Norges Bank Mini-Course: Monetary & Fiscal Policy Interactions IV

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Spring 2013
So far we have taken outright default off the table. We have argued that Euro area countries effectively issue real debt without fiscal reforms, default is only option. Now explicitly integrate default & nominal debt, independent central bank, fiscal policy that might be active.

Notes draw on
- Bi, Leeper, Leith (2010), manuscript, “Stabilization versus Sustainability: Macroeconomic Policy Tradeoffs”
When fiscal policy active & default is possible, under what kind of monetary policy will debt be default-free?

- target current inflation
- target expected inflation
- target price level

The economy

- closed, endowment, flexible prices, nominal debt, cashless limit
 Uribe: Model

Households maximize

\[ E_0 \sum_{t=0}^{\infty} \beta^t U(c_t), \quad 0 < \beta < 1 \]

subject to

\[ P_t c_t + E_t r_{t+1} D_{t+1} + P_t \tau_t \leq D_t + P_t y_t \quad (1) \]

\[ \lim_{j \to \infty} E_t q_{t+j} D_{t+j} \geq 0 \quad (2) \]

\[ q_t \equiv r_1 r_2 \cdot \ldots \cdot r_t, \quad q_0 \equiv 1 \]

endowment: \( y_t \equiv y \); lump-sum taxes: \( \tau_t \); complete contingent claims, \( r_{t+1} \) is stochastic discount factor; \( E_t r_{t+1} D_{t+1} \) is price at \( t \) of random nominal payment of \( D_{t+1} \) at \( t + 1 \); (2) rules out Ponzi schemes
Uribe: Model

- Household chooses \( \{c_t, D_t\} \) to maximize utility subject to (1) & (2), taking \( \{P_t, r_{t+1}, \tau_t\} \) & \( D_0 \) as given
- Fiscal policy: set \( g_t \equiv 0 \) & taxes according to
  \[
  \tau_t - \bar{\tau} = \rho(\tau_{t-1} - \bar{\tau}) + \varepsilon_t, \quad \rho \in [0, 1) \tag{3}
  \]
- Default: government may default on fraction \( \delta_t \) of its liabilities
- Government budget constraint is
  \[
  B_t = R_{t-1}B_{t-1}(1 - \delta_t) - P_t\tau_t, \quad \text{given} \quad R_{-1}B_{-1} \tag{4}
  \]
Impose equilibrium, $c_t = y$, to obtain conditions

$$r_{t+1} = \beta \frac{P_t}{P_{t+1}}$$  \hspace{1cm} (5)

$$1 = \beta R_{t+1}^f E_t \frac{P_t}{P_{t+1}}$$  \hspace{1cm} (6)

$$1 = \beta R_t E_t (1 - \delta_{t+1}) \frac{P_t}{P_{t+1}}$$  \hspace{1cm} (7)

$$D_t = R_{t-1} B_{t-1} (1 - \delta_t)$$  \hspace{1cm} (8)

$$\lim_{j \to \infty} \beta^{t+j+1} E_t R_{t+j} (1 - \delta_{t+j}) \frac{B_{t+j}}{P_{t+j}}$$  \hspace{1cm} (9)

plus (4) and policy rules

An equilibrium is sequences $\{P_t, B_t, R_t, R^f_t, \delta_t, D_t\}$ that satisfy these conditions.
Uribe: Solution

- Convert GBC to real terms, multiply by $R_t(1 - \delta_{t+1})$, iterate

$$R_{t+j} \frac{B_{t+j}}{P_{t+j+1}} (1 - \delta_{t+j+1})$$

$$= \left( \prod_{h=0}^{j} R_{t+h} (1 - \delta_{t+h+1}) \frac{P_{t+h}}{P_{t+h+1}} \right) R_{t-1} \frac{B_{t-1}}{P_t} (1 - \delta_t)$$

$$- \sum_{h=0}^{j} \left( \prod_{k=h}^{j} R_{t+k} (1 - \delta_{t+k+1}) \frac{P_{t+k}}{P_{t+k+1}} \right) \tau_{t+h}$$

- Take expectations, use Euler equation (7)

$$E_t R_{t+j} \frac{B_{t+j}}{B_{t+j+1}} (1 - \delta_{t+j+1}) = \beta^{-j-1} R_{t-1} \frac{B_{t-1}}{P_t} (1 - \delta_t) - \sum_{h=0}^{j} \beta^{h-j-1} E_t \tau_{t+h}$$

