Redistributive Taxation in a Partial-Insurance Economy

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London School of Economics, May 28th 2010
Taxation

Two objectives for government taxation:

1. Financing the purchase of goods and services

2. Redistribution / “social insurance"
Taxation

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1. Financing the purchase of goods and services
2. Redistribution / “social insurance"

Constraint:

1. The design of taxes and transfers must be sensitive to private incentives (Mirlees, 1971)

In light of this trade-off, how progressive should the tax system be?
Approach: Ramsey problem

• R.A. economy with benevolent government who takes C.E. allocations, $G$ to be financed, and tax instruments as given

• Generalization:
  1. heterogeneous agents and incomplete markets
  2. government expenditures valued by households
  3. nonlinear tax/transfer system (conditional earnings)
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  3. nonlinear tax/transfer system (conditional earnings)

- Our contribution: tractable equilibrium framework that delivers insights on the key economic forces shaping optimal progressivity

- Relationship with Mirleesian approach?
• Equilibrium heterogeneous-agents model featuring:
  
  1. differential “innate ability" + idiosyncratic productivity risk
  
  2. flexible labor supply and risk-free bond (self-insurance)
Preview of the model (based on HSV, 2009)

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  3. additional risk-sharing (financial markets, family, institutions)
  4. government operates a nonlinear tax/transfer system to redistribute and finance the provision of a public good
  5. no physical capital
Technology and resource constraint

- Aggregate technology linear in effective labor:

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

- Resource constraint:

\[ Y = \int c_i di + G \]
Individual labor productivity

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

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

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

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

- \( \varepsilon_{it} \) component can be any ARIMA process. We assume:

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

- Shocks i.i.d. across agents: L.L.N. \( \Rightarrow \) no aggregate fluctuations
Demographics and preferences

- **Perpetual youth** demographics with constant survival probability $\delta$
  - Perfect annuity against survival risk
Demographics and preferences

• Perpetual youth demographics with constant survival probability $\delta$
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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:

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

- Assets traded competitively (all in zero net supply)
  - Non-contingent bond
  - Complete set of insurance claims for $\varepsilon$ shocks
Financial assets

• Assets traded competitively (all in zero net supply)
  ▶ Non-contingent bond
  ▶ Complete set of insurance claims for $\varepsilon$ shocks

• Model encompasses a variety of economies
  ▶ $v_\alpha = v_\varepsilon = 0 \Rightarrow$ representative agent economy
  ▶ $v_\alpha = 0, v_\varepsilon > 0 \Rightarrow$ full insurance economy
  ▶ $v_\alpha > 0, v_\varepsilon = 0 \Rightarrow$ bond economy
  ▶ $v_\alpha > 0, v_\varepsilon > 0 \Rightarrow$ “partial insurance” economy

Heathcote-Storesletten-Violante, "Optimal Taxation" – p. 8/32
Taxes gross earnings through the function:

\[ T(y_i; \tau, \lambda) = y_i - \lambda y_i^{1-\tau} \]

\[ \tilde{y}_i \equiv y_i - T(y_i; \tau, \lambda) = \lambda y_i^{1-\tau} \]
• Taxes gross earnings through the function:

\[ T(y_i; \tau, \lambda) = y_i - \lambda y_i^{1-\tau} \rightarrow \tilde{y}_i \equiv y_i - T(y_i; \tau, \lambda) = \lambda y_i^{1-\tau} \]

• Balances the budget (no government debt):

\[ G = \int T(y_i; \tau, \lambda) di \]

• Chooses \((\tau, G)\) and \(\lambda\) is the residual instrument that balances the budget in equilibrium
Our model of fiscal redistribution

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

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

- $\tau = 1$: full redistribution ($\tilde{y}_i = \lambda$)
- $0 < \tau < 1$: partial redistribution (progressivity)
- $\tau = 0$: no redistribution (proportional tax $1 - \lambda$)
- $\tau < 0$: negative redistribution ( regressivity)
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- Marginal tax rate monotone in earnings: $T'(y) = 1 - \lambda(1 - \tau)y_i^{-\tau}$

- Zero marginal tax rate at earnings threshold $y^0 = \lambda^{\frac{1}{\tau}}$
Empirical relevance of our specification


- Estimated slope of model line ($R^2 = 0.88$) yields $\tau = 0.26$
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- Estimated slope of model line \( R^2 = 0.88 \) yields \( \tau = 0.26 \)
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 C.E. is a set of allocations \((c, h, b', B)\), prices \((q, Q(\cdot))\) and a policy triplet \((G, \tau, \lambda)\) s.t. (i) given prices and policy agents optimize, (ii) markets clear, and (iii) the government budget is balanced.
Tractable “no bond trading” equilibrium

- Equilibrium allocations are function of \((\alpha, \varepsilon)\), but do not depend on wealth \(\Rightarrow\) tractability
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- Micro-foundation for Constantinides and Duffie (JPE, 1996) who assume exogenous I(1) process for log-disposable income \(\tilde{y}_i\)
Tractable “no bond trading” equilibrium

