MONETARY POLICY SWITCHING TO AVOID A LIQUIDITY TRAP

Siddhartha Chattopadhyay  
Vinod Gupta School of Management  
IIT Kharagpur

Betty C. Daniel  
Department of Economics  
University at Albany – SUNY

September 28, 2012
Motivation
Liquidity Trap

- Large negative demand shock can send nominal interest rate to zero
  - Conventional monetary policy loses ability to stimulate
  - Equilibrium values for inflation and output become indeterminate

- Design monetary policy switching to
  - Stimulate economy following a large negative demand shock
  - While avoiding a liquidity trap
  - And avoiding indeterminacy
Other Literature
Policy in Liquidity Trap

- **Bernanke, Reinhart (2004), Bernanke, Reinhart, Sack (2004):** keeping long-term interest expectation low through non-standard policy alternatives
- **Svensson (2003):** raising inflation expectation by currency depreciation
- **Krugman (1998):** permanent increase in money supply
- **Eggertson and Woodford (2003):** optimal policy with price level target
- **Adam and Billi (2006):** optimal policy commitment under zero lower bound
- **Nakov (2008):** optimal policy with truncated Taylor rule
The Sticky Price New-Keynesian DSGE Model
Woodford (2003), Walsh (2010)

- **Expectational IS:**

  \[ E_t(y_{t+1}) = y_t + \sigma [\hat{i}_t - E_t(\pi_{t+1})] + u_t, \sigma \geq 1 \]  
  \hspace{1cm} (1)

- **Sticky Price Phillips curve:**

  \[ \pi_t = \beta E_t(\pi_{t+1}) + \kappa y_t, \quad \kappa \in (0, \infty) \]  
  \hspace{1cm} (2)
Optimal Monetary Policy
Woodford (2003)

- **Loss function:**

\[
L_t = \frac{1}{2} E_t \sum_{j=0}^{\infty} \beta^j (\pi_{t+j}^2 + \lambda y_{t+j}^2), \quad \beta \in (0, 1), \quad \lambda \in [0, \infty) \tag{3}
\]

- **Optimal policy chooses** \( \hat{i} \) **to**
  - minimize (3)
  - subject to
    - IS equation (1)
    - Phillips Curve equation (2)
    - feasibility: \( i_t \geq 0 \)
Monetary authority sets

- \( \hat{i} \) is interest deviation from long-run equilibrium
- \( \bar{i} \) is long-run equilibrium interest
- optimal policy

\[
\hat{i}_t = i_t - \bar{i} = -\sigma^{-1} u_t
\]

\[
y_t = \pi_t = L_t = 0
\]
\( \Delta y = 0 \) curve

- equation

\[
E_t (y_{t+1}) - y_t = \sigma \hat{i}_t - u_t - \frac{\sigma}{\beta} (\pi_t - \kappa y_t) = 0
\]

- positive slope

\[
y_t = \kappa^{-1} \pi_t
\]

- arrows of motion point away

\[
\frac{\partial [E_t (y_{t+1}) - y_t]}{\partial y_t} = \frac{\sigma}{\beta} \kappa > 0
\]
\( \Delta \pi = 0 \) curve

- **Equation**

\[
E_t (\pi_{t+1}) - \pi_t = \frac{1}{\beta} [(1 - \beta) \pi_t - \kappa y_t] = 0
\]

- positive slope, but flatter than slope of \( \Delta y = 0 \) curve

\[
y_t = \frac{1 - \beta}{\kappa} \pi_t
\]

- arrows of motion point away

\[
\frac{\partial [E_t (\pi_{t+1}) - \pi_t]}{\partial \pi_t} = \frac{1 - \beta}{\beta} > 0
\]
Graph of Phase Diagram with Optimal Interest Rate

Saddlepath

\[ \Delta y = 0 \]

\[ \Delta \pi = 0 \]

\[ y_0 \]

\[ \pi_0 \]
Optimal Interest Rate
Two Problems

- **equilibrium indeterminacy**
  - no feedback on endogenous variables
  - yields model with saddlepath

