Optimal Progressivity with Age-Dependent Taxation

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How progressive should labor income taxation be?

- Arguments in favor of progressivity:
  - Redistribution with respect to unequal initial conditions
  - Redistribution over life cycle when credit constraints are tight
  - Public insurance when markets are missing

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- Q: Life-cycle $\rightarrow$ optimal progressivity should vary with age?
- We take a Ramsey-approach to this question

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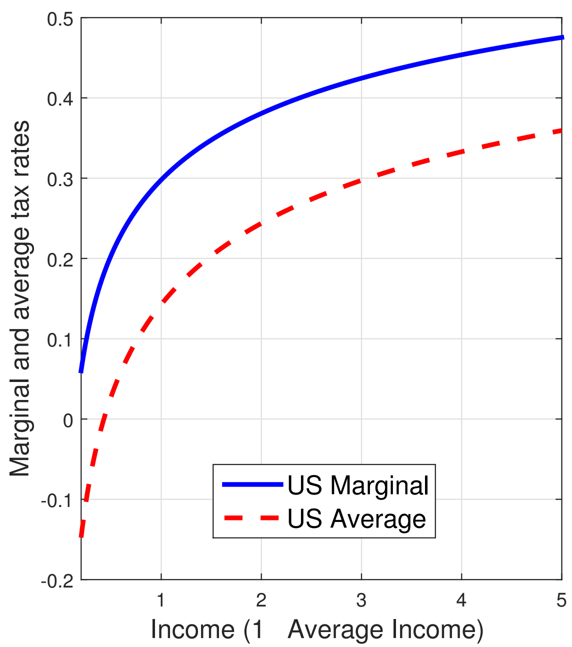
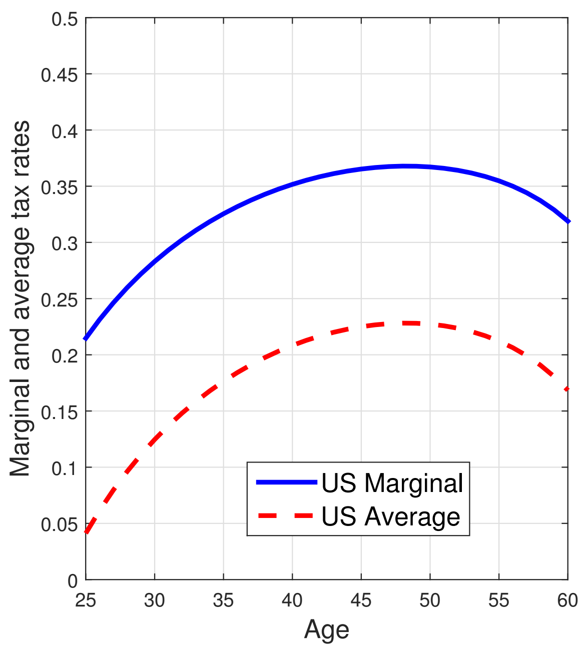
- It preserves analytical tractability
- It closely approximates actual US system ($\tau^{US} = 0.181$)





This Paper

- Generalize HSV tax/transfer system to allow age variation:

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- OLG equilibrium model with:

1. differential disutility of work & learning ability [ex-ante heter.]
2. partial insurance against earnings risk [ex-post uncertainty]
3. age profile for productivity and disutility of work [life cycle]
4. flexible labor supply [static choice]
5. skill investment [dynamic choice]

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- Extension: numerically solved model with saving and borrowing

Environment

Preferences

- Preferences over consumption (c), hours (h), publicly-provided goods (G), and skill-investment (s) effort:

$$U_i = -v_i(s_i) + \mathbb{E}_0 \sum_{a=0}^{A} \beta^a u_i(c_{ia}, h_{ia}, G)$$

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$$\begin{aligned} v_i(s_i) &= \frac{1}{(\kappa_i)^{1/\psi}} \cdot \frac{s_i^{1+1/\psi}}{1+1/\psi} \\ \kappa_i &\sim Exp(1) \\ u_i(c_{ia}, h_{ia}, G) &= \log c_{ia} - \frac{\exp\left[(1+\sigma)\left(\varphi_i + \bar{\varphi}_a\right)\right]}{1+\sigma}(h_{ia})^{1+\sigma} + \chi \log G \\ \varphi_i &\sim \mathcal{N}\left(\frac{v_\varphi}{2}, v_\varphi\right) \end{aligned}$$

Individual Wages and Earnings

- Wages:

$$\log z_{ia} = x_a + \alpha_{ia} + \varepsilon_{ia}$$

  - x_a deterministic age-productivity profile
  - $\alpha_{ia} = \alpha_{i,a-1} + \omega_{ia}, \quad \omega_{ia} \sim \mathcal{N}\left(-\frac{v_\omega}{2}, v_\omega\right)$ [perm. uninsurable]
  - $\varepsilon_{ia} = \varepsilon_{i,a-1} + \eta_{ia}, \quad \eta_{ia} \sim \mathcal{N}\left(-\frac{v_\eta}{2}, v_\eta\right)$ [private insurance]

- Pre-tax earnings:

$$y_{ia} = \underbrace{p(s_i)}_{\text{skill price}} \times \underbrace{\exp(x_a)}_{\text{deterministc age-profile}} \times \underbrace{\exp(\alpha_{ia} + \varepsilon_{ia})}_{\text{shocks}} \times \underbrace{h_{ia}}_{\text{hours}}$$

- Asset markets:
  - Within-period insurance against ε, but no inter-temporal trade

Technology

- Output a CES aggregator over continuum of skill types s:

$$Y = \left[\int_0^\infty N(s)^{\frac{\theta-1}{\theta}}\, ds\right]^{\frac{\theta}{\theta-1}}, \quad \theta \in [1, \infty)$$

- Skill price: $p(s) =$ marginal product of $N(s)$

$$\log p(s) = \frac{1}{\theta}\log Y - \frac{1}{\theta}\log N(s)$$

- Aggregate resource constraint:

$$Y = \sum_{a=0}^{A} \int_{i=0}^{1} c_{i,a}\, di + G$$

Government

- Government budget constraint (no government debt):

$$G = \sum_{a=0}^{A} \int_0^1 \left[y_i - \lambda_a y_i^{1-\tau_a} \right] di$$

- Planner chooses policy once and for all s.t. balanced budget

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- Government chooses G, or equivalently $g \equiv \frac{G}{Y}$
  - Optimal public good provision: $g^* = \frac{\chi}{1+\chi}$
  - Samuelson condition: $MRS_{C,G} = MRT_{C,G} = 1$

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- Government chooses vector $\{\lambda_a, \tau_a\}_{a=0}^{A}$

Skill Prices and Skill Investment

- Skill price has the Mincerian form:

$$\log p(s) = \pi_0(\bar{\tau}) + \pi_1(\bar{\tau}) s(\kappa; \bar{\tau})$$

- Closed form expressions for $\pi_0(\bar{\tau})$ and $\pi_1(\bar{\tau})$

- Optimal skill investment linear in κ:

$$s(\kappa; \bar{\tau}) = \left[(1 - \bar{\tau}) \pi_1(\bar{\tau})\right]^{\psi} \cdot \kappa$$

where: $\bar{\tau} = \frac{1-\beta}{1-\beta^{A+1}} \sum_{a=0}^{A} \beta^a \tau_a$

- Distribution of $p(s)$ is Pareto with parameter θ

Equilibrium c, h Allocations

$$\log c_a \quad = \quad \log \lambda_a + (1-\tau_a)\left[\frac{\log(1-\tau_a)}{1+\sigma} - (\varphi + \bar{\varphi}_a) + \log p(s) + x_a + \alpha\right] + \mathcal{C}_a$$

