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Macroeconomic and interest rate volatility under alternative monetary operating procedures

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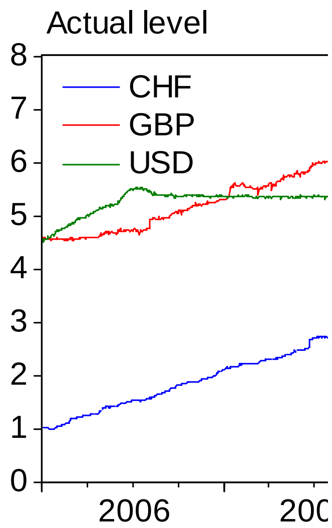
Motivation

- The stance of monetary policy can be defined and announced with different interest rates
  - Rate at which the central bank lends money to the financial sector; Bank of England
  - Rate at which commercial banks lend and borrow overnight funds; Federal Reserve
  - Longer-term money market rate; Swiss National Bank
- Two dimensions
  - Riskless vs risky rate
  - Overnight vs longer-term maturity

Before the financial crisis

- ... the difference between these rates used to be small and stable
  - Changes in the implementation rate had a predictable effect on money market rates
- Question which rate matters for the economy was not important
- Macro models typically assumed only one interest rate i_t

Three-month market rates



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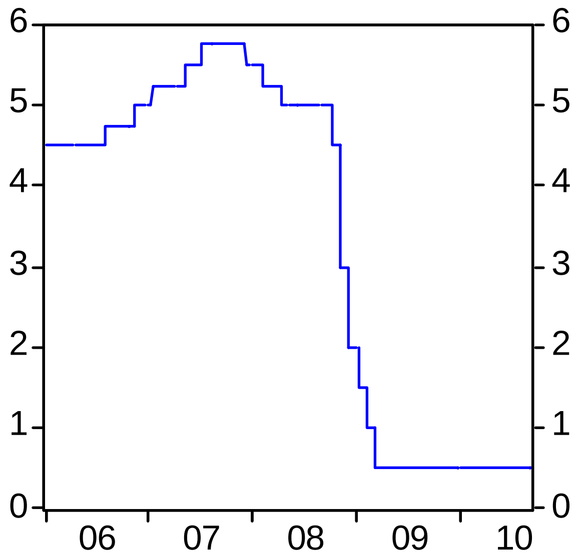

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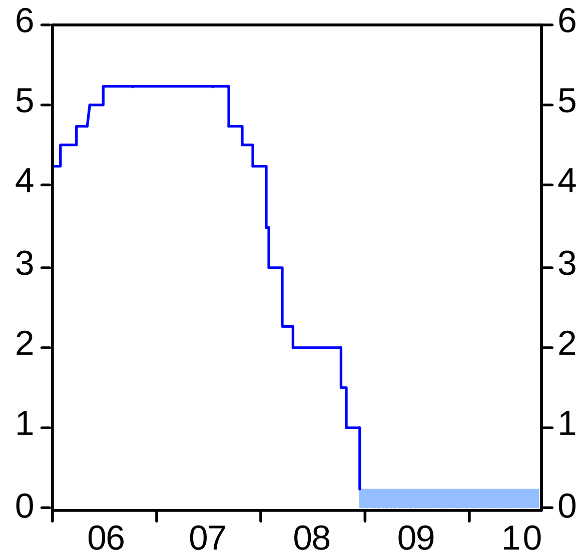
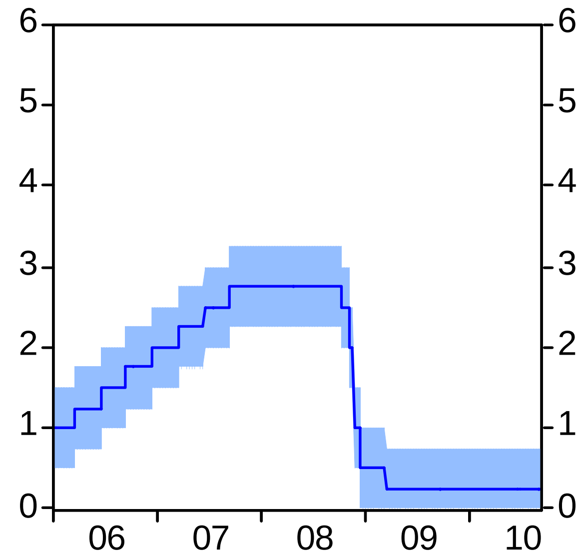


Switzerland



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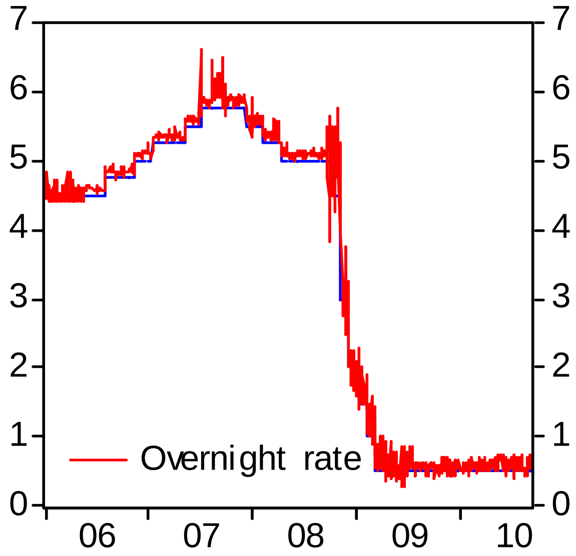

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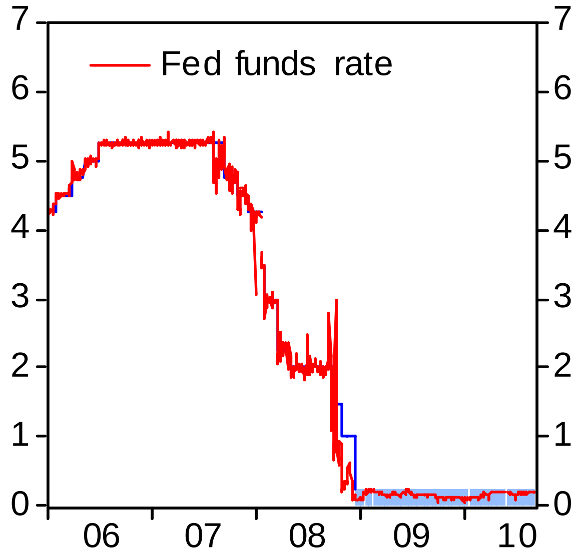

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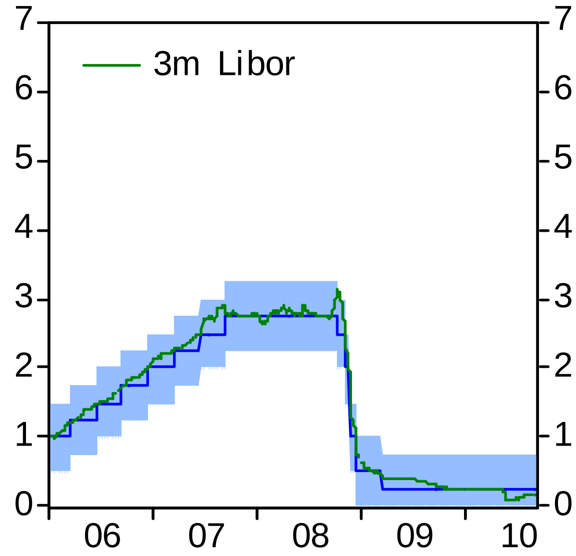

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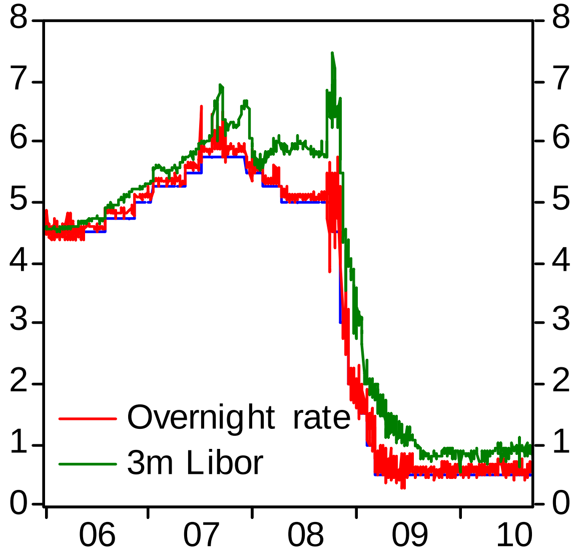

