Optimal Fiscal Policy under Preference Heterogeneity

Marek Kapička, CERGE-EI

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The Problem

- How should marginal taxes and transfers change over the business cycle and with government spending?
- Reexamine some of the long-standing questions from the Ramsey literature in a dynamic Mirrlees framework with hererogenity in productivity, IES and risk aversion.
  - Lucas and Stokey 83, Karantounias 18, Werning 07
- What is the role of heterogenity in the intertemporal elasticity of substitution (IES) and risk aversion (RA) in the optimal tax design?

Motivation

- Substantial body of evidence on hetereogeneity in IES:
  - across income levels: Blundell-Browning-Meghir (1994)
  - stockholders vs non-stockholders: Vissing-Jorgensen (2002)
  - Barsky, Juster, Kimball, and Shapiro (1997)
- Thinking about dynamic fiscal policy requires a framework with realistic movements in asset prices (especially risk-free rate), because it directly affects the cost of debt.

Preview of Results

- If low income individuals have *either* higher RA or lower IES, they face lower marginal taxes and higher transfers in bad times
- Subsequent dynamics differs. In the example solved,
  - If low income individuals have higher RA, the changes are persistent
  - If low income individuals have lower IES, the changes are anti-persistent
  - If both, subsequent effects are zero
- Preliminary quantitative results: If IES of low income individuals is 0.1 and IES of high income individuals is 0.3,
  - 1% increase in TFP leads to 2% increase in the marginal tax rate
  - 1% increase in govt spending leads to 0.2% decrease in the marginal tax rate

Outline

- The model
- Three examples
  - differences in RA
  - differences in IES
  - differences in both IES and RA
- Log-linearization around the steady state

The Model

- Time is discrete and infinite
- Aggregate shocks $s_t \in S$. Probability of $s^t = (s_0, s_1, \ldots, s_t)$ is $\pi_t(s^t)$. Time zero shock s_0 known.
- Aggregate shocks determine aggregate productivity $Z_t(s^t)$ and government spending $G_t(s^t)$.
- Two types of agents, A and B. Differ in their productivity, IES and risk aversion.
  - type A agents have low productivity, normalized to $Z_t(s^t)$.
  - type B agents have high productivity $\theta Z_t(s^t)$, where $\theta > 1$.
- Fraction of A types is λ. Fraction of B types is $1 - \lambda$.

The Model

Preferences

- Preferences of type $i \in \{A, B\}$ agents:

$$V_t^i(s^t) = \left[(1-\beta) U \left(c_t^i(s^t), n_t^i(s^t) \right)^{1-\rho^i} + \beta \mu_t^i \left(V_{t+1}^i(s^{t+1}) \right)^{1-\rho^i} \right]^{\frac{1}{1-\rho^i}}$$

- $c_t^i(s^t) \geq 0$ is consumption, $n_t^i(s^t) \geq 0$ are hours worked
- $U(c, n)$ is a period utility function, increasing in c, decreasing in n, concave, twice differentiable
- μ^i is the certainty equivalent of a risky continuation utility,

$$\mu_t^i(V) = \left[\mathbb{E}_t (V^{1-\gamma^i}) \right]^{\frac{1}{1-\gamma^i}}.$$

- relative risk aversion is γ_i
- intertemporal elasticity of substitution **of utilities** is $1/\rho_i$

The Model

incentive compatibility

- Agent's type is either $(1, \rho^A, \gamma^A)$ or $(\theta, \rho^B, \gamma^B)$.
- Income and consumption is publicly observable. Type and hours worked are private information.
- I focus on a situation where the incentive constraints for type B bind.
- The utility that type B agent gets from choosing consumption and income of type A is

$$\hat{V}_t^B(s^t) = \left[(1-\beta) U \left(c_t^A(s^t), \frac{n_t^A(s^t)}{\theta} \right)^{1-\rho^B} + \beta \mu_t^B \left(\hat{V}_{t+1}^B(s^{t+1}) \right)^{1-\rho^B} \right]^{\frac{1}{1-\rho^B}}$$

- Incentive compatibility requires

$$V_0^B(s_0) \geq \hat{V}_0^B(s_0). \tag{1}$$

The Model

- The social planner maximizes a weighted average of the types' utilities
$$\max \ \alpha V_0^A(s_0) + V_0^B(s_0)$$
subject to the aggregate resource constraint
$$\lambda c_t^A(s^t) + (1-\lambda) c_t^B(s^t) + G_t(s^t) \leq Z_t(s^t)\left[\lambda n_t^A(s^t) + (1-\lambda)\theta n_t^B(s^t)\right].$$
and the incentive constraint (1).

