Bringing Fiscal Policy into Monetary Policy

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Motivation

- So far, we always neglected the transversality condition
- The government budget constraint did not play much of a role either
- Time for them to take center stage

The household present-value budget constraint (PVBC): Start from periods 0 and 1...

- Period 0:

$$W_0 = M_0 + \frac{B_0}{1 + R_0} + E_0(z_{0,1} A_1)$$

- Period 1 (after multiplying by $z_{0,1}$ and taking expected value as of period 0):

$$E_0 \left[z_{0,1} \left(B_0 + M_0 + P(y_0 - c_{1\,0} - c_{2\,0}) + A_1 - T_1 \right) \right]$$
$$= E_0[z_{0,1} W_1] = E_0 \left[z_{0,1} \left(\frac{B_1}{1 + R_1} + M_1 + z_{1,2} A_2 \right) \right]$$

Combine periods 0 and 1

Substitute for $E_0(z_1 A_1)$:

$$W_0 = M_0(1 - E_0 z_{0,1}) + B_0\left(\frac{1}{1+R_0} - E_0 z_{0,1}\right) +$$
$$E_0\left[z_{0,1}\left(P(c_{1\,0} + c_{2\,0} - y_0) + T_1 + \frac{B_1}{1+R_1} + M_1 + z_{1,2}A_2\right)\right]$$

Note: no-arbitrage requires $\frac{1}{1+R_t} = E_t z_{t,t+1}$ So,

$$W_0 = M_0\frac{R_0}{1+R_0}$$
$$+E_0\left[z_{0,1}\left(P(c_{1\,0} + c_{2\,0} - y_0) + T_1 + \frac{B_1}{1+R_1} + M_1 + z_{1,2}A_2\right)\right]$$

... on to periods up to $J+1$...

$$W_0 = \sum_{s=0}^{J} E_0 z_{0,s} \frac{R_s}{1+R_s} M_s + \sum_{s=0}^{J} E_0 \left[z_{0,s+1} \left(T_{s+1} - P_s (y_s - c_{1s} - c_{2s}) \right) \right]$$

$$+ E_0 [z_{0,J+1} \left(\frac{B_{J+1}}{1+R_{J+1}} + M_{J+1} + z_{J+1,J+2} A_{J+2} \right)]$$

$$= \sum_{s=0}^{J} E_0 z_{0,s} \frac{R_s}{1+R_s} M_s + \sum_{s=0}^{J} E_0 \left[z_{0,s+1} \left(T_{s+1} - P_s (y_s - c_{1s} - c_{2s}) \right) \right]$$

$$+ E_0 [z_{0,J+1} W_{J+1}]$$

... and to infinity

Use no-Ponzi to replace $E_0[z_{0,J+1}W_{J+1}]$ and take limit as $J \to \infty$:

- $E_0[z_{0,J+1}W_{J+1}] \geq -E_0[\sum_{s=J+1}^{\infty} z_{0,s+1}(P_s y_s - T_{s+1})]$
- $$W_0 \geq \sum_{s=0}^{J} E_0 z_{0,s}\frac{R_s}{1+R_s}M_s + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}\left(T_{s+1} - P_s y_s\right)\right] + \sum_{s=0}^{J} E_0\left[z_{0,s+1}p_s(c_{1s}+c_{2s})\right]$$
- $$W_0 \geq \frac{R_0}{1+R_0}M_0 + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}\left(T_{s+1} - P_s y_s\right)\right] + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}\left(p_s(c_{1s}+c_{2s}) + \frac{R_{s+1}}{1+R_{s+1}}M_{s+1}\right)\right]$$

