Does Bank Lending Tightness Matter?

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March 17, 2008

Introduction

- Estimate a small Global Projection Model (GPM) using U.S. data on GDP, unemployment, inflation and the Fed Funds Rate

- Add information on Bank Lending Tightness (BLT) to see how much it matters

Three Major Findings

- The model produces plausible forecasts and sensible IRFs
- BLT results in a significant improvement in forecast accuracy
- The model predicts significant weakness in the U.S. economy in 2008

The US economy over the sample period

- In 1994, as the economy completed its recovery from the recession of 1990-1991 the Fed raised its policy interest rate towards a more neutral, less stimulative level.

- Over the period 1996 to 1999, the economy continued to grow at a fairly rapid pace, with unemployment falling.

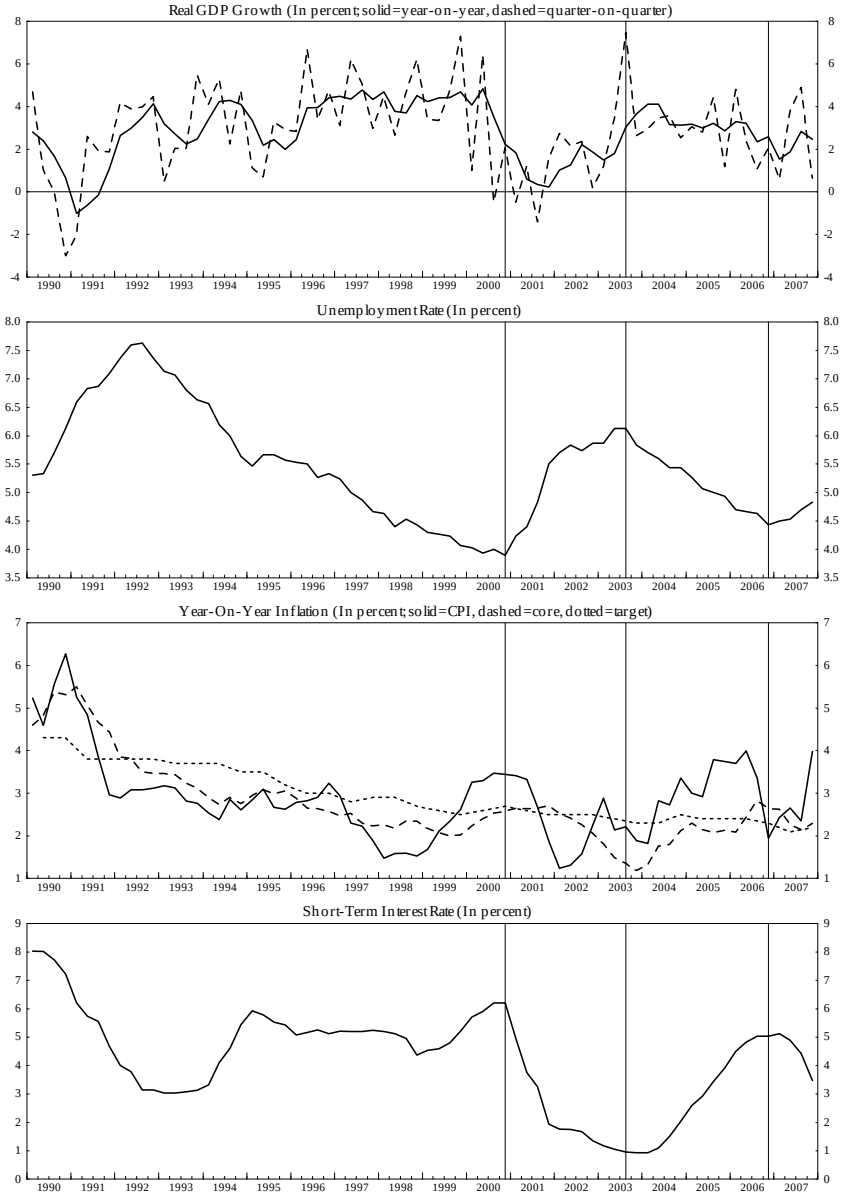
- In response to concerns about inflationary pressures the Fed began to raise interest rates gradually through 1999 and into 2000. GDP growth slowed partly in response to the high tech slowdown and the fall in the stock market.

The US economy over the sample period (cont.)

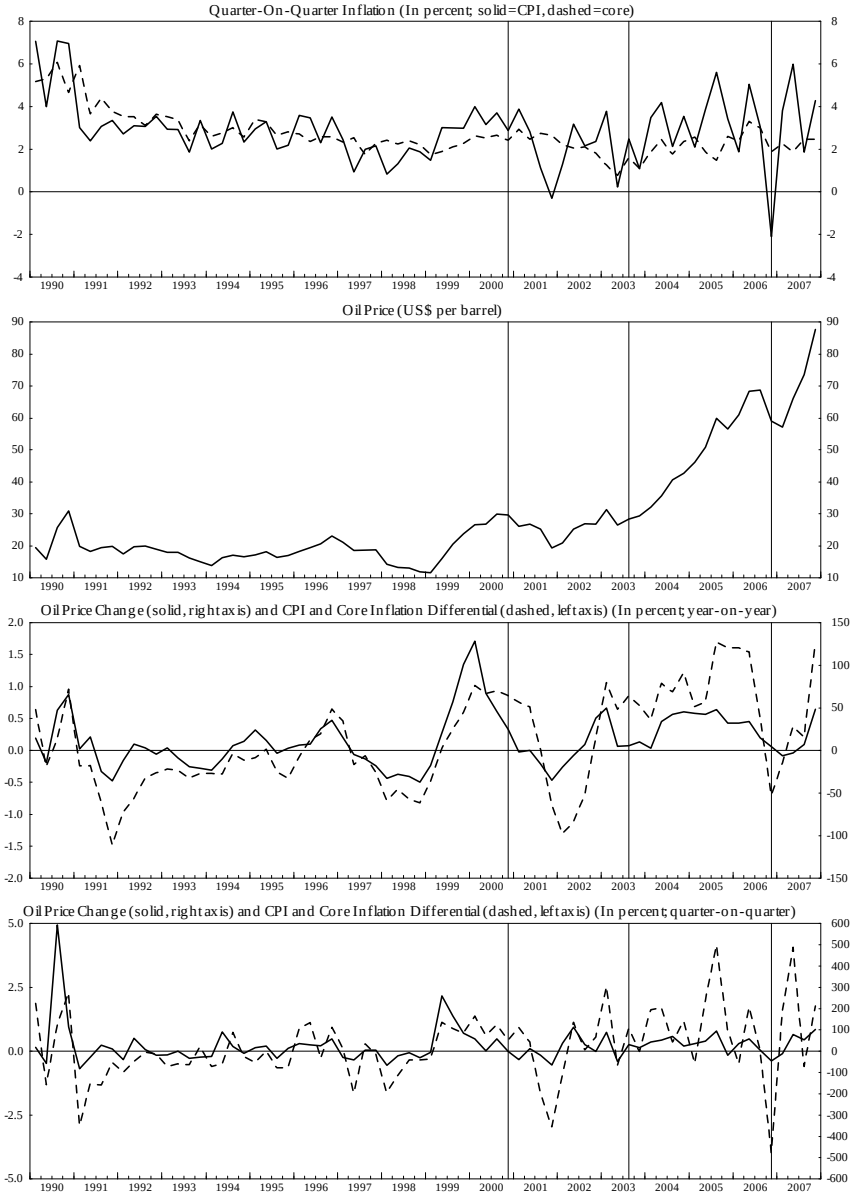
- The Fed gradually reduced its policy interest rate with the decline of inflation to very low levels. The period of low interest rates was successful in reinvigorating the economy and causing unemployment to decline from a peak of about 6% in 2003 to a trough of about 4 1/2% in 2006.

- Finally, over the past few months, the end of the housing price boom, the liquidity problems in the asset-backed commercial paper market, and the problems faced by holders of structured financial instruments have together led to a negative outlook for the United States

United States



United States



The Model (case US)

- Headline Inflation
- Output Gap
- Reaction Function
- Unemployment Gap

1. Inflation Equation

$$\pi_t = \lambda_1 \pi 4_{t+4} + (1 - \lambda_1)\pi 4_{t-1} + \lambda_2 y_{t-1} + \varepsilon_t^{\pi}$$

- Backward and Forward-Looking Components $(\lambda_1 \pi 4_{t+4} + (1 - \lambda_1)\pi 4_{t-1})$
- Output Gap $(\lambda_2 y_{t-1})$
- Supply Shock (ε_t^{π})

2. Output Gap Equation

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t+1} - \beta_3 (rr_{t-1} - \overline{rr}_{t-1}) + \varepsilon_t^y$$

- Backward and Forward-Looking Components ($\beta_1 y_{t-1} + \beta_2 y_{t+1}$)
- Real Interest Rate Gap $\beta_3(\text{rr}_{t-1} - \overline{rr}_{t-1})$
- Demand Shock (ε_t^y)

3. Reaction Function Equation

$$\begin{aligned} rs_t &= (1-\gamma_1)\left[\overline{rr}_t + \pi 4_{t+3} + \gamma_2(\pi 4_{t+3} - \pi^{tar}) + \gamma_4 y_t\right] \\ &\quad +\gamma_1 rs_{t-1} + \varepsilon_t^{rs} \end{aligned}$$

- Expected 1-Year-Ahead Y-O-Y Inflation Gap $\gamma_2(\pi 4_{t+3} - \pi^{tar})$
- Inertia $\gamma_1(rs_{t-1})$
- Output Gap $\gamma_4(y_t)$
- Discretionary or Random Component of Monetary Policy (ε_t^{rs})

System Estimation Using Bayesian Methods

- More Meaningful Statistical Inference
- Model Validation
- Estimates of Uncertainty
- Actually Works in Small Samples
- Fexible Stochastic Processes

- Nothing Special about Unit Roots
- Not a Panacea
- AVOIDS PREFILTERING!

