Redistributive Taxation in a Partial-Insurance Economy

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Taxation

Two classic roles for government taxation:

1. Provision of public goods

2. Redistribution / insurance

At the same time, the design of taxes and transfers must be sensitive to private incentives

In light of these objectives, how progressive should the tax system be?
More specifically

• How does the optimal rate of progressivity depend upon...

  1. the elasticity of labor supply

  2. the level of inequality in the economy

  3. the amount of risk and privately-provided insurance

  4. the desire for consuming public goods
More specifically

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• Our contribution: tractable framework that delivers insights on the trade-offs
Approach: Ramsey problem with incomplete markets

- Take tax instruments and market structure as given

- Generalization:
  1. nonlinear tax/transfer system (no lump-sum taxes)
  2. endogenous choice of G
  3. heterogeneous agents and incomplete markets ⇒ redistributive motive

  - HSV vs. Conesa-Krueger and Bohacek-Kejak: more restrictive tax function, but analytical solution
The Model (H-S-V, 2009)

- **Equilibrium heterogeneous-agents model** featuring:
  1. differential labor productivity + idiosyncratic productivity risk
  2. flexible labor supply and risk-free bond (*self-insurance*)
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  2. flexible labor supply and risk-free bond (*self-insurance*)
  3. additional risk-sharing (financial markets, family, etc.)
  4. nonlinear tax/transfer system
  5. government expenditures valued by households
Technology and resource constraint

• Aggregate technology *linear* in effective labor:

\[ Y = \int w_i h_i di \equiv \int y_i di \]

• Resource constraint:

\[ Y = \int c_i di + G \]
Demographics and preferences

• **Perpetual youth** demographics with constant survival probability $\delta$
Demographics and preferences

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- **Preferences** over sequences of private consumption, hours worked, and public good:

$$U(c_i, h_i, G) = \mathbb{E}_0 \sum_{t=0}^{\infty} (\beta \delta)^t u(c_{it}, h_{it}, G_t)$$

- with period-utility:

$$u(c_{it}, h_{it}, G_t) = \frac{c_{it}^{1-\gamma} - 1}{1 - \gamma} - \tilde{\phi} \frac{h_{it}^{1+\sigma}}{1 + \sigma} + \chi \frac{G_t^{1-\gamma} - 1}{1 - \gamma}$$
Individual labor productivity

- Individual endowments of **efficiency units** of labor:

\[
\ln w_{it} = \alpha_{it} + \varepsilon_{it}
\]
Individual labor productivity

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\[ \ln w_{it} = \alpha_{it} + \varepsilon_{it} \]

\( \alpha_{it} \) component follows unit root process

\[ \alpha_{it} = \alpha_{i,t-1} + \omega_{it} \quad \text{with} \quad \omega_{it} \sim F_{\omega} \quad \text{and} \quad \alpha_{i0} \sim F_{\alpha_0} \]
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- \( \varepsilon_{it} \) component is transitory

\[ \varepsilon_{it} \quad \text{i.i.d.} \quad \text{with} \quad \varepsilon_{it} \sim F_{\varepsilon} \]
Financial and insurance markets

- **Assets traded competitively** (all in zero net supply)
  - Perfect annuity against survival risk
  - Non-contingent bond
  - Complete markets for $\varepsilon$ shocks
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  - Complete markets for $\varepsilon$ shocks

- **Market structure**
  - $v_\varepsilon = 0 \Rightarrow$ bond economy
  - $v_\alpha = 0 \Rightarrow$ full insurance
  - In between: “partial insurance”
Government

• Two-parameter tax/transfer function to redistribute/insure and finance public good $G$
Government

- **Two-parameter tax/transfer function** to redistribute/insure and finance public good $G$

- Disposable post-government earnings:

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

- Government budget constraint (no government debt):

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

  ▶ Given $(G, \tau)$, $\lambda$ balances the budget in equilibrium
Our model of fiscal redistribution

• The parameter $\tau$ measures the rate of progressivity:

$$\ln(\tilde{y}_i) = const + (1 - \tau) \ln(y_i)$$

1. $\tau = 0 \rightarrow \tilde{y}_i = \lambda y_i$: no redistribution, i.e. flat tax $(1 - \lambda)$

