Optimal Monetary Policy With and Without Debt.

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July 2024

Introduction

- Motivation:
  Recent surge in government debt in US and elsewhere, raises concerns about how to finance.
  - There might not be a significant margin of adjusting taxes upwards.
  - If taxes cannot finance debt, then inflation (monetary policy) needs to do it.

- Question: **What is the optimal monetary policy in cases where debt is a constraint for the monetary authority?**
  - Surprisingly, **we know little about this!**
  - We know a lot about optimal monetary policy in the *standard New Keynesian model*, where debt doesn't matter (Woodford, Gianoni, Svensson, Eggertsson and company)..
  - But we don't know much about optimal policy in the **Fiscal Theory of the Price Level (FTPL), when debt matters.**

Introduction

- Let me be more precice:
  - Large DSGE literature on FTPL (e.g. Leeper (1991), Bianchi, Melosi, Ilut, Mackowiak and company...
  - ...assumes *ad hoc interest rate rules*. (i_t is a function of inflation).
  - Monetary policy is not optimal.

  - Large literature on Ramsey policy (Schmitt-Grohe and Uribe, Faraglia et al, Lustig et al, Leeper and Zhu and many many others) solves for optimal policies under the debt constraint, however...
  - interest rates in these models are complex functions of Lagrange multipliers on debt.
    - Not possible to draw practically relevant conclusions out of these models.
    - Interest rates should be *conditioned on macroeconomic variables*, not multipliers.

Introduction

- This paper:
  - Derives optimal monetary policy rules when debt matters, under Ramsey optimal policies.
  - We derive rules where the nominal rate is a function of inflation, not Lagrange multipliers.
  - *Rules are simple to implement and to interpret.*

- Main results:
  - Optimal rules are passive (e.g. Leeper (1991)). .
  - It is optimal to track the real interest rate and respond to inflation. $\hat{i}_t = r_t + \phi_\pi \hat{\pi}_t$
  - The optimal coefficients on inflation are transparent functions of debt maturity, the IES, the slope of the Phillips curve.
  - In the case where maturity ≈ 5 years $\hat{i}_t = r_t + (1 - \frac{1}{\text{maturity}})\hat{\pi}_t$

Model

- Standard New Keynesian model with a fiscal block:

$$\hat{\pi}_t = \kappa_1 \hat{Y}_t - \kappa_2 \hat{G}_t + \beta E_t \hat{\pi}_{t+1}, \quad (1)$$

(Phillips curve)

$$\hat{i}_t = E_t\left(\hat{\pi}_{t+1} - \hat{\xi}_{t+1} + \hat{\xi}_t - \sigma\left[\frac{\overline{Y}}{\overline{C}}(\hat{Y}_t - \hat{Y}_{t+1}) - \frac{\overline{G}}{\overline{C}}(\hat{G}_t - \hat{G}_{t+1})\right]\right), \quad (2)$$

(Euler equation)

$\hat{G}_t$ = Gov. Spending. $\hat{\xi}_t$ = Preference Shock (HH discount factor shock).

σ = inverse of IES. $\overline{Y}, \overline{C}, \overline{G}$ (steady state output, consumption, gov. spending).

Model

- Standard New Keynesian model with a fiscal block:

$$\overline{p}_\delta \overline{b}\hat{b}_{t,\delta} + \overline{p}_\delta \overline{b}\hat{p}_{t,\delta} = -\overline{s}\hat{s}_t + (1+\delta\overline{p}_\delta)\overline{b}\left(\hat{b}_{t-1,\delta} - \hat{\pi}_t\right) + \delta\overline{p}_\delta \overline{b}\hat{p}_{t,\delta}, \tag{3}$$

$$\hat{p}_{t,\delta} = -\hat{i}_t + \beta\delta E_t \hat{p}_{t+1,\delta}. \tag{4}$$

(Gov. Budget Constraint and long bond pricing equations).

Long bonds are perpetuities with decaying coupons. δ is the decay factor. Average maturity is $\frac{1}{1-\delta}$.

Model

- Fiscal Policy Rule:

$$\hat{\tau}_t = \phi_{\tau,b}\hat{b}_{t-1,\delta} \tag{5}$$

Consider two cases:

i) Fiscal policy is passive (debt is backed by taxes): $\phi_{\tau,b} > \widetilde{\phi_\tau}$

ii) Fiscal policy is active (taxes do not adjust to government debt.) $\phi_{\tau,b} = 0$ (Convenient and common assumption).

