Financial Frictions and Credit Spreads

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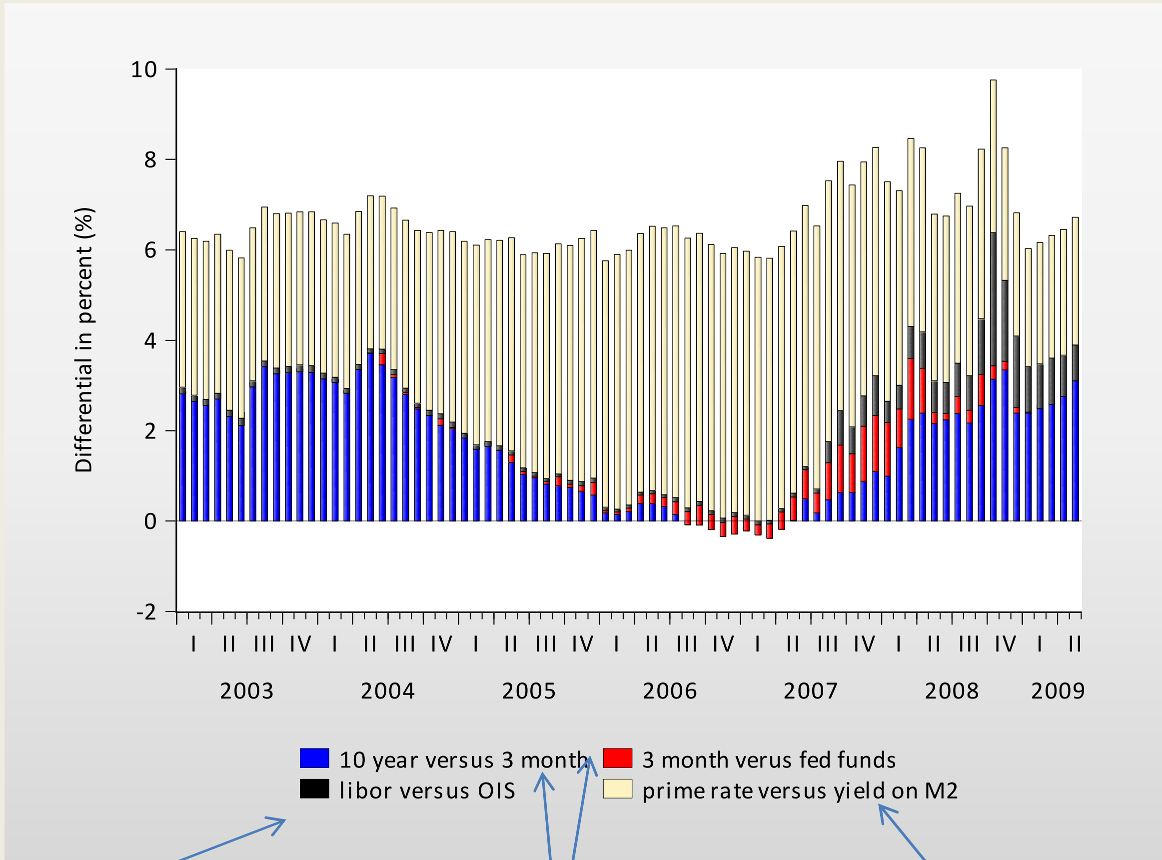
Modelling Challenges

- Considerable work underway to incorporate a role for financial frictions
  - the financial crisis highlighted this as a weakness of DSGE models
  - Understood here to represent a cost that gives rise to a *spread* between borrowing and lending rates. A wedge exists (i.e., due to asymmetric information) between borrowers and savers, and there are *intermediation costs* financial institutions must absorb

Selected Spreads: view I

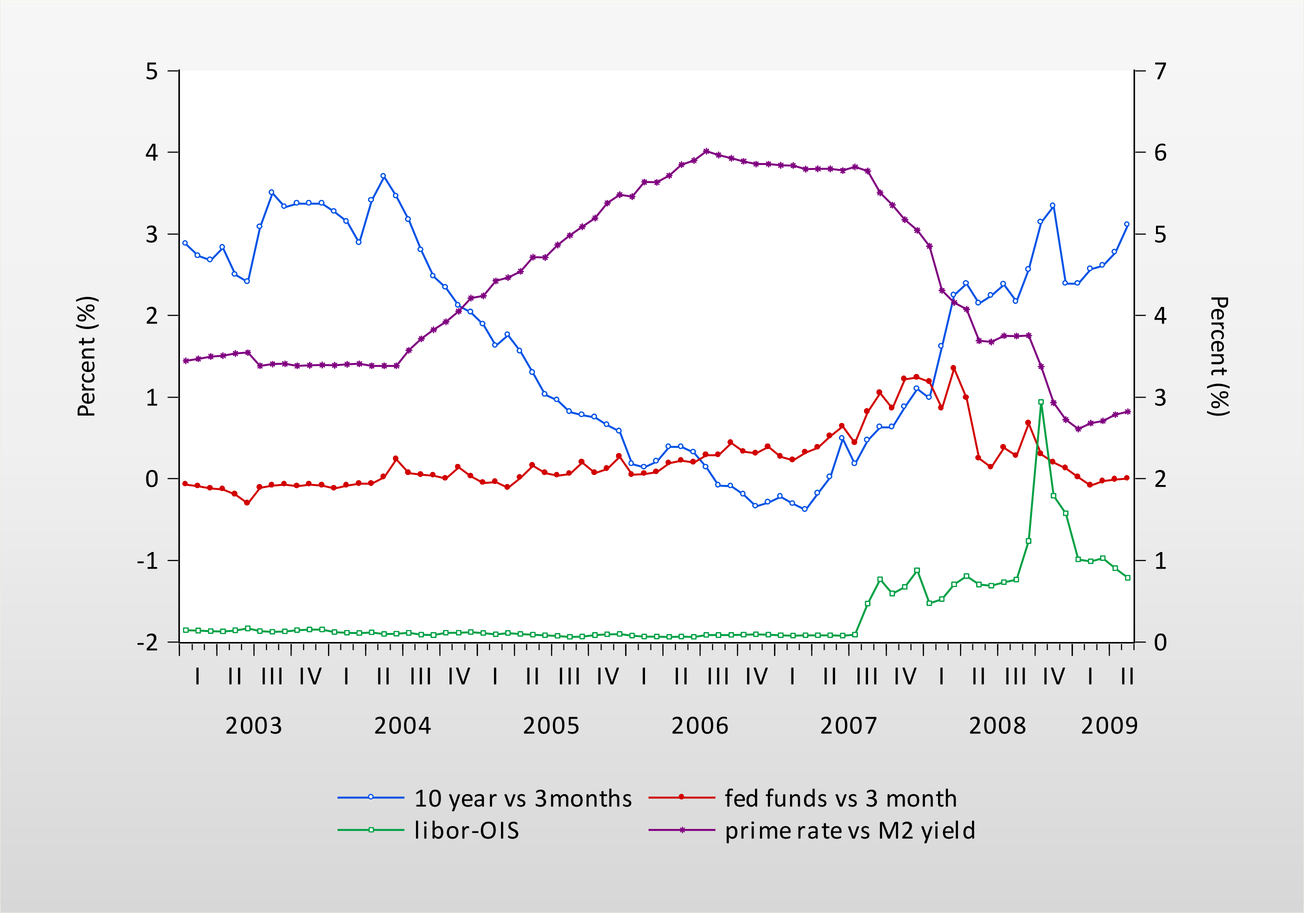


Taylor & Williams 2009

'staple' of many
Term structure studies

May be representative
of theoretical spread
In this study

Selected Spreads: view II



Modelling Challenges

- The ‘canonical’ model (Woodford 2003) has been seen as not ideally suited to handling to capital market imperfections
  - In general, the weaknesses of the New Keynesian paradigm are well-known (Goodhart 2008, Tovar 2008, Chari et.al. 2009)
  - But...its either the best we have or it may be more fruitful to ‘repair’ it rather than discard it completely
    - Provides a ‘disciplined’ way of thinking about interactions of key macroeconomic variables

Focus of the Study

- Spreads play a central role in the transmissions mechanism
  - Bernanke and Gertler (1989, 1995)
    - The economy is ‘interest sensitive’, that is, there exists a “credit channel”
      - May operate through balance sheets or bank lending behaviour
      - We don’t take a stand on one versus the other although <u>focus is on the latter in this study</u>
- Walsh (2009)“...factors that generate movements in spreads, or the degree to which these movements reflect inefficient fluctuations that call for policy responses” still eludes us
  - In particular why are spreads subject to <u>sharp movements</u> and why can they be so <u>volatile</u>?
  - Do they really matter (in a crisis): NO Chari. et.al. 2008); YES (Cohen-Cole e.al.2008)

