MACRO-LINKAGES, OIL PRICES AND DEFLATION WORKSHOP
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Credit Frictions and Optimal Monetary Policy

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IMF Research Department Macro-Modeling Workshop

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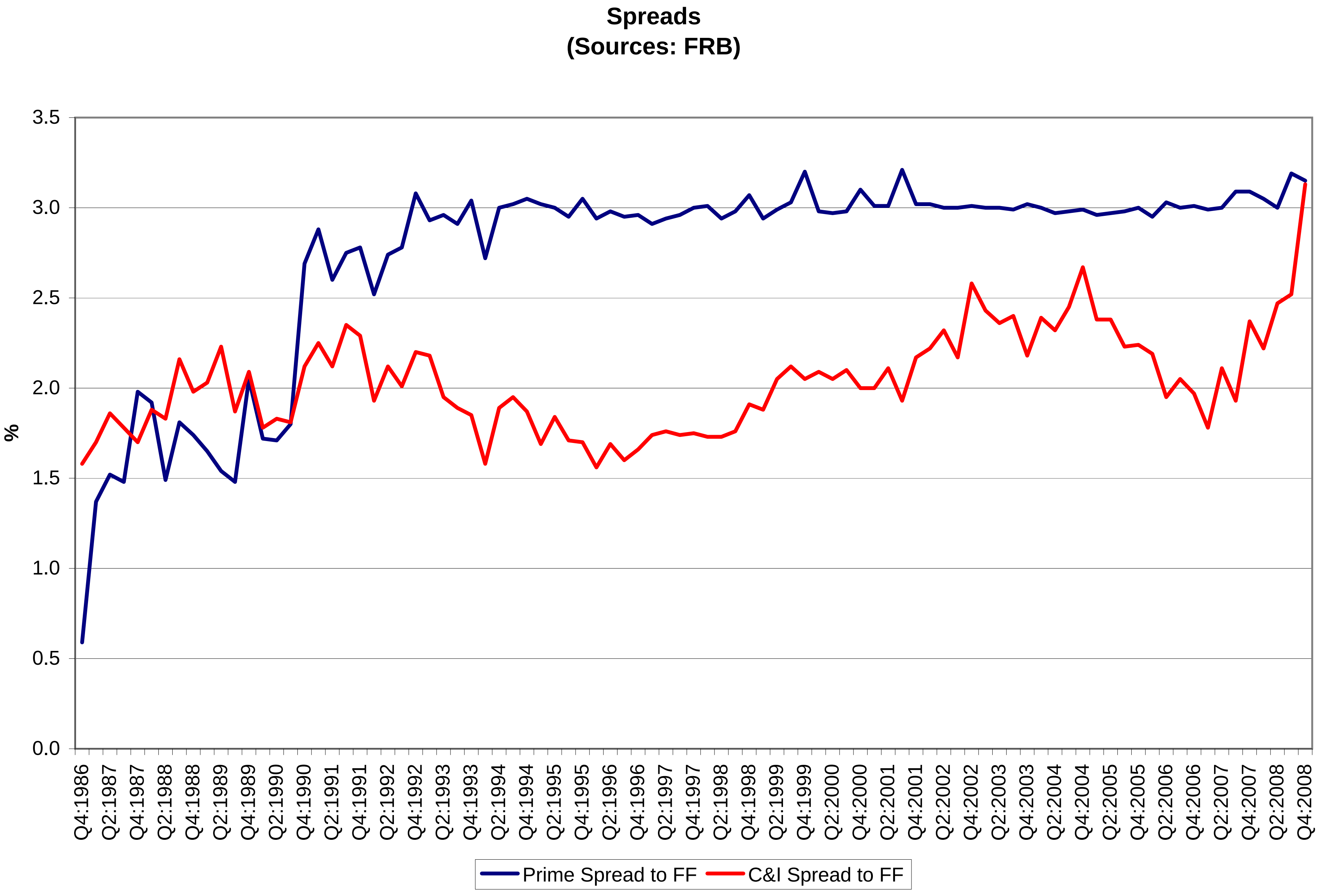
  - Single interest rate (which is also the policy rate) relevant for all decisions

- But in actual economies (even financially sophisticated), there are different interest rates, that do not move perfectly together


