The Information Content of News Announcements

Burçin Kısacıkoğlu

Bilkent University
Department of Economics
Conference on Real-Time Data Analysis, Methods and Applications
Bank of Spain

Introduction

- Asset prices move sharply around macro announcements
- Understanding financial market responses to macroeconomic news is important for policy, private sector and academics.

Typical Interpretation of Jumps in Yields

Change in non-farm payrolls is lower than expected :

> “ Treasury bonds strengthened on Friday as a smaller-than-expected increase in October nonfarm payrolls bolstered expectations that the Federal Reserve would be in no hurry to raise official interest rates.” - WSJ, 11/7/2014

> “As for the market, ... the quick drop in bond yields, which move inversely to prices, was a commentary on expectations for the economy. ” - CNBC, 10/2/2015

Introduction

- Typical interpretation has two features:
  - Based on some conventional macro model.
  - Gives little if any role to changing term premia.

Issues

- Not checked whether the stories we tell for bond yield jumps are consistent with the models we derive the stories from.
- No reason to think term premia are fixed around macro news.

My Questions

- Are the market moves collectively consistent with the models we use to interpret them?
- If so, do changing term premia play a role

Quick Answers

- Are the market moves collectively consistent with the models we use to interpret them?

  Yes.

- If so, do changing term premia play a role

  Term premia are often at least half of the story.

Building Blocks

1. Macro Model
2. Imperfect information about the state of the economy
3. No-arbitrage term structure model with macro factors
4. Estimate the model by keeping track of the days of information arrival.

Macro Model

- Simple three-equation new Keynesian model:
  - IS curve
  - Phillips curve
  - Short rate equation

The Model

- Representative household has CRRA utility function with habit formation and a preference shock:

$$\frac{(C_t H_t^{\eta})^{(1-\gamma)}}{1-\gamma} Q_t - \frac{N_t^{(1+\varphi)}}{1+\varphi}$$

  H_t: Habit formation ($H_t = C_{t-1}$)

  Q_t: Preference shock

- Key variable: Q_t.

The Model

- Typical specification of preference shocks helps us fit macro variables.
  - Baxter and King (1991), Ireland (2004), Smets and Wouters (2005,2007)
- However doesn't help with risk premia.
  - In power utility models, volatility of marginal utility is far too low to explain average risk premia on assets.

Time varying risk premia

- Shocks to Q_t raise the volatility of marginal utility.
  - Q_t loads linearly on output and inflation shocks.
  - To capture time-varying risk premia, model has time-varying sensitivity of Q_t to shocks.
- Preference shocks capture:
  - Sentiment shocks
  - Demand for safe and liquid assets
  - Higher demand from foreign central banks

math

The Model

- Monopolistically competitive firms:
  - A fraction of the firms set prices following the Calvo mechanism and the rest follow a “rule of thumb” (Gali and Gertler (1999)).
  - Identical Cobb-Douglas production function with labor.
  - Aggregate technology: $a_t = \rho a_{t-1} + \varepsilon_t^a$

Policy

- Short rate is set to minimize the following loss function:

$$L_t = E_t \left[\sum_{k=0}^{\infty} \beta^k [\lambda_y (y_{t+k} - \bar{y}_{t+k})^2 + (\pi_{t+k} - \pi^*_{t+k})^2 + \lambda_i (i_{t+k} - i_{t+k-1})^2 \right]$$

- Potential output:

$$\bar{y}_t = \bar{a} y_{t-1} + \bar{b} a_t + \bar{c} q_t$$

- Long run inflation follows an AR(1) process:

$$\pi^*_t = \rho_{\pi^*} \pi^*_{t-1} + \varepsilon^{\pi^*}_t$$

- The IS curve:

$$y_t = \mu E_t y_{t+1} + (1-\mu) y_{t-1} - \chi(i_t - E_t \pi_{t+1} + E_t \Delta q_{t+1}) + \varepsilon_t^y$$