- **liquidity trap** for large adverse demand shock
Taylor Rule

- Taylor Rule with Taylor principle eliminates indeterminacy
  - Taylor Rule: interest rate responds to endogenous variables
    \[ \hat{i}_t = -\sigma^{-1}u_t + \phi_{\pi}\pi_t + \phi_y y_t \]
  - Taylor principle (Bullard and Mitra, 2002): responsiveness must be large enough
    \[ \phi_{\pi} + \phi_y \left( \frac{1 - \beta}{\kappa} \right) - 1 > 0 \]
Δy = 0 curve

- equation

\[ E_t (y_{t+1}) - y_t = \sigma \left[ \phi_\pi \pi_t + \phi_y y_t \right] - \frac{\sigma}{\beta} (\pi_t - \kappa y_t) = 0 \]

- slope less than Δπ = 0 if Taylor Principle satisfied (we’ll draw as negative)

\[ y_t = \frac{1 - \beta \phi_\pi \pi_t}{\kappa + \beta \phi_y} \]

- arrows of motion point away

\[ \frac{\partial [E_t (y_{t+1}) - y_t]}{\partial y_t} = \sigma \left( \frac{\kappa}{\beta} + \phi_y \right) > 0 \]
Phase Diagram with Taylor Rule
Globally Unstable
Globally unstable model solves equilibrium indeterminacy for positive interest rates

Does not solve liquidity trap problem

**Large adverse demand shock** \((u_t > \sigma \bar{i})\)

1. monetary authority reduces nominal interest rate close to zero yielding liquidity trap
2. set \(\phi_\pi = \phi_y = 0\) yielding indeterminacy and sunspots

our proposed switching policy solves both
Woodford (2003):

- Nominal interest rate deviation is sum of real interest deviation and inflation deviation
  \[ \hat{i}_t = \hat{r}_t + \hat{\pi}_t \]

- Woodford’s optimal monetary policy allows time-varying real interest rate
  - natural rate of interest
    \[ \hat{r}_t = -\sigma^{-1}u_t \]
  - inflation deviation is set to zero
    \[ \hat{\pi}_t = 0 \]
Evidence for Time-Varying Inflation Target

  - significant variation in inflation target in post-war US
  - Taylor rule with time-varying inflation target better capture interest rate movement of US
  - expectation theory of term structure works better for US under time-varying inflation target
Introduce Time-varying Inflation Target into Taylor Rule

- **Our Taylor rule:**

\[
\hat{i}_t = -\sigma^{-1} u_t + \phi_{\pi}(\pi_t - \pi_t^*) + \phi_y(y_t - y_t^*),
\]

- Time-varying short-run inflation target where monetary authority chooses \(\pi_t^*\), and makes it highly persistent

\[
\pi_{t+1}^* = \rho_{\pi} \pi_t^*
\]

- \(\rho_{\pi} < 1\), but close to unity

- Output target must be consistent implying

\[
y_t^* = \frac{\pi_t^* - \beta E_t (\pi_{t+1}^*)}{\kappa}
\]
Taylor Rule with Time-varying Inflation Target

- Substitute time-varying inflation and output targets into Taylor Rule

\[ i_t = \bar{i} - z \pi_t^* - \sigma^{-1} u_t + \phi_{\pi} \pi_t + \phi_y y_t \]

where,

\[ z = \phi_{\pi} + \phi_y \left( \frac{1 - \rho_{\pi}\beta}{\kappa} \right) - 1 > 1 \]

- Taylor principle
  - requires \( z > 0 \)
  - assures sunspot-free determinate equilibrium
Equilibrium with Our Taylor Rule

- **Output:**
  \[ y_t = \frac{1 - \rho_\pi \beta}{\beta (\lambda_1 - \rho_\pi) (\lambda_2 - \rho_\pi)} \sigma z \pi_t^* \]

- **Inflation:**
  \[ \pi_t = \frac{\kappa}{\beta (\lambda_1 - \rho_\pi) (\lambda_2 - \rho_\pi)} \sigma z \pi_t^* \]

- **Nominal interest rate**
  \[ i_t = \bar{i} - z \pi_t^* - \sigma^{-1} u_t + \phi_\pi \pi_t + \phi_y y_t \]
  \[ = \bar{i} - \sigma^{-1} u_t + qz \pi_t^* \]  
  \[ (4) \]