Spreads
(Sources: FRB)
%
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Q4:1986
Q2:1987
Q4:1987
Q2:1988
Q4:1988
Q2:1989
Q4:1989
Q2:1990
Q4:1990
Q2:1991
Q4:1991
Q2:1992
Q4:1992
Q2:1993
Q4:1993
Q2:1994
Q4:1994
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Q2:2001
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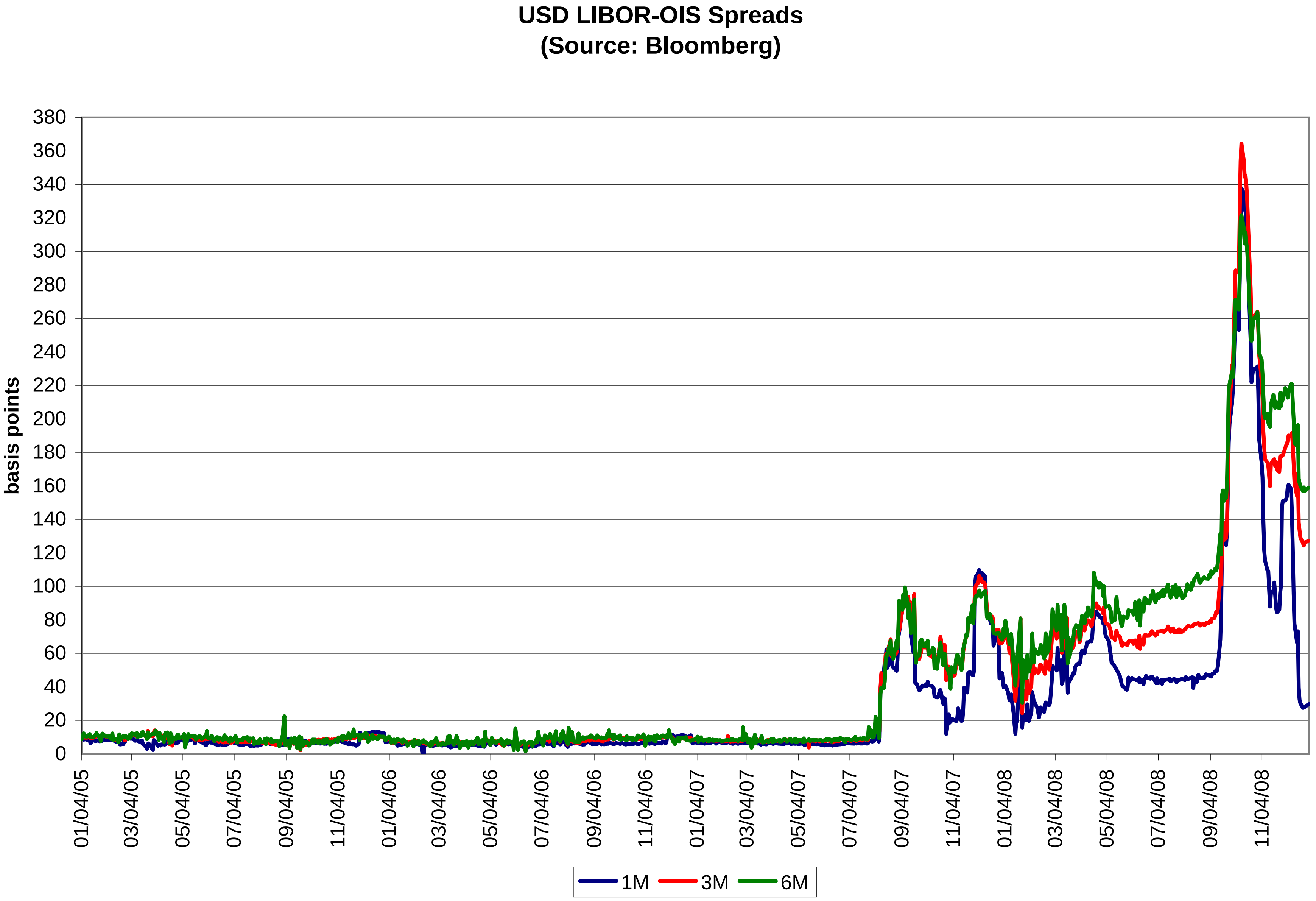
Q4:2003
Q2:2004
Q4:2004
Q2:2005
Q4:2005
Q2:2006
Q4:2006
Q2:2007
Q4:2007
Q2:2008
Q4:2008
Prime Spread to FF
C&I Spread to FF