- The relative Pareto weight of type A is $\alpha > 0$ (assumed sufficiently large)

Why state-dependent marginal tax rates on low types?

- Optimal tax formulas:

$$\tau_t^A(s^t) = \frac{\kappa\left(\nu_t(s^t) - \phi_t(s^t)\right)}{\alpha_t(s^t) - \kappa\phi_t(s^t)}$$

where

  - κ is the Lagrange multiplier on IC
  - $\phi_t = \frac{\left(\hat{u}_t^A\right)^{-\rho^B}}{\left(u_t^A\right)^{-\rho^A}} \frac{U_n\left(c_t^A, n_t^A/\theta\right)}{U_n\left(c_t^A, n_t^A\right)} \frac{1}{\theta}$ represents the informational rent from higher productivity,
  - $\nu_t = \frac{\left(\hat{u}_t^A\right)^{-\rho^B}}{\left(u_t^A\right)^{-\rho^A}} \frac{U_c\left(c_t^A, n_t^A/\theta\right)}{U_c\left(c_t^A, n_t^A\right)}$ represents the effects from non-separability in the utility function,
  - α_t represents implicit Pareto weight on type A, and has initial value of α.

A Benchmark Result

- What if there is no hetereogenity in preferences?
- No changes in the implicit Pareto weight over time. If, in addition, there are no changes in the informational rent, then marginal taxes are constant over time and state:

Proposition

Suppose that $\rho^A = \rho^B = \rho$ and $\gamma^A = \gamma^B = \gamma$, and that

$$U(c,n) = \left[c^{1-\rho} - (1-\rho)\frac{n^{1+\eta}}{1+\eta}\right]^{\frac{1}{1-\rho}}.$$

Then the marginal tax rates are constant over time and states.

A Benchmark Result

- The result differs markedly from what one would obtain in the Ramsey environment, where Epstein-Zin preferences matter (Karantounias 2018).
- In Ramsey, the government manipulates interest rates and the marginal cost of issuing debt by varying the tax rates.
- In Mirrlees, the presence of nonlinear taxes means that the marginal cost of issuing debt is equalized across states.

Three examples

- Type B agents have zero aversion toward utility risk ($\gamma^B = 0$) and infinite elasticity of intertemporal substitution ($\rho^B = 0$):

$$V^B = (1-\beta)\mathbb{E}\sum_{t=0}^{\infty}\beta^t U\left(c_t^B(s^t), n_t^B(s^t)\right).$$

- preferences of type A agents:
  1. infinite risk aversion ($\gamma^B = \infty$)
  2. zero intertemporal elasticity of substitution ($\rho^A = \infty$)
  3. both infinite risk aversion and zero intertemporal elasticity of substitution. ($\gamma^B = \rho^A = \infty$)

- Period utility is

$$U(c,n) = \ln c - \frac{n^{1+\eta}}{1+\eta}.$$

Three examples

- Let κ and $\beta^t \pi(s^t)\alpha_t(s^t)$ be the Lagrange multiplier on IC and on the promise keeping constraint on type A (after a history s^t)
- Interpretation of α_t: implicit Pareto weights of type A:

$$\alpha_t(s^t) = (1+\kappa)\frac{\lambda}{1-\lambda}\frac{U^B_{ct}(s^t)}{U^A_{ct}(s^t)} + \kappa.$$

- The optimal marginal tax rate on type A reduces in all three examples to

$$\tau^A_t(s^t) = \frac{\kappa(1-\phi)}{\alpha_t(s^t) - \kappa\phi}, \quad \phi = \theta^{-1-\eta}. \tag{2}$$

- Intuition? Higher α_t $\rightarrow$ relatively higher consumption, of type A agent $\rightarrow$ decreases hours worked (positive income effect) $\rightarrow$ relax the incentive constraint $\rightarrow$ less distortion needed.
- The three examples differ in the behavior of $\alpha_t(s^t)$.

Example 1: differences in risk aversion

- Type A agents have infinite intertemporal elasticity of substitution ($\rho^A = 0$), and infinite aversion ($\gamma^A = \infty$)
- Preferences are

$$V_t^A(s^t) = (1-\beta)U\left(c_t^A(s^t), n_t^A(s^t)\right) + \beta \min_{s_{t+1}} \left\{V_{t+1}^A(s^{t+1})\right\}.$$

- This requires that $V_{t+1}^A(s^t, s_{t+1})$ is independent of s_{t+1}, and so

$$V_t^A(s^{t-1}) = (1-\beta)U\left(c_t^A(s^t), n_t^A(s^t)\right) + \beta V_{t+1}^A(s^t) \quad \forall s^t.$$