Overview of the Approach of the Paper

- Credit frictions model of Curdia & Woodford (2009, 2009a) is <u>starting</u> point
  - NOTE: has changed in its various incarnations
- The model is adapted to the concerns of this study, namely attempting to replicate <u>movements and volatility in spreads</u>
  - Agents are heterogeneous, intermediation is 'inefficient' or costly
  - Actual U.S. time series are used for exogenous factors (e.g., TFP shocks, government spending)
  - We try to replicate movements in selected spreads
  - We explore the impact of two types of monetary policies
    - QUANTITATIVE EASING: varying the amount of aggregate reserves to influence the spread between the fed funds rate and the interest rate on reserves (liabilities of the Fed's balance sheet)
    - CREDIT EASING: debt-financed fiscal policy (asset composition of the Fed's balance sheet)

MODEL: Households I

- 2 types of households
  - *b* more impatient than *s*
    - *b* borrows, *s* saves
  - Remain the same type form one period to the next with prob. [δ, 1-δ]
- Borrowing is done ONLY via intermediary
  - One period contracts (riskless) + households can insure against various risks
  - Necessary because
    - 1. heterogeneity of households; 2. credit frictions; 3. risk sharing
    - Represents a 'key' source of financial frictions

- Lifetime utility function

$$\sum_{t=0}^{\infty}\beta^t \{U^{\tau_t(i)}[c_t(i)] - V^{\tau_t(i)}[h_t(i)]\}$$

- Household *i*'s (net) wealth

$$A_t(i) = [B_{t-1}(i)]^+(1+i_{t-1}^d) + [B_{t-1}(i)]^-(1+i_{t-1}^b) + D_t^{\text{int}}(i) + T_t(i)$$

Deposit and borrowing rates (riskless)

- Budget constraint

$$B_t(i) = A_t(i) - P_t c_t(i) + W_t h_t(i) + D_t(i) + T_t^g(i)$$

MODEL: Households II

- $B_t(i)$ is the budget constraint
- Lifetime utility is maximized subject to $A_t(i)$ & $B_t(i)$
- Euler equation governs labour supply

$$w_t \lambda_t^{\tau_t(i)} = V_h^{\tau_t(i)}[h_t^{\tau_t(i)}]$$

- Optimal consumption for borrower (b), saver (s)

$$\lambda_t^b = \beta \frac{1+i_t^b}{\Pi_{t+1}} \{[\delta + (1-\delta)\pi_b]\lambda_{t+1}^b + (1-\delta)\pi_s \lambda_{t+1}^s\}$$

$$\lambda_t^s = \beta \frac{1+i_t^d}{\Pi_{t+1}} \{(1-\delta)\pi_b \lambda_{t+1}^b + [\delta + (1-\delta)\pi_s]\lambda_{t+1}^s\}$$

inflation

Probability of being type *b* or *s*

MODEL: Financial Intermediaries

- Perfectly competitive
- *Intermediation costs are non-linear (convex function)*
- Interest rates are given, determine supply of loans to maximize profits
- Leads to a functional form that describes spread
- *Intermediation costs create a spread & changes, NOT increased risk*

- ‘Technolog[ies]’

$$d_t = b_t + \Phi(b_t) \Rightarrow d_t = b_t + \Phi(b_t - \bar{b})$$

Real deposit, real credit

- Spread

$$1 + i_t^b = (1 + \omega_t)(1 + i_t^d)$$

- Equilibri[a]

$$\omega_t = \Phi'(b_t)$$

$$\Rightarrow \omega_t = \Phi'(b_t - \bar{b})$$

Benchmark/Modified

MODEL: Firms & Government

- Firms
  - A single good
  - Perfectly competitive price takers
  - Isoelastic production function (subject to a TFP (i.e., productivity) shock [TFP is exogenous]
- Government
  - Budget is balanced every period [spending and transfers are exogenously given]

MODEL: Monetary Policy

- A 'Taylor' type rule
  - Contemporaneous
  - The 'policy rate' is the deposit rate
  - CB makes optimal policy projections that *asymptotically approaches the s.s. (Svensson & Tetlow 2005)*
- Model closed with 2 market clearing conditions

- Policy rule

$$i_t^d = \bar{I}^d \left(\frac{\Pi_t}{\bar{\Pi}} \right)^{\gamma_\pi} \left(\frac{Y_t}{\bar{Y}} \right)^{\gamma_y}, \quad \gamma_\pi, \gamma_y \geq 0$$

- Goods & labour markets

$$Y_t = \pi_b c_t^b + \pi_s c_t^s + G_t + \Phi(b_t)$$

$$h_t = \pi_b h_t^b + \pi_s h_t^s$$

Evolution of b

- Aggregate over all borrowers

$$\int_{B_t} A_t(i)di = -\delta P_{t-1}b_{t-1}(1+i_{t-1}^b) + \delta\pi_b D_t^{\text{int}} + (1-\delta)\pi_b A_t \leftarrow \quad A_t = P_{t-1}[d_{t-1}(1+i_{t-1}^d) - b_{t-1}(1+i_{t-1}^b)] + D_t^{\text{int}}$$

- Aggregate budget constraints

$$P_t b_t = -\int_{B_t} A_t(i)di + \pi_b(P_t c_t^b - W_t h_t^b - D_t - T_t^g)$$

- Substitution yields debt dynamics:

$$b_t = \pi_b\pi_s[(c_t^b - c_t^s) - w_t(h_t^b - h_t^s)] - \pi_b\Phi(b_t)$$

$$+\frac{\delta(1+i_{t-1}^d)}{\Pi_t}[b_{t-1} + \pi_b\Phi(b_{t-1}) + \pi_s b_{t-1}\omega_{t-1}]$$

$\{c_t^b, c_t^s, h_t^b, h_t^s, b_t, Y_t, h_t\}$

QUANTITIES

$\{i_t^d, \Pi_t, \omega_t, w_t\}$

PRICES

$\{Z_t, g_t, \tau_t\}$ **EXOGENOUS**

Calibration - Baseline

- *η= 51.6 (Curdia-Woodford)*
- δ=0.9
- $\pi_b = \pi_s$ =0.5
- β/ i^d = 4%
- ϕ^s =1, ϕ^b /h for both types the same in s.s.
- ω=2% in s.s.
- Debt/GDP=80% in s.s.
- Y,Z=1 in s.s.

$$U^\tau(c_t^\tau) = \frac{\theta^\tau (c_t^\tau)^{1-\frac{1}{\sigma^\tau}}}{1-\frac{1}{\sigma^\tau}}, \quad \sigma^\tau > 0$$

$$V^\tau(h_t^\tau) = \frac{\varphi^\tau (h_t^\tau)^{1+\nu}}{1+\nu}, \quad \nu \geq 0$$

