Roundheads versus Cavaliers: An Early Assessment of Quantitative Easing

"...I wouldn't start from here if I were you..."

Professor Jagjit S. Chadha

University of Kent and Cambridge CIMF

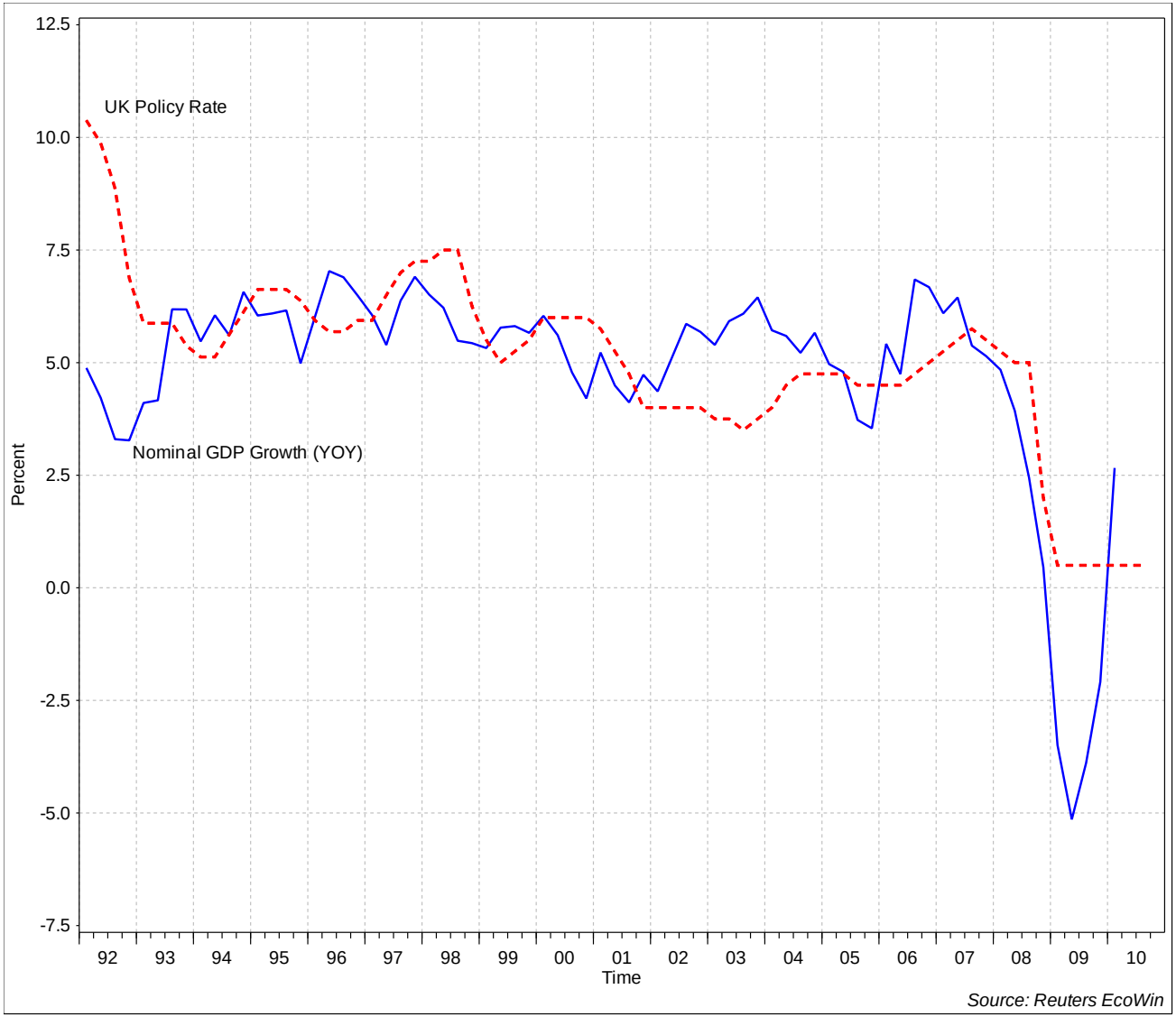
13th May 2011

A New Policy Tool

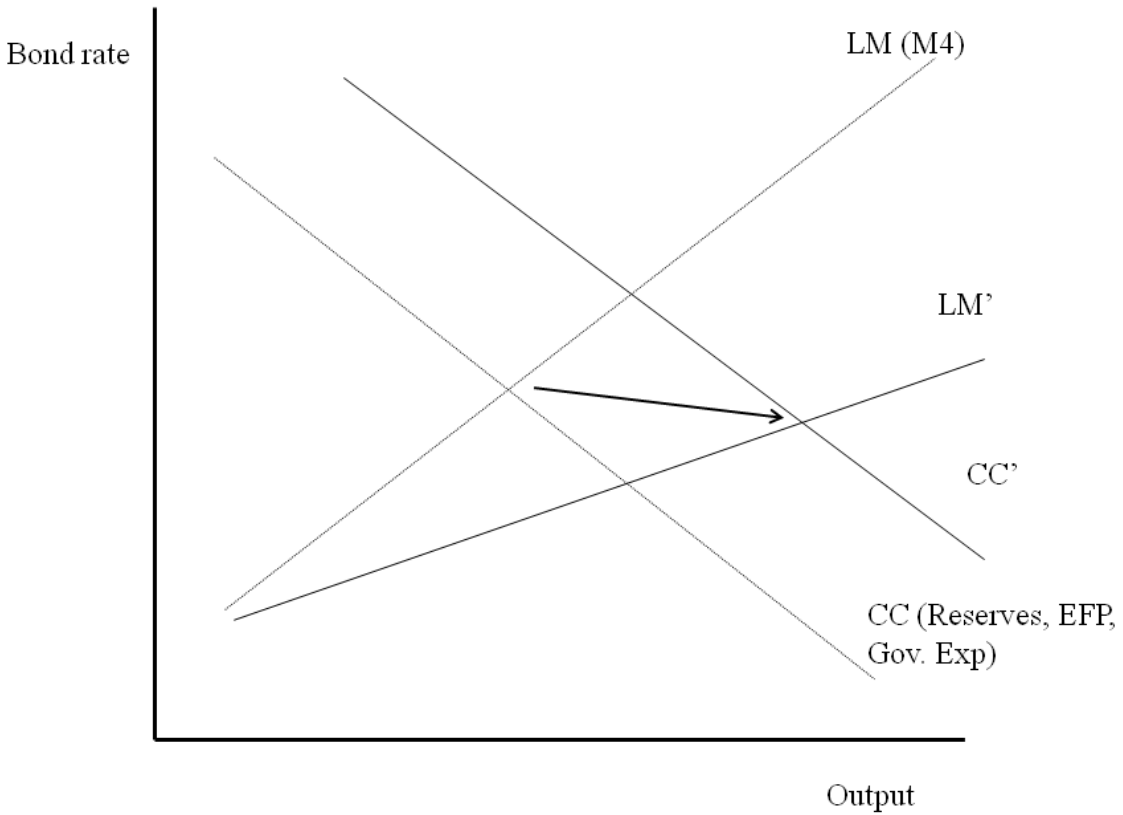
- Asset Purchase Facility borrows £200bn reserves at Bank Rate and uses them to buy bonds from the non-bank financial sector at an average coupon of 5%
- Unsterilised open market operation with objective to get nominal GNP growth back to 5% or more:

