Federal Reserve Credibility and the Term Structure

Aeimit Lakdawala       Shu Wu
Michigan State University  University of Kansas

Society for Economic Measurement
Effect of monetary policy on term structure of interest rates

- Policymakers: Monetary policy transmission mechanism
- Bond Traders: Informed investment decisions
Motivation

Large finance literature on latent-factor models
  • No clear economic interpretation of factors

New and growing macro finance literature
  • reduced form macro dynamics

Newer macro-finance literature with structural macro models
  • reduced form monetary policy

⇒ This paper: Explore implications of optimal monetary policy on the term structure in a structural macro model
Motivation

Large finance literature on latent-factor models
  • No clear economic interpretation of factors

New and growing macro finance literature
  • reduced form macro dynamics

⇒ This paper: Explore implications of optimal monetary policy on the term structure in a structural macro model
Motivation

Large finance literature on latent-factor models
  - No clear economic interpretation of factors

New and growing macro finance literature
  - reduced form macro dynamics

Newer macro-finance literature with structural macro models
  - reduced form monetary policy

⇒ This paper: Explore implications of optimal monetary policy on the term structure in a structural macro model
Motivation

Large finance literature on latent-factor models
  • No clear economic interpretation of factors

New and growing macro finance literature
  • reduced form macro dynamics

Newer macro-finance literature with structural macro models
  • reduced form monetary policy

⇒ This paper: Explore implications of optimal monetary policy on the term structure in a structural macro model
Optimal monetary policy

- in a setting with forward looking agents

Current choices affected by future policies
Optimal monetary policy

- in a setting with forward looking agents

Current choices affected by future policies

Time-inconsistency problem

Kydland & Prescott (1977), Barro & Gordon (1983)
"economic planning is not a game against nature but, rather, a game against rational economic agents"
Typically one of two cases

1. **Full Commitment**
   - Central bank is fully credible

2. **Discretion or No Commitment**
   - Central bank thinks it has no effect on agents expectations
Typically one of two cases

1. **Full Commitment**
   - Central bank is fully credible

2. **Discretion or No Commitment**
   - Central bank thinks it has no effect on agents’ expectations

This paper: **Loose Commitment**
- Nests full commitment and discretion
Commitment

$T=0 \quad T=1 \quad T=2 \quad T=t$

$\pi_0 \quad \pi_1 \quad \pi_2 \quad \pi_t$

- Red circle: New Plan
- Blue circle: Follow old plan
Discretion

\[ T=0 \quad T=1 \quad T=2 \quad T=t \]

A New Plan in EVERY PERIOD

\[ \pi_0 \quad \pi_1 \quad \pi_2 \quad \pi_t \]
This paper: Loose Commitment

The policymaker has access to a commitment technology ... BUT
This paper: Loose Commitment

In each period:

- with Prob. $\gamma$: Follow plan
- with Prob. $1-\gamma$: Re-Optimize

The policymaker has access to a commitment technology ... BUT
This paper: Loose Commitment

In each period:

- with Prob. $\gamma$: Follow plan
- with Prob. $1-\gamma$: Re-Optimize

NOTE: Re-Optimization ≠ Discretion
This Paper: Loose Commitment

In each period:

- with Prob. $\gamma$: Follow plan
- with Prob. $1-\gamma$: Re-Optimize

The policymaker has access to a commitment technology ... BUT

Limiting cases:

- $\gamma=0 \rightarrow$ Discretion
- $\gamma=1 \rightarrow$ Full-Commitment
Optimal Monetary policy and the term structure in simple model

- Flexible loose commitment framework
- Show how degree of credibility affects the term structure
- Show how re-optimization shocks affect term structure factors
Contribution

Optimal Monetary policy and the term structure in simple model

- Flexible loose commitment framework
- Show how degree of credibility affects the term structure
- Show how re-optimization shocks affect term structure factors

Medium scale regime-switching DSGE model

- Bayesian MCMC estimation
- Counterfactual: How would bond yields have behaved under different credibility scenarios?
- Historical effects of Re-optimization shocks
Preview of Results

- Probability of commitment ($\gamma$): 0.86
- Re-optimization shocks affect the “curvature” of the yield curve
- Yield data cannot be explained well by either commitment or discretion
Related Literature

Loose Commitment Literature (Theory)

Commitment Literature (Empirical)
Related Literature

Loose Commitment Literature (Theory)

Commitment Literature (Empirical)

Monetary Policy & Term Structure in DSGE Models

Optimal monetary policy & term structure
- Palomino (2012)
Intuition: Simple Model

Central bank loss function

$$\min \frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left[ \kappa y_t^2 + \theta \pi_t^2 \right]$$

s.t.

