Fiscal Policy with Heterogenous Agents and Incomplete Markets

Sean Flynn

NYU

Methodology

- Goal:
  - To quantify the importance of distortionary taxation and capital market imperfections in generating deviations from Ricardian equivalence
- Approach:
  - The author considers six infinite horizon, heterogenous agent models.
- Each model employs a different permutation of the following assumptions:
  - Incomplete markets vs. complete markets
  - Endogenous labor vs. exogenous labor
  - Fixed factor prices vs. Endogenous factor prices
  - Lump Sum taxes vs. Proportional taxes

Benchmark Model

- Features
  - Proportional taxes, IM, endogenous labor supply, endogenous factor prices
  - Measure 1 of infinitely-lived agents
  - HH saves through 2 Assets – capital and government debt
  - Stochastic tax rate
  - Zero-borrowing constraint

Individual States

- Individual states:
  - Asset holdings
  - Idiosyncratic productivity
- 3-state Markov process for productivity

$$e^t \equiv \{e_0, \ldots, e_t\}$$

$$e_s(e^t) \equiv \text{the sth element of the sequence}$$

$$m^t(e^t) \equiv \text{probability of individual history } e^t$$

$$\prod \equiv \text{transition matrix}$$

$$p_t \equiv \text{probability distribution over the 3 states at t}$$

Aggregate States

- Aggregate states
  - Date 0 (z_0)
    - Initial distribution of HH's across individual states
    - Initial level of government debt
  - Date t
    - History of the tax rate from date 0 up to t
- Markov process for tax rate

$$h^t = \text{aggregate history to date t}$$
$$t_s(h^t) = \text{the sth element of this sequence}$$
$$v^t(h^t : z_0) = \text{probability of aggregate history } h^t$$

Preferences

Expected discounted utility:

$$\sum_{t=0}^{\infty} b^{t} \sum_{h^t \in H^t} v^t(h^t) \sum_{e^t \in E^t} m^t(e^t) u(c_t(h^t, e^t), n_t(h^t, e^t))$$

GHH utility function:

$$u(c,n) = \frac{1}{1-g}\left[\left(c - y\,\frac{n^{1+1/e}}{1+1/e}\right)^{1-g} - 1\right]$$

Budget constraint: $c_t(h^t, e^t) + a_t(h^t, e^t) =$

$$[1+(1-t_t(h^t))r_t(h^t)]a_{t-1}(h^{t-1}, e^{t-1}) + (1-t_t(h^t))w_t(h^t)e_t(e^t)n_t(h^t, e^t)$$

$\forall e^t \in E^t$ such that $e^t \succ e^{t-1}$, $\forall h^t \in H^t$ such that $\mathrm{h}^t \succ h^{t-1}$, $\forall t$

Model

- Production
  - Aggregate output: $Y_t(h^t) = K_{t-1}(h^{t-1})^a N_t(h^t)^{1-a}$
  - RC: $C_t(h^t) + G_t(h^t) + K_t(h^t) = Y_t(h^t) + (1-d)K_{t-1}(h^{t-1})$
- Government
  - Constant government spending
  - Stochastic taxes
  - Real government bonds
  - Budget constraint:

$$B_t(h^t) + \mathbf{t}_t(h^t)\left[r_t(h^t)A_{t-1}(h^{t-1}) + w_t(h^t)N_t(h^t)\right] = (1 + r_t(h^t))B_{t-1}(h^{t-1}) + g$$

Process for taxes

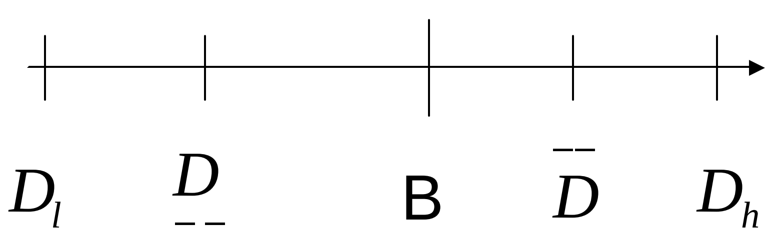
- Constant bounds D for level of government debt (Let $\text{D} = [D_l , D_h]$)
- Markov process for tax rate such that if initial government debt is bounded by D, so is all future debt

$$B_t(h^t) \text{ close to } D_h \Rightarrow t_{t+1}(h^{t+1}) \text{ will be high}$$

$$p_t((t, B), t') \equiv \text{time invariant transition function for taxes}$$

Process for Taxes

	$B \le \underline{D}$	$\underline{D} < B < \overline{D}$	$B \ge \overline{D}$
$p_t((t_h, B), t_h)$	0	$\left[\dfrac{B - \underline{D}}{\overline{D} - \underline{D}}\right]^l$	1
$p_t((t_l, B), t_l)$	1	$\left[\dfrac{\overline{D} - B}{\overline{D} - \underline{D}}\right]^l$	0