1. Implemented to offset zero bound and planned to be withdrawn gradually;
2. Relaxes government's present value budget constraint;
3. Portfolio Balance effect for non-bank financial intermediaries;
4. Announcement effects;
5. Bank lending.

Basic Policy Idea



Output and Interest Rate Effects



- Reserves issuance pushes out LM curve and also CC curve as external finance premia are relaxed and demand shifts out

Announcement Effects I

Announcement Date	Amount of new unsterlised asset purchases (£Bn)	Cumulative total of unsterilised asset purchases (£Bn)	Unsterilised asset purchases as percentage of net debt
11th February 2009	75	75	10.1
5th March 2009	50	125	16.1
7th May 2009	50	175	21.8
6th August 2009	25	200	23.7
5th November 2009	0	200	23.1

Announcement Effects II

Total impact of QE over event study on key variables

	Level	Slope	Curvature
Gilts Yields	-102 bp	-45.7 bp	-39 bp
Corporates Yields (AAA)	-72.5 bp	-34.9 bp	82.5 bp

Inflation Forwards	**5 Years**	**10 Years**	**20 Years**
	-36 bp	-38 bp	-72 bp

LIBOR Spread	**3 Months**	**6 Months**	**12 Months**
	39.1 bp	38.5 bp	39.5 bp

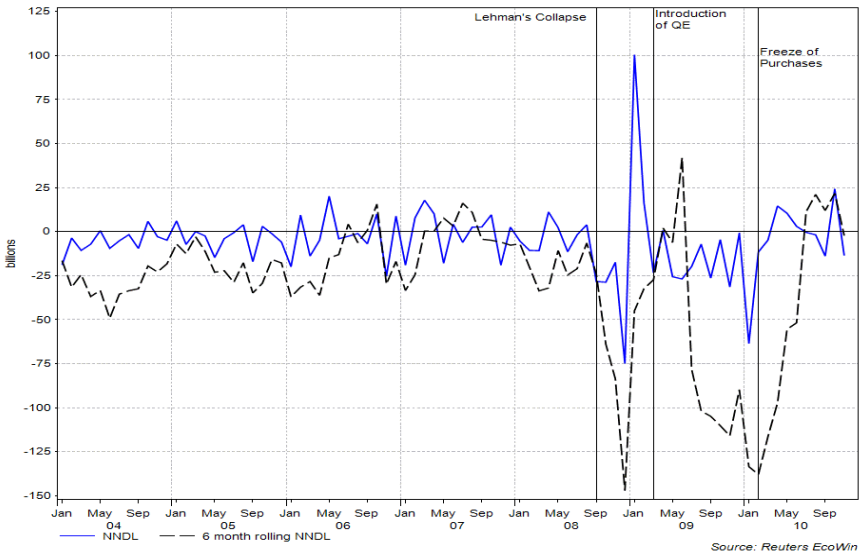
LIBOR-OIS Spread	**1 Month**	**3 Months**
	19.7 bp	26.8 bp

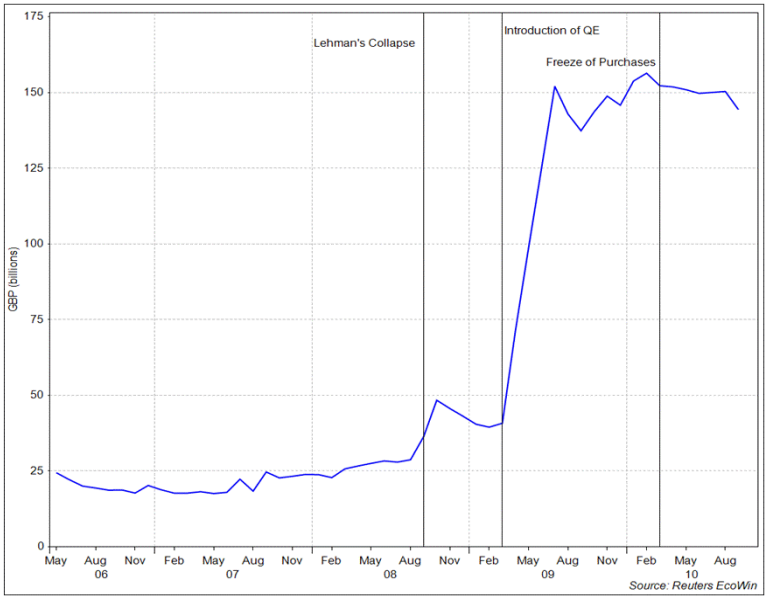
FTSE Index Values	**All Share**	**Pharmaceuticals**	**Mining**	**Mobile Telecoms**	**Banks**	**Oil & Gas Producers**
(% change)	0.35	0.383	-4.95	-6.34	-0.82	6.63

Stocks in Major UK Banks	**HSBC**	**Standard Chartered**	**RBOS**	**Barclays**
(% change)	4.35	2.13	-21.98	-34.43