- Unaffected by individual insurable shocks ε
- $\mathcal{C}_a$ is increasing in $v_{\varepsilon a} \Rightarrow$ higher productive efficiency

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$$\log h_a = \frac{\log(1-\tau_a)}{1+\sigma} - (\varphi + \bar{\varphi}_a) + \left(\frac{1-\tau_a}{\sigma+\tau_a}\right)\varepsilon - \frac{1}{\sigma+\tau_a}\mathcal{C}_a$$

- log-utility $\rightarrow$ hours unaffected by $\{\lambda_a, p(s), x_a, \alpha\}$
- $\frac{1-\tau_a}{\sigma+\tau_a}$ is the tax-modified Frisch elasticity

SOCIAL WELFARE

Social Welfare Function

- Planner puts equal weight on all currently alive agents, discounts utility of future cohorts at rate $\gamma = \beta$
- Start with policy that maximizes steady state welfare
- Then consider policy that maximizes welfare including transition
  - Transition driven by irreversible skill choice of existing cohorts
- Easy to optimize over large vector of policy choices because social welfare has a closed-form

QUALITATIVE ANALYSIS

Optimal Policy: Conditions for Age Invariance of τ_a

1. Optimal $\{\tau_a^*, \lambda_a^*\}$ are age-invariant iff:
   (a) $\theta = \infty$ or $\beta = 1$: no skill investment or no discounting
   (b) $v_\eta = 0$: flat profile of insurable productivity dispersion
   (c) $v_\omega = 0$: flat profile of uninsurable productivity dispersion
   (d) $\{x_a, \bar{\varphi}_a\}$ constant: flat profile of average efficiency / disutility

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3. Given any profile for $\{\tau_a\}$, the optimal profile for $\{\lambda_a^*\}$ equates average consumption by age

Optimal Age-Varying Progressivity

- Four separate channels that shape age profile of progressivity:

  (a) Individual Discounting Channel
  Lower β *implies steeper optimal profile* $\{\tau_a^*\}$

  (b) Insurable Risk Channel
  Permanent insurable risk $(v_\eta > 0)$ *tilts optimal* $\{\tau_a^*\}$ *towards zero more at old ages than at young ages*

  (c) Uninsurable Risk Channel
  Permanent uninsurable risk $(v_\omega > 0)$ *implies optimal profile* $\{\tau_a^*\}$ *increasing in age*

  (d) Life-Cycle Channel
  Upward-sloping age profile of efficiency net of disutility of work $\{x_a - \bar{\varphi}_a\}$ *implies decreasing optimal profile* $\{\tau_a^*\}$

Calibration

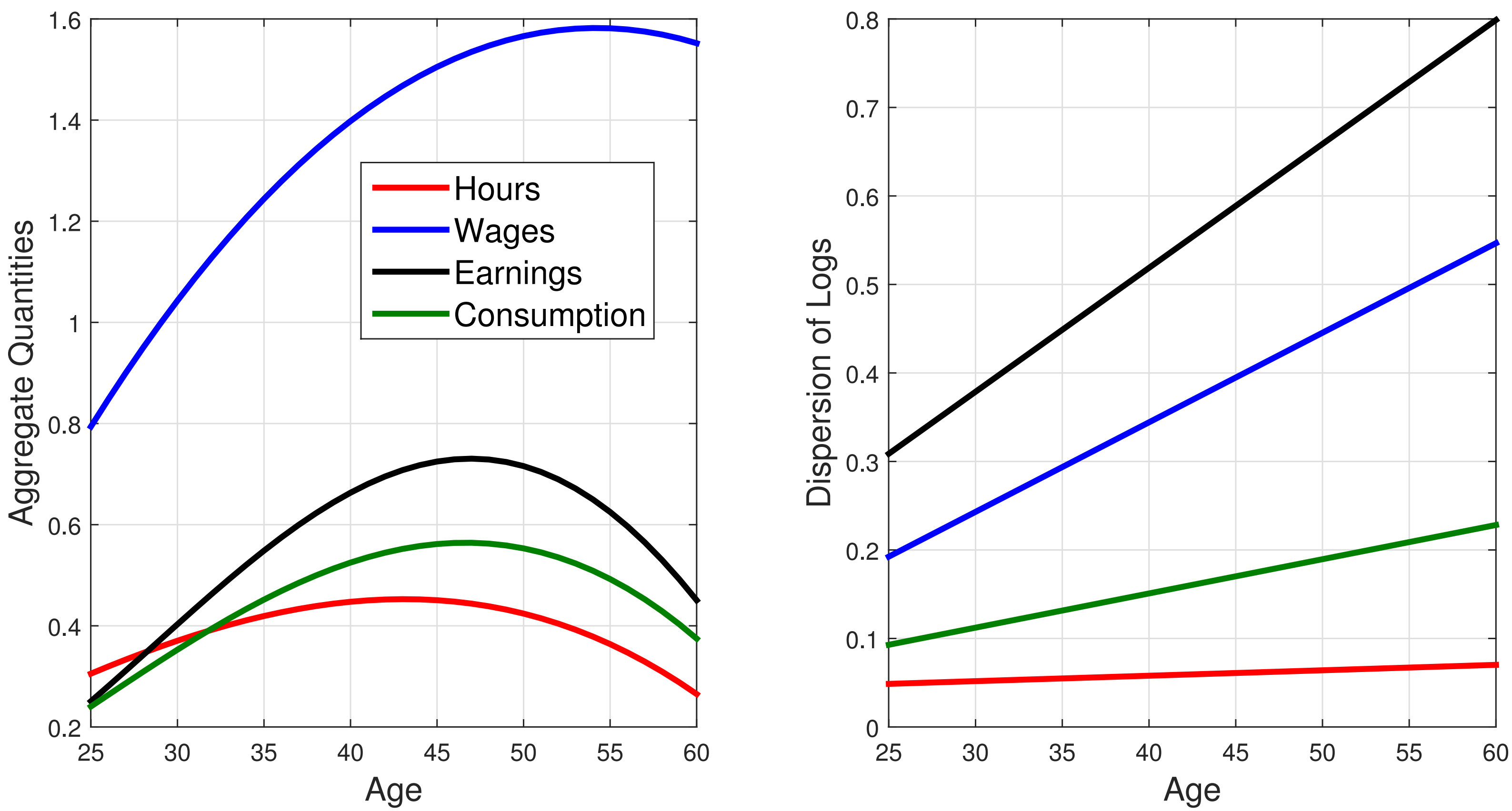
Parameterization

- Parameter vector $\{\chi, \tau^{US}, \sigma, \psi, \theta, v_\varphi, v_\omega, v_{\varepsilon 0}, v_\eta\}$ and $\{x_a, \bar{\varphi}_a\}$
- Assume observed $G/Y = 0.19 = g^*$ $\rightarrow \chi = 0.233$
- US progressivity estimated on micro data $\rightarrow \tau^{US} = 0.181$
- Frisch elasticity (micro-evidence ~ 0.5) $\rightarrow \sigma = 2$
- Price-elasticity of skill investment $\rightarrow \psi = 0.65$