(10)
Multiply (10) by $\beta^j$, take $\lim_{j \to \infty}$, impose TVC (9)

$$\delta_t = 1 - \sum_{h=0}^{\infty} \frac{\beta^h E_t \tau_{t+h}}{R_{t-1}B_{t-1}/P_t}, \quad t \geq 0$$

**Comments**

- $\delta_t \equiv 0$ yields usual no-default case—value of liabilities $= EPV(s)$
- when $EPV(s) < R_{t-1}B_{t-1}/P_t$, $\delta_t > 0$
- surpluses discounted by $\beta$: $\delta_t$ doesn’t enter discounting of cash flows because for private sector to voluntarily hold bonds, need expected returns to equal expected returns on risk-free assets
Uribe: Solution

- If $\delta_t \equiv 0$, then

$$\frac{R_{t-1}B_{t-1}}{P_t} = \sum_{h=0}^{\infty} \beta^h E_t \tau_{t+h}$$

(12)

The usual intertemporal equilibrium condition

- The precise restrictions that (12) imposes on the equilibrium $\{P_t\}$ process depends on monetary policy behavior

- Using tax process, (3), can solve out for expectations in (11)

$$\delta_t = 1 - \frac{(1 - \beta)(\tau_t - \bar{\tau}) + (1 - \beta \rho)\bar{\tau}}{\frac{R_{t-1}B_{t-1}}{P_t}(1 - \beta)(1 - \beta \rho)}$$

(13)

Higher $\rho \Rightarrow$ higher default rate triggered by given decline in revenues
Monetary policy 1: Taylor rule

\[ R_t = R^* + \alpha \left( \frac{P_t}{P_{t-1}} - \pi^* \right), \quad \alpha \beta > 1 \]  \hspace{1cm} (14)

Impossible to keep \( \pi_t \) near \( \pi^* \) without default

- if \( \delta_t \equiv 0 \), then

\[ P_0 = \frac{R_{-1}B_{-1}}{\sum_{h=0}^{\infty} \beta^h E_0 \tau_h} \]  \hspace{1cm} (15)

in general, \( P_0/P_{-1} \neq \pi^* \Rightarrow \{\pi_t\} \) grows without bound

- if \( \pi_0 > \pi^* \), then \( \pi_t \rightarrow +\infty \)
- if \( \pi_0 < \pi^* \), then \( \pi_t \rightarrow -\infty \)

To target inflation, must occasionally default

- if \( \pi_t = \pi^*, \ t \geq 0 \), (14) \Rightarrow in equilibrium

\[ R_t = R^* = \pi^*/\beta \quad t \geq 0 \]

\[ (7) \Rightarrow E_t \delta_{t+1} = 0 \quad t \geq 0 \]

equilibrium default rate unforecastable
Can compute default rate for each period

\[
\delta_0 = 1 - \frac{\pi^* \sum \beta^h E_0 \tau_h}{R_{-1} B_{-1} P_{-1}}
\]

\[
\delta_t = 1 - \frac{\sum_{h=0}^{\infty} \beta^h E_t \tau_{t+h}}{\sum_{h=0}^{\infty} \beta^h E_{t-1} \tau_{t+h}}, \quad t > 0
\]

- Each date have 1 equation in 1 unknown—default rate
- Government defaults in response to surprise deteriorations in \(EPV(s)\)
- Because \(E_t \delta_{t+1} = 0\), at times \(\delta_t < 0\)—government subsidizes
- Longer postpone default, higher is default rate
- \(R_t^f = \pi^*/\beta \) & \(R_t = \pi^*/\beta\), so risk premium is \(R_t/R_t^f = 1\)
- Risk premia arise only from \(\textit{anticipated}\) default
Monetary Policy 2

- Monetary policy 2: forward-looking Taylor rule

\[ R_t = R^* + \alpha \left( \frac{1}{E_t \frac{P_t}{P_{t+1}}} - \pi^* \right), \quad \alpha \beta > 1 \]  

- Uribe calls this “active MP” but with passive FP, inflation undetermined (the usual PM/AF)

- If \( \delta_t \equiv 0, t \geq 0 \), (7) & (16) \( \Rightarrow \)

\[ R_t = \frac{\pi^*}{\beta}, \quad \pi^* = \frac{1}{E_t (P_t/P_{t+1})} \]