$$\Phi(b_t) = \varphi b_t^\eta, \quad \eta > 1$$

'Conventional' TR coeffs

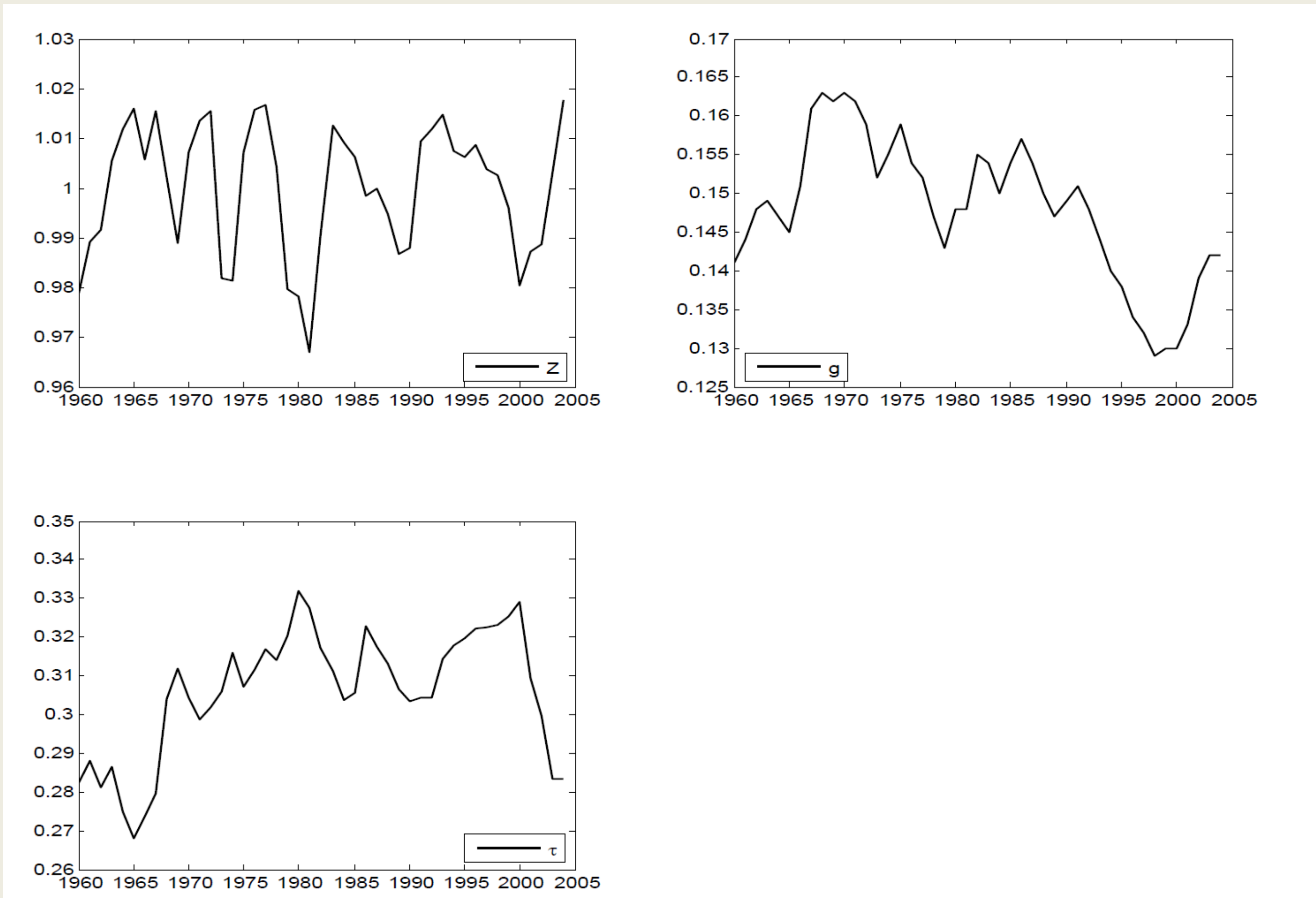
Table 1: List of Parameters

α	0.75	β	0.9512
ν	0.1	ϕ	31.0475
σ^b	12.5	θ^b	2.3074
σ^s	2.5	θ^s	1.7088
γ_π	1.5	ϕ^b	1.2177
γ_y	0.5	ϕ^s	1
η	51.6	$\bar{Z}$	1
δ	0.9	$\bar{g}$	0.15
π_b	0.5	$\bar{\tau}$	0.3
π_s	0.5		

Calibration – Sensitivity Analysis I

eta	8	16.6	21.6	24	31.6	36.6	41.6	46.6	**51.6**	56.6	61.6	66.6	71.6
phi	0.0119	0.0391	0.0918	0.1412	0.5845	1.5401	4.1351	11.2652	**31.0475**	86.3794	242.2122	683.6796	1940.7
phib	1.2177	1.2177	1.2177	1.2177	1.2177	1.2177	1.2177	1.2177	**1.2177**	1.2177	1.2177	1.2177	1.2177
thetab	2.307	2.3072	2.3073	2.3073	2.3073	2.3073	2.3073	2.3073	**2.3074**	2.3074	2.3074	2.3074	2.3074
thetas	1.7071	1.7081	1.7083	1.7084	1.7086	1.7086	1.7087	1.7087	**1.7088**	1.7088	1.7088	1.7088	1.7088
beta	0.9512	0.9512	0.9512	0.9512	0.9512	0.9512	0.9512	0.9512	**0.9512**	0.9512	0.9512	0.9512	0.9512

$\{Z_t\,, g_t\,, \tau_t\}$

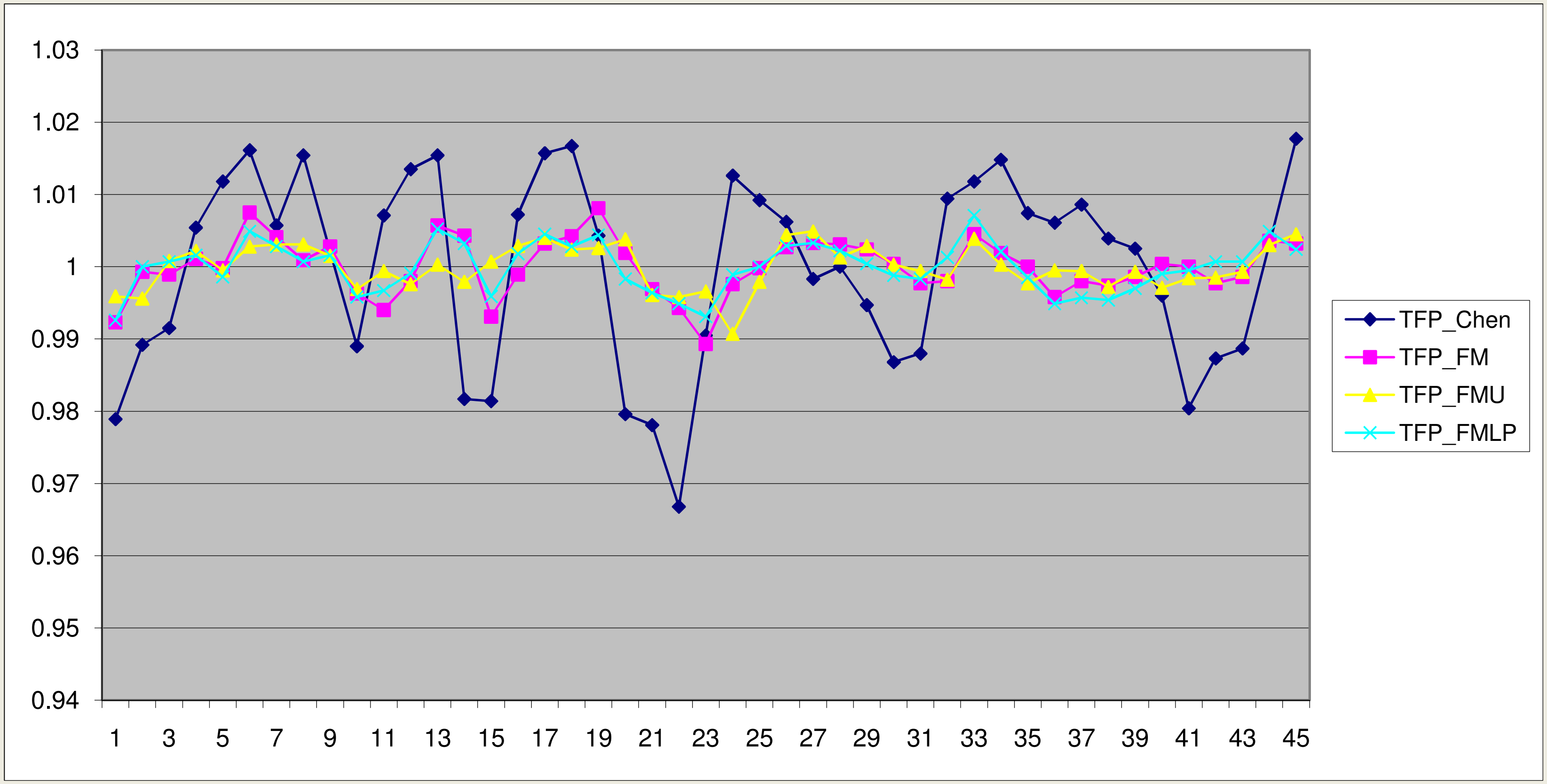


TFP from Chen et.al. (2008)

Results

- Solution is numerical to non-linear equations
  - Allow 200 periods [years] to converge (happens much faster
  - Implies 1600 equations
- What TFP?
- Role of exogenous ‘drivers’
- Simulated spreads: what they look like
- Model assessment: a bird’s eye view
- Impact of ‘unconventional’ monetary policies

Which TFP?



1.03
1.02
1.01
1
0.99
0.98
0.97
0.96
0.95
0.94
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45
TFP_Chen
TFP_FM
TFP_FMU
TFP_FMLP

The role of Specific Shocks I

Figure 4: Benchmark Model with Only TFP

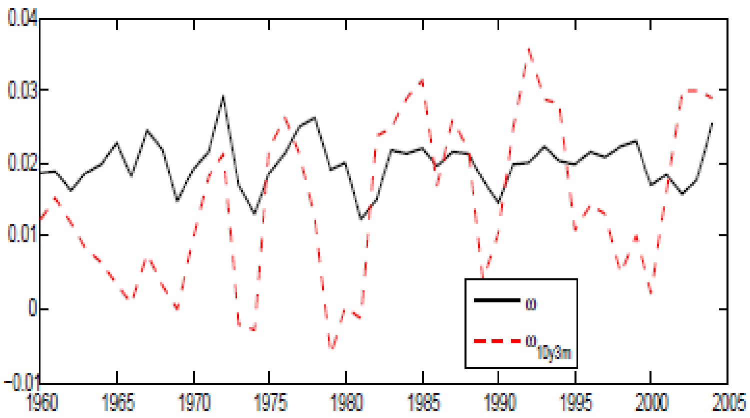
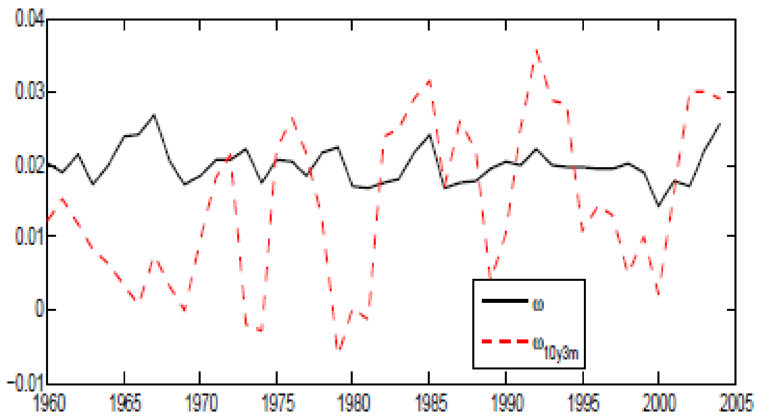