2. $\tau = 1 \rightarrow \tilde{y}_i = \lambda$: full redistribution
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2. $\tau = 1 \rightarrow \tilde{y}_i = \lambda$: full redistribution

- Then, if $\tau > 0$:

1. The system is progressive:

$$\frac{T'(y)}{T(y)/y} = \frac{1 - \lambda(1 - \tau)y^{-\tau}}{1 - \lambda y^{-\tau}} > 1 \quad \forall y$$

2. The system generates a transfer $(\tilde{y}_i > y_i)$ for low earnings
Empirical relevance of our model for taxes / transfers


- Estimated slope of model line ($R^2 = 0.88$) yields $\tau = 0.26$
Empirical relevance of our model for taxes / transfers


- Estimated slope of model line \((R^2 = 0.88)\) yields \(\tau = 0.26\)

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**Fiscal Progressivity in Year 2000**

- Data
- Model
Household’s Problem

\[ V(\alpha, b) = \max_{c,h,b',B(\cdot)} \int_{\mathcal{E}} \left[ u(c, h, G) + \delta \beta \int_{\Omega} V(\alpha + \omega, b') dF_\omega \right] dF_\varepsilon \]

subject to

\[ \int_{\mathcal{E}} Q(\cdot) B(\cdot) d\varepsilon = b \]

\[ c + q \delta b' = B(\varepsilon) + \lambda \cdot (\exp(\alpha + \varepsilon) h)^{1-\tau} \quad \forall \varepsilon \]

\[ c \geq 0, \quad h \geq 0, \quad b' \geq B \]

\[ b_0 = 0 \]

A stationary equilibrium is a set of prices \((q, Q(\cdot))\) and a policy \((G, \tau, \lambda)\) s.t. (i) agents take these as given and optimize, (ii) markets clear, and (iii) the government budget is balanced.
“No bond trading” equilibrium

• In equilibrium, agents choose not to save/borrow, and individual allocations only depend on \((\alpha, \varepsilon)\)
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• Generalization of Constantinides and Duffie (JPE, 1996) who assume unit root shocks to log-disposable income
“No bond trading” equilibrium

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- Generalization of Constantinides and Duffie (JPE, 1996) who assume unit root shocks to log-disposable income

- Our environment micro-founds I(1) disposable income:
  1. Individual wage process richer than unit root
  2. Flexible labor supply \(\Rightarrow\) earnings endogenous
  3. Private risk sharing
  4. Non-linear taxation and transfers
Equilibrium risk-free rate $r^*$

- Under log-normality of the shocks, closed form for $r^*$
- With inelastic labor ($\sigma = \infty$) and linear taxes ($\tau = 0$):

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

where $(\gamma + 1)$ is the coefficient of relative prudence
Equilibrium risk-free rate $r^*$

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- With inelastic labor ($\sigma = \infty$) and linear taxes ($\tau = 0$):

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

where $(\gamma + 1)$ is the coefficient of relative prudence

- With inelastic labor and non-linear taxes ($\tau \neq 0$):

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

- $\frac{\partial r^*}{\partial \tau} > 0$: more progressivity $\Rightarrow$ more government insurance $\Rightarrow$ less precautionary saving $\Rightarrow$ higher risk-free rate
Equilibrium allocations: hours worked

\[
\ln h^*(\alpha, \varepsilon) = \frac{1}{(1 - \tau)(\hat{\sigma} + \gamma)} [(1 - \gamma) \ln \lambda^* + \ln(1 - \tau) - \varphi]
\]

- Representative agent
- Wealth effect
- Unins. shock
- Insurable shock
Equilibrium allocations: hours worked

\[ \ln h^* (\alpha, \varepsilon) = \frac{1}{(1 - \tau)(\hat{\sigma} + \gamma)} \left[ (1 - \gamma) \ln \lambda^* + \ln(1 - \tau) - \varphi \right] \]

- **Representative agent**
- **Wealth effect**
  \[ - M_h(v_\varepsilon) \]
- **Unins. shock**
  \[ \frac{1 - \gamma}{\hat{\sigma} + \gamma} \alpha \]
- **Insurable shock**
  \[ \frac{1}{\hat{\sigma}} \varepsilon \]

