Optimal Tax Progressivity: An Analytical Framework

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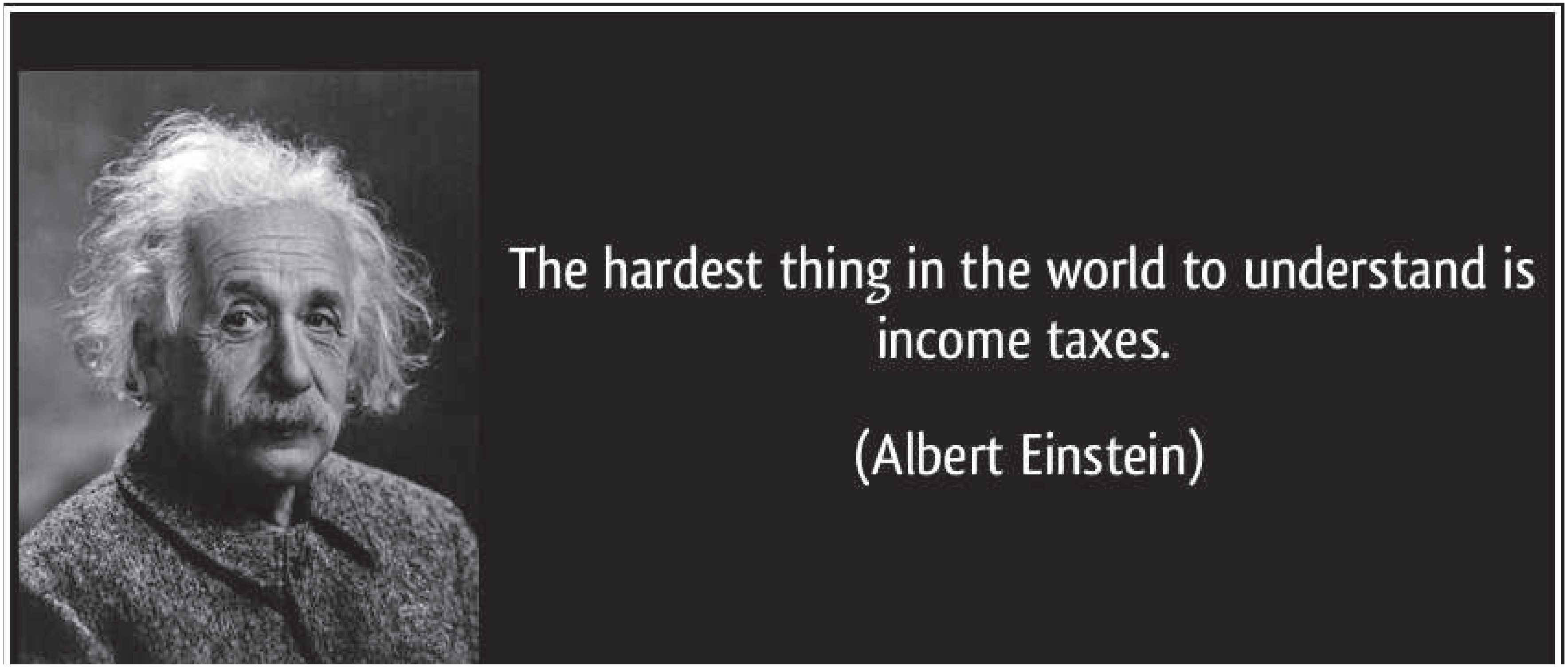
Motivation


The hardest thing in the world to understand is income taxes.
(Albert Einstein)

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  - Labor supply
  - Human capital investment
- Argument II against progressivity: externality
  - Financing of public good provision

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- Model ingredients:

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$\rightarrow$ closed-form Social Welfare Function

Tax/Transfer Function

The tax/transfer function

$$y - T(y) = \lambda y^{1-\tau}$$

- The parameter τ measures the degree of progressivity:
  - $\tau = 1:$ full redistribution $\rightarrow$ $T(y) = y - \lambda$
  - $0 < \tau < 1$: progressivity $\rightarrow$ $T'(y) > \frac{T(y)}{y}$
  - $\tau = 0:$ no redistribution $\rightarrow$ $T'(y) = \frac{T(y)}{y} = 1 - \lambda$
  - $\tau < 0:$ regressivity $\rightarrow$ $T'(y) < \frac{T(y)}{y}$
- Break-even income level: $y^0 = \lambda^{\frac{1}{\tau}}$

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Restrictions: (i) no lump-sum transfer $\&$ (ii) $T'(y)$ monotone

Measurement of τ^{US}

- PSID 2000-06, age of head of hh 25-60, $N = 12,943$
- Pre gov. income: income minus deductions (medical expenses, state taxes, mortgage interest and charitable contributions)
- Post-gov income: ... minus taxes (TAXSIM) plus transfers

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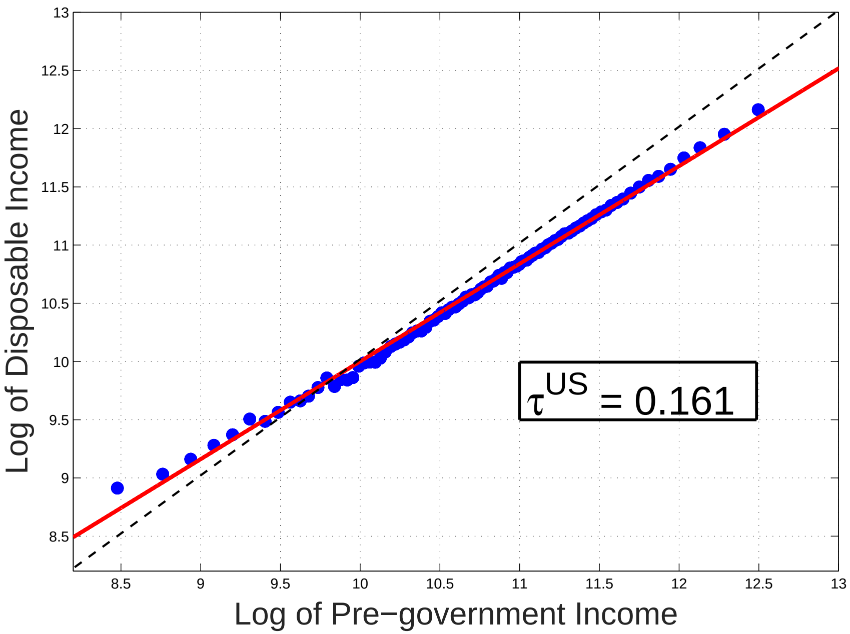

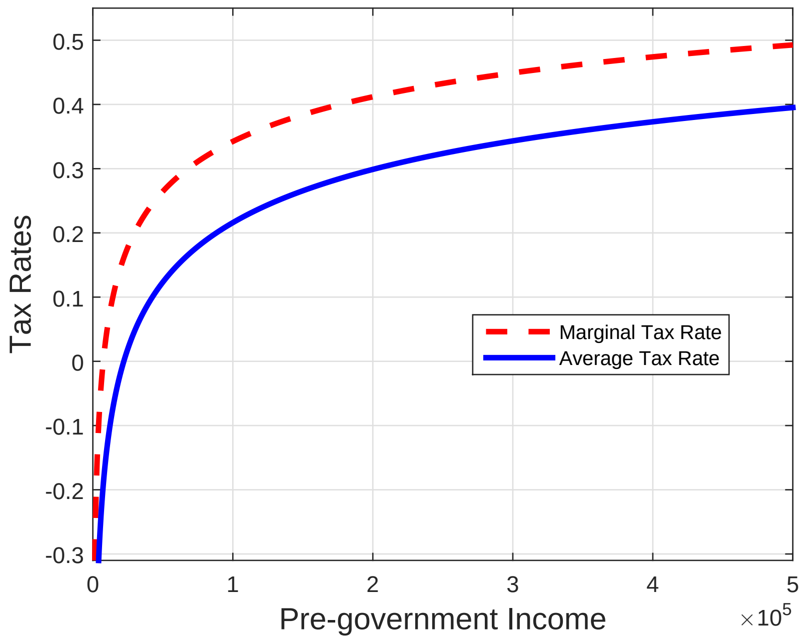

Model

Demographics and preferences

- Perpetual youth demographics with constant survival probability δ
- Preferences over consumption (c), hours (h), publicly-provided goods (G), and skill-investment (s) effort:

$$U_i = -v_i(s_i) + \mathbb{E}_0 \sum_{t=0}^{\infty} (\beta\delta)^t u_i(c_{it}, h_{it}, G)$$