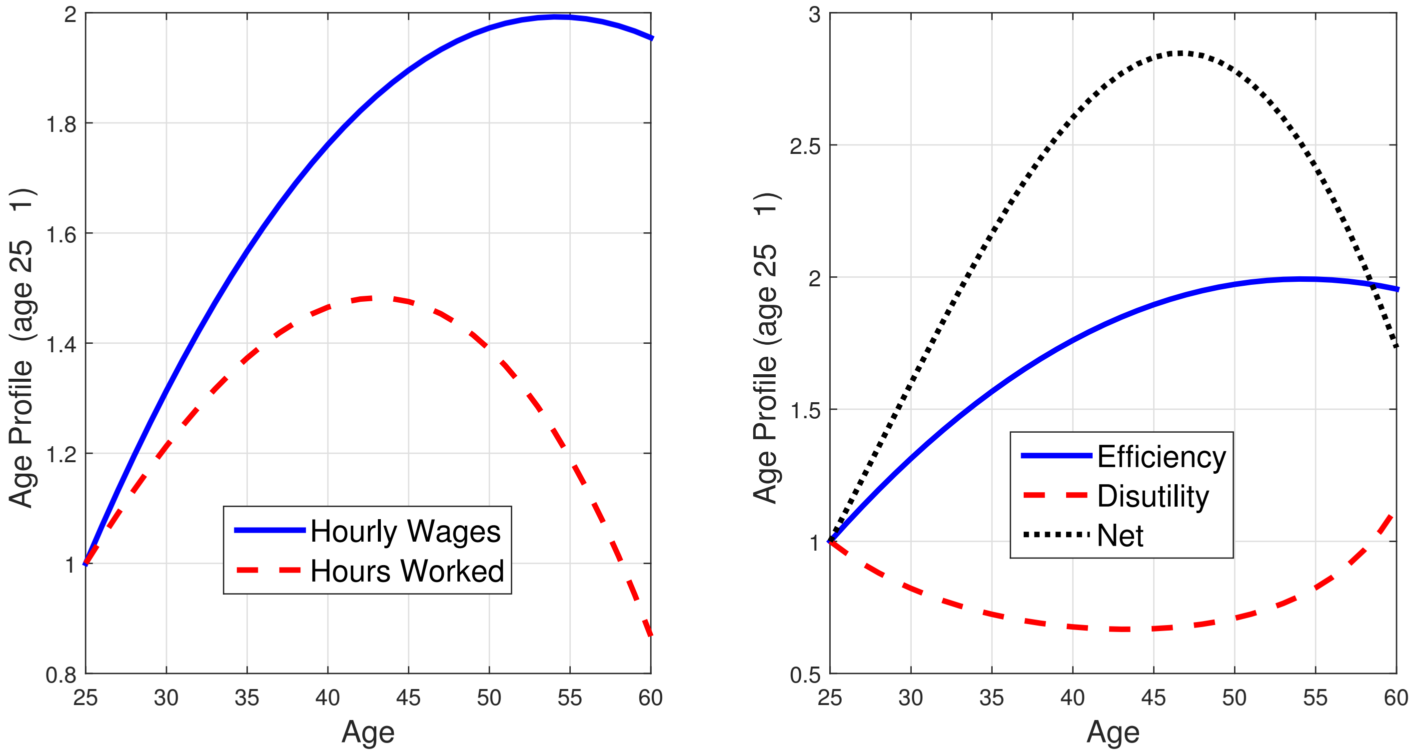
$$\begin{aligned} var_0(\log c) &\rightarrow \quad \theta = 3.12 \\ var(\log h) &\rightarrow \quad v_\varphi = 0.035 \\ cov(\log w, \log c) &\rightarrow \quad v_\omega = 0.0058 \\ cov(\log w, \log h) &\rightarrow \quad v_{\varepsilon,0} = 0.09, v_\eta = 0.044 \end{aligned}$$

- $\{x_a, \bar{\varphi}_a\}$ estimated to match age profiles wages of and hours

Life-cycle Means and Variances



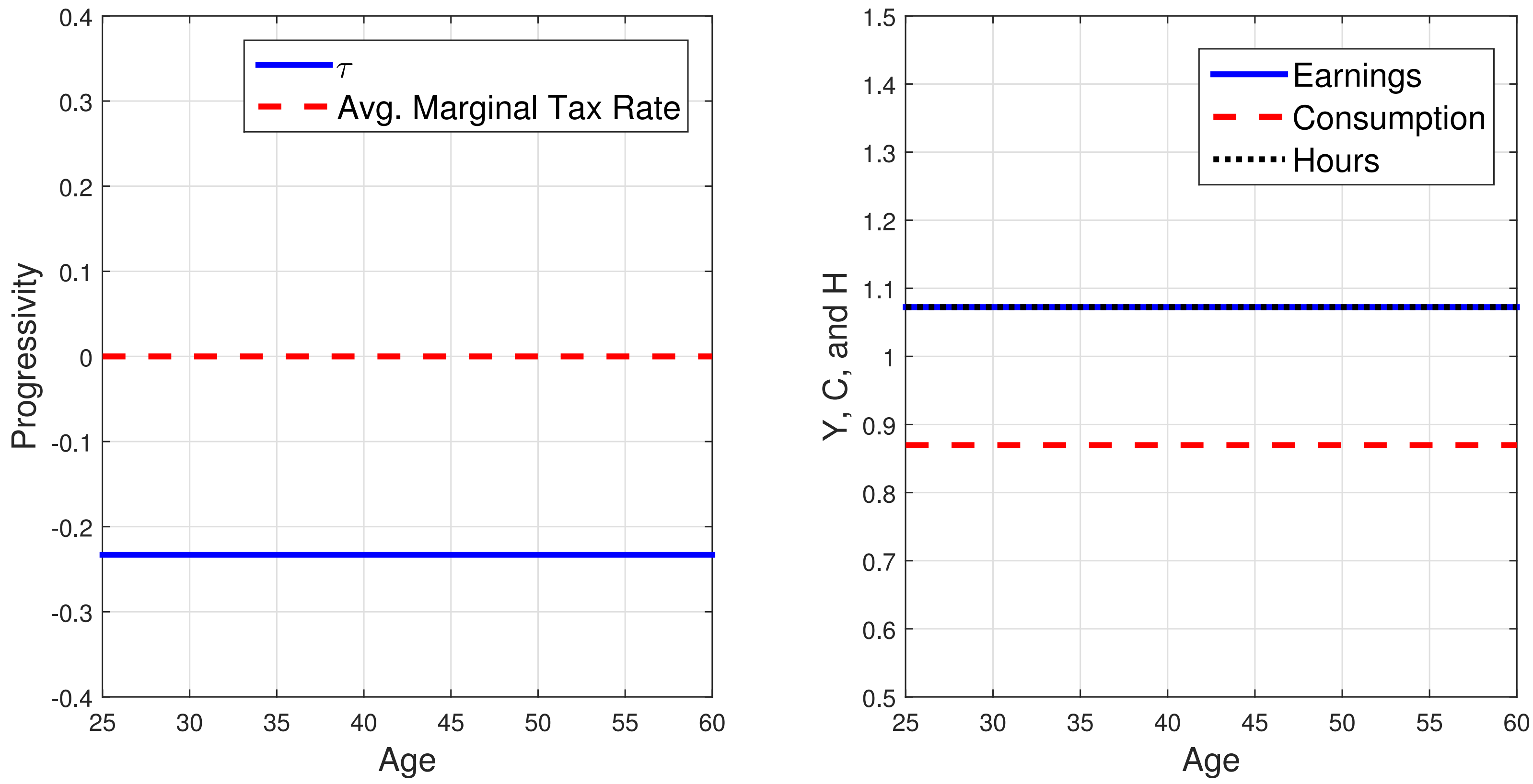
Age Profile for Efficiency and Disutility of Work