- **Tax-modified Frisch elasticity** (decreasing in \( \tau \)):
  \[ \frac{1}{\hat{\sigma}} \equiv \frac{1 - \tau}{\sigma + \tau} \]

- **\( \gamma \)** measures the relative strength of income vs. substitution effect for uninsurable shocks
Equilibrium allocations: consumption

$$\ln c^*(\alpha) = \frac{1}{\hat{\sigma} + \gamma} \left[ (1 + \hat{\sigma}) \ln \lambda^* + \ln(1 - \tau) - \varphi \right]$$

Representative agent

$$+ M_c(v_\varepsilon) + \pi(\gamma, \sigma, \tau)\alpha$$

Wealth effect Uninsurable shocks
Equilibrium allocations: consumption

\[ \ln c^*(\alpha) = \frac{1}{\sigma + \gamma} \left[ (1 + \hat{\sigma}) \ln \lambda^* + \ln(1 - \tau) - \phi \right] \]

Representative agent

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Wealth effect Uninsurable shocks

• The transmission coefficient of a permanent uninsured shock:

\[ \pi(\gamma, \sigma, \tau) = (1 - \tau) \left[ \frac{\sigma + \gamma}{\sigma + \gamma + \tau (1 - \gamma)} \right] \]

TAX PROGRESSIVITY LABOR SUPPLY

Heathcote-Storesletten-Violante, "Redistributive Taxation" – p. 17/34
Equilibrium allocations: consumption

$$\ln c^*(\alpha) = \frac{1}{\hat{\sigma} + \gamma} [(1 + \hat{\sigma}) \ln \lambda^* + \ln(1 - \tau) - \varphi]$$

Representative agent

$$+ \underbrace{M_c(v_{\varepsilon})}_{\text{Wealth effect}} + \underbrace{\pi(\gamma, \sigma, \tau)\alpha}_{\text{Uninsurable shocks}}$$

• The transmission coefficient of a permanent uninsured shock:

$$\pi(\gamma, \sigma, \tau) = (1 - \tau) \left[ \frac{\sigma + \gamma}{\sigma + \gamma + \tau(1 - \gamma)} \right] \frac{\sigma + 1}{\sigma + \gamma}$$

TAX PROGRESSIVITY LABOR SUPPLY

• Quantitatively ($\gamma = \sigma = 2, \tau = 0.26$):

$$0.60 = 0.74 \times 1.07 = 0.79 \times 0.75$$
Government’s problem

• \((F_\alpha, F_\varepsilon)\) are the aggregate states, exogenous and time-invariant: given \((\tau, G)\), economy is in a stationary no bond-trade equilibrium

• Government puts weight \(\beta^t\) on the welfare of all agents born at dates \(t = -\infty, ..., \infty\), and chooses a pair \((\tau, G)\)

• The Social Welfare Function becomes:

\[
W(\tau, G) \equiv \frac{1}{1 - \beta} \int \int u(c^*(\alpha; \tau, G), h^*(\alpha, \varepsilon; \tau, G), G) \, dF_\varepsilon dF_\alpha
\]
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- The government chooses the pair \((\tau, G)\) to maximize \(W(\tau, G)\) subject to: (i) \((c^*, h^*)\) are competitive equilibrium allocations; and (ii) the government budget constraint is satisfied.
Roadmap for welfare analysis

- Assumption: log-normal shocks

- Assumption: log-utility over private and public goods ($\gamma = 1$)
Roadmap for welfare analysis

- Assumption: log-normal shocks

- Assumption: log-utility over private and public goods ($\gamma = 1$)

1. No utility from public goods ($\chi = 0$)
   - Instrument chosen: $\tau$

2. Valued $G$ ($\chi > 0$)
   - Instruments chosen: $(\tau, G)$
Social welfare function \((\chi = 0)\)

- **Representative agent** \((v_\alpha = 0, v_\varepsilon = 0)\):

\[
W^{RA}(\tau) = -\varphi + \frac{\ln(1 - \tau) - (1 - \tau)}{1 + \sigma}
\]

- Welfare maximizing progressivity: \(\tau^* = 0\)
Social welfare function \((\chi = 0)\)