Figure 1: US Unemployment HP1600

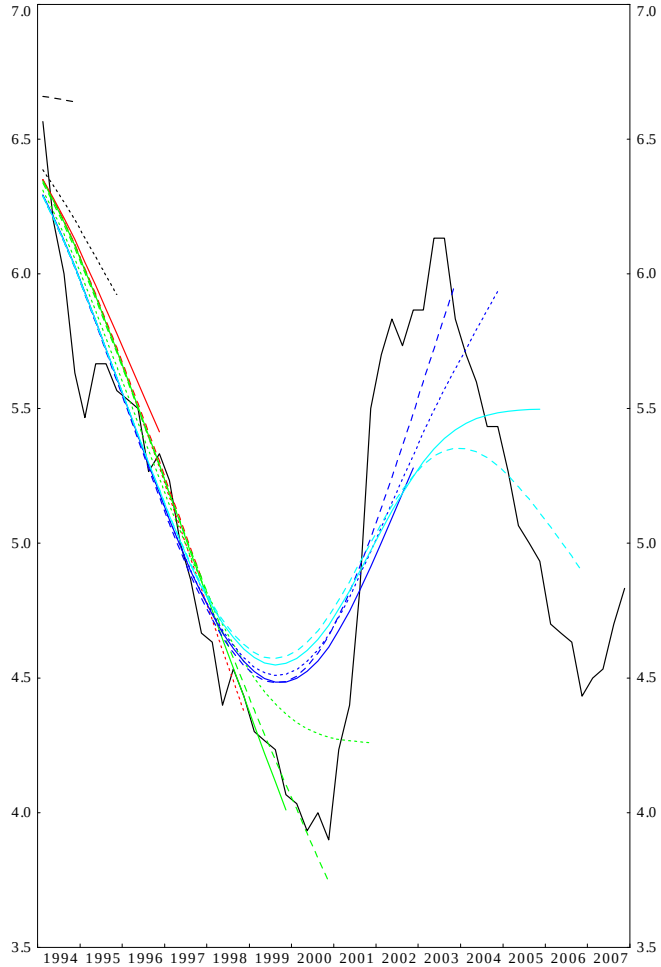
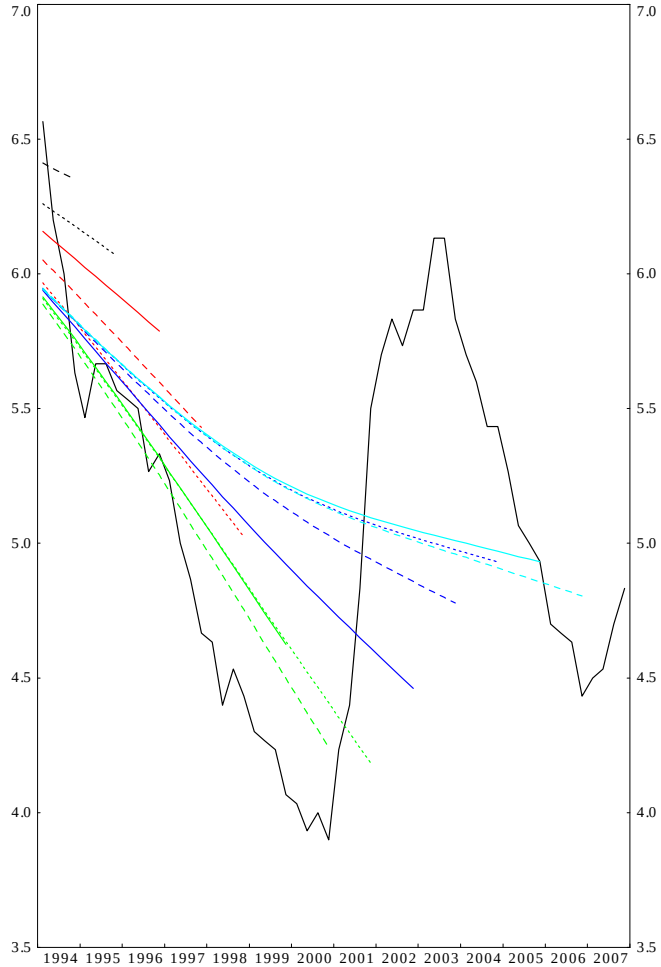


Figure 2: US Unemployment HP 100000



4. Unemployment Gap Equation (Dynamic Okun's Law)

$$(u_t - \overline{u}_t) = \alpha_1(u_{t-1} - \overline{u}_{t-1}) + \alpha_2 y_t + \varepsilon_t^{(u_t - \overline{u}_t)}$$

- Inertia $\alpha_1(u_{t-1} - \overline{u}_{t-1})$
- Output Gap $\alpha_2 y_t$
- Shock $\varepsilon_t^{(u_t - \overline{u}_t)}$

5. NAIRU Process

$$\begin{aligned} \overline{u}_t &= \overline{u}_{t-1} + ug_t + \varepsilon_t^{\overline{u}} \\ ug_t &= (1-\alpha_3)ug_{t-1} + \varepsilon_t^{ug} \end{aligned}$$

- Level shocks to NAIRU ($\varepsilon_t^{\overline{u}}$)

- Shock to NAIRU Growth (ε_t^{ug})

6. Potential Output Process

$$\begin{aligned} \overline{y}_t &= \overline{y}_{t-1} + g_t/4 + \varepsilon_t^{\overline{y}} \\ g_t &= \tau g^{ss} + (1-\tau) g_{t-1} + \varepsilon_t^{g} \end{aligned}$$

- Level shocks to potential output ($\varepsilon_t^{\overline{y}}$)
- Persistence deviations in potential growth from long-run growth ($\tau g^{ss} + (1 - \tau) g_{t-1}$)
- Shock to Potential Growth (ε_t^{g})

7. Equilibrium Real Interest Rate Process

$$\overline{rr}_t = \rho \overline{rr}_t^{ss} + (1-\rho)\overline{rr}_{t-1} + \varepsilon_t^{\overline{rr}}$$

- Persistence deviations in equlibrium real interest rate ($\overline{rr}_t$) from its steady-state rate($\overline{rr}_t^{ss}$)

The Model with BLT

- Bank Lending Tightness (BLT) index

- Stronger Macro-financial linkages

Simple Measure of BLT Based on Fed's Senior Loan Officer Survey

$$BLT_t = 0.25(CILF_t + CISF_t + CR_t + RM_t)$$

- Commercial and industrial loans for large firms ($CILF_t$)
- Commercial and industrial loans for small firms ($CISF_t$)
- Commercial real estate loans (CR_t)
- Residential mortgage loans (RM_t)

Figure 3: BLT and the Model-Consistent Output Gap

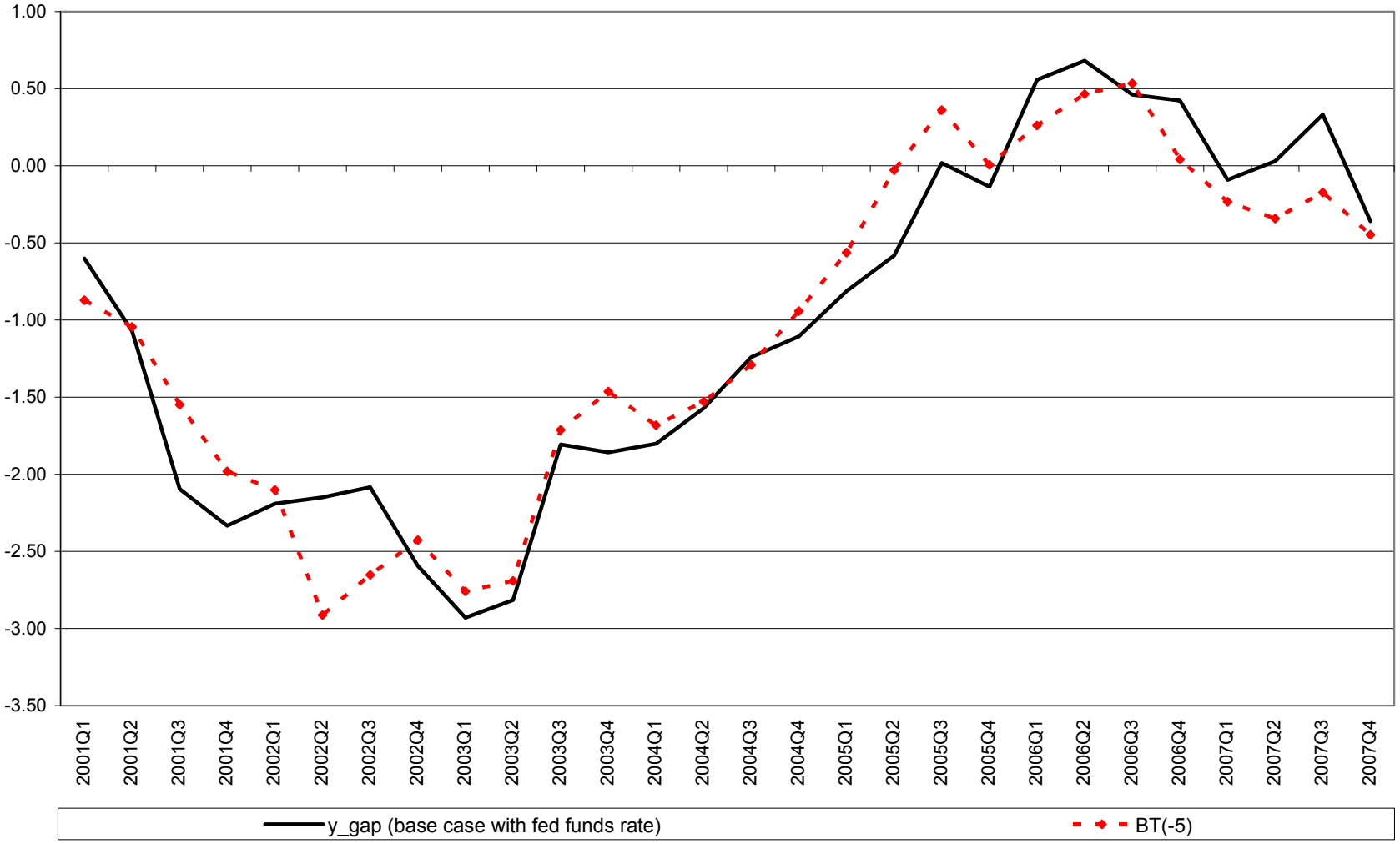
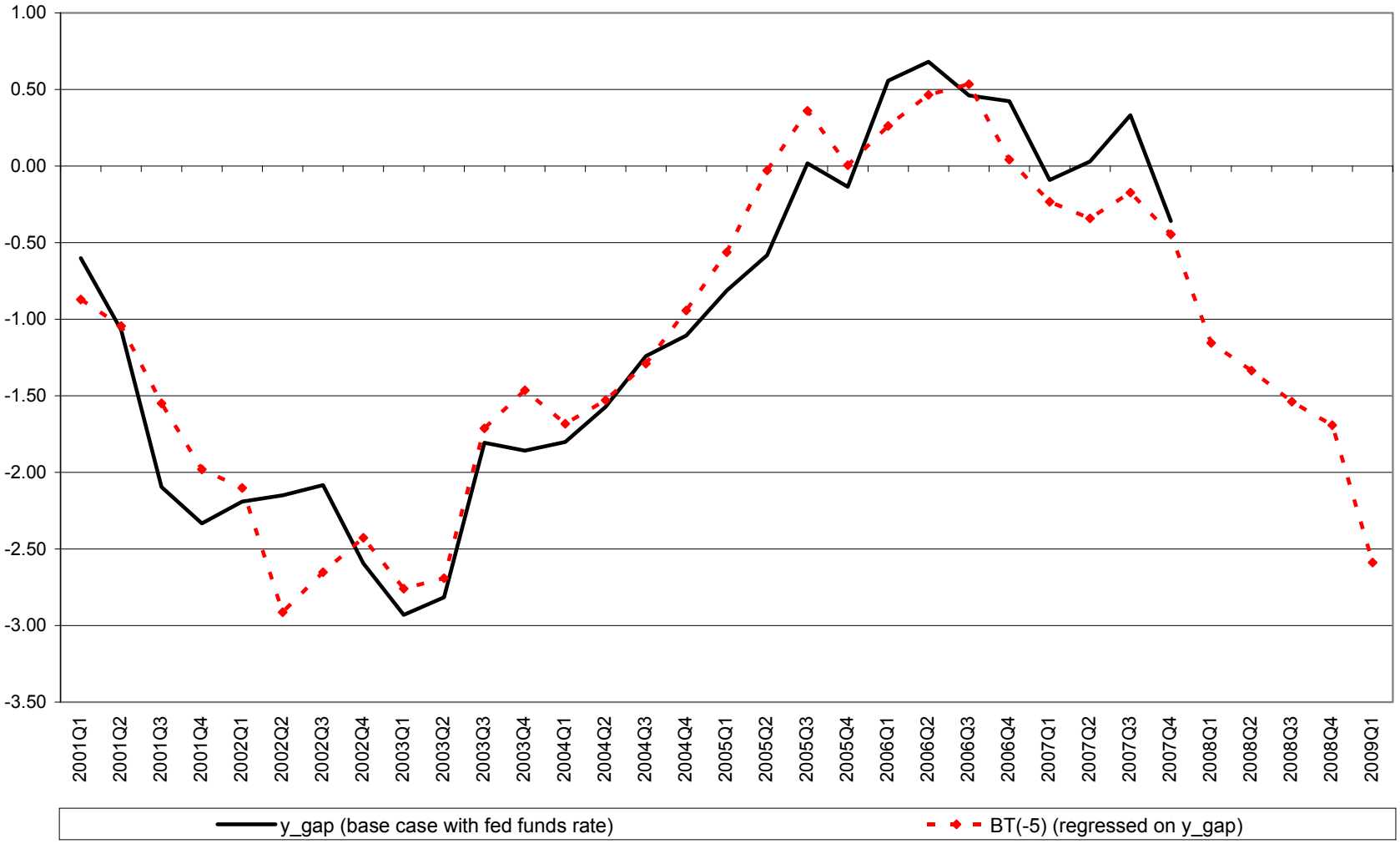