Figure 5: Benchmark Model with All Except TFP



The Role of Specific Shocks II

Figure 6: Benchmark Model with Only g

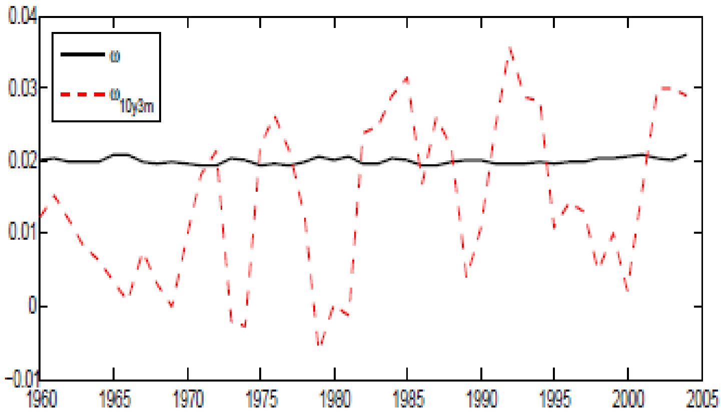
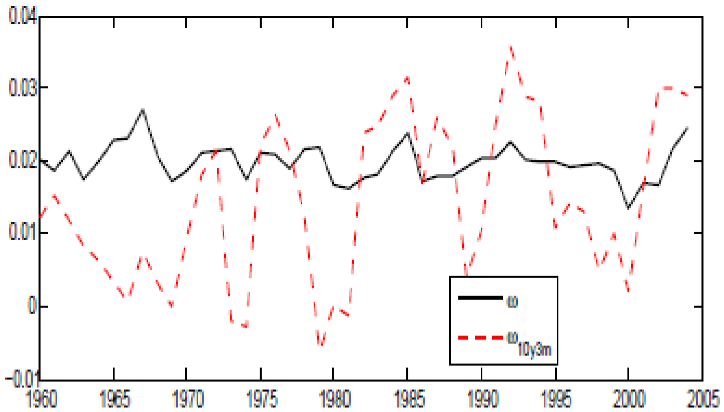
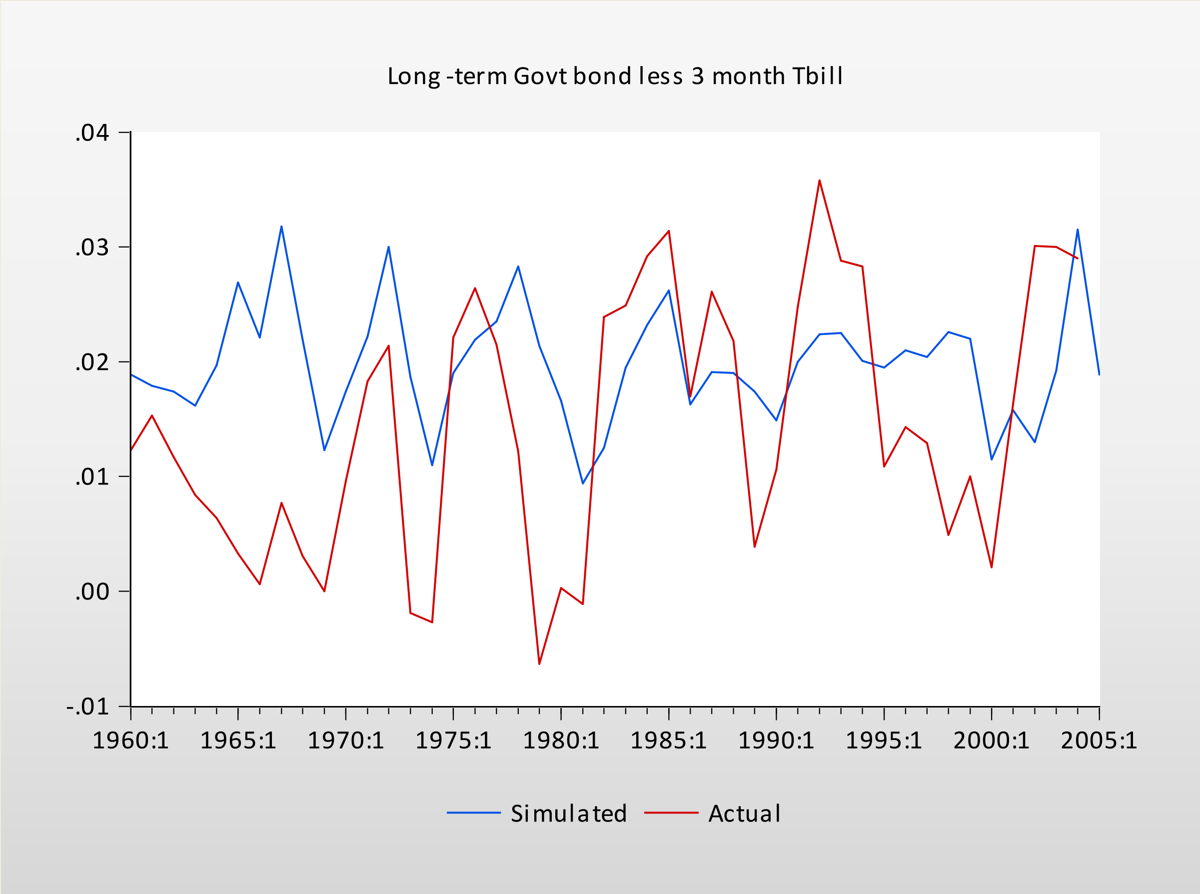


Figure 7: Benchmark Model with Only τ



Simulation I: Benchmark



Simple test I

Variable	Coeff.	Std error	Z-statistic	p-value
C	-.004	.005	-.83	.41
omega	.94	.24	3.95	.00

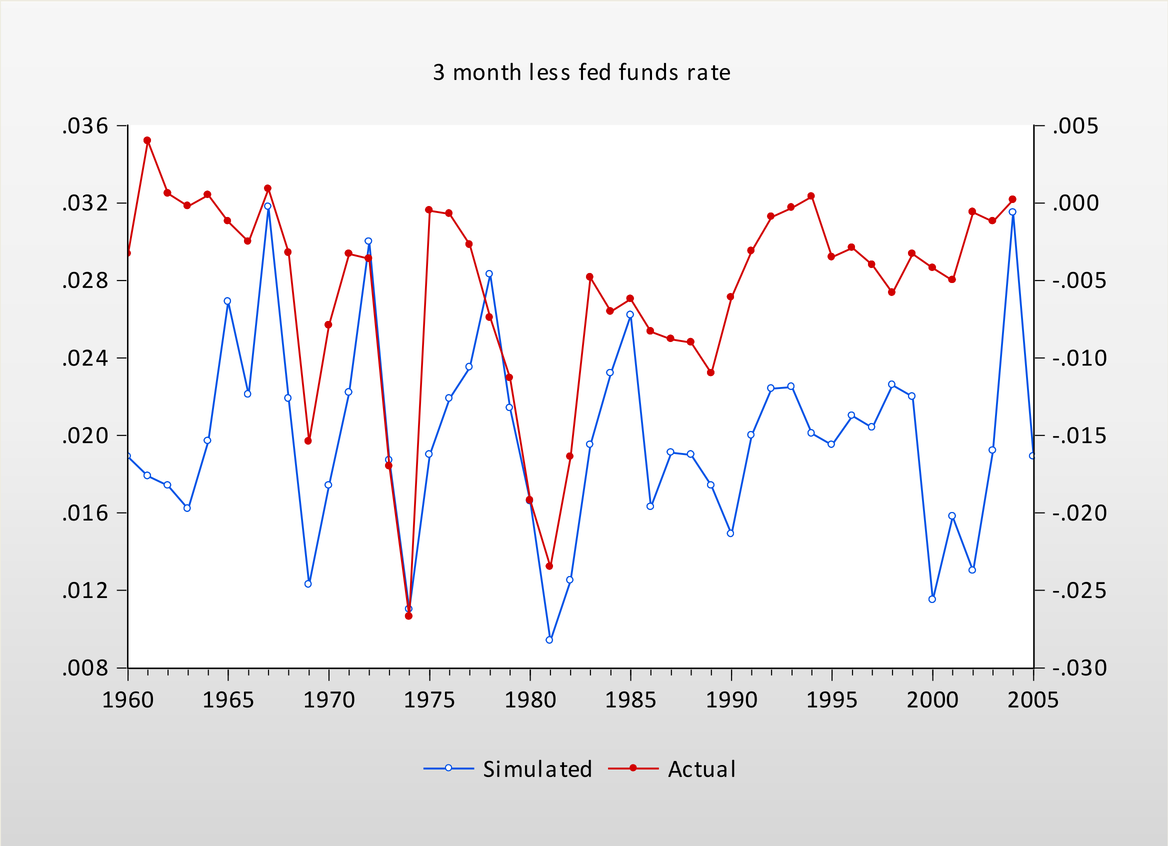
Eta = 51.6

Simple test Ia

Variable	Coeff.	Std error	t-statistic	p-value
C	.001	.002	9.06	.00
omega	.57	.27	2.07	.04

