Fiscal and monetary policy interaction with lump sum taxes

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Outline

- A shopping time model.
- Fiscal and monetary policies.
- A few comparative dynamic experiments.

References

Lijungquist, L. and T. Sargent (2004), *Recursive Macroeconomic Theory*, MIT Press, second edition, ch. 24.

Leeper, E. (2008), Lecture Notes, Indiana University.

Walsh, C (2003), *Monetary Theory and Policy*, MIT Press.

1 Some Preliminary

• Difficult to introduce fiat (inconvertible) money in competitive general equilibrium models with complete markets.

- Fiat money is an intrinsically useless piece of paper.

- Many commodities can be used as numeraire or as a medium of exchange (e.g. shells, cigarettes, etc.).

- Real rate of return on money = inverse of the inflation rate ≤ 1. That is, money is an asset which is dominated in rate of return (e.g. by physical capital).

• What do we need to change for money to have value in DSGE models?

Need frictions or trading restrictions.

- Goods must be bought with money and not with other commodities *Cash-in-advance (CIA) technology*. $c_t \leq \frac{M_t}{p_t}$.

- Goods can be purchased with money or other means, but if you use the latter need to devote time *Shopping-time (ST) technology*.

- Money gives utility - it proxies for future consumption *Money-in-the-utility (MIUF) function*. $U(c_t, l_t, \frac{M_t}{p_t})$. Reasonable? Realistic?

- There are non-competitive aspects (monopolistic competition) plus technological restrictions (Calvo pricing).

Here use ST technology. For alternatives, see Walsh, 2003 (chapters 4 and 5). The exact way money enters will not matter for what we derive.

Idea of ST: Time must be allocated between alternative activities (market work, leisure, home work, shopping). Time allocated shopping is an increasing function of the amount of goods purchased and a decreasing function of available real balances.

$$s_t = H(c_t, \frac{M_t}{p_t}) \equiv H(c_t, m_t) \tag{1}$$

with $H, H_c, H_{cc}, H_{mm} \geq 0; H_m, H_{mc} \leq 0$ (that is, H is convex). M_t nominal balances chosen at time t (m_t real balances).

Example 1.1 *Baumol and Tobin transaction function.*

$$H(c_t, m_t) = \frac{c_t}{m_t}\epsilon \tag{2}$$

$\epsilon > 0$. *When a household spends money holdings for consumption at a constant rate* c_t *per unit of time,* $\frac{c_t}{m_t}$ *is the number of trips to the bank which are needed to finance* c_t *and* ϵ *the time cost per trip to the bank.*

- Shopping time technology is a reduced form (black box) setup.

2 A simple model

- Constant endowment, $y_t = y > 0$.

- No uncertainty.

- Shopping time constraint.

- Lump sum taxes/transfers available

Preferences: $\sum_t \beta^t u(c_t, l_t)$,

$0 < \beta < 1, u_c, u_l > 0, u_{cc}, u_{ll} < 0, u_{cl} \geq 0$.

Constraints:

- Shopping time: $s_t = H(c_t, m_t)$. H is convex, i.e. $H, H_c, H_{cc} H_{mm} \geq 0$, $H_m, H_{cm} \leq 0$.

- Time constraint: $l_t + s_t = 1$.

- Budget constraint: $c_t + \frac{B_t}{R_t} + \frac{M_t}{p_t} = y_t - Z_t + B_{t-1} + \frac{M_{t-1}}{p_t}$

B_t are one period real bonds, p_t the price level, Z_t lump sum taxes; $m_t \equiv \frac{M_t}{p_t} \geq 0$ (household can't issue currency), B_t unrestricted.

Let λ_t be the multiplier for BC and μ_t the multiplier for ST.

Let $R_{mt} = \frac{p_t}{p_{t+1}}$ be the return on the currency. The budget constraint can be written as

$$c_t + \frac{B_t}{R_t} + m_t = y_t - Z_t + B_{t-1} + m_{t-1}R_{mt-1}$$

Optimality requires:

1)$1 - \frac{R_{mt}}{R_t} = \frac{i_t}{1+i_t} \geq -\frac{\mu_t}{\lambda_t} H_{mt} \geq 0$ (arbitrage between m and B)

2) $\lambda_t = u_{ct} - u_{lt} H_{ct}$ (consumption leisure trade-off)

3) $R_t = \beta^{-1}[\frac{\lambda_t}{\lambda_{t+1}}]$ (intertemporal consumption trade-off)

1) implies that $i_t \geq 0$ i.e. nominal interest rate non-positive, and money is dominated by bonds in rate of return).

