A model of the Fed's view on inflation

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28 March 2018

The Federal Reserve's View

"Inflation is characterized by an underlying trend that has been essentially constant since the mid-1990s; …. Theory and evidence suggest that this **trend is strongly influenced by inflation expectations** that, in turn, depend on monetary policy. In particular, the remarkable stability of various measures of expected inflation in recent years presumably represents the fruits of the Federal Reserve's sustained effort since the early 1980s to bring down and stabilize inflation at a low level. The anchoring of inflation expectations … does not, however, prevent actual inflation from fluctuating from year to year in response to the temporary influence of movements in **energy prices and other disturbances**. In addition, inflation will tend to run above or below its underlying trend to the extent that **resource utilization–which may serve as an indicator of firms' marginal costs**–is persistently high or low."

— Janet Yellen, 60th Boston Fed Conference

An Econometric Model
(of Policymakers' View)

Inflation dynamics:

1. A **trend in inflation**, reflecting expectations

2. The **Phillips curve**, relating