Redistributive Taxation in a Partial Insurance Economy

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- Arguments in favor of progressivity:

  1. Social insurance of privately-uninsurable shocks

  2. Redistribution from high to low innate ability

- Arguments against progressivity:

  1. Distortion to distribution of labor supply

  2. Distortion to human capital investment

  3. Redistribution from low to high taste for leisure

  4. Inefficient financing of G expenditures

Ramsey Approach

Government/Planner takes policy instruments and market structure as given, and chooses the CE that yields the largest social welfare

- CE of an heterogeneous-agent, incomplete-market economy
- Nonlinear tax/transfer system
- Utilitarian social welfare function
- Valued public expenditures also chosen by the government

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Tractable equilibrium framework clarifies economic forces shaping the optimal degree of progressivity

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- Steady-state analysis

Demographics and preferences

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

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

$$\begin{aligned} v(s_i) &= -\frac{1}{\kappa_i}\frac{s_i^2}{2\mu} \\ u_i\left(c_{it}, h_{it}, G, s_{it}\right) &= \log c_{it} - \exp(\varphi_i)\frac{h_{it}^{1+\sigma}}{1+\sigma} + \chi \log G \end{aligned}$$

$$\begin{aligned} \kappa_i &\sim Exp\left(\eta\right) \\ \varphi_i &\sim N\left(\frac{v_\varphi}{2}, v_\varphi\right) \end{aligned}$$

Technology

- Output is CES aggregator over continuum of skill types:

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

- Aggregate effective hours by skill type:

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

- 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 $\omega_{it} \sim N\left(-\frac{v_\omega}{2}, v_\omega\right)$

  $\alpha_{i0} = 0 \quad \forall i$

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

- $\varphi \perp \kappa \perp \omega \perp \varepsilon$ 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

Markets

- Competitive good and labor markets

- Competitive asset markets (all assets in zero net supply)
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    - If $v_\omega = 0$, it is a full insurance economy
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- Perfect annuity against survival risk

Budget constraints

1. Beginning of period: innovation ω to α shock is realized

2. Middle of period: buy insurance against ε:

$$b = \int_E Q(\varepsilon)B(\varepsilon)d\varepsilon,$$

   where $Q(\cdot)$ is the price of insurance and $B(\cdot)$ is the quantity

3. End of period: ε realized, consumption and hours chosen:

$$c + \delta q b' = \lambda (wh)^{1-\tau} + B(\varepsilon)$$

Government

- Runs a two-parameter tax/transfer function to redistribute and finance publicly-provided goods G
- Disposable (post-government) earnings:

$$\tilde{y}_i = \lambda y_i^{1-\tau}$$

- 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

Our model of fiscal redistribution

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

- The parameter τ measures the rate of progressivity:
  - $\tau = 1:$ full redistribution $\rightarrow \tilde{y}_i = \lambda$
  - $0 < \tau < 1$: progressivity $\rightarrow \frac{T'(y)}{T(y)/y} > 1$
  - $\tau = 0:$ no redistribution $\rightarrow$ flat tax $1 - \lambda$
  - $\tau < 0:$ regressivity $\rightarrow \frac{T'(y)}{T(y)/y} < 1$

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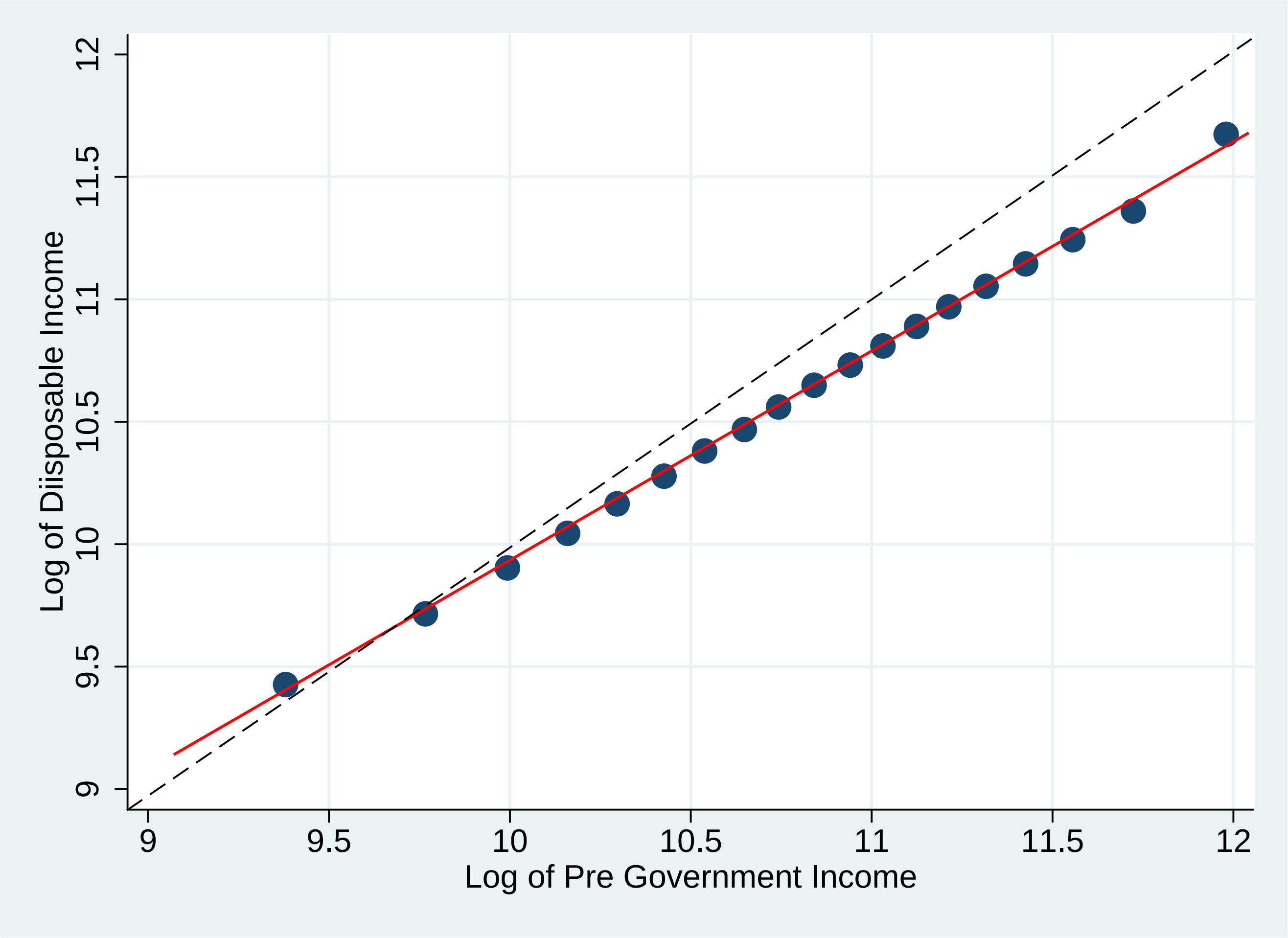
  - $\tau < 0:$ regressivity $\rightarrow \frac{T'(y)}{T(y)/y} < 1$
- Marginal tax rate monotone in earnings
- Negative average tax rates below $y^0 = \lambda^{\frac{1}{\tau}}$