Model

- <u>Optimal Monetary Policy</u>:

Solves

$$-\frac{1}{2}\sum_{t=0}^{\infty}\beta^t E_0\left\{\hat{\pi}_t^2+\lambda_Y \widetilde{Y}_t^2\right\}$$

$\lambda_Y \geq 0$
subject to the competitive equilibrium equations and under a timeless perspective.

- $\widetilde{Y}_t :=$ output gap measure,
  - Can be steady state output and natural output.
  - Can assume a microfounded weight λ_Y but also establish more general formulas for $\lambda_Y \geq 0$. The broader approach enables to better evaluate the various margins of policy.

Optimal Policy

- First order conditions are::

$$-\hat{\pi}_t + \Delta\psi_{\pi,t} + \frac{\overline{b}}{1-\beta\delta}\sum_{l=0}^{\infty}\delta^l \Delta\psi_{gov,t-l} = 0$$

$$-\lambda_Y \widetilde{Y}_t - \psi_{\pi,t}\kappa_1 + \sigma\frac{\overline{Y}}{\overline{C}}\overline{b}\sum_{l=0}^{\infty}\delta^l \Delta\psi_{gov,t-l} + \sigma\frac{\overline{Y}}{\overline{C}}(\overline{G}-\overline{\tau})\psi_{gov,t} = 0$$

$$\frac{\overline{b}}{1-\beta\delta}\left(\psi_{gov,t} - E_t\psi_{gov,t+1}\right) + \phi_{\tau,b}\overline{\tau}E_t\psi_{gov,t+1} = 0$$

Red denotes Woodford (2003), Giannoni and Woodford (2003).
Black is what the debt constraint brings.

Optimal Policy

- Interpretation of the multiplier terms:

$$E_t \sum_{j=0}^{\infty} \beta^j \overline{s} \hat{S}_{t+j} = \frac{\overline{b}}{1-\beta\delta} \hat{b}_{t-1,\delta} +$$

$$\overline{b} \sum_{j=0}^{\infty} \beta^j \delta^j E_t \left[-\sigma \left(\frac{\overline{Y}}{\overline{C}} \hat{Y}_{t+j} - \frac{\overline{G}}{\overline{C}} \hat{G}_{t+j} \right) - \sum_{l=0}^{j} \hat{\pi}_{t+l} + \hat{\xi}_{t+j} \right]$$

The Intertemporal budget constraint equates the present value of surpluses to the real payout of debt.
A positive spending shock 'tightens' the budget constraint.
$\Delta\psi_{gov,t} > 0$ essentially captures the shock being filtered through the IBC.

Optimal Policy

Rearranging one gets the following optimality condition:

$$\hat{\pi}_t + \frac{\lambda_Y}{\kappa_1}\Delta\widetilde{Y}_t = \frac{\overline{b}}{1-\beta\delta}\sum_{l=0}^{\infty}\delta^l\Delta\psi_{gov,t-l}$$

$$+\sigma\frac{\overline{Y}}{\overline{C}}\overline{b}\sum_{l=0}^{\infty}\delta^l\left(\Delta\psi_{gov,t-l}-\Delta\psi_{gov,t-l-1}\right)+\sigma\frac{\overline{Y}}{\overline{C}}(\overline{G}-\overline{\tau})\Delta\psi_{gov,t}$$

When $\Delta\psi_{gov,t} = 0$ we obtain

$$\hat{\pi}_t + \frac{\lambda_Y}{\kappa_1}\Delta\widetilde{Y}_t = 0$$

standard target policy criterion in the NK model.
However, here $\hat{\pi}_t + \frac{\lambda_Y}{\kappa_1}\Delta\widetilde{Y}_t$ is not equated to zero but to the weighted sum of current and lagged values of $\Delta\psi_{gov}$.

Optimal Policy

It is straightforward (given extensive previous research) to characterize optimal monetary policy with an interest rate rule that implements $\hat{\pi}_t + \frac{\lambda_Y}{\kappa_1}\Delta \widetilde{Y}_t = 0$.

In the presence of the multipliers, however, it is not straightforward.

Optimal Policy

- Fiscal Regimes:

The model admits two equilibria.