- The Phillips curve:

$$\pi_t = \alpha E_t \pi_{t+1} + (1-\alpha)\pi_{t-1} + \kappa mc_t + \varepsilon_t^\pi$$

$$mc_t = (\gamma + \varphi) y_t + (\eta - \eta\gamma) y_{t-1} + (1+\varphi) a_t - q_t$$

Perfect Information Solution

- If the agents (households, investors and policy makers) observe the true state of the economy the solution is:

$$X_t = \Gamma X_{t-1} + \Sigma \varepsilon_t$$

  X_t: State of the economy

  ε_t : Structural shocks

- Decision rules depend on the true state.

Imperfect Information

- Agent's cannot observe the state perfectly.
- They observe an announcement or a survey at time t.
  - Announcements and surveys are noisy signals of the truth.
  - Agents estimate the state of the economy using the new information (i.e. Kalman filter setup).
- Decision rules depend on the optimal estimate of the state.

infoset

Imperfect Information Solution

- The solution under imperfect information is:

$$\begin{bmatrix} X_t \\ X_{t|t} \end{bmatrix} = \Phi \begin{bmatrix} X_{t-1} \\ X_{t-1|t-1} \end{bmatrix} + \Psi \begin{bmatrix} \varepsilon_t \\ v_t \end{bmatrix}$$

X_t: True state of the economy

$X_{t|t}$: Optimal estimate of the true state

ε_t : Structural shocks

v_t : One-step ahead prediction errors

system

Evolution of $X_{t|t}$

- What is left is to describe how the perceived state evolves.
- Standard Kalman updating framework.

Observation Equation

- Measurement equation for announcements/surveys:

$$Z_t^{j,m} = DX_t + u_t^{j,m}$$

D picks up the element of the state is being announced.

$j \in \{GDP, CPI, Nonfarm\}$

$m \in \{Survey, Announcement\}$

σ_u^2 varies by topic (GDP vs. CPI vs. Nonfarm) and by type (announcement vs. survey).

Observation Equation

- Measurement equation for bond yields:

$$\mathcal{Y}_t^O = \mathcal{Y}_t + u_t^{\mathcal{Y}}$$

$\mathcal{Y}_t^O$: Observed yields

$\mathcal{Y}_t$: True yields

$u_t^{\mathcal{Y}}$: Vector of measurement errors

Treatment of Information

- Suppose news arrives at time t.
- There will be a surprise relative to what was expected in both the macro news and yields.
  - $u_t^{j,m}$ and $u_t^{\mathcal{Y}}$ from previous slides.
- The update in the perceived state vector will be linear in the news:

$$X_{t|t} = X_{t|t-1} + K \begin{bmatrix} u_t^{j,m} \\ u_t^{\mathcal{Y}} \end{bmatrix}$$

where K is the Kalman gain.

Closing the Model

- Linear decision rule for central bank:

$$i_t = FX_{t|t}$$

state

Details on Bond Pricing

- Zero coupon bond pricing:

$$1 = E_t[M_{t+1} R_{t+1}]$$

where $R_{t+1} = \frac{p_{t+1}^{(n-1)}}{p_t^{(n)}}$

- Model implied log-linear nominal stochastic discount factor (SDF):

$$m_{t+1} = \log\beta - \gamma\Delta c_{t+1} + (\gamma\eta - \eta)\Delta c_t - \pi_{t+1} + \Delta q_{t+1}$$

- Log of bond prices are an affine function of the state:

$$\log p_t^{(n)} = A_n + B_n \bar{X}_t$$

where $\bar{X}_t = [X_t, X_{t|t}]'$

Data

- Macro announcements and surveys:
  - GDP growth (advance), core CPI and non-farm payrolls.
- Yields:
  - 1-month, 1-year, 2-year, 5-year, 7-year and 10-year nominal zero coupon bonds.
- Inflation expectations:
  - 5-10 year ahead inflation forecasts from Blue Chip.
  - Missing Blue Chip forecasts are interpolated using Michigan Household Survey via Kalman filter.