Our model of fiscal redistribution



- CPS 2005, Nobs=52,539: $R^2 = 0.92$ and $\tau = 0.18$

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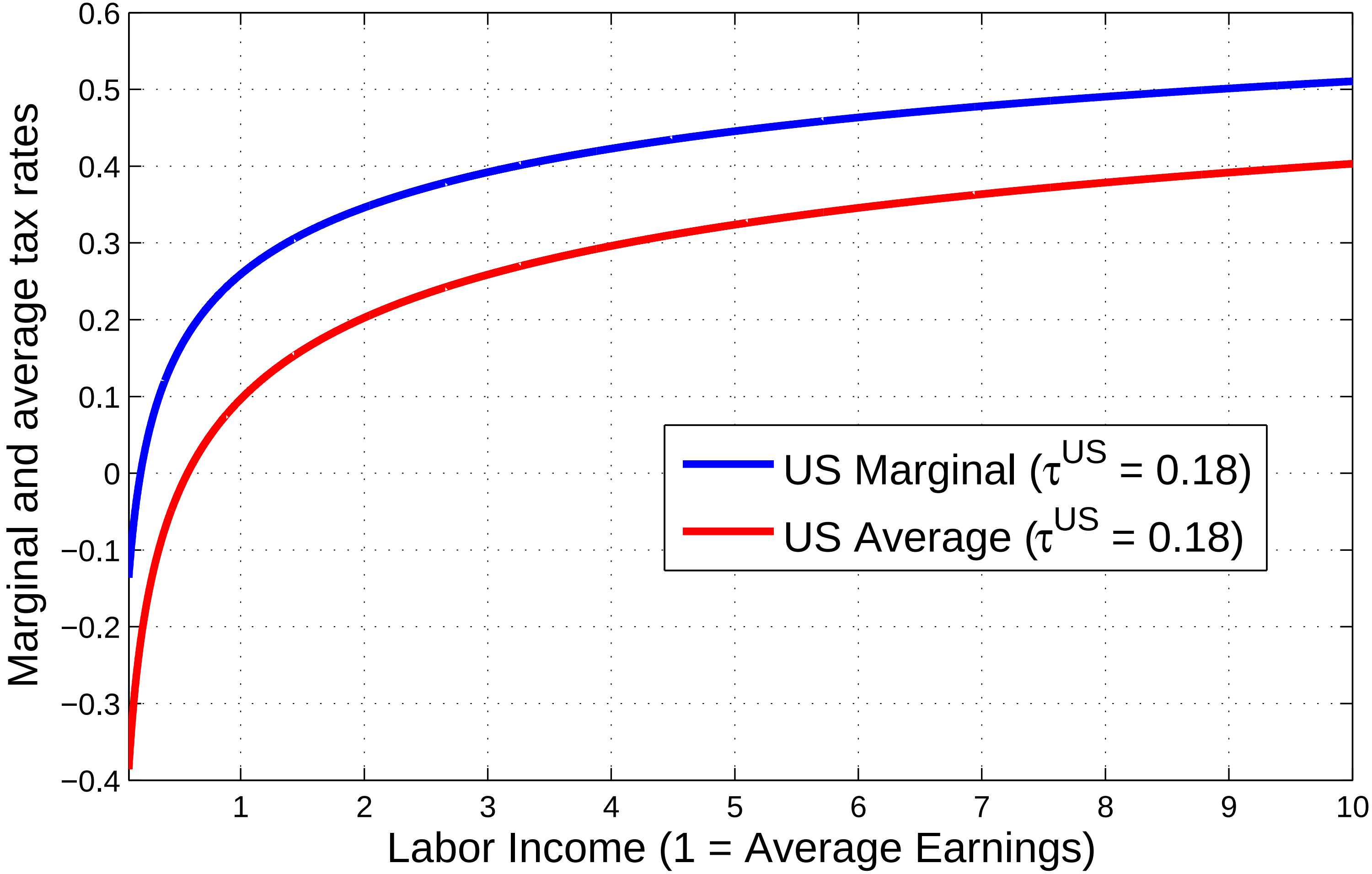

Recursive stationary equilibrium

- Given (G, τ), a stationary RCE is a value λ^*, asset prices $\{Q(\cdot), q\}$, skill prices $p(s)$, decision rules $s(\varphi, \kappa, 0)$, $c(\alpha, \varepsilon, \varphi, s, b)$, $h(\alpha, \varepsilon, \varphi, s, b)$, and aggregate quantities $N(s)$ such that:
  - households optimize
  - markets clear
  - the government budget constraint is balanced

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  - households optimize
  - markets clear
  - the government budget constraint is balanced
- The equilibrium features no bond-trading
  - $b = 0 \rightarrow$ allocations depend only on exogenous states
  - α shocks remain uninsured, ε shocks fully insured

No bond-trade equilibrium

- Micro-foundations for Constantinides and Duffie (1996)
  - CRRA, unit root shocks to log disposable income
  - In equilibrium, no bond-trade $\Rightarrow c_t = \tilde{y}_t$

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- Unit root disposable income micro-founded in our model:
  1. Skill investment+shocks: $\rightarrow$ wages
  2. Labor supply choice: wages $\rightarrow$ pre-tax earnings
  3. Non-linear taxation: pre-tax earnings $\rightarrow$ after-tax earnings
  4. Private risk sharing: after-tax earnings $\rightarrow$ disp. income
  5. No bond trade: disposable income = consumption

Equilibrium risk-free rate r^*

$$\rho - r^* = (1-\tau)\left((1-\tau)+1\right)\frac{v_\omega}{2}$$

- Intertemporal dissaving motive $=$ precautionary saving motive
- Key: precautionary saving motive common across all agents
- $\frac{\partial r^*}{\partial \tau} > 0$: more progressivity $\Rightarrow$ less precautionary saving $\Rightarrow$ higher risk-free rate

Equilibrium skill choice and skill price

- FOC $\rightarrow$ $\frac{s}{\kappa\mu} = (1-\beta\delta)\frac{\partial U_0(\varphi,s)}{\partial s} = (1-\tau)\frac{\partial \log p(s)}{\partial s}$

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

$$\pi_1 = \sqrt{\frac{\eta}{\theta\mu\,(1-\tau)}}$$

(return to skill)

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Offsetting effects of τ on s and $p(s)$ leave pre-tax inequality unchanged