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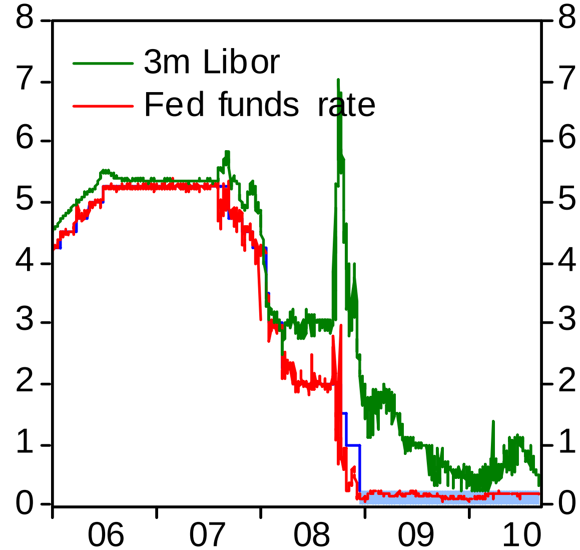

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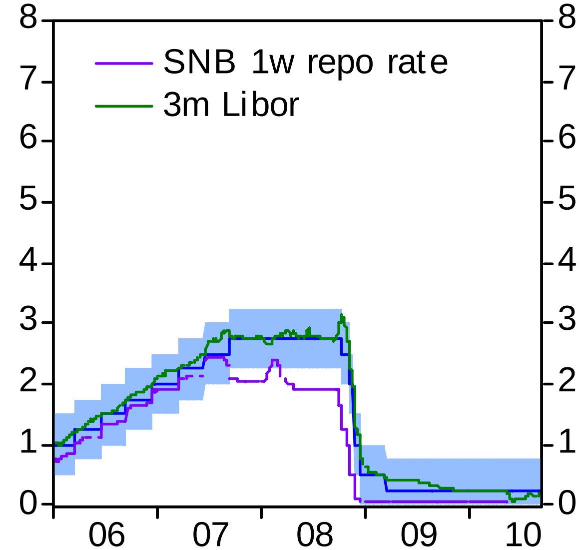


Overview

- Related literature
- The model
- Reaction functions, impulse responses and simulated volatilities
- Robustness checks
- Planned extension
- Conclusions

Related literature

- Longer-term interest rate in the IS curve
  - Eijffinger, Schaling and Verhagen (2000), Fendel (2009), Lansing and Trehan (2003), Svensson (2000)
- Longer-term interest rate in the reaction function
  - Kulish (2007), McGough, Rudebusch and Williams (2005); Gerlach-Kristen and Rudolf (2010)
- Larger models with several interest rates
  - Goodfriend and McCallum (2007), Curdia and Woodford (2010)

Interest rates in the model

- Central bank implements policy with a one-month repo rate
  - Only interest rate that is fully controlled by the bank
- Policy may be formulated with
  - that repo rate (1MR procedure)
  - a one-month money market rate (1MM procedure)
  - a three-month repo rate (3MR procedure)
  - a three-month money market rate (3MM procedure)
- The policy rate is smoothed
- Caveat: We assume the existence of money markets

Main characteristics of the model

- Standard New-Keynesian Phillips curve with partly forward-looking agents
- Standard IS curve given by log-linearised Euler equation in which a risky market rate matters
- Risk premia reflect default risk and depend on the expected path of the output gap

- We compute the optimal reaction functions for the one-month repo rate for the 1MR, the 1MM, the 3MR and the 3MM procedure

Optimisation

- Loss functions differ between operating procedures
  - 1MR: $L_{1MR,t} = \lambda_\pi \pi_t^2 + \lambda_y y_t^2 + \lambda_i (\Delta i_{1,t}^r)^2$
  - 1MM: $L_{1MM,t} = \lambda_\pi \pi_t^2 + \lambda_y y_t^2 + \lambda_i (\Delta i_{1,t}^m)^2$
  - 3MR: $L_{3MR,t} = \lambda_\pi \pi_t^2 + \lambda_y y_t^2 + \lambda_i (\Delta i_{3,t}^r)^2$
  - 3MM: $L_{3MM,t} = \lambda_\pi \pi_t^2 + \lambda_y y_t^2 + \lambda_i (\Delta i_{3,t}^m)^2$
- Technical problem
  - Three-month rates depend on the expected policy path
  - Market rates depend on the expected output gap path
  - Assume optimal solution and iterate until convergence

Phillips and IS curve

$$\pi_t = a_\pi E_t \pi_{t+1} + (1 - a_\pi)\pi_{t-1} + a_y y_t + u_{\pi,t}$$

$$u_{\pi,t} = \rho_\pi u_{\pi,t-1} + \sigma_\pi e_{\pi,t}$$

$$y_t = b_y E_t y_{t+1} + (1 - b_y) y_{t-1} - b_r (i^m_{1,t} - E_t \pi_{t+1} - \mu_{1,r}) + u_{y,t}$$

$$u_{y,t} = \rho_y u_{y,t-1} + \sigma_y e_{y,t}$$

Risk premia

- The one-month money market rate differs from the one-month repo rate by a risk premium $\theta_{1,t}$

$$i^m_{1,t} = i^r_{1,t} + \theta_{1,t}$$

- Risk premium mirrors default risk, which we proxy as a function of the output gap

$$\theta_{1,t} = \theta_1 - cE_t y_{t+1} + \varepsilon_{1,t}$$

$$\varepsilon_{1,t} = \rho_\varepsilon \varepsilon_{1,t-1} + e_{1,t}$$

Risk premia and the macroeconomy

- Fama and French (1989) show that default and term spreads are correlated with the NBER business cycle
- Campbell, Lo and MacKinlay (1997) argue that risk aversion is time-varying either because of habit formation or agents' heterogeneity
- Affine models of the term structure find that inflation and the output gap have explanatory power for term premia (e.g. Ang and Piazzesi, 2003)
- DSGE models link risk and term premia to consumption and investment shocks (e.g. Emiris, 2006)

Longer-term interest rates

- The three-month repo rate is given by a fixed term premium τ_3 and the expected path of the one-month repo rate

$$i^r_{3,t} = \tau_3 + \frac{1}{3} E_t \sum_{j=0}^{2} i^r_{1,t+j}$$

- The three-month market rate includes a risk premium $\theta_{3,t}$

$$i^m_{3,t} = i^r_{3,t} + \theta_3 - \frac{c}{3} E_t \sum_{j=1}^{3} y_{t+j} + \varepsilon_{3,t}$$

- The innovations are correlated across horizons

Calibration

- IS and Phillips curve

$$a_\pi = b_y = 0.5 \qquad a_y = 0.2$$

$$b_r = 0.5 \qquad c = 0.25$$

$$\rho_\pi = \rho_y = 0.9 \qquad \sigma_\pi = \sigma_y = 0.1$$

- Central bank preferences

$$\lambda_\pi = \lambda_y = 1 \qquad \lambda_i = 0.5 \qquad \delta = 0.999$$

Calibration

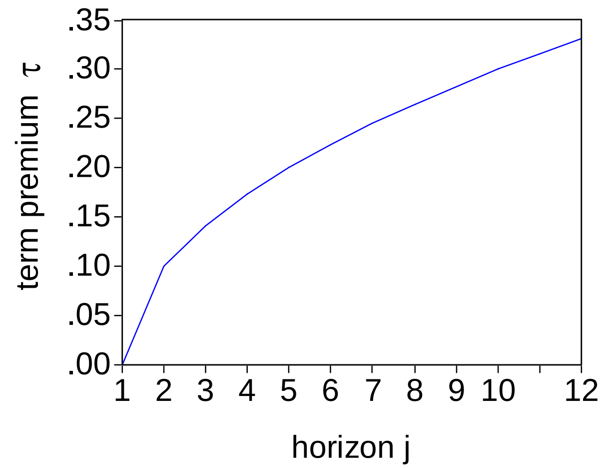
- Risk premia

$$\theta_1 = \theta_j = 0.1$$

$$\rho_\varepsilon = 0.5 \qquad \sigma_{e,j} = 0.01 \qquad \sigma_{e,jk} = 0.001$$