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

Technology

- Aggregate effective hours by skill type:

$$N(s) = \int_0^1 \mathbb{I}_{\{s_i = s\}} \, z_i h_i \, di$$

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

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

  - Determination of skill price: $p(s) = MPN(s)$

- Aggregate resource constraint:

$$Y = \int_0^1 c_i \, di + G$$

Individual efficiency units of labor

$$\log z_{it} = \alpha_{it} + \varepsilon_{it}$$

- $\alpha_{it} = \alpha_{i,t-1} + \omega_{it}$ with $\omega_{it} \sim \mathcal{N}\left(-\frac{v_\omega}{2}, v_\omega\right)$ [permanent]

  +

- ε_{it} i.i.d. over time with $\varepsilon_{it} \sim \mathcal{N}\left(-\frac{v_\varepsilon}{2}, v_\varepsilon\right)$ [transitory]

- $\omega_{it} \perp \varepsilon_{it}$ cross-sectionally and longitudinally

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- Pre-government earnings:

$$y_{it} = \underbrace{p(s_i)}_{\text{skill price}} \times \underbrace{\exp(\alpha_{it} + \varepsilon_{it})}_{\text{efficiency}} \times \underbrace{h_{it}}_{\text{hours}}$$

determined by skill, fortune, and diligence

Government

- Government budget constraint (no government debt):

$$G = \int_0^1 \left[y_i - \lambda y_i^{1-\tau} \right] di$$

- Government chooses (G, τ), and λ balances the budget residually

- Without loss of generality, we let the government choose:

$$g \equiv \frac{G}{Y}$$

Market structure

- Final good (numeraire) market and labor markets are competitive
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- Perfect annuity markets against survival risk
- Full set of insurance claims against ε shocks
- No market to insure ω shock [microfoundation with bond]
  - $v_\varepsilon > 0, v_\omega > 0 \rightarrow$ partial insurance economy
  - $v_\omega = 0 \rightarrow$ full insurance economy
  - $v_\omega = v_\varepsilon = v_\varphi = 0 \quad \& \quad \theta = \infty \rightarrow$ RA economy

Special case: representative agent economy

$$
\begin{aligned}
\max_{C,H} \quad U &= \log C - \frac{H^{1+\sigma}}{1+\sigma} + \chi \log gY \\
&s.t. \\
C &= \lambda Y^{1-\tau} \\
Y &= H \\
C + G &= Y
\end{aligned}
$$

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- Substitute equilibrium allocations into U to obtain:

$$\mathcal{W}^{RA}(g,\tau) = \log(1-g) + \chi \log g + (1+\chi)\frac{\log(1-\tau)}{1+\sigma} - \frac{1-\tau}{1+\sigma}$$

- Ramsey planner chooses (g,τ) to maximize $\mathcal{W}^{RA}$

Optimal policy in the RA economy

$$g^* = \frac{\chi}{1+\chi}$$

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$$\tau^* = -\chi$$

- Regressivity corrects the externality linked to valued G

- Allocations are first best, i.e., same as with lump-sum taxation

Equilibrium skill choice and skill price

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- Skill price has Mincerian shape: $\log p(s;\tau) = \pi_0(\tau) + \pi_1(\tau) s(\kappa;\tau)$

$$s(\kappa;\tau) = \left(\frac{1-\tau}{\theta}\right)^{\frac{\psi}{1+\psi}} \cdot \kappa \qquad \text{skill choice}$$

$$\pi_1(\tau) = \left(\frac{1}{\theta}\right)^{\frac{1}{1+\psi}} (1-\tau)^{-\frac{\psi}{1+\psi}} \qquad \text{marginal return to skill}$$

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- Direct effect: τ reduces skill accumulation

- Equilibrium (Stiglitz) effect: τ raises skill premium through scarcity

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Neutrality $\rightarrow var(\log p(s;\tau)) = \frac{1}{\theta^2}$

- Distribution of skill prices p is Pareto with parameter θ

Equilibrium consumption and hours allocation

$$\log c(\alpha,\varphi,s;g,\tau) = \log C^{RA}(g,\tau) + \underbrace{(1-\tau)\log p(s;\tau)}_{\text{skill price}}$$

$$+\underbrace{(1-\tau)\,\alpha}_{\text{unins. shock}} - \underbrace{(1-\tau)\,\varphi}_{\text{pref. het.}} + \underbrace{\mathcal{M}(v_\varepsilon;\tau)}_{\text{welf. gain from ins. variation}}$$

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$$\log h(\varepsilon,\varphi;\tau) \quad = \quad \log H^{RA}(\tau) - \underbrace{\varphi}_{\text{pref. het.}} + \underbrace{\frac{1}{\widehat{\sigma}}\varepsilon}_{\text{ins. shock}} - \underbrace{\frac{1}{\widehat{\sigma}(1-\tau)}\mathcal{M}(v_\varepsilon;\tau)}_{\text{welf. gain from ins. variation}}$$

- $\frac{1}{\hat{\sigma}} := \frac{1-\tau}{\sigma+\tau}$ is the tax-modified Frisch elasticity

Social Welfare Function

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Economy is in steady-state with pair (g_{-1}, τ_{-1})

Planner chooses, once and for all, a new pair (g^*, τ^*)

We make two assumptions:

1. Planner puts equal weight on all currently alive agents, discounts U of future cohorts at rate β
2. Skill investments are reversible

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   - SWF becomes average period-utility in the cross-section
   - τ^* does not depend on the pre-existing skill distribution
   - The transition to the new steady-state is instantaneous

Exact expression for SWF

$$
\begin{aligned}
\mathcal{W}(g,\tau) \quad = \quad & \log(1+g) + \chi \log g + (1+\chi)\frac{\log(1-\tau)}{(1+\hat{\sigma})(1-\tau)} - \frac{1}{(1+\hat{\sigma})} \\
& +(1+\chi)\left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta-1}\log\left(1-\tau\right) \\
& -\left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta}(1-\tau) - \left[-\log\left(1-\left(\frac{1-\tau}{\theta}\right)\right) - \left(\frac{1-\tau}{\theta}\right)\right] \\
& -(1-\tau)^2\,\frac{v_\varphi}{2} \\
& -\left[(1-\tau)\,\frac{\delta}{1-\delta}\,\frac{v_\omega}{2} - \log\left(\frac{1-\delta\exp\left(\frac{-\tau(1-\tau)}{2}v_\omega\right)}{1-\delta}\right)\right] \\
& +(1+\chi)\frac{1}{\hat{\sigma}}v_\varepsilon - (1+\chi)\sigma\frac{1}{\hat{\sigma}^2}\,\frac{v_\varepsilon}{2}
\end{aligned}
$$

Representative Agent component

$$\mathcal{W}(g,\tau) = \underbrace{\log(1+g) + \chi \log g + (1+\chi)\frac{\log(1-\tau)}{(1+\hat{\sigma})(1-\tau)} - \frac{1}{(1+\hat{\sigma})}}_{\text{Representative Agent Welfare } = \mathcal{W}^{RA}(g,\tau)}$$

$$+(1+\chi)\left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta-1}\log\left(1-\tau\right)$$

$$-\left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta}(1-\tau) - \left[-\log\left(1-\left(\frac{1-\tau}{\theta}\right)\right) - \left(\frac{1-\tau}{\theta}\right)\right]$$

$$-\left(1-\tau\right)^2\frac{v_\varphi}{2}$$

$$-\left[\left(1-\tau\right)\frac{\delta}{1-\delta}\frac{v_\omega}{2} - \log\left(\frac{1-\delta\exp\left(\frac{-\tau(1-\tau)}{2}v_\omega\right)}{1-\delta}\right)\right]$$

$$+(1+\chi)\frac{1}{\hat{\sigma}}v_\varepsilon - (1+\chi)\sigma\frac{1}{\hat{\sigma}^2}\frac{v_\varepsilon}{2}$$

Exact expression for SWF(τ)

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& - \left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta}(1-\tau) - \left[-\log\left(1-\left(\frac{1-\tau}{\theta}\right)\right) - \left(\frac{1-\tau}{\theta}\right)\right] \\
& - (1-\tau)^2\,\frac{v_\varphi}{2} \\
& - \left[(1-\tau)\,\frac{\delta}{1-\delta}\,\frac{v_\omega}{2} - \log\left(\frac{1-\delta\exp\left(\frac{-\tau(1-\tau)}{2}v_\omega\right)}{1-\delta}\right)\right] \\
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Skill investment component