Towards a government PVBC

- Repeat same steps on the government side
- Very similar, what is asset for household is liability for gov't
- No output, consumption (gov't does not trade in goods)
- Period 0 (note initial position of gov't is opposite of households, so the government owes W_0)

$$W_0 = M_0^S + \frac{B_0^S}{1+R_0} = M_0^S + B_0 E_0 z_{0,1}$$

- Period 1 (after multiplying by $z_{0,1}$ and taking exp value as of period 0)

$$E_0[z_{0,1}(B_0^S + M_0^S - T_1)] = E_0\left[z_{0,1}\left(z_{1,2}B_1^S + M_1^S\right)\right]$$

Combine periods

- Combine with period 1:

$$W_0 = M_0^S \frac{R_0}{1+R_0} + E_0 \left[z_{0,1} \left(T_1 + \frac{B_1^S}{1+R_1} + M_1^S \right) \right]$$

- On to periods up to $J+1$:

$$W_0 = \sum_{s=0}^{J} E_0 z_{0,s} \frac{R_s}{1+R_s} M_s^S + \sum_{s=0}^{J} E_0 z_{0,s+1} T_{s+1} +$$

$$+ E_0 [z_{0,J+1} \left(\frac{B_{J+1}}{1+R_{J+1}} + M_{J+1}^S \right)]$$

- Does gov't have a transversality condition?

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$$+ E_0 [z_{0,J+1} \left(\frac{B_{J+1}}{1+R_{J+1}} + M_{J+1}^S \right)]$$

- Does gov't have a transversality condition?
- Does gov't have a no-Ponzi condition?

Gov't PVBC

If we could say $\lim_{J\to\infty} E_0[z_{0,J+1}(B^S_{J+1}/(1+R_{J+1})+M^S_{J+1})]=0$, then get Gov't PVBC

$$W_0 = \frac{R_0}{1+R_0}M_0^S + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}\left(T_{s+1} + \frac{R_{s+1}}{1+R_{s+1}}M^S_{s+1}\right)\right]$$

Seigniorage (inflation tax):

$$\frac{R_0}{1+R_0}M_0^S + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}\frac{R_{s+1}}{1+R_{s+1}}M^S_{s+1}\right]$$

Seigniorage are revenues that gov't cashes because money is an interest-free loan

A different expression for seigniorage

$$\frac{R_0}{1+R_0}M_0^S + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}\frac{R_{s+1}}{1+R_{s+1}}M_{s+1}^S\right] =$$

$$M_0^S(1-E_0 z_{0,1}) + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}M_{s+1}^S(1-z_{s+1,s+2})\right] =$$

$$M_0^S + \sum_{s=0}^{\infty} E_0\left[z_{0,s+1}(M_{s+1}^S - M_s^S)\right]$$

- Seigniorage are revenues from printing money
- Notice: two definitions are equivalent ways of writing the same thing!

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- Households: no-Ponzi imposed because otherwise would get stuck in a debt spiral
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- Suppose real bound is imposed on taxes
- Debt is still a promise to money
  Can gov't print unlimited quantities of money?

The transversality condition under a money supply rule

- Under money supply rule, gov't cannot print unlimited money
- Then, taxes must adjust to meet budget constraint
- Limit on taxes $\Longrightarrow$ no-Ponzi condition, at least for debt:

$$\Longrightarrow \lim_{J \to \infty} E_0[z_{0,J} B_J^S] = 0$$

- Our example tax policy satisfied this (we had $B_t^S \equiv 0$)
- There are many others that would work, but, given prices, gov't must meet obligations

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- Even here, no need to back money with tax revenue

The transversality condition under an interest-rate rule

- Under interest-rate rule, money supply infinitely elastic
- Gov't can meet debt obligations by printing money
- $\Longrightarrow$ no-Ponzi constraint absent, transversality condition not imposed on gov't

A first peek at CB independence

- Right now, we have only a consolidated gov't budget constraint
- Treasury can't print money to repay debt
- CB can (though usually done in a round-about way)
- Independent CB $\Longrightarrow$ Treasury may face limit

One last important point

- B_t^S: nominal debt
- no-Ponzi applies to real debt (denominated in gold, foreign currency)

Does this matter?