USD LIBOR-OIS Spreads
(Source: Bloomberg)
basis points
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
01/04/05
03/04/05
05/04/05
07/04/05
09/04/05
11/04/05
01/04/06
03/04/06
05/04/06
07/04/06
09/04/06
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07/04/07
09/04/07
11/04/07
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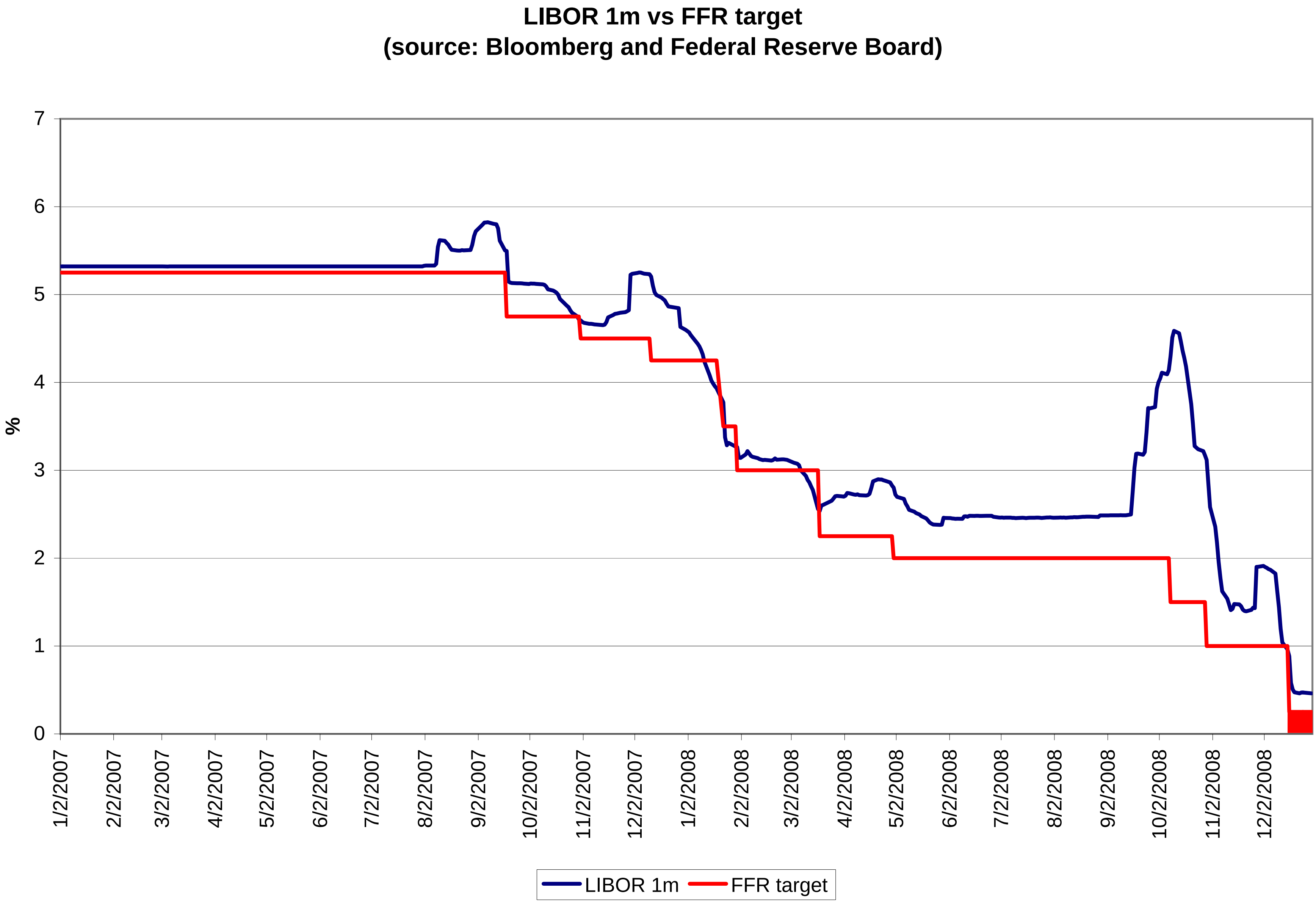
09/04/08
11/04/08
1M
3M
6M



LIBOR 1m vs FFR target
(source: Bloomberg and Federal Reserve Board)
%
7
6
5
4
3
2
1
0
1/2/2007
2/2/2007
3/2/2007
4/2/2007
5/2/2007
6/2/2007
7/2/2007
8/2/2007
9/2/2007
10/2/2007
11/2/2007
12/2/2007
1/2/2008
2/2/2008
3/2/2008
4/2/2008
5/2/2008
6/2/2008
7/2/2008
8/2/2008
9/2/2008
10/2/2008
11/2/2008
12/2/2008
LIBOR 1m
FFR target

Motivation

Questions:

- How much is monetary policy analysis changed by recognizing existence of spreads between different interest rates?