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& +(1+\chi) \qquad \underbrace{\left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta-1}\log\left(1-\tau\right)}_{\text{productivity gain } = \log E\left[(p(s))\right] = \log\left(Y/N\right)} \\
& \underbrace{-\left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta}(1-\tau)}_{\text{avg. education cost}} - \underbrace{\left[-\log\left(1-\left(\frac{1-\tau}{\theta}\right)\right)-\left(\frac{1-\tau}{\theta}\right)\right]}_{\text{consumption dispersion across skills}} \\
& -(1-\tau)^2\frac{v_\varphi}{2} \\
& -\left[(1-\tau)\frac{\delta}{1-\delta}\frac{v_\omega}{2} - \log\left(\frac{1-\delta\exp\left(\frac{-\tau(1-\tau)}{2}v_\omega\right)}{1-\delta}\right)\right] \\
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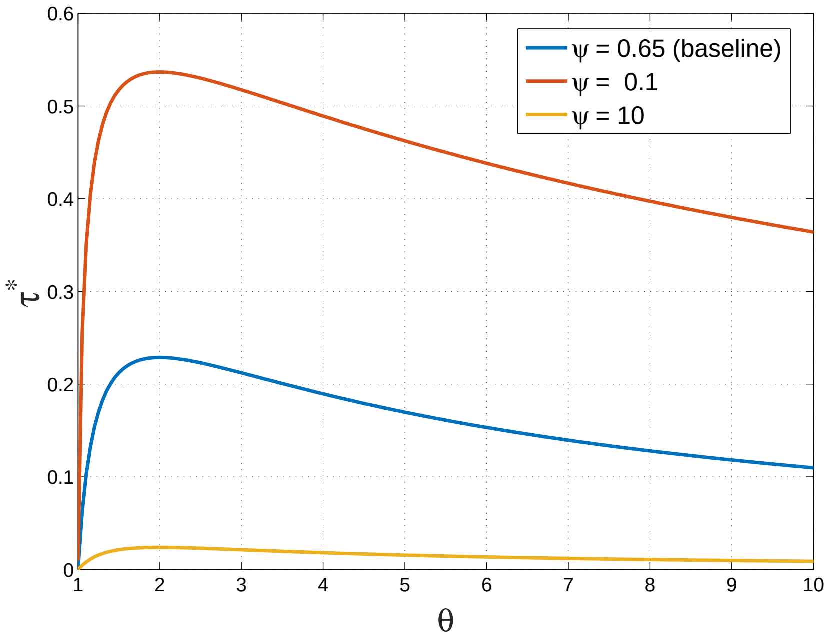
Skill investment component



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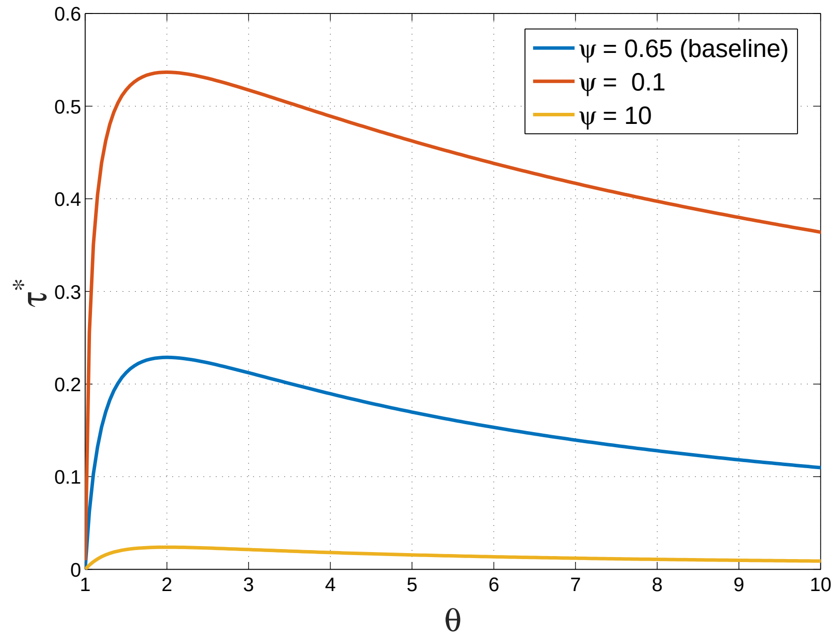

- Diamond-Saez formula for top marginal rate: $\bar{t} = \frac{1+\sigma}{\theta+\sigma}$
  - Lower θ: thicker Pareto tail in y dist. $\rightarrow$ more redistribution
- Our model: endogenous skill accumulation
  - Lower θ: strong skill complementarity $\rightarrow$ more skill investment

Uninsurable component

$$
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\mathcal{W}(\tau) \quad = \quad & \chi \log \chi - (1+\chi)\log(1+\chi) + (1+\chi)\frac{\log(1-\tau)}{(1+\hat{\sigma})(1-\tau)} - \frac{1}{(1+\hat{\sigma})} \\
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& - \underbrace{(1-\tau)^2\frac{v_\varphi}{2}}_{\text{cons. disp. due to prefs.}} \\
& - \underbrace{\left[(1-\tau)\frac{\delta}{1-\delta}\frac{v_\omega}{2} - \log\left(\frac{1-\delta\exp\left(\frac{-\tau(1-\tau)}{2}v_\omega\right)}{1-\delta}\right)\right]}_{\text{consumption dispersion due to uninsurable shocks} \approx (1-\tau)^2\frac{v_\alpha}{2}} \\
& +(1+\chi)\frac{1}{\hat{\sigma}}v_\varepsilon - (1+\chi)\sigma\frac{1}{\hat{\sigma}^2}\frac{v_\varepsilon}{2}
\end{aligned}
$$

Insurable component

$$
\begin{aligned}
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& +(1+\chi)\left(\frac{\psi}{1+\psi}\right)\frac{1}{\theta-1}\log\left(1-\tau\right) \\
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& +(1+\chi)\underbrace{\frac{1}{\hat{\sigma}}v_\varepsilon}_{\text{prod. gain from ins. shock}=\log(N/H)} - (1+\chi)\sigma\underbrace{\frac{1}{\hat{\sigma}^2}\frac{v_\varepsilon}{2}}_{\text{hours dispersion}}
\end{aligned}
$$

QUANTITATIVE IMPLICATIONS

Parameterization

- Parameter vector $\{\chi, \sigma, \psi, \theta, v_\varphi, v_\omega, v_\varepsilon\}$

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- Frisch elasticity (micro-evidence ~ 0.5) $\rightarrow \sigma = 2$