- Households will exhaust their net worth, PVBC will hold as equality

$$\lim_{J\to\infty} E_0[z_{0,J+1} W_{J+1}] = 0$$

- Substitute market clearing:

$$\lim_{J\to\infty} E_0[z_{0,J+1} \left(\frac{B^S_{J+1}}{1+R_{J+1}} + M^S_{J+1} \right)] = 0$$

- Voilà: transversality condition obtained, write PVBC:

$$W_0 = \frac{R_0}{1+R_0} M^S_0 + \sum_{s=0}^{\infty} E_0 \left[z_{0,s+1} \left(T_{s+1} + \frac{R_{s+1}}{1+R_{s+1}} M^S_{s+1} \right) \right]$$

It does matter!

- Market clearing is an equilibrium condition
- Does not have to hold for all prices
- If gov't PVBC does not hold, what adjusts: prices or taxes?

What adjusts?

- Money supply rule, real debt, independent CB: taxes
- Otherwise: maybe taxes, maybe prices
- When prices adjust, fiscal theory of the price level (FTPL)

The FTPL with an interest rate peg

- We saw that setting a constant interest rate $\bar{R}$ would deliver indeterminate P_0 (and sunspots)
- Suppose now we set T_0 fixed, $T_t = \bar{T}P_{t-1}$ for some constant $\bar{T}$.
- Check transversality condition (or gov't PVBC): what prices are consistent with competitive equilibrium?

Gov't PVBC under fixed real taxes - 1

- Need to check

$$W_0 = \frac{\bar{R}}{1+\bar{R}} M_0 + \sum_{s=0}^{\infty} E_0 \left[z_{0,s+1} \left(P_s \bar{T} + \frac{\bar{R}}{1+\bar{R}} M_{s+1} \right) \right]$$

Gov't PVBC under fixed real taxes - 1

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- Use CIA, Friedman distortion:

$$M_s = P_s c_{1s} = P_s \bar{c}, \text{ where } \bar{c} := (u')^{-1}(1+\bar{R})$$

- Need to check

$$W_0 = \frac{P_0 \bar{c} \bar{R}}{1+\bar{R}} + \sum_{s=0}^{\infty} E_0 \left[z_{0,s+1} P_s \bar{T} \right] + \frac{\bar{c}\bar{R}}{1+\bar{R}} \sum_{s=0}^{\infty} E_0 \left[z_{0,s+1} P_{s+1} \right]$$

Gov't PVBC under fixed real taxes - 2

From CE conditions

- $\lambda_t P_t = u'(c_{1t}) = u'(\bar{c})$
- $z_{t,t+1} P_{t+1} = \beta \lambda_{t+1} P_{t+1} / \lambda_t = \beta P_t$ (note no expectation)
- Recursively, $z_{0,t+1} P_{t+1} = \beta^{t+1} P_0$ (also, $E_0(z_{s,s+1}) = 1/(1+\bar{R})$)

Substitute, need to check

$$W_0 = \frac{P_0}{(1-\beta)(1+\bar{R})}[\bar{c}\bar{R} + \bar{T}]$$

The FTPL in action

- Equation to check:

$$W_0 = \frac{P_0}{(1-\beta)(1+\bar{R})}[\bar{c}\bar{R} + \bar{T}]$$

- W_0 given (initial condition)
- $\bar{T}, \bar{R}$ given, $\bar{c}$ determined by $\bar{R}$
- $\implies$ at most one P_0 will work!
- Solution exists if $\text{sign}(W_0) = \text{sign}(\bar{T} + \bar{R}\bar{c})$

Economic intuition on the FTPL

- Initial nominal government liabilities: W_0
- Gov't PVBC: PV of gov't surpluses = liabilities
- Given fiscal policy, PV of taxes fixed real amount
- Seigniorage ($\bar{R}\bar{c}$) also fixed real amount
- Price level must be the ratio of nominal liabilities to real surpluses

