right)}^{\text{Health spending channel}}} + \text{prem}^{\text{MCare}}$$

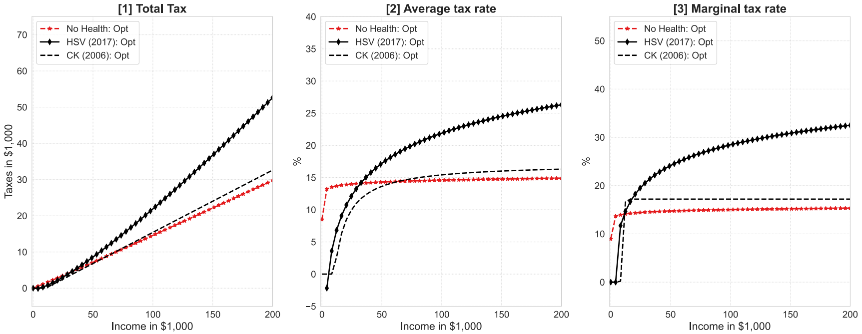
$$= (1+r)\, a_j + b_j^{\text{SS}} + b_j^{\text{SI}} + \left(1-\tau^{\text{Beq}}\right) b^{\text{Beq}} \overbrace{- T^y \left(y_j^{\text{T}} \left(\cancel{m_j\left(\epsilon^h\right)}, h\left(\epsilon^h\right)\right)\right)}^{\text{Health tax channel}},$$

More Details

	Health spending risk		No health spend. Risk	
	US-tax	**Opt.** τ^*	**US-tax**	**Opt.** τ^*
Output (GDP)	100	93.37	100	106.51
Capital (K)	100	90.77	100	110.86
Non-med. cons. (C)	100	93.25	100	106.80
Labor part. rate	67.14	69.21	66.86	65.27
Weekly hours worked	100	93.92	100	105.3
Suits index (Income tax)	0.12	0.22	0.11	0.014
Tax progressivity (τ)	**0.053**	**0.113**	**0.053**	**0.005**
Scaling parameter (λ)	1.02	1.28	1.02	0.87
Tax break threshold	$1,402	$8,810	$1,630	$1
Welfare (CEV):	0	+0.10	0	+0.86

- Conesa and Krueger (2006) $\Rightarrow$ Prop. tax 17.2% with $9,400 deduction

The Optimal Income Tax System



The Role of Health Insurance

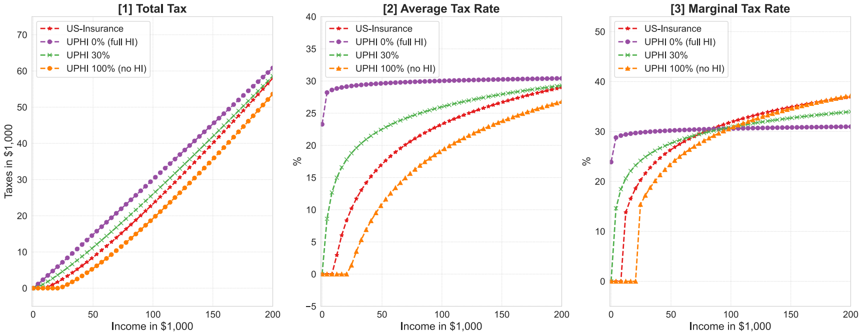
- How does health insurance system affect optimal income tax progressivity?

- **Hypothesis:** If HI takes care of health risk $\Rightarrow$ income tax system does NOT have to
  - More generous HI $\Rightarrow$ the less progressive opt. income tax
  - Less generous HI $\Rightarrow$ more progressive income tax

- Implement alternative **Universal public health insurance** (UPHI) systems and optimize τ^*:
  1. Medicare-for-all $\Rightarrow$ UPHI with 30% coins. rate
  2. Full insurance $\Rightarrow$ UPHI with 0% coins. rate
  3. No insurance $\Rightarrow$ UPHI with 100% coins. rate