- Term permia

$$\tau_j = \frac{\sqrt{j-1}}{10}$$



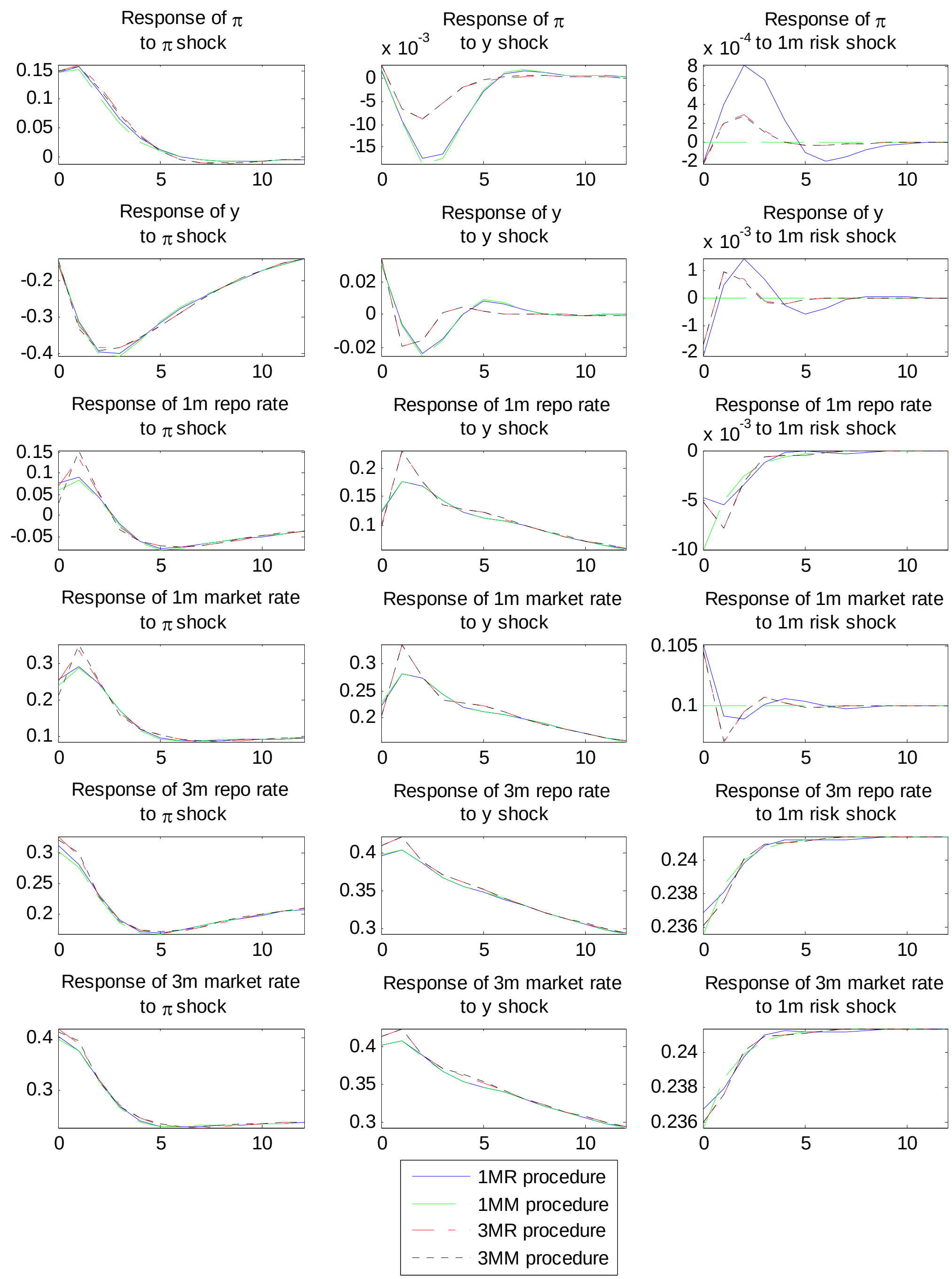
Optimal reaction functions

Commitment												
Procedure	π_{t-1}	y_{t-1}	$u_{\pi,t}$	$u_{y,t}$	$\varepsilon_{1,t}$	$\varepsilon_{3,t}$	$i^r_{1,t-1}$	$i^m_{1,t-1}$	$i^r_{3,t-1}$	$i^m_{3,t-1}$	ξ^{PC}_{t-1}	ξ^{IS}_{t-1}
1MR	0.16	0.31	0.77	1.21	-0.47	0	0.36	0	0	0	0	0.09
1MM	0.13	0.31	0.60	1.25	-1	0	0	0.34	0	0	0	0.07
3MR	0.21	0.53	0.71	0.99	-0.52	0	0	0	0.52	0	0.03	0.35
3MM	0.17	0.52	0.27	0.98	-0.51	-0.89	0	0	0	0.53	0.03	0.34

$$i^m_{1,t} = i^r_{1,t} + \theta_{1,t}$$

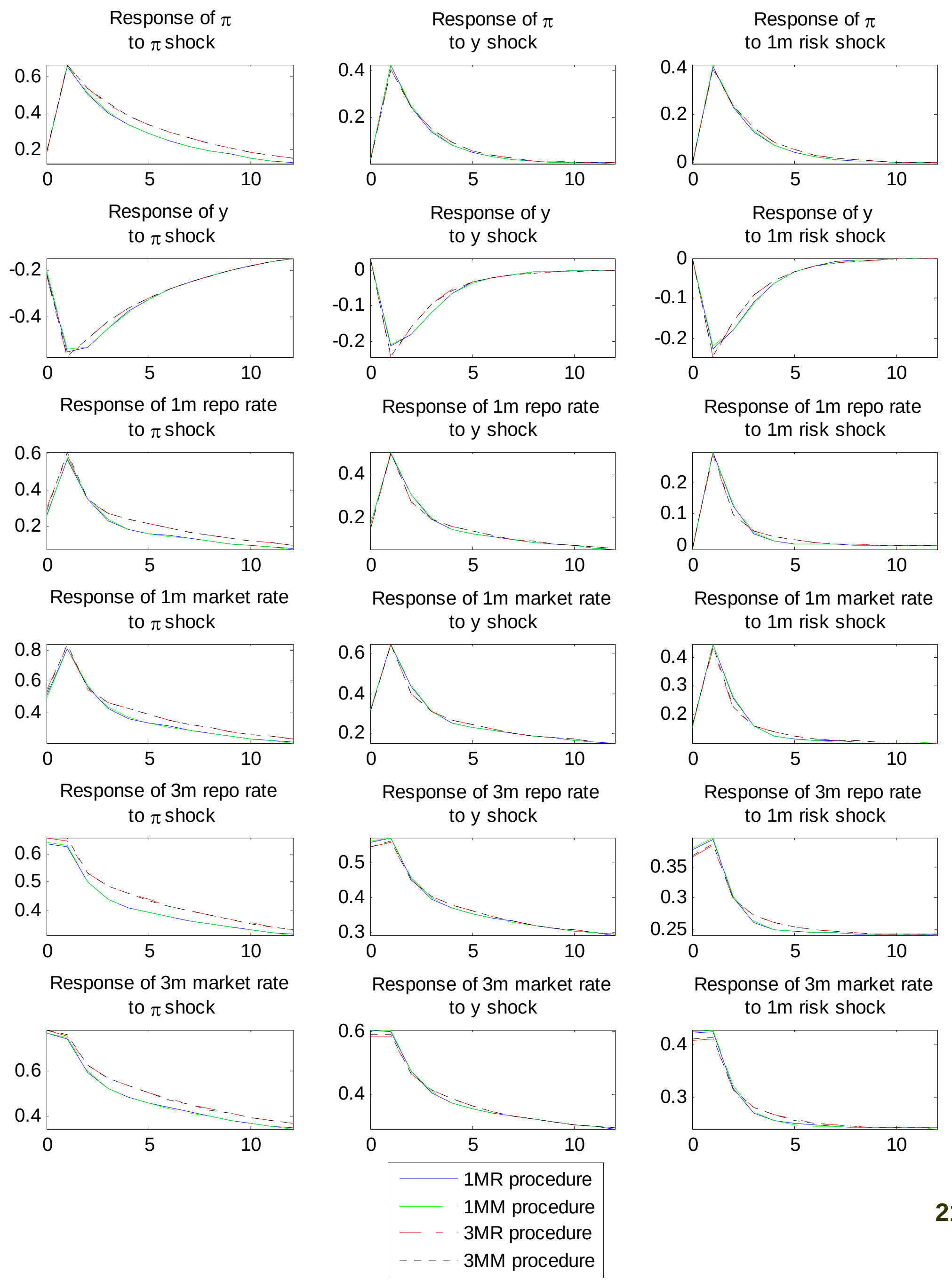
Impulse responses

Commitment



Impulse responses

Discretion



Volatility

- Macroeconomic volatility: inflation and output gap

$$\text{inflation volatility} = \frac{1}{T}\sum_{t=1}^{T}\pi_t^2$$

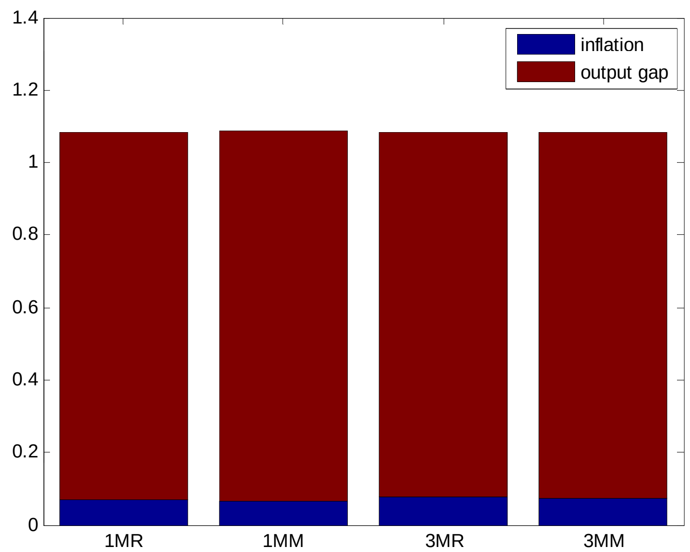
$$\text{output gap volatility} = \frac{1}{T}\sum_{t=1}^{T}y_t^2$$