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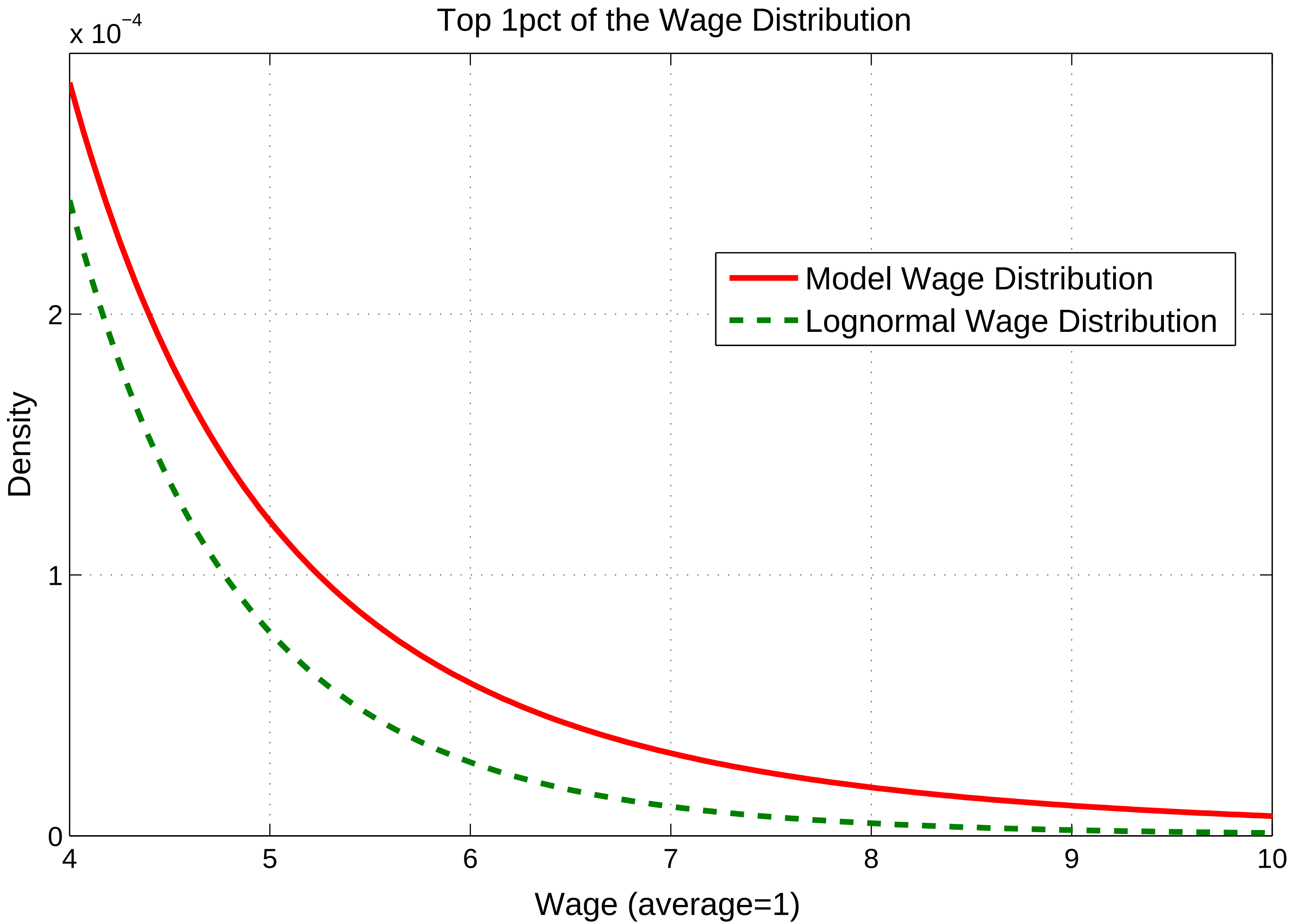
Offsetting effects of τ on s and $p(s)$ leave pre-tax inequality unchanged

- Distribution of skill prices (in level) is Pareto with parameter θ:

$$\frac{E[p(s)|s > s^*]}{p(s^*)} = \frac{\theta}{\theta - 1}$$

Upper tail of wage distribution



Equilibrium consumption allocation

$$
\begin{aligned}
\log c^*(\alpha, \varphi, s; G, \tau) \quad = \quad & \underbrace{\log \lambda^*(G, \tau) + \frac{1}{1+\hat{\sigma}} \log (1-\tau)}_{\text{C of representative agent}} \\
& + \qquad \underbrace{\mathcal{M}(v_\varepsilon)}_{\text{level effect from ins. variation}} \\
& + (1-\tau) \underbrace{\log p(s;\tau)}_{\text{skill price}} \\
& \underbrace{-(1-\tau)\,\varphi}_{\text{pref. het.}} + \underbrace{(1-\tau)\,\alpha}_{\text{unins. shock}}
\end{aligned}
$$

- Response to variation in $(p(s), \varphi, \alpha)$ mediated by progressivity
- Invariant to insurable shock ε

Equilibrium hours allocation

$$\log h^*(\varepsilon, \varphi; G, \tau) = \underbrace{\frac{1}{(1-\tau)(\widehat{\sigma}+1)} \log(1-\tau)}_{\text{H of representative agent}}$$

$$- \underbrace{\frac{1}{\widehat{\sigma}(1-\tau)} \mathcal{M}(v_\varepsilon)}_{\text{level effect from ins. variation}}$$

$$- \underbrace{\varphi}_{\text{pref. het.}}$$

$$+ \underbrace{\frac{1}{\widehat{\sigma}} \varepsilon}_{\text{ins. shock}}$$

- Response to ε mediated by tax-modified Frisch elasticity $\frac{1}{\hat{\sigma}} = \frac{1-\tau}{\sigma+\tau}$
- Invariant to skill price $p(s)$ and uninsurable shock α

Utilitarian Social Welfare Function

- Steady states with constant (G, τ)

$$\mathcal{W}(G,\tau) \propto \sum_{k=-\infty}^{\infty} \mu_k \int_0^1 U_{i,k}(\cdot; G, \tau) di$$

- Government sets weights: $\mu_k = \beta^k \times$ cohort size
  - SWF becomes average period utility in the cross-section
  - Skill acquisition cost for those currently alive imputed to SWF proportionally to their remaining lifetime

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  - Skill acquisition cost for those currently alive imputed to SWF proportionally to their remaining lifetime
- WLOG, government chooses $g = G/Y$

Exact expression for SWF

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

Representative Agent component

$$
\begin{aligned}
\mathcal{W}(g,\tau) \quad = \quad & \underbrace{\log(1+g)+\chi\log g+(1+\chi)\frac{\log(1-\tau)}{(1+\hat{\sigma})(1-\tau)}-\frac{1}{(1+\hat{\sigma})}}_{\text{Representative Agent Welfare} = \mathcal{W}^{RA}(g,\tau)} \\
& +(1+\chi)\left[\frac{-1}{\theta-1}\log\left(\sqrt{\frac{\eta\theta}{\mu(1-\tau)}}\right)+\frac{\theta}{\theta-1}\log\left(\frac{\theta}{\theta-1}\right)\right] \\
& -\frac{1}{2\theta}(1-\tau)-\left[-\log\left(1-\left(\frac{1-\tau}{\theta}\right)\right)-\left(\frac{1-\tau}{\theta}\right)\right] \\
& -(1-\tau)^2\frac{v_\varphi}{2} \\
& -\left[(1-\tau)\frac{\delta}{1-\delta}\frac{v_\omega}{2}-\log\left(\frac{1-\delta\exp\left(\frac{-\tau(1-\tau)}{2}v_\omega\right)}{1-\delta}\right)\right] \\
& -(1+\chi)\sigma\frac{1}{\hat{\sigma}^2}\frac{v_\varepsilon}{2}+(1+\chi)\frac{1}{\hat{\sigma}}v_\varepsilon
\end{aligned}
$$

Representative Agent

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

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

- Welfare maximizing (g,τ) pair:

$$
\begin{aligned}
g^* &= \frac{\chi}{1+\chi} \\
\tau^* &= -\chi
\end{aligned}
$$