Eta = 2

Simulation II: Benchmark

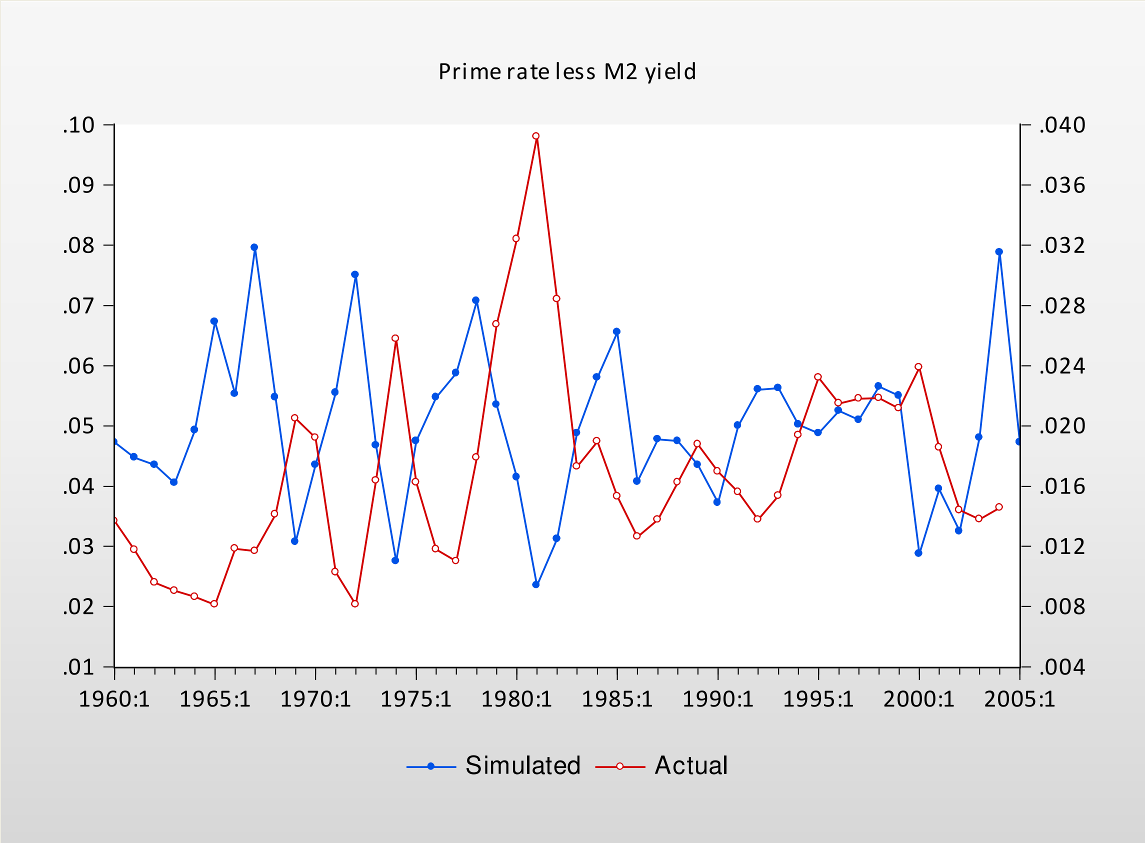


Simple test II

Variable	Coefficient	Std Error	t-Statistic	p-value
C	-0.013	.013	-4.26	.00
Omega	.43	.15	2.80	.01

Eta = 51.6

Simulation III: Benchmark



Simple Test III

Variable	Coeff	Std error	t-statistic	p-value
C	.06	.01	12.15	.00
Omega	-1.24	.26	-4.73	.00

Eta = 51.6

Simulations vs Facts I

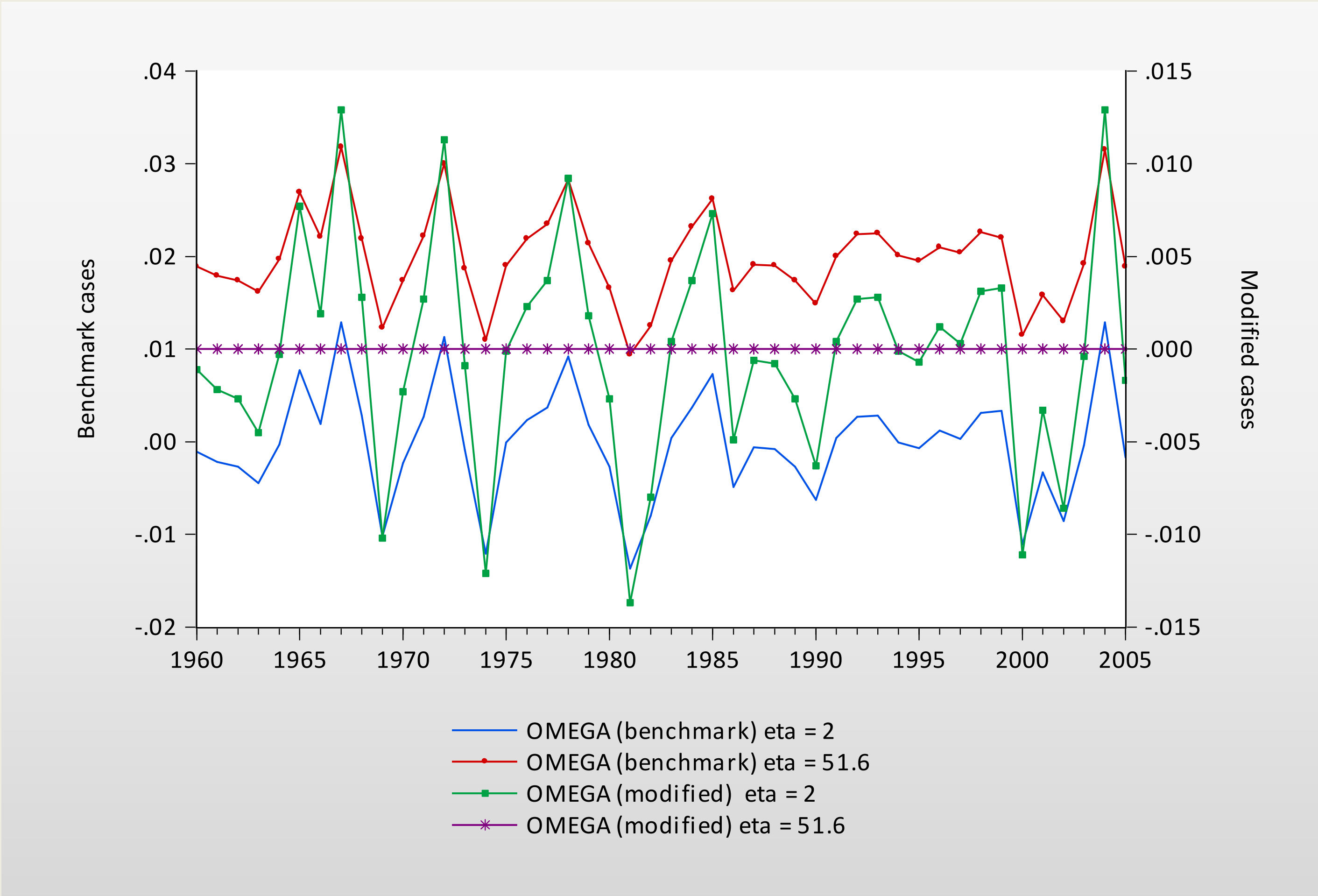
Standard Dev of Inflation	ACF (1)	H-P filtered PCE inflation
Chen TFP =.0099	.28	.34
FM TFP = .006	.29	
FMLP = .0058	.25	
FMU = .0059	.30	