- Note: Net effect strongly hump-shaped

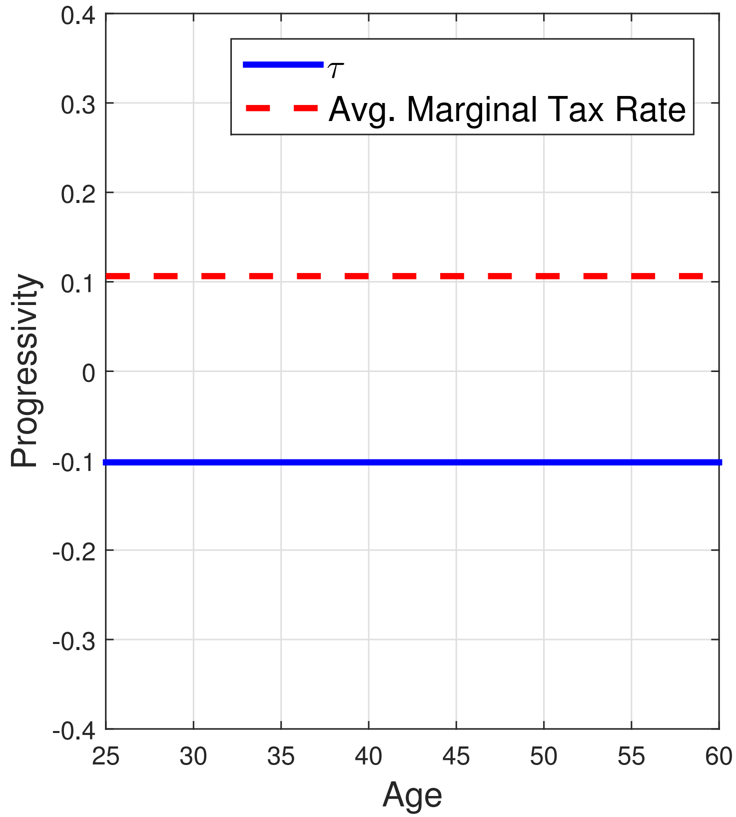
Quantitative Results

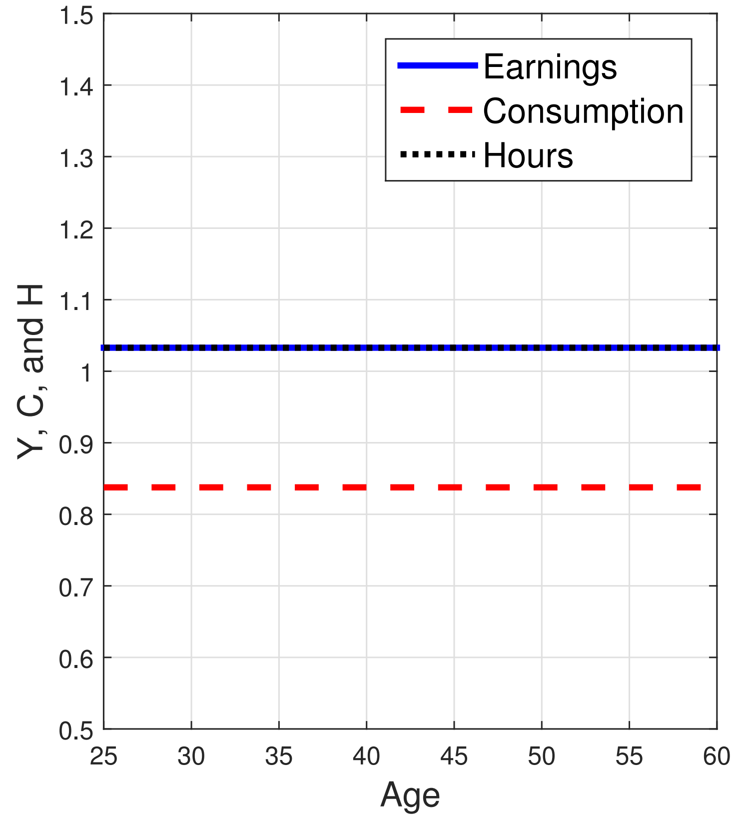
Representative Agent



- Optimality: $\tau_a^* = -\chi$

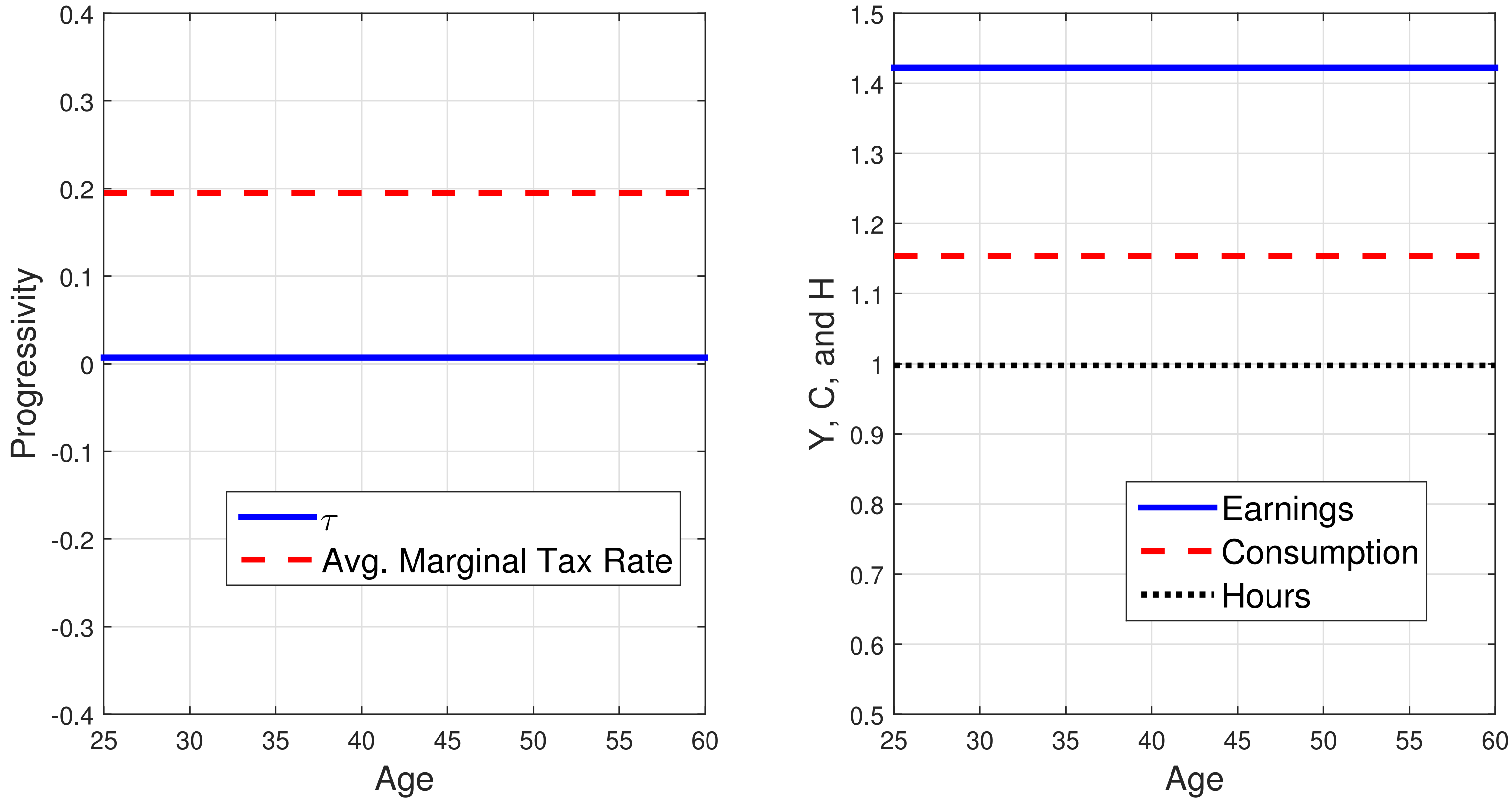
Add Heterogeneity in Disutility of Work (φ)