Figure 4: BLT and the Model-Consistent Output Gap



Model Extensions for Macro-financial linkages(1)

$$\begin{aligned} BLT_t - \overline{BLT}_t &= -\kappa y_{t+4} + \eta_t^{BLT} \\ \overline{BLT}_t &= \overline{BLT}_{t-1} + \eta_t^{\overline{BLT}} \end{aligned}$$

- BLT gap ($BLT_t - \overline{BLT}_t$) depends on the expected output gap one year ahead

- BLT index depends on shifts in its equilibrium level ($\overline{BLT}_t$)

Model Extensions for Macro-financial linkages (2)

$$
\begin{aligned}
y_t &= \beta_1 y_{t-1} + \beta_2 y_{t+1} - \beta_3 (rr_{t-1} - \overline{rr}_{t-1}) - \theta(\varepsilon_t^{BLT})) \\
\varepsilon_t^{BLT} &= 0.04(\eta_{t-1}^{BLT} + \eta_{t-9}^{BLT}) + 0.08(\eta_{t-2}^{BLT} + \eta_{t-8}^{BLT}) \\
&\quad + 0.12(\eta_{t-3}^{BLT} + \eta_{t-7}^{BLT}) + 0.16(\eta_{t-4}^{BLT} + \eta_{t-6}^{BLT}) + 0.20\eta_{t-5}^{BLT}
\end{aligned}
$$

- Effect of innovations in BLT equation on output gap ($\theta(\varepsilon_t^{BLT})$)
- Distributed lags of innovations in BLT equation (ε_t^{BLT})

Observable Variables

- CPI, unemployment rate, Fed Funds rate, real GDP, BLT index
- Sample without near-term judgment is 1994q1 to 2007q4
- Compare results with near-term judgment for 2008q1 - 2008q2 and 2008q1 - 2008q4
- Conditional forecast scenarios