- Interest rate volatility for each maturity j

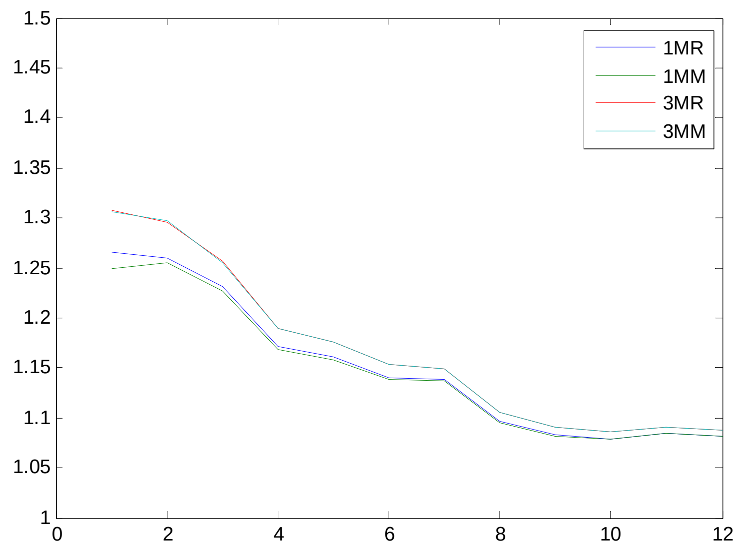
$$\text{yield curve volatility}_j = \frac{1}{T}\sum_{t=1}^{T}\left(i_{j,t}^{m}\right)^2$$

Volatilities

Macroeconomy



Yield curve



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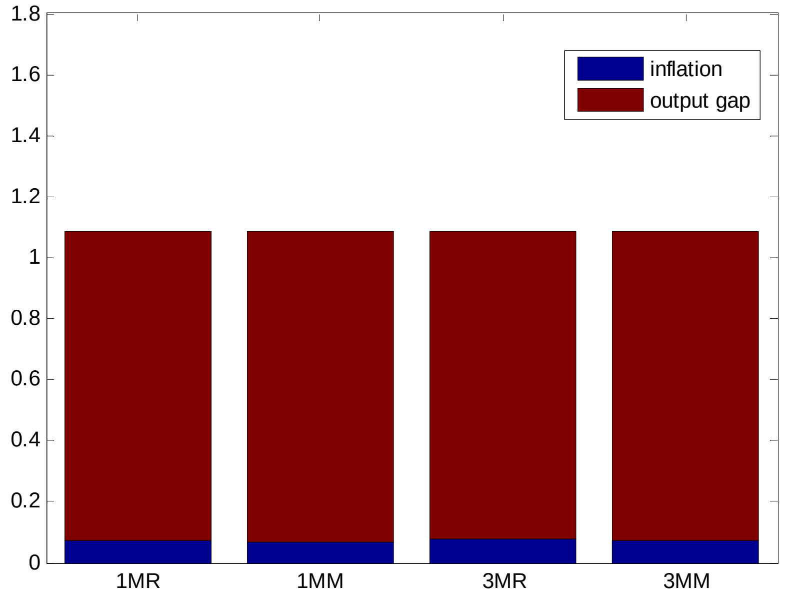

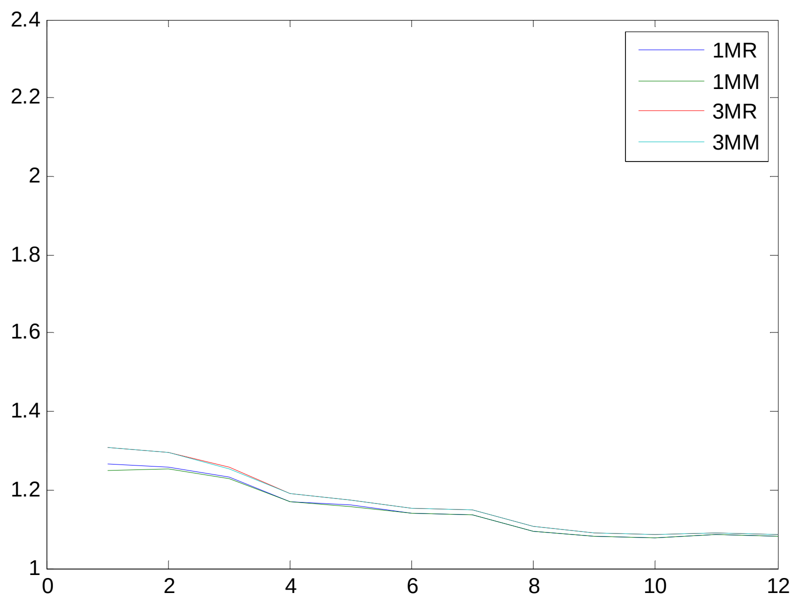

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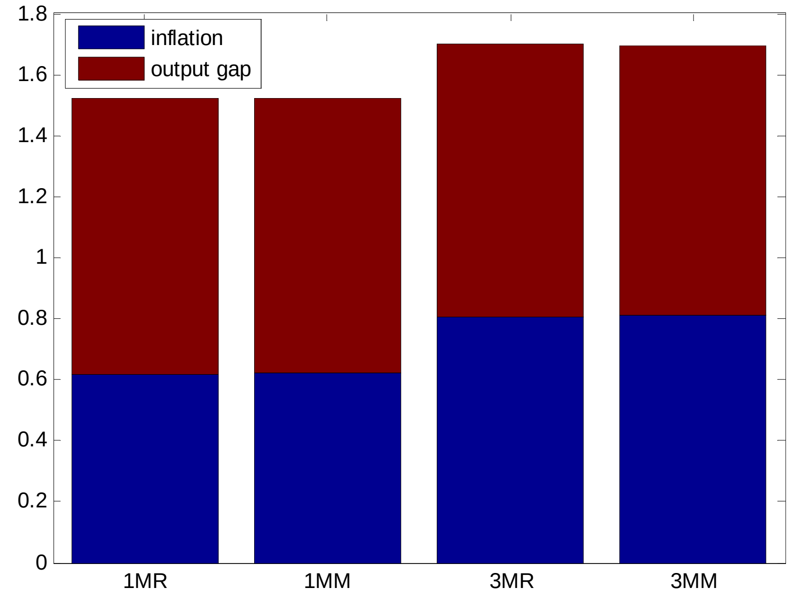
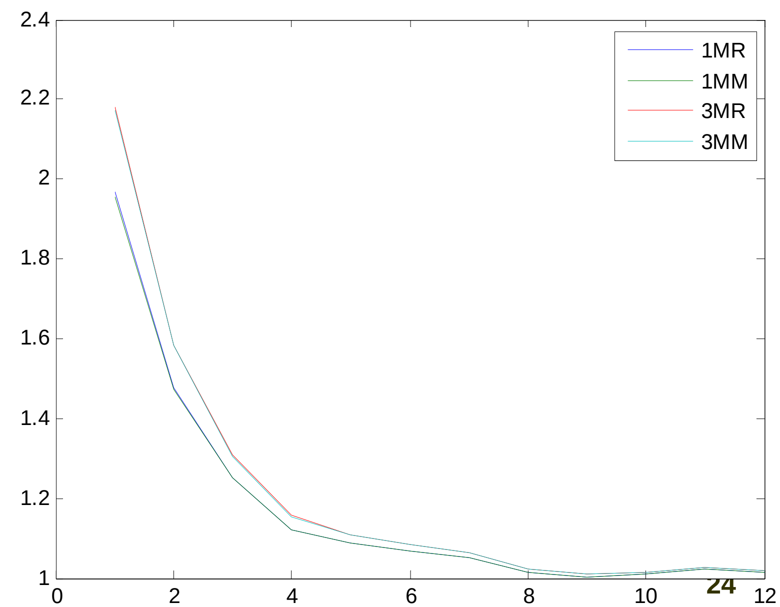