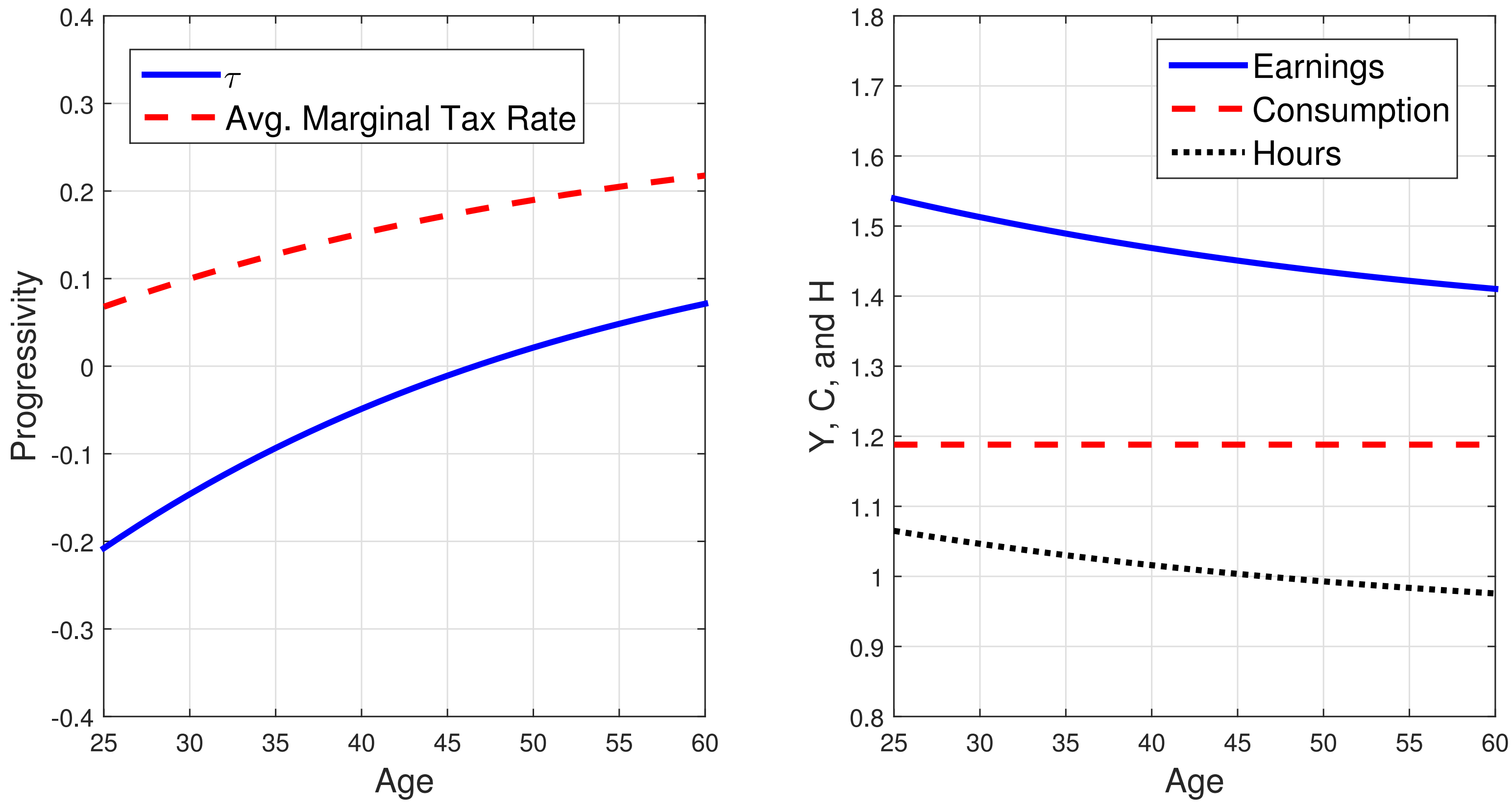
- τ_a^* still flat but shifted up (redistribution) $\Rightarrow$ lower labor supply

Add Heterogeneity in Ability (θ finite)



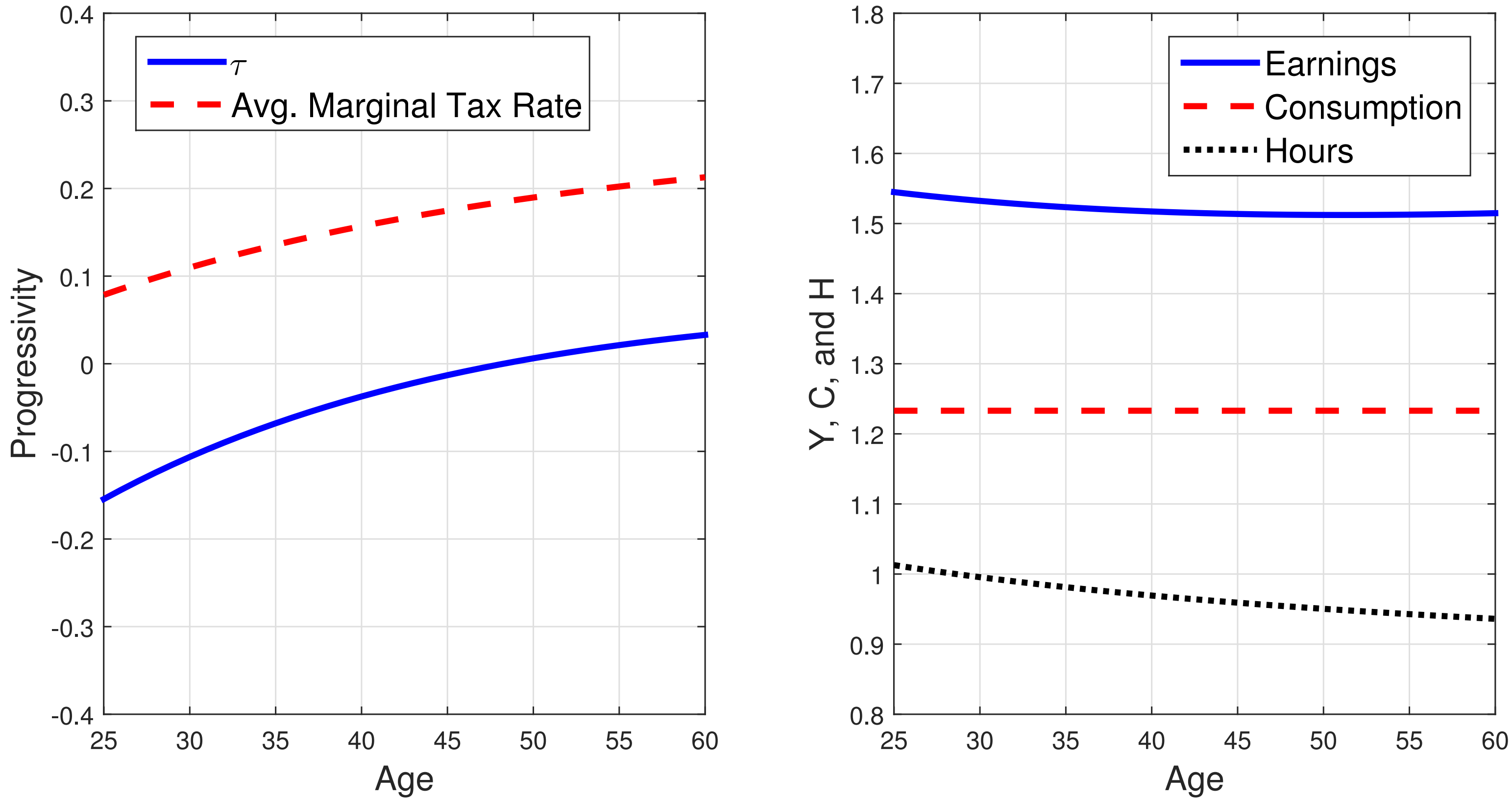
- τ_a^* still flat but shifted further up (redistribution > distortion)