Simulations vs Facts II

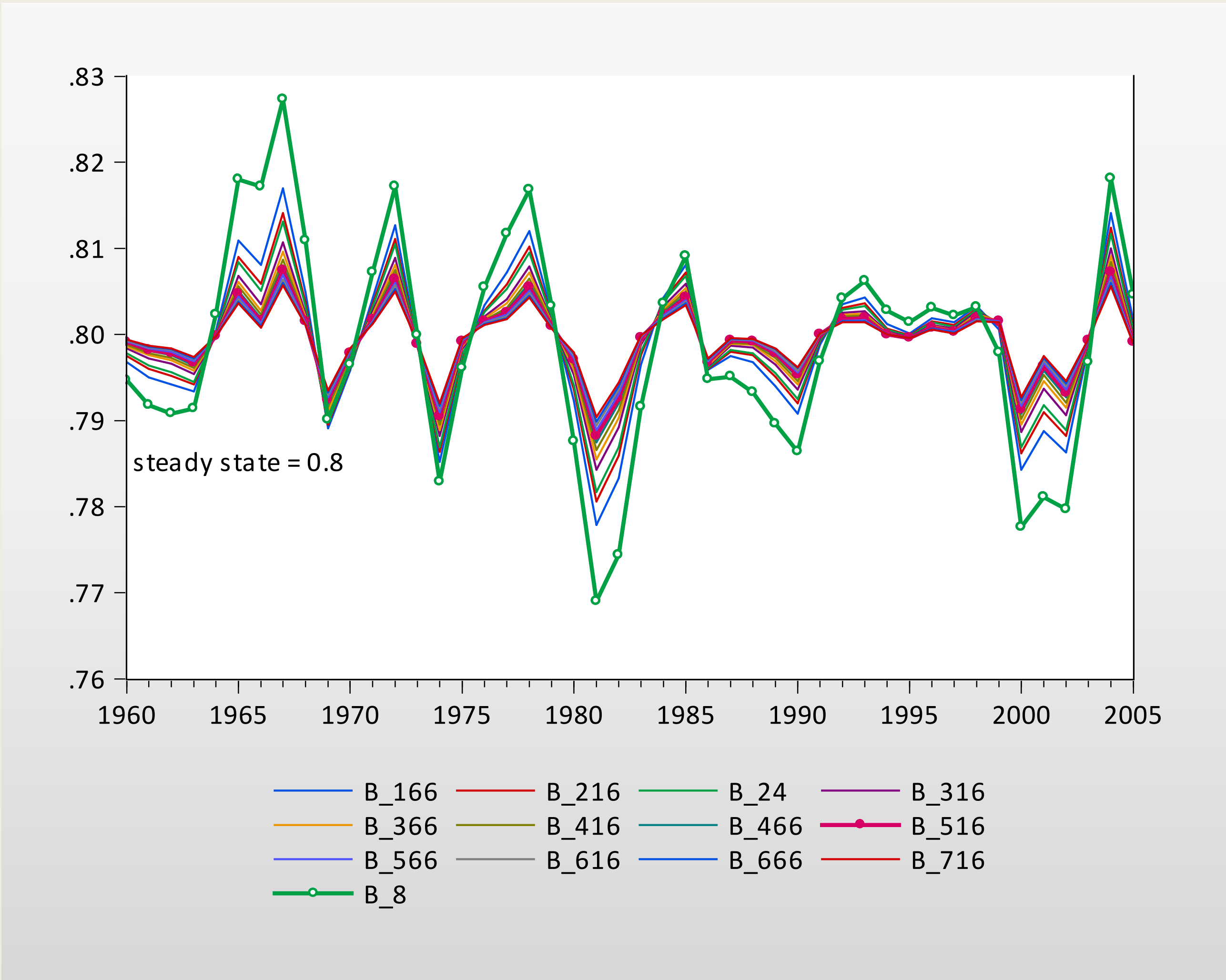
Statistic	Omega (bench) eta=2	Omega (bench) eta = 51.6	Omega (10 yr LESS 3 m)
Mean	.00	.02	.02 ('03-'09) .014 ('34-'09)
Std. Dev.	.0159	.0150	.013 .019
AC (1)	.22	.29	.22*
AC (2)	-.25	-.23	-.14
AC (3)	-.37	-.41	.06
AC (4)	-.34	-.35	.14
AC (5)	.15	.10	-.03

