Topic for Today

1.) Ricardian Equivalence

Dynamic Effects of Fiscal Policy

- Fiscal policy has been in the news a lot recently. There has been much debate about the appropriate fiscal policy response to the recent financial crisis. Some argue in favor of more govt. spending. Some argue in favor of lower taxes. Some argue that the resulting deficits + debt will be disastrous. Others argue that govt. debt is neutral, etc.

- We now use our knowledge of Dynamic Stochastic General Equilibrium (DSGE) models to shed light on some of these questions. The analysis proceeds in 4 steps:

  1.) Lump-Sum Taxes (Ricardian Equivalence)

  2.) Exogenous Flat Rate Taxes

  3.) Optimal Flat Rate Taxation (Ramsey Taxation)

  4.) Optimal Taxation with Informational Frictions (Mirrlees)

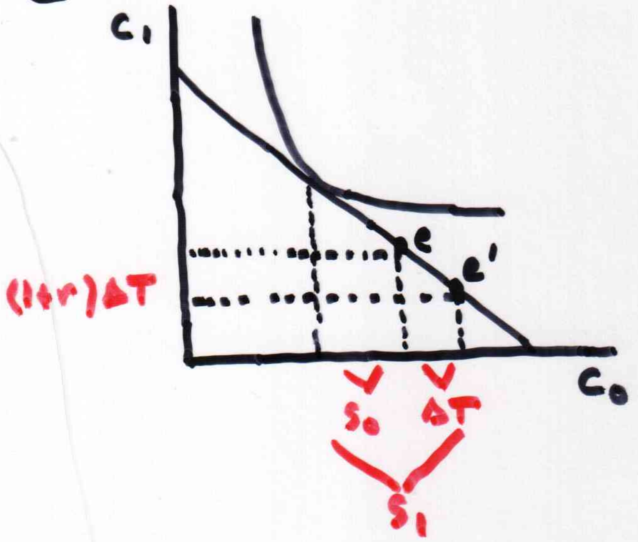
- Analysis of distortionary taxation requires a change in methodology. So far, we have exploited the 2nd Welfare Theorem when studying Competitive Equilibria. With distortionary taxation, this methodology is inapplicable. Instead, we must work directly with a system of first-order conditions and budget + resource constraints.

Ricardian Equivalence

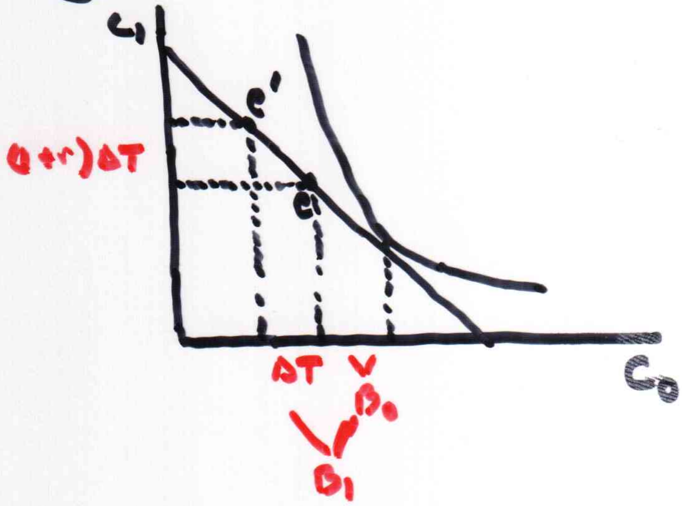
- With lump-sum taxation, the only real issue is whether the timing of taxes matters. With (effectively) infinite-horizon agents + perfect capital markets we know the timing of taxes is irrelevant. Only the level + timing of govt. spending matters, not how its financed. This irrelevance of govt. debt policy is called "Ricardian Equivalence".