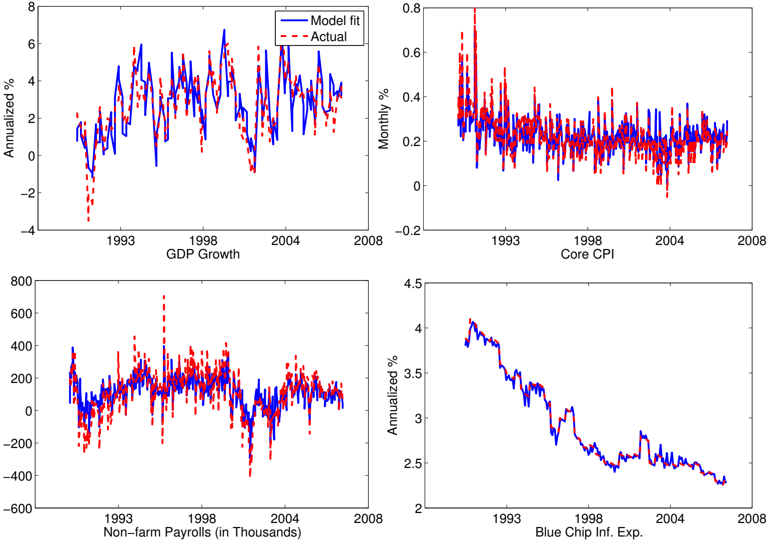
Estimation

- Estimate the model using Bayesian methods. priors1 priors2
  - Mixed frequency
- Pay close attention to the days of macro news releases along with associated bond yields.

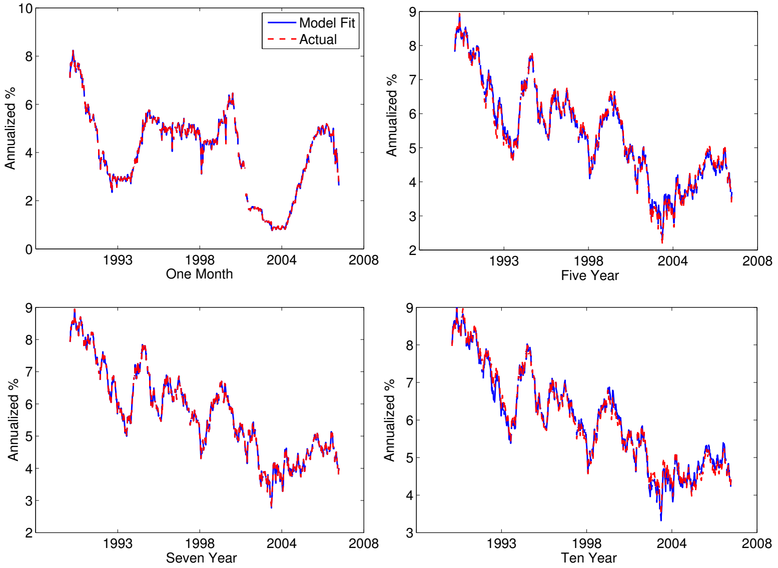
Question #1

Are the market moves collectively consistent with the models we use to interpret them?