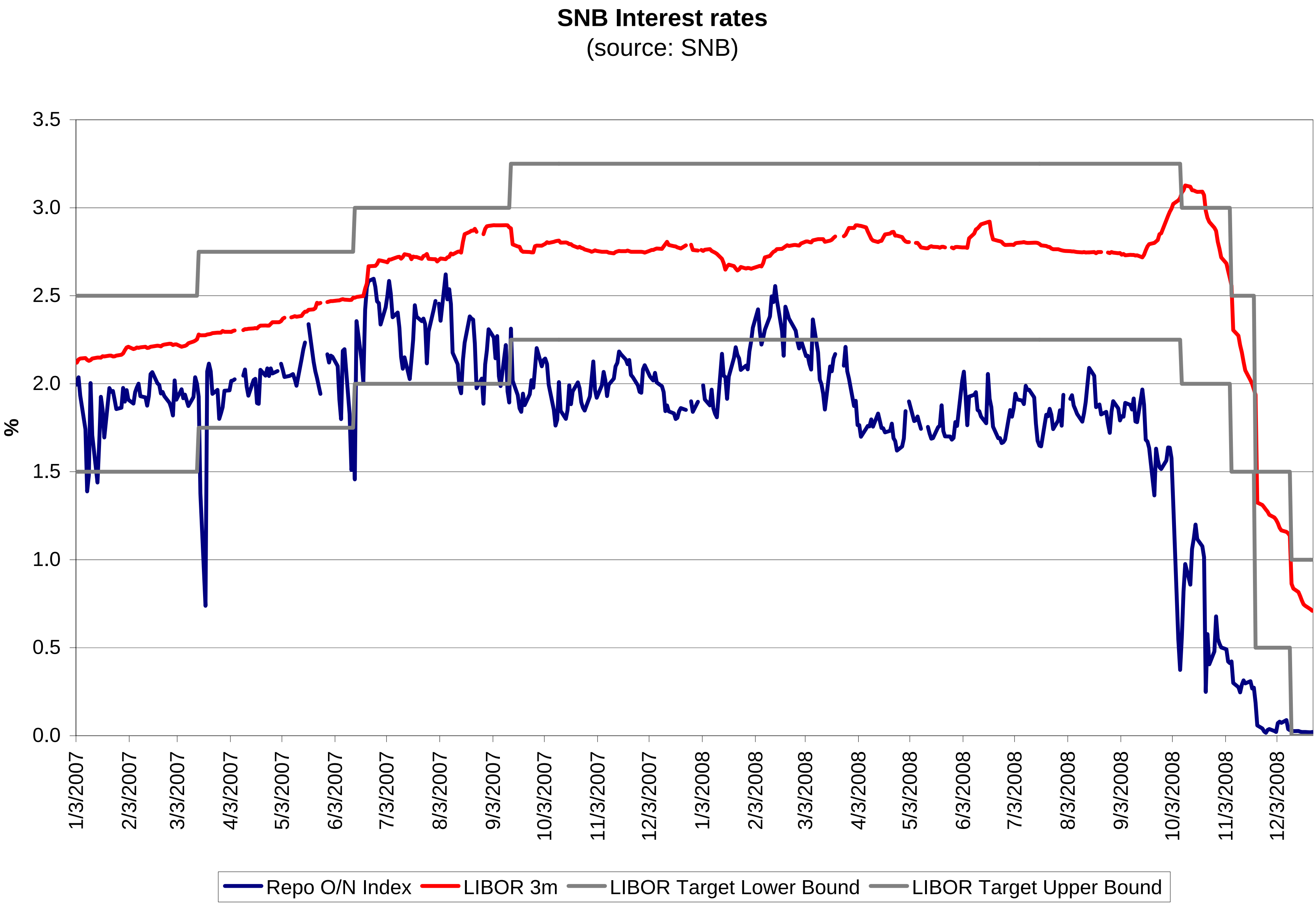
- How should policy respond to "financial shocks" that disrupt financial intermediation, dramatically widening spreads?

Motivation

- John Taylor (Feb. 2008) has proposed that "Taylor rule" for policy might reasonably be adjusted, lowering ff rate target by amount of increase in LIBOR-OIS spread

— Essentially, Taylor rule would specify operating target for LIBOR rate rather than ff rate

— Would imply automatic adjustment of ff rate in response to spread variations, as under current SNB policy



SNB Interest rates
(source: SNB)
%
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/3/2007
2/3/2007
3/3/2007
4/3/2007
5/3/2007
6/3/2007
7/3/2007
8/3/2007
9/3/2007
10/3/2007
11/3/2007
12/3/2007
1/3/2008
2/3/2008
3/3/2008
4/3/2008
5/3/2008
6/3/2008
7/3/2008
8/3/2008
9/3/2008
10/3/2008
11/3/2008
12/3/2008
Repo O/N Index
LIBOR 3m
LIBOR Target Lower Bound
LIBOR Target Upper Bound

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- Is a systematic response of that kind desirable?

The Model

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  - heterogeneity in spending opportunities
  - costly financial intermediation

- Each household has a type $\tau_t(i) \in \{b, s\}$, determining preferences

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[u^{\tau_t(i)}\left(c_t(i); \xi_t\right) - \int_0^1 v^{\tau_t(i)}\left(h_t\left(j; i\right); \xi_t\right) dj \right],$$

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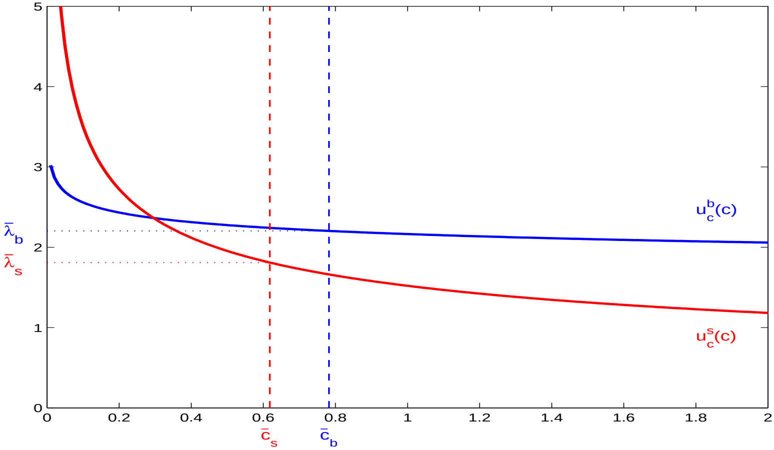
- Each period type remains same with probability $\delta < 1$; when draw new type, always probability π_τ of becoming type τ