Example 1: differences in risk aversion

- Key result: α_t it follows a random walk:

$$\alpha_t(s^t) = \sum_{s_{t+1}} \pi(s_{t+1}|s^t)\alpha_{t+1}(s^{t+1}).$$

- Type A agents are fully insured against fluctuations in states, and their implicit Pareto weight fluctuates across states.
- On the other hand, type A agents are no different in their IES, and their Pareto weights are, in expectation, constant.
- Two implications:
    1. marginal tax rates are, on average, increasing over time
    2. inverse marginal tax rates are follow a random walk

Example 2: differences in IES

- Type A agents have zero intertemporal elasticity of substitution ($\rho^A = \infty$) and zero aversion toward utility risk ($\gamma^A = 0$):

$$V_t^A(s^t) = \min\left\{U\left(c_t^A(s^t), n_t^A(s^t)\right), \sum_{s_{t+1}} \pi(s_{t+1}|s^t)V_{t+1}^A(s^{t+1})\right\}.$$

- Key result: changes in α_t must off-set over time:

$$(1-\beta)\sum_{t=0}^{\infty}\beta^t\alpha_t(s^t) = \alpha \quad \forall s^\infty \in S^\infty.$$

- The opposite of what was in Example 1: an increase in $\alpha_t(s^t)$ will be followed by a decrease.
- Marginal tax rates inherit the off-setting property.

Example 3: differences in both IES and risk aversion

- Type A agents have both zero IES ($\rho^A = \infty$) and infinite risk aversion ($\gamma^A = \infty$):

$$V_t^A(s^t) = \min\left\{U\left(c_t^A(s^t), n_t^A(s^t)\right), \min\left\{V_{t+1}^A(s^{t+1})\right\}\right\},$$

- This is equivalent to requiring a constant period utility V^A across time and states.
- The solution is now "static" in that α_t, as well as the allocations, are only a function of the current shocks Z_t, G_t:

$$\alpha_t(s^t) = \bar{\alpha}\left[Z_t(s^t), G_t(s^t)\right]$$

- Reminiscent of Ramsey under complete markets.
- It follows that τ_t^A is also a function of Z_t, G_t only. No history dependence in taxes!

Numerical Example

- 6 periods, equal shares ($\lambda = 0.5$), type B agents are 40 percent more productive ($\theta = 1.4$), and the Frisch elasticity of labor is 0.5 ($\eta = 2$).
- The Pareto weight α is set so that the initial period marginal tax rate is 0.4.
- Aggregate productivity is $Z(s_0) = 1$ in the first period, while $Z_t(s^t)$ is an iid random variable taking three possible values 0.9 (recession), 1.0, and 1.1 (expansion) with equal probability
- Government consumption set to zero

Aggregate Productivity Shock: Marginal Tax Rates

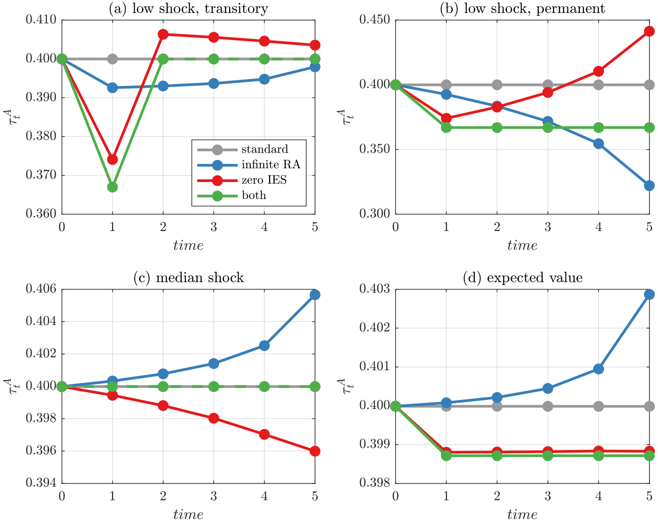

Figure: Marginal tax rates on type A agents. Infinite RA, zero IES, or a combination of both refers to preferences of type A agents.

Transfers

- Transfers are not unique. Under complete markets, Ricardian equivalence applies. Time and state variations in transfers will be offset by asset trades.

- We determine transfers by assuming incomplete markets for type A agents: type-A agents are hand-to-mouth:

$$T_t^A(s^t) = c_t^A(s^t) - z_t(s^t) n_t^A(s^t)$$

- This assumption will not change the optimal allocation, because the government can still issue state contingent claims and trade them with type B agents.

- Full market incompleteness would change the solution.