* 1st difference

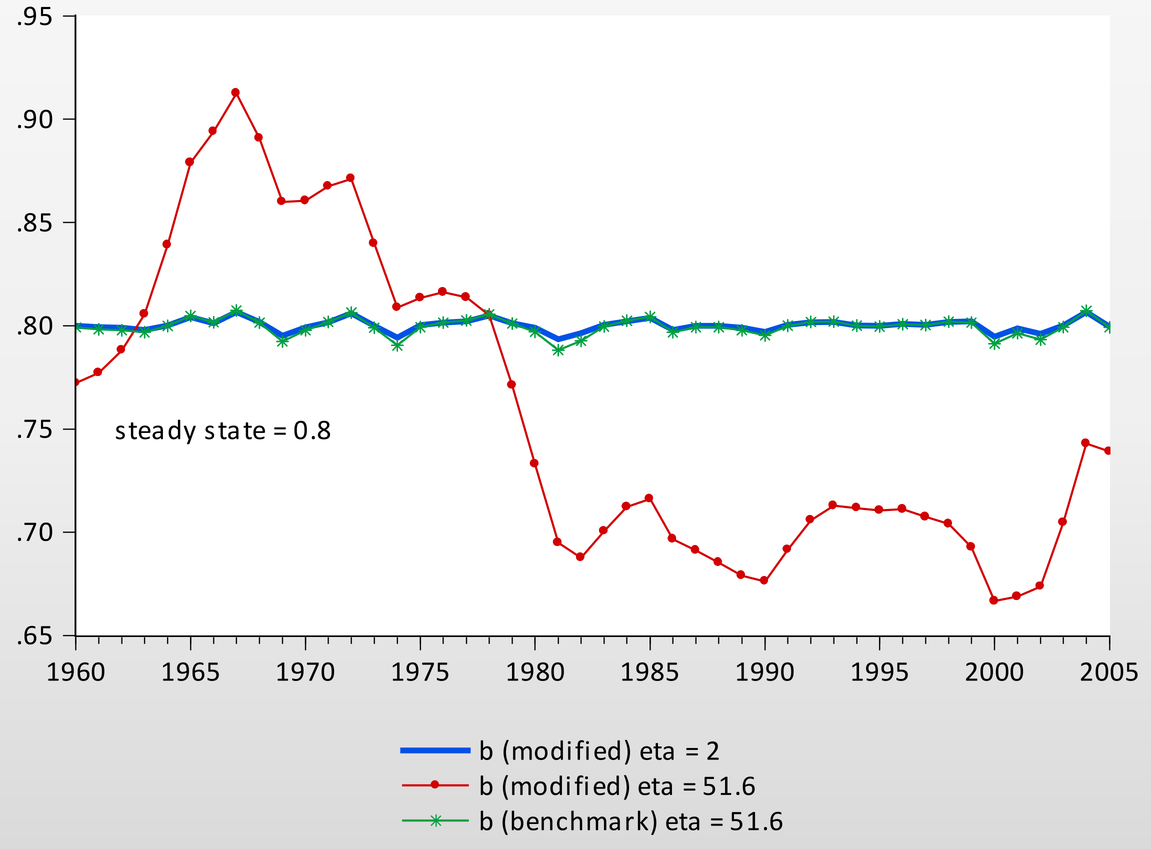
Varieties of Omegas



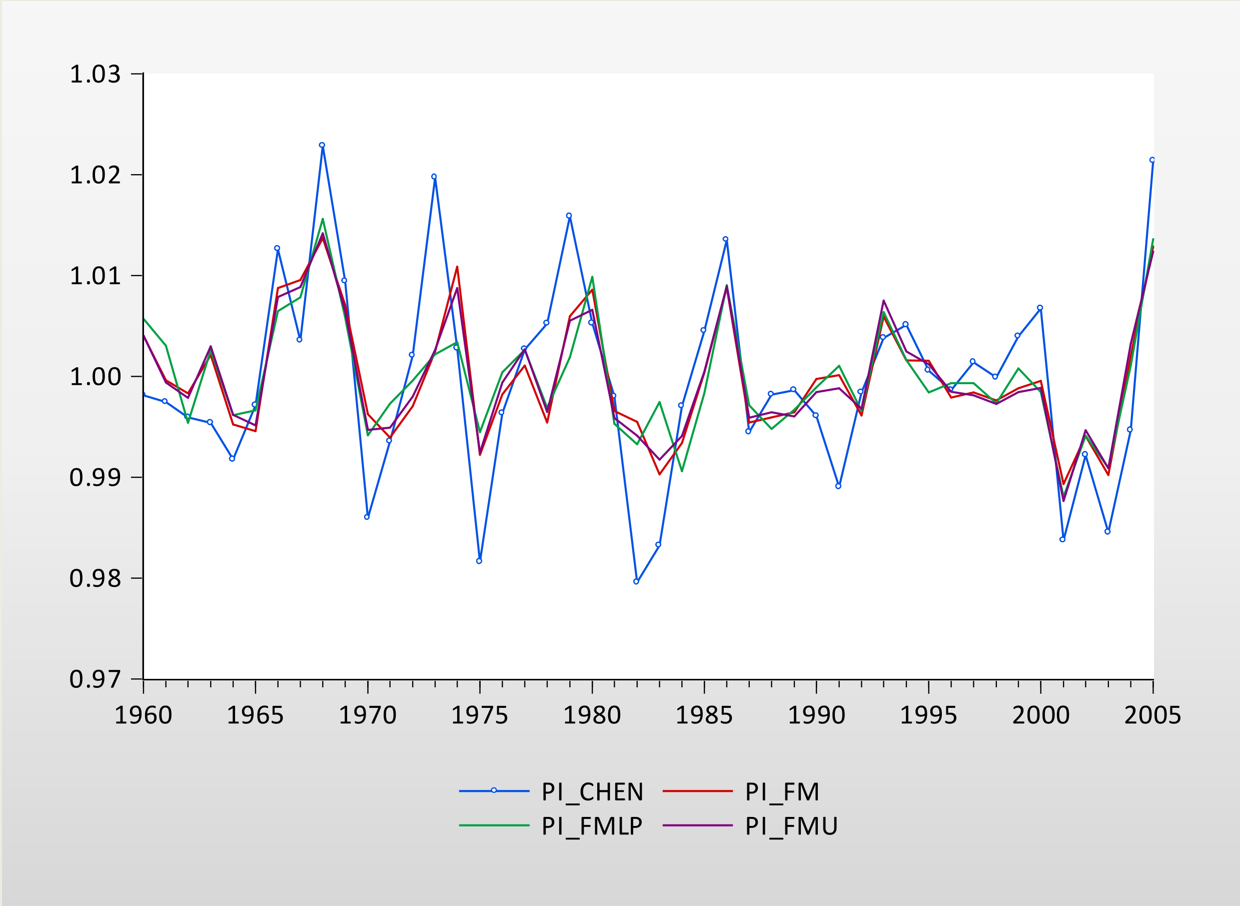
Debt Dynamics



Convexity

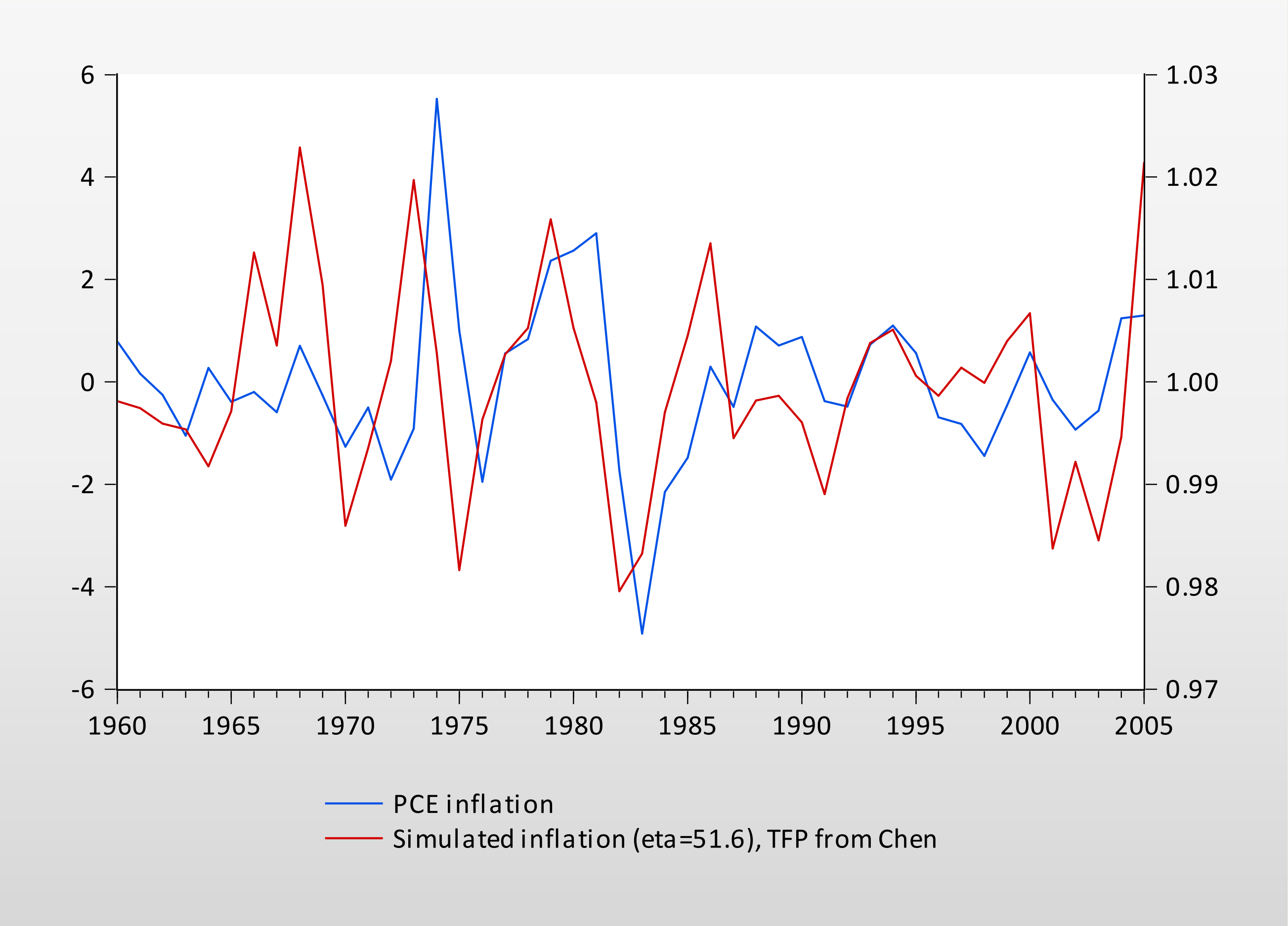

.95
.90
.85
.80
.75
.70
.65
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
steady state = 0.8
b (modified) eta = 2
b (modified) eta = 51.6
b (benchmark) eta = 51.6

Inflation



Steady state = 1

Comparing Inflation



Sources of Changes in the Spread

	$\omega^{\eta=51.6}$		$\omega^{\eta=51.6} \mid \omega_j$
ω_g	-0.06 (.70)	ω_g, ω_{TFP} -0.26 (.08)	0.60 (.00)
ω_τ	0.81 (.00)	ω_g, ω_τ -0.05 (.73)	0.96 (.00)
ω_{TFP}	0.88 (.00)	$\omega_{TFP}, \omega_\tau$ 0.46 (.00)	0.98 (.00)
IVE Est.	$\omega^{\eta=51.6} = \underset{(.00)^*}{0.02} + \underset{(0.39)^*}{1.16}\,\omega_\tau + \underset{(0.87)}{1.46}\,\omega_g + \underset{(0.21)^*}{0.89}\,\omega_{TFP}$ $* = 1\%, + = 10\%$		

p-values in parenthesis

‘Unconventional’ Monetary Policies

- Credit easing
  - Central bank does NOT incur the same intermediation costs (passed on in the GVT budget)
- Quantitative easing
  - An increase in the monetary base (i.e., bank reserves)

- **For C.E.** add a new element to *b*

$$b_t = L_t + L_t^{cb}$$

Zero in s.s.

