Redistributive Taxation in a Partial-Insurance Economy

Jonathan Heathcote and Kjetil Storesletten
*Federal Reserve Bank of Minneapolis*

Gianluca Violante
*New York University*

*Minneapolis Fed, February 11, 2009*
Redistributive Taxation in a Partial-Insurance Economy

Jonathan Heathcote and Kjetil Storesletten
*Federal Reserve Bank of Minneapolis*

Gianluca Violante
*New York University*

*Minneapolis Fed, February 11, 2009*
Redistributive taxation

Two classic roles for government:

1. Provision of public goods
2. Redistribution / insurance

At the same time, the design of public taxation must be sensitive to private incentives

In this light, how progressive should the tax system be?
More specifically

- How does the **optimal rate of progressivity** for earnings taxation vary with ...

  1. the elasticity of labor supply
  2. the level of inequality / risk in the economy
  3. the amount of privately-provided insurance
  4. the desire for public goods
More specifically

- How does the optimal rate of progressivity for earnings taxation vary with ...
  1. the elasticity of labor supply
  2. the level of inequality / risk in the economy
  3. the amount of privately-provided insurance
  4. the desire for public goods

- Our contribution: Tractable framework that delivers insights on the trade-offs
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*)
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)
  3. additional risk-sharing (financial markets, family etc.)
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*)
  3. additional risk-sharing (financial markets, family etc.)
  4. nonlinear tax/transfer system
Technology

• Aggregate output **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 $\delta$

$$U(c_i, h_i, G) = \int_0^\infty \sum_0^t (\beta \delta)^t u(c_{it}, h_{it}, G_t)$$

- with period-utility:

$$u(c_{it}, h_{it}, G_t) = c_{1t}^{1-\gamma} h_{1t}^{\sigma} + \frac{\chi}{1-\gamma} G_t^{1-\gamma}$$
Demographics and preferences

- **Perpetual youth** demographics with constant survival probability $\delta$

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

$$U(c_i, h_i, G) = E_0 \sum_{t=0}^{\infty} (\beta \delta)^t u(c_{it}, h_{it}, G_t)$$

- with period-utility:

$$u(c_{it}, h_{it}, G_t) = \frac{c_{it}^{1-\gamma} - 1}{1-\gamma} - \varphi \frac{h_{it}^{1+\sigma}}{1+\sigma} + \chi \frac{G_t^{1-\gamma} - 1}{1-\gamma}$$
Wages

- Log individual wage is the sum of two components:

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

• Log individual wage is the sum of two components:

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

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

\[ \alpha_{it} = \alpha_{i,t-1} + \omega_t \quad \text{with} \quad \omega_{it} \sim F_\omega \quad \text{and} \quad \alpha_{i0} \sim F_{\alpha_0} \]
Wages

• Log individual wage is the sum of two components:

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

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

\[ \alpha_{it} = \alpha_{i,t-1} + \omega_t \quad \text{with} \quad \omega_{it} \sim F_{\omega} \quad \text{and} \quad \alpha_{i0} \sim F_{\alpha_0} \]

• \( \varepsilon_{it} \) 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
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
- 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 and finance public good $G$

\[
\tilde{y}_i = \lambda y_1 - \tau_i
\]

Government budget constraint (no public debt):

\[
G = \int \left[ y_i - \lambda y_1 - \tau_i \right] \, di
\]
Government

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

- Disposable post-government earnings:
  \[ \tilde{y}_i = \lambda y_i^{1-\tau} \]

- Government budget constraint (no public debt):
  \[ G = \int \left[ y_i - \lambda y_i^{1-\tau} \right] di \]
Our model of fiscal redistribution

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

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

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

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

• The parameter \( \tau \) measures the rate of progressivity:

\[
\ln(\tilde{y}_i) = \ln(\lambda) + (1 - \tau) \ln(y_i)
\]

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

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

• 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

• **CPS 1980-2005**, positive labor income: 1,026,829 obs.

• Estimated slope by OLS: $\tau = 0.26 \ (R^2 = 0.88)$
Agent’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. when agents take these as given and maximize utility, markets clear and the government budget is balanced.
“No bond trading” equilibrium

- There exists an equilibrium in which the wealth distribution is always degenerate at zero
  \[ \Rightarrow \text{individual allocations only depend on } (\alpha, \varepsilon) \]

- Generalization of Constantinides and Duffie (JPE, 1996)
  - CRRA prefs, unit root shocks to log disposable income
    - Flexible labor supply \(\Rightarrow\) earnings endogenous
    - Private risk sharing
    - Non-linear taxation and transfers
    - Individual wage process richer than unit root
“No bond trading” equilibrium