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\begin{aligned}
cov(\log h, \log w) &= \frac{1}{\hat{\sigma}} v_\varepsilon \\
var(\log h) &= v_\varphi + \frac{1}{\hat{\sigma}^2} v_\varepsilon \\
var^0(\log c) &= (1-\tau)^2 \left(v_\varphi + \frac{1}{\theta^2} \right) \\
var(\log w) &= \frac{1}{\theta^2} + \frac{\delta}{1-\delta} v_\omega + v_\varepsilon
\end{aligned}
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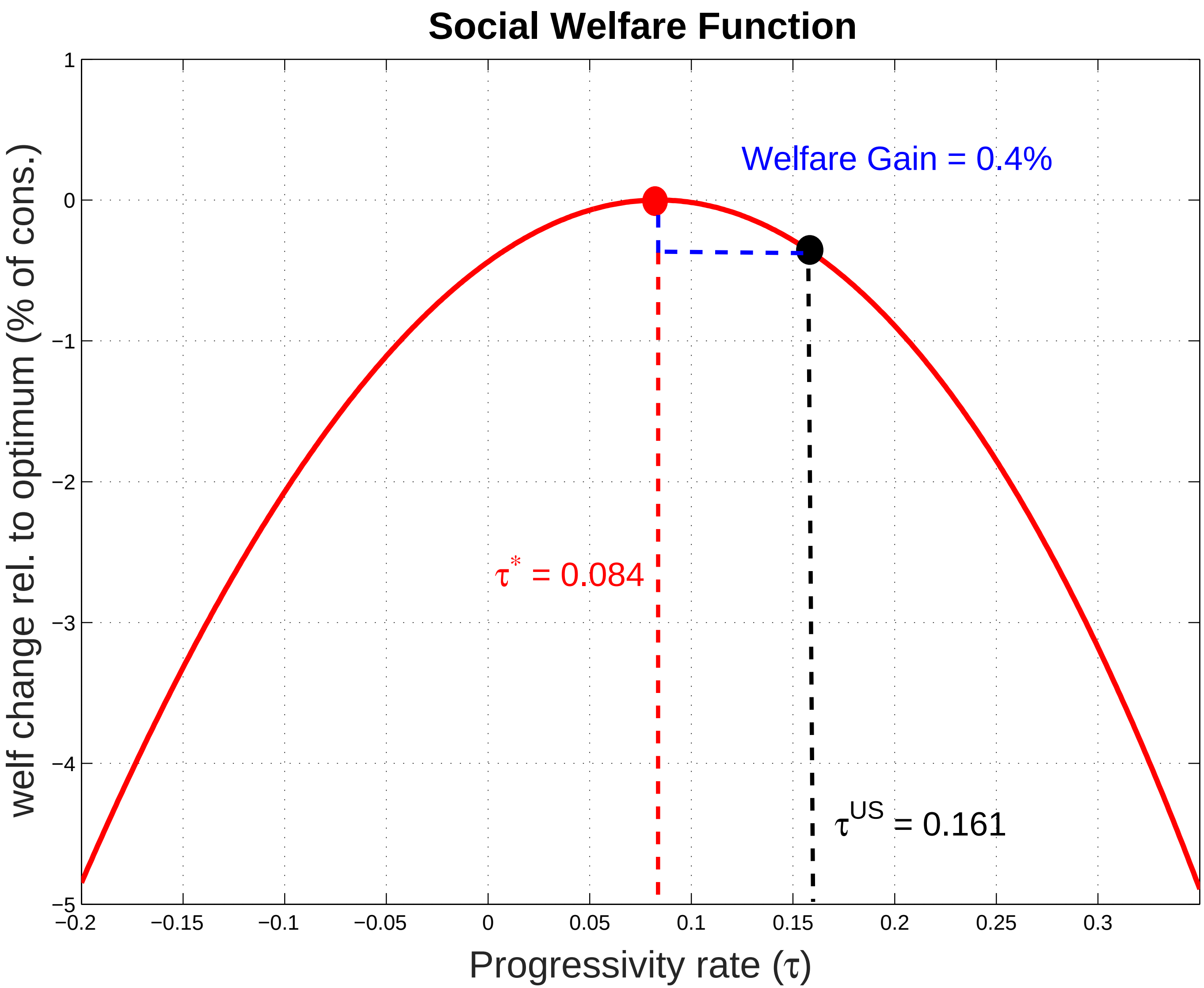
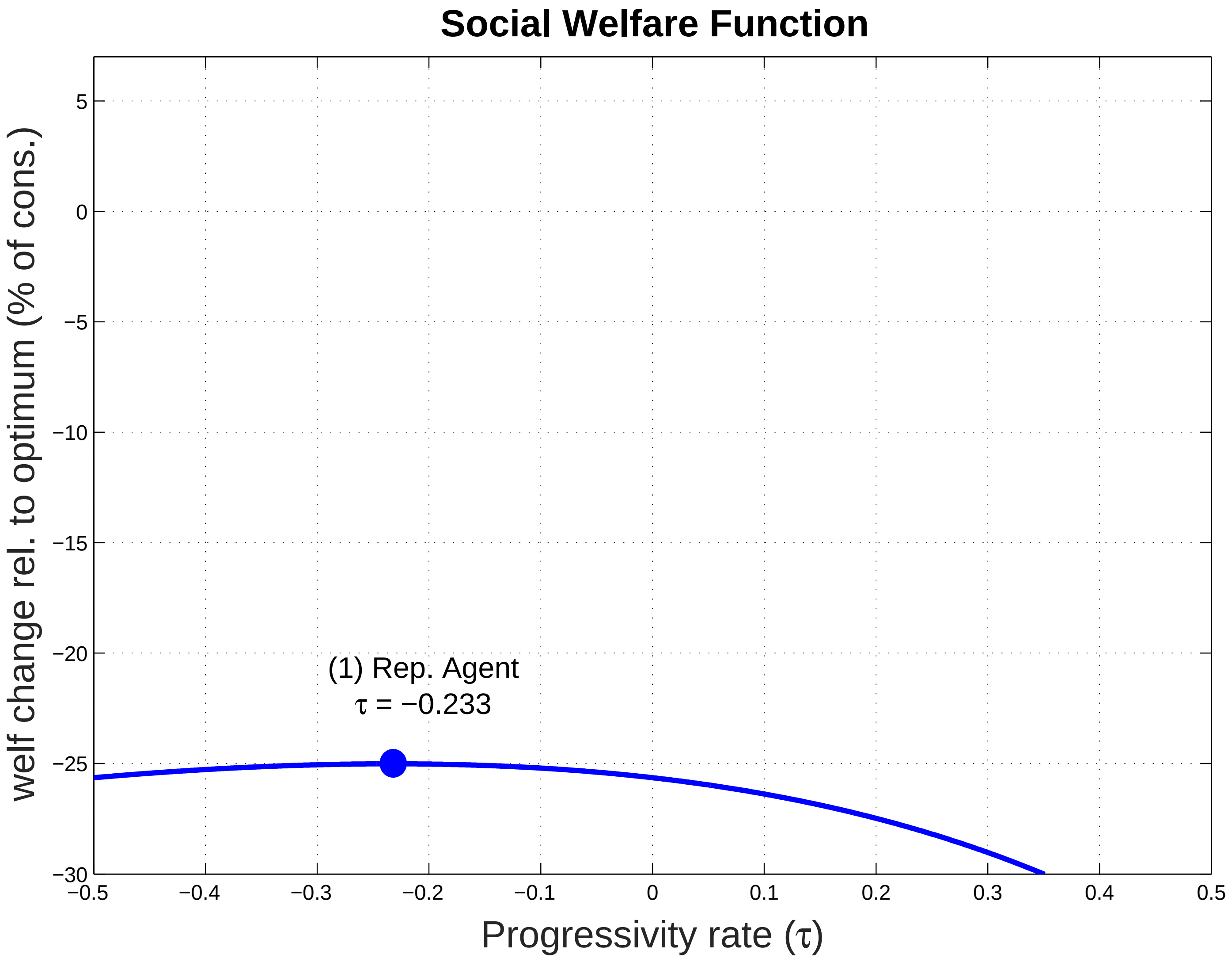
\begin{aligned}
cov(\log h, \log w) &= \frac{1}{\hat{\sigma}} v_\varepsilon && \rightarrow v_\varepsilon = 0.17 \\
var(\log h) &= v_\varphi + \frac{1}{\hat{\sigma}^2} v_\varepsilon && \rightarrow v_\varphi = 0.035 \\
var^0(\log c) &= (1-\tau)^2 \left(v_\varphi + \frac{1}{\theta^2} \right) && \rightarrow \theta = 3.12 \\
var(\log w) &= \frac{1}{\theta^2} + \frac{\delta}{1-\delta} v_\omega + v_\varepsilon && \rightarrow v_\omega = 0.003
\end{aligned}
$$

Optimal progressivity



Optimal progressivity: decomposition



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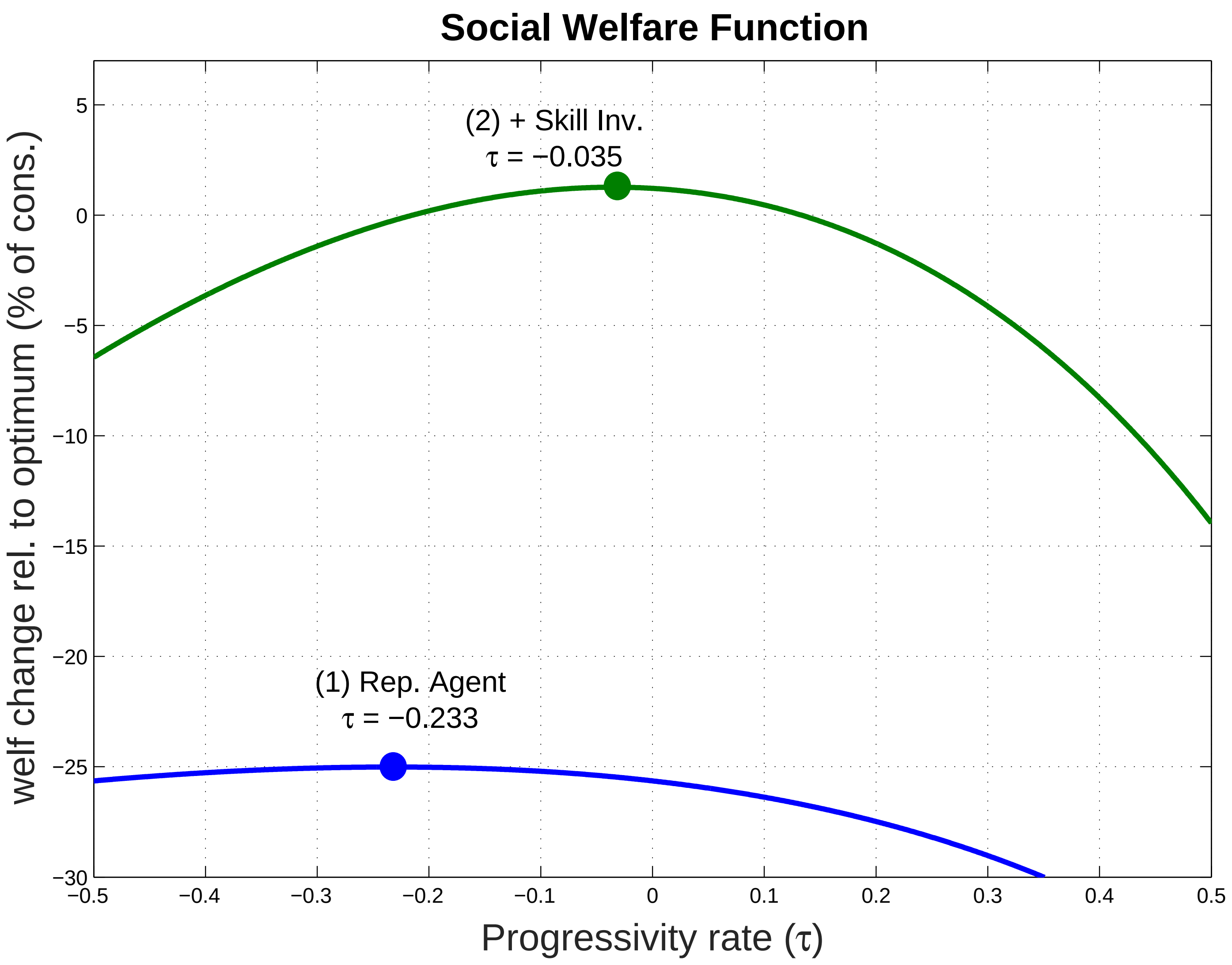