Aggregate Productivity Shock: Transfers

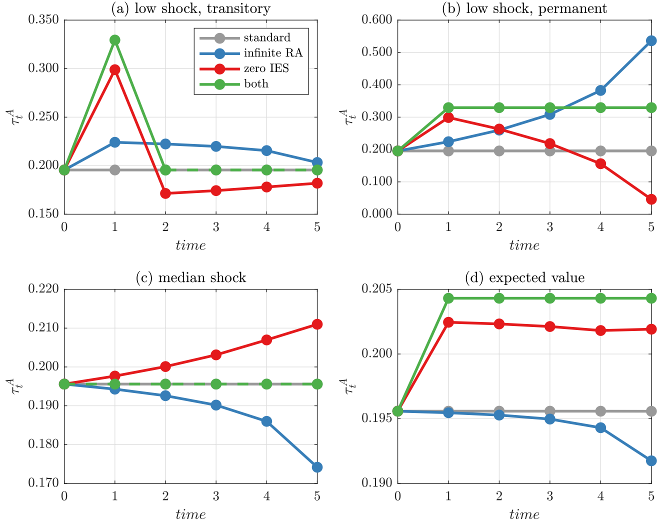

Figure: Transfers to type A agents as a fraction of income. Infinite RA, zero IES, or a combination of both refers to preferences of type A agents.

Log-Linearization around Steady State

- Study the role of preference parameters for the response of the optimal tax and transfer system (τ_t^A, T_t^A), and the optimal allocations, to a small change in Z_t or G_t.
- Solve for the steady-state and log-linearize around it.
- No need to worry about IC: It holds in steady state by construction, and continues to hold (up to the log-linear approximation)
- Simplifying assumptions:
  1. $$\rho^A = \gamma^A \quad \text{and} \quad \rho^B = \gamma^B$$
  2. $$U^i(c, n) = \left[c^{1-\rho^i} - (1 - \rho^i) \frac{n^{1+\eta}}{1+\eta} \right]^{\frac{1}{1-\rho^i}}.$$
- Assumption 1 simplifies the dynamics of the responses similarly to example 3.

Log-Linearization around Steady State

First-order conditions

- marginal tax rates (optimal formulas):

$$\tau_t^A = \frac{\kappa\left((c_t^A)^{\rho^A-\rho^B} - \phi\right)}{\alpha - \kappa\phi}$$

$$\tau_t^B = 0$$

where

$$\tau_t^A = 1 - \frac{(n_t^A)^\eta (c_t^A)^{\rho^A}}{Z_t}, \quad \tau_t^B = 1 - \frac{(n_t^B)^\eta (c_t^B)^{\rho^B}}{\theta Z_t}$$

- efficient allocation of consumption:

$$\alpha \cdot (c_t^A)^{-\rho^A} - \kappa \cdot (c_t^A)^{-\rho^B} = \frac{\lambda}{1-\lambda}(1+\kappa) \cdot (c_t^B)^{-\rho^B}$$

- plus IC and RC

Log-Linearization around Steady State

Log-linearization

- Let
$$dx_t = \ln x_t - \ln x$$
be a percentage deviation of a variable x_t from steady state.
- relative response of consumption:
$$dc_t^B = \left(1 + \frac{\rho^A - \rho^B}{\rho^B} \frac{\alpha}{\alpha - \kappa\phi} \frac{1}{1 - \tau^A}\right) dc_t^A$$
- If A type has low IES (high ρ^A), his consumption responds relatively less.
- marginal tax rates:
$$d\tau_t^A = \frac{(c^A)^{\rho^A - \rho^B}}{(c^A)^{\rho^A - \rho^B} - \phi} (\rho^A - \rho^B) dc_t^A$$
$$d\tau_t^B = 0.$$
- If A type has low IES (high ρ^A), marginal tax rate is positively correlated with his consumption

- Solving for the response of consumption,

$$dc_t^A = \frac{dz_t\left(1+\frac{1}{\eta}\right) - (1-\chi)dg_t}{\chi\left[h_c + (1-h_c)\left(1+F_1\right)\right] + \frac{1}{\eta}\left[h_y\left(\rho^A + F_2\right) + (1-h_y)\rho^B\left(1+F_1\right)\right]}$$

  where F_1 and F_2 are positive coefficients, and h_c and h_y are steady-state consumption and income shares of type A.

- Consumption of type A responds positively to TFP shock and negatively to government spending shock

- If $\rho^A > \rho^B$, marginal tax rate on type A also responds positively to TFP shock and negatively to government spending shock.

