Optimal Monetary Policy in a Regime-Switching DSGE Model with Time-Varying Concern for Model Uncertainty

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INTRODUCTION AND CONCLUSION

Issues

- Unconventional policy tools are not as powerful as the normal time monetary policy in stimulating the economy.
  - Filardo and Hofmann (2014), Giannoni et al. (2016), McKay et al. (2016)
- Model uncertainy rises with the usage of unconventional tools.
  - Masolo and Monti (2017), Castelnuovo and Pellegrino (2018)

Motivation

- Acknowledge the possible uncertainties about the structure of the economy
  - the propagation of shocks hence implied policy suggestion could change substantially.
- Seek for policies that are robust across different, uncertain states of the world.

Questions

- Does risks about future effectiveness of the monetary policy change normal time monetary policy?
- How does uncertainty play a role in optimal policy?

Building Blocks

- A model with a time-varying effectiveness of monetary policy under uncertainty.
  - Allow for regime-dependent elasticity of substitution
    - as a short-cut to model a possible weakening of monetary policy subject to an effective lower bound on nominal interest rate.
  - Allow the interest rate to fall below zero
    - to abstract from model complexity of switching to unconventional tools.
  - The idea is to use the shadow rate to summarize the overall stance of monetary policy-yet in a less effective manner
- Show the importance of model uncertainty and risks about future (in)effectiveness of the monetary policy.

Conclusion

- Weakening of the monetary policy transmission mechanism calls for stronger policy actions in response to shocks.
- The optimal response of the monetary authority is to respond aggressively to a negative demand shock in order to reduce the probability to switch to the second regime.
- This result is because of the expectations channel inherent in regime switching structure.

THE MODEL

Simple New Keynesian Model

- The economy consists of households, final and intermediate goods producers, and a monetary authority.
  - Households
    - full sharing of consumption risk
  - Final goods firms
    - package intermediate goods into an homogenous good
    - sell the good to households in a competitive market
  - Intermediate good firms
    - produce differentiated good which is sold under monopolistic competition to final good firms
    - hire labor in competitive market and set price à la Calvo (1983)

The IS Curve
$$y_t = E_t y_{t+1} - \Omega(r_t - E_t\pi_{t+1}) + u_t$$
The Phillips Curve
$$\pi_t = \beta E_t\pi_{t+1} + \kappa y_t + e_t$$
Demand Shock
$$u_t = \rho_u u_{t-1} + \upsilon_t \quad \upsilon_t \sim N(0,1), \quad |\rho_u| < 1$$
Supply Shock
$$e_t = \rho_e e_{t-1} + \varepsilon_t \quad \varepsilon_t \sim N(0,1), \quad |\rho_e| < 1$$

Different States of the Economy

- New: Model uncertainty together with regime switching
- distinguish from two different regimes
  1. normal regime (N) in which monetary policy transmission mechanism works as usual
  2. worst case regime (W) in which monetary policy transmission weakens, and model uncertainty increases
- I describe the regime switching as a change in the sensitivity of the economy to policy rate
- IS equation varies depending on the two regimes as follows:

$$\Omega_{s_t} = \begin{cases} \Omega_N & \text{if } s_t = N \\ \Omega_W (< \Omega_N) & \text{if } s_t = W \end{cases} \tag{1}$$

- In the first regime, decision makers trust their model and do not worry about model uncertainty, yet in the second regime, decision makers guard against possible model misspecification.

$$z_{t+1} = \begin{cases} Az_t + Br_t + C\epsilon_{t+1} & \text{if } s_t = N \\ Az_t + Br_t + C(\epsilon_{t+1} + \upsilon_{t+1}) & \text{if } s_t = W \end{cases} \tag{2}$$

- This structure provides a basis for time-varying uncertainty aversion.

Worst-Case Specification for Monetary Policy

- Following Hansen and Sargent (2008), to allow for model uncertainty, I introduce a second type of disturbances in the shock process which leads:

$$e_{t+1} = \rho_e e_t + \varepsilon_{t+1} + v^e_{t+1}$$

$$u_{t+1} = \rho_u u_t + \upsilon_{t+1} + v^u_{t+1}$$

- Hence, model uncertainty is described by the set $\{v^e_{t+1}, v^u_{t+1}\}$ satisfying the constraint:

$$E_0 \sum_{\tau=0}^{\infty} \beta^t \{[v^e_{t+\tau}]^2 + [v^u_{t+\tau}]^2\} \leq \eta_0, \quad \eta_0 > 0$$

- Reformulate the optimization problem to obtain a policy rule that performs well under the worst-case model
- Introduce a fictitious evil agent who shares the same reference model that the policymaker considers and tries to maximize the same objective function
- A two-person game → Each player simultaneously commits to sequences for $\{r_t\}$, and $\{v^e_{t+1}, v^u_{t+1}\}$ at time zero, taking the other player's moves as given.