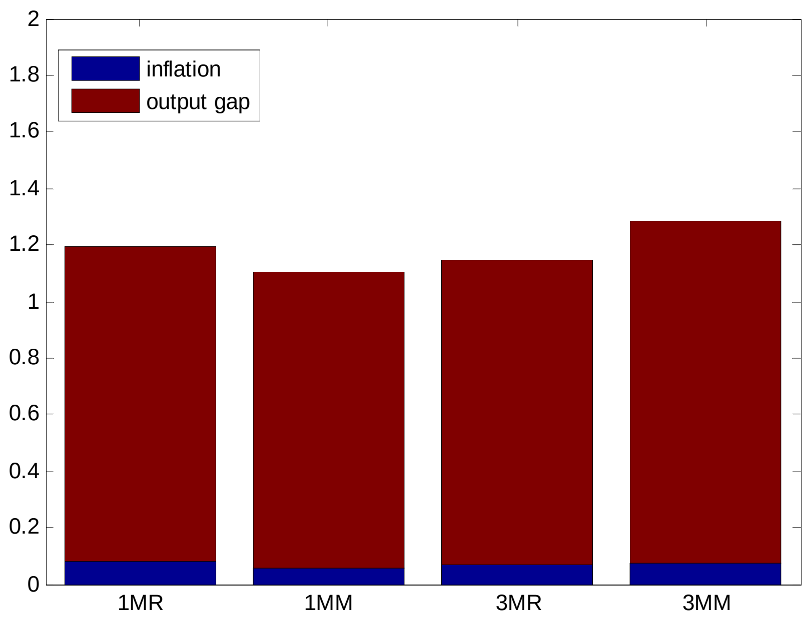


Robustness tests

- Financial turmoil
  - Larger risk shocks with higher covariances and autocorrelation
- More forward-looking economy
  - $a_\pi = b_y = 0.8$
- Longer-term market rate in the IS curve
  - 3-month rate
  - Average rate

Financial turmoil

Commitment



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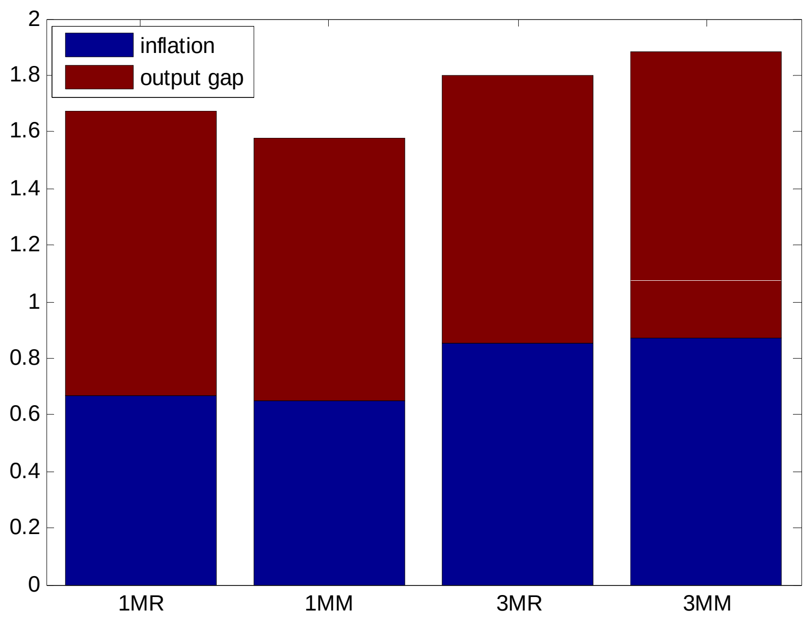
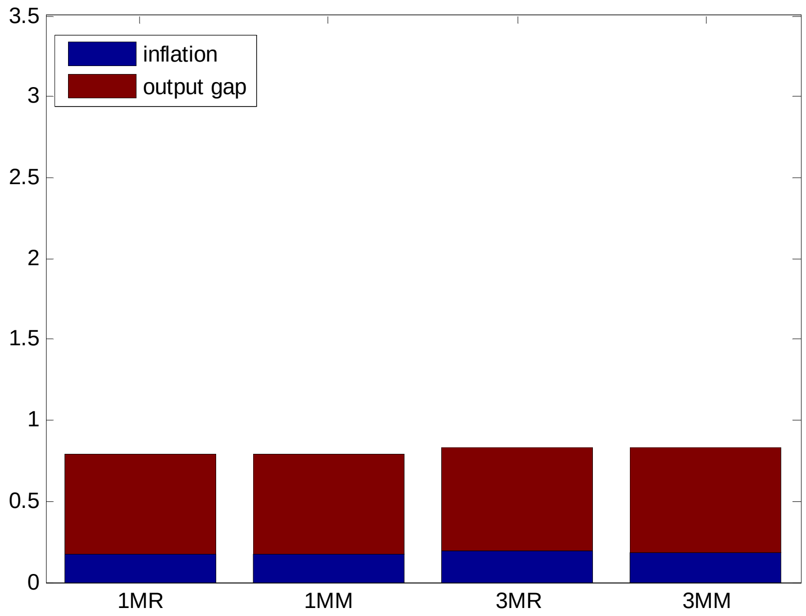


More forward-looking economy

Commitment



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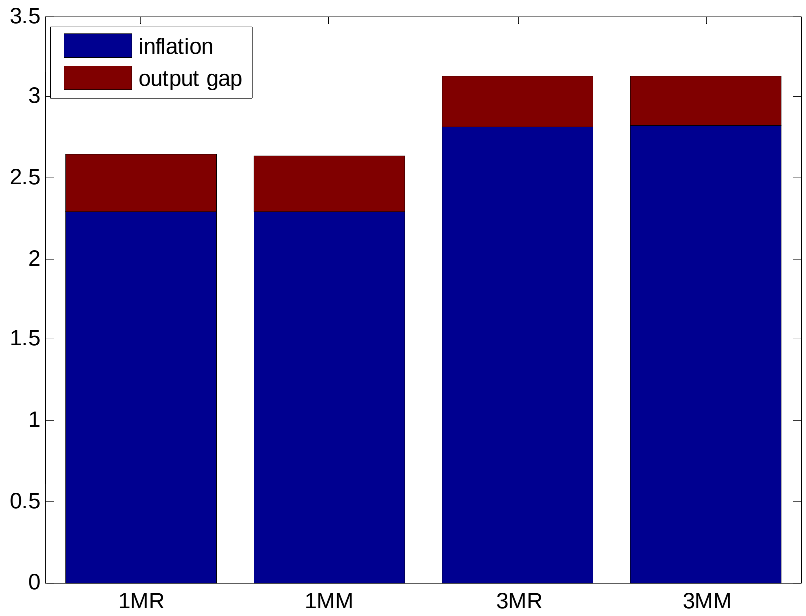