	[1]	Optimized tax progressivity τ^*				
		[2]	[3]	[4]	[5]	[6]
			Full	Partial	Partial	Null
	Bench.	US-HI	$\rho = 0$	$\rho = 0.3$	$\rho = 0.5$	$\rho = 1$
Output (GDP)	100	93.36	85.86	95.12	93.88	107.24
Capital (K)	100	90.77	74.72	90.53	91.54	115.16
Non-med. cons. (C)	100	93.25	87.97	95.74	92.88	104.97
Labor part. rate	67.14	69.21	62.07	67.18	71.70	73.06
Weekly hours worked	100	93.92	98.58	98.18	92.33	98.056
Workers insured (%)	80.40	81.58	100	100	100	0
Retirees insured (%)	100	100	100	100	100	0
Interest rate (r in %)	5.9	6.16	7.30	5.39	6.13	5.27
Wage rate (w)	100.00	98.48	92.40	97.22	98.70	103.91
Gini (Income)	0.353	0.320	0.413	0.359	0.300	0.291
Gini (Health exp.)	0.548	0.543	0.960	0.547	0.553	0.560
Suits index (Inc. tax)	0.122	0.218	0.003	0.070	0.225	0.415
Tax progressivity (τ)	**0.053**	**0.113**	**0.003**	**0.039**	**0.125**	**0.155**
Scaling parameter (λ)	1.017	1.277	0.710	0.900	1.317	1.646
Tax break threshold	\$1,402	\$8,810	\$1	\$201	\$9,210	\$25,226
Welfare (CEV):	0	+0.10	−7.41	−2.05	−0.94	−5.05
• Inc group 1 (sick)	0	+1.82	−3.10	−0.26	+1.26	−1.08
• Inc group 2 (sick)	0	+0.72	−6.29	−1.89	−0.78	−7.97
• Inc group 2 (healthy)	0	+1.16	−6.95	−1.83	+0.10	−7.58
• Inc group 3 (healthy)	0	−2.58	−10.09	−3.33	−3.92	−3.88

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



Extensions

- Health in the utility function Extension 1
- Sensitivity Analysis–Preference Parameters Extension 2
- Endogenous health capital accumulation Extension 3

Conclusion

1. **Health risk** and **health insurance** are important determinants of optimal progressivity
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. Medicare-for-all would reduce optimal progressivity substantially

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Model Details

Firms offering GHI

- Firms offering GHI subsidizes fraction ψ of premium cost
- Firm passes costs c_E to employees e.g. Jeske and Kitao (2009)

$$\widehat{w} = \left(w - 1_{\left[\epsilon^{\text{GHI}}=1\right]} \times c_E \right)$$

with

$$c_E = \frac{\psi \times \sum_{j=1}^{J_R-1} \mu_j \int \left(1_{[\text{in}_{j+1}(x_j)\,=\,2]} \times \text{prem}_j^{\text{GHI}} \right) d\Lambda(x_j)}{\sum_{j=1}^{J_R-1} \mu_j \int \left(1_{\left[\varepsilon_j^{\text{GHI}}=1\right]} \times e_j(\vartheta, \epsilon^n, \epsilon^h) \times n_j \right) d\Lambda(x_j)}$$

- Remaining share of GHI premium $\widehat{\text{prem}}^{\text{GHI}} = (1-\psi) \times \text{prem}^{\text{GHI}}$ is tax deductible

Back to Firms

Worker's Dynamic Optimization Problem I

- State vector: $x_j = \left\{\vartheta, a_j, \mathrm{in}_j, \epsilon_j^n, \epsilon^h, \epsilon_j^{\mathrm{GHI}}\right\}$
- Choice set: $\mathcal{C}_j \equiv \{(c_j, \ell_j, a_{j+1}, \mathrm{in}_{j+1}) \in R^+ \times [0,1] \times R^+ \times \{0,1,2,3\}\}$

$$V(x_j) = \max_{\{c_j, \ell_j, a_{j+1}, \mathrm{in}_{j+1}\}} \left\{u(c_j, \ell_j) + \beta \times \pi_j\left(\epsilon^h\right) \times \mathbb{E}\left[V(x_{j+1}) \mid x_j\right]\right\} \text{ s.t.}$$

$$(1+\tau^c)\, c_j + a_{j+1} + o_j(m_j) + 1_{\{\mathrm{in}_{j+1}=1\}} \mathrm{prem}^{\mathrm{IHI}}\left(j, \epsilon^h\right) + 1_{\{\mathrm{in}_{j+1}=2\}} \widehat{\mathrm{prem}}_j^{\mathrm{GHI}}$$