The Model



Marginal utilities of the two types

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- MUI and expenditure same each period for all households of a given type: hence only increase state variables from 1 to 2

The Model

- Euler equation for each type $\tau \in \{b, s\}$:

$$\lambda_t^\tau = \beta E_t \left\{ \frac{1 + i_t^\tau}{\Pi_{t+1}} [\delta \lambda_{t+1}^\tau + (1 - \delta)\lambda_{t+1}] \right\}$$

where

$$\lambda_t \equiv \pi_b \lambda_t^b + \pi_s \lambda_t^s$$

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- Aggregate demand relation:

$$Y_t = \sum_\tau \pi_\tau c^\tau(\lambda_t^\tau; \xi_t) + G_t + \Xi_t$$

where Ξ_t denotes resources used in intermediation

Log-Linear Equations

- Intertemporal IS relation:

$$\hat{Y}_t = E_t \hat{Y}_{t+1} - \bar{\sigma}[\hat{\imath}_t^{avg} - \pi_{t+1}] - E_t[\Delta g_{t+1} + \Delta\hat{\Xi}_{t+1}]$$

$$-\bar{\sigma} s_\Omega \hat{\Omega}_t + \bar{\sigma}(s_\Omega + \psi_\Omega) E_t \hat{\Omega}_{t+1},$$

where

$$\hat{\imath}_t^{avg} \equiv \pi_b \hat{\imath}_t^b + \pi_s \hat{\imath}_t^d,$$

$$\hat{\Omega}_t \equiv \hat{\lambda}_t^b - \hat{\lambda}_t^s,$$

g_t is a composite exogenous disturbance to expenditure of type b, type s, and government,

$$\bar{\sigma} \equiv \pi_b s_b \sigma_b + \pi_s s_s \sigma_s > 0,$$

and s_Ω, ψ_Ω depend on asymmetry

Log-Linear Equations

- Determination of the marginal-utility gap:

$$\hat{\Omega}_t = \hat{\omega}_t + \hat{\delta} E_t \hat{\Omega}_{t+1},$$

where $\hat{\delta} < 1$ and

$$\hat{\omega}_t \equiv \hat{\imath}_t^b - \hat{\imath}_t^d$$

measures deviation of the credit spread from its steady-state value

The Model

- Financial intermediation technology: in order to supply loans in (real) quantity b_t, must obtain (real) deposits

$$d_t = b_t + \Xi_t(b_t),$$

where $\Xi_t(0) = 0$, $\Xi_t(b) \geq 0, \Xi_t'(b) \geq 0, \Xi_t''(b) \geq 0$ for all $b \geq 0$, each date t.

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$$\omega_t(b_t) = \Xi_{bt}(b_t)$$

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- More generally, we allow

$$1 + \omega_t(b_t) = \mu_t^b(b_t)(1 + \Xi_{bt}(b_t)),$$

where $\{\mu_t^b\}$ is a markup in the banking sector (perhaps a risk premium)

BGG Example

- Example of a (microfounded) intermediation technology of this general form: CSV model as in Bernanke-Gertler-Gilchrist (1999)

  — but with the financial contracting between savers and intermediaries, rather than "households" and "entrepreneurs"

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- Key relation of this model:

$$k_t = \psi(s_t; \mu_t)$$

where k_t = leverage ratio of banks = b_t / n_t
n_t = net worth of banks;
s_t = external finance premium = $1 + \omega_t$
μ_t = (exogenously varying) bankruptcy costs

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- Purely financial disturbances: exogenous variation in n_t, μ_t

Log-Linear Equations

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- Hence the rate $\hat{\imath}_t^{avg}$ that appears in IS relation is determined by

$$\hat{\imath}_t^{avg} = \hat{\imath}_t^d + \pi_b \hat{\omega}_t$$

The Model

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- Only difference: labor supply depends on both MUI: λ_t^b, λ_t^s, or alternatively on Ω_t as well as λ_t

Log-Linear Equations

- Log-linear AS relation: generalizes NKPC:

$$\pi_t = \kappa(\hat{Y}_t - \hat{Y}_t^n) + u_t + \xi(s_\Omega + \pi_b - \gamma_b)\hat{\Omega}_t - \xi\bar{\sigma}^{-1}\hat{\Xi}_t + \beta E_t \pi_{t+1}$$

where

$$\gamma_b \equiv \pi_b \left(\frac{\bar{\lambda}^b}{\bar{\bar{\lambda}}} \right)^{1/\nu}$$

depends on $\bar{\Omega}$

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— other coefficients, and disturbance terms $\hat{Y}_t^n$, u_t, defined as in basic NK model, using $\bar{\sigma}$ in place of the rep hh's elasticity