Examples

1. TAX CUT

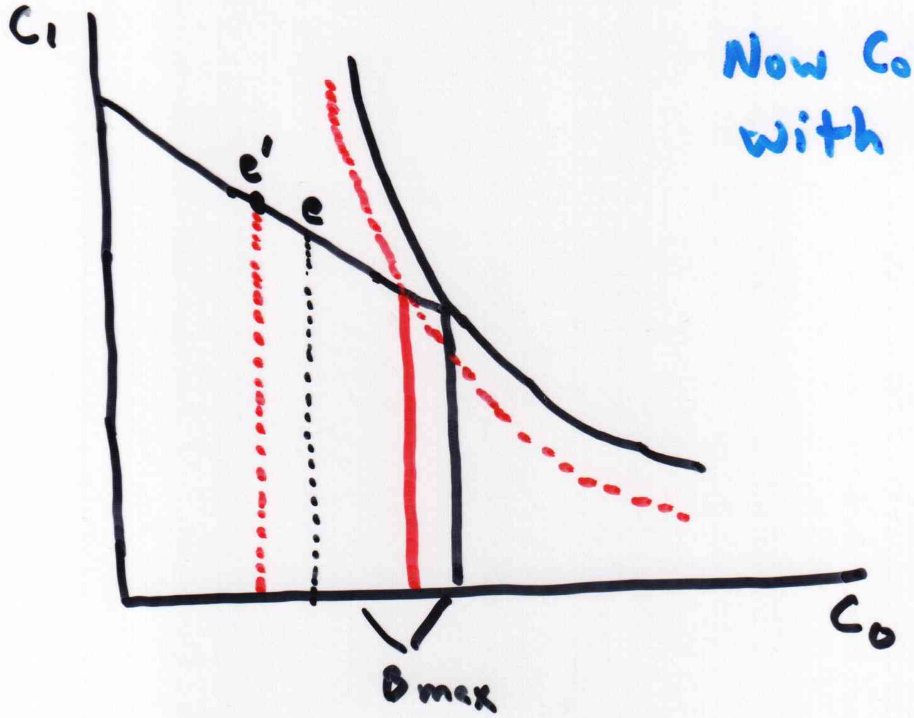


2. TAX INCREASE



- With perfect capital mkts, a change in the timing of taxes just shifts the (after-tax) endowment point of the household, without changing the budget constraint. Hence, it has no effect on consumption or national saving. The household just saves a tax cut (govt. dissaving), or borrows in response to a tax increase (govt. saving).

• Hence, it is more interesting to consider the possibility of imperfect capital mkts. Specifically, suppose households face borrowing constraints. Then we can easily see that Ricardian Equivalence might not hold. Consider a tax increase:



Now $c_0 \downarrow$ one-for-one with $\tau_0 \uparrow$

• In what follows, we extend this analysis to an infinite horizon. Analysis of borrowing constraints in infinite horizon models is a little harder. We first have to understand how households respond to borrowing constraints.

Borrowing Constraints

- We first study how an individual household responds to borrowing constraints.

Assumptions

1.) Interest Rate is exogenous, constant, & $R \cdot \beta = 1$

2.) No uncertainty. Income is deterministic.

Preferences & Budget Constraint

$$\max_{c_t} \sum \beta^t u(c_t)$$

$$\text{s.t.} \quad c_t + R^{-1} b_{t+1} = y_t + b_t$$

b_t: stock of riskless assets at time t

Two Kinds of Borrowing Constraints

1.) "Natural" Borrowing Constraint: Without uncertainty it obviously can't be the case that debt gets so large that the agent cannot repay, even if consumption is zero from now on. Setting $c_t = 0$ in the budget constraint & iterating forward

$$b_t \geq -\sum_{j=0} R^{-j} y_{t+j} \quad \text{for all } t$$

2.) No Borrowing Constraint: Here the household can't borrow at all. It can only lend. Hence $b_t \geq 0 \ \forall t$.

- Note, with borrowing constraints our Euler equation becomes an Euler <u>inequality</u>:

$$\boxed{u'(c_t) \geq \beta R u'(c_{t+1})}$$

- When the constraint binds, the inequality is strict.