Figure 5: Unemployment Rate and Model-Consistent NAIRU

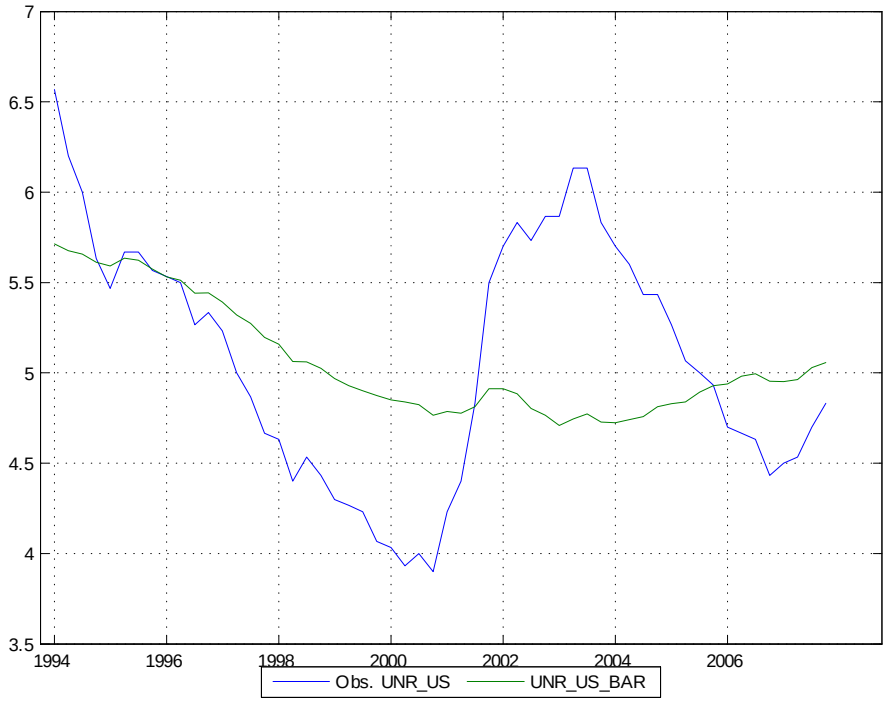


Figure 6: GDP and Model-Consistent Potential GDP

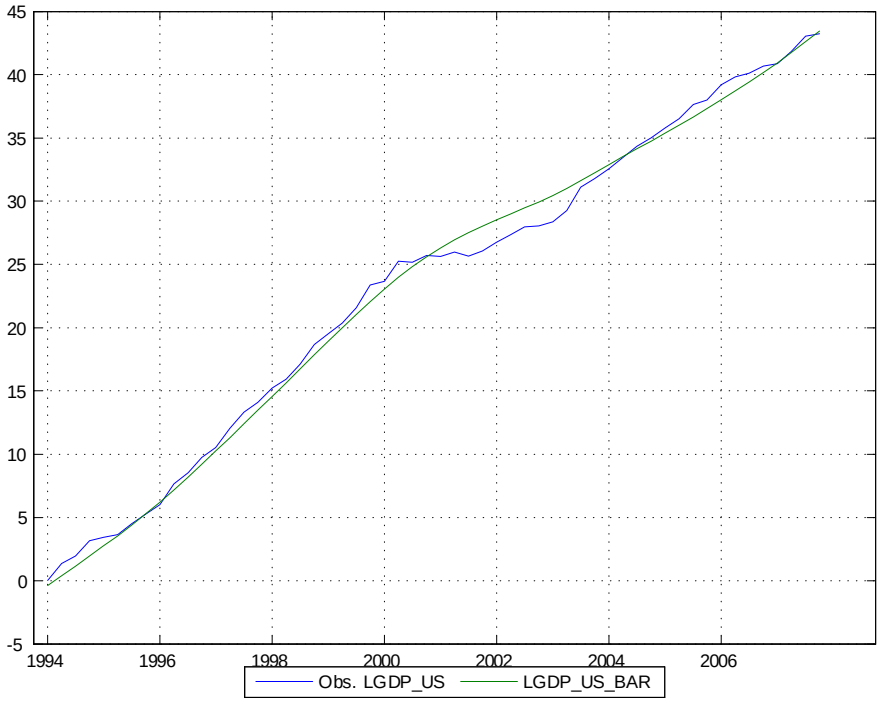


Figure 7: GDP Gap, Unemployment Gap and Inflation

Figure 8: BLT and the Model-Consistent Output Gap

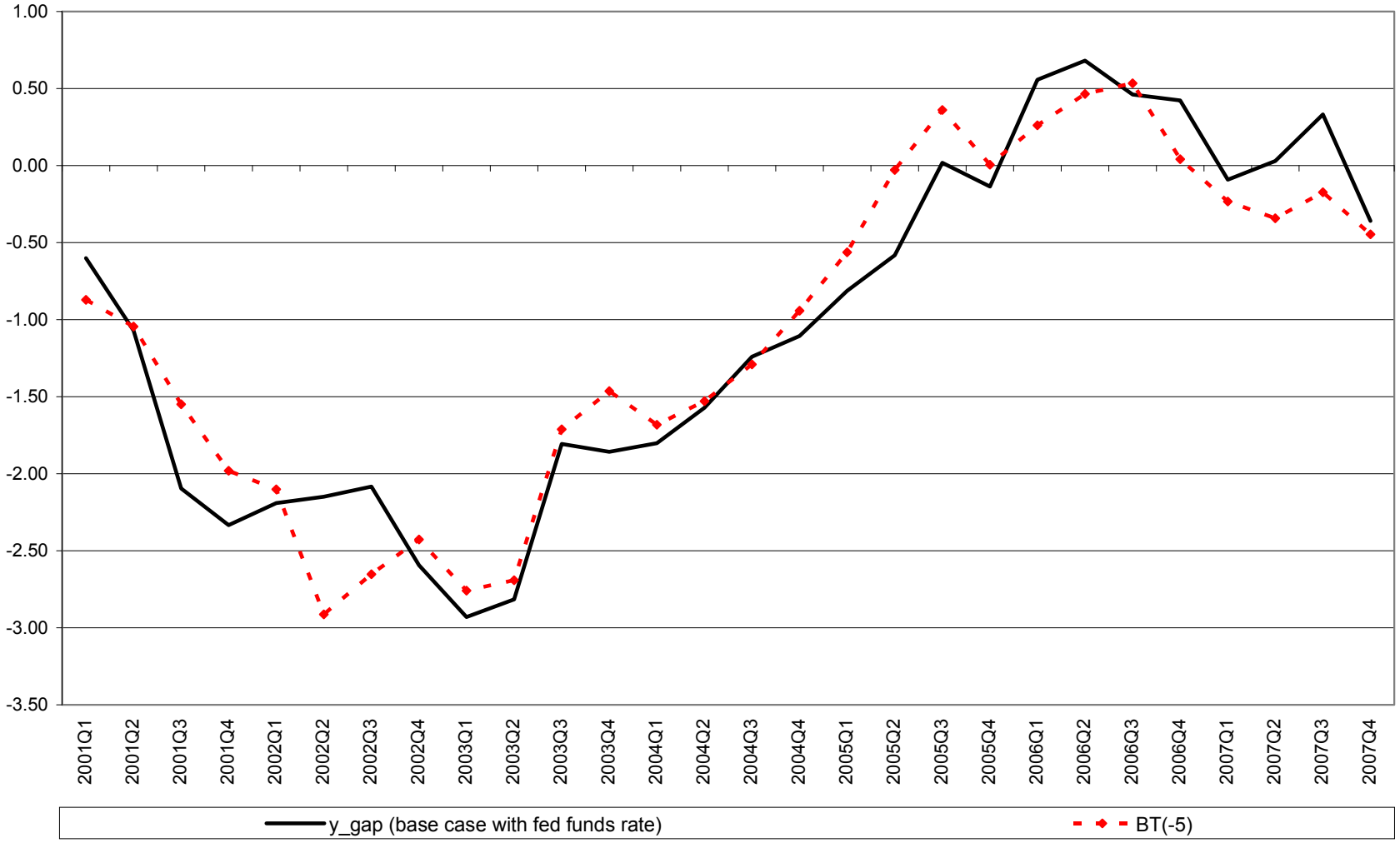
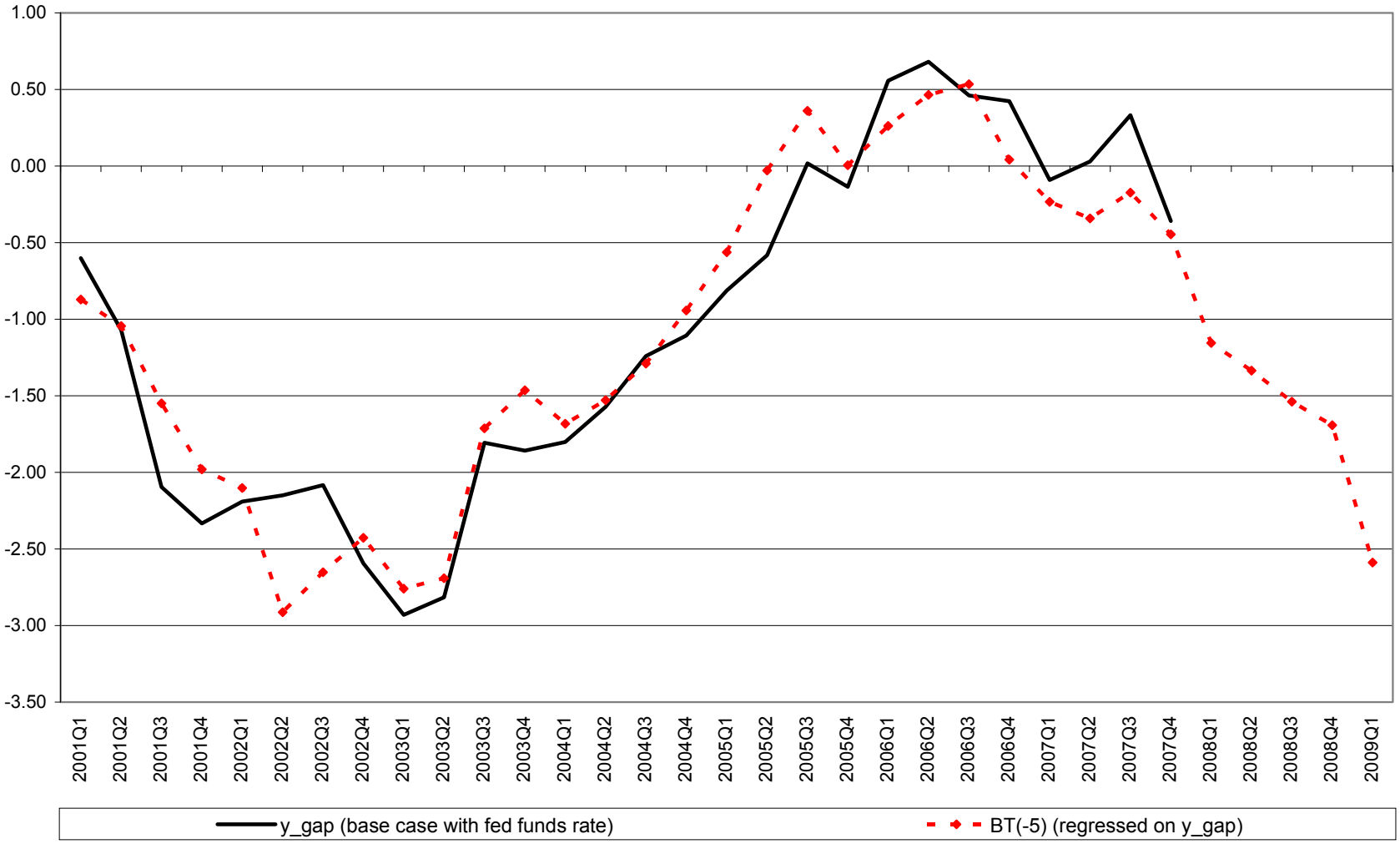


Figure 9: BLT and the Model-Consistent Output Gap



The Properties of the Model

- Posterior Maximization (parameters and standard deviations of structural shocks)

- Analysis of Impulse Response Functions

Table 1: Results from posterior maximization (parameters)

	Prior distribution	Prior mean	Prior s.d.	Posterior mode	s.d.
α_{us1}	beta	0.800	0.1000	0.8800	0.0472
α_{us2}	gamm	0.300	0.2000	0.1700	0.0285
α_{us3}	beta	0.500	0.2000	0.5068	0.2793
$growth\_us\_ss$	norm	2.500	0.2500	2.6189	0.2340
$rr\_us\_bar\_ss$	norm	2.000	0.2000	1.8441	0.1723
ρ_{us}	beta	0.900	0.0500	0.9240	0.0462
τ_{us}	beta	0.100	0.0500	0.0818	0.0376
β_{us1}	gamm	0.750	0.1000	0.6622	0.0556
β_{us2}	beta	0.150	0.1000	0.0494	0.0527
β_{us3}	gamm	0.200	0.0500	0.1404	0.0314
λ_{us1}	beta	0.600	0.1000	0.7471	0.0606
λ_{us2}	gamm	0.200	0.0500	0.1878	0.0385
γ_{us1}	beta	0.500	0.0500	0.7812	0.0254
γ_{us2}	gamm	1.500	0.3000	1.2952	0.2424
γ_{us4}	gamm	0.200	0.0500	0.2134	0.0555
κ_{us}	gamm	20.000	0.5000	19.9651	0.4960
θ_{us}	gamm	1.000	0.5000	1.1032	0.5530

Table 2: Results from posterior maximization (standard deviation of structural shocks)

	Prior distribution	Prior mean	Prior s.d.	Posterior mode	s.d.
$RES\_UNR\_US\_GAP$	invg	0.200	Inf	0.0996	0.0164
$RES\_UNR\_US\_BAR$	invg	0.100	Inf	0.0473	0.0201
$RES\_UNR\_G\_US$	invg	0.100	Inf	0.0449	0.0164
RES_Y_US	invg	0.250	Inf	0.3433	0.0413
$RES\_LGDP\_US\_BAR$	invg	0.050	Inf	0.0230	0.0094
RES_G_US	invg	0.100	Inf	0.3509	0.0894
RES_PIE_US	invg	0.700	Inf	1.2246	0.1162
RES_RS_US	invg	0.700	Inf	0.4533	0.0542
$RES\_RR\_US\_BAR$	invg	0.200	Inf	0.0932	0.0389
RES_BLT_US	invg	0.400	Inf	0.8759	0.3990
$RES\_BLT\_US\_BAR$	invg	0.200	Inf	0.0926	0.0382