1. *If*

$$\phi_{\tau,b} > \frac{(1-\beta)}{(1-\beta\delta)} \frac{\overline{b}}{\overline{\tau}} \equiv \widetilde{\phi}_{\tau}$$

(fiscal policy is passive) then $\psi_{gov,t} = 0$ *endogenously.*

2. *If* $\phi_{\tau,b} = 0$ *then* $\psi_{gov,t} \neq 0$.

Moreover,

$$\psi_{gov,t} = E_t \psi_{gov,t+1}$$

The multiplier follows a random walk (Aiyagari et al (2002), Faraglia et al (2013), Lustig et al (2008) and others).

Optimal Policy

- Optimal Monetary Policy Rules: We can make progress analytically with the following cases.
  - Case 1. Simple Fisherian model no output smoothing (Sims, Cochrane, Leeper and others)
  - Case 2. Fisherian model with output smoothing
  - Case 3. Canonical New Keynesian model, no output smoothing.

Optimal Policy

- Fisherian models: Suppose that $\sigma = 0$ and $\lambda_Y = 0$

  Optimal monetary policy can be implemented with a rule of the form

  $$\hat{i}_t = \hat{\xi}_t + \phi_\pi \hat{\pi}_t \tag{6}$$

  $\hat{\xi}_t :=$ real interest rate.

  Proposition: *fiscal policy is passive, the optimal monetary policy sets $\phi_\pi > 1$ (Taylor principle).*
  When fiscal policy is active, ***the optimal inflation coefficient is $\phi_\pi = \delta \in [0, 1]$****. Optimal monetary policy is 'passive' (e.g. Leeper (1991)).*

Optimal Policy

- Why?:

  The Fisher/Euler equation is $\hat{i}_t = E_t \hat{\pi}_{t+1} + \hat{\xi}_t$

- Track the real rate to eliminate the shock from the Euler equation (standard way to deal with demand innovation).

- ϕ_π has to be ≤ 1 to induce a stable REE (Leeper (1991)).

- Under passive money policy, inflation becomes a backward looking process. Therefore, ϕ_π is the persistence of inflation.

- Set $\phi_\pi = \delta$ to have persistence match the payment profile of government debt.

Optimal Policy

- Output Smoothing:

  Assume first $\lambda_Y > 0$. Then:

- Optimal policy results in second order difference equation:

$$E_t\hat{\pi}_{t+1} - (1 + \frac{1}{\beta} + \widetilde{\kappa})\hat{\pi}_t + \frac{1}{\beta}\hat{\pi}_{t-1} = -\zeta_t + O(\Delta\psi_{gov,\leq t})$$

  where $\zeta_t = \hat{\pi}_t - E_{t-1}\hat{\pi}_t$.

- The two roots are:

$$\widetilde{\lambda}_{1,2} = \frac{1}{2}\left((1 + \frac{1}{\beta} + \widetilde{\kappa}) \pm \sqrt{(1 + \frac{1}{\beta} + \widetilde{\kappa})^2 - \frac{4}{\beta}}\right)$$

  (λ_1 is the stable root).

Optimal Policy

- Output Smoothing:

Proposition:

- *When fiscal policy is passive, the optimal rule*

$$\hat{i}_t = \hat{\xi}_t + (\widetilde{\lambda}_1 + \widetilde{\lambda}_2)\hat{\pi}_t - \widetilde{\lambda}_1\widetilde{\lambda}_2\hat{\pi}_{t-1}$$

satisfies the Taylor principle.

- *When fiscal policy is active, the optimal rule is*

$$\hat{i}_t = \hat{\xi}_t + (\widetilde{\lambda}_1 + \delta)\hat{\pi}_t - \widetilde{\lambda}_1\delta\hat{\pi}_{t-1} - \delta\frac{\widetilde{o}}{\widetilde{\lambda}_2 - 1}\Delta\psi_{gov,t}$$

$\widetilde{o} > 0$. *This is a passive money rule.*

Optimal Policy

- What are the mechanics behind monetary policy?
- Inertial rule leads to a smoother path of inflation . This in turn accomplishes to smooth output.
- Even in the case where debt is short term $\delta = 0$ inflation features persistence. $\hat{i}_t = \hat{\xi}_t + \widetilde{\lambda}_1 \hat{\pi}_t$ implies persistence $\widetilde{\lambda}_1 \to 1$ as $\lambda_Y \to \infty$
  But output smoothing does not contribute anything towards making debt sustainable. There is a tradeoff...
- When debt is long term, the goals of smoothing inflation and smoothing output line up. There is no (or less of a) tradeoff!
- $-\delta \frac{\widetilde{o}}{\widetilde{\lambda}_2 - 1} \Delta \psi_{gov,t}$ is a stochastic intercept (a function of the spending and preference shocks).