In general, solving models like this is very difficult, since one must constantly check Kuhn-Tucker/complementary-slackness conditions.

In practice, a guess & verify strategy is usually employed:

1.) Solve assuming the constraints don't bind
2.) Check to see if they bind at any point
3.) If not, you've done. If so, then make adjustments where necessary, solve again, and check to see if any other violations occur.

- It's hard to see this in the abstract, so let's consider some examples.

Examples

1.) $\boxed{y_t = \{y_h, y_\ell, y_h, y_\ell\}}$ where $y_h > y_\ell$. $b_0 = 0$ $\beta R = 1$
$\boxed{b_t \geq 0 \ \forall t}$

$$\sum_{t=0}^{\infty} \beta^t y_t = \sum_{t=0}^{\infty} \beta^{2t}(y_h + \beta y_\ell) = \frac{y_h + \beta y_\ell}{1-\beta^2}$$

Conjecture perfect consumption-smoothing,

$$\frac{\bar{c}}{1-\beta} = \frac{y_h + \beta y_\ell}{1-\beta^2} \implies \bar{c} = \frac{y_h + \beta y_\ell}{1+\beta}$$

Use budget constraint to check for violation of constraint

$$\bar{c} + \beta b_{t+1} = y_h + b_t \quad \text{even periods}$$

$$\bar{c} + \beta b_{t+1} = y_\ell + b_t \quad \text{odd periods}$$

$$\implies b_{t+1} = \frac{y_h - y_\ell}{1+\beta} \quad \text{in even periods}$$

$$= 0 \quad \text{in odd periods}$$

$\implies$ constraint never binds

2.) Again suppose $b_t \geq 0$ is the constraint, but now suppose $\boxed{y_t = \{y_\ell, y_h, y_\ell, y_h, \cdots\}}$.

Applying the same steps as before you will find $b_{t+1} = \frac{y_\ell - y_h}{1+\beta} < 0$ in even periods, which violates the borrowing constraint.

Instead, the optimal policy is to set $c_0 = y_\ell$ and so $b_1 = 0$, and then proceed as in Example 1.

3.) $\boxed{y_t = \lambda^t \text{ where } 1 < \lambda < R.}$ $b_0 = 0$.

Suppose $b_t \geq 0$ is the constraint.

PDV of endowment: $\sum_{t=0}^{\infty} \beta^t \lambda^t = \frac{1}{1-\lambda\beta}$

Guess perfect consumption smoothing

$$\frac{\bar{c}}{1-\beta} = \frac{1}{1-\lambda\beta} \implies \bar{c} = \frac{1-\beta}{1-\lambda\beta}$$

Plug into budget constraint

$$b_t = \frac{1-\lambda^t}{1-\lambda\beta} < 0 \implies \text{Not feasible}$$

Optimal constrained soln: $c_t = \lambda^t$, $b_t = 0$ (constraint always binds)

(4.) Same as example (3) $[y_t = \lambda^t, \quad 1 < \lambda < R]$, except now assume the constraint is the "Natural" debt limit

$$\tilde{b}_t = \frac{-\lambda^t}{1-\lambda\beta}$$

Notice from above that the optimal (unconstrained) debt path is

$$b_t = \frac{1-\lambda^t}{1-\lambda\beta} > \tilde{b}_t$$

Therefore, the Natural Debt constraint is never binding.

(5.) Now suppose $y_t = \lambda^t$, but with $\lambda < 1$. Clearly, the optimal (unconstrained) plan is now feasible even when the constraint is $b_t \geq 0$.

Borrowing Constraints + Ricardian Equivalence

- Let's now incorporate the govt.