- Allocations are first best

Exact expression for SWF

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

Skill investment component

$$\mathcal{W}(\tau) = \chi\log\chi - (1+\chi)\log(1+\chi) + (1+\chi)\frac{\log(1-\tau)}{(1+\hat{\sigma})(1-\tau)} - \frac{1}{(1+\hat{\sigma})}$$

$$+(1+\chi)\underbrace{\left[\frac{-1}{\theta-1}\log\left(\sqrt{\frac{\eta\theta}{\mu(1-\tau)}}\right) + \frac{\theta}{\theta-1}\log\left(\frac{\theta}{\theta-1}\right)\right]}_{\text{productivity gain} = \log E[(p(s))] = \log(Y/N)}$$

$$\underbrace{-\frac{1}{2\theta}(1-\tau)}_{\text{avg. education cost}} - \underbrace{\left[-\log\left(1-\left(\frac{1-\tau}{\theta}\right)\right) - \left(\frac{1-\tau}{\theta}\right)\right]}_{\text{consumption dispersion across skills}}$$

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

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

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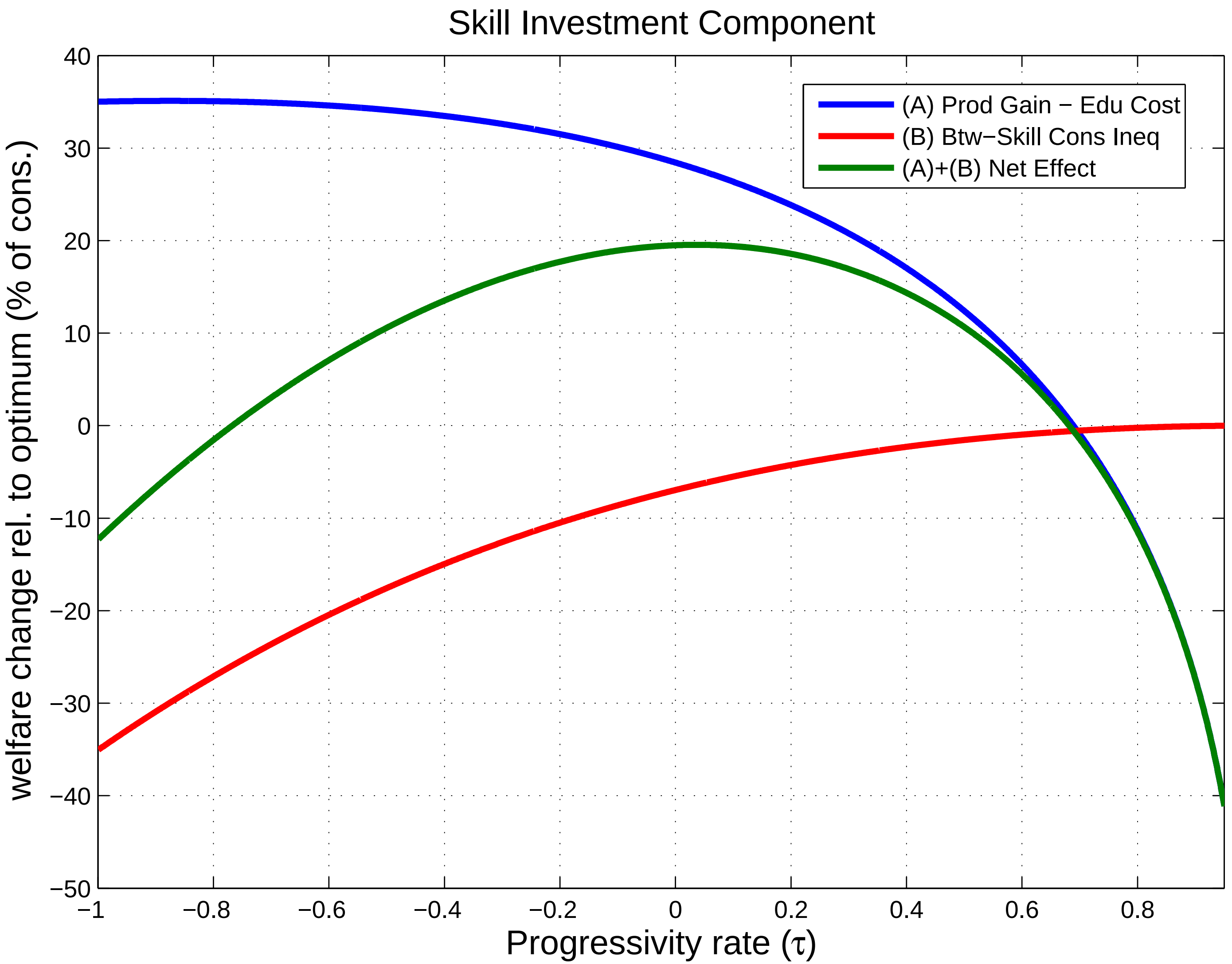
Skill investment component



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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& -\frac{1}{2\theta}(1-\tau) - \left[-\log\left(1-\left(\frac{1-\tau}{\theta}\right)\right) - \left(\frac{1-\tau}{\theta}\right)\right] \\
& - \quad \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}} \\
& -(1+\chi)\sigma\frac{1}{\hat{\sigma}^2}\frac{v_\varepsilon}{2} + (1+\chi)\frac{1}{\hat{\sigma}}v_\varepsilon
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& - \quad \underbrace{(1-\tau)^2\,\frac{v_\varphi}{2}}_{\text{cons. disp. due to prefs}} \\
& - \underbrace{(1-\tau)^2\,\frac{\delta}{1-\delta}\frac{v_\omega}{2}}_{\approx \quad (1-\tau)^2 v_\alpha} \\
& -(1+\chi)\sigma\frac{1}{\hat{\sigma}^2}\frac{v_\varepsilon}{2} + (1+\chi)\frac{1}{\hat{\sigma}}v_\varepsilon
\end{aligned}
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Insurable component