$$= (1+r)\, a_j + y_j^n + b_j^{\mathrm{SI}} + \left(1-\tau^{\mathrm{Beq}}\right) b^{\mathrm{Beq}} - \mathrm{Tax}$$

$$c \geq \underline{c},\ a_j \geq 0$$

Worker's Dynamic Optimization Problem II

- Taxable income

$$
\begin{aligned}
y_j^n &= \widehat{w} \overbrace{\times e_j\left(\vartheta, \epsilon_j^n, \epsilon^h\right) \times}^{\text{Health-dependent income}} (1-\ell_j), \\
y_j^{\mathrm{T}} &= y_j^n + r \times a_j - 1_{\{\mathrm{in}_{j+1}=2\}} \widehat{\mathrm{prem}}_j^{\mathrm{GHI}} - \max\left[0,\, o\left(m_j\right) - 0.075 \times \left(y_j^n + r \times a_j\right)\right] \\
y_j^{ss} &= y_j^n - 1_{\{\mathrm{in}_{j+1}=2\}} \mathrm{prem}_j^{\mathrm{GHI}}
\end{aligned}
$$

- Taxes

$$
\begin{aligned}
\mathrm{Tax} &= T^y\left(y_j^{\mathrm{T}}\right) + T^{\mathrm{SS}}\left(y_j^{\mathrm{SS}};\, \bar{y}^{\mathrm{SS}}\right) + T^{\mathrm{MCare}}\left(y_j^{\mathrm{SS}}\right) \\
T^{ss}\left(y_j^{\mathrm{SS}};\, \bar{y}^{\mathrm{SS}}\right) &= \tau^{\mathrm{SS}} \times \min\left[y_j^{\mathrm{SS}};\, \bar{y}^{\mathrm{SS}}\right] \\
T^{\mathrm{MCare}}\left(y_j^{\mathrm{SS}}\right) &= \tau^{\mathrm{MCare}} \times y_j^{ss}
\end{aligned}
$$

- Transfers

$$
\begin{aligned}
b_j^{\mathrm{SI}} &= \max\left[0,\ \underline{c} + o\left(m_j\right) - y_j^{\mathrm{AT}} - a_j - b^{\mathrm{Beq}}\right] \\
y_j^{\mathrm{AT}} &= y_j^n + r \times a_j - \mathrm{Tax}
\end{aligned}
$$

Worker's Dynamic Optimization Problem III

- Average past labor earnings by income group ϑ

$$\bar{y}^{\vartheta} = \int_{j \leq J_W} y_j^n \left(\boldsymbol{x}\left(\vartheta\right)\right) d\Lambda \left(\boldsymbol{x}\left(\vartheta\right)\right)$$

Back to Worker Problem

Retiree's Dynamic Optimization Problem

- State vector: $x_j = \left\{\vartheta, a_j, \epsilon^h\right\}$

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

$$\left(1+\tau^c\right) c_j + a_{j+1} + o_j\left(m_j\right) + \text{prem}^{\text{MCare}}$$

$$= \left(1+r\right) a_j + b_j^{\text{SS}} + b_j^{\text{SI}} + \left(1-\tau^{\text{Beq}}\right) b^{\text{Beq}} - T^y\left(y_j^{\text{T}}\right)$$

$$c_j \geq \underline{c}$$
$$a_j \geq 0$$

- Taxable income

$$y_j^{\text{T}} = r \times a_j + b_j^{\text{SS}} - \max\left[0,\ \left(o_j\left(m_j\right) + 1_{[j>J_W]}\text{prem}^{\text{MCare}}\right) - 0.075 \times \left(r \times a_j + b_j^{\text{SS}}\right)\right]$$

- Social insurance transfers

$$b_j^{\text{SI}} = \max\left[0,\ \underline{c} + o_j\left(m_j\right) + \text{prem}^{\text{MCare}} + T^y\left(y_j^{\text{T}}\right) - \left(1+r\right) a_j - b_j^{\text{SS}} - b^{\text{Beq}}\right]$$