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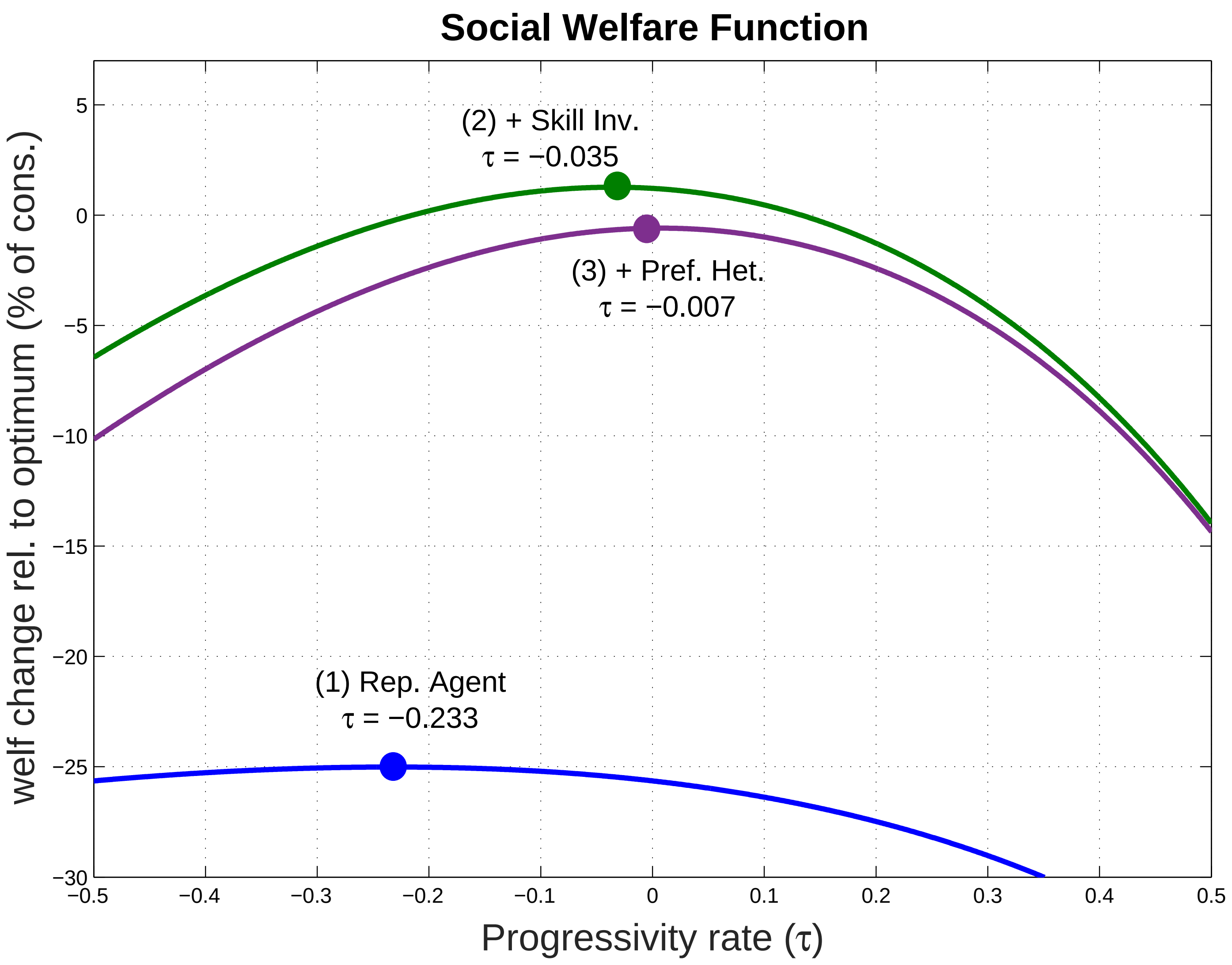
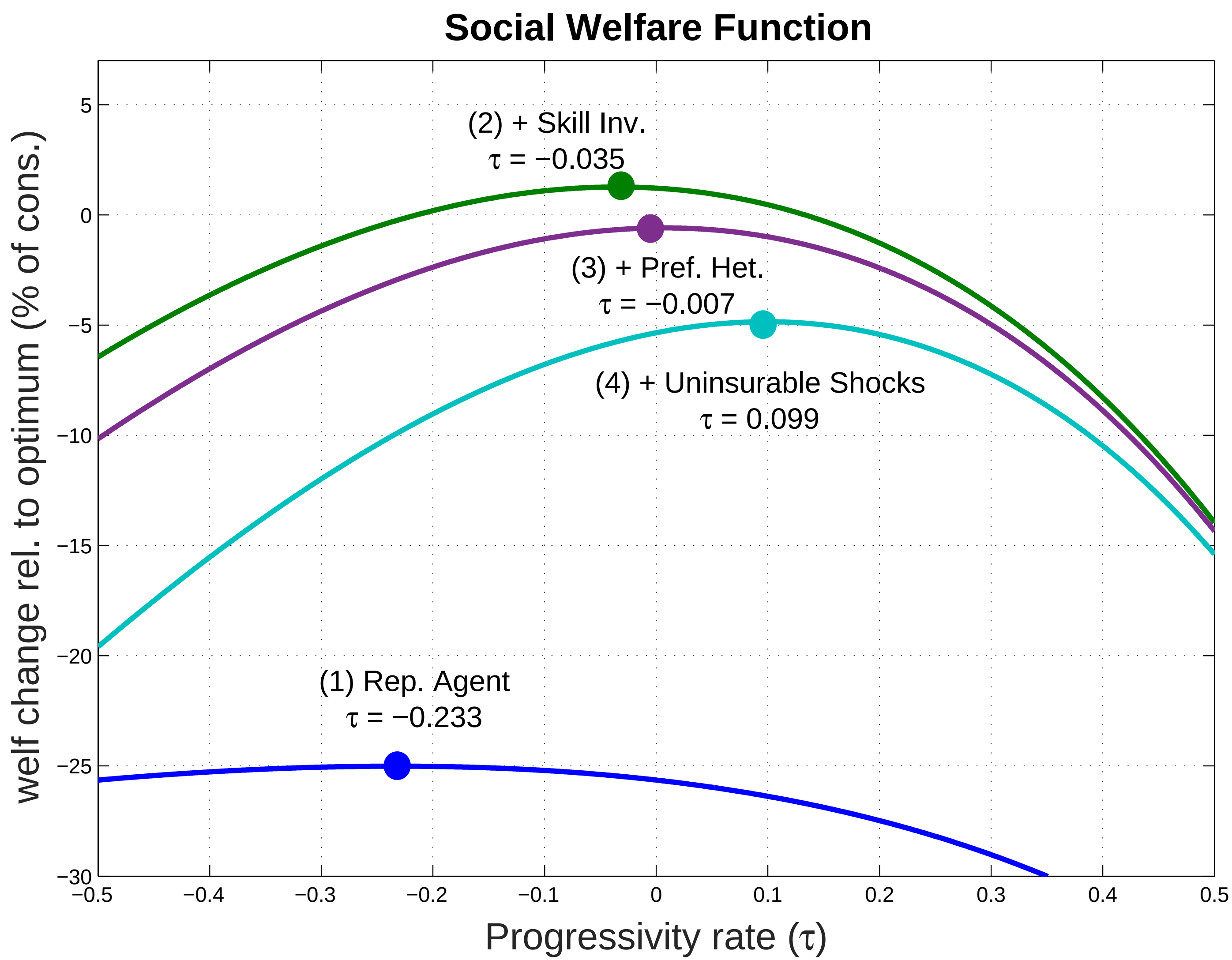