Exchange Rate	**Euro/Sterling**	**US$/Sterling**
(% change)	3.23	3.05

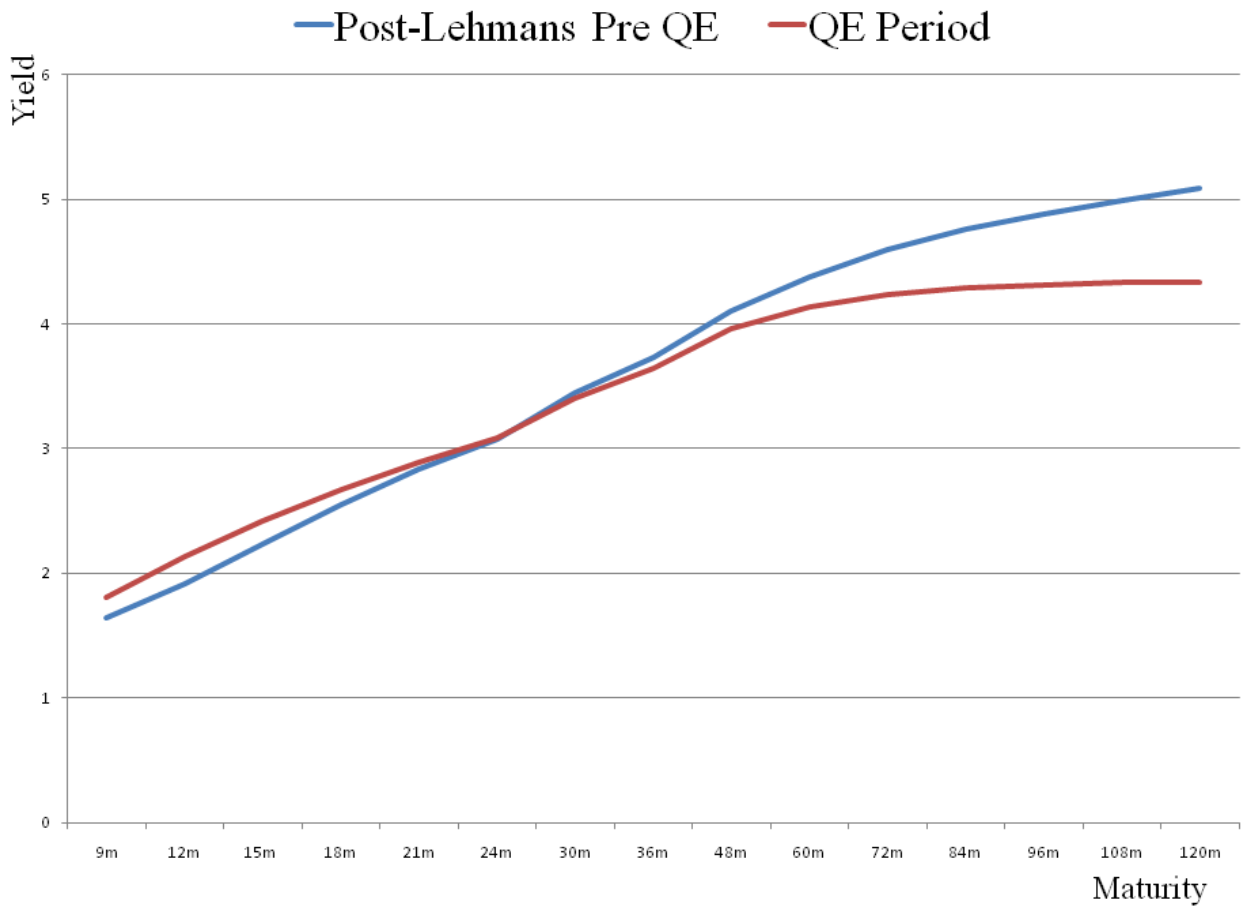
Monetary Analysis





- £200bn split between increase in reserves and creation of non-deposit liabilities (recapitalisation)

Government Liability Curve



- By announcement effect - QE has flattened the yield curve let's compare to the macro-finance yield curve

Macro-Finance Yield Curve

- The short rate is the sum of two latent factors; level and slope

$$i_t = \delta_0 + L_t + S_t$$

- Monetary policy acts through a Taylor Rule. The yield curve factors are connected to π_t and y_t

- The level is the perceived inflation objective of the CB:
  $L_t = \rho L_{t-1} + (1 - \rho_L)\,\pi_t + \varepsilon_{L,t}$

- The slope is set by CB to stabilise π_t and y_t:
  $S_t = g_y y_t + g_\pi\,(\pi_t - L_t) + u_{S,t}$ where $u_{S,t} = \rho_u u_{S,t-1} + \varepsilon_{S,t}$

Estimating this problem

Rudebusch and Wu (2008) Structural Model

- New Keynesian Structure drives macroeconomy

$$\pi_t = \mu_\pi L_t^m + (1-\mu_\pi)(\alpha_{\pi 1}\pi_{t-1} + \alpha_{\pi 2}\pi_{t-2}) + \alpha_y y_{t-1} + \varepsilon_{\pi,t}$$

$$y_t = \mu_y E_t y_{t+1} + \left(1-\mu_y\right)\left(\beta_{y1} y_{t-1} + \beta_{y2} y_{t-2}\right) - \beta_r\left(i_{t-1} - L_{t-1}^m\right) + \varepsilon_{y,t}$$

- Standard no-arbitrage formulation for the yield curve

$$\Lambda_t = \lambda_0 + \lambda_1 X_t;\ y_t(n) = \frac{1}{n}(a_n + b_n' X_t)$$

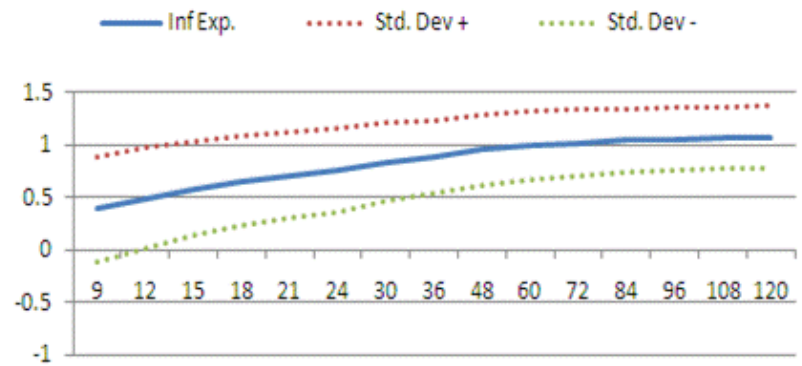
Diebold, Rudebusch and Aruoba (2006) Non-Structural Model