Longer-term rate in IS curve

- Three-month market rate

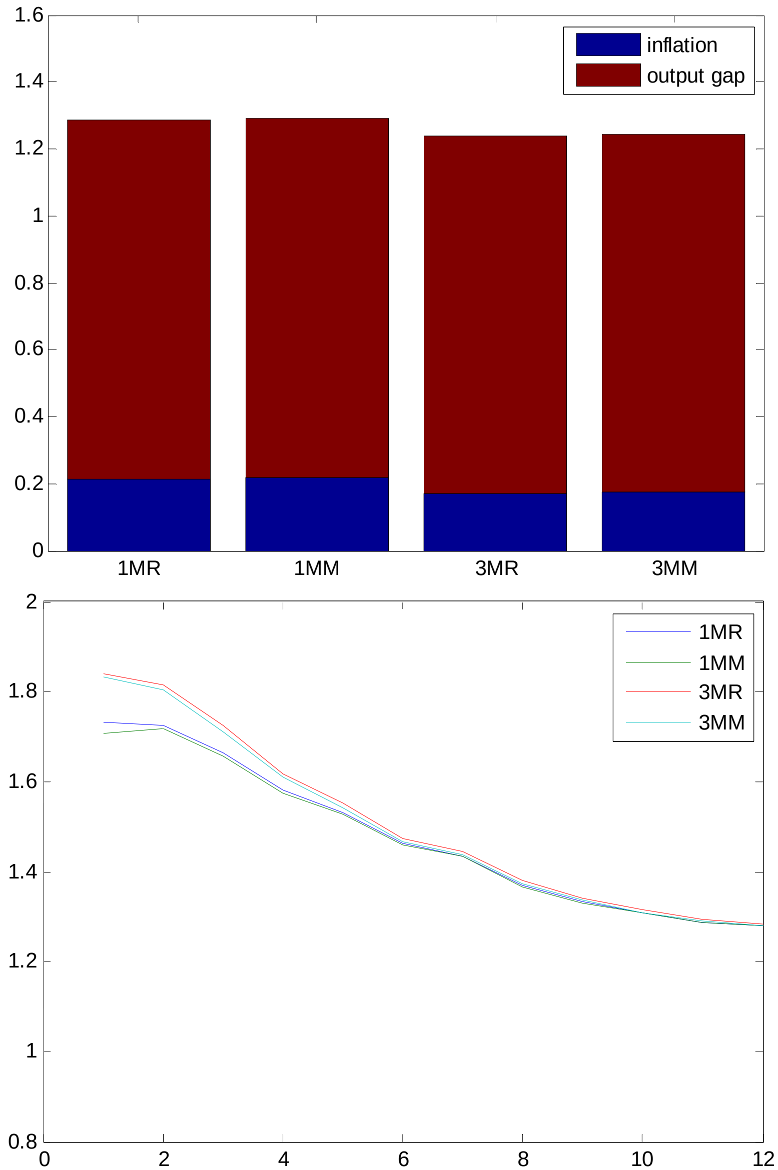
$$y_t = b_y E_t y_{t+1} + (1 - b_y) y_{t-1} - b_r (i^{m}_{3,t} - E_t \pi_{3,t+1} - \mu_{3,r}) + u_{y,t}$$

- Average market rate

$$y_t = b_y E_t y_{t+1} + (1 - b_y) y_{t-1} - b_r (i^{m}_{av,t} - E_t \pi_{av,t+1} - \mu_{av,r}) + u_{y,t}$$

Three-month market rate in IS curve

Commitment



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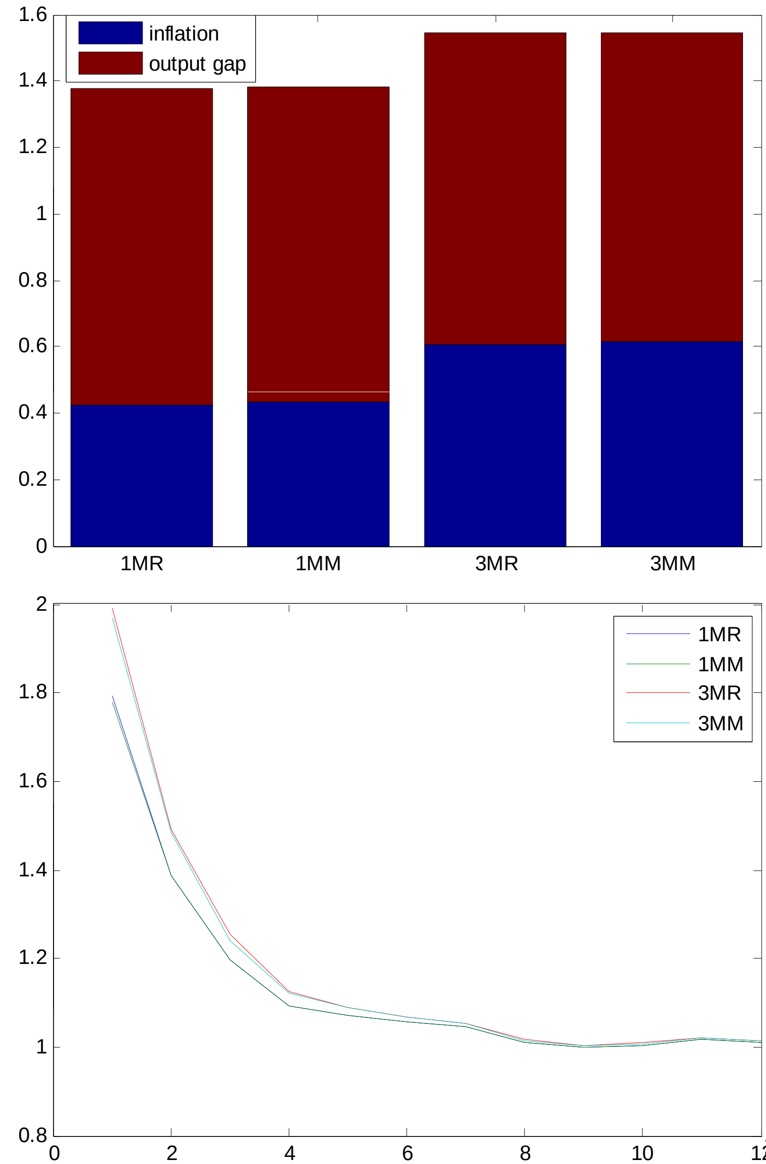
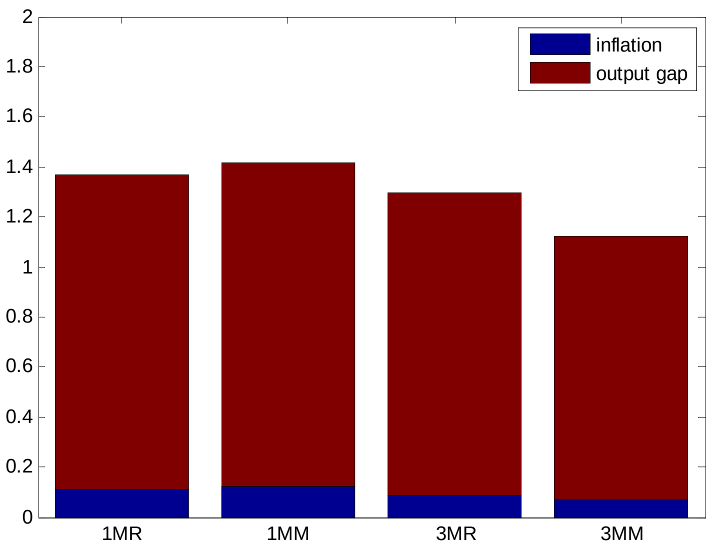
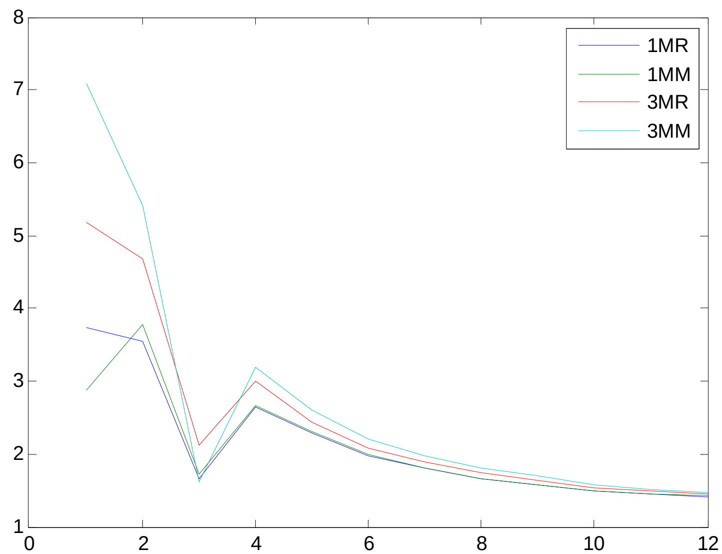