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

Parameterization

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

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

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- To match $G/Y = 0.20$: $\rightarrow \chi = 0.25$
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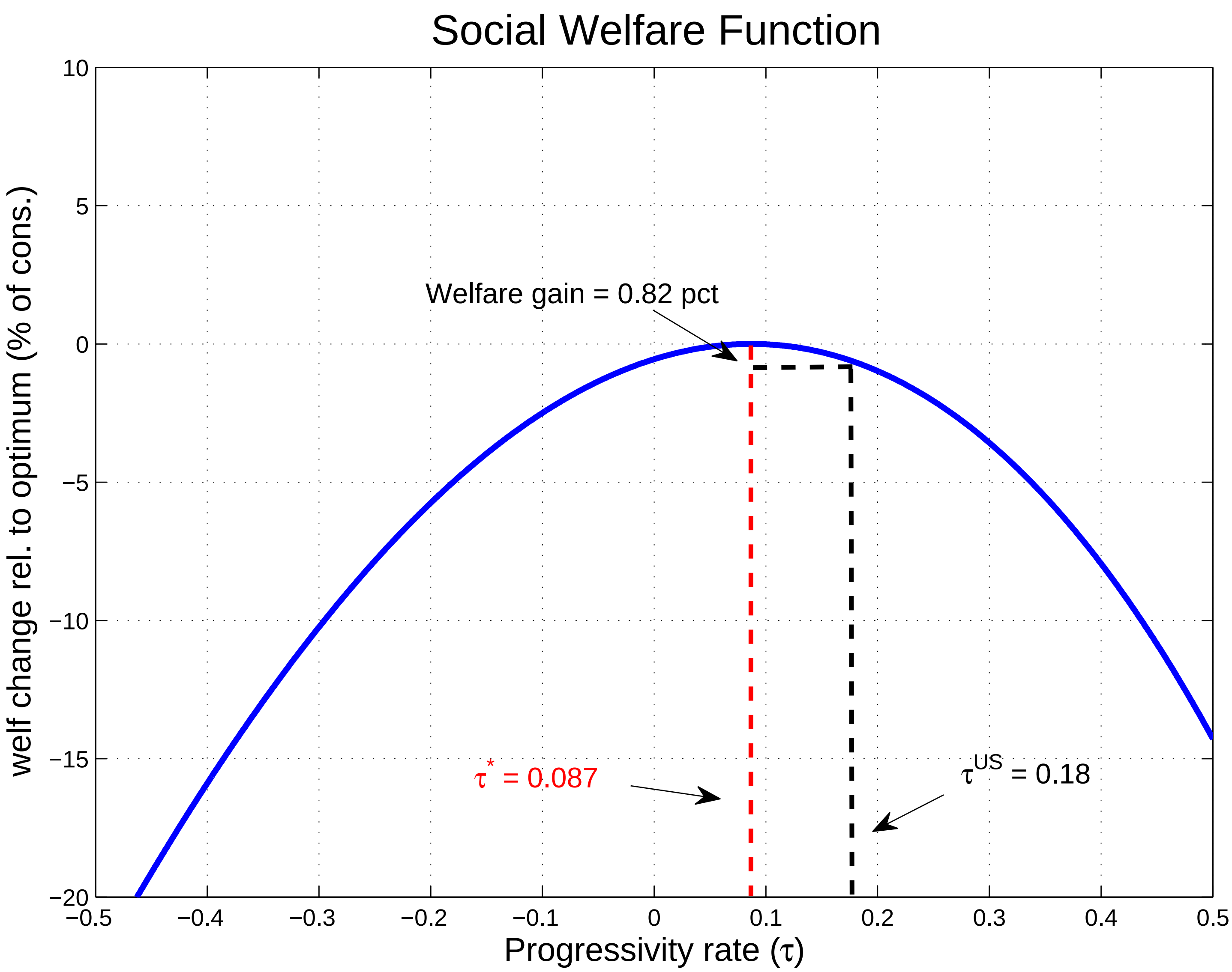
$$
\begin{aligned}
cov(\log h, \log w) &= \frac{1}{\hat{\sigma}} v_\varepsilon \\
var(\log h) &= v_\varphi + \frac{1}{\hat{\sigma}^2} v_\varepsilon \\
var^0(\log c) &= v_\varphi + \frac{1}{\theta^2} \\
var(\log w) &= \frac{1}{\theta^2} + v_\alpha + v_\varepsilon \\
\Delta var(\log w) &= v_\omega
\end{aligned}
$$

Parameterization

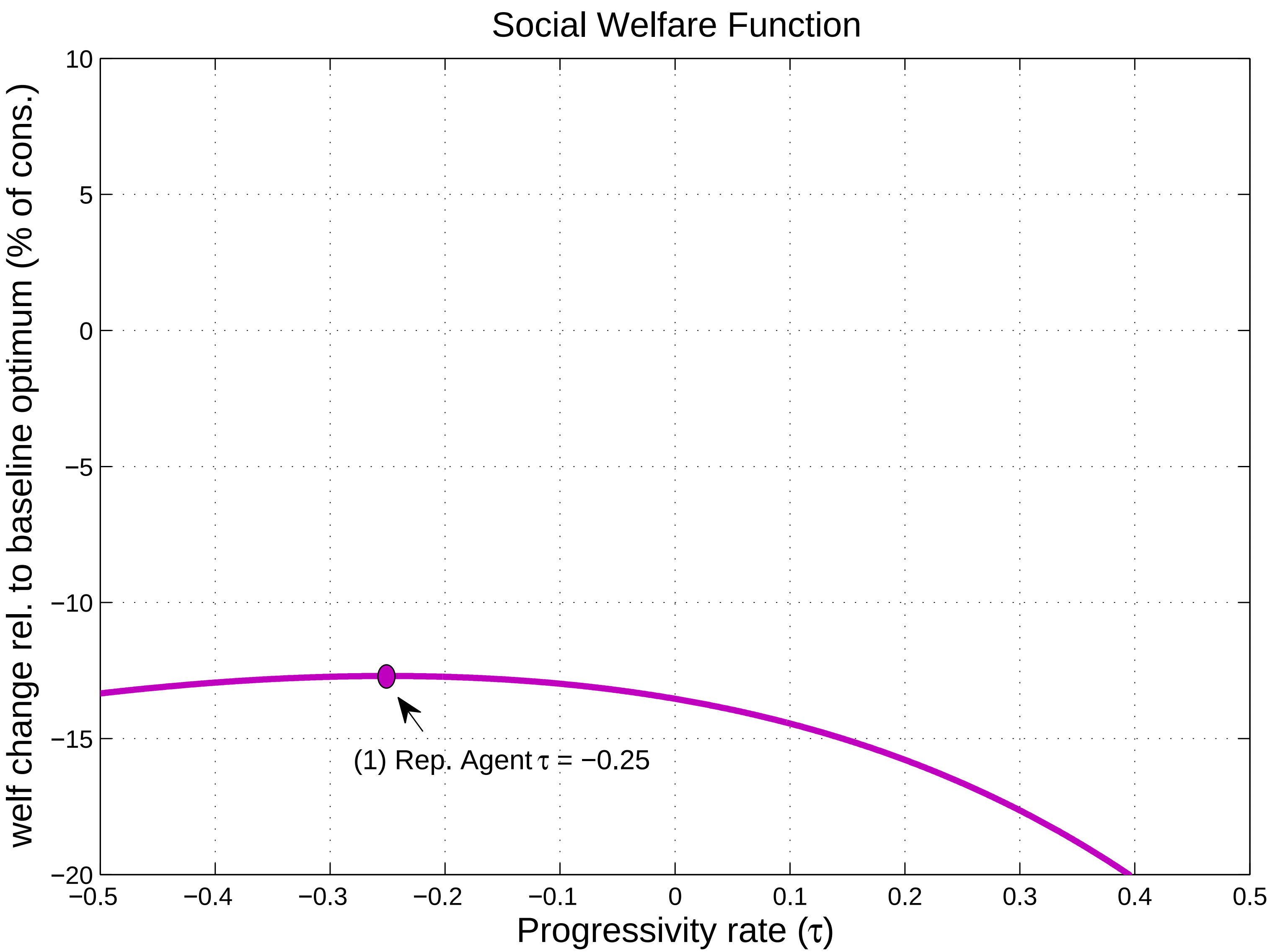
- Parameter vector $\{\chi, \sigma, \delta, \theta, v_\varphi, v_\omega, v_\varepsilon, \}$
- To match $G/Y = 0.20$: $\rightarrow \chi = 0.25$
- Frisch elasticity (micro-evidence): $\rightarrow \sigma = 2$

$$
\begin{aligned}
cov(\log h, \log w) &= \frac{1}{\hat{\sigma}} v_\varepsilon && \rightarrow v_\varepsilon = 0.18 \\
var(\log h) &= v_\varphi + \frac{1}{\hat{\sigma}^2} v_\varepsilon && \rightarrow v_\varphi = 0.06 \\
var^0(\log c) &= v_\varphi + \frac{1}{\theta^2} && \rightarrow \theta = 3 \\
var(\log w) &= \frac{1}{\theta^2} + v_\alpha + v_\varepsilon && \rightarrow v_\alpha = 0.13 \\
\Delta var(\log w) &= v_\omega && \rightarrow v_\omega = 0.005, \delta = 0.963
\end{aligned}
$$