- (4) & (11) \( \Rightarrow \)

\[ P_0 = \frac{R_{-1} B_{-1}}{\sum_{h=0}^{\infty} \beta^h E_0 \tau_h}, \quad \frac{P_t}{P_{t-1}} = \frac{\pi^* \sum_{h=0}^{\infty} \beta^h E_{t-1} \tau_{t+h}}{\sum_{h=0}^{\infty} \beta^h E_t \tau_{t+h}}, \quad t \geq 1 \]
Given the solution

\[ P_0 = \frac{R_{-1}B_{-1}}{\sum_{h=0}^{\infty} \beta^h E_0 \tau_h}, \quad \frac{P_t}{P_{t-1}} = \frac{\pi^* \sum_{h=0}^{\infty} \beta^h E_{t-1} \tau_{t+h}}{\sum_{h=0}^{\infty} \beta^h E_t \tau_{t+h}}, \quad t \geq 1 \]

- deviations of \( \pi_t \) from \( \pi^* \) are unforecastable & equal to surprise in \( EPV(s) \)
- news at \( t \) that \( PV(s) \) higher than expected
  \[ \Rightarrow P_t/P_{t-1} < \pi^* \] (inflation below target)
- **Message:** forward-looking Taylor rule achieves inflation target *on average*
  - even with active FP & no default
- If surpluses are smooth and largely predictable, deviations of inflation from target are small
- **Suggests** that fiscal rules are integral to stabilization policy
  - even if fiscal policy is active
Monetary policy 2: price-level targeting

- like pegging exchange rate between domestic currency & low-inflation country currency
- pegged price level $\Rightarrow$ cannot deflate value of liabilities, so default necessary

MP delivers $P_t = 1, t \geq 0$, so $R_t^f = \beta^{-1}$

Equilibrium conditions become

\[
1 = \beta R_t E_t (1 - \delta_{t+1}) \quad (17)
\]
\[
B_t = R_{t-1} B_{t-1} (1 - \delta_t) - \tau_t \quad (18)
\]
\[
\lim_{j \to \infty} E_t \beta^{t+j+1} R_{t+j} B_{t+j} (1 - \delta_{t+j+1}) \quad (19)
\]

Analog to (13) is

\[
\delta_t = 1 - \sum_{h=0}^{\infty} \frac{\beta^h E_t \tau_{t+h}}{R_{t-1} B_{t-1}}, \quad t \geq 0 \quad (20)
\]
To compute equilibrium debt, use (20) in GBC, (18)

\[ B_t = \sum_{h=1}^{\infty} \beta^h E_t \tau_{t+h} \]  

(21)

Applying (20) at \( t = 0 \)

\[ \delta_0 = 1 - \frac{\sum_{h=0}^{\infty} \beta^h E_0 \tau_h}{R_{-1}B_{-1}} \]  

(22)

right side (22) predetermined, so any negative tax news at \( t = 0 \) ⇒ \( \delta_0 > 0 \)

Can government set \( \delta_t = \bar{\delta}, t > 0 \)? No.

- using AR for taxes, (20) determines \( R_t \)

\[ \bar{\delta} = 1 - \frac{(1 - \beta)(\tau_{t+1} - \bar{\tau}) + (1 - \beta \rho)\bar{\tau}}{R_t B_t (1 - \beta)(1 - \beta \rho)} \]

- \( \tau_{t+1} \) known at \( t + 1 \) but \( R_t \) & \( B_t \) known at \( t \)
- can hold only if realization of \( \tau_{t+1} \) is just right
- \( \delta_t = \bar{\delta}, t > 0 \) cannot occur
Additional Considerations: Passive FP

- Bi, Leeper, Leith raise some additional considerations in models with default
- Taxes set to stabilize post-default value of debt

\[
\tau_t - \tau^* = \gamma \left[ (1 - \delta_t) \frac{B_{t-1}}{P_{t-1}} - b^* \right]
\quad (23)
\]

- Let \( b_t \equiv B_t/P_t \), substitute (23) into (4) at \( t + 1 \) and take expectations

\[
E_t b_{t+1} + (\tau^* - \gamma b^*) = [\beta^{-1} - \gamma(1 - E_t \delta_{t+1})] b_t
\quad (24)
\]

- Passive fiscal policy requires

\[
\gamma > \frac{\beta^{-1} - 1}{1 - E_t \delta_{t+1}}
\]

- Condition may be more demanding than the usual one that \( \gamma > \beta^{-1} - 1 \)

- Assume passive fiscal policy in what follows
Must decide whether monetary policy controls the risky rate on government bonds or the risk-free rate

- there is significant pass through from policy rates to contractual rates
- central banks accept government bonds as collateral for repos
- implies policy interest rates pick up some of the default risk