Log-Linearization around Steady State

Quantification

- Set $\lambda = 0.6$ and $\theta = 2.0$ (loosely approximating college vs non-college division)
- Set $\eta = 2$ (Frisch = 0.5)
- Choose G to match steady-state government consumption to output ratio of 0.15.
- Fix $1/\rho^B = 0.3$ (Guevenen, 2009) and vary $1/\rho^A$ from 0.3 to 0.067
- For each exercise, I choose the Pareto weight α so that the steady-state marginal tax rate τ^A equals 0.4

Response to 1 % increase in TFP

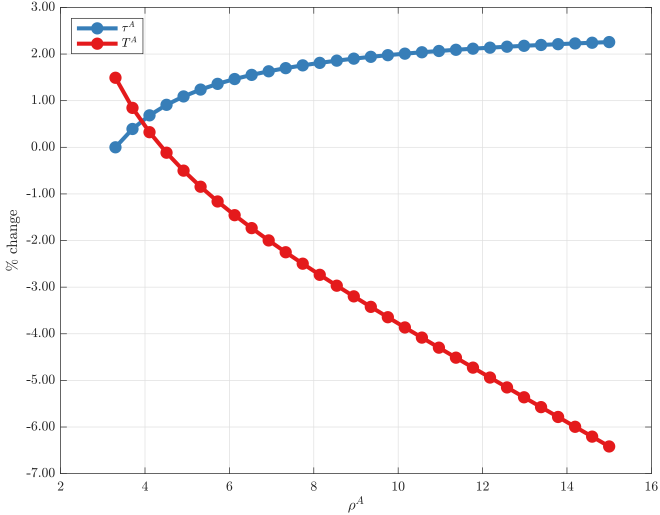

Figure: Response of the marginal tax rate τ_t^A and transfers to low types T_t^A to a 1 % increase in Z_t.

Response to 1 % increase in Govt Spending

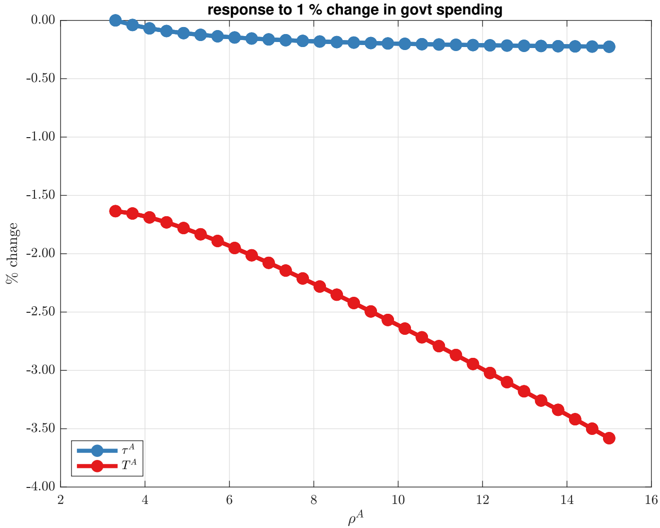

Figure: Response of the marginal tax rate τ_t^A and transfers to low types T_t^A to a 1 % increase in G_t.

Response to 1 % increase in TFP: First vs Second Best

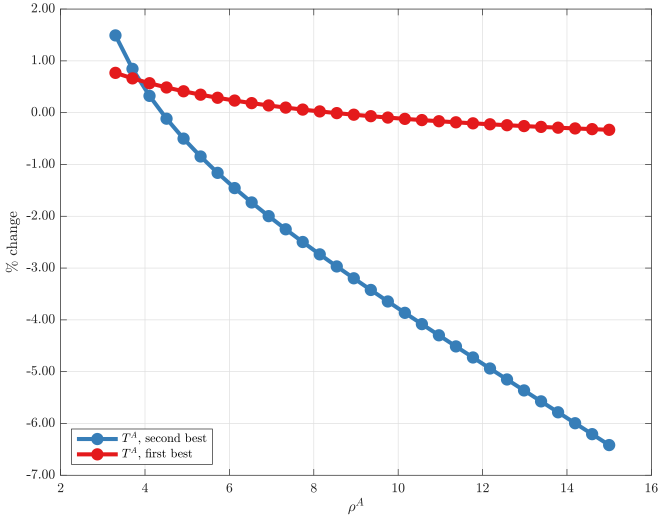

Figure: Response of transfers to low types T_t^A to a 1 % increase in Z_t.

Conclusions

- Preference heterogeneity important for procyclical marginal tax rates and countercyclical transfers.
- Higher risk aversion and lower IES for type A agents have similar effects on the current marginal taxes, but an opposite effect on future dynamics.
- Optimal tax systems in general depend on the history of aggregate shocks.