Optimal progressivity



Optimal progressivity: decomposition



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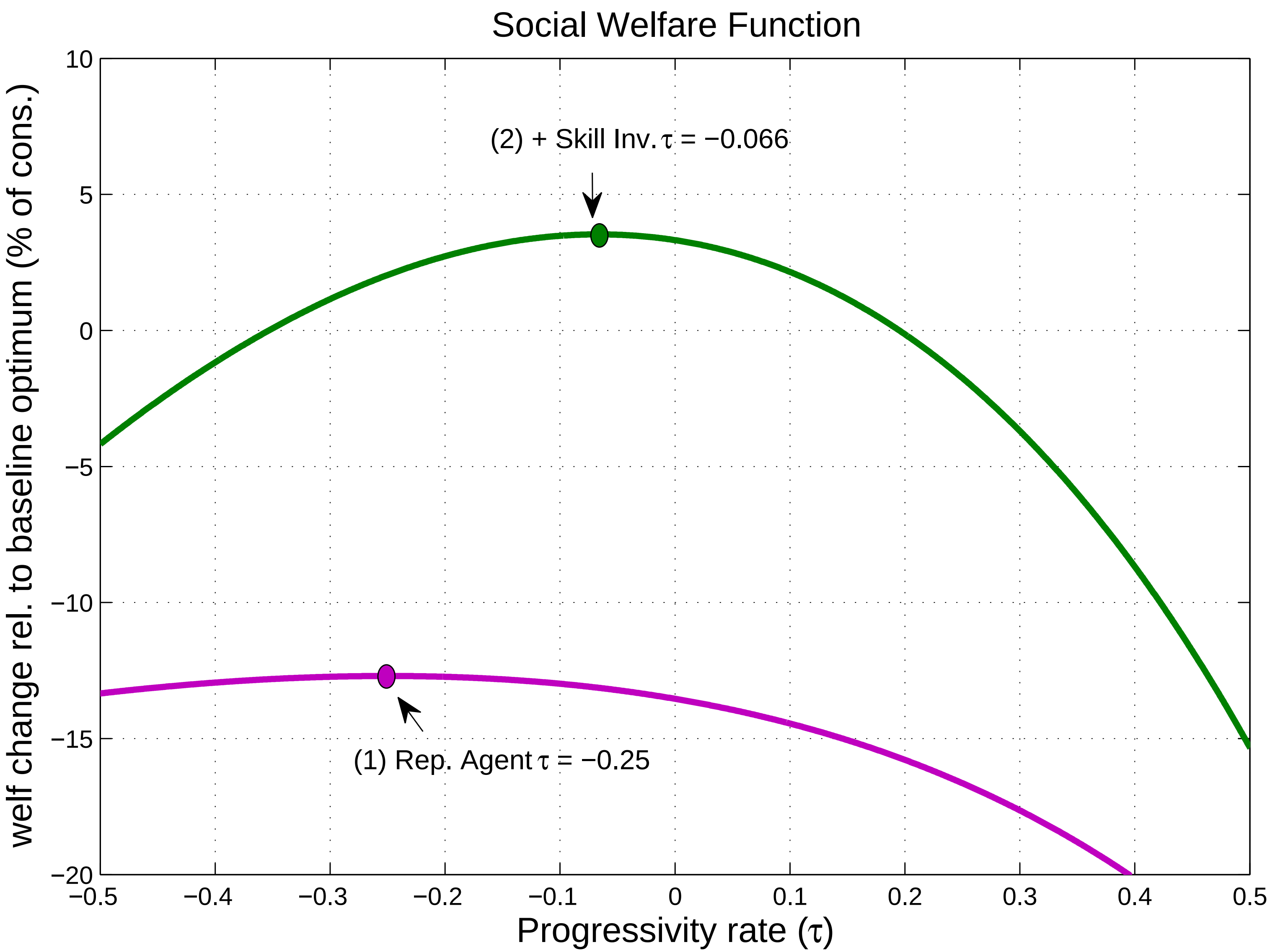

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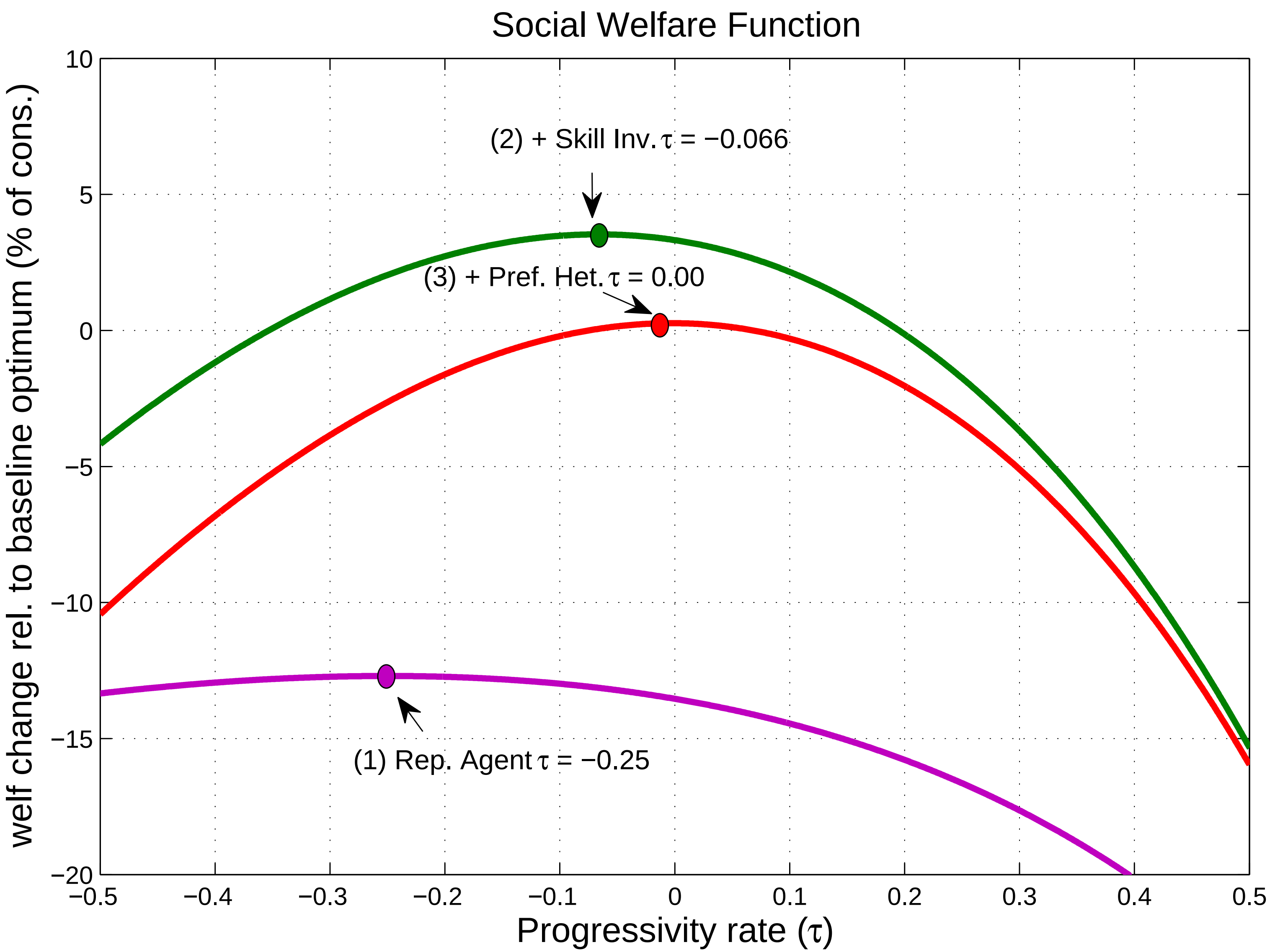