Optimal Policy

- The canonical NK model:

- Real interest rates depending on output ($\sigma > 0$)
- We show that the optimal monetary policy rule under active fiscal policy is:

$$\hat{i}_t = \hat{r}_t^n + \left(\delta + \frac{\overline{Y}}{\overline{C}} \frac{\sigma}{\kappa_1}(1-\delta)(\delta\beta - 1)\right)\hat{\pi}_t - f\Delta\psi_{gov,t}$$

where $\hat{r}_t^n \equiv \hat{\xi}_t + \sigma(\frac{\overline{G}}{\overline{C}} - \frac{\kappa_2}{\kappa_1}\frac{\overline{Y}}{\overline{C}})\hat{G}_t$ (natural interest rate consistent with constant output under flexible prices).

- $-f\Delta\psi_{gov,t}$:= Stochastic intercept.

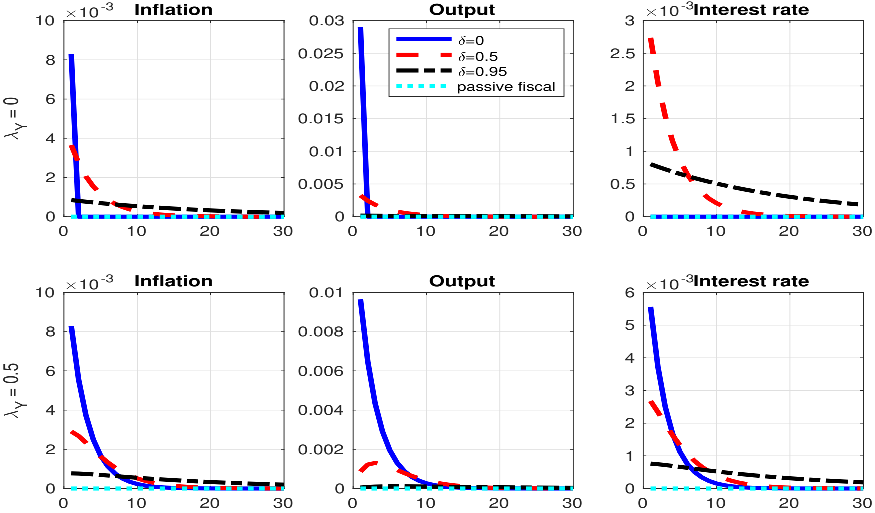
Optimal Policy

- The canonical NK model:

- Again track real rate to eliminate the demand shock from the Euler equation. Only have to deal with the effect on the GBC.
- Differently from before, the optimal inflation coefficient now is: $\delta + \frac{\overline{Y}}{\overline{C}} \frac{\sigma}{\kappa_1}(1-\delta)(\delta\beta - 1)$ not just δ.
  - Inflation has both *direct* and *indirect* effects on debt.
  - Indirect effects are changes in real bond prices stemming from inflation. These are captured by $\frac{\overline{Y}}{\overline{C}} \frac{\sigma}{\kappa_1}(1-\delta)(\delta\beta - 1)$.
  - Monetary policy needs to be mindful of these impacts.
- Result: When debt is long term δ close to 1, then indirect effects are unimportant. $\frac{\overline{Y}}{\overline{C}} \frac{\sigma}{\kappa_1}(1-\delta)(\delta\beta - 1) \approx 0$