More economic intuition on the FTPL

- Under the FTPL, bonds are claims to money
- Money (and thus bonds) is an entitlement to tax revenues, cannot be worthless
- Suppose P_0 above equilibrium level and $W_0 > 0$
- Gov't has excess resources $\Longrightarrow$ households do not have enough wealth to support their consumption
- $\Longrightarrow$ households cut back on their consumption
- Excess supply $\Longrightarrow$ prices go down, until equilibrium attains

Why intuition in previous slide is loose

- Previous slide describes a process by which the equilibrium is attained
- But this is really a mental process
- The economy is always in equilibrium
- "Starting from P_0 low" is a thought experiment, we do not model this

The FTPL and sunspots

- Without FTPL, under a fixed interest rate peg, we got lots of sunspot equilibria
- Sunspot equilibrium: inflation can be random
- Just as FTPL pins down P_0, it kills all sunspots as well (repeat algebra from period 1)

The FTPL and CB independence

- FTPL is the only complete theory of what pins down the price level
- Unpleasant feature: it's not CB, it's Treasury that matters!!

The effect of uncertainty and fiscal news: before the news breaks

- Introduce uncertainty in a single period,
  $T_{T+1} = P_T(\bar{T} + \tilde{T}_{T+1})$
- $\tilde{T}_{T+1}$ revealed at time $t < T + 1$, and $E_s \tilde{T}_{T+1} = 0$ for $s < t$
- Note: similar logic when $t = T + 1$, but equations a bit more involved because jump in taxes and jump in prices occur at the same time $\Longrightarrow$ jump in real taxes depends on jump in prices

Period 0

- We still get

$$W_0 = \frac{R_0}{1+R_0} M_0^S + \sum_{s=0}^{\infty} E_0 \left[z_{0,t+1} \left(T_{t+1} + \frac{R_{t+1}}{1+R_{t+1}} M_{t+1}^S \right) \right]$$

-

$$W_0 = \frac{P_0 \bar{c} \bar{R}}{1+\bar{R}} + \sum_{t=0}^{\infty} E_0 \left[z_{0,t+1} P_t T_{t+1} \right] + \frac{\bar{c}\bar{R}}{1+\bar{R}} \sum_{t=0}^{\infty} E_0 \left[z_{0,t+1} P_{t+1} \right]$$

- Risk neutrality crucial here ($z_{0,t+1} P_{t+1} = \beta^t P_0$)

$$W_0 = \frac{P_0 \bar{c} \bar{R}}{(1+\bar{R})(1-\beta)} + P_0 \sum_{t=0}^{\infty} \beta^t E_0 \left[T_{t+1} \right] = \frac{P_0 (\bar{c}\bar{R} + \bar{T})}{(1-\beta)(1+\bar{R})}$$

- Without risk neutrality, fiscal risk would have an effect on expected values

Subsequent periods

- Can verify that the PVBC holds for all periods $s \geq 0$:

$$W_s = \frac{R_s}{1+R_s} M_s^S + \sum_{v=s}^{\infty} E_s \left[z_{s,v+1} \left(T_{v+1} + \frac{R_{v+1}}{1+R_{v+1}} M_{v+1}^S \right) \right]$$

- But also (flow bc + mkt clearing)

$$W_{s+1} = W_s(1+R_s) - T_{s+1} - R_s M_s$$

Periods $0 < s < t$

- $$E_s T_v = \bar{T} \quad s \leq v, \quad s < t$$
- From PVBC
$$W_s = \frac{P_s}{(1-\beta)(1+\bar{R})}[\bar{c}\bar{R} + \bar{T}]$$
- From flow BC (and PV as of $s-1$)
$$W_s = W_{s-1}(1+\bar{R}) - P_{s-1}(\bar{T} + \bar{c}\bar{R}) = \frac{P_{s-1}\beta}{1-\beta}[\bar{c}\bar{R} + \bar{T}]$$
- Get $P_s = \beta P_{s-1}/(1+\bar{R})$