Add Discounting ($\beta < 1$)



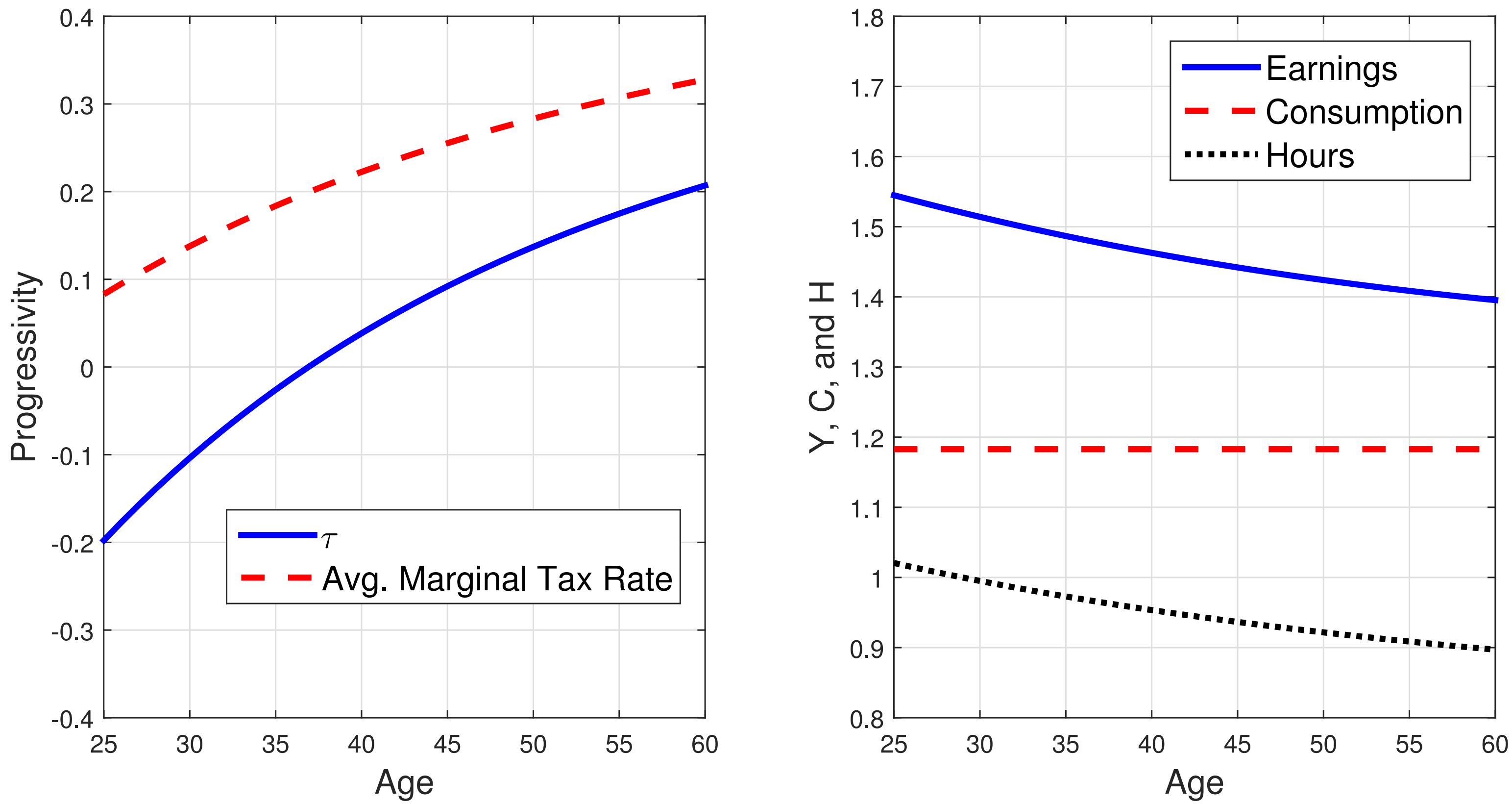
- Skill choice depends on $\bar{\tau} = \frac{1-\beta}{1-\beta^{A+1}} \sum_{a=0}^{A} \beta^a \tau_a$

Add Insurable Risk ($\upsilon_\varepsilon > 0$)



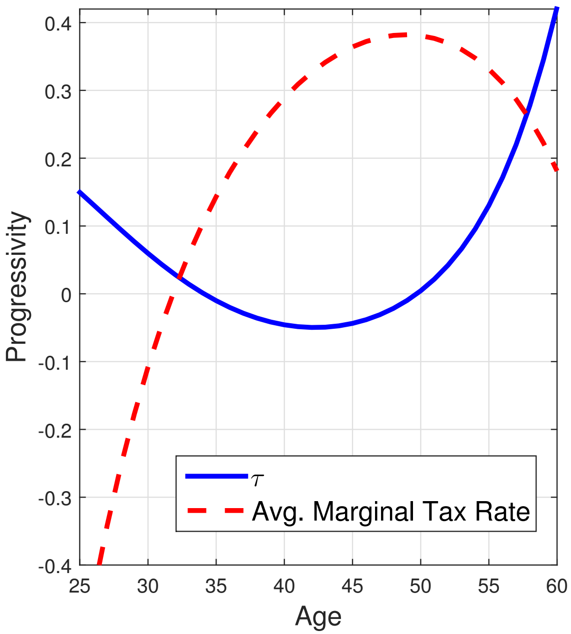
- Profile for τ_a^* is flattened towards zero

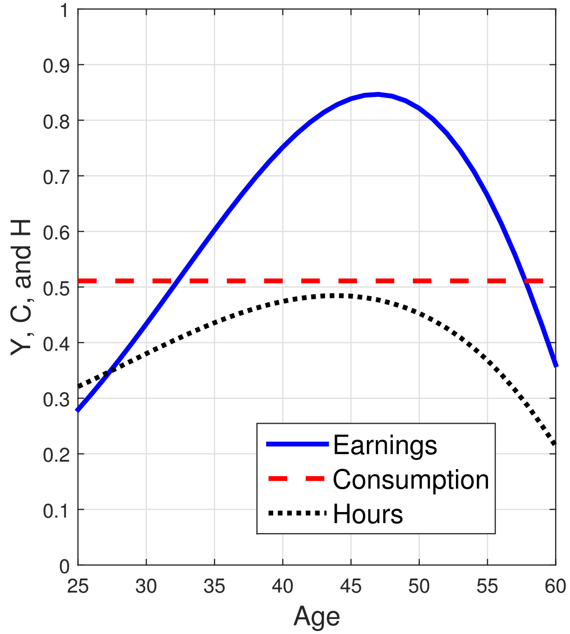
Add Uninsurable Risk ($\upsilon_\omega > 0$)



- Profile for τ_a^* steeper: more redistribution needed later in life since uninsurable risk cumulates