Household's Problem

lump-sum tax

$$\max_{c_t} \sum_{t=0}^{\infty} \beta^t u(c_t) \quad \text{s.t.} \quad c_t + R^{-1} b_{t+1} \leq y_t - \tau_t + b_t$$

b_t = bond holdings at time-t

b_0 given

Iterate budget constraint forward,

$$b_t \geq \sum_{j=0}^{\infty} R^{-j} \left(c_{t+j} + \tau_{t+j} - y_{t+j} \right)$$

And the Natural debt constraint becomes

$$b_t \geq - \sum_{j=0}^{\infty} R^{-j} \left(y_{t+j} - \tau_{t+j} \right) = \tilde{b}_t$$

Government's Problem (g_t enters additively)

$$\boxed{B_t + g_t = \tau_t + R^{-1} B_{t+1}}$$

govt. debt

} Note, same R as for household

$$\Rightarrow \quad \boxed{B_{t+1} - B_t = r B_t + (1+r)[g_t - \tau_t]}$$

$R = (1+r)$

Iterate forward,

$$\boxed{B_t = \sum_{j=0}^{\infty} R^{-j}(\tau_{t+j} - g_{t+j}) \quad \forall t}$$

} Debt must equal PDV of future primary surpluses

Definition: Given initial conditions (b_0, B_0), an equilibrium, is a household plan $\{c_t, b_{t+1}\}$ and a govt. policy $\{g_t, \tau_t, B_{t+1}\}$ such that:

a.) The govt. policy satisfies the govt's. intertemporal budget constraint

b.) Given τ_t, the household's plan is optimal.

Proposition 1: Suppose households are subject to "natural" debt limits. Given (b_0, B_0), let $\{\bar{c}_t, \bar{b}_{t+1}\}$ and $\{\bar{g}_t, \bar{\tau}_t, \bar{B}_{t+1}\}$ be an equilibrium. Now consider any other tax policy $\{\hat{\tau}_t\}$ satisfying:

$$\sum_{t=0}^{\infty} R^{-t}\hat{\tau}_t = \sum_{t=0}^{\infty} R^{-t}\bar{\tau}_t \qquad (*)$$

Then $\{\bar{c}_t, \hat{b}_{t+1}\}$ and $\{\bar{g}_t, \hat{\tau}_t, \hat{B}_{t+1}\}$ is also an equilibrium, where

$$\hat{b}_t = \sum_{j=0}^{\infty} R^{-j}(\bar{c}_{t+j} + \hat{\tau}_{t+j} - y_{t+j})$$

$$\hat{B}_t = \sum_{j=0}^{\infty} R^{-j}(\hat{\tau}_{t+j} - \bar{g}_{t+j})$$

<u>Proof</u>: Straight from the budget constraints,

$$b_0 = \underbrace{\sum_{t=0}^{\infty} R^{-t}(c_t - y_t)}_{\text{doesn't change given } (*)} + \sum_{t=0}^{\infty} R^{-t}\tau_t$$

$$B_0 = \sum_{t=0}^{\infty} R^{-t}\tau_t - \underbrace{\sum_{t=0}^{\infty} R^{-t} g_t}_{\text{doesn't change given } (*)}$$

- Note, this result does <u>not</u> say that Ricardian Equiv. holds even with borrowing constraints. (The initial equil. could be constrained). It simply identifies an "equivalence class" of tax policies that yield the same equil. outcome for consumption.

- Not surprisingly, with a stricter borrowing constraint we get a weaker equivalence result.

<u>Proposition 2</u>: Suppose $b_t \geq 0$ is the borrowing constraint. Consider an initial equilibrium $\{\bar{c}_t\}$ in which $b_{t+1} > 0 \ \forall t \geq 0$. Let $\{\bar{\tau}_t\}$ be the tax policy in the initial equilibrium, and let $\{\hat{\tau}_t\}$ be any other tax policy such that

$$\hat{b}_t = \sum_{j=0}^{\infty} R^{-j}(\bar{c}_{t+j} + \hat{\tau}_{t+j} - y_{t+j}) \geq 0$$

for all $t \geq 0$. Then $\{\bar{c}_t\}$ is also an equilibrium for $\{\hat{\tau}_t\}$.

- In other words, any tax policy that does not lead to a violation of the borrowing constraint produces the same equil. consumption path.