Optimal Policy

Natural objective for stabilization policy: average expected utility:

$$E_0 \sum_{t=0}^{\infty} \beta U(Y_t, \lambda_t^b, \lambda_t^s, \Delta_t; \tilde{\xi}_t)$$

where

$$U(Y_t, \lambda_t^b, \lambda_t^s, \Delta_t; \tilde{\xi}_t) \equiv \pi_b u^b(c^b(\lambda_t^b; \xi_t); \xi_t) + \pi_s u^s(c^s(\lambda_t^s; \xi_t); \xi_t) - \frac{\psi}{1+\nu} \left(\frac{\tilde{\lambda}_t}{\tilde{\Lambda}_t} \right)^{-\frac{1+\nu}{\nu}} \bar{H}_t^{-\nu} \left(\frac{Y_t}{A_t} \right)^{1+\omega} \Delta_t,$$

and $\tilde{\lambda}_t / \tilde{\Lambda}_t$ is a decreasing function of $\lambda_t^b / \lambda_t^s$, so that total disutility of producing given output is increasing function of the MU gap

Optimal Policy: LQ Approximation

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- Results especially simple in special case:
  - No steady-state distortion to level of output (P = MC, W/P = MRS)(Rotemberg-Woodford, 1997)
  - No steady-state credit frictions: $\bar{\omega} = \bar{\Xi} = \bar{\Xi}_b = 0$

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  —Note, however, that we do allow for shocks to the size of credit frictions

Optimal Policy: LQ Approximation

- Approximate objective: max of expected utility equivalent (to 2d order) to minimization of quadratic loss function

$$\sum_{t=0}^{\infty} \beta^t [\pi_t^2 + \lambda_y (\hat{Y}_t - \hat{Y}_t^n)^2 + \lambda_\Omega \hat{\Omega}_t^2 + \lambda_\Xi \Xi_{bt} \hat{b}_t]$$

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  - New weights $\lambda_\Omega, \lambda_\Xi > 0$

- LQ problem: minimize loss function subject to log-linear constraints: AS relation, IS relation, law of motion for $\hat{b}_t$, relation between $\hat{\Omega}_t$ and expected credit spreads

Optimal Policy: LQ Approximation

- Consider special case:
  - No resources used in intermediation ($\Xi_t(b) = 0$)
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$$\pi_t + (\lambda_y/\kappa)(x_t - x_{t-1}) = 0$$

("flexible inflation targeting")

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("flexible inflation targeting")

- However, state-contingent path of policy rate required to implement the target criterion is not the same

Implementing Optimal Policy: Interest-Rate Rule

- Instrument rule to implement the above target criterion:
  - Given lagged variables, current exogenous shocks, and observed current expectations of future inflation and output, solve the AS and IS relations for target i_t^d that would imply values of π_t and x_t projected to satisfy the target relation

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  - What Evans-Honkapohja (2003) call "expectations-based" rule for implementation of optimal policy
  - Desirable properties:

    — ensures that there are no REE other than those in which the target criterion holds

    — hence ensures determinacy of REE

    — in this example, also implies "E-stability" of REE, hence convergence of least-squares learning dynamics to REE

Implementing Optimal Policy: Interest-Rate Rule

$$i_t^d = r_t^n + \phi_u u_t + [1 + \beta\phi_u] E_t \pi_{t+1} + \bar{\sigma}^{-1} E_t x_{t+1} - \phi_x x_{t-1}$$

$$-[\pi_b + \hat{\delta}^{-1} s_\Omega]\hat{\omega}_t + [(\hat{\delta}^{-1} - 1) + \phi_u \xi] s_\Omega \hat{\Omega}_t$$

where $\phi_u \equiv \frac{\kappa}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0, \qquad \phi_x \equiv \frac{\lambda_y}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0$

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where $\phi_u \equiv \frac{\kappa}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0$, $\phi_x \equiv \frac{\lambda_y}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0$

- a forward-looking Taylor rule, with adjustments proportional to both the credit spread and the marginal-utility gap

Implementing Optimal Policy: Interest-Rate Rule

- Note that if $s_b \sigma_b >> s_s \sigma_s$, then $s_\Omega \approx \pi_s$, so that if in addition $\delta \approx 1$, the rule becomes approximately

$$i_t^d = \ldots - \hat{\omega}_t + \phi_\Omega \hat{\Omega}_t$$

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- Since for our calibration, ϕ_Ω is also quite small $(\approx .03)$, this implies that a 100 percent spread adjustment would be close to optimal, except in the case of very persistent fluctuations in the credit spread

Implementing Optimal Policy: Interest-Rate Rule

- Essentially, in the case that $s_b\sigma_b >> s_s\sigma_s$, it is really only i_t^b that matters much to the economy, and the simple intuition for the spread adjustment is reasonably accurate.

Implementing Optimal Policy: Interest-Rate Rule

- Essentially, in the case that $s_b\sigma_b >> s_s\sigma_s$, it is really only i_t^b that matters much to the economy, and the simple intuition for the spread adjustment is reasonably accurate.