• Equilibrium allocations are function of \((\alpha, \varepsilon)\), but do not depend on wealth ⇒ tractability

• Micro-foundation for Constantinides and Duffie (JPE, 1996) who assume exogenous I(1) process for log-disposable income \(\tilde{y}_i\)

• We start from ARIMA exogenous process for individual wages:
  1. Elastic labor supply: wages → earnings
  2. Private risk sharing: earnings → gross income
  3. Non-linear taxes: gross income → disposable income still I(1)

• No borrowing/saving: disposable income = consumption
Equilibrium risk-free rate $r^*$ supporting this equilibrium

- Under log-normality of the shocks, closed form for $r^*$

- With inelastic labor supply ($\sigma = \infty$):

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

- Intertemporal dissaving motive = precautionary saving motive

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

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

Representative agent

- Insurable shocks
- Uninsurable shocks
Equilibrium allocations: hours worked

\[
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Representative agent

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

Insurable shocks Uninsurable shocks

• Response of hours worked to:

  ▶ insurable shocks depends on the tax-modified Frisch elasticity:

  \[
  \frac{1}{\hat{\sigma}_\tau} \equiv \frac{1 - \tau}{\sigma + \tau}
  \]

  ▶ uninsured shocks smaller as long as \( \gamma > 0 \)
Equilibrium allocations: consumption

\[
\ln c^*(\alpha) = \frac{1}{\hat{\sigma}_\tau + \gamma} [(1 + \hat{\sigma}) \ln \lambda^*(\tau, G) + \ln(1 - \tau) - \varphi] + M_c(v_\varepsilon) + \pi(\gamma, \sigma, \tau)\alpha
\]

Representative agent

Insurable shocks

Uninsurable shocks
Equilibrium allocations: consumption

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

Representative agent

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

Insurable shocks Uninsurable shocks

• Response of consumption to uninsurable wage shocks is:

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

TAXATION LABOR SUPPLY

Heathcote-Storesletten-Violante, "Optimal Taxation" – p. 16/32
Equilibrium allocations: consumption

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

Representative agent

\[
\begin{align*}
+ M_c(v_e) & \quad + \pi(\gamma, \sigma, \tau) \alpha \\
\text{Insurable shocks} & \quad \text{Uninsurable shocks}
\end{align*}
\]

• Response of consumption to uninsurable wage shocks is:

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

- $\tau > 0 \Rightarrow$ consumption smoothing through taxation
- $\gamma > 1, \sigma < \infty \Rightarrow$ consumption smoothing through labor supply
Government’s problem

- Government chooses pair \((τ, G)\) to maximize social welfare s.t.:
  1. \((c^*, h^*)\) are competitive equilibrium allocations, given \((τ, G)\)
  2. the government budget constraint is satisfied
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• Government puts weight \(\beta^t\) on expected utility of all agents born at dates \(t = -\infty, \ldots, \infty\)

• The surprise announcement of a new pair \((\tau, G)\) preserves no-bond trading equilibrium and hence transition is instantaneous
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- The Social Welfare Function becomes:

\[
W(\tau, G) \equiv \frac{1}{1 - \beta} \int \int u(c^*(\alpha; \tau, G), h^*(\alpha, \varepsilon; \tau, G), G) \, dF_\varepsilon \, dF_\alpha
\]
Solving the Ramsey problem

- **Assumptions:**
  a) log-normal shocks
  b) log-utility over private and public consumption ($\gamma = 1$)
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• WLOG, recast choice of $G$ in terms of $g \equiv G/Y$

• $\mathcal{W}(\tau, g)$ is concave in $g$. It’s concave in $\tau$ if $\sigma \geq 2$
Solving the Ramsey problem

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- **Roadmap:**
  1. Representative agent ($v_\alpha = v_\epsilon = 0$)
  2. Full insurance ($v_\alpha = 0, v_\epsilon > 0$)
  3. Partial insurance ($v_\alpha > 0, v_\epsilon > 0$)
Representative agent

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

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

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

- Regressive taxation mimics lump-sum taxation and achieves first best allocations.
Full insurance

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

\[ \ln(Y/H) \]

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

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

\[
\frac{\ln(Y/H)}{\ln(Y/H)} \quad \text{var} \left( \ln h \right)
\]

- Second component of the welfare function maximized at \( \tau = 0 \)
  \[ \Rightarrow \text{Labor misallocation minimized with linear tax} \]

- A stronger desire for \( G \) makes misallocation of labor more costly
Full insurance

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

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

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- A stronger desire for \( G \) makes misallocation of labor more costly

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

\[ \mathcal{W}(\tau, g) = \mathcal{W}^{FI}(\tau, g) - (1 - \tau)^2 \frac{\nu_\alpha}{2} \underbrace{\text{var(ln } c)}_{\text{var(ln } c)} \]
Partial insurance

\[ W(\tau, g) = W^{FI}(\tau, g) - (1 - \tau)^2 \frac{\nu_\alpha}{2} \]

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

- \( \frac{\partial \tau^*}{\partial \nu_\alpha} > 0 \): more uninsurable risk ⇒ more progressivity