Back to Retired Problem

Insurance Sector

- Individual HI

$$\text{prem}_{j,\epsilon^h}^{\text{IHI}} = \frac{\left(1+\omega^{\text{IHI}}\right)\mu_{j+1}\int\left[\underset{\left[\text{in}_j(x)=1\right]}{1\times}\left(1-\gamma^{\text{IHI}}\right)m_{j+1}\left(x\right)P\left(\epsilon_{j+1}^h|\epsilon_j^h\right)\right]d\Lambda\left(x_{j+1,-\epsilon^h}\right)}{R\times\mu_j\int\left(1_{\left[\text{in}_{j,h}(x)=1\right]}\right)d\Lambda\left(x_{j,-\epsilon^h}\right)}$$

- Employer provided group HI

$$\begin{aligned}
&\left(1+\omega^{\text{GHI}}\right)\sum_{j=2}^{J_1}\mu_j\int\left[\underset{\left[\text{in}_j(x)=2\right]}{1\times}\left(1-\gamma^{\text{GHI}}\right)m_j\left(x\right)\right]d\Lambda\left(x\right)\\
= \quad & R\sum_{j=1}^{J_1-1}\mu_j\int\left(1_{\left[\text{in}_j(x)=2\right]}\text{prem}_j^{\text{GHI}}\right)d\Lambda\left(x\right),
\end{aligned}$$

Back to Remaining Parts

Government Budget

- Gov't BC:

$$C_G + \overbrace{\int \left[1_{[\text{MAid}]}\gamma^{\text{MAid}} \times m_j(\boldsymbol{x})\right] d\Lambda(\boldsymbol{x})}^{\text{Medicaid Payments}} + \overbrace{\int b^{\text{SI}}(\boldsymbol{x})\, d\Lambda(\boldsymbol{x})}^{\text{Social Transfers}}$$

$$= \int \left[\tau^c \times c(\boldsymbol{x}) + T^y\left(y^{\text{T}}(\boldsymbol{x})\right)\right] d\Lambda(\boldsymbol{x}) + \tau^{\text{Beq}} B^{\text{Beq}} + \text{surplus}^{\text{SS}} + \text{surplus}^{\text{MCare}}$$

- Pensions

$$\text{surplus}^{\text{SS}} = \int T^{\text{SS}}\left(y_j^{\text{SS}}(\boldsymbol{x});\, \bar{y}^{\text{SS}}\right) d\Lambda(\boldsymbol{x}) - \int_{j>J_W} b^{\text{SS}}\left(\bar{y}_\vartheta\right) d\Lambda(\boldsymbol{x})$$

- Medicare

$$\text{surplus}^{\text{MCare}} = \int \left[T^{\text{MCare}}\left(y_j^{\text{SS}}(\boldsymbol{x})\right) + 1_{[j>J_W]}\text{prem}^{\text{MCare}}\right] d\Lambda(\boldsymbol{x}) - \int_{j>J_W} \left[\gamma^{\text{MCare}} \times m_j(\boldsymbol{x})\right] d\Lambda(\boldsymbol{x})$$

Back to Remaining Parts

Bequests

- Accidental Bequests (per capita)

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

Back to Remaining Parts

A Competitive Equilibrium I

Given the transition probability matrices $\left\{\Pi_j^n, \Pi_j^h, \Pi_{j,\vartheta}^{\mathrm{GHI}}\right\}_{j=1}^{J}$ for $\vartheta \in \{1,2,3\}$, the survival probabilities $\left\{\pi_j\left(\epsilon^h\right)\right\}_{j=1}^{J}$ and the exogenous government policies $\left\{T_j^y, b_j^{\mathrm{SI}}, b_j^{\mathrm{SS}}\right\}_{j=1}^{J}$ and $\left\{\tau^c, \tau^{\mathrm{SS}}, \tau^{\mathrm{MCare}}, \mathrm{prem}^{\mathrm{MCare}}, \gamma^{\mathrm{MCare}}, \gamma^{\mathrm{MAid}}, C_G\right\}$, a competitive equilibrium is a collection of sequences of distributions $\Lambda(\boldsymbol{x})$ of individual household decisions $\{c(\boldsymbol{x}), \ell(\boldsymbol{x}), a(\boldsymbol{x}), \mathrm{in}(\boldsymbol{x})\}$, aggregate stocks of physical capital and effective labor services $\{K, N\}$, factor prices $\{w, q, R\}$, and insurance premiums $\left\{\mathrm{prem}^{\mathrm{IHI}}\left(j, \epsilon^h\right), \mathrm{prem}^{\mathrm{GHI}}\right\}$ such that:

(a) $\{c(\boldsymbol{x}), \ell(\boldsymbol{x}), a(\boldsymbol{x}), in(\boldsymbol{x})\}$ solves the consumer problem,

A Competitive Equilibrium II

(b) the firm first order conditions hold

$$
\begin{aligned}
w &= \frac{\partial F(K,N)}{\partial N} \\
q &= \frac{\partial F(K,N)}{\partial K} \\
R &= 1 + q - \delta = 1 + r
\end{aligned}
$$

(c) markets clear

$$K = \int a(\boldsymbol{x}) + \text{Prem}^{\text{GHI}}(\boldsymbol{x}) + \text{Prem}^{\text{IHI}}(\boldsymbol{x})\, d\Lambda(\boldsymbol{x})$$

$$N = \int e(\boldsymbol{x})\,(1 - \ell(\boldsymbol{x}))\, d\Lambda(\boldsymbol{x})$$

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

A Competitive Equilibrium III

(d) the aggregate resource constraint holds

$$C_G + \int \left(c\left(\boldsymbol{x}\right) + m\left(\boldsymbol{x}\right) + a\left(\boldsymbol{x}\right)\right) d\Lambda\left(\boldsymbol{x}\right) = Y + \left(1 - \delta\right) K$$

(e) the government programs clear
(f) the budget conditions of the insurance companies hold
(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 on the measure distribution

$$\Lambda\left(\boldsymbol{x}'\right) = T_{\Lambda}\left(\Lambda\left(\boldsymbol{x}\right)\right).$$

Back to Remaining Parts

Calibration Details

Health State

- ϵ^h and Π_j^h from MEPS

Human Capital Formation

- Human capital:

$$e_j\left(\vartheta, \epsilon^n, \epsilon^h\right) = \bar{e}_j\left(\vartheta,\ h\left(\epsilon^h\right)\right) \times \epsilon_j^n$$

- 1999–2009 MEPS data we distinguish between three permanent educational groups

$$\vartheta = \begin{cases} 1 & \text{if less than high school} \\ 2 & \text{if high school} \\ 3 & \text{if college graduate or higher} \end{cases}$$

- 5 health states but only 2 health statuses (only the latter determine survival prob. and effective wages)

$$h\left(\epsilon^h\right) = \begin{cases} \text{healthy} & \text{if } \epsilon^h \in \{\text{excellent, very good, good}\} \\ \text{sick} & \text{if } \epsilon^h \in \{\text{fair, poor}\} \end{cases}$$

- Following Rupert and Zanella (2015) and Casanova (2013) we estimate a selection model to remove the selection bias in wage offers
- The stochastic component is modeled as an auto-regressive process so that

Parameterization: Production Function

- Final goods production:

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

- Parameters from other studies
- $A = 1$

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

- N is average/aggregate effective human capital and
- $w \times N$ average wage income
- Pension payments: $t^{\text{Soc}}(\vartheta) = \Psi(\vartheta) \times w \times N$
- 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

- Benabou (2002), Heathcote, Storesletten and Violante (2017) federal progressive income tax

$$T^y(y) = \max\left[0,\, y - \tau_0^i \times y^{\left(1-\tau_1^i\right)}\right]$$