Figure 10: *IRF (Demand Shock (ε_t^y))*

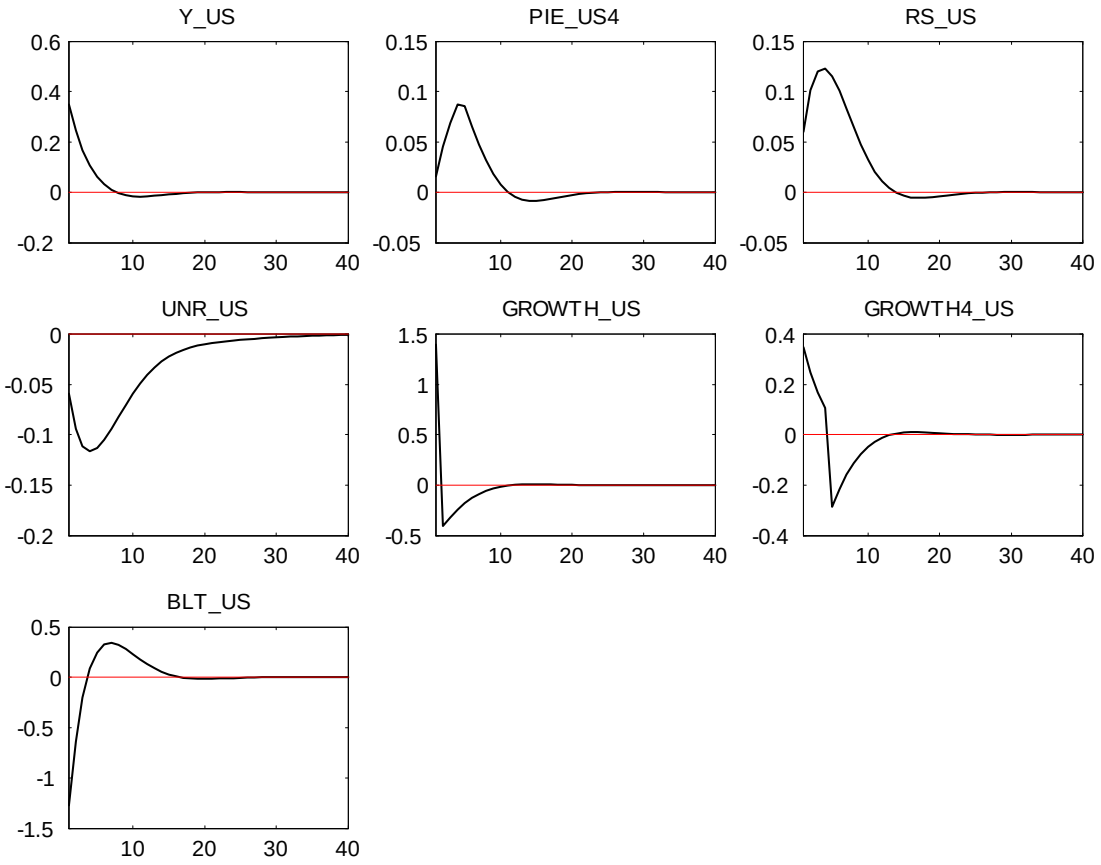


Figure 11: *IRF (Supply Shock (ε_t^{π}))*

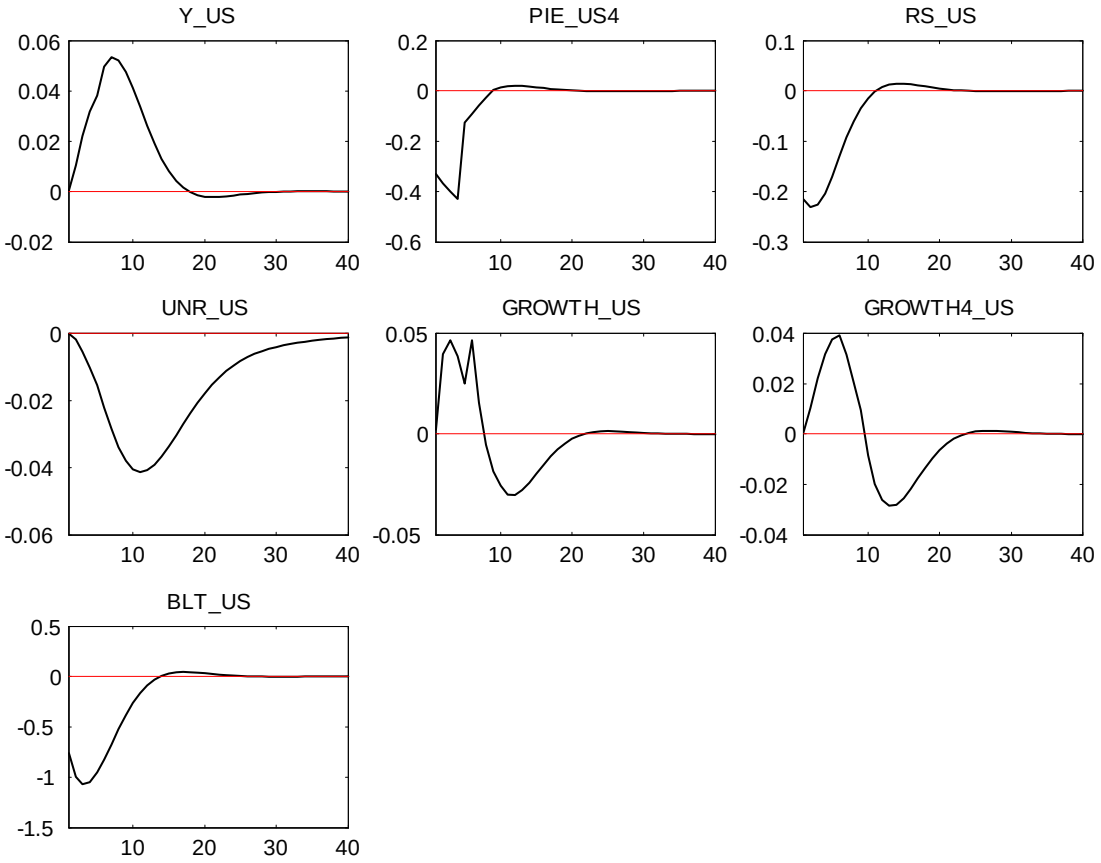


Figure 12: *IRF (Monetary Policy Shock(ε_t^{rs}))*

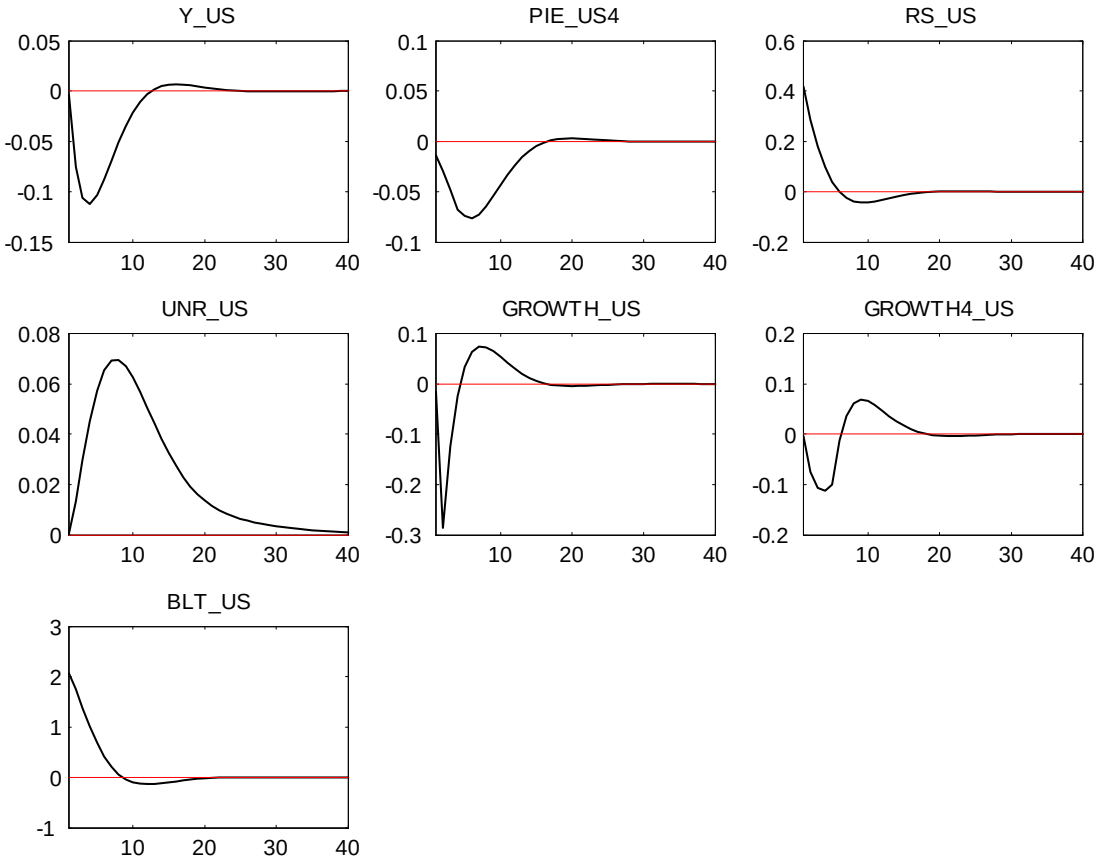


Figure 13: *IRF (BLT Shock(η_t^{BLT}))*

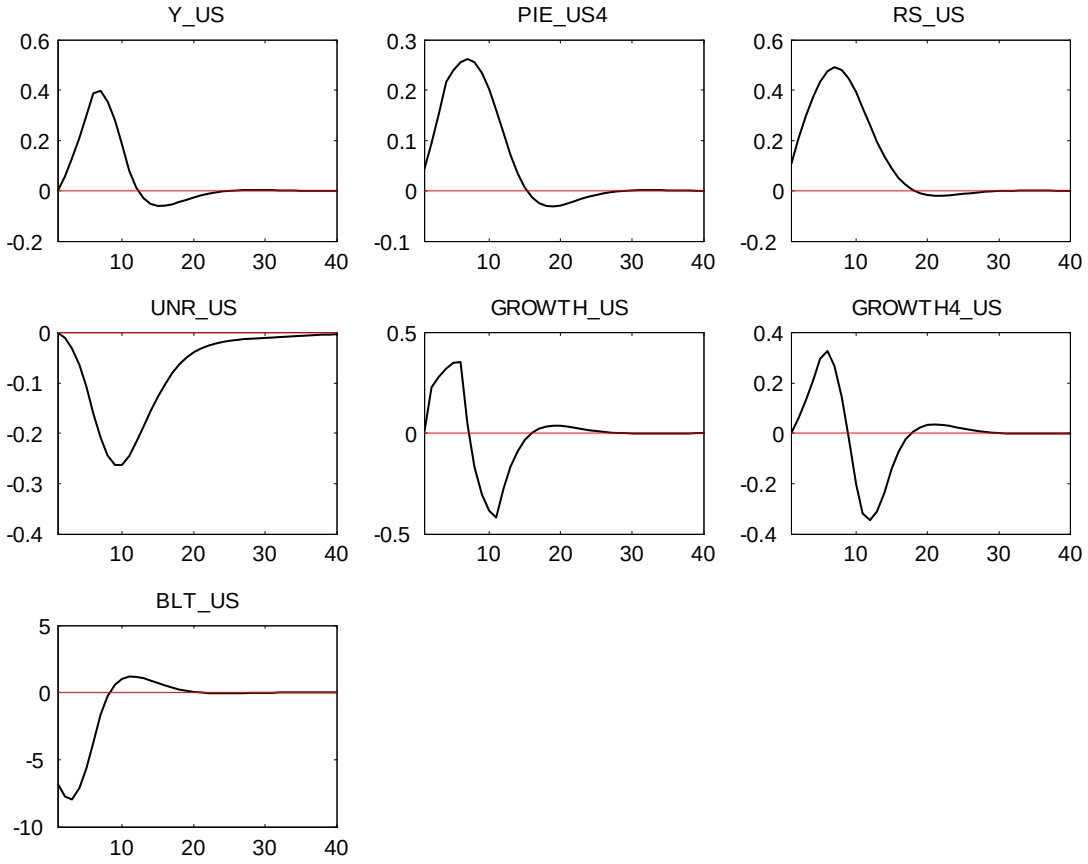
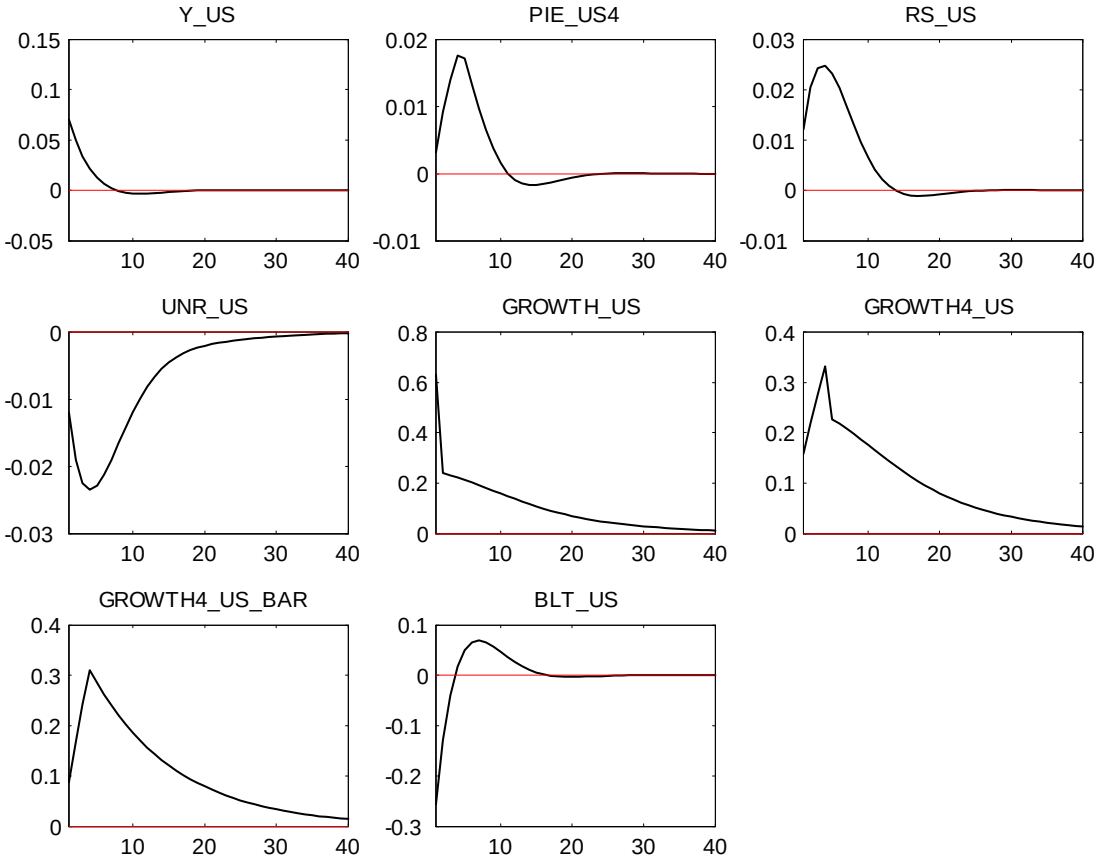