Optimal progressivity: decomposition



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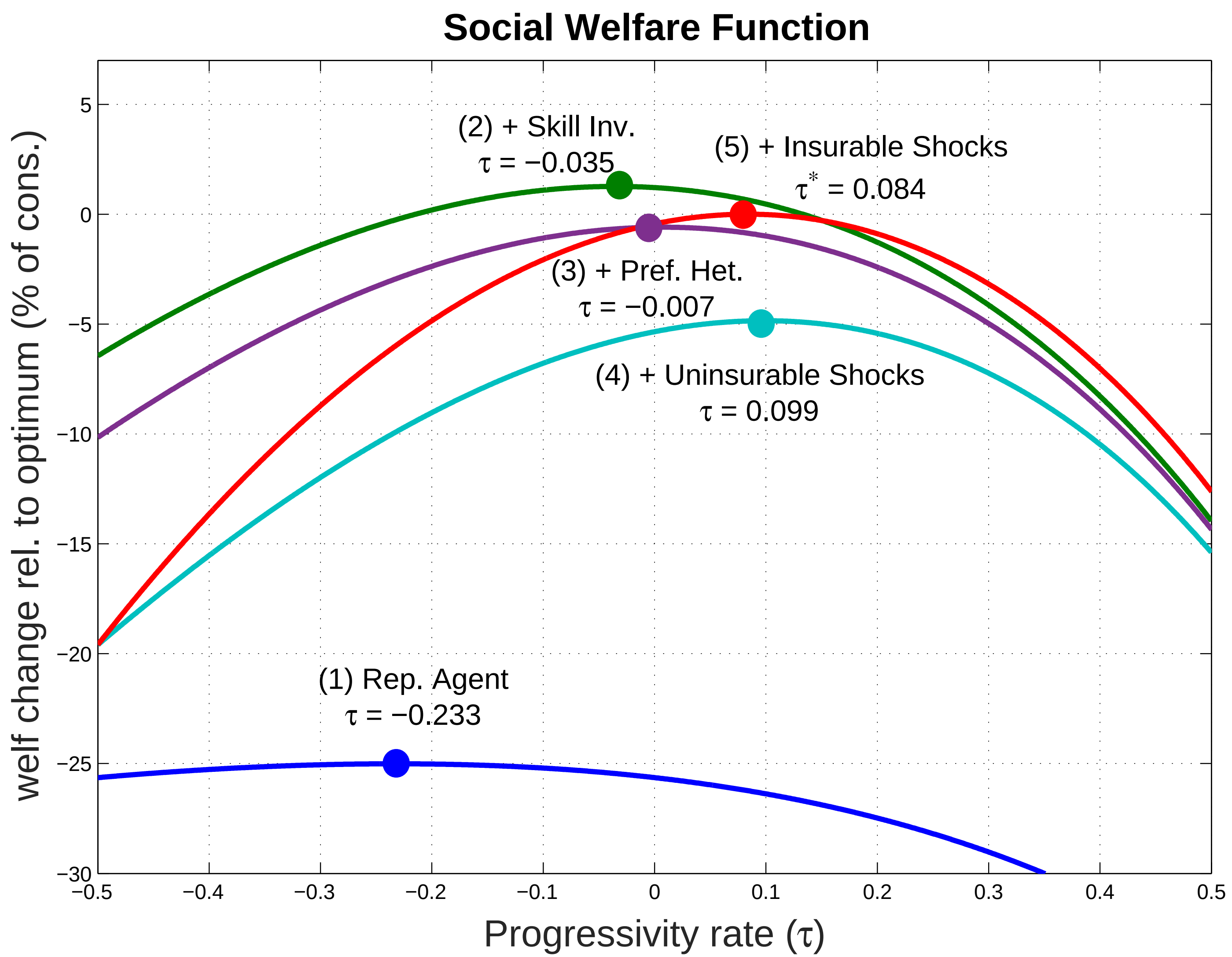
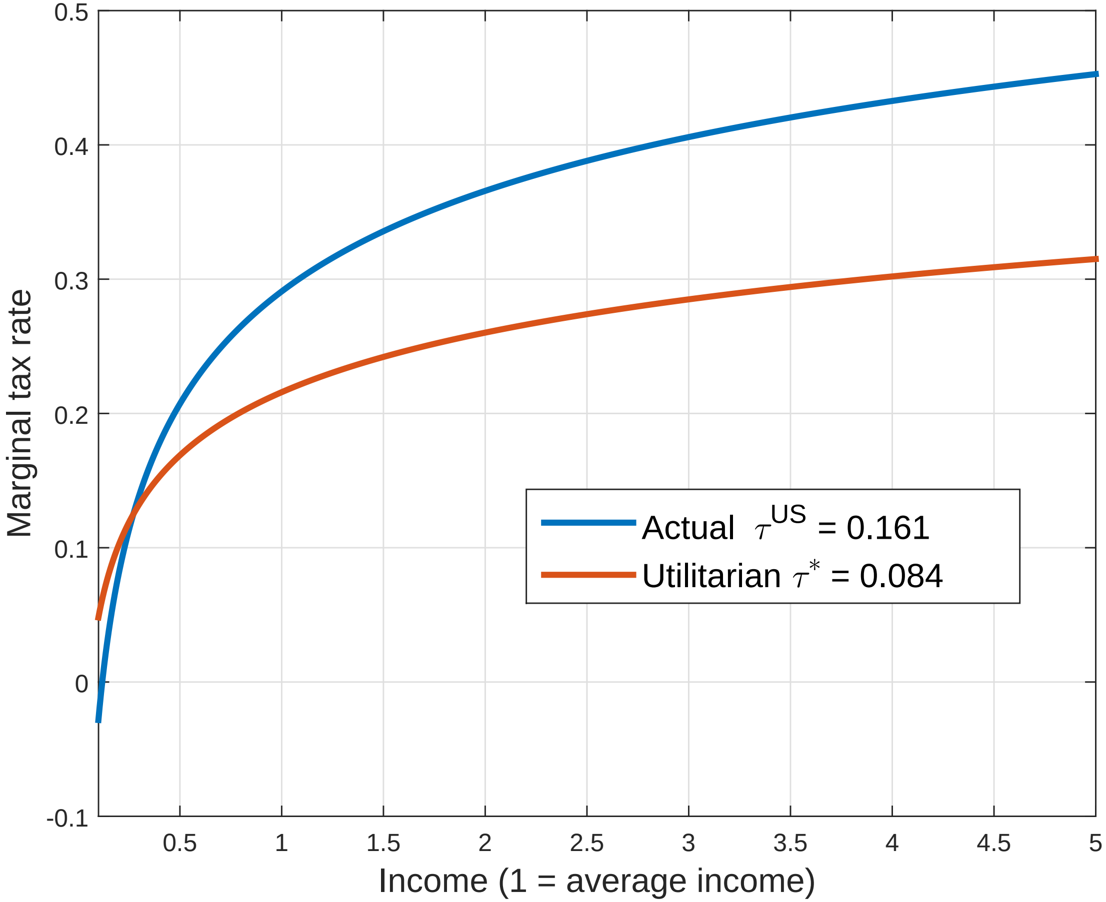


Actual and optimal progressivity



Income-weighted average marginal: down from 32% to 26%

If you believe that...

- G does not yield any utility $(\chi = 0)$:
  - $\tau^* = 0.20 \quad \rightarrow \quad$ y-weighted average MTR: 36 pct

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- All uninsurable wage ineq. is due to endogenous choices $(v_\omega = 0)$
  - $\tau^* = 0.06 \quad \rightarrow \quad$ y-weighted average MTR: 24 pct