- Medicare tax is 2.9%
- Social security tax is 10.6%
- Consumption tax is 5%

External Parameters	Parameter vals	Sources
Periods J	15	
Periods work J_W	9	Age 20–64
Years modeled	75	Age 20–94
TFP A	1	Normalization
Capital share in prod. α	0.36	Koh, Santaeulàlia-Llopis and Zheng (2020)
Capital depreciation δ	6.4%	Koh, Santaeulàlia-Llopis and Zheng (2020)
Firm share of prem$^{\text{GHI}}$ ψ	0.8	Jeske and Kitao (2009)
Relative risk aversion σ	3	Standard values between $2.5 - 3.5$
Survival prob. $\pi_j\left(h\left(\epsilon^h\right)\right)$	Pan. 8, Fig.1	İmrohoroğlu and Kitao (2012)
Health Shocks ϵ_j^h	Pan.7, Fig.1	MEPS 1999–2009
Med. spend. shocks $m\left(j, \vartheta, \epsilon^h\right)$	Pan.1–3, Fig.1	MEPS 1999–2009
Health transition prob. Π_j^h	Appendix	MEPS 1999–2009
Pers. labor shock auto-corr. ρ	0.977	French (2005)
Var. transitory labor shock $\sigma_{\epsilon_1}^2$	0.0141	French (2005)
Bias adj. wages $\bar{e}_j\left(\vartheta, h\left(\epsilon^h\right)\right)$	Appendix	MEPS 1999–2009
Private HI coins. γ^{IHI}	46%	MEPS 1999–2009
Private group HI coins. γ^{GHI}	31%	MEPS 1999–2009
Medicaid coins. γ^{MAid}	11%	MEPS 1999–2009
Medicare coins. γ^{MCare}	30%	MEPS 1999–2009
Medicare premiums/GDP	2.11%	Jeske and Kitao (2009)
Consumption tax τ^C	5%	IRS
Bequest Tax τ^{Beq}	20%	De Nardi and Yang (2014)
Payroll tax Soc. Sec. τ^{SS}	12.4%	SSA (2007)
Payroll tax Medicare τ^{MCare}	2.9%	SSA (2007)
Govt cons C_G/Y	15%	BEA 2009
Tax progressivity para. τ	0.053	Guner, Lopez-Daneri and Ventura (2016)

Back to Exogenous Parameter Graph

Extension 1:
Health in Utility (HIU)

Health in Utility (HIU)

- Utility shifter $\theta(h) = 1 + \theta_h \times h$
- Set $\theta_h = -0.36$ based on De Nardi, French and Jones (2010)
- Given our parameterization, this results in $u_c > 0$, $u_h > 0$ and $u_{c,h} < 0$

$$u(c_j, \ell_j; \bar{n}_j) = \theta\left(h\left(\epsilon^h\right)\right) \frac{\left(c_j^\eta \times \left[\ell_j - \bar{n}_j \cdot 1_{[0 \leq n_j]}\right]^{1-\eta}\right)^{1-\sigma}}{1-\sigma}$$

Optimal Progressivity with Health in Utility

	US-HI		UPHI Full $\overbrace{\rho^{UPHI} = 0}$		UPHI Partial $\overbrace{\rho^{UPHI} = 0.3}$		UPHI Null $\overbrace{\rho^{UPHI} = 1}$	
	[1] Bench.	**[2] HIU**	**[3] Bench.**	**[4] HIU**	**[5] Bench.**	**[6] HIU**	**[7] Bench.**	**[8] HIU**
GDP	93.36	93.45	85.86	85.25	91.56	91.66	107.24	108.24
Capital (K)	90.77	90.76	74.72	73.30	85.62	85.82	115.16	117.45
Cons. (C)	93.25	93.42	87.97	88.28	92.08	92.56	104.97	105.85
Suits index	0.218	0.220	0.004	0.004	0.107	0.109	0.415	0.464
Opt.tax (τ^*)	**0.113**	**0.113**	**0.003**	**0.004**	**0.067**	**0.071**	**0.155**	**0.178**
Scaling (λ)	1.277	1.277	0.710	0.713	1.108	1.015	1.646	1.821
Tax break	\$8.8k	\$8.8k	\$0	\$0	\$1.2k	\$1.4k	\$25.2k	\$28.8k
Welf. (CEV):	$+0.10$	$+0.14$	-7.41	-6.59	-1.84	-1.58	-5.05	-6.27

Back to Extension List

Extension 2: Preference Parameter Sensitivity

Sensitivity: Preference Parameters

	Benchmark: US Health Insurance System			
	$\eta = 0.265$ $\sigma = 3.0$ **[1]**	$\eta = 0.28$ $\sigma = 3.0$ **[2]**	$\eta = 0.272$ $\sigma = 2.5$ **[3]**	$\eta = 0.272$ $\sigma = 3.5$ **[4]**
Output (GDP)	94.38	95.73	95.46	92.98
Capital (K)	92.03	93.98	93.17	90.61
Non-med. cons. (C)	94.39	95.76	95.49	92.079
Suits index (Income tax)	0.207	0.192	0.187	0.223
Optimal Tax (τ^*)	**0.105**	**0.097**	**0.092**	**0.117**
Scaling parameter (λ)	1.239	1.200	1.179	1.297
Tax break threshold	\$7,809	\$6,808	\$6,007	\$9,410
Welfare (CEV):	+0.257	+0.569	+0.106	+0.147