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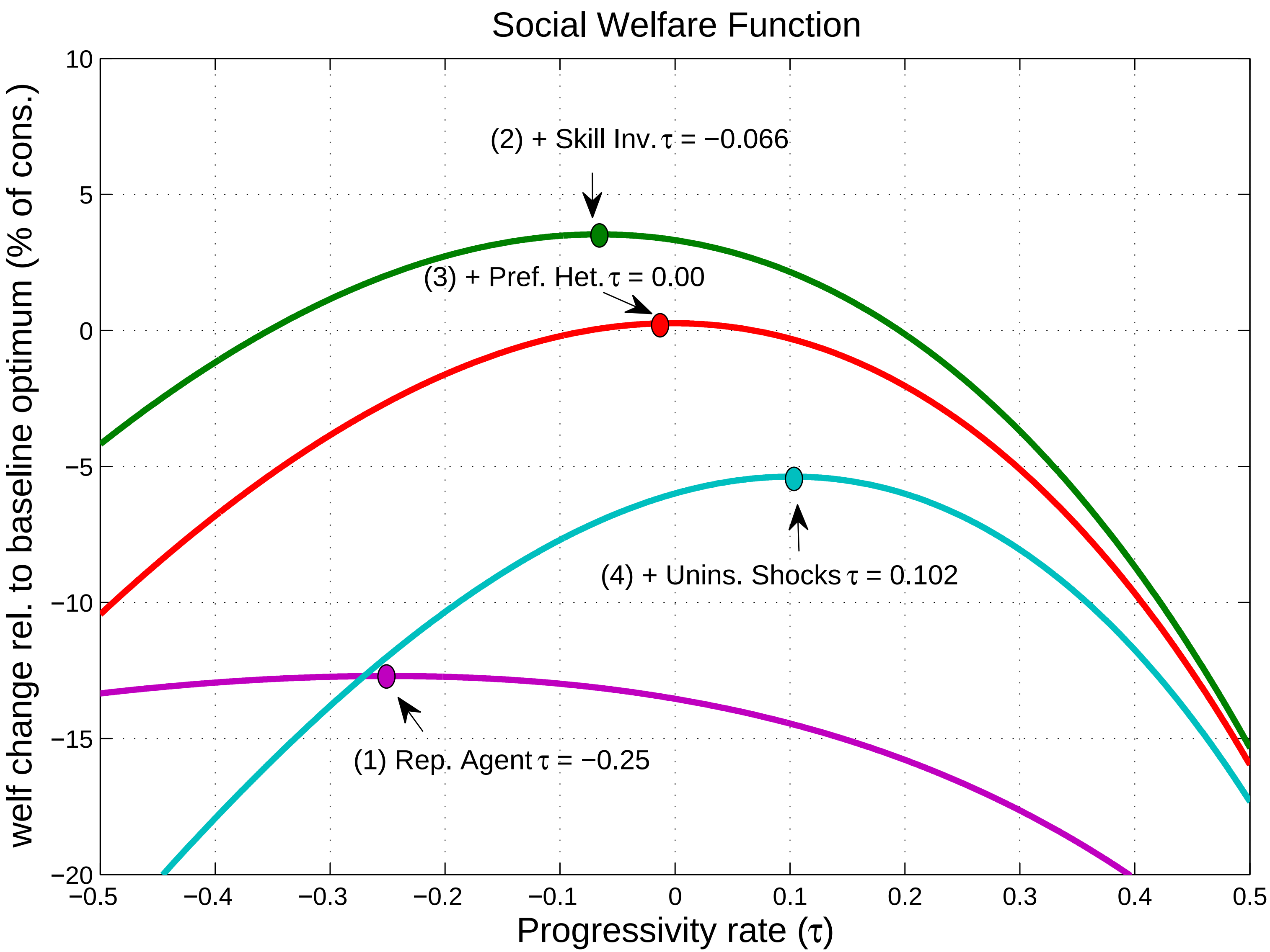

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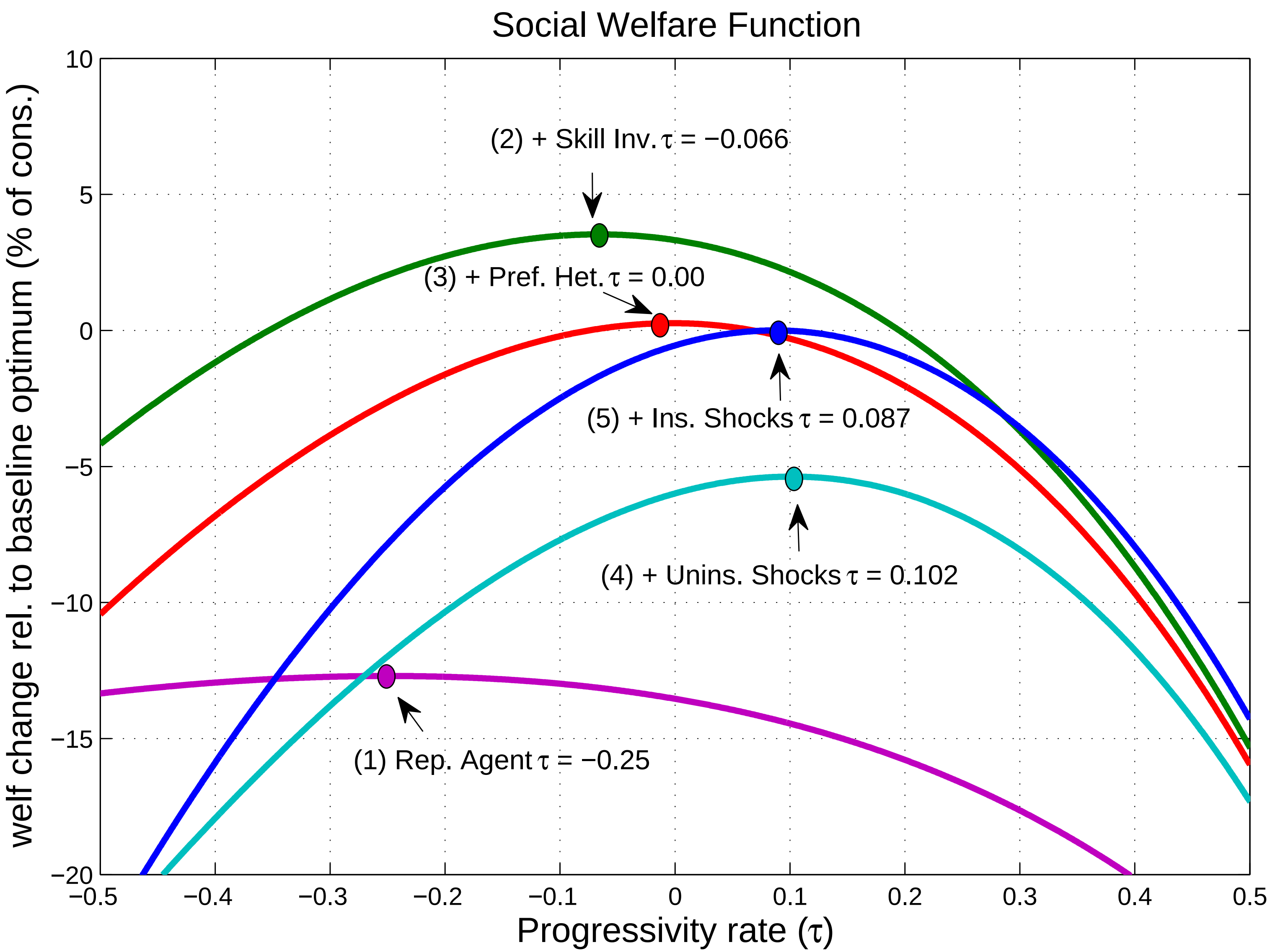