Figure 14: *IRF (Equilibrium Quarterly Growth Rate Shock(ε_t^g))*



The Forecast Analysis

- RMSEs
- Dynamic Forecast
- Fan Chart

Table 3: Base Case Root Mean Square Errors

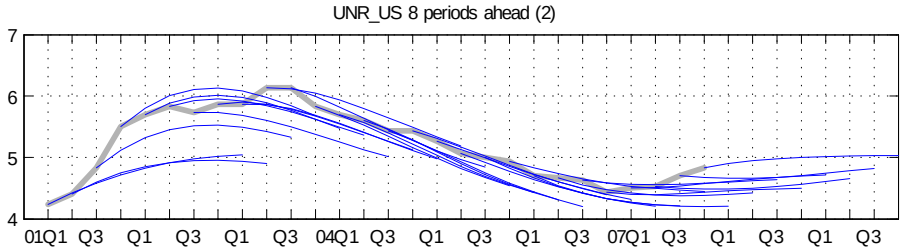
	1 Q Ahead	4 Q Ahead	8 Q Ahead	12 Q Ahead
Y_US	0.63	0.96	1.4	1.6
PIE_US4	0.37	1.1	0.91	0.74
RS_US	0.37	1	1.4	1.8
UNR_US	0.15	0.39	0.75	1.1
UNR_US_BAR	0.19	0.33	0.51	0.65
$GROWTH\_US$	1.9	2.1	2.1	2
$GROWTH4\_US$	0.53	1.2	1.5	1.4
$GROWTH4\_US\_BAR$	0.41	0.65	0.82	0.91

Table 4: BLT Root Mean Square Errors

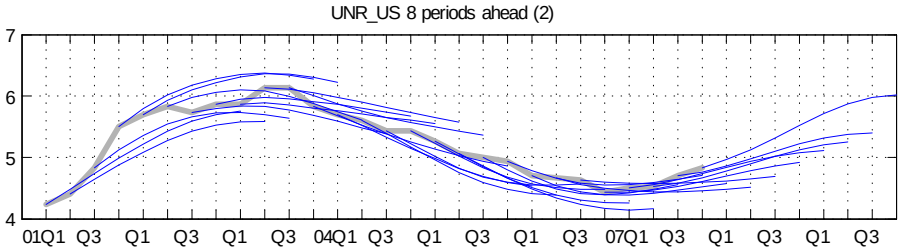
	1 Q Ahead	4 Q Ahead	8 Q Ahead	12 Q Ahead
Y_US	0.43	0.57	0.8	0.91
PIE_US4	0.34	0.74	0.71	0.73
RS_US	0.44	1.1	1.5	1.7
UNR_US	0.15	0.39	0.68	0.89
UNR_US_BAR	0.34	0.4	0.48	0.55
$GROWTH\_US$	1.8	2	2.2	2.1
$GROWTH4\_US$	0.53	1.2	1.6	1.5
$GROWTH4\_US\_BAR$	0.32	0.62	0.92	1

Unemployment Rate Dynamic Forecast

without BLT

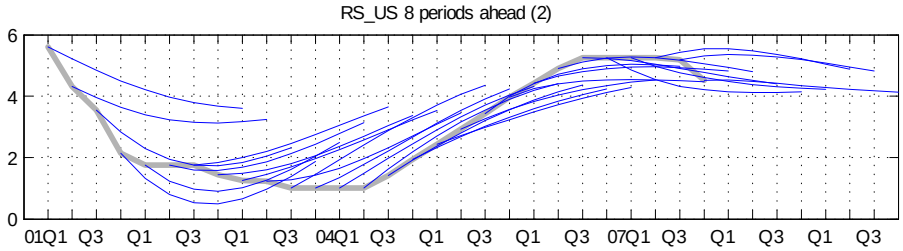


with BLT

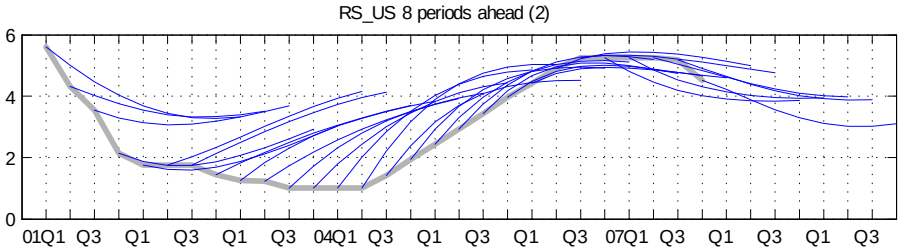


Interest Rate Dynamic Forecast

without BLT

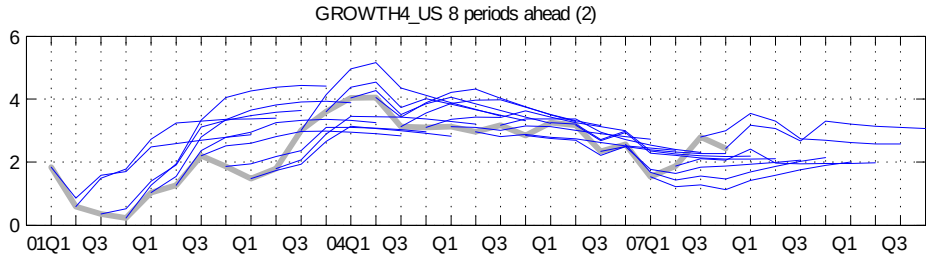


with BLT

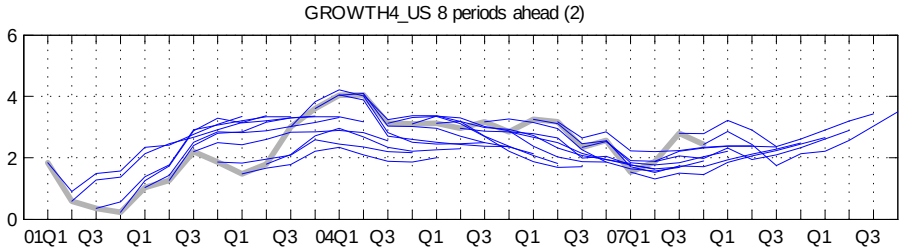


Y-O-Y GDP Growth Rate Dynamic Forecast

without BLT

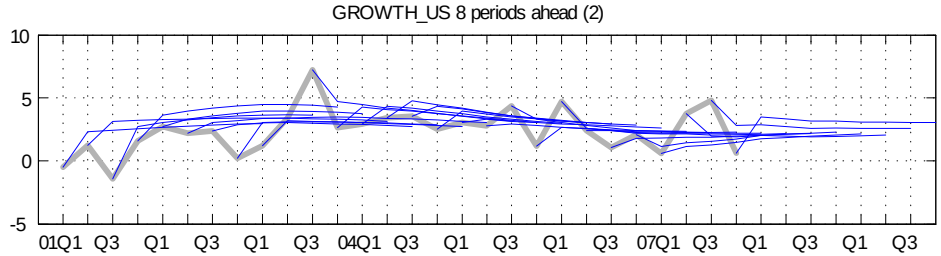


with BLT

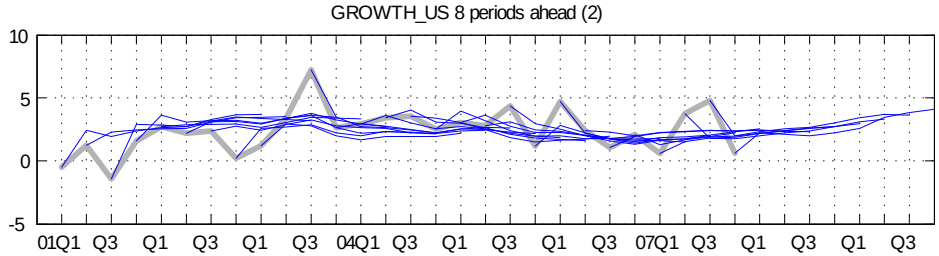


Q-o-Q *GDP Growth Rate Dynamic Forecast*

without BLT

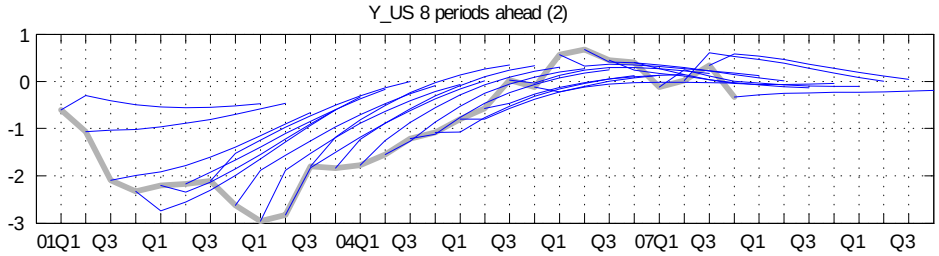


with BLT

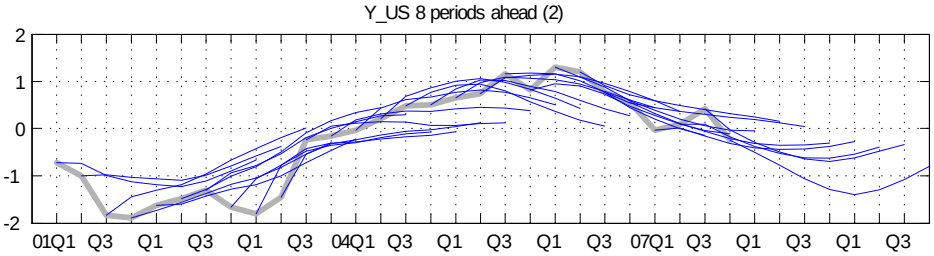


Output Gap Dynamic Forecast

without BLT

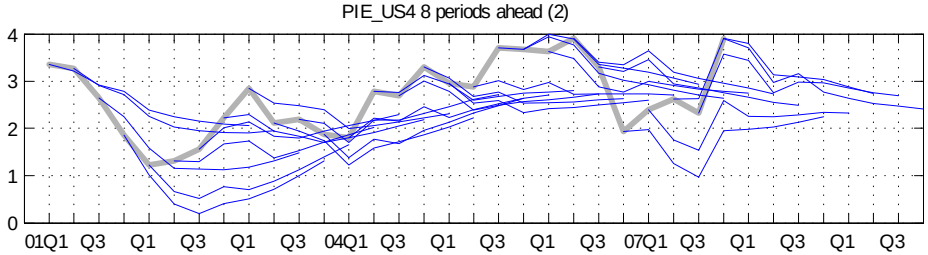


with BLT



Inflation Dynamic Forecast

without BLT



with BLT

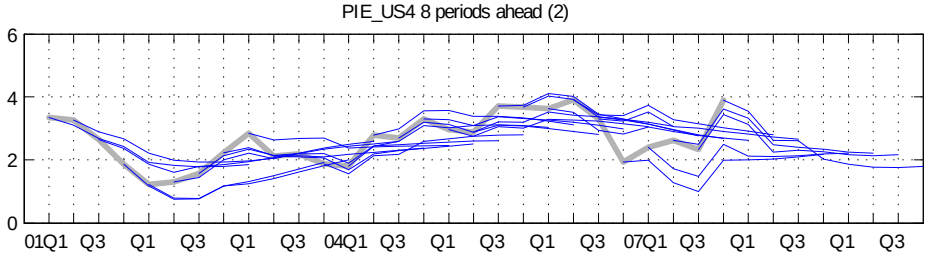


Figure 15: Base-Case Model Baseline Forecast with 50 and 95 Percent Confidence Bands