- There exists an equilibrium in which the wealth distribution is always degenerate at zero
  \[ \Rightarrow \text{individual allocations only depend on } (\alpha, \varepsilon) \]

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

- Our environment micro-founds unit root disposable income:
  1. Flexible labor supply \[ \Rightarrow \text{earnings endogenous} \]
  2. Private risk sharing
  3. Non-linear taxation and transfers
  4. Individual wage process richer than unit root
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
- With non-linear taxes ($\tau \neq 0$):
  \[
  \frac{\rho - r^*}{\gamma} = (1 - \tau) (\gamma (1 - \tau) + 1) \frac{v\omega}{2}
  \]
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

- With 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 $\Rightarrow$ less precautionary saving $\Rightarrow$ higher risk-free rate
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

\[
\begin{align*}
& - M_h(\nu \varepsilon) + \frac{1 - \gamma}{\hat{\sigma} + \gamma} \alpha + \frac{1}{\hat{\sigma}} \varepsilon
\end{align*}
\]

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

\[-M_h(v\varepsilon) + \frac{1 - \gamma}{\hat{\sigma} + \gamma} \alpha + \frac{1}{\hat{\sigma}} \varepsilon\]

Wealth effect

Unins. shock

Insurable shock

- 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

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

Representative agent

\[ + M_c(v_\varepsilon) \]

Wealth effect

\[ + \pi(\gamma, \sigma, \tau) \alpha \]

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
Equilibrium allocations: consumption

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

- Representative agent
- Wealth effect
- Uninsurable shocks

- The transmission coefficient of a permanent uninsured shock:

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

- 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

- Government puts weight $\beta^t$ on all agents born at date $t = 0, \ldots, \infty$ and chooses sequences $\{\tau_t, G_t\}_{t=0}^\infty$

- $(F_\alpha, F_\varepsilon)$ are the exogenous aggregate states
Government’s problem

- Government puts weight $\beta^t$ on all agents born at date $t = 0, \ldots, \infty$ and chooses sequences $\{\tau_t, G_t\}_{t=0}^{\infty}$

- $(F_\alpha, F_\varepsilon)$ are the exogenous aggregate states

$\Rightarrow$ The dynamic Ramsey problem reduces to a sequence of static problems, where the government chooses the pair $(\tau, G)$ to maximize:

$$W(\tau, G) \equiv \int \int u(c^*(\alpha; \tau, G), h^*(\alpha, \varepsilon; \tau, G), G) \, dF_\varepsilon dF_\alpha$$

subject to

- $(h^*, c^*)$ are competitive equilibrium allocations

- 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 \((v_\alpha = 0, v_\varepsilon = 0)\):
  \[
  \mathcal{W}^{RA}(\tau) = -\varphi + \frac{\ln (1 - \tau) - (1 - \tau)}{1 + \sigma}
  \]
  - Welfare maximizing \(\tau = 0\)
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** \( \tau = 0 \)

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

\[
\mathcal{W}(\tau) = -\varphi + \frac{\ln(1 - \tau) - (1 - \tau)}{1 + \sigma} + \frac{1}{\hat{\sigma}} v_\varepsilon - \left(1 - \tau\right)^2 \frac{v_\alpha}{2} - \sigma \left(\frac{1}{\hat{\sigma}^2}\right) \frac{v_\varepsilon}{2} \\
\quad \text{ln}(Y/H) \quad \text{var(ln c)} \quad \text{var(ln h)}
\]
Comparative statics

- $\mathcal{W}(\tau)$ is globally concave in $\tau$ if $\sigma \geq 2$
Comparative statics

- $\mathcal{W}(\tau)$ is globally concave in $\tau$ if $\sigma \geq 2$

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

- $\frac{\partial \mathcal{W}(\tau)}{\partial \tau} \big|_{\tau=0} > 0$ iff $v_\alpha > 0 \Rightarrow$ strictly positive solution for $\tau^*$

- $\frac{\partial \tau^*}{\partial \sigma} > 0$: less elastic labor supply $\Rightarrow$ less severe distortions

- $\frac{\partial \tau^*}{\partial v_\varepsilon} < 0$: more insurable risk $\Rightarrow$ more distortion of labor effort
Comparative statics

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

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

- \( \frac{\partial \mathcal{W}(\tau)}{\partial \tau} \bigg|_{\tau=0} > 0 \) iff \( v_\alpha > 0 \) \( \Rightarrow \) strictly positive solution for \( \tau^* \)

- \( \frac{\partial \tau^*}{\partial \sigma} > 0 \): less elastic labor supply \( \Rightarrow \) less severe distortions
Comparative statics