Consider two alternative monetary policy rules

\[ \frac{1}{R^f_t} = \frac{1}{R^*} + \alpha \left( \frac{1}{\pi_t} - \frac{1}{\pi^*} \right) \]  \hspace{1cm} (25)

\[ \frac{1}{R_t} = \frac{1}{R^*} + \alpha \left( \frac{1}{\pi_t} - \frac{1}{\pi^*} \right) \]  \hspace{1cm} (26)

- (25) policy rate risk-free; (26) policy rate risky (as in Uribe)
Additional Considerations: MP Instrument

- When the policy instrument is the risk-free rate...
  - combine (25) with Fisher relation (6)

\[
\frac{1}{\pi_t} - \frac{1}{\pi^*} = \frac{\beta}{\alpha} E_t \left( \frac{1}{\pi_{t+1}} - \frac{1}{\pi^*} \right)
\]

- active MP, $\beta/\alpha < 1$, with passive FP, satisfying (16)
  - unique bounded solution is $\pi_t = \pi^*$ all $t$

- Can successfully target inflation when instrument is risk-free rate
When the policy instrument is the risky rate...

- combine (26) with Fisher relation (7)

\[
\frac{1}{\pi_t} - \frac{1}{\pi^*} = \frac{\beta}{\alpha} E_t \left( \frac{1 - \delta_{t+1}}{\pi_{t+1}} - \frac{1}{\pi^*} \right)
\]  

(28)

- active MP, \( \beta/\alpha < 1 \), with passive FP, satisfying (16) yields solution

\[
\frac{1}{\pi_t} = \frac{1}{\pi^*} \left( 1 - \frac{\beta}{\alpha} \right) \left[ 1 + E_t \sum_{i=1}^{\infty} \left( \frac{\beta}{\alpha} \right)^i \prod_{j=1}^{i} (1 - \delta_{t+j}) \right]
\]

(29)

- only if \( \delta_t \equiv 0 \) can achieve \( \pi_t \equiv \pi^* \)
- farther into future is expected default, smaller impact on inflation
\[ \frac{1}{\pi_t} = \frac{1}{\pi^*} \left( 1 - \frac{\beta}{\alpha} \right) \left[ 1 + E_t \sum_{i=1}^{\infty} \left( \frac{\beta}{\alpha} \right)^i \prod_{j=1}^{i} (1 - \delta_{t+j}) \right] \]  \hspace{1cm} (29)

- If \( \delta \equiv \delta \in [0, 1] \)

\[ \pi_t = \pi^* \left[ \frac{1 - (1 - \delta) \frac{\beta}{\alpha}}{1 - \frac{\beta}{\alpha}} \right] \]

- as \( \alpha \to \infty, \pi_t \to \pi^* \)

- more aggressive MP reduces inflationary impacts of default

- Experiment: news at \( t \) raises \( E_t \delta_{t+1} > 0 \), but \( E_t \delta_{t+j} = 0 \) for \( j > 1 \); (29) is

\[ \pi_t = \pi^* \left[ \frac{1}{1 - \frac{\beta}{\alpha} E_t \delta_{t+1}} \right] > \pi^* \]

- more aggressive MP mitigates effects of default
Why does default affect inflation?

- let $\delta_t \equiv \delta \in [0, 1]$ so $1/R_t = (1 - \delta)/R_t^f$, rewrite risky-rate MP rule as

$$\frac{1}{R_t^f} = \frac{1}{R^*} + \frac{\alpha}{1 - \delta} \left[ \frac{1}{\pi_t} - \left( \frac{1}{\pi^*} - \frac{\delta}{\alpha R^*} \right) \right]$$

- default raises aggressiveness of MP ($\alpha/(1 - \delta) > \alpha$)
- default raises effective inflation target from $\pi^*$ to $\pi^*/(1 - \delta \beta/\alpha)$
- higher default rate creates partial MP accommodation
  - MP must allow risky rate to rise to induce bondholders to continue to hold debt
  - but Taylor rule means MP will not raise rate unless inflation rises
  - default induces bondholders to sell bonds, raises aggregate demand & inflation
  - process stops once bondholders compensated for default risk & inflation and interest rates consistent with MP rule
Two channels connect expected default rates to inflation

1. Fiscal theory: active FP coupled with either active or passive MP
   ▶ fiscal consequences of tight MP can worsen inflation

2. Response of MP to default: active MP & passive FP
   ▶ linkages between risky & risk-free rates can induce MP to partially accommodate default

In (1), delaying default or making MP more aggressive make it harder for MP to hit inflation target.
In (2), delaying default or making MP more aggressive reduces deviations of inflation from target.
Useful to model interest rate linkages to avoid assuming MP instrument is risky or risk-free.