Model Fit


Model fit
Actual
Annualized %
GDP Growth
Monthly %
Core CPI
Non–farm Payrolls (in Thousands)
Annualized %
Blue Chip Inf. Exp.
1993
1998
2004
2008

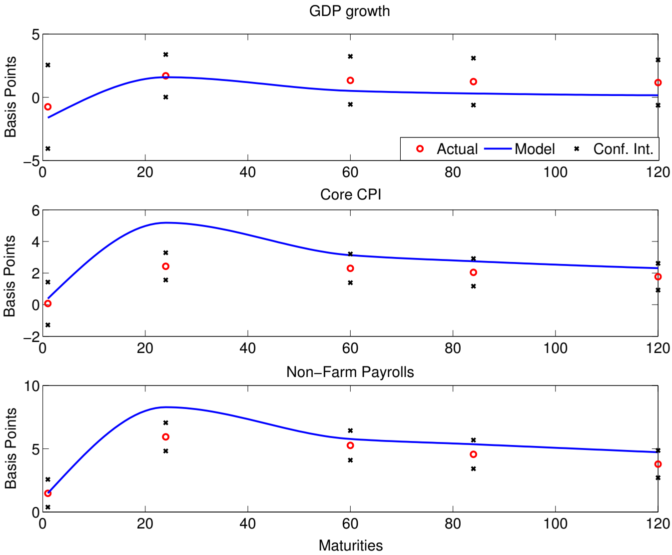
Model Fit


Model Fit
Actual
Annualized %
One Month
Five Year
Seven Year
Ten Year
1993
1998
2004
2008

Event Study vs. Model Implied Responses

- Can the model match average responses of bond yields around announcements?
- Event study:
  - Regress bond yield changes around announcements on surprises. (Fleming and Remolona (1999), Beechey and Wright (2009))

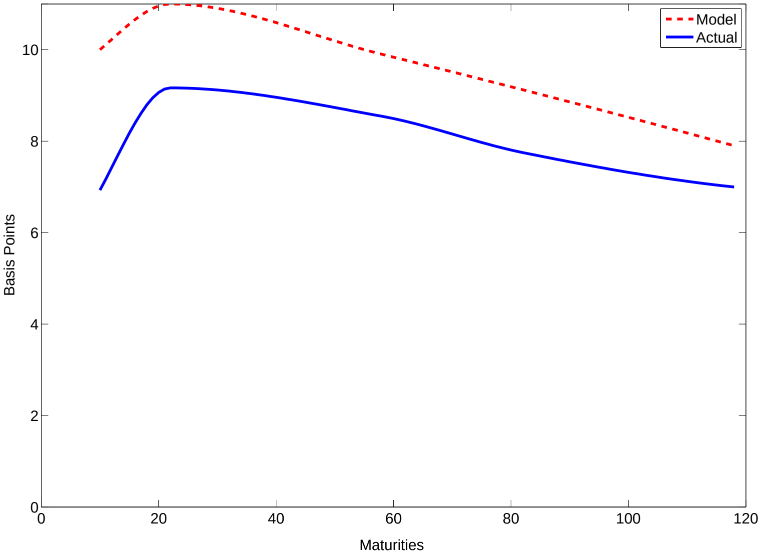
Event Study vs. Model Implied Responses



Volatility of Yield Changes Around News

- Empirical fact:
  - Term structure of interest rate volatility associated with macro news has a hump-shaped pattern. (Fleming and Remolona (1999), Kim and Wright (2015))
- Can the model match this empirical fact?

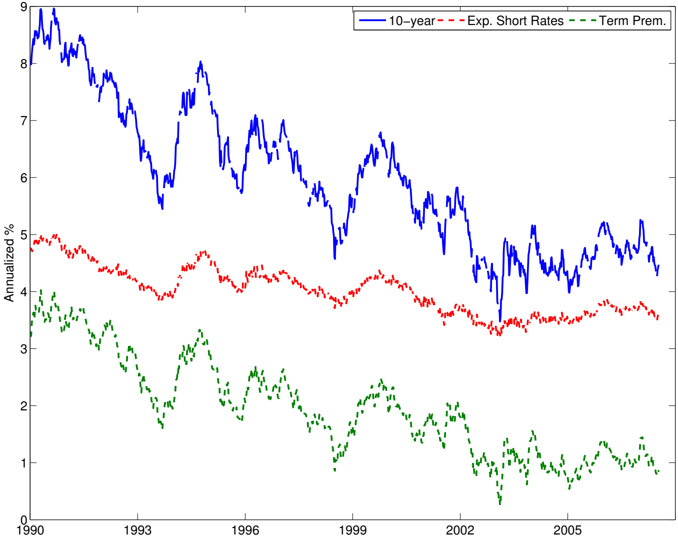
Volatility of Yield Changes Around Nonfarm Payrolls



Question #2

Do changing term premia play a role?