- \( \mathcal{W}(\tau) \) is **globally concave** in \( \tau \) if \( \sigma \geq 2 \)

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

- \( \left. \frac{\partial \mathcal{W}(\tau)}{\partial \tau} \right|_{\tau=0} > 0 \) iff \( v_\alpha > 0 \) \( \Rightarrow \) **strictly positive solution** for \( \tau^* \)

- \( \frac{\partial \tau^*}{\partial \sigma} > 0 \): less elastic labor supply \( \Rightarrow \) less severe distortions

- \( \frac{\partial \tau^*}{\partial v_\varepsilon} < 0 \): more insurable risk \( \Rightarrow \) more distortion of labor effort
Welfare Functions, $\chi = 0$
Valued government consumption: \( \chi > 0 \)

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

- Define \( g \equiv G/Y \)

- Welfare-maximizing fiscal policy given by:
  \[
  g^* = \frac{\chi}{1 + \chi} \quad \text{Samuelson's condition}
  \]
  \[
  \tau^* = -\chi \quad \text{Regressive taxation}
  \]

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

- 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)

- Note that $H^*$ is larger than it would be absent taxes: taxation is used to increase hours worked to socially efficient level
Heterogeneity and public goods

- Optimal public good provision $g^*$ is unchanged: $g^* = \frac{\chi}{1+\chi}$
Heterogeneity and public goods

- Optimal public good provision $g^*$ is unchanged: $g^* = \frac{\chi}{1+\chi}$

- Trade-off in determining optimal rate of progressivity:
  - Stronger taste for $G$ (higher $\chi$) $\Rightarrow$ more regressive taxation
  - More uninsurable risk (higher $v_\alpha$) $\Rightarrow$ more progressive taxation
  - More rigid labor supply (higher $\sigma$) $\Rightarrow$ more progressive taxation
  - More insurable risk (higher $v_\varepsilon$) $\Rightarrow$ flatter taxation
Welfare Functions, $\chi = 0.25$

![Graph showing Social Welfare, Progressivity rate (\(\tau\)), Utility of RA (G valued), \(v_\alpha\), \(v_\epsilon\), Optimal, Actual US.](image)
Progressive or regressive taxation?

- Parameter space can be divided into two regions:

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

- Parameter space can be divided into two regions:

\[
\begin{align*}
\chi > v\alpha(1 + \sigma) & \Rightarrow \tau^* < 0 \\
\chi = v\alpha(1 + \sigma) & \Rightarrow \tau^* = 0 \\
\chi < v\alpha(1 + \sigma) & \Rightarrow \tau^* > 0
\end{align*}
\]

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

- Parameter space can be divided into two regions:

  \[ \chi > v_\alpha(1 + \sigma) \Rightarrow \tau^* < 0 \]
  \[ \chi = v_\alpha(1 + \sigma) \Rightarrow \tau^* = 0 \]
  \[ \chi < v_\alpha(1 + \sigma) \Rightarrow \tau^* > 0 \]

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

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

  \[ \sigma = 0.8 \Rightarrow \tau^* = 0.00 \text{ (flat)} \]
  \[ \sigma = 2.0 \Rightarrow \tau^* = 0.07 \text{ (optimal)} \]
  \[ \sigma = 6.3 \Rightarrow \tau^* = 0.26 \text{ (actual US)} \]
Average tax rate: actual US vs optimal

- Actual US
- Optimal when G nonvalued
- Optimal when G valued

\[\tau = 0.26\]
\[\tau = 0.21\]
\[\tau = 0.07\]
Political Economy

- 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 $\alpha \sim N(-v_\alpha^2, v_\alpha)$, the outcome of the voting game is equal to the Ramsey policy

... but different motives for redistribution:
- Ramsey planner values equality given utilitarian SWF
- Median voter benefits since $\alpha_{\text{median}} = -v_\alpha^2 < \alpha_{\text{mean}} = 0$
Political Economy

- 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
Political Economy

• 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

• ... but different motives for redistribution:
  • Ramsey planner values equality given utilitarian SWF
  • Median voter benefits since $\alpha_{median} = -\frac{v_\alpha}{2} < \alpha_{mean} = 0$
$c = \lambda \tilde{c}^{1-\tau}$

- Recall that consumption depends on $\alpha$ but does not depend on the realization of $\varepsilon$.

- Thus consumption taxes can redistribute with respect to uninsurable shocks without distorting the efficient response of hours to insurable shocks.

- Trade-off between public good provision and redistribution remains.
Concluding remarks

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

- Positive and normative analysis

- 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)
Concluding remarks

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

- Positive and normative analysis

- 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)
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., $E_t[MRS_{t,t+1}]$

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