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t + u_t$$

$$y_t = E_t y_{t+1} - \frac{1}{\sigma} \left( i_t - E_t \pi_{t+1} \right)$$
Intuition: Simple Model

Central bank loss function

$$\min \frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left[ \kappa y_t^2 + \theta \pi_t^2 \right]$$

s.t.

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t + u_t$$
$$y_t = E_t y_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1})$$

FOC: (Discretion)

$$\pi_t = -\frac{1}{\theta} y_t$$
Intuition: Simple Model

Central bank loss function

\[
\min \frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left[ \kappa y_t^2 + \theta \pi_t^2 \right]
\]

s.t.

\[
\pi_t = \beta E_t \pi_{t+1} + \kappa y_t + u_t
\]

\[
y_t = E_t y_{t+1} - \frac{1}{\sigma} \left( i_t - E_t \pi_{t+1} \right)
\]

FOC: (Discretion)

\[
\pi_t = -\frac{1}{\theta} y_t
\]

FOC: (Full Commitment)

\[
\pi_t = -\frac{1}{\theta} \left[ y_t - y_{t-1} \right]
\]
i.i.d. cost-push shock

Cost-Push Shock

Inflation

Output Gap

Short Rate

- Discretion
- Full Commitment
i.i.d. cost-push shock

Cost–Push Shock

Inflation

Output Gap

Short Rate

Discretion Full Commitment Loose Commitment: (γ = 0.5) Re–optimization
Price of n-period zero coupon bond

\[ P_{n,t} = E_t [M_{t+1} P_{n-1,t+1}] \]

\( M_{t+1} \): Stochastic Discount Factor
Price of n-period zero coupon bond

\[ P_{n,t} = E_t \left[ M_{t+1} P_{n-1,t+1} \right] \]

\( M_{t+1} \): Stochastic Discount Factor

In the simple model: CRRA utility with risk aversion parameter \( \sigma \)

\[ M_{t+1} = \beta \left( \frac{y_{t+1}}{y_t} \right)^{-\sigma} \frac{1}{\pi_{t+1}} \]

Let \( z_t = [y_t, \pi_t] \), then

\[ \log(M_{t+1}) = -\lambda_0 - \lambda'_1 z_{t+1} - \lambda'_2 z_t \] (1)
Under loose commitment, solution to macro model

\[ z_t = F_{s_t} z_{t-1} + G v_t \]
\[ v_t \sim N(0, Q) \]
Under loose commitment, solution to macro model

\[
\begin{align*}
z_t &= F_s z_{t-1} + G v_t \\
v_t &\sim N(0, Q)
\end{align*}
\]

Bond Price:

\[
P_{n,t} = \exp\{-A_n - B_n' z_t\}
\]

\[
A_n = A_{n-1} + \lambda_0 - \frac{1}{2} (\lambda_1 + B_{n-1})' G Q G' (\lambda_1 + B_{n-1})
\]

\[
B_n = \bar{F}' B_{n-1} + (\lambda_2 + \bar{F}' \lambda_1)
\]

where

\[
\bar{F} = \gamma F_{(s_t=1)} + (1 - \gamma) F_{(s_t=0)}
\]
Effect of re-optimization (after i.i.d. cost-push shock)

Discretion Full Commitment Loose Commitment: ($\gamma = 0.5$) Re-optimization
Response of term structure factors to re-optimization shock (after i.i.d. cost-push shock)
Medium-scale DSGE model

- Embed optimal policy under loose commitment
- Regime-switching estimation using macro and yield data
- Explore implications for term structure

Smets & Wouters (2007) AER:
- Nominal rigidities, markup shocks, capital adjustment costs
- 7 observable variables, 7 shocks
Medium-scale DSGE model

- Embed optimal policy under loose commitment
- Regime-switching estimation using macro and yield data
- Explore implications for term structure

Smets & Wouters (2007) AER:

- Nominal rigidities, markup shocks, capital adjustment costs
- 7 observable variables, 7 shocks
Optimal Policy under Loose Commitment: Central Bank