Long Term Bond Yield Decomposition



Variance Decomposition around News

- What is the decomposition of yield reactions into news about expected future short rates and shocks to term premia?
  - Do they vary with macro news?

Variance Decomposition around News

	std(Δ10-year)	std(ΔExp)	std(ΔTP)	corr(ΔExp , ΔTP)
GDP	7	5	5	0.12
Core CPI	6	4	5	-0.07
Non-farm	9	5	5	0.51

Conclusion

- First paper to analyze effects of announcements on bond yields in a structural macroeconomic model.
- Model can match yields and macro news.
- Conventional expectations only interpretations miss half the story.

State Variables

$$X_{1,t} = \begin{bmatrix} a_t & y_{t-1} & \pi_{t-1} & n_{t-1} & \varepsilon_t^y & \varepsilon_t^\pi & \pi_{t-1}^* & \pi_{t-1}^* & \varepsilon_t^* & i_{t-1} \\ \Delta i_{t-1} \end{bmatrix}$$

$$X_{2,t} = \begin{bmatrix} y_{t-2} & y_{t-3} & y_{t-4} & y_{t-5} & y_{t-6} & b_t & q_t \end{bmatrix}$$

$$X_t = \begin{bmatrix} X_{1,t} & X_{2,t} \end{bmatrix}'$$

signal

System

$$X_t = HX_t + JX_{t-1|t-1} + C\varepsilon_t$$

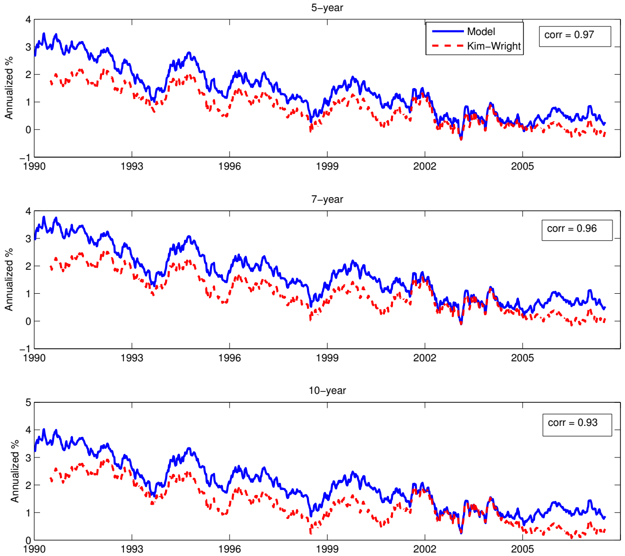
$$x_t = G^1 X_t + (G - G^1)X_{t|t}$$

$$X_{t|t} = X_{t|t-1} + K[Z_t - LX_{t|t-1}]$$

$$Z_t = LX_t + v_t^Z$$

$$\mathcal{Y}_t = T_1 X_t + T_2 X_{t|t} + v_t^{\mathcal{Y}}$$

transition


5−year
Model
Kim−Wright
corr = 0.97
Annualized %
7−year
corr = 0.96
Annualized %
10−year
corr = 0.93
Annualized %
1990
1993
1996
1999
2002
2005