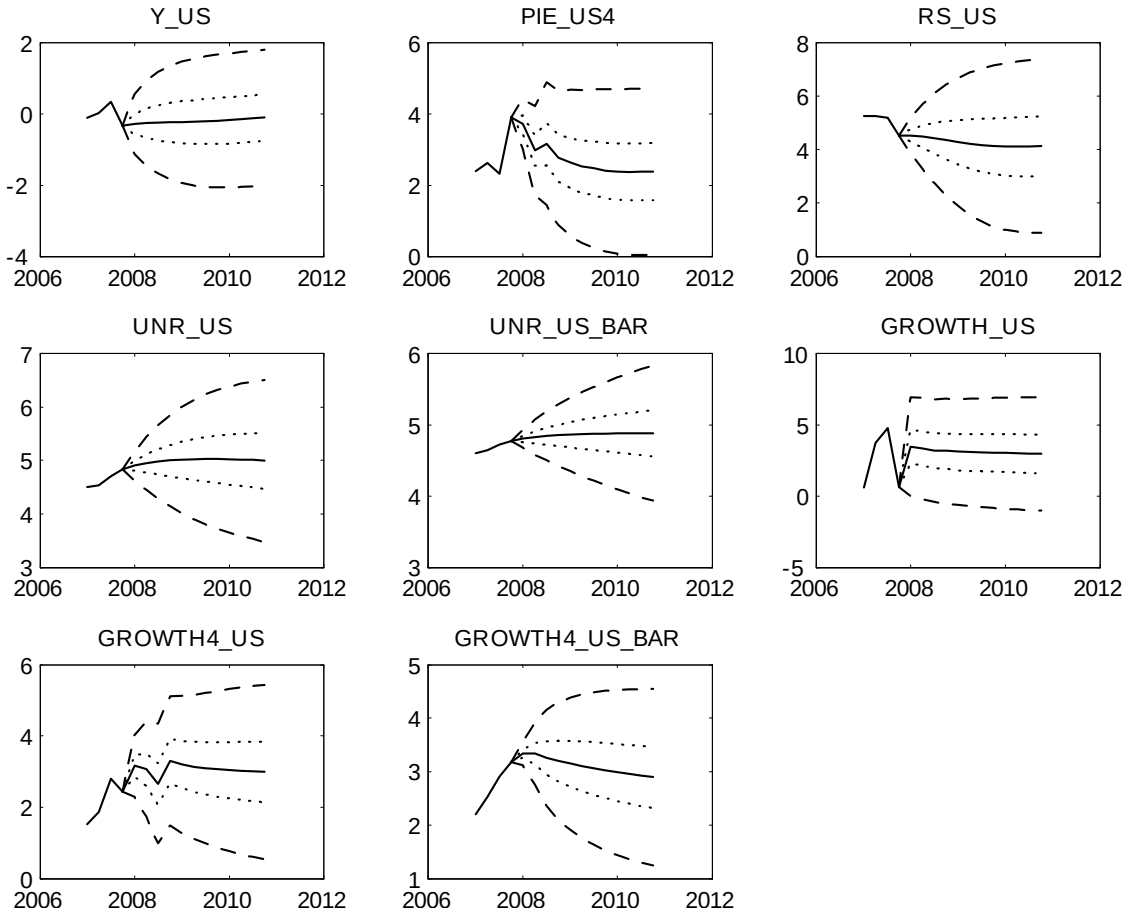


Figure 16: BLT-Case Model Baseline Forecast with 50 and 95 Percent Confidence Bands

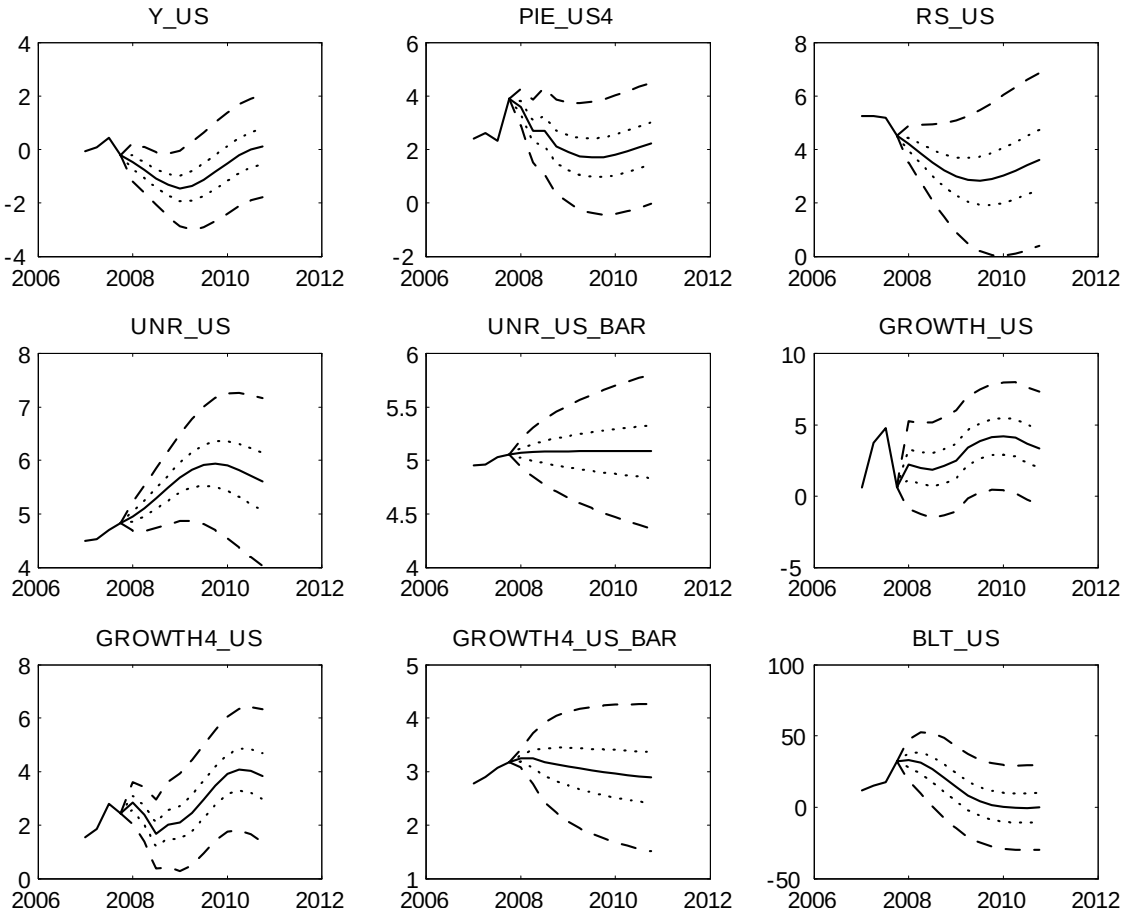


Figure 17: Lower Potential Growth (1.5%)

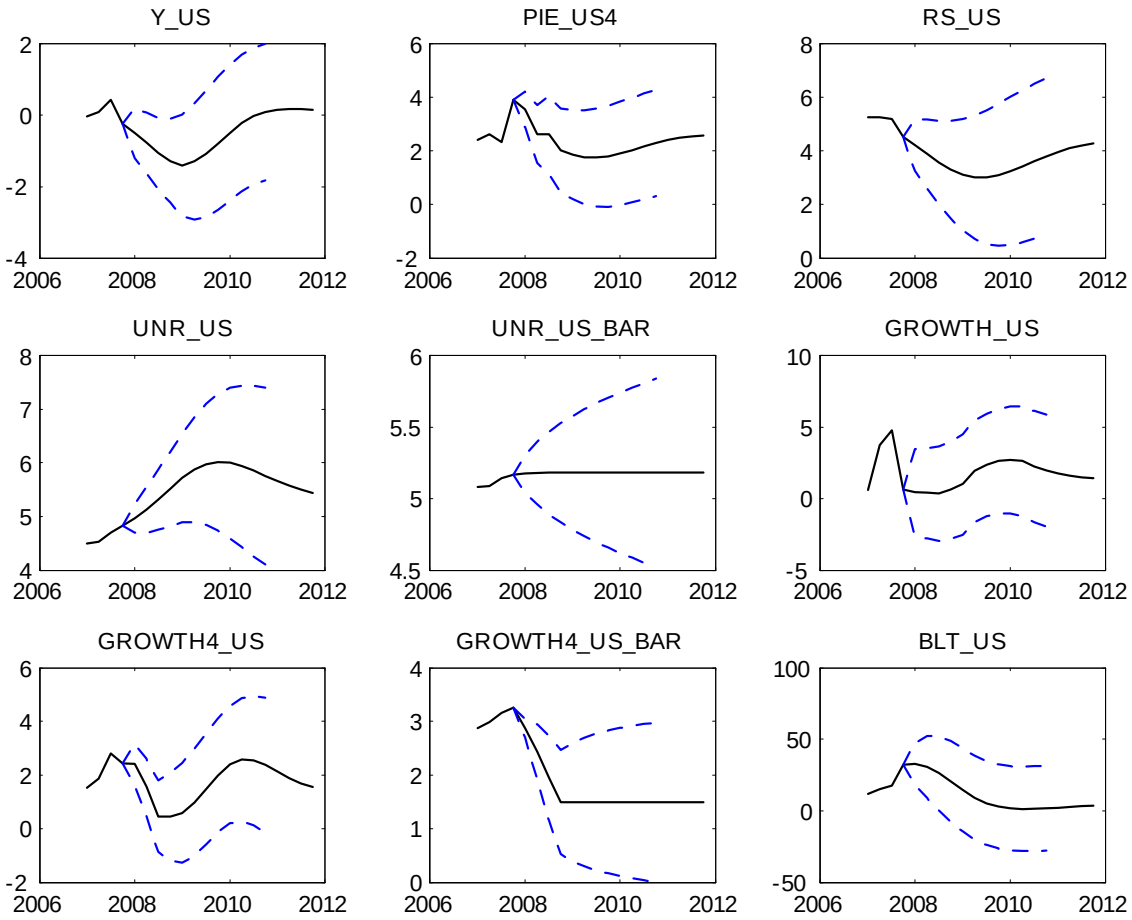


Figure 18: Lower Potential Growth (1.5%), Tuned BT (2008q1-2008q2), and Tuned Flat GDP (2008q1-2008q2)