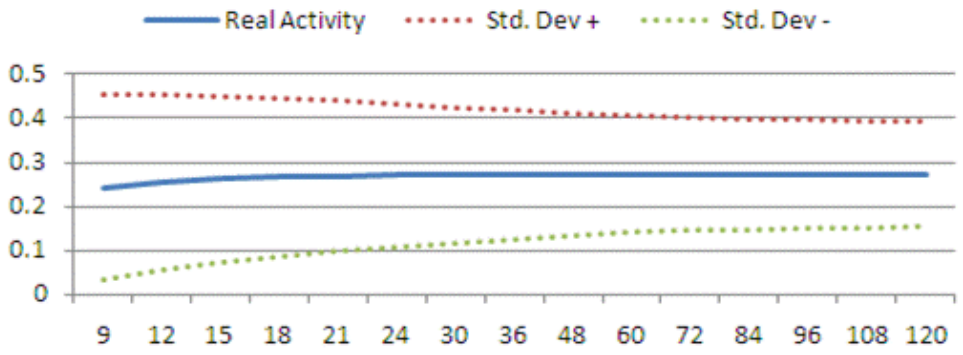
- $y_t(\tau) = L_t + S_t\left(\frac{1-e^{\tau\lambda}}{\tau\lambda}\right) + C_t\left(\frac{1-e^{\tau\lambda}}{\tau\lambda} - e^{\tau\lambda}\right)$ where lambda is fixed and the L_t, S_t and C_t are time varying
- $$\begin{pmatrix} L_t - \mu_L \\ S_t - \mu_S \\ C_t - \mu_C \end{pmatrix} = \begin{pmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{pmatrix} \begin{pmatrix} L_{t-1} - \mu_L \\ S_{t-1} - \mu_S \\ C_{t-1} - \mu_C \end{pmatrix} + \begin{pmatrix} \eta_t(L) \\ \eta_t(S) \\ \eta_t(C) \end{pmatrix}$$
- The state space system is then written in a vector/matrix notation as: $(f_t - \mu) = A(f_{t-1} - \mu) + \eta$ and $y_t = \Lambda f_t + \varepsilon_t$. Where where $f_t' = (L_t, S_t, C_t, CU_t, INFL_t, FFR_t)$. This methodology allows for bidirectional feedback between the interest rates and the macroeconomy.

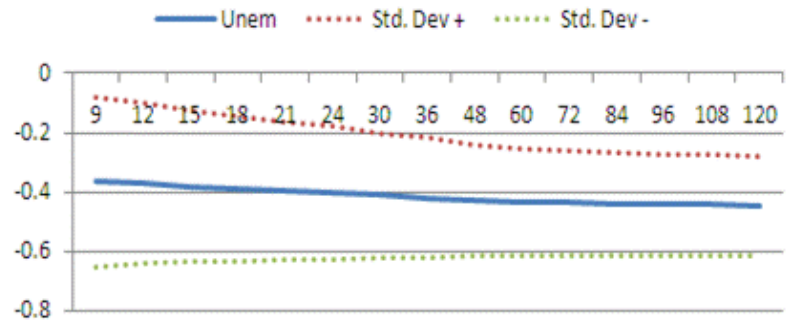
Estimated Impact Oct. 1992 to Feb. 2009

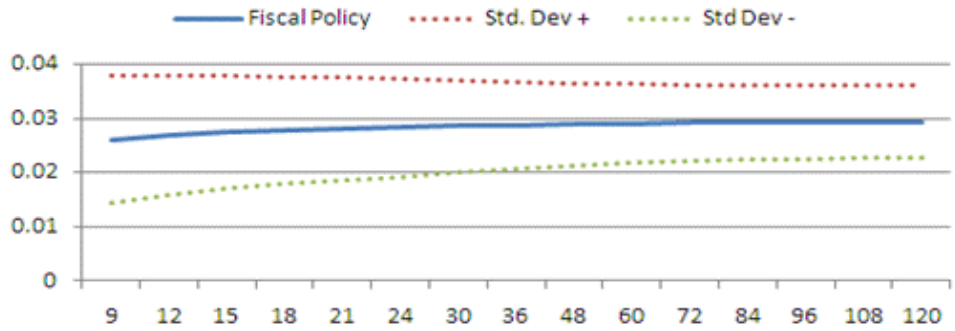
Nominal	October 1992 to February 2009		
	Level	Slope	Curvature
Constant	7.38379 (0.3248)**	**0.255671** (0.3663)	1.64982 (0.4528)**
Trend	–0.0155141 (0.003090)**	–0.00925716 (0.003481)**	–0.0131344 (0.004306)**
Inflation Exp.	1.15956 (0.1363)**	–1.11033 (0.1535)**	–0.842676 (0.1650)**
Real Activity	0.274424 (0.05551)**	–0.168530 (0.06145)**	0.155721 (0.07722)*
Unemployment	–0.455764 (0.07710)**	0.0572309 (0.08346)	0.215328 (0.09933)*
Financial Returns	**0.0128929** (0.02611)	–0.0689577 (0.02912)*	–0.278671 (0.03641)**
Libor	0.671020 (0.1188)**	0.671423 (0.1325)**	0.844724 (0.1665)**
IFO	–0.0448944 (0.01140)**	0.111213 (0.01288)**	0.113856 (0.01632)**
German Ret. Sales	**–0.0138904** (0.03021)	0.0931447 (0.03396)**	0.148029 (0.04277)**
U.S. Non-Farm Pay.	–0.373923 (0.05747)**	0.110858 (0.06487)	**0.00064** (0.07922)
Feds Funds Rate	0.367788 (0.03897)**	–0.113737 (0.04394)*	–0.00702 (0.05574)
BoE Policy Rate	**–0.0228950** (0.06804)	0.340386 (0.07724)**	–0.253459 (0.09650)**
Fiscal Policy	0.0296201 (0.003065)**	–0.00976801 (0.003459)**	0.003389 (0.004397)
Euro Effective ER	0.0635058 (0.01059)**	–0.0725216 (0.01187)**	–0.0948235 (0.01487)**
Dollar Effective ER	0.0219838 (0.009725)*	–0.0293055 (0.01098)**	–0.0278929 (0.01361)*
UK Effective ER	–0.0747123 (0.01178)**	0.0857165 (0.01346)**	–0.0129110 (0.01660)