Information Set

- The CB can observe relevant macroeconomic variables (output, inflation and employment) with a lag.
- Inflation and employment are sampled monthly:
  - Announcement at time t is news about $t-1$.
- Output growth is sampled quarterly:
  - Announcement at time t is news about the previous quarter growth rate:

$$\Delta y^{Q}_{t-1} = \sum_{i=t-3}^{t-1} y_i - \sum_{i=t-6}^{t-4} y_i$$

imperfectinfo

Priors and Posteriors

	Prior mode	Prior Std. Dev.	Dist.	Post. mean	Post. Std. Dev.
γ	2	0.1	Normal	1.64	0.0353
φ	5	1	Normal	5.14	0.0217
η	1	0.05	Normal	1.01	0.0234
θ	0.9	0.1	Beta	0.94	0.0558
ω	0.3	0.05	Beta	0.17	0.0247
β	0.99	0.03	Beta	0.98	0.0135
ρ	0.5	0.15	Beta	0.51	0.0349
λ_y	0.5	0.1	Beta	0.46	0.0083
λ_i	0.5	0.1	Beta	0.54	0.0137
ρ_{π^*}	0.95	0.01	Beta	0.93	0.0394
ϕ_1	-	-	Uniform(0,∞)	1.02	0.06
ϕ_2	-	-	Uniform(0,∞)	0.94	0.05
ρ_b	0.95	0.01	Beta	0.95	0.0366
σ_a	-	-	Uniform(0,∞)	0.21	0.096
σ_y	-	-	Uniform(0,∞)	0.12	0.0928
σ_π	-	-	Uniform(0,∞)	0.29	0.01
σ_{π^*}	0.01	0.01	Inverse Gamma	0.4	0.04
σ_b	0.01	0.01	Inverse Gamma	0.09	0.038

Data

Priors and Posteriors

	Prior mode	Prior Std. Dev.	Dist.	Post. mean	Post. Std. Dev.
$\sigma_y^{v,cb} \times 12$	-	-	Uniform(0,σ_y)	0.8	0.02
$\sigma_\pi^{v,cb}$	-	-	Uniform(0,σ_π)	0.03	0.003
$\sigma_n^{v,cb} \times 1000$	-	-	Uniform(0,σ_n)	72	3.2
$\sigma_{\pi^*}^{v,cb} \times 12$	0.013	0.1	Inverse Gamma	0.3	0.0032
$\sigma_y^v \times 12$	-	-	Uniform(0,σ_y)	1.6	0.08
σ_π^v	-	-	Uniform(0,σ_π)	0.05	0.0032
$\sigma_n^v \times 1000$	-	-	Uniform(0,σ_n)	132	6.1
$\sigma_{\pi^*}^v \times 12$	0.013	0.1	Inverse Gamma	0.44	0.01
$\sigma_{y,survey}^v \times 12$	-	-	Uniform(0,σ_y)	1.09	0.0099
$\sigma_{\pi,survey}^v$	-	-	Uniform(0,σ_π)	0.01	0.007
$\sigma_{n,survey}^v \times 1000$	-	-	Uniform(0,σ_n)	28	0.3
$\sigma_{y^{1m}}^v \times 1200$	10 bps	0.1	Normal	10 bps	0.46
$\sigma_{y^{1y}}^v \times 1200$	10 bps	0.1	Normal	7 bps	0.022
$\sigma_{y^{2y}}^v \times 1200$	10 bps	0.1	Normal	6 bps	0.03
$\sigma_{y^{5y}}^v \times 1200$	10 bps	0.1	Normal	8 bps	0.02
$\sigma_{y^{7y}}^v \times 1200$	10 bps	0.1	Normal	1 bps	0.0046
$\sigma_{y^{10y}}^v \times 1200$	10 bps	0.1	Normal	9 bps	0.03

Data

- Assume a functional form for the preference shock (following Gallmeyer et al. (2005)):

$$-\Delta q_{t+1} = 0.5\,\text{var}_t(\Delta q_{t+1}) + (\phi_1 b_t)(y_{t+1} - E_t y_{t+1}) + (\phi_2 b_t)(\pi_{t+1} - E_t \pi_{t+1})$$