- But for other parameterizations that would not be true. For example, if $s_b\sigma_b = s_s\sigma_s$, the optimal rule is

$$i_t^d = \ldots - \pi_b \hat{\omega}_t$$

which is effectively an instrument rule in terms of i_t^{avg} rather than either i_t^d or i_t^b

Optimal Policy: Numerical Results

- Above target criterion no longer an exact characterization of optimal policy, in more general case in which ω_t and/or Ξ_t depend on the evolution of b_t

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- But numerical results suggest still a fairly good approximation to optimal policy

Calibrated Model

- Calibration of preference heterogeneity: assume equal probability of two types, $\pi_b = \pi_s = 0.5$, and $\delta = 0.975$ (average time that type persists = 10 years)

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  - Assume $C^b/C^s = 1.27$ in steady state (given $G/Y = 0.3$, this implies $C^s/Y \approx 0.62$, $C^b/Y \approx 0.78$)

    — implied steady-state debt: $\bar{b}/\bar{Y} = 0.8$ years (avg non-fin, non-gov't, non-mortgage debt/GDP)

Calibrated Model

- Calibration of preference heterogeneity: assume equal probability of two types, $\pi_b = \pi_s = 0.5$, and $\delta = 0.975$ (average time that type persists = 10 years)

  - Assume $C^b/C^s = 1.27$ in steady state (given $G/Y = 0.3$, this implies $C^s/Y \approx 0.62$, $C^b/Y \approx 0.78$)

    — implied steady-state debt: $\bar{b}/\bar{Y} = 0.8$ years (avg non-fin, non-gov't, non-mortgage debt/GDP)

  - Assume relative disutility of labor for two types so that in steady state $H^b/H^s = 1$

Calibrated Model

- Assume $\sigma_b/\sigma_s = 5$

  — implies credit contracts in response to monetary policy tightening (consistent with VAR evidence [esp. credit to households])

Calibrated Model

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- Calibrate η in convex-technology case so that 1 percent increase in volume of bank credit raises credit spread by 1 percent (ann.)

  — implies $\eta \approx 52$

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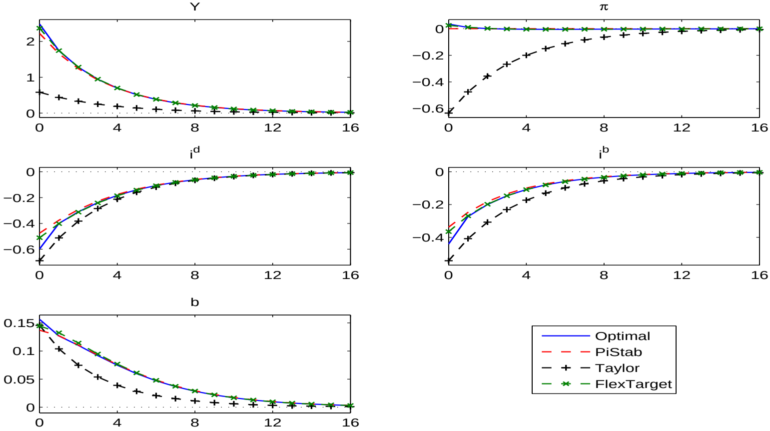
- flexible inflation targeting:

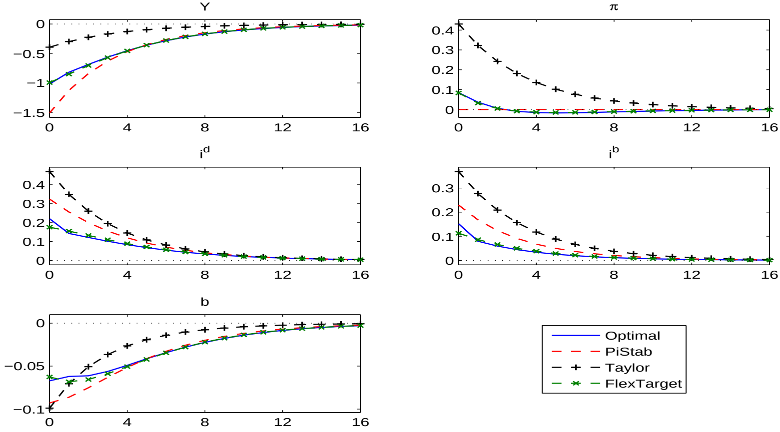
$$\pi_t + (\lambda_y/\kappa)(x_t - x_{t-1}) = 0$$

Numerical Results: Optimal Policy



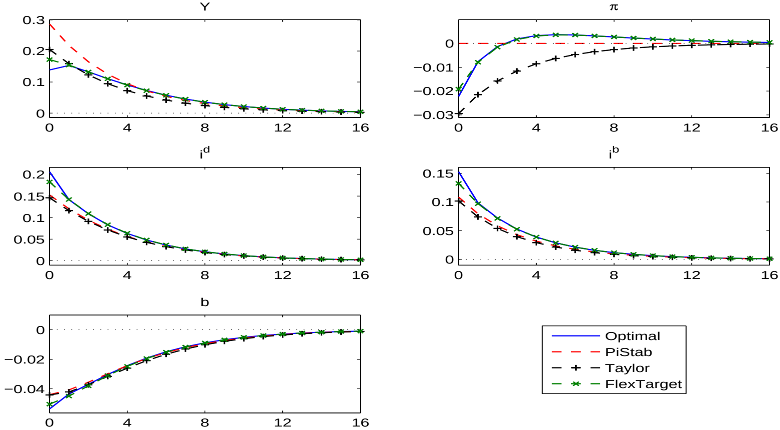
Responses to technology shock, under 4 monetary policies