Periods $0 < s < t$

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- Get $P_s = \beta P_{s-1}/(1+\bar{R})$
- Same as Euler equation, but no uncertainty (sunspots not possible; here risk neutrality not important, just no news)

Period t

- $$E_t T_v = \bar{T} \quad v \neq T+1, \quad E_t T_{T+1} = \bar{T} + \tilde{T}_{T+1}$$
- From PVBC
$$W_t = \frac{P_t}{(1-\beta)(1+\bar{R})}[\bar{c}\bar{R} + \bar{T}] + \frac{\beta^{T-t}\tilde{T}_{T+1}P_t}{1+\bar{R}}$$
- From flow BC (and PV as of $t-1$)
$$W_t = \frac{P_{t-1}\beta}{1-\beta}[\bar{c}\bar{R} + \bar{T}]$$
- Get
$$\frac{1}{P_t} = \frac{1}{P_{t-1}}\left[\frac{1}{\beta(1+\bar{R})} + \frac{\beta^{T-t}(1-\beta)\tilde{T}_{T+1}}{\beta(1+\bar{R})(\bar{T}+\bar{c}\bar{R})}\right]$$
- Euler holds (expected value as of $t-1$), still no sunspots, price jumps on fiscal news

Period $s \geq t + 1$

- Homework
- Verify that $P_s = \beta P_{s-1}/(1 + \bar{R})$
- No uncertainty again, no sunspots

Patching up CB independence

- Is that a death knell for CB independence?

Patching up CB independence

- Is that a death knell for CB independence?
- CB retains control of inflation after time 0 (it is deterministic and equal to $\beta(1+\bar{R})$)
- Also, no more pesky sunspots

Combining local determinacy with FTPL

- Start from an active Taylor rule ($\alpha > 1$)
- Add a fiscal policy that prunes equilibria with very high or very low inflation
- On a day-to-day basis inflation responds the way it would in the locally-unique equilibrium

Active and Passive Monetary Policy Rules

- Recall Taylor principle for interest-rate rules:
  - $\alpha > 1$: strong response to inflation, Fisher equation is a divergent difference equation (except for SS)
  - $\alpha < 1$: weak response to inflation, Fisher equation is convergent
- When Fisher equation is divergent, we say that monetary policy is active
- When Fisher equation is convergent, we say that monetary policy is passive

Active and Passive Fiscal Policy Rules

- Same "active" and "passive" language applies to fiscal policy rules, but what is the relevant difference equation?

Active and Passive Fiscal Policy Rules

- Same "active" and "passive" language applies to fiscal policy rules, but what is the relevant difference equation?
- The gov't budget constraint!
- Define $H_t := E_0 \left[z_{0,t} \left(\frac{B_t^S}{1+R_t} + M_t^S \right) \right]$
- Get

$$H_t = H_{t-1} + E_0[M_{t-1}^S (z_{0,t} - z_{0,t-1})] - E_0[z_{0,t} T_t] = \\ H_{t-1} - E_0 \left[\frac{z_{0,t-1} M_{t-1}^S R_{t-1}}{1 + R_{t-1}} \right] - E_0[z_{0,t} T_t] \quad (1)$$

Initial condition

$$H_0 = \frac{B_0^S}{1+R_0} + M_0^S = W_0$$

Why do we write the budget constraint as in the previous slides?