Sensitivity: Preference Parameters with UPHI

	Medicare-for-all (UPHI with 30% coins.)			
	$\eta = 0.265$ $\sigma = 3.0$ **[1]**	$\eta = 0.28$ $\sigma = 3.0$ **[2]**	$\eta = 0.272$ $\sigma = 2.5$ **[3]**	$\eta = 0.272$ $\sigma = 3.5$ **[4]**
Output (GDP)	95.20	91.55	93.56	90.94
Capital (K)	90.84	85.81	88.64	84.99
Non-med. cons. (C)	95.71	91.93	94.01	91.25
Suits index (Income tax)	0.072	0.107	0.094	0.107
Optimal tax (τ^*)	**0.041**	**0.071**	**0.057**	**0.071**
Scaling parameter (λ)	0.904	1.015	0.964	1.016
Tax break threshold	\$201	\$1,402	\$602	\$1,402
Welfare (CEV):	-2.921	-2.081	-2.022	-2.411

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Extension 3: Endogenous Health

Endogenous Health Capital

- **Health capital** accumulation based on Grossman (1972)

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

  - δ_j^h depreciation rate of health capital
  - ϵ_j^h idiosyncratic health shock following Markov process $\Rightarrow$ trans. prob. matrix Π_j^h
  - Individuals **decide** spending on medical care m_j to improve health
  - Multiplicative instantaneous utility introduced **consumption motive**

$$u\left(c,n,h;\bar{n}_j\right) = \frac{\left(\left(c_j^{\eta} \times \left[\ell_j - \bar{n}_j \cdot 1_{[0\leq n_j]}\right]^{1-\eta}\right)^{\kappa} \times h^{1-\kappa}\right)^{1-\sigma}}{1-\sigma}$$

  - Compare shifting term to HIU from before: $h^{(1-\kappa)(1-\sigma)}$
  - Given $\sigma > 1$ this results in $u_h > 0$ and $u_{c,h} < 0$

- Healthcare production sector

$$\max_{\{K_m,\ N_m\}} p_m F_m\left(K_m, N_m\right) - qK_m - wN_m$$

Endogenous Health: Worker

- State vector: $x_j = \left\{\vartheta, a_j, h_j, \text{in}_j, \epsilon_j^n, \epsilon^h, \epsilon_j^{\text{GHI}}\right\}$
- Choice set:
  $\mathcal{C}_j \equiv \{(c_j, \ell_j, a_{j+1}, m_j, \text{in}_{j+1}) \in R^+ \times [0,1] \times R^+ \times R^+ \times \{0,1,2,3\}\}$

$$V(x_j) = \max_{\mathcal{C}_j} \left\{ \overbrace{u\left(c_j, \ell_j, h\left(\epsilon^h\right)\right)}^{\text{Health cons. motive}} + \beta \overbrace{\times \pi_j\left(h\left(\epsilon^h\right)\right)}^{\text{Health surv. motive}} \times \mathbb{E}\left[V\left(x_{j+1}\right) \mid x_j\right] \right\} \text{ s.t.}$$

$$(1+\tau^c)\, c_j + a_{j+1} + o_j\left(m_j\left(\epsilon^h\right)\right) + \underset{\{\text{in}_{j+1}=1\}}{1\times} \text{prem}^{\text{IHI}}\left(j, h\left(\epsilon^h\right)\right) + \underset{\{\text{in}_{j+1}=2\}}{1\times} \text{prem}_j^{\text{GHI}}$$

$$= (1+r)\, a_j + \widehat{w} \overbrace{\times e_j\left(\vartheta, \epsilon_j^n, h\left(\epsilon^h\right)\right)}^{\text{Health investment motive}} (1-\ell_j) + b_j^{\text{SI}} + \left(1-\tau^{\text{Beq}}\right) b^{\text{Beq}} - Tax$$

$$\text{Tax} = T^y\left(y_j^{\text{T}}\right) + T^{\text{SS}}\left(y_j^{\text{SS}}; \bar{y}^{\text{SS}}\right) + T^{\text{MCare}}\left(y_j^{\text{SS}}\right)$$