Numerical Results: Optimal Policy



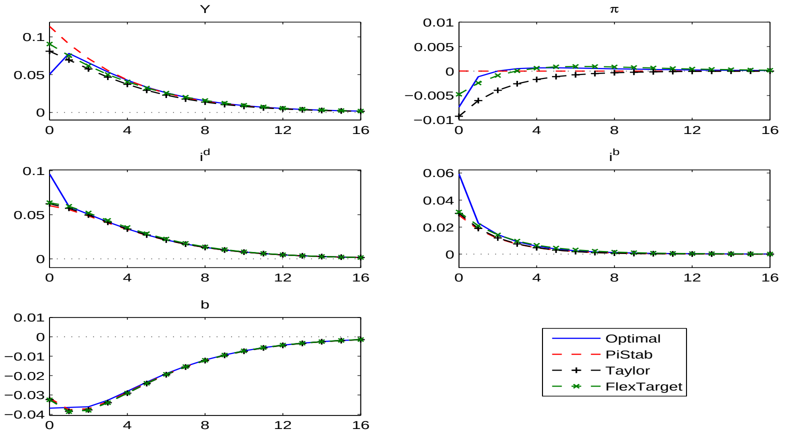
Responses to wage markup shock, under 4 monetary policies

Numerical Results: Optimal Policy



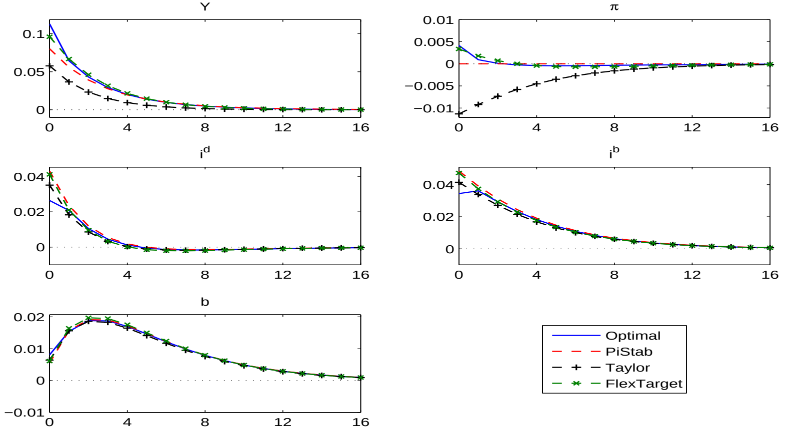
Responses to shock to government purchases, under 4 monetary policies

Numerical Results: Optimal Policy



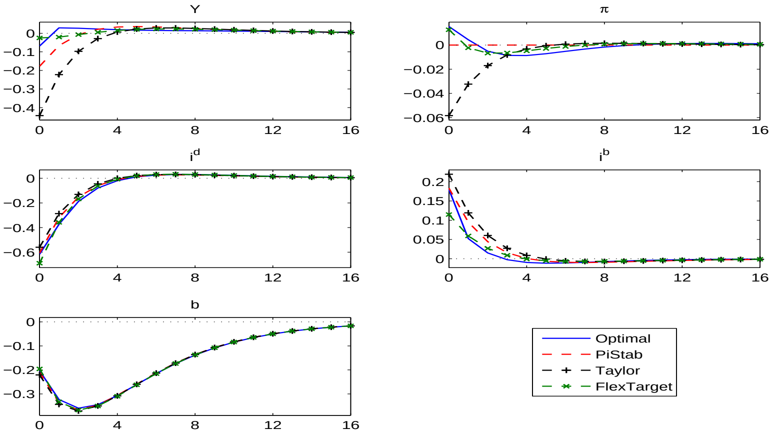
Responses to shock to demand of savers, under 4 monetary policies

Numerical Results: Optimal Policy



Responses to shock to demand of borrowers, under 4 monetary policies

Numerical Results: Optimal Policy



Responses to financial shock, under 4 monetary policies

Provisional Conclusions

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  - In a special case: the same "3-equation model" continues to apply, simply with additional disturbance terms
  - More generally, a generalization of basic NK model that retains many qualitative features of that model of the transmission mechanism
  - For example, recognizing importance of credit frictions does not require reconsideration of the de-emphasis of monetary aggregates in NK models

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  - And desirability of spread adjustment depends on change in deposit rate being passed through to lending rates
  - General principle can be expressed more robustly in terms of a target criterion

Provisional Conclusions

- Simple guideline for policy: base policy decisions on a target criterion relating inflation to output gap (optimal in absence of credit frictions)
    - Take account of credit frictions only in model used to determine policy action required to fulfill target criterion