- Strictly positive solution for \( \tau^* \) only if \( \nu_\alpha > 0 \)
Partial insurance

\[ \mathcal{W}(\tau, g) = \mathcal{W}^{FI}(\tau, g) - (1 - \tau)^2 \frac{v_\alpha}{2} \]

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

• \( \frac{\partial \tau^*}{\partial v_\alpha} > 0 \): more uninsurable risk \( \Rightarrow \) more progressivity

• Strictly positive solution for \( \tau^* \) only if \( v_\alpha > 0 \)

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

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

\( \sum \)
Summarizing

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

- Optimal rate of progressivity depends upon:

1. the desire for consuming public goods \((\chi)\): ↓

2. the size of labor supply distortions \((\sigma)\): →0

3. the amount of privately-provided insurance \((v_\varepsilon)\): →0

4. the amount of uninsurable risk \((v_\alpha)\): ↑
Progressive/regressive taxation with partial insurance?
Progressive/regressive taxation with partial insurance?

- Parameter space can be divided into two regions:

\[ \chi > v\alpha(1 + \sigma) \quad \Rightarrow \quad \tau^* < 0 \]
\[ \chi = v\alpha(1 + \sigma) \quad \Rightarrow \quad \tau^* = 0 \]
\[ \chi < v\alpha(1 + \sigma) \quad \Rightarrow \quad \tau^* > 0 \]
Progressive/regressive taxation with partial insurance?

- Parameter space can be divided into two regions:
  
  \[
  \begin{align*}
  \chi &> v_\alpha(1+\sigma) \quad \Rightarrow \quad \tau^* < 0 \\
  \chi &= v_\alpha(1+\sigma) \quad \Rightarrow \quad \tau^* = 0 \\
  \chi &< v_\alpha(1+\sigma) \quad \Rightarrow \quad \tau^* > 0
  \end{align*}
  \]

- With \( v_\alpha = v_\varepsilon = 0.14 \) and \( \chi = 0.25 \) (\( \Rightarrow \) \( g^* = 0.2 \)):
  
  \[
  \begin{align*}
  \sigma = 0.8 &\quad \Rightarrow \quad \tau^* = 0.00 \text{ (proportional)} \\
  \sigma = 2.0 &\quad \Rightarrow \quad \tau^* = 0.07 \text{ (optimal)} \\
  \sigma = 6.3 &\quad \Rightarrow \quad \tau^* = 0.26 \text{ (actual US)}
  \end{align*}
  \]
Components of the welfare function

Healthcote-Storesletten-Violante, “Optimal Taxation” – p. 24/32
Average tax rate: actual US vs optimal

Heathcote-Storesletten-Violante, "Optimal Taxation" – p. 25/32
Relationship with Mirlees approach \( (\nu_\varepsilon = 0) \)

- Our Ramsey-style approach
  - restricted tax schedule conditional on earnings
Relationship with Mirlees approach \((v_\varepsilon = 0)\)

- **Our Ramsey-style approach**
  - restricted tax schedule conditional on earnings

- **Mirlees approach**
  - \(\alpha\) unobservable \(\Rightarrow\) constrained-efficient allocations \(\Rightarrow\) unrestricted tax schedule conditional on earnings
Relationship with Mirlees approach \((v_\varepsilon = 0)\)

- **Our Ramsey-style approach**
  - restricted tax schedule conditional on earnings

- **Mirlees approach**
  - \(\alpha\) unobservable \(\Rightarrow\) constrained-efficient allocations \(\Rightarrow\)
    unrestricted tax schedule conditional on earnings

- **Complete markets**
  - \(\alpha\) observable \(\Rightarrow\) efficient allocations \(\Rightarrow\) unrestricted tax
    schedule conditional on \(\alpha\)

- In all three economies: \(g^* = \frac{G}{Y} = \frac{\chi}{1-\chi}\)
Allocations and implied taxes in 3 economies

Heathcote-Storesletten-Violante, "Optimal Taxation" – p. 27/32
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.
Optimal progressive consumption taxation

- Household budget constraint:

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

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

- Welfare in the partial insurance economy:

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

\[ \frac{1}{\sigma} \frac{v_\varepsilon}{\ln(Y/H)} - \frac{1}{\sigma^2} \frac{v_\varepsilon}{\var(\ln h)} - \frac{v_\alpha}{\var(\ln c)} \]

- No misallocation of labor under this tax scheme \( \Rightarrow \) one can achieve higher welfare than with income taxation
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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• No strategic interaction between successive median voters
  $\Rightarrow$ each median voter solves a static maximization problem
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• 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 $\alpha_{median} < \alpha_{mean} = 0$
Concluding remarks

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

- Analytical characterization of optimal fiscal policy
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- Analytical characterization of optimal fiscal policy

- What’s next?
  - Solve model for general CRRA preferences ($\gamma \neq 1$)
  - Case where $G$ is partly pure public good (e.g., defense), partly transfer (e.g., public education), and partly waste
  - Mirlees problem with observable/insurable shocks $\varepsilon$
  - Politico-economic analysis

Heathcote-Storesletten-Violante, “Optimal Taxation” – p. 31/32
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