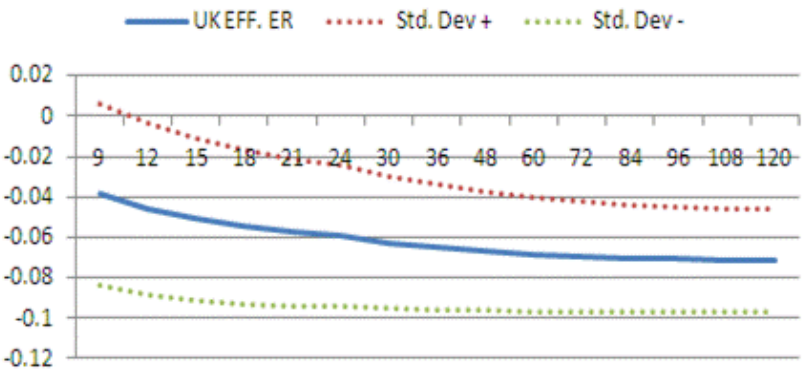
Impulse Responses of Forwards

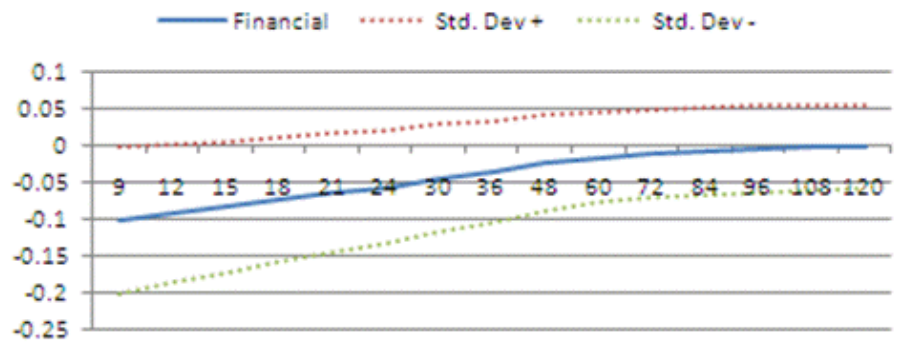




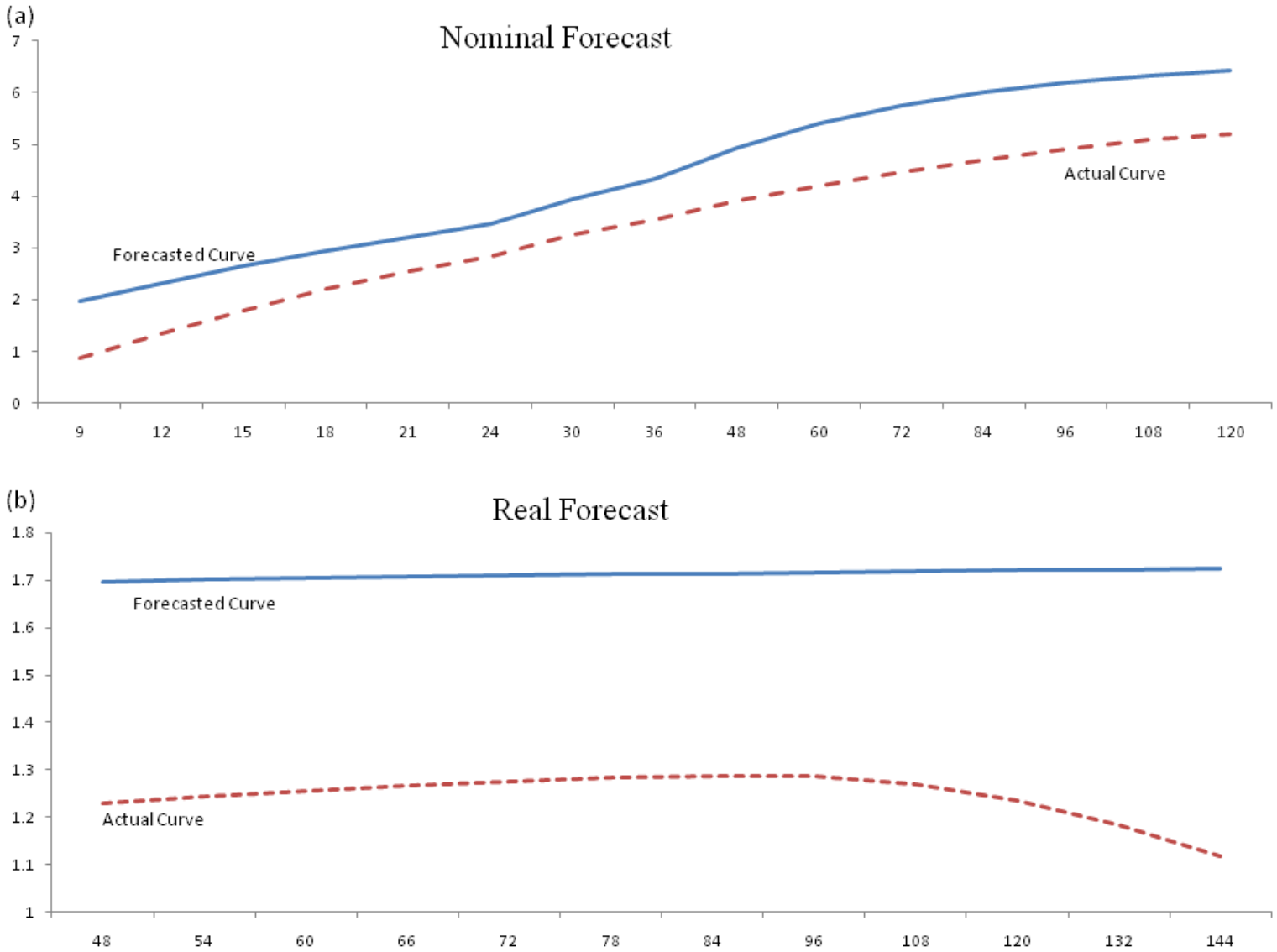








The Impact of QE on Forwards



Portfolio Balance Model

Households

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \phi_t \left[\frac{c_2^{1-\frac{1}{\phi}}}{1-\frac{1}{\sigma}} - \frac{n_t^{1+\psi}}{1+\psi} + \frac{\chi_m^{-1}}{1-\sigma_m^{-1}} \left(\frac{M_t}{P_t} \right)^{1-\frac{1}{\sigma m}} \right]$$