Three-month market rate and turmoil

Commitment





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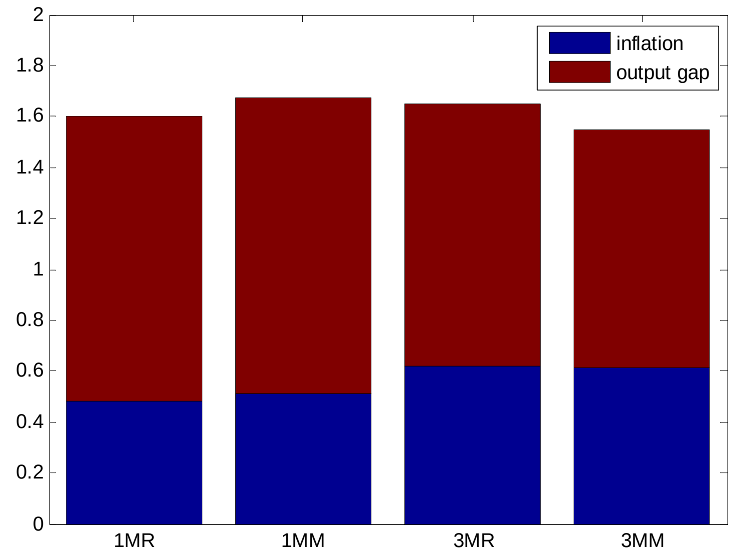
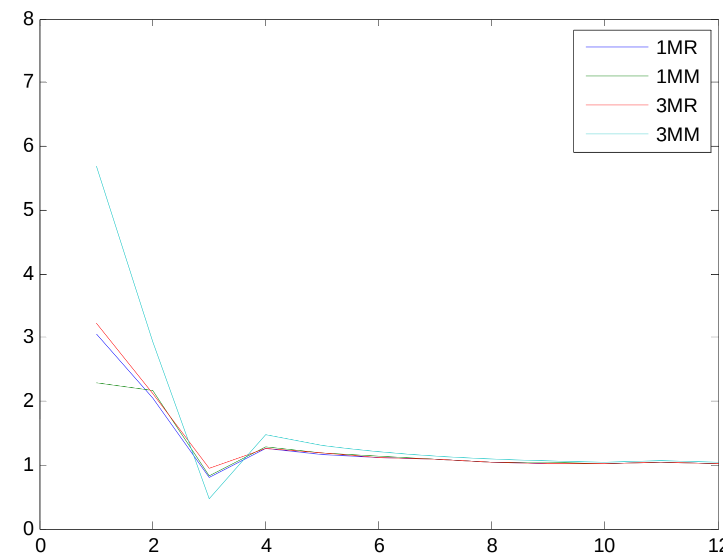
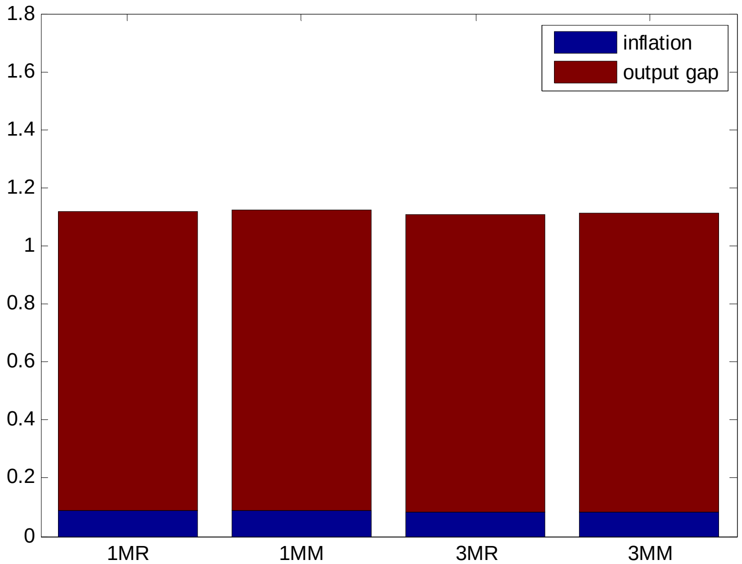
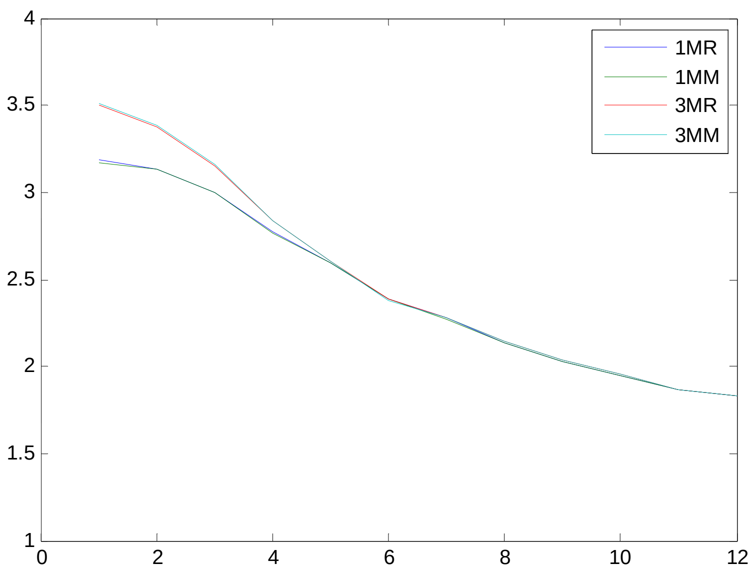




Average market rate in IS curve

Commitment





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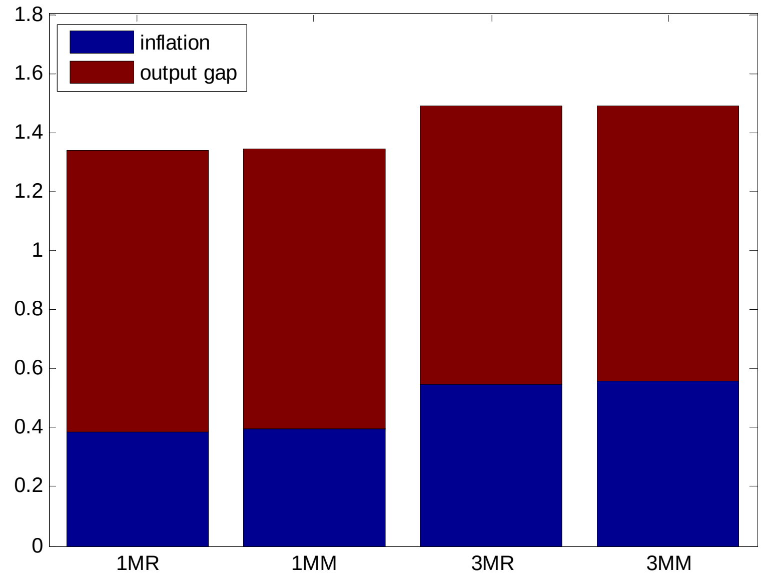
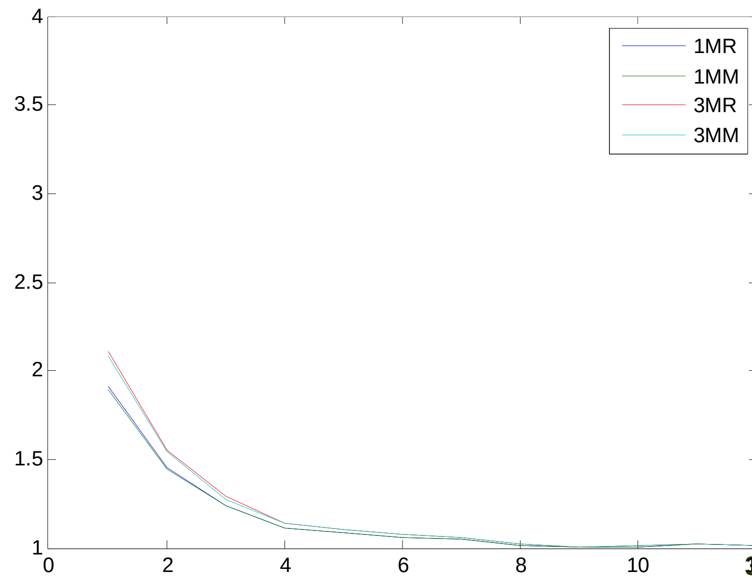




Extension

- International Framework for Liquidity Risk Measurement, Standards and Monitoring (Basel Committee on Banking Supervision)
  - Liquidity Coverage Ratio: Forces banks to hold high quality assets
  - Net Stable Funding Ratio: Shifts funding towards longer-term liabilities
  - Minimum standards in 2015/2018
  - Limits supply and demand in short-term money markets
- Implement monetary policy in longer-term market?