Endogenous Health: Retiree

- State vector: $x_j = \left\{\vartheta, a_j, h_j, \epsilon^h\right\}$
- Choice set: $\mathcal{C}_j \equiv \{(c_j, a_{j+1}, m_j) \in R^+ \times R^+ \times R^+\}$

$$V(x_j) = \max_{\mathcal{C}_j} \left\{ \overbrace{u\left(c_j, h\left(\epsilon^h\right)\right)}^{\text{Health cons. motive}} + \beta \overbrace{\times \pi_j\left(h\left(\epsilon^h\right)\right)}^{\text{Health surv. motive}} \times \mathbb{E}\left[V\left(x_{j+1}\right) \mid x_j\right] \right\} \text{s.t.}$$

$$(1+\tau^c)\, c_j + a_{j+1} + o_j\left(m_j\left(\epsilon^h\right)\right) + \text{prem}^{\text{MCare}}$$

$$= (1+r)\, a_j + b_j^{\text{SS}} + b_j^{\text{SI}} + \left(1-\tau^{\text{Beq}}\right) b^{\text{Beq}} - \mathit{Tax}$$

Optimal Progressivity with Endogenous Health

		Optimized tax progressivity τ^*			
	[1] Bench.	**[2] US-HI**	**[3] UPHI** Almost full $\underbrace{}$ $\rho^{UPHI} = 0.04$	**[4] UPHI** Partial $\underbrace{}$ $\rho^{UPHI} = 0.2$	**[5] No HI** Null $\underbrace{}$ $\rho^{UPHI} = 1$
Output (GDP)	100	94.34	76.62	89.54	104.08
Capital (K)	100	93.55	55.76	85.96	113.07
Weekly hours worked	100	98.74	0.80	92.48	100.34
Non-med. consumption (C)	100	93.13	58.46	85.66	101.49
Med. spending ($p_m M$)	100	100.46	157.19	92.97	87.72
Workers insured (%)	78.59	75.55	100	100	0
Interest rate (r in %)	5.07	5.08	6.50	5.29	4.37
Wage rate (w)	100.00	99.94	93.61	98.97	103.48
Gini (Net income)	0.38	0.31	0.39	0.32	0.33
Suits index (Income tax)	0.17	0.53	0.15	0.43	0.59
Optimal tax (τ^*)	**0.053**	**0.237**	**0.07**	**0.14**	**0.266**
Scaling para. (λ)	1.095	2.317	1.117	1.567	2.682
Tax break threshold	\$6,060	\$36,360	\$6,061	\$26,260	\$42,425
Welfare (CEV):	0	+5.64	-49.50	−4.32	+5.14

	Bench.	Optimal Tax US-HI	Optimal Tax UPHI-20%
Benchmark Case ($\sigma = 3$)			
Tax progress. (τ)	0.053	**0.237**	**0.140**
Tax break (US$)	$6,061	$36,360	$26,260
Suits index (Income tax)	0.17	0.53	0.43
Endogenous survival rate			
Tax progress. (τ)	0.053	**0.193**	**0.110**
Tax break (US$)	$6,061	$32,324	$20,203
Suits index (Income tax)	0.17	0.48	0.37
Less elastic health exp. ($\eta_m = 1.0$)			
Tax progress. (τ)	0.053	**0.180**	**0.108**
Tax break (US$)	$6,061	$30,303	$18,183
Suits index (Income tax)	0.17	0.46	0.35
No health in labor prod. ($\chi = 1.0$)			
Tax progress. (τ)	0.053	**0.240**	**0.060**
Tax break (US$)	$6,061	$38,385	$4,041
Suits index (Income tax)	0.18	0.53	0.14
Risk aversion ($\sigma = 2$)			
Tax progress. (τ)	0.053	**0.186**	**0.121**
Tax break (US$)	$6,061	$32,324	$22,223
Suits index (Income tax)	0.17	0.47	0.38
Risk aversion ($\sigma = 4$)			
Tax progress. (τ)	0.053	**0.186**	**0.145**
Tax break (US$)	$6,061	$30,303	$26,263
Suits index (Income tax)	0.17	0.47	0.43

Time Cost of Health Spending

- Reducing variation in m_j by introducing cost term in utility

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

- $\eta_m \geq 0$ controls the utility cost of the procurement of medical services
- Benchmark: $\eta_m = 0$ no direct time cost associated with healthcare investments
- $\eta_m > 0$ procurement of medical services imposes a time cost as it reduces leisure

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