+ a budget constraint μ

Households supply labour

Recieve transfers from gov. and dividends

Government Budget Constraint

$$\hat{b}_t + \frac{m}{b}(\hat{m}_t - \hat{m}_{t-1}) = \delta q_t - \left[\frac{m}{b} + \frac{1+\delta}{\beta} \right] \hat{\pi}_t + \left(\frac{1}{\beta} - \theta \right) \hat{b}_{t-1} - \frac{\delta}{\beta} q_{t-1}$$

No government spending

The government issues short term debt b_t

and long term debt $b_{L,t}$

Sells debt to central banks and households

Fin. Intermediaries

$$\hat{R}_t = E_t \hat{R}_{L,t+1} + \nu \left(\hat{b}_t - \hat{b}_{L,t} \right)$$

Accept deposits from

households at R^A

Earn profits on R_t and $R_{L,t}$

Firms

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left[P_t(i) Y_t(i) - W_t n_t(i) - \frac{\chi_p}{2} \left[\frac{P_t(i)}{P_{t-1(i)}} - 1 \right]^2 P_t Y_t \right]$$

Monopolistically competitive firms

profit maximisation is subject too aggregate prices

and the productivity of labour

Interest Rates

R^A Returns to Households $\hat{R}_t^A = \frac{1}{1+\delta} \hat{R}_t + \frac{\delta}{1+\delta} E_t \hat{R}_{L,t+1}$

$\hat{R}$ Short term nominal

$R_{L,t}$ Long term nominal $E_t \hat{R}_{L,t+1} = \beta E_t \hat{V}_{t+1} - \hat{V}_t$

$\hat{r}_t^*$ Natural Real Rate $\hat{r}_t^* = \rho \hat{r}_{t-1}^* + \varepsilon_t$

Aggregate demand shock

Market clearing

$$\hat{b}_{L,t} = -q_t + \hat{V}_t$$

Supply of bonds available

to households is taken

up by financial

intermediaries

Conventional Monetary Policy

$$\hat{R}_t = \rho_R \hat{R}_{t-1} + (1-\rho_R)(\alpha_\pi \hat{\pi}_t + \alpha_x \hat{x}_t) + \varepsilon_t^R$$

Monetary policy shock

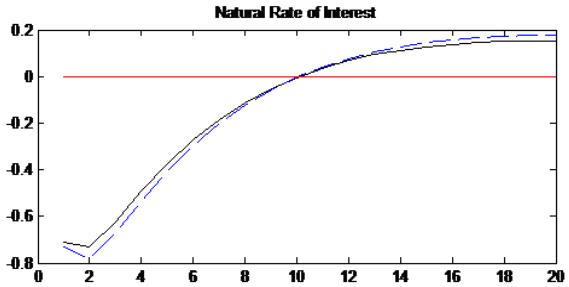
Unconventional Monetary Policy

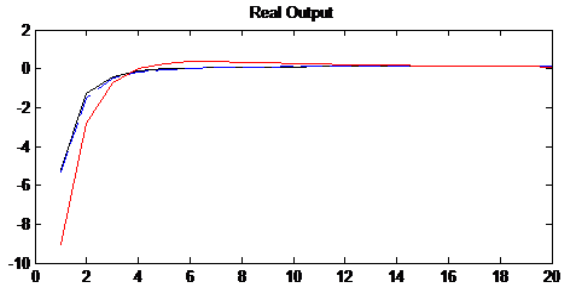
$$q_t = \rho_q q_{t-1} + \varepsilon_t^q$$

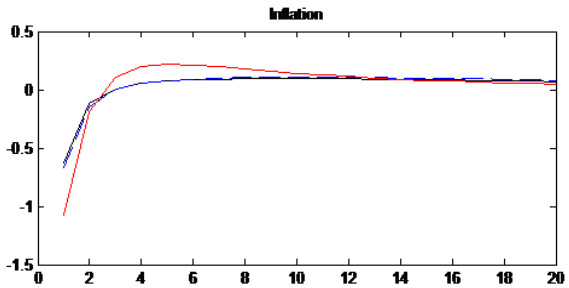
Asset purching shock

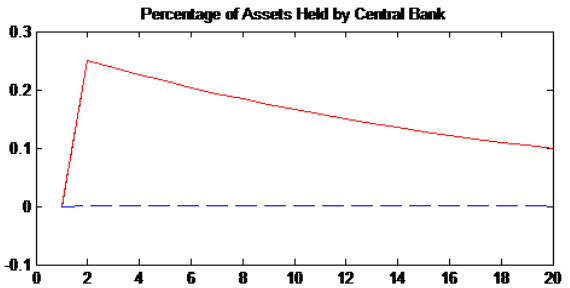
- Government purchases offset the household preference for short term bonds