Policymaker's Problem

$$\max_{\{v^e_{t+1}, v^u_{t+1}\}_{t=0}^{\infty}} \min_{\{r_t, \pi_t, y_t\}_{t=0}^{\infty}} (\frac{1}{2}) E_0 \sum_{t=0}^{\infty} \beta^t \{[\pi_t^2 + \lambda_y y_t^2 + \lambda_r (\Delta r_t)^2]\}$$

subject to IS and Phillips Equations, and

$$e_{t+1} = \rho_e e_t + [\epsilon_{t+1} + v^e_{t+1}]$$
$$u_{t+1} = \rho_u u_t + [\upsilon_{t+1} + v^u_{t+1}]$$
$$E_0 \sum_{t=0}^{\infty} \beta^t \{[v^e_{t+1}]^2 + [v^u_{t+1}]^2\} \leq \eta_0$$

Calibration

Parameter	Description	Values
β	Discount Factor	0.99
Ω_N	Elasticity of Intertemporal Substitution	0.5
Ω_W	Elasticity of Intertemporal Substitution	0.2
κ	Slope of the Phillips Relation	0.75
λ_y	Weight of the output gap in loss function	0.25
λ_r	Weight of the interest rate in loss function	0.1
p_N	Persistence in regime N	0.95
p_W	Persistence in regime W	0.8

SOLUTION AND RESULTS

Methodology

- Deterministic Switching versus Stochastic Switching

1. Deterministic Switching with Occasionally binding constraints: utilizing piecewise linear solutions as a benchmark
   - by Guerrieri and Iacoviello (JME, 2015)
   - The regimes are determined by a threshold interest rate as follows:

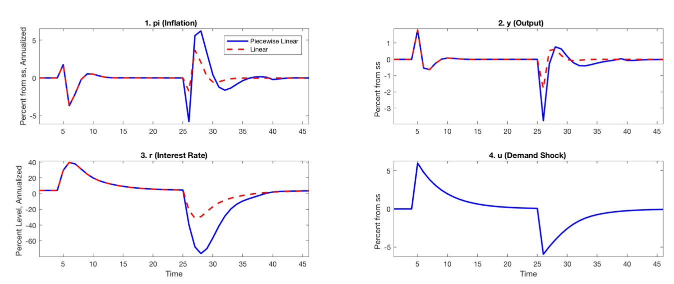
$$s_t = \begin{cases} N \text{ (Normal Regime)} & \text{if } r_t > r^* \\ W \text{ (Weak Regime)} & \text{if } r_t \leq r^* \end{cases} \tag{3}$$

   - Does not accounting for the risk of the constraint binding in the future!
2. Endogenous regime switching structure: taking into account the possibility of future switches
   - by Barthelemy and Marx (JEDC, 2017)
     in the spirit of Davig and Leeper (NBER, 2008)
   - The probability to remain in regime $j \in \{N, W\}$ is

$$\Pr(s_t = N | s_{t-1} = N, r_{t-1}) = p_N + \lambda_{jj} g(r_{t-1} - r^N) \tag{4}$$
$$\Pr(s_t = W | s_{t-1} = W) = p_W \tag{5}$$

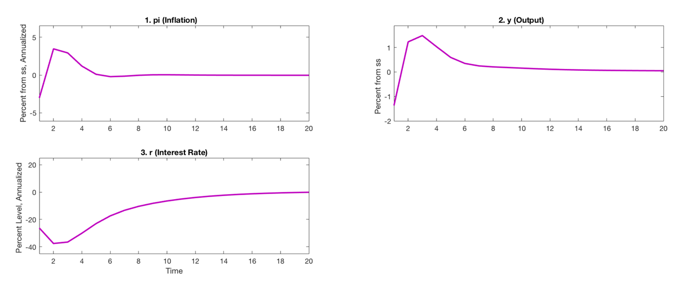
   where r^N the interest rate threshold for entering the second regime.
   - Takes into account the possibility of future switches!

Figure 1: IRF's for Piecewise Linear Solution-Demand Shock



- IRF's are represented as a combination of the two regimes:
  i in which the constraint is never binding.
  ii in which the constraint is binding all the time.
- Weakening of the monetary policy transmission mechanism calls for stronger policy actions in response to shocks.

Figure 2: IRF's with endogenous transition probabilities-Demand Shock



- IRF's are generated conditional on a specific regime.
- When agents acknowledge this possible future change in the economic structure, optimal policy becomes more active even in normal times.