Combining the three first order conditions:

$$(1-\frac{R_{mt}}{R_t})[\frac{U_{ct}}{U_{lt}}-H_{ct}]+H_{mt}=0 \tag{3}$$

If we evaluate U_{ct} and U_{lt} at $l_t = 1 - H(c_t.m_t)$ (3) implicitly produces a money demand function

$$m_t = F(c_t, \frac{R_{mt}}{R_t}) = F(c_t, i_t) \tag{4}$$

with $F_c > 0, F_i < 0$.

Government:

$$g_t = Z_t + \frac{B_t}{R_t} - B_{t-1} + \frac{M_{t+1} - M_t}{M_t} \tag{5}$$

Equilibrium:

A price system $\{R_t, p_t\}_{t=0}^{\infty}$ and a allocation vector $\{c_t, M_t, B_t\}_{t=0}^{\infty}$ are an equilibrium if taking as exogenous $\{g_t Z_t\}_{t=0} \infty, B_{-1} = \bar{B}_{-1}, M_{-1} = \bar{M}_{-1}$

a) the consumer FOC are satisfied.

b) the government budget constraint holds.

c) the resource constraint $c_t + g_t = y_t$ is satisfied.

- To characterize equilibrium need to specify policy choice in detail.

- Assume $g_t = g, z_t = z, B_t = B$.

- Permit $Z_{-1} \neq Z, B_{-1} \neq B$.

- This allows to split analysis at time 0 (short run), and at stationary equilibrium (long run)

- Collapse an infinite horizon problem into a two period one ($t = 0, t \geq 1$).

Seek for an equilibrium where for all $t \geq 0$

$$\begin{aligned} \frac{p_t}{p_{t+1}} &= R_m && (6) \\ R_t &= R && (7) \\ c_t &= c && (8) \end{aligned}$$

Then consumers optimality conditions are

$$\begin{aligned} R &= \beta^{-1} && (9) \\ m_t &= F(c, \frac{R_m}{R}) = F(R_m) && (10) \end{aligned}$$

with $f' > 0$.

Plugging the money demand function into the government budget constraint for $t \geq 1$

$$D \equiv g - z + \frac{B(R-1)}{R} = f(R_m)(1 - R_m) \tag{11}$$

Plugging the money demand function into the government budget constraint at $t = 0$

$$\frac{M_{-1}}{p_0} = f(R_m) - (g - B_{-1} - Z_0) + \frac{B}{R} \tag{12}$$

Given g, z, B and $R = \beta^{-1}$ (11) determines R_m (inverse of inflation rate)

Given $g, z_0, B, M_{-1}, B_{-1}, R, R_m$ (11) determines p_0.

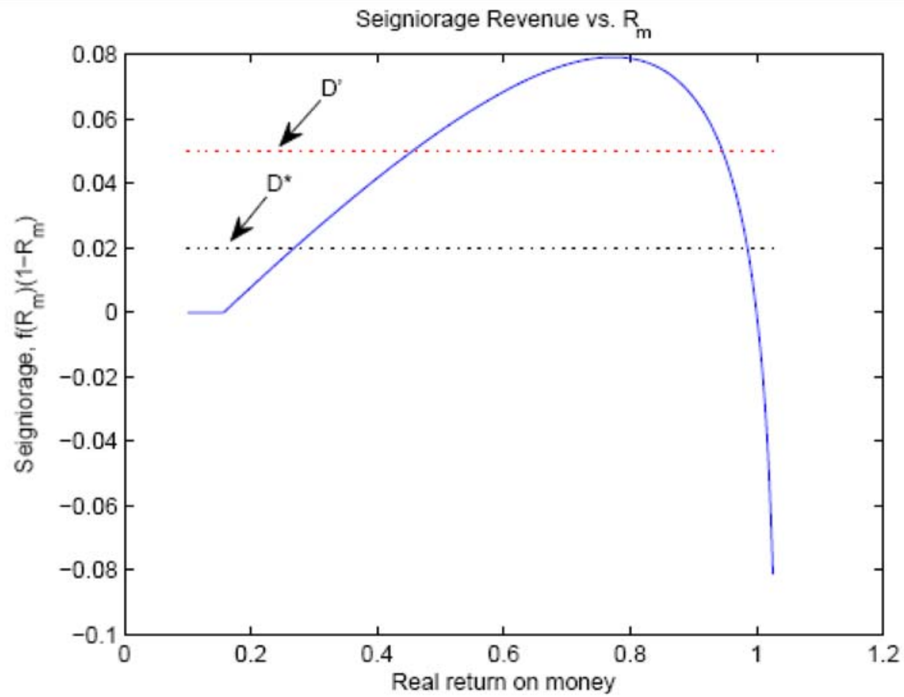
We have the whole sequence of $\{p_t\}_{t=0}^{\infty}$.