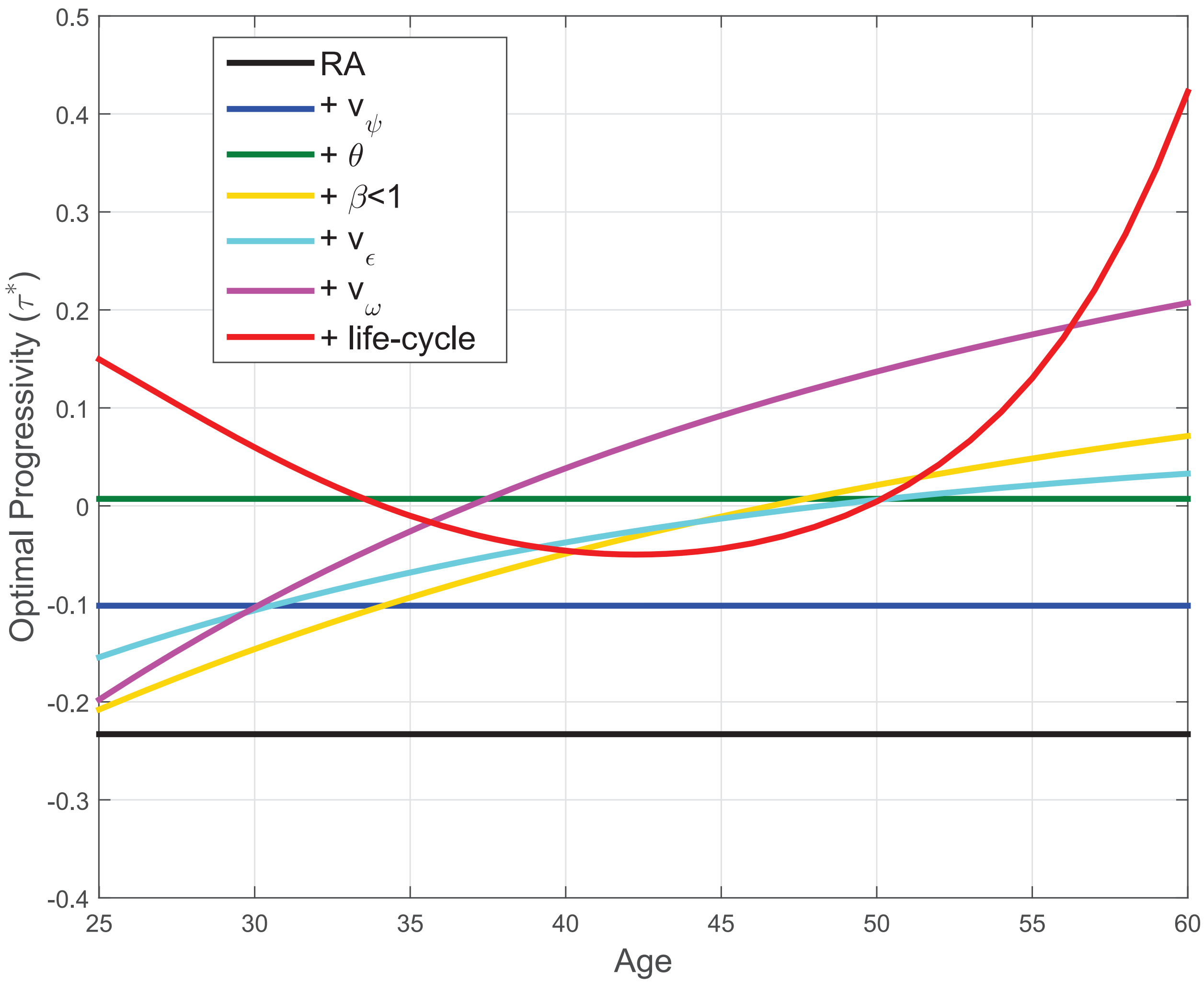
Add Life Cycle $\{x_a, \bar{\varphi}_a\}$



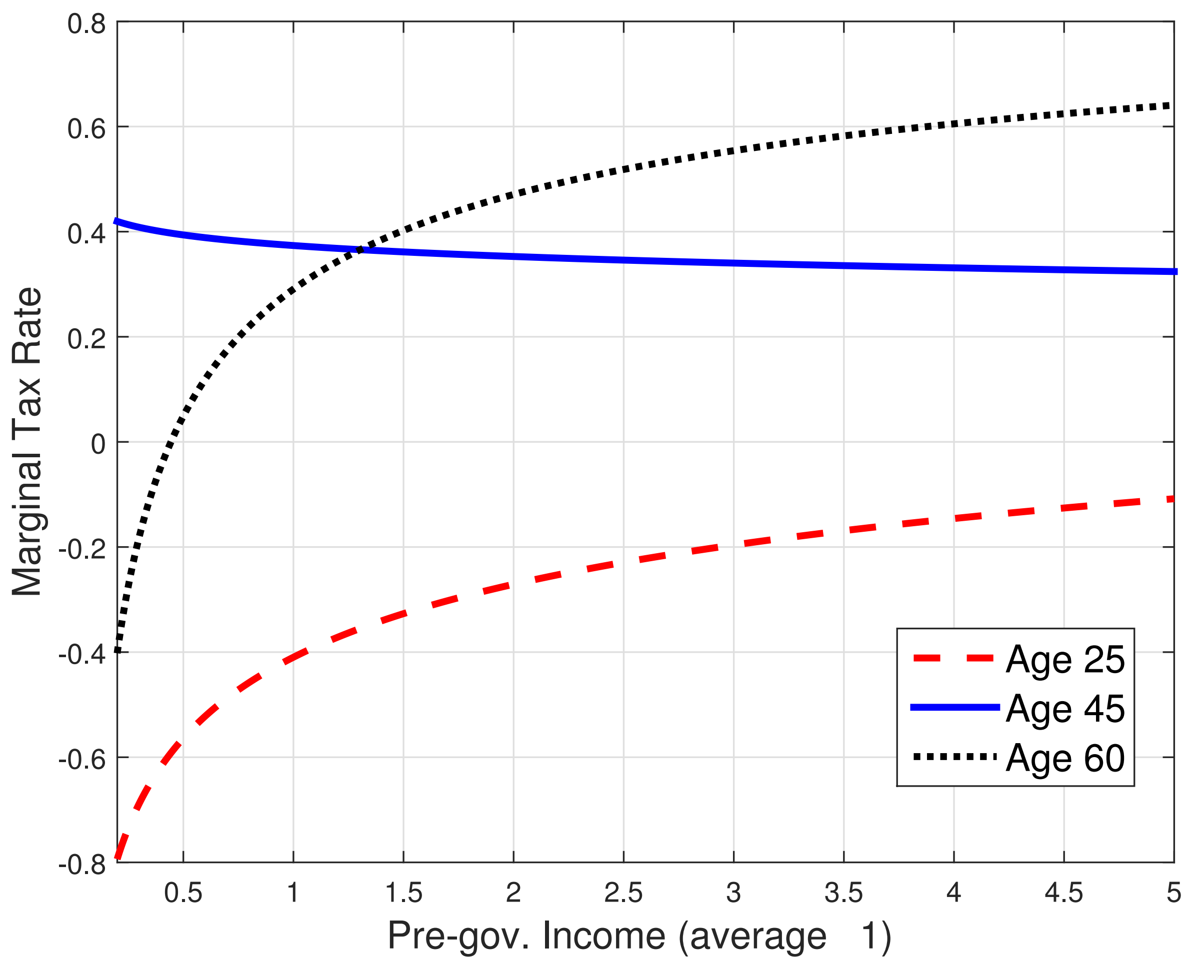


- $x_a - \bar{\varphi}_a$ hump-shaped + τ_a distorts labor supply $\Rightarrow \tau_a$ U-shaped
- If $\{x_a, \bar{\varphi}_a\}$ is the only source of heterogeneity, then optimal $\{\tau_a^*\}$ equates labor wedge by age (tax smoothing)
- Recall $\{\lambda_a^*\}$ equates average C by age (resource wedge)