$, \; l \in (0,1]$

Equilibrium

- A set of functions, probability measures, and initial aggregate states such that

$$\forall h^t \in H^t, \forall e^t \in E^t, \forall a_{-1} \in A, \forall t = 0,1,...$$

1. The decision rule functions $\{a_t, c_t, n_t\}$ solve the HP

2. $\{m^t(\cdot)\}_{t=0}^{\infty}$ is consistent with the transition matrix Π

3. $\{v^t(\cdot)\}_{t=0}^{\infty}$ is consistent with the transition function p_t

Equilibrium

4. Aggregate quantities are consistent with individual decision rules

$$A_t(h^t) = \int_{AxE} \sum_{e^t \in E^t} m^t(e^t) a_t(h^t, e^t) d\, l$$

$$C_t(h^t) = \int_{AxE} \sum_{e^t \in E^t} m^t(e^t) c_t(h^t, e^t) d\, l$$

$$N_t(h^t) = \int_{AxE} \sum_{e^t \in E^t} m^t(e^t) e_t(e^t) n_t(h^t, e^t) d\, l$$

5. Market for savings clears

$$K_{t-1}(h_{t-1}) + B_{t-1}(h^{t-1}) = A_{t-1}(h^{t-1})$$

6. Factor markets clear

7. Goods market clears

8. Government budget constraint is satisfied

Calibration – Tax Process

- Simultaneously choose parameters:

$$g, t_l, t_h, D_h, D_l, l$$

- To approximately satisfy six criteria
  - Average ratio of tax revenue to GDP
  - First order autocorrelation and std. deviation of the ratio of tax revenue to GDP
  - Average ratio of government debt to GDP
  - High tax and low tax regimes are equally persistent
  - Debt remains bounded for every possible history for tax rates h^t

Numerical Solution

- Het agents, IM, and aggregate uncertainty ➔ Krusell and Smith (1998)
- Instead of h^t, agents solve the HP with information on:

$$Z_t = (K_{t-1}(h^{t-1}), B_{t-1}(h^{t-1}), t_t(h^t))$$

– So, agents correctly compute current prices:

$$1.\ N_t(h^t) = \left(\sum_{i=1}^{3} p_i^* e_i^{1+e} \left[\frac{(1-a)K_{t-1}(h^{t-1})^a (1-t_t(h^t))}{y} \right]^e \right)^{\frac{1}{1+ae}}$$

$$2.\ w_t(h^t) = (1-a)K_{t-1}(h^{t-1})^a N_t(h^t)^{-a}$$

$$3.\ r_t(h^t) = a K_{t-1}(h^{t-1})^{a-1} N_t(h^t)^{1-a} - d$$

Recursive HP

$$V(s,Z) = \max\left\{u(c,n) + b\,E[V(s',Z') \mid s,Z]\right\}$$

subject to

$$c + a' = [1 + r(Z)(1 - t(Z))]a(s) + (1 - t(Z))w(Z)e(s)n$$

$$c \geq 0,\; a' \in A,\; \mathrm{n} \in [0,1]$$

Taking as given:

1. The Markov processes $\prod$ and p_t

2. The standard functions for factor prices

$$r(Z) = a\,K(Z)^{a-1} N(Z)^{1-a} - d$$
$$w(Z) = (1-a)K(Z)^{a} N(Z)^{-a}$$

Recursive HP

Taking as given:

3. An aggregate decision rule for labor

$$N(Z) = \left(\sum_{i=1}^{3} p_i^* e_i^{1+e} \left[\frac{(1-a)K(Z)^a (1-t(Z))}{y} \right]^e \right)^{\frac{1}{1+ae}}$$

4. The LOM for government debt

$$B(Z') = \underbrace{(1+r(Z))B(Z)+g}_{\text{Government outlays last period}} - \underbrace{t(Z)[r(Z)(K(Z)+B(Z))+w(Z)N(Z)]}_{\text{Total tax revenue last period}}$$

5. The LOM for aggregate capital of the form

$$\ln(K(Z')) = a_0 + a_1 \ln(K(Z)) + a_2 \ln(B(Z)) + a_3 \ln(t(Z))$$

Comparison #3: CM vs. IM (Prop taxes, endog labor and factor prices)

Table 8. Responses to tax cuts: economies with proportional taxes

	Percentage change on impact					*PCT*
	Tax rev.	Hours	GDP	Cons	Inv	$\frac{100\times(C_t - C_{t-1})}{(T_t - T_{t-1})}$
Incomplete Markets	-6.24	0.97	0.62	0.92	0.56	-28.8
Complete Markets	-6.39	0.91	0.57	0.71	0.80	-23.2