- **Representative agent** \((v_\alpha = 0, v_\varepsilon = 0)\):

  \[
  \mathcal{W}^{RA}(\tau) = -\varphi + \frac{\ln(1 - \tau) - (1 - \tau)}{1 + \sigma}
  \]

  ▶ Welfare maximizing progressivity: \(\tau^* = 0\)

- **Heterogeneous agents** \((v_\alpha > 0, v_\varepsilon > 0)\):

  \[
  \mathcal{W}(\tau) = \mathcal{W}^{RA}(\tau) + \frac{1}{\hat{\sigma}} v_\varepsilon \left( \frac{1}{\hat{\sigma}^2} \right) \frac{v_\varepsilon}{2} - \left(1 - \tau\right)^2 \frac{v_\alpha}{2}
  \]

  \[
  \ln(Y/H) \quad \text{var}(\ln h) \quad \text{var}(\ln c)
  \]
Comparative statics on the optimal progressivity rate
Comparative statics on the optimal progressivity rate

• $\mathcal{W}(\tau)$ is globally concave in $\tau$ if $\sigma \geq 2$
Comparative statics on the optimal progressivity rate

- \( W(\tau) \) is globally concave in \( \tau \) if \( \sigma \geq 2 \)

- \( \frac{\partial \tau^*}{\partial v_\alpha} > 0 \): more uninsurable risk \( \Rightarrow \) more public insurance

- \( \frac{\partial W(\tau)}{\partial \tau} \bigg|_{\tau=0} > 0 \) iff \( v_\alpha > 0 \) \( \Rightarrow \) strictly positive solution for \( \tau^* \)
Comparative statics on the optimal progressivity rate

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- $\frac{\partial \tau^*}{\partial v_{\alpha}} > 0$: more uninsurable risk $\Rightarrow$ more public insurance

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- $\frac{\partial \tau^*}{\partial \sigma} > 0$: less elastic labor supply $\Rightarrow$ less severe distortions
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• $\frac{\partial \tau^*}{\partial v_\varepsilon} < 0$: more insurable risk $\Rightarrow$ more severe distortions
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- $\frac{\partial \tau^*}{\partial v_\varepsilon} < 0$: more insurable risk $\Rightarrow$ more severe distortions

- $\frac{\partial \tau^*}{\partial \varphi} = 0$: independent of the disutility of work
Optimal progressivity with $\chi = 0$

Parameterization: $\sigma = 2, v_\alpha = v_\varepsilon = 0.14 \Rightarrow \tau^*(\sigma, v_\alpha, v_\varepsilon) = 0.21$
Valued government consumption: $\chi > 0$

- Define $g \equiv G/Y$

- Welfare of the representative agent ($v_\alpha = v_\varepsilon = 0$):

\[
\mathcal{W}^{RA}(\tau, g) = -(1 + \chi)\varphi + \frac{(1 + \chi) \ln (1 - \tau) - (1 - \tau)}{1 + \sigma} + \ln(1 - g) + \chi \ln g
\]

- Welfare-maximizing fiscal policy is given by the pair:

\[
g^* = \frac{\chi}{1 + \chi} \quad \text{Samuelson’s condition}
\]

\[
\tau^* = -\chi \quad \text{Regressive taxation}
\]
Intuition

- Allocations $(C^*, H^*, G^*)$ induced by $(g^*, \tau^*)$ are first best
Intuition

- **Allocations** $(C^*, H^*, G^*)$ induced by $(g^*, \tau^*)$ are **first best**

- **Optimal regressivity** $(\tau^* = -\chi)$ achieves both:
  - desired **average tax rate** (to finance $G$)
  - zero marginal tax rate at $H^*$ (as with a lump-sum tax)

- **Public good externality**: $H^*$ is larger than it would be absent taxes: taxation is used to increase hours worked to socially efficient level
Valued govt. consumption and heterogeneity

\[ W(\tau, g) = W^{RA}(\tau, g) + (1 + \chi) \left[ \frac{1}{\hat{\sigma}} \nu_\varepsilon \right. \left. \ln\left(\frac{Y}{H}\right) - \sigma \left(\frac{1}{\hat{\sigma}^2}\right) \frac{\nu_\varepsilon}{2} \right] - (1 - \tau)^2 \frac{\nu_\alpha}{2} \]