Because it is the left-hand side that has to converge to 0 for PVBC to hold

Example of a Passive Fiscal Policy Rule

- Passive fiscal policy rule = difference equation converges to 0 no matter what P_0 is
- Technical assumption : $\lim_{R \to \infty} R(u')^{-1}(1+R) < \infty$
- $\implies$ implies $R(u')^{-1}(1+R) < \bar{S}$, i.e., seigniorage revenues are bounded

$$T_t = \gamma(M_{t-1}^S + B_{t-1}^S)$$

With $\gamma \in (0,1)$: taxes cover at least fraction γ of nominal liabilities

Verifying that the previous rule is passive - 1

Substitute fiscal policy rule

$$
\begin{aligned}
H_t =& H_{t-1} - E_0\left[z_{0,t-1}\left(\frac{M^S_{t-1}R_{t-1}}{1+R_{t-1}} + \gamma\frac{M^S_{t-1}+B^S_{t-1}}{1+R_{t-1}}\right)\right] \\
=& (1-\gamma)H_{t-1} - (1-\gamma)E_0\left[z_{0,t-1}\frac{M^S_{t-1}R_{t-1}}{1+R_{t-1}}\right], \quad t>0
\end{aligned}
$$

Verifying that the previous rule is passive - 2

From competitive equilibrium

$$z_{0,t-1} = \frac{\beta^{t-1}(1+R_{t-1})P_0}{P_{t-1}(1+R_0)}$$

$$H_t = (1-\gamma)\left(H_{t-1} - (1+R_0)^{-1}\beta^{t-1}\frac{R_{t-1}M^S_{t-1}P_0}{P_{t-1}}\right), \quad t > 0$$

Use Friedman distortion, CIA if $R_t > 0$, and technical assumption:

$$|H_t| \leq (1-\gamma)|H_{t-1}| + (1-\gamma)\beta^{t-1}(1+R_0)^{-1}P_0\bar{S}, \quad t > 0$$

Verifying that the previous rule is passive - 3

$$|H_t| \leq (1-\gamma)^t |H_0| + (1+R_0)^{-1} P_0 \bar{S} \sum_{s=0}^{t-1} \beta^s (1-\gamma)^{t-s} =$$

$$(1-\gamma)^t \left[|H_0| + \frac{(1+R_0)^{-1} P_0 \bar{S} \left(1 - \left(\frac{\beta}{1-\gamma}\right)^t\right)}{1 - \frac{\beta}{1-\gamma}} \right] =$$

$$(1-\gamma)^t \left[|H_0| + \frac{(1+R_0)^{-1} P_0 \bar{S}}{1 - \frac{\beta}{1-\gamma}} \right] - \frac{\beta^t (1+R_0)^{-1} P_0 \bar{S}}{1 - \frac{\beta}{1-\gamma}} \rightarrow_{t\rightarrow\infty} 0.$$

Active Fiscal Policy Rule

- Active fiscal policy rule = difference equation does not converge to 0, except for one value of P_0
- Example: $T_t = \bar{T} P_{t-1}$ (with $R_t = \bar{R}$)

A Difference between Exploding Paths

- Paths where inflation explodes according to

$$(\log \pi_{t+1} - \log \bar{\pi}) = \alpha(\log \pi_t - \log \bar{\pi})$$

are not ruled out by any equilibrium conditions

- Paths where debt explodes according to

$$H_t = H_{t-1} = H_{t-1} - E_0 \left[\frac{z_{0,t-1} M^S_{t-1} R_{t-1}}{1 + R_{t-1}} \right] - E_0[z_{0,t} T_t]$$

violate the households' transversality condition, ruled out by equilibrium

A Weaker Notion of Active Fiscal Policy

- Compute equilibrium difference equation for W_t/P_t
- Fiscal policy active if the difference equation is explosive
- Adopted by Bianchi, Melosi and coauthors, sometimes Leeper and coauthors,...
- Rationale: equilibria with exploding household wealth are weird...
- ... but they are still equilibria, unless the explosion is sufficiently fast to violate transversality

A Final Classification

	Fiscal Policy	
	Passive	Active (strong sense)
Interest-rate rule: Passive	Indeterminacy	Uniqueness
Interest-rate rule: Active	Local uniqueness	Uniqueness, explosive