Extensions

Role of weight on future vs. current cohorts

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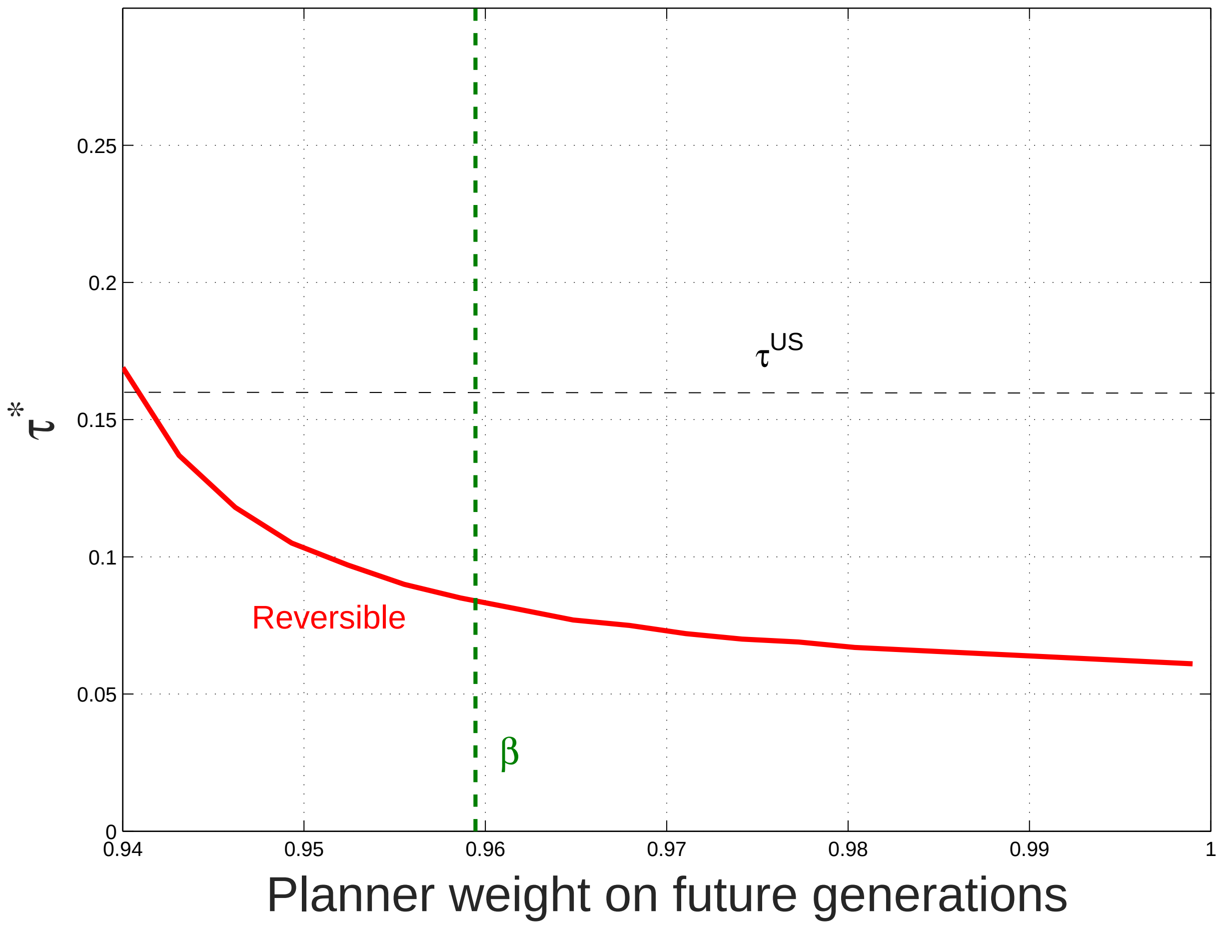
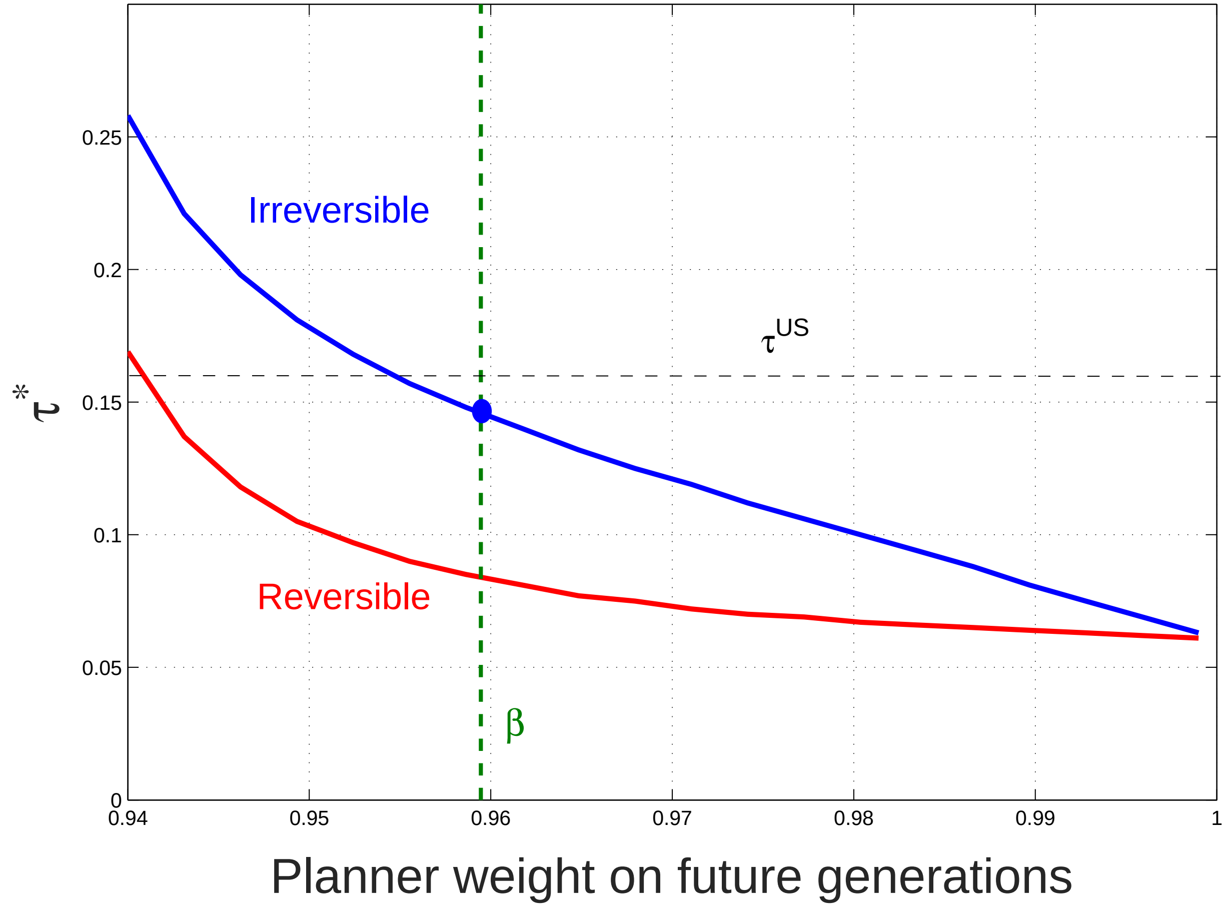


Lower weight $\rightarrow$ more concern for current inequality and redistribution

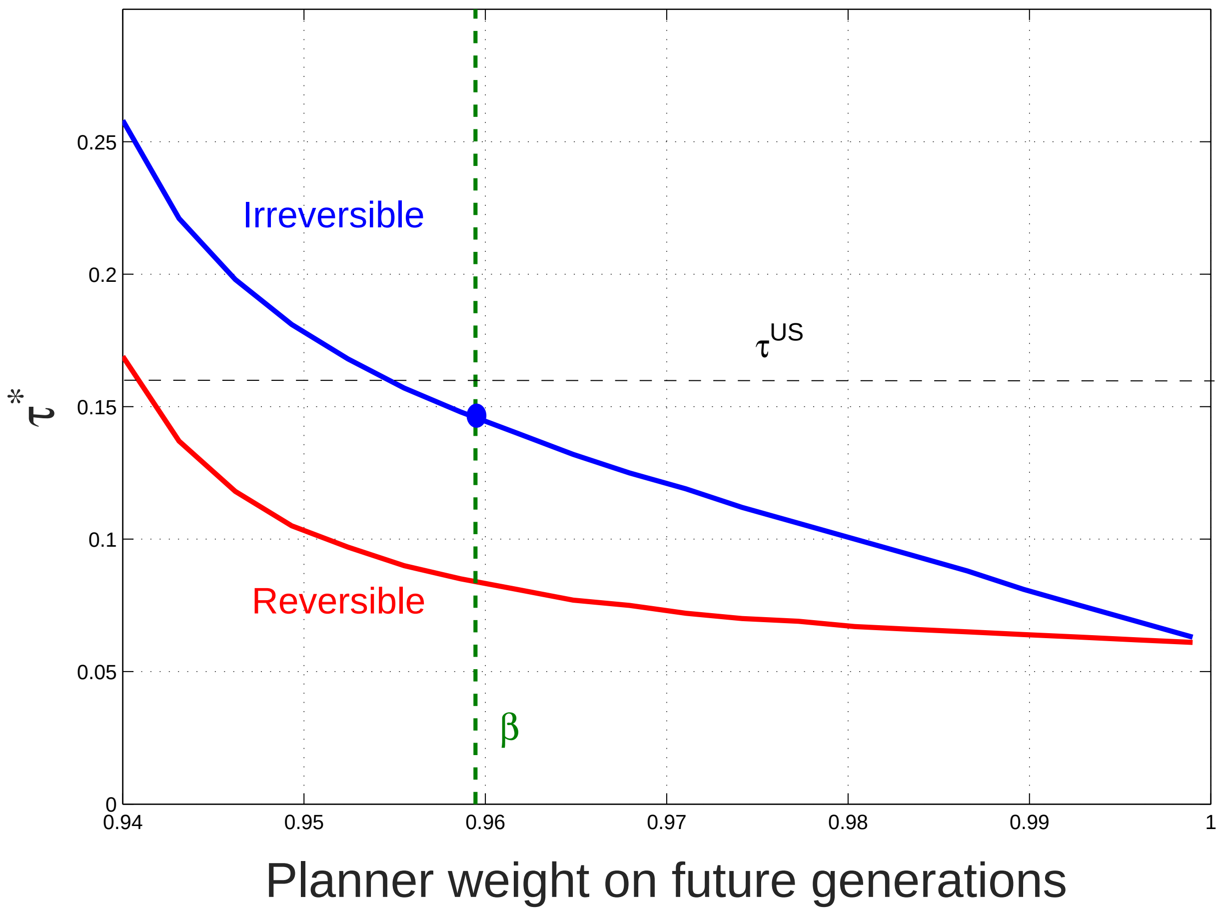
Irreversible skill investment

Irreversible skill investment



- Progressivity does not distort sunk skill inv. of existing cohorts

Irreversible skill investment



- Progressivity does not distort sunk skill inv. of existing cohorts
- As weight $\rightarrow 1$, (ir)-reversibility does not matter