Heathcote-Storesletten-Violante, “Redistributive Taxation” – p. 25/34
Valued govt. consumption and heterogeneity

\[ W(\tau, g) = W^{RA}(\tau, g) + (1 + \chi) \left[ \frac{1}{\hat{\sigma}} \nu_\varepsilon - \sigma \left( \frac{1}{\hat{\sigma}^2} \right) \frac{\nu_\varepsilon}{2} \right] - (1 - \tau)^2 \frac{\nu_\alpha}{2} \]

- Optimal public good provision is unchanged: \( g^* = \chi / (1 - \chi) \)
Valued govt. consumption and heterogeneity

\[ \mathcal{W}(\tau, g) = \mathcal{W}^{RA}(\tau, g) + (1 + \chi) \left[ \frac{1}{\hat{\sigma}} \nu_\varepsilon - \sigma \left( \frac{1}{\hat{\sigma}^2} \right) \frac{\nu_{\varepsilon}}{2} \right] - (1 - \tau)^2 \frac{\nu_\alpha}{2} \]

\[ \ln(Y/H) \]

\[ \text{var}(\ln h) \]

\[ \text{var}(\ln c) \]

• Optimal public good provision is unchanged: \( g^* = \chi/(1 - \chi) \)

• Trade-off in determining optimal rate of progressivity:
  
  ▶ More rigid labor supply (higher \( \sigma \)) ⇒ more progressive taxation
  
  ▶ More uninsurable risk (higher \( \nu_\alpha \)) ⇒ more progressive taxation
  
  ▶ More insurable risk (higher \( \nu_\varepsilon \)) ⇒ flatter taxation
  
  ▶ Stronger taste for \( G \) (higher \( \chi \)) ⇒ more regressive taxation
Progressive or regressive taxation?

- Parameter space can be divided into two regions:

\[
\begin{align*}
\chi > v_\alpha (1 + \sigma) & \implies \tau^* < 0 \\
\chi = v_\alpha (1 + \sigma) & \implies \tau^* = 0 \\
\chi < v_\alpha (1 + \sigma) & \implies \tau^* > 0
\end{align*}
\]
Progressive or regressive taxation?

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• Insurable risk \( v_\varepsilon \) irrelevant because at \( \tau^* = 0 \) labor supply response to insurable shocks is undistorted
Progressive or regressive taxation?

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\end{align*}
\]

- Insurable risk \( v_\varepsilon \) is irrelevant because at \( \tau^* = 0 \) labor supply response to insurable shocks is undistorted.

- With \( v_\alpha = v_\varepsilon = 0.14 \), and \( \chi = 0.25 \) (\( g^* = 0.2 \))

\[
\begin{align*}
\sigma = 0.8 & \Rightarrow \tau^* = 0.00 \quad \text{(flat)} \\
\sigma = 2.0 & \Rightarrow \tau^* = 0.07 \quad \text{(optimal)} \\
\sigma = 6.3 & \Rightarrow \tau^* = 0.26 \quad \text{(actual US)}
\end{align*}
\]
Optimal progressivity with $\chi = 0.25$

[Graph showing Social Welfare vs. Progressivity rate ($\tau$)]

Utility of RA (G valued)

Optimal

$V_\alpha$

$V_\epsilon$

Actual US

Heathcote-Storesletten-Violante, “Redistributive Taxation” – p. 27/34
Average tax rate: actual US vs optimal

\[ \tau = 0.26 \]

\[ \tau = 0.21 \]

\[ \tau = 0.07 \]

Heathcote-Storesletten-Violante, “Redistributive Taxation” – p. 28/34
Progressive consumption taxation

• President’s Advisory Panel on Tax Reform (2005) lists a progressive consumed income tax among its proposals

• Implementation: progressive income tax with full deduction for savings

• Argument: avoids distortions to capital accumulation, while retaining scope for redistribution

• Additional argument: consumption taxes redistribute wrt. uninsurable shocks without distorting the efficient response of hours to insurable shocks
Progressive consumption taxation