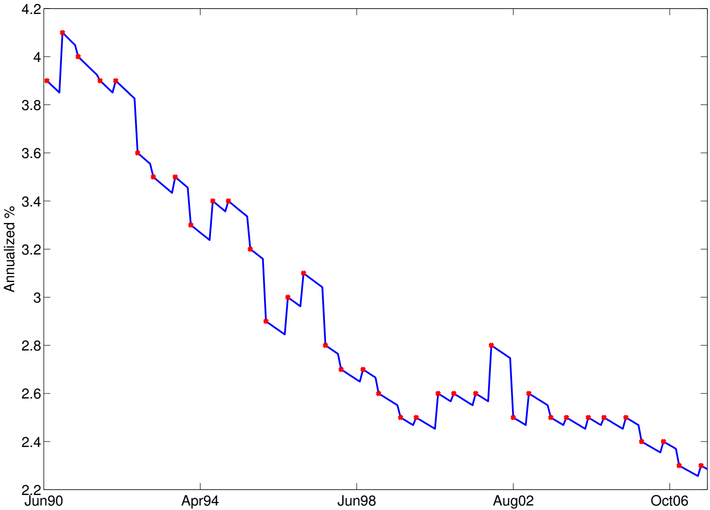
  b_t follows an AR(1) process.
- Rewriting the SDF yields:

$$\lambda'_{0,b} = \begin{bmatrix} -1 & -\gamma \end{bmatrix} G\Sigma$$

$$\lambda'_{1,b} = \begin{bmatrix} \phi_1 & \phi_2 \end{bmatrix} G\Sigma$$

intu

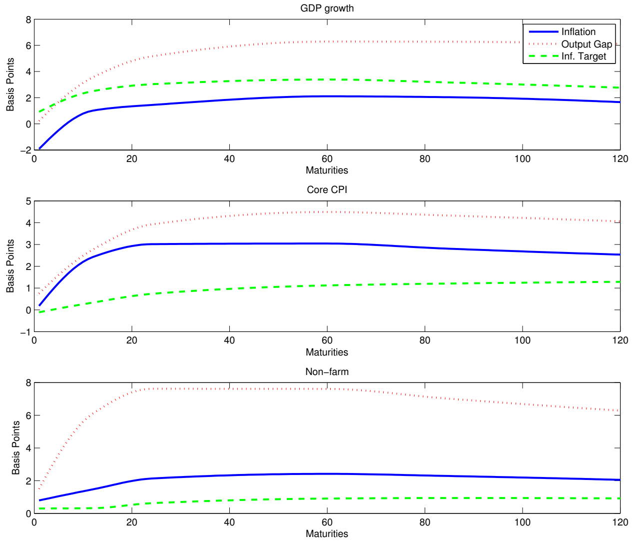
Interpolated Blue Chip



Data

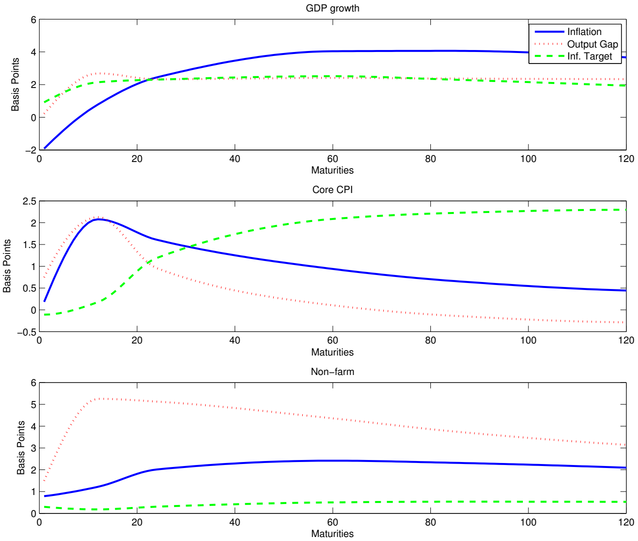
Yield Responses to State Variables

VarDecomp



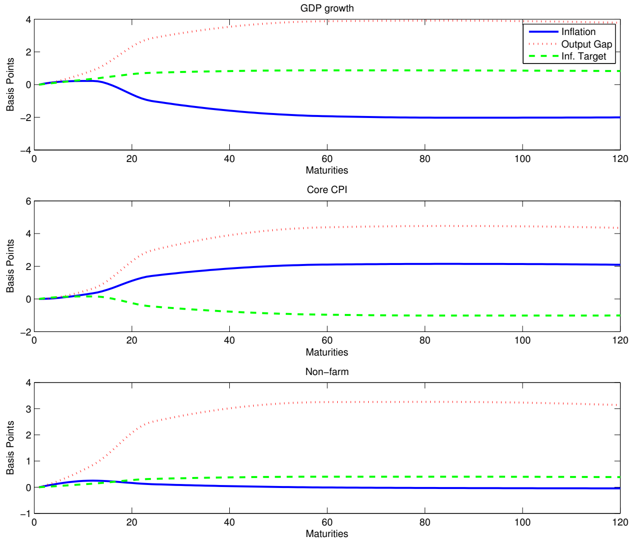
Exp. Short Rate Responses to State Variables

VarDecomp

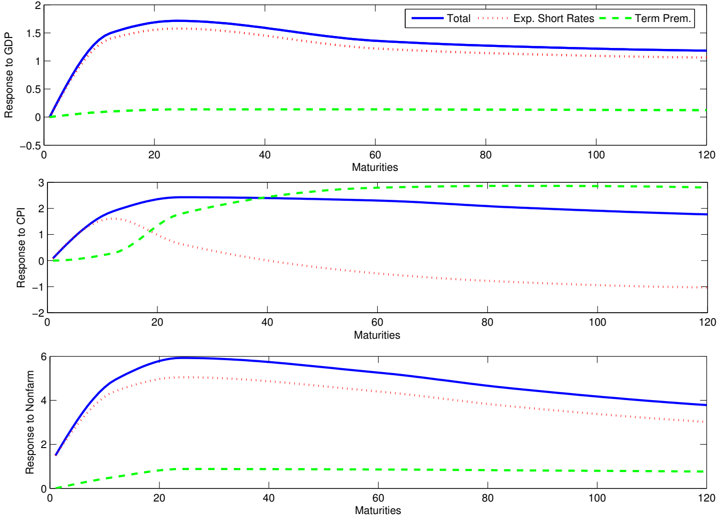


Term Premia Responses to State Variables

VarDecomp

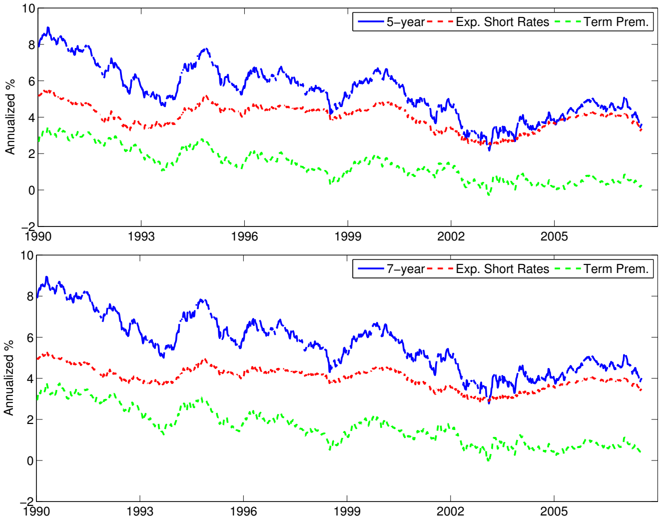


Responses to News



VarDecomp

Decomposition



decompose