- Profit max as before but s.t.

$$s.t.\ \ d_t = L_t + \Phi(L_t)$$

- Where $\Phi(L_t) = \varphi L_t^{\eta}$

- **For Q.E.** Augment intermediation

$$R_t^{cb} + d_t = b_t + \Phi(b_t)$$

Dynamics of Unconventional MP

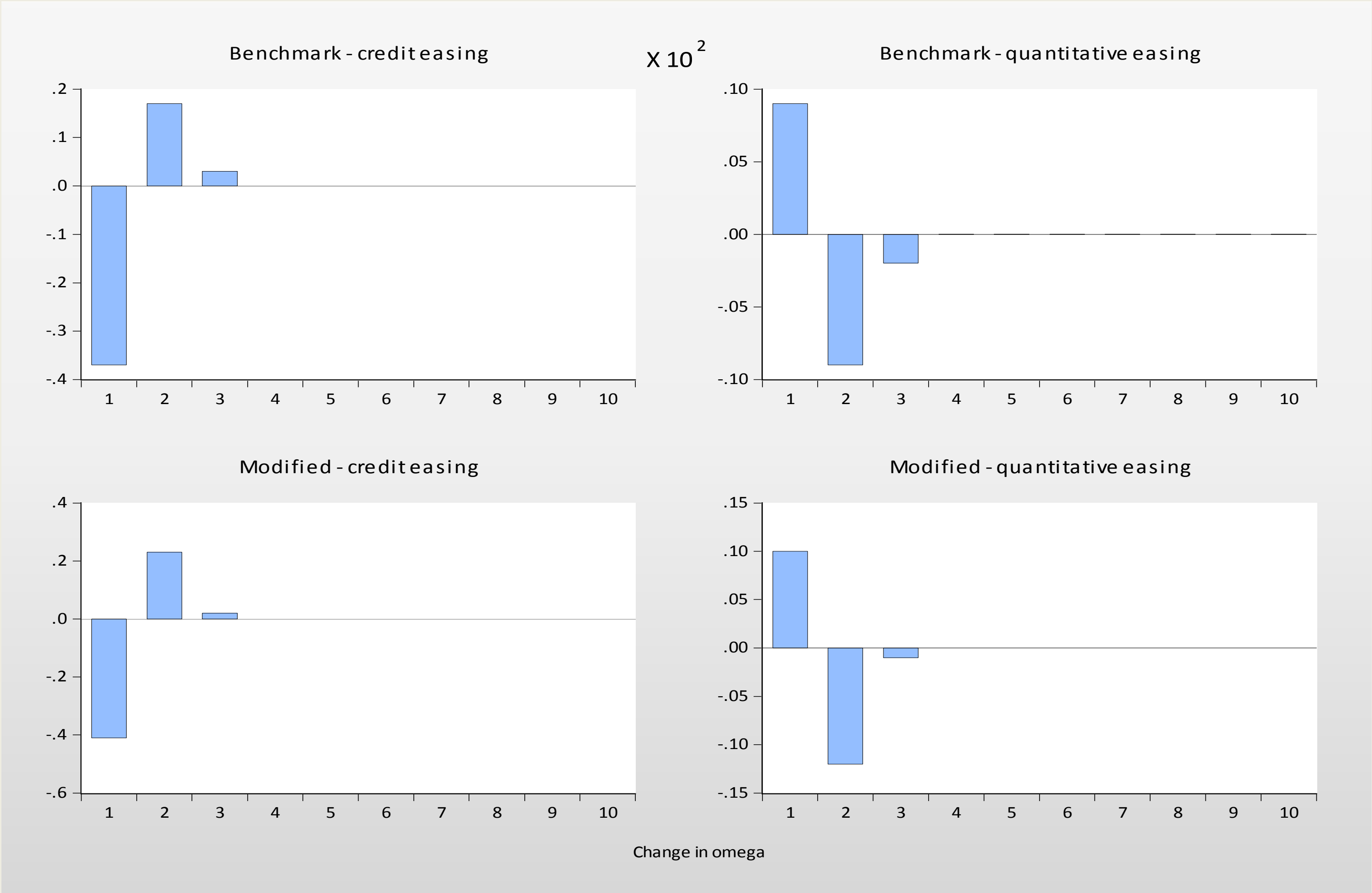
- Credit Easing

$$b_t = \pi_b \pi_s [(c_t^b - c_t^s) - w_t (h_t^b - h_t^s)] - \pi_b \Phi(b_t - L_t^{cb})$$
$$+ \frac{\delta(1+i_{t-1}^d)}{\Pi_t}[b_{t-1} + \pi_b \Phi(b_{t-1} L_t^{cb}) + \pi_s b_{t-1}\omega_{t-1}]$$
$$+ \frac{\pi_b (1+i_{t-1}^d) L_{t-1}^{cb}}{\Pi_t}(\omega_{t-1} + 1 - \delta)$$

- Quantitative Easing

$$b_t = \pi_b \pi_s [(c_t^b - c_t^s) - w_t (h_t^b - h_t^s)] - \pi_b \Phi(b_t)$$
$$+ \frac{\delta(1+i_{t-1}^d)}{\Pi_t}[b_{t-1} + \pi_b \Phi(b_{t-1}) + \pi_s b_{t-1}\omega_{t-1} - \pi_b R_{t-1}^{cb}]$$

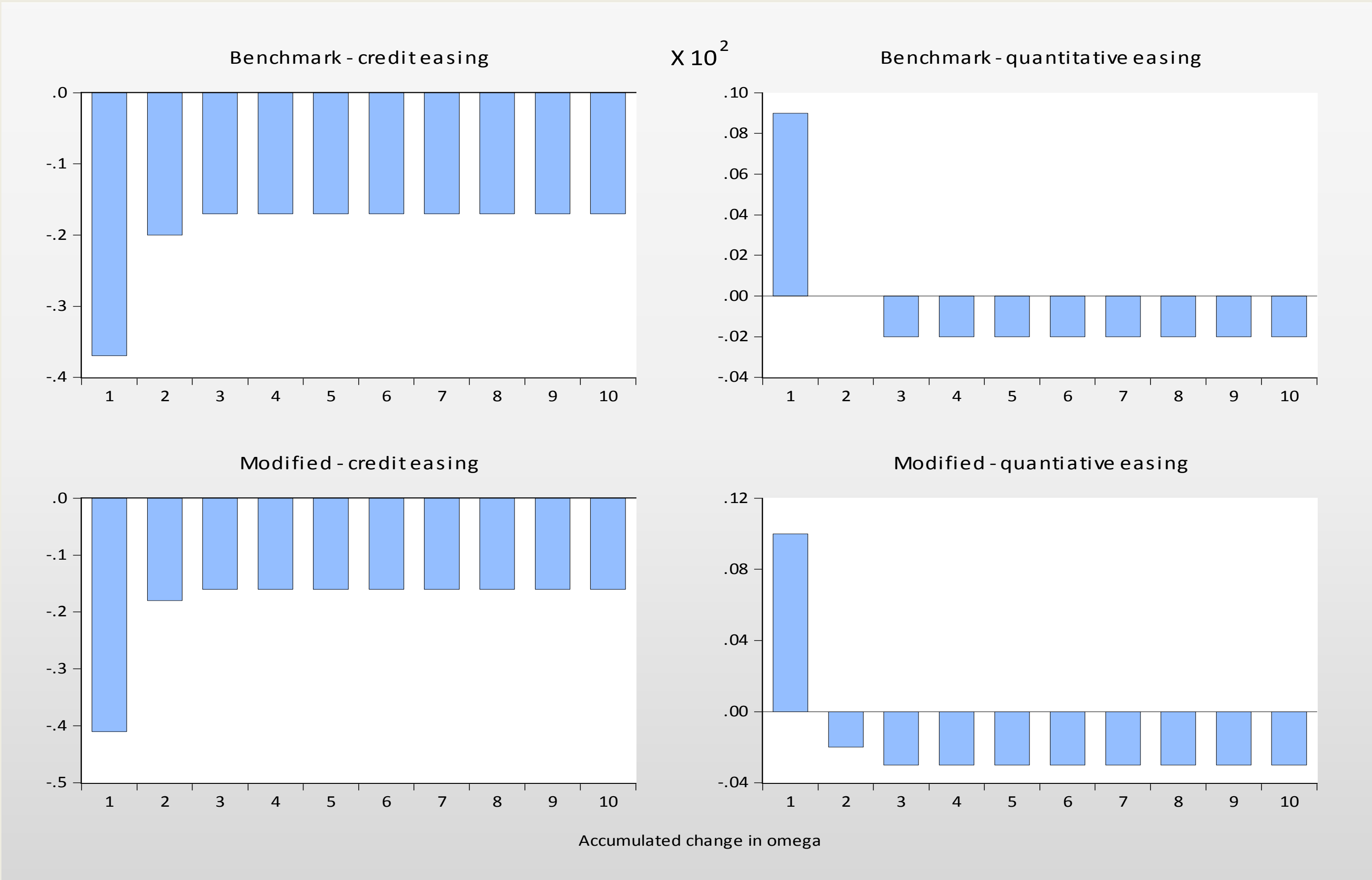
IRFs: CE vs QE



CE:1% increase CB s.s credit, $L^{cb} = .01 \; \overline{b}$

QE:1% of s.s. Credit $R^{cb} = 0.01\overline{b}$

Accum. IRFs: CE vsQE



$$R^{cb} = 0.01\bar{b}$$

What's next?

- Simulations
  - Change inflation target
  - Relax perfect substitutability of government debt & deposits
  - Relax the 'costless' CE easing policy assumption
  - Consider other kinds of 'financial shocks'
- Empirical
  - Many ways to proceed but...

Conclusions

- A highly level of convexity is needed to match sharp movements and volatility in the spread
  - a less non-linear intermediation costs function would lead to conditions as in the Great Moderation
  - A challenge is to link this type of phenomenon to how intermediation costs are actually determined
- Credit easing when its a ‘free lunch’ to the CB can reduce the spread
- QE is less effective and actually leads to a rise in the spread. This appears to describe the early days of the crisis in the fall of 2007