• Individual budget constraint:

\[ y = \tilde{c} = \lambda c^{\frac{1}{1-\tau}} \]

where \( \tilde{c} \) are expenditures and \( c \) physical units

• Welfare can be expressed as:

\[ W(\tau, g) = W^{RA}(\tau, g) + \left( \frac{1 + \chi}{2} \right) \frac{1}{\sigma} \frac{v_{\varepsilon}}{\ln(Y/H)} - (1 - \tau)^{2} \frac{v_{\alpha}}{2} \]

• No misallocation of labor under this tax scheme \( \Rightarrow \) one can achieve higher welfare than with income taxation
Concluding remarks

• Tractable incomplete-markets model to study the two key roles of fiscal policy: redistribution/insurance and public good provision

• Characterization of optimal fiscal policy ("Ramsey-style")
Concluding remarks

• Tractable incomplete-markets model to study the two key roles of fiscal policy: redistribution/insurance and public good provision

• Characterization of optimal fiscal policy (“Ramsey-style”)

• What’s next?
  ▶ Solve model for general CRRA preferences \((\gamma \neq 1)\)
  ▶ Quantify how much of \(G\) is pure public good (e.g., defense) and how much is a transfer (e.g., public education)
  ▶ Politico-economic analysis
  ▶ Relationship with static Mirlees problem
Political economics

- Policy is determined in a repeated voting game
- Each period the agent with median $\alpha$ picks $(\tau, G)$
Political economics

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- Each period the agent with median $\alpha$ picks $(\tau, G)$
- No strategic interaction between successive median voters
  $\Rightarrow$ each median voter solves a static maximization problem
Political economics

• Policy is determined in a repeated voting game

• Each period the agent with median $\alpha$ picks $(\tau, G)$

• No strategic interaction between successive median voters
  $\Rightarrow$ each median voter solves a static maximization problem

• For $\gamma = 1$ and $\alpha \sim N \left( -\frac{v_\alpha}{2}, v_\alpha \right)$ the outcome of the voting game is equal to the Ramsey policy

• ... same redistribution, but for different motives:
  
  ▶ Ramsey planner values equality given utilitarian SWF
  
  ▶ Median voter benefits since $\alpha_{median} = -\frac{v_\alpha}{2} < \alpha_{mean} = 0$
Solving for competitive equilibrium

1. Conjecture no bond-trade: $\alpha$ uninsured and $\varepsilon$ fully insured

2. Economy as continuum of groups indexed by $\alpha$: within group, the Welfare Theorems apply
   - Use group-planner problem to derive allocations, taking tax function ($\lambda^*$) as given

3. Use agents FOC to back out “shadow” bond price for each group, i.e., $\mathbb{E}_t[MRS_{t,t+1}]$

4. Verify no-bond-trading equilibrium: check that shadow bond price is independent of island-specific characteristics

5. Given eq. allocations, solve for $\lambda^*$ via aggregate government budget constraint
Government’s problem

• \((F_{\alpha}, F_{\varepsilon})\) are the aggregate states, exogenous and time-invariant

• Government puts weight \(\beta^t\) on the welfare of all living agents born at dates \(t = -\infty, \ldots, \infty\), and chooses a sequence \(\{\tau_t, G_t\}_{t=0}^\infty\)

• The SWF becomes: 

\[
W(\{\tau_t, G_t\}_{t=0}^\infty) = \sum_{t=0}^\infty \beta^t W(\tau_t, G_t)
\]

where

\[
W(\tau, G) \equiv \int \int u(c^*(\alpha; \tau, G), h^*(\alpha, \varepsilon; \tau, G), G)\,dF_{\varepsilon}dF_{\alpha}
\]
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  \[ W(\{\tau_t, G_t\}_{t=0}^\infty) = \sum_{t=0}^\infty \beta^t W(\tau_t, G_t) \] 
  where 
  \[ W(\tau, G) \equiv \int \int u(c^*(\alpha; \tau, G), h^*(\alpha, \varepsilon; \tau, G), G) \, dF_\varepsilon \, dF_\alpha \]

⇒ The dynamic Ramsey problem reduces to a static problem

- The government chooses the pair \((\tau, G)\) to maximize \(W(\tau, G)\) subject to: (i) \((c^*, h^*)\) are competitive equilibrium allocations; and (ii) the government budget constraint is satisfied