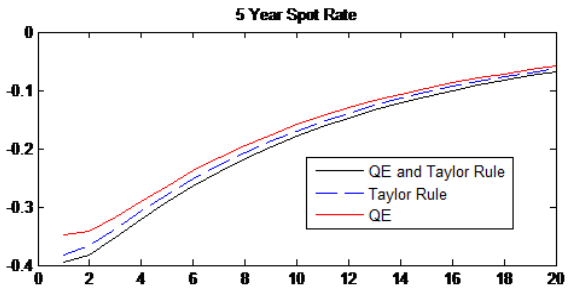
Portfolio Effects and AD - Zero Bound

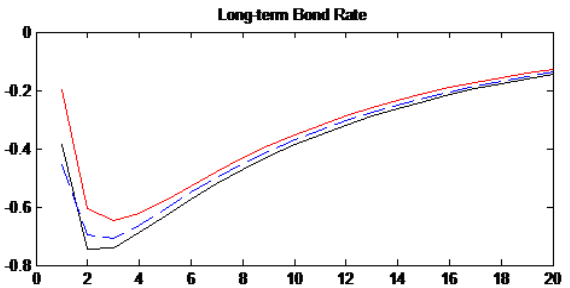












Bank Capital Model

Households

Consume and produce

Standard intertemporal preferences over consumption

$-\sigma C_t = -\sigma E[C_{t+1}] + R_t - E[\pi_{t+1}]$

Euler consumption equation

Hold deposits with banks and need loans to finance investment activity

Production

Monopolistic competition

Calvo- pricing

Production function

$Y_t = Z_t + \alpha K_{t-1} + (1-\alpha)H_t$

where Z is TFP

Labour market equilibrium

$Y_t - H_t + X_t - \sigma C_t = \varkappa H_t$

Banks

Provide loans to households subject to a monitoring cost λ

Take deposits from households and pay deposit rate R which equals the policy rate

Households can only finance investment with bank loans so stock of physical capital equals level of bank loans

$q_t K_t = L_t$

Banks hold no assets other than loans so

$L_t = B_t + D_t$

Bank capital is defined by

$B_t = \gamma\left[\theta_2(R^k - R)D_{t-1} + R^k B_{t-1} + \theta_1 R R_t^k - \theta_2 R R_{t-1}\right] - \tau$

and bank leverage by

$L_t - B_t = \theta_1 R_{t+1}^k - \theta_2 R_t - \lambda_t$

Monetary Policy

Conventional Policy Rule

$R_t = \rho R_{t-1} + (1-\rho)(\alpha_\pi \pi + \alpha_Y Y + \alpha_K K)$

Inclusion of K reflects financial stability concerns

Unconventional Policy (τ) - a bank levy/subsid

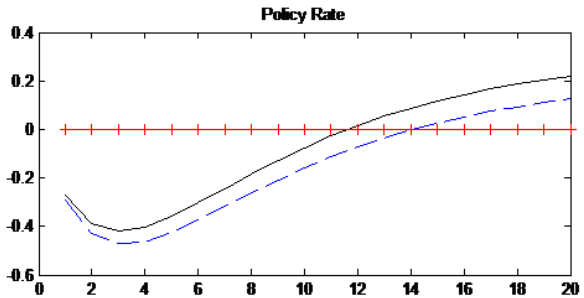
$\tau = \nu(E\left[R_{t+1}^k - R_{t+1}\right] - (R_t^k - R_t)$

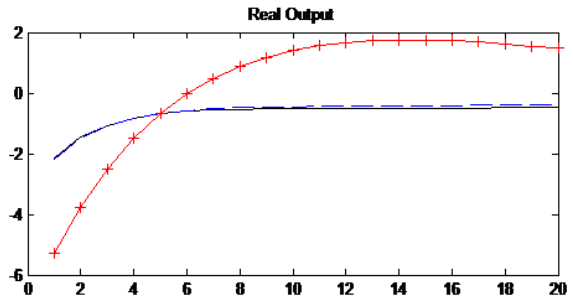
Interest Rates

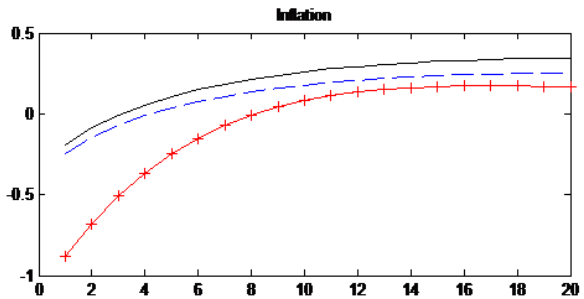
R = Policy/Deposit Rate (short term nominal)

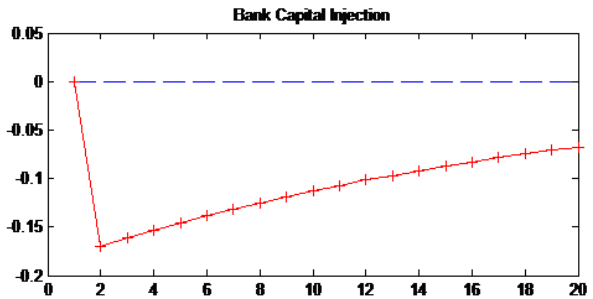
R^k = Return on Physical Capital

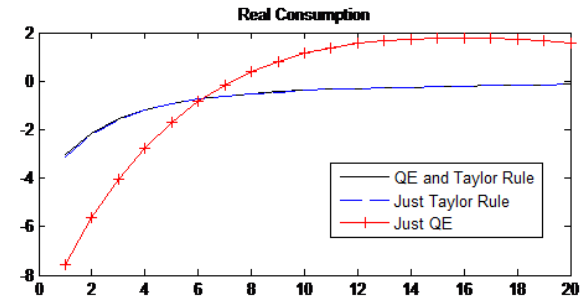
Bank Capital and AD

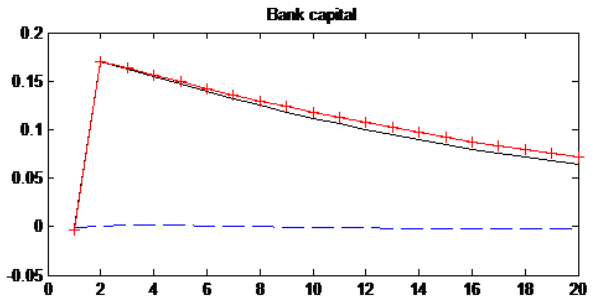












Reserves and Banking Model

Households

$$U_t = \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{l} \phi \log c_t + \\ (1-\phi)\log(1-m_t-n_t) \end{array} \right]$$