Assume $U(c_t, l_t) = \frac{c_t^{1-\sigma}}{1-\sigma} + \frac{l_t^{1-\gamma}}{1-\gamma}$.

Assume $H(c_t, m_t) = \frac{c_t}{1+m_t}$

Set $(\beta, \sigma, \gamma, c) = (0.96, 0.7, 0.5, 0.4)$.

Policy analysis 1: Deficit "cause" inflation.



- Suppose $D' > D$.

- On the normal side of the Laffer curve $D' > D$ implies $R'_m < R_m$.

- On the other side? Why is the Laffer curve non-monotone?

Policy analysis 2: Zero inflation policy.

Set $\pi = 0$ then $R_m = 1$ and seigniorage $=0$ Then $g - z + \frac{B(R-1)}{R} = 0$ or

$$B = \frac{R}{R-1}(z-g) = \sum_{t=1}^{\infty} R^{-t}(z-g) \tag{13}$$

- Real value of interest bearing government debt = present value of net-of-interest primary surpluses

- Inflation targeting requires fiscal responsibility. Have inflation targeting countries adopted fiscal policy consistent with the government budget constraint (at least in the steady state)?

Policy analysis 3: Unpleasant monetary arithmetic.

- Consider an open market sale of bonds at $t = 0$, $-dM_0 = dB_0 > 0$.

- Keep fiscal policy (g, z_0, z) fixed.

- Open market operation raise B in both (11) and (12)

- There is a higher debt service in the future

- With fixed fiscal policy, seigniorage must increase in the future $f(R_m)(1-R_m) = \frac{R-1}{R} dB$

- Then R_m falls (π increases).

$$\frac{M_{-1}}{p_0} = f(R_m) - (g - B_{-1} - Z_0) + \frac{B}{R} \tag{14}$$

Effect on p_0 unclear:

- if $f'(R_m)$ small, p_0 falls (usual result)

- if $f'(R_m)$ large, p_0 rises.

Conclusion: tighter money today can at best temporarily lower p at the cost of raising π in the future.

Policy analysis 4: Quantity theory of money.

Classic helicopter drop:

- change M_{-1} to $\lambda M_{-1}, \lambda > 1$

- keep (g, Z_0, Z, B) constant

If current p_0 increases by λ, $\frac{M_{-1}}{p_0}$ is unchanged and (12) is unchanged.

(11) is unchanged as well.

Conclusions: quantity theory holds. Money is neutral. It requires portfolio of assets to be unperturbed by the change in M (important).

Policy analysis 5: Optimum quantity of money

Friedman (1969): given (g, B), the household prefers equilibria where the return on money R_m is higher.

- By running a sufficiently large gross of interest surplus i.e. $g - z + B(R - 1)/R < 0$, the government can pay return on the currency in the interval $(1, \beta^{-1})$.

- Given (g, z) and the target value of R_m, z must produce the required surplus.

- In practice, the proceeds of the lump sum tax are used to retire currency in circulation (generating deflation).

- Optimal policy is the one that satiates households with real balances.

- Social value of money in the model is to reduce shopping time.

- Optimal quantity of money is the one that minimize the time allocated to shopping.

- Suppose there exist a satiation point in real balances equal to $\psi(c)$ for any level of c, i.e. $H_m(c, m) = 0, \ \forall m > \psi(c)$.

- The government can achieve this allocation if $R_m = R$, since $\lambda_t, \mu_t > 0$. So welfare is at the maximum if the economy is satiated with real balances.

(Note: with Baumol-Tobin function $H(c, m)$ no satiation point exists).

Policy analysis 6: Neutral OMO.

(redefine OMO so that monetary authority has fiscal power)

- Let $\bar{x}$ be the initial equilibrium and $\hat{x}$ the new equilibrium.

- Suppose $-dM_0 = dB_0 > 0$; suppose z_0 fixed and let z adjusts so that

$$1 - \frac{1}{R}(\hat{B} - \bar{B}) = \hat{z} - \bar{z} \tag{15}$$

If this is the case (11) satisfied at the initial R_m (i.e. $dz + dB(1 - \frac{1}{R}) = 0$).