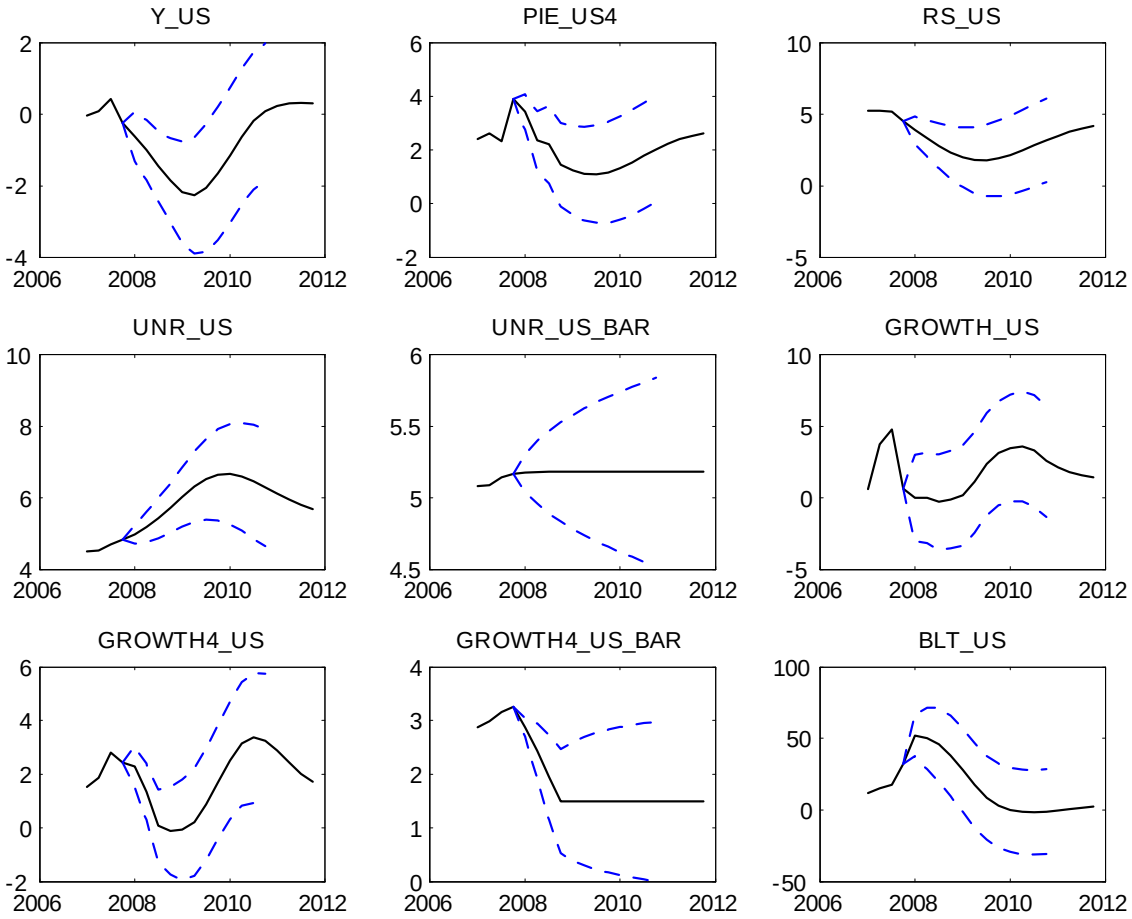


Figure 19: Lower Potential Growth (1.5%), Tuned BT (2008q1-2009q4), and Tuned Flat GDP (2008q1-2008q2)

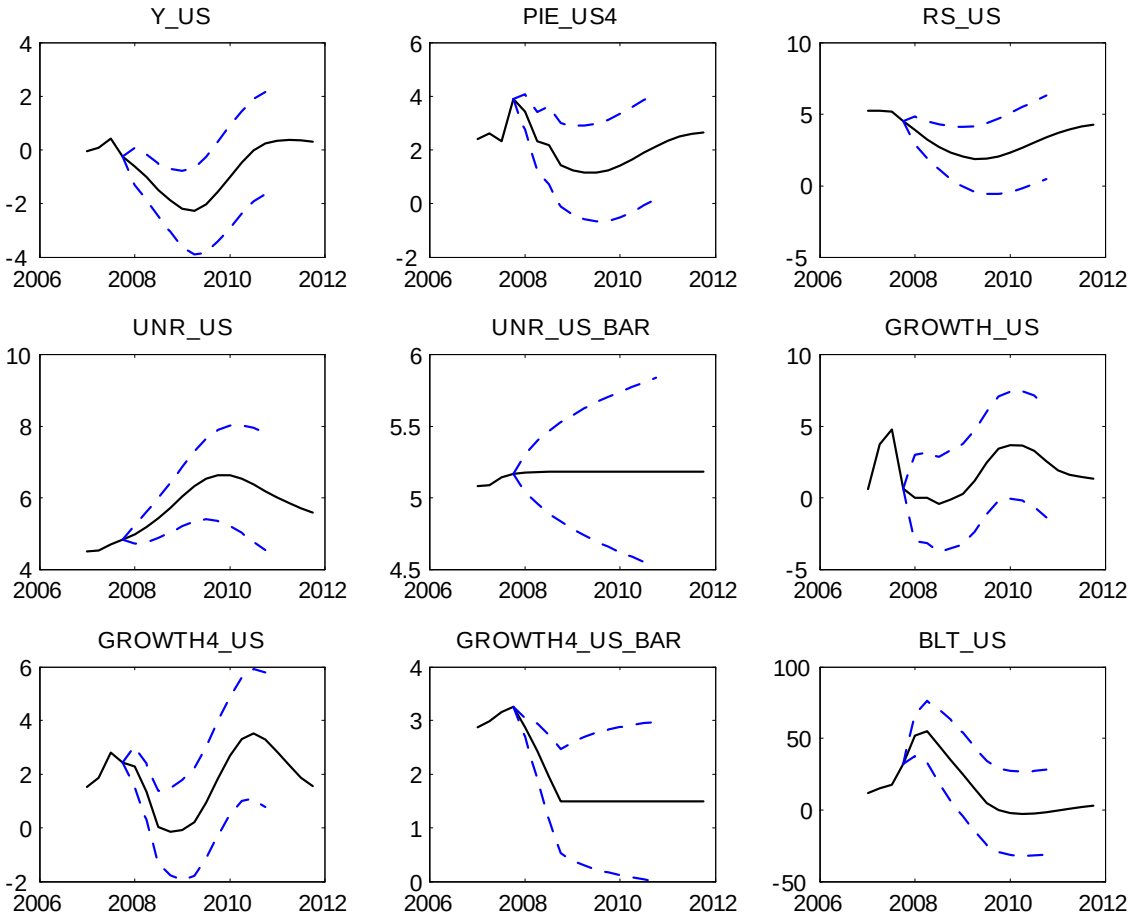


Figure 20: Lower Potential Growth (1.5%), BLT Tuned to Upper Band (2008q1-2009q4), and Tuned Declining GDP (2008q1-2008q2)

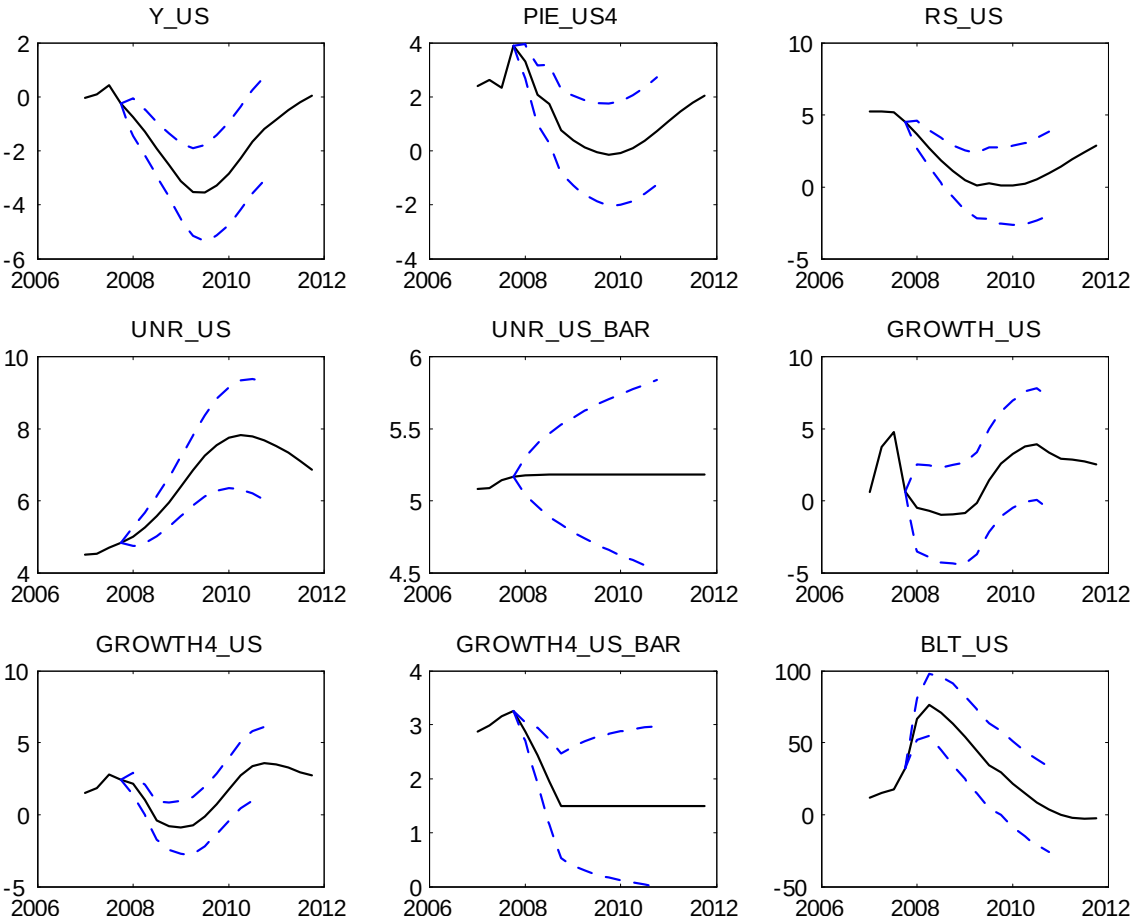


Table 5: Root Mean Square Errors for Base-Case Model (short sample)

	1 Q Ahead	4 Q Ahead	8 Q Ahead	12 Q Ahead
Y_US	0.62	0.96	1.1	0.82
PIE_US4	0.48	1.2	0.99	0.89
RS_US	0.56	1.2	1.3	1.6
UNR_US	0.15	0.41	0.55	0.52
UNR_US_BAR	0.17	0.21	0.23	0.23
$GROWTH\_US$	1.7	1.6	1.5	1.3
$GROWTH4\_US$	0.56	0.77	0.55	0.61

Table 6: Root Mean Square Errors for BLT-Case Model (short sample)

	1 Q Ahead	4 Q Ahead	8 Q Ahead	12 Q Ahead
Y_US	0.45	0.72	0.93	0.47
PIE_US4	0.46	1	0.77	0.81
RS_US	0.53	1.3	1.6	1.6
UNR_US	0.14	0.41	0.53	0.45
UNR_US_BAR	0.13	0.16	0.15	0.15
$GROWTH\_US$	1.8	1.4	1.5	1.3
$GROWTH4\_US$	0.62	0.74	0.51	0.66

Conclusion and Next Extension

- Results challenge simple models that assume that the policy rate, GDP, inflation, and unemployment contain sufficient information for measuring and predicting business cycles.

- Add risky spreads and asset prices.

- Some preliminary results extending the results to a 2-country version (U.S. and euro area are encouraging), but will require some technological innovation in DYNARE as the BLT variable for the euro area only goes back to 2003.