Age-dependent progressivity

- Give the planner ability to index the pair (λ, τ) on individual age a
- Link with dynamic Mirrlees approach: age-dependent tax scheme realizes most of gains from fully history-dependent tax reform

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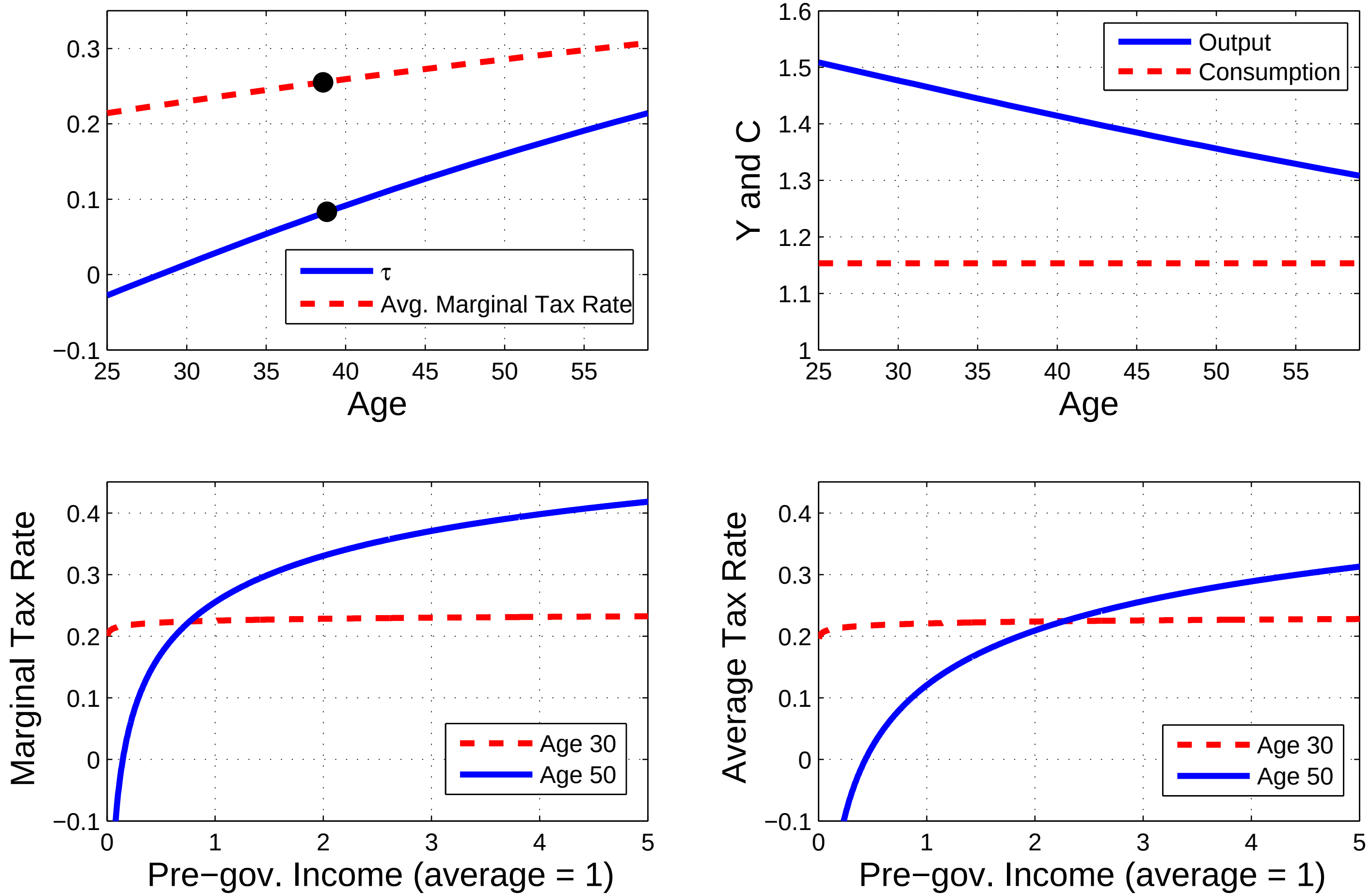
- Link with dynamic Mirrlees approach: age-dependent tax scheme realizes most of gains from fully history-dependent tax reform
- Three results:
  - Optimal public good provision g^* is unchanged
  - The sequence $\{\lambda_a^*, \tau_a^*\}$ is independent of age iff $v_\omega = 0$
  - With $v_\omega > 0$, the sequence $\{\lambda_a^*, \tau_a^*\}$ is strictly increasing in a

Age-dependent progressivity



Welfare gains from making τ^* age dependent near 5%!

Three lessons on optimal progressivity

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    - Key: skill-complementarity in production (θ), price-elasticity of skill investment (ψ), alterability of past skill choices

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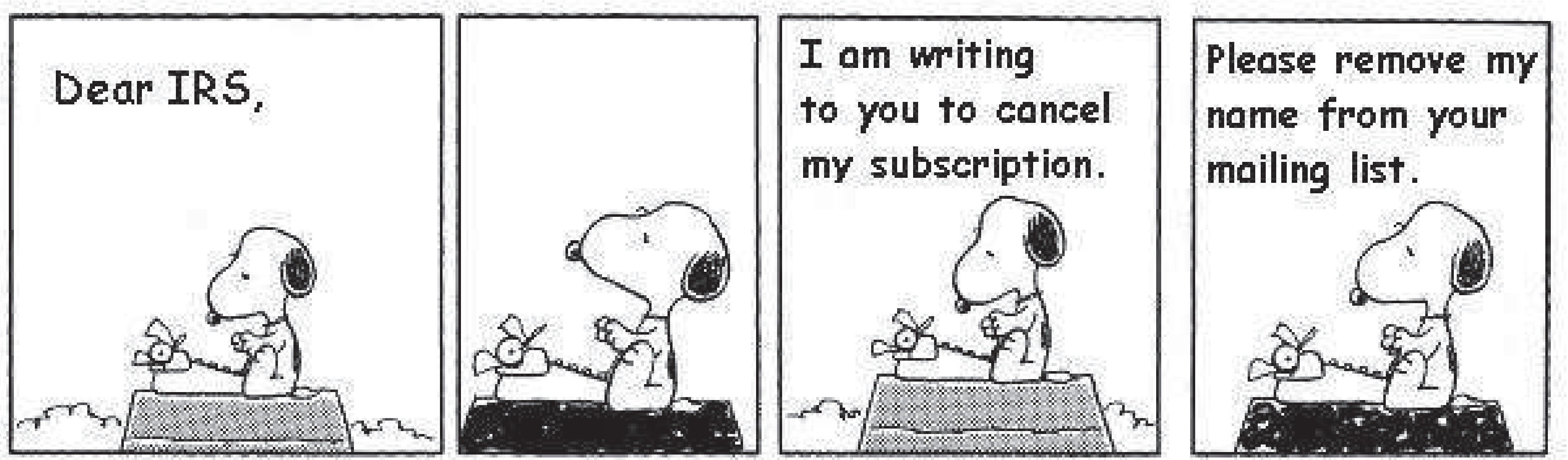
3. Age-dependent progressivity delivers large welfare gains
   - Low progressivity at young ages induces skill investment
   - High progressivity at old ages redistributes against shocks

Alternative drastic solution to increase welfare...



THANKS!

Inequality aversion

- Utilitarian planner: equal concern for redistributing across individuals and for insuring consumption fluctuations over time
- New inequality aversion parameter $\nu \in (0, \infty)$ to vary the strength of the concern for redistribution

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- Planner only concerned with consumption insurance $(\nu \rightarrow \infty)$ choosess an income-weighted average marginal tax rate of 6%