New model

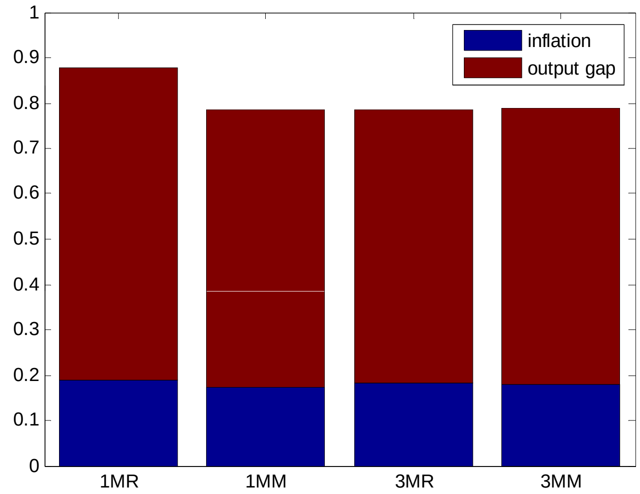
- Policy is implemented with the one- or the three-month repo rate
- One-month market rate matters in IS curve
- Larger market volatility in the shortest segment of the money market – more responsive implementation
- Expectations hypothesis works through the market rates
  - Before $$i^r_{3,t} = \tau_3 + \frac{1}{3} E_t \sum_{j=0}^{2} i^r_{1,t+j}$$
  - Now $$i^m_{3,t} = \tau_3 + \frac{1}{3} E_t \sum_{j=0}^{2} i^m_{1,t+j} + \varepsilon_{3,t}$$

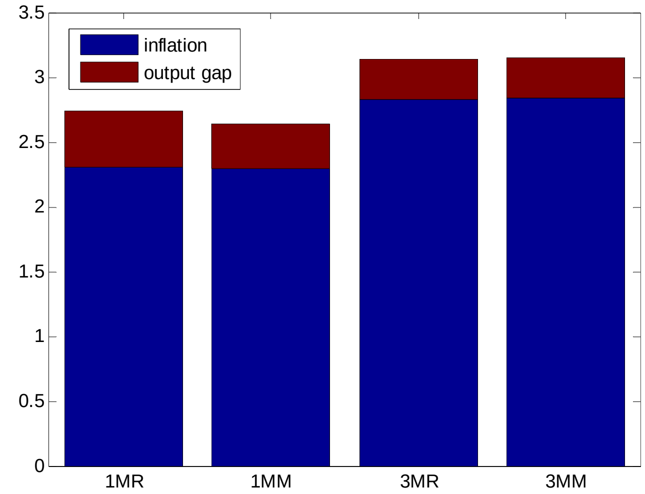
One-month rate in the IS curve

Commitment

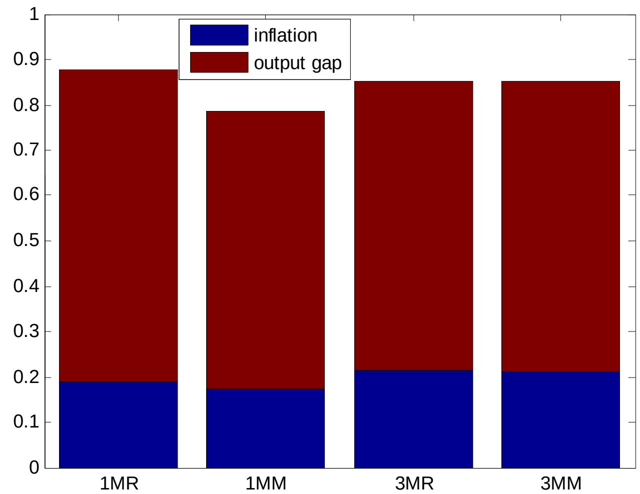
Discretion

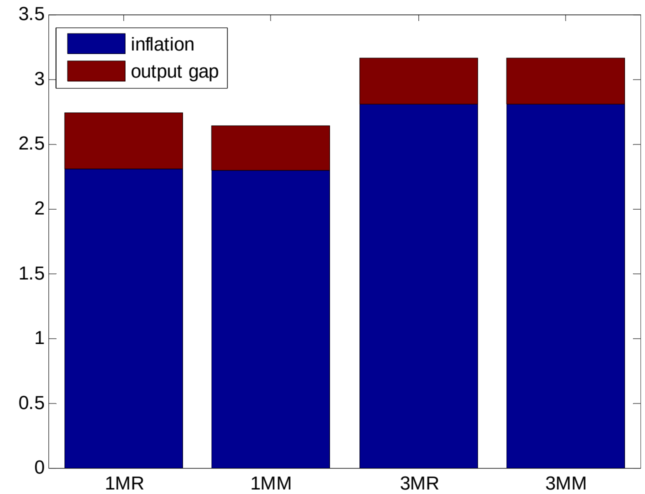
One-month implementation





Three-month implementation





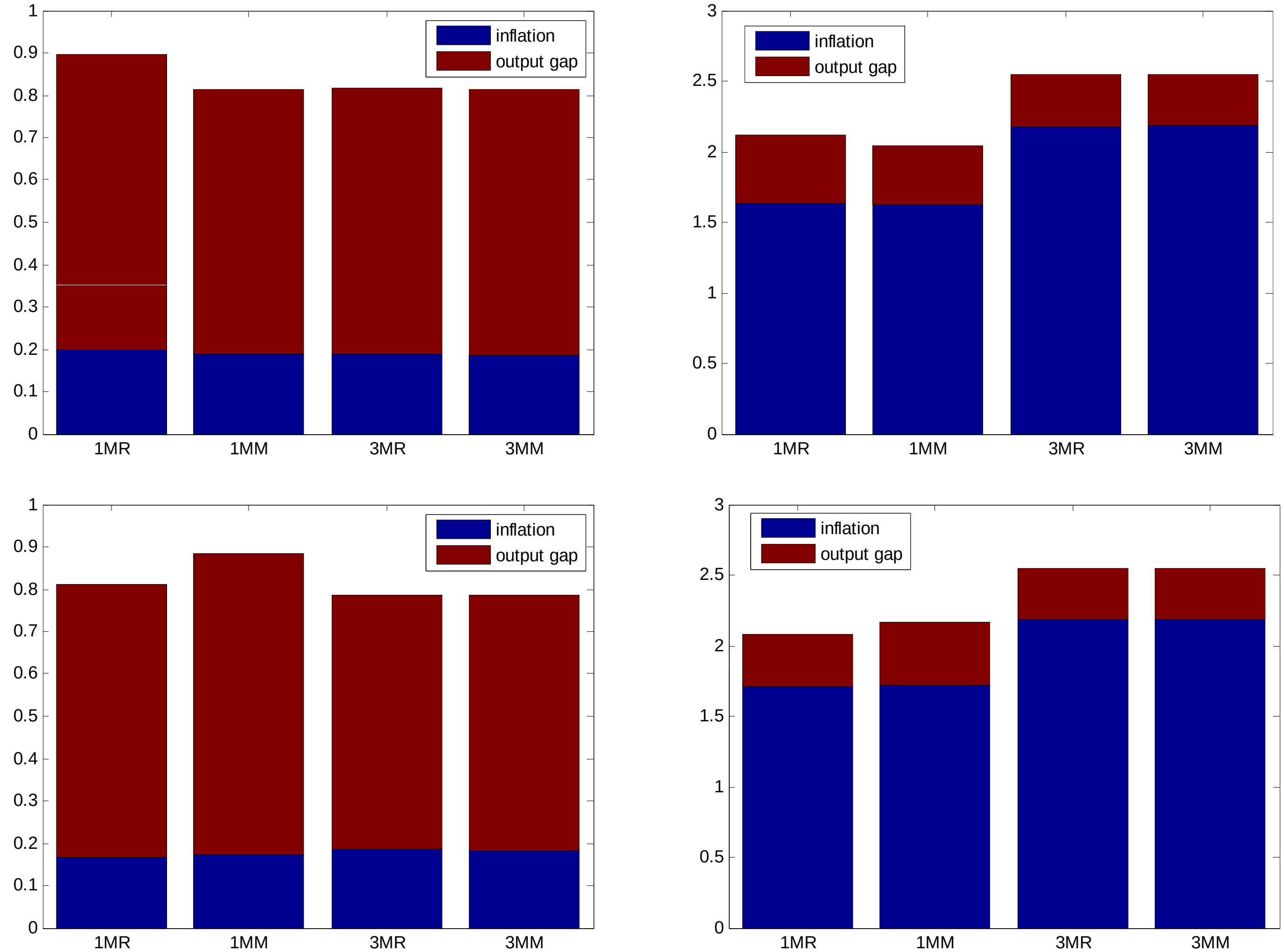
Three-month rate in the IS curve

Commitment

Discretion

One-month implementation

Three-month implementation



Conclusions

- Under commitment, the volatilities of inflation, the output gap and the yield curve are essentially the same for all procedures
  - Under large risk shocks, one-month procedures better
  - In more forward-looking world, likewise
  - If longer-term rate matters in IS curve, three-month procedures better
- Under discretion, one-month procedures work better
  - Except for case of longer-term rate in IS curve and large risk shocks

Conclusions (2)

- If volatility in the short-term segment of the money market increases
  - Implementation complicated
  - Changing to longer-term implementation perhaps advisable
  - Depends on what rate matters in the IS curve
  - Presumably stronger argument for longer-term implementation if the central bank does not observe risk premia in real time (to be confirmed)