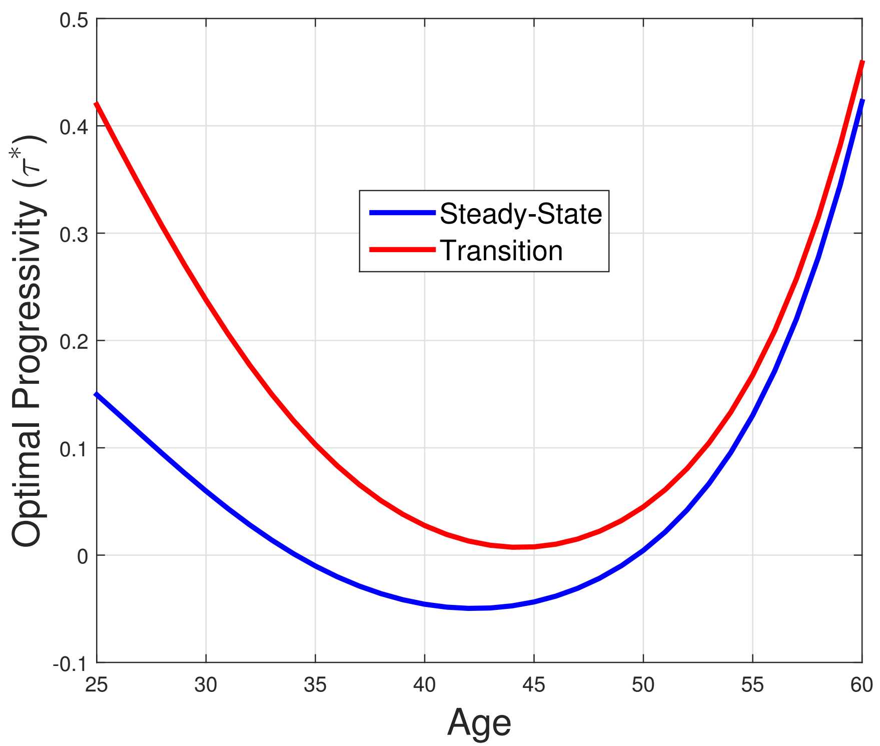
All Channels: Summary



All Channels: Marginal Tax Rates by Age



All Channels: SS vs Transition



- Sunk skill investment channel: $\Rightarrow \tau_a^*$ higher at all ages
- Planner discounting channel $\Rightarrow \tau_a^*$ increases more for young

Welfare Gains

- Equivalent variation in lifetime consumption

INTERTEMPORAL TRADE

Introducing Borrowing and Lending

- Two modifications to baseline model:
  1. Non-contingent bonds in zero net supply s.t. credit limit
  2. No insurable productivity shocks $(v_{\varepsilon,0} = v_{\eta} = 0)$

Introducing Borrowing and Lending

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  1. Non-contingent bonds in zero net supply s.t. credit limit
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- Numerical solution:
  1. Skill investment decision rules unchanged
  2. Solve numerically for hours worked, savings, interest rate
  3. Search for optimal $\{\tau_a\}$ as 5th order polynomial of age

Value of the Credit Limit

- We use SCF 2013 data to compute it for US households 25-60

  (a) Limit on each credit card

  (b) Limit on HELOC

  (c) Installment loans for vehicle and durables (not education)

  (d) Other debt

- Credit limit: (a) + (b) + 2$\times$(c) + 2$\times$(d)
- The 90th percentile (conditional on > 0) is 1.7 $\times$ annual Y
- We set it to 2 $\times$ Y

Findings from Numerical Experiment

- With flat $\{x_a, \bar{\varphi}_a\}$, negligible differences with / without wealth
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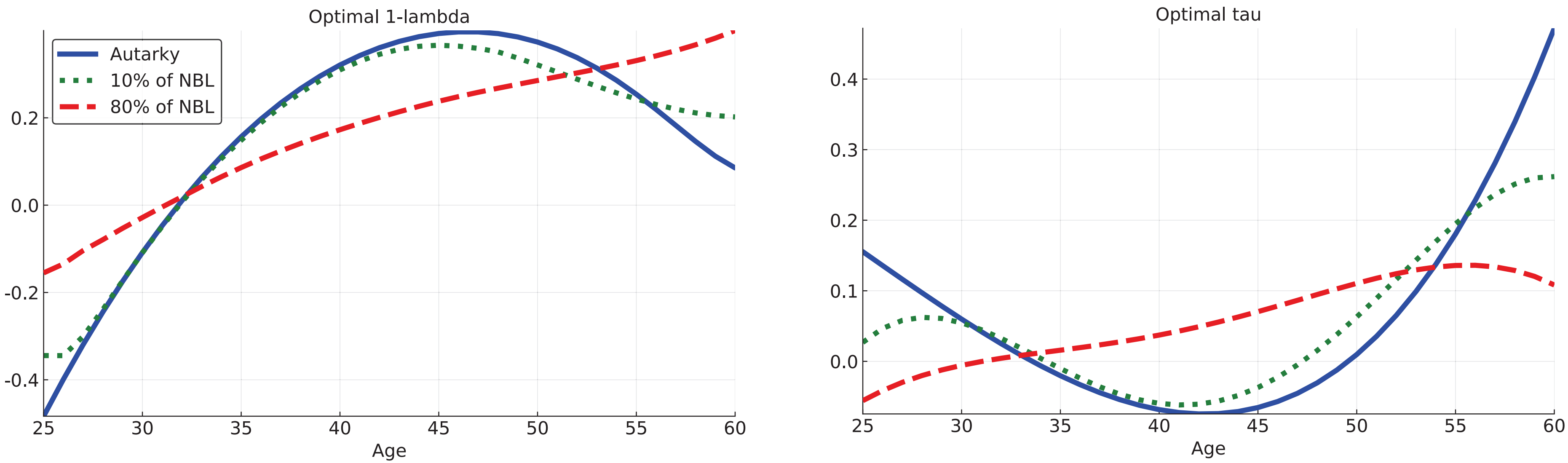
- With flat $\{x_a, \bar{\varphi}_a\}$, negligible differences with / without wealth
  - Ex-ante heter. and permanent shocks $\Rightarrow$ bond of little use
- With empirical profile of $\{x_a, \bar{\varphi}_a\}$, young households borrow to smooth consumption over the life-cycle
  - $\{\lambda_a^*\}$ flatter: less need for intergenerational redistribution
  - $\{\tau_a^*\}$: less U-shaped as a consequence
  - How much? It depends on credit limit

Optimal Progressivity with Borrowing/Saving



- Shape of τ_a^* profile is closer to the case w/o life-cycle, but flatter

THANKS!

HSV tax-transfer system

- It preserves tractability $\Rightarrow$ forces at work are transparent
- But is this specification too restrictive?
- Static setting: optimal policy in this comes class close to Mirrlees
  - Heathcote and Tsujiyama, 2018
- Dynamic setting: possible welfare gains if taxes age-varying
  - Weinzierl 2009, Farhi & Werning 2013, Golosov, Troshkin & Tsyvinski, 2016, Karabarbounis, 2016, Ndiaye 2017
- Age is observable!