$+ \lambda_t$ Budget Constraint

- Aggregate Demand
- Supply of Labour n
- Supply of Monitoring Work m

CIA: Demand Deposits

$D_t = c_t + p_t - V_t$

Cash in Advance

Production

$$y_t^s = K_t^{\eta} (a1_t n_t)^{1-\eta}$$

a1: productivity shock

Assumptions:

- Monopolistic competition
- Calvo pricing

- Aggregate Supply
- Demand for Labour n

Banking Sector

$$L_t^s = F(b_t + a3_t q_t)^{\alpha} (a2_t m_t)^{1-\alpha}$$

a2 and *a3*: shocks to collateral q and monitoring work m

- Supply Loans (depends on q and m)
- Reserves: depend on penalty rate of a liquidity shortfall and on return on loans

$$L_t + R_t = D_t$$

Monetary Policy

$$R_t^{IB} = \gamma(\beta_1 \pi_t + \beta_2 mc_t) + (1-\gamma) R_{t-1}^{IB}$$

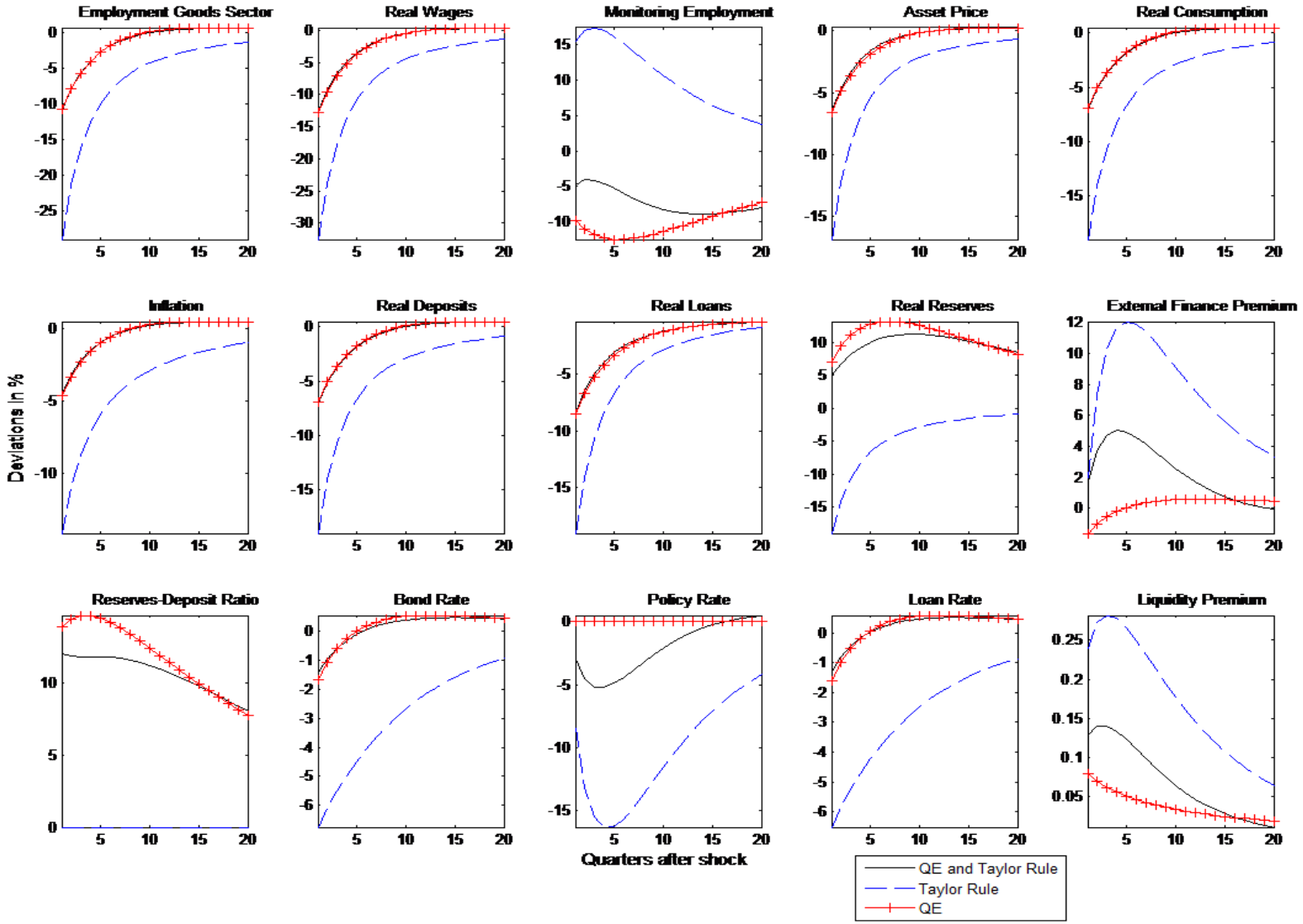
Fiscal Policy

$$g_t - tax_t = \frac{r_t}{P_t^A (1+R_t^{IB})} - \frac{r_{t-1}}{P_t^A} + \frac{B_{t+1}}{P_t^A (1+R_t^B)} - \frac{B_t}{P_t^A}$$

Interest Rate	Description	Equation
R^T	Benchmark rate	$E_t(\lambda_t - \lambda_{t+1}) + E_t(\Delta p_{t+1})$
R^B	Yield on government bonds	$R^T - \left(\frac{\phi}{c_t \lambda_t} - 1\right) \Omega_t$
R^{IB}	Interbank (and policy) rate	$R^T - \left[\frac{V w_t m_t}{(1-\alpha)(1-rr)c_t}\right]$
R^L	Interest rates on loans	$R^{IB} + \left[\frac{V w_t m_t}{(1-rr)c_t}\right]$
R^D	Deposit rate	$R^{IB}(1-rr)$

EFP

Reserves and AD



QE Next Steps

- Raw estimates suggest 100bp from announcement effects and a similar amount from macro-finance yield curve
- Theoretical models find limited role for portfolio balance effect but significantly more when credit policy acts on bank capital or on bank liquidity - models do not have *long and variable lags...*
- Question of whether to purchase more illiquid/riskier assets
- Work on Exit Strategy from fiscal, low rates and QE
- Consider case for negative QE or bank capital taxes in a boom
- Basel III is about stocks but our models improve business cycle dynamics...