- **Taylor principle with \( \rho_\pi \) high enough** ⇒
  \[ q = \left[ \frac{\phi_\pi \kappa + \phi_y (1 - \rho_\pi \beta)}{\beta (\lambda_1 - \rho_\pi) (\lambda_2 - \rho_\pi)} \sigma - 1 \right] > 0 \]
Monetary authority follows zero inflation target policy ($\pi_t^* = 0$)

1. minimizes loss ($y_t = \pi_t = L_t = 0$)
2. policy feasible ($i_t = \bar{i} - \sigma^{-1}u_t \geq 0$)
3. standard Taylor Rule which eliminates sunspots and stabilizes output in face of demand shocks
Monetary authority switches to positive inflation target

- Inflation target large enough to keep nominal interest rate fixed at $\bar{i}$

$$\pi_t^* = \frac{\sigma^{-1} u_t}{zq}$$

- To maintain inflation target going forward need

$$\rho_{\pi t} = \rho_{u t}$$

where

$$u_t = \rho_u u_{t-1}$$
Monetary Transmission Mechanism

- Negative demand shock reduces output and inflation
  - Monetary authority wants to reduce the interest rate to reduce the real rate and stimulate economy
  - When the demand shock is too large, nominal interest rate would fall below zero

- Our policy reduces the real interest rate by raising inflationary expectations
  - Raise inflation target
  - Promise to keep it high for a long period of time by promising high persistence
  - With sufficient persistence, output and inflation rise even if the nominal interest rate does not fall

- Promise of persistence requires the inflation target to remain high even after the demand disturbance has fallen sufficiently that a traditional Taylor Rule could stimulate
  - Policy is dynamically inconsistent
  - Requires ability to commit to a rule
Adam and Billi (2006):

\[ \sigma = 1, \ \beta = 0.99, \ \kappa = 0.057, \ \rho_{\pi} = \rho_u = \rho = 0.8 \]

\[ \phi_{\pi} = 1.5, \ \phi_y = 0.5 \]

Large adverse demand shock:

\[ u_0 = 1.04\% > \sigma \bar{\iota} = 1.01\% \]
Policy-Switching
Large Adverse Demand Shock

- Impulse response under inflation target to keep nominal interest constant:
Policy-Switching
Large Adverse Demand Shock

- Excessive fluctuations (annualized):
  - output: 93.05% per annum
  - inflation: 25.50% per annum

- Unacceptable welfare loss
Monetary Authority Switches to Positive Inflation Target

- Allow nominal interest rate to fall
- Inflation target just high enough to keep nominal interest rate positive

\[ i_0 = \bar{i} - \eta_0 > 0 \]

with

\[ i_0 \geq 0 \]

\[ \pi_0^* = \frac{\sigma^{-1} u_0 - \eta_0}{zq} \]

and

\[ \pi_t^* = \rho_\pi^t \pi_0^* \]
- Impulse response under inflation target which allows nominal interest to fall but remain positive
Monetary Policy Switching
Large Adverse Demand Shock

- **Reasonable fluctuations (annualized):**
  - output: 2.69% per annum
  - inflation: 0.73% per annum

- **Smaller welfare loss than policy of fixed nominal interest rate**
Comparison of Our Switching Policy with Standard Taylor Rule in Liquidity Trap

- Large adverse demand shock
  - Our switching policy
    - Reduce nominal interest rate and raise inflation target
    - Stimulates output and inflation
    - Retain positive responsiveness of interest to output and inflation in Taylor Rule so retain determinacy
  - Standard policy of reducing nominal interest to zero with fixed inflation target
    - Cannot reduce nominal interest rate enough to stimulate enough
    - Lose responsiveness of interest to output and inflation so lose determinacy

Similar results

- Avoid liquidity trap stimulating both output and inflation
- Peak effect on inflation delayed due to delay in information about new inflation target
Conclusion

- Zero inflation target is an optimal policy under small demand shock
- Switch to positive inflation target policy under large adverse demand shock
  - credible implementation avoids liquidity trap when persistence is high enough
  - robust as supported both the sticky price and sticky information model
- Costs and benefits
  - our switching policy stimulates at cost of inflation bias
  - standard policy has period of indeterminacy and insufficient stimulus