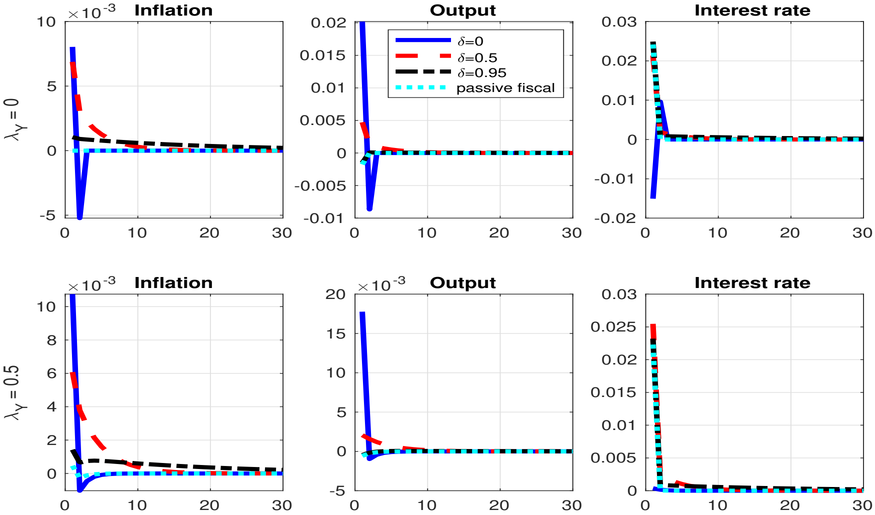
Impulse response functions, G shock

Fisherian model



Impulse response functions, G shock

NK model



Dual Mandate Policy

Proposition: *Assume that fiscal policy is active and* $\sigma, \lambda_Y > 0$. *The optimal interest rate rule is:*

$$\hat{i}_t = \widetilde{r}_t + \left\{ \frac{\sigma}{\kappa_1} \frac{\overline{Y}}{\overline{C}} \left[\left(1 - \left(\widetilde{\lambda}_1 + \delta\right)\right) \left(\left(\widetilde{\lambda}_1 + \delta\right) \beta - 1 \right) + \beta \delta \widetilde{\lambda}_1 \right] + \left(\widetilde{\lambda}_1 + \delta\right) \right\} \hat{\pi}_t - \\ -\delta \widetilde{\lambda}_1 \left\{ \frac{\sigma}{\kappa_1} \frac{\overline{Y}}{\overline{C}} \left[(1+\beta) - \beta \left(\widetilde{\lambda}_1 + \delta\right) \right] + 1 \right\} \hat{\pi}_{t-1} + \underbrace{\widetilde{f} \Delta \psi_{gov,t}}_{\text{Stochastic intercept}} \tag{7}$$

where $\widetilde{r}_t = \widetilde{r}_t^n$ *under the natural output target and* $\widetilde{r}_t = \widetilde{r}_t^n + \widetilde{\upsilon}_t$ *under the steady state output target.*

Simple optimal rules

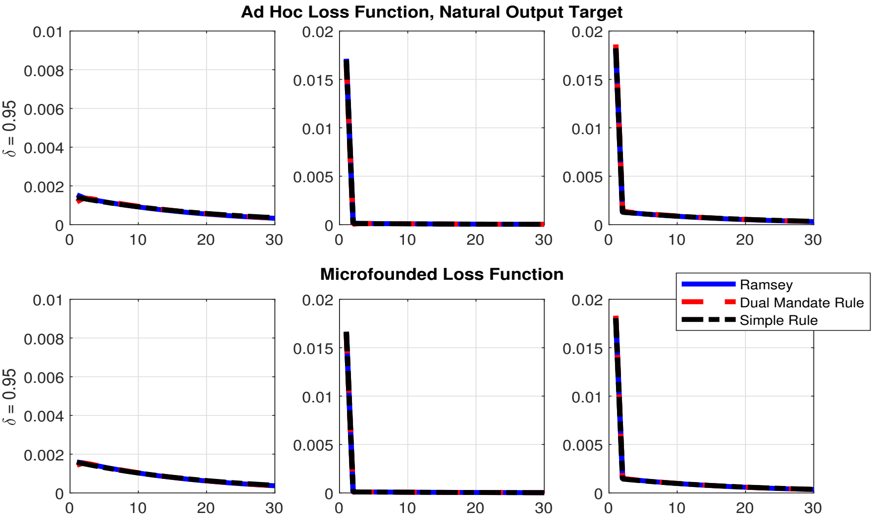
Assuming $\delta = 0.95$ (5 years maturity) is a very good approximation of payment profiles of US government debt.

Set $\sigma = 1$ and other parameters as in standard calibrations of the NK model.

Exercise: Simple rule $\hat{i}_t = r_t^n + \delta\hat{\pi}_t$ vs Ramsey policy.

Ramsey Policies vs Simple Rules.

US data calibration



Conclusions

Thanks for listening!