Alternative SWF

Utilitarian SWF embeds desire to insure and to redistribute wrt (κ, φ)

Isolate desire to insure against ω shocks

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Utilitarian SWF embeds desire to insure and to redistribute wrt (κ, φ)

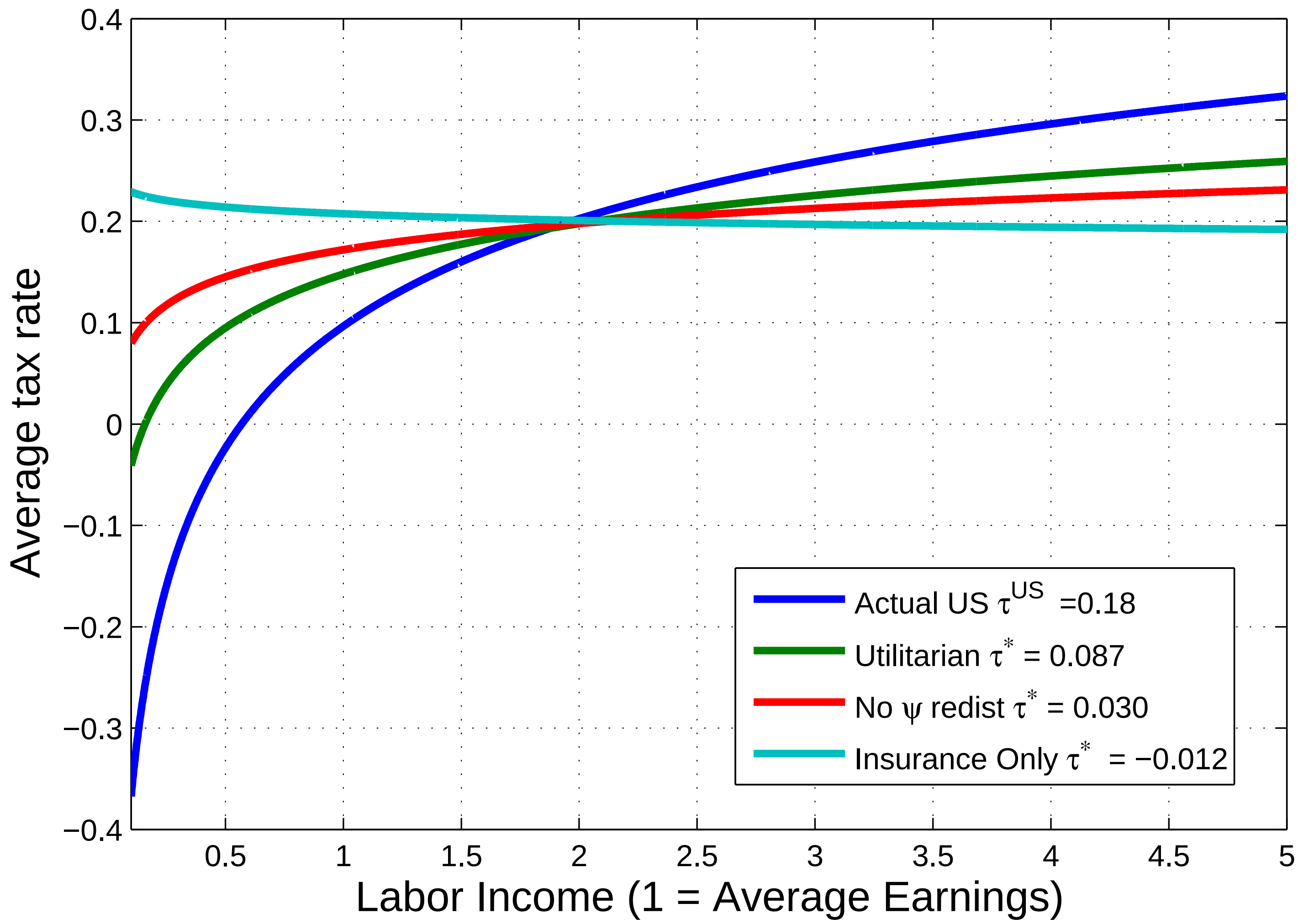
Isolate desire to insure against ω shocks

- Economy with heterogeneity in (κ, φ), and $\chi = v_\omega = \tau = 0$
- Compute CE allocations
- Compute Negishi weights s.t. planner's allocation $=$ CE
- Use these weights in the SWF

Alternative SWF

	Utilitarian	κ-neutral	φ-neutral	Insurance-only
Redist. wrt κ	Y	N	Y	N
Redist. wrt φ	Y	Y	N	N
Insurance wrt ω	Y	Y	Y	Y
τ^*	0.087	0.046	0.030	-0.012
Welf. gain (pct of c)	0.82	1.33	1.66	2.67

Optimal progressivity: alternative SWF



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1. G endogenous and valued: $\chi = 0.25$, $G^* = \chi/(1+\chi) = 0.2$

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			Utilitarian SWF	Insurance-only SWF
		$\frac{G}{Y(\tau^*)}$	τ^*	τ^*
G endogenous	$\chi = 0.25$	0.200	0.087	-0.012
G endogenous	$\chi = 0$	0.000	0.209	0.103
g exogenous	$\bar{g} = 0.2$	0.200	0.209	0.103
G exogenous	$\bar{G} = 0.2 \times Y(\tau^{US})$	0.188	0.095	0.002

Progressive consumption taxation

$$c = \lambda \tilde{c}^{1-\tau}$$

where c are expenditures and $\tilde{c}$ are units of final good

- Implement as a tax on total (labor plus asset) income less saving
- Consumption depends on α but not on ε
- Can redistribute wrt. uninsurable shocks without distorting the efficient response of hours to insurable shocks
- Higher progressivity and higher welfare