Highlights a key aspect of conventional monetary policy analysis in NK models:

- Lump sum taxes are assumed to adjust in the future just enough to service any additional interest payment arising from OMO's effects on bonds.

- Fiscal policy is constant in the sense of unchanged gross-of interest quantities.

Policy analysis 7: Ricardian experiment.

- Consider a debt financed tax cut at $t = 0$ with future z adjusting

- Keep monetary policy fixed (no change in M)

- $-dz_0 = \frac{dB}{R}$; $dz = \frac{R-1}{R} dB$.

Both (11) and (12) are satisfied at initial R_m, p_0

Conclusion: if lump sum taxes in the future adjust to service the additional interest payment on the debt, tax cuts have no effects on prices or inflation. The presence of lump sum taxes crucial!

Policy analysis 8: A version of FTPL (Ljungqvist and Sargent).

- FTPL is about nominal government bonds. Here we discuss it in terms of indexed (real) bonds

- FTPL changes assumptions about which variables the government sets.

-Suppose monetary Policy commits to set the present value of seigniorage $f(R_m)(1 - R_m)$, so that B is endogenous. This is equivalent to peg inflation or the return on money (see later notes).

(Aside: earlier RE models said that pegging nominal rate implies price level indeterminacy.)

Rewrite (11) as

$$\frac{B}{R} = \frac{1}{R-1}[(Z-g)+f(R_m)(1-R_m)] \quad (16)$$

$$= \sum_{t=1}^{\infty} R^{-t}(z-g)+f(R_m)\frac{1-R_m}{R-1} \quad (17)$$

Substitute in (12) and impose that future policy restricts current policy through the value of the debt

$$\frac{M_{-1}}{p_0}+B_{-1}=\sum_{t=0}^{\infty} R^{-t}(z-g)+\sum_{t=1}^{\infty} R^{-t}f(R_m)\frac{1-R_m}{R-1}$$

Suppose government chooses (g, z, z_0, R_m) ($i = (\beta R_m)^{-1}$).

- B is determined by expected surpluses plus seigniorage. This determines p_0 given M_{-1}.

- Money demand is $\frac{M_0}{p_0} = F(y - g, \frac{R_m}{R})$.

- If M_0 is fixed, given R_m and R, if g changes p_0 adjusts.

- Analysis highlights the centrality of monetary fiscal interaction for the determination of equilibrium.

- Often ignored because

a) introduced inconvenient considerations.

b) make policy analysis more complicated.

c) deriving optimal monetary and fiscal policy is much harder than deriving optimal monetary policy,given that fiscal policy (lump sum taxes) adjusts to ensure fiscal sustainability.

Deviating from simple setup where lump sum taxes automatically adjust gives interesting conclusions.

3 Exercises

Exercise 1 *Consider the case of a stochastic shopping time economy, were the endowment of goods is random with mean $\bar{y}$ and variance σ_y^2.*

a) Set up the Lagrangian and derive the first order condition.

b) Derive the arbitrage condition, the consumption-leisure trade-off and the money demand. How would equations (11)-(12) look like in this case.

c) Would the result of a quantity theory experiment and of increasing the deficit change in this case? Why?

Exercise 2 *Describe the effect of a steady state increase in output and in the return on goverment bonds on equations (11) and (12). Explain how the quantitative conclusions obtained in the zero targetting inflation and unpleasant monetary arithmetic experiments would be affected if steady state output would be higher.*

Exercise 3 *Consider the same shopping time technology describe in this notes but allow another margin in the model. That is, suppose that the time constraint is* $1 = l_t + H(c_t, \frac{M_t}{p_t}) + n_t$ *and the production function is* $y_t = f(n_t) = n_t^{\alpha}$ *where* $\alpha < 1$. *Study (with the computer) the effect of a temporary increase in* g_t *financed with (i) money creation, (ii) tax increases, (iii) bond creation. (Hint: You need to define as a state variable the level of real (or nominal) goverment liabilities).*

Exercise 4 *(Empirical) Take data on inflation, the goverment deficit, the level of real goverment debt, the real interest rate for the last 15 years in the UK. Using the shopping time technology* $H(c_t, m_t) = \frac{c_t}{1+m_t}$ *check whether the use of inflation targetting has been accompanied by adjstment of fiscal policy which are consistent with the existence of a stationary equilibrium.*