Quadratic loss function

$$E_0 \sum_{t=0}^{\infty} \beta^t x_t' W x_t$$

Specific Loss function for Baseline Results

$$\pi_t^2 + w_y \tilde{y}_t^2 + w_r (i_t - i_{t-1})^2$$
The central bank's problem is:

\[ x'_{-1} Vx_{-1} + d = \min_{\{x_t\}_{t=0}^\infty} E_0 \sum_{t=0}^\infty (\beta \gamma)^t [x'_t Wx_t + \beta (1 - \gamma) (x'_t Vx_t + d)] \]
The central bank’s problem is:

\[ x'_1 V x_1 + d = \min_{\{x_t\}_{t=0}^\infty} E_0 \sum_{t=0}^\infty (\beta \gamma)^t [x'_t W x_t + \beta (1 - \gamma) (x'_t V x_t + d)] \]

s.t. \[ A_{-1} x_{t-1} + A_0 x_t + \gamma A_1 E_t x_{t+1} + (1 - \gamma) A_1 E_t x_{t+1}^r + B v_t = 0 \]
The central bank's problem is:

\[
x_{t-1}' V x_{t-1} + d = \min_{\{x_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} (\beta \gamma)^t \left[ x_t' W x_t + \beta (1 - \gamma) (x_t' V x_t + d) \right]
\]

s.t. \[ A_{-1} x_{t-1} + A_0 x_t + \gamma A_1 E_t x_{t+1} + (1 - \gamma) A_1 E_t x_{t+1}^r + B v_t = 0 \]

Solution to planner's problem

\[
z_t = F_{st} z_{t-1} + G v_t
\]

where \( z_t \equiv [x_t, \lambda_t] \), \( \lambda_t \) denote Lagrange multipliers.
Data 1984:Q1 - 2008:Q3

Macro Data: 7 observables (Same as Smets & Wouters)

1. Real GDP
2. Real Consumption
3. Real Investment
4. Real Wages
5. Hours
6. GDP Deflator
7. Fed Funds Rate (3 month T-bill)

Yield Data: Zero-coupon Treasury rates (Gurkaynak et al)

1. 6 month
2. 1 year
3. 3 year
4. 6 year
5. 10 year
Model setup for estimation

\begin{align*}
    x_t^{obs} &= A + Hz_t + w_t \\
    z_t &= F_{s_t}z_{t-1} + Gv_t \\
    w_t &\sim N(0, R) \\
    v_t &\sim N(0, Q) \\
    s_t &= \begin{cases} 
    1 \text{ if no reoptimization} \\
    0 \text{ if reoptimization} 
    \end{cases} \\
    \text{Transition matrix of } s_t \\
    P &= \begin{bmatrix} 
    \gamma & 1 - \gamma \\
    \gamma & 1 - \gamma 
    \end{bmatrix}
\end{align*}
Model Fit

6 month

1 year

3 year

6 year

10 year

Data

Model
Model implied steady state yields

<table>
<thead>
<tr>
<th></th>
<th>6 month</th>
<th>1 year</th>
<th>3 year</th>
<th>6 year</th>
<th>10 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data (Average)</td>
<td>4.95</td>
<td>5.41</td>
<td>5.93</td>
<td>6.41</td>
<td>6.81</td>
</tr>
<tr>
<td>Loose Commitment</td>
<td>4.68</td>
<td>4.73</td>
<td>5.44</td>
<td>6.04</td>
<td>6.60</td>
</tr>
<tr>
<td>Full Commitment</td>
<td>5.12</td>
<td>5.21</td>
<td>5.72</td>
<td>5.86</td>
<td>6.08</td>
</tr>
<tr>
<td>Discretion</td>
<td>3.23</td>
<td>2.98</td>
<td>3.26</td>
<td>3.67</td>
<td>4.28</td>
</tr>
</tbody>
</table>
Prob of Commitment: $\gamma = .86$ (Posterior mean)

**Figure:** Smoothed Probability of Re-optimization
Re-optimization effect on yields
Re-optimization effect on “factors”
Counterfactual

Data

Full Commitment

Discretion

---

Graphs showing data, full commitment, and discretion over different time periods (3 month, 6 month, 1 year, 3 year, 6 year, 10 year) from 1985 to 2005.

Legend:
- Red dash line: Data
- Blue solid line: Full Commitment
- Black solid line: Discretion
Federal Reserve Credibility and Term structure

- Estimated DSGE model to explore how credibility affects term structure
- Re-optimization shocks affect the “curvature” of the yield curve
- Yield data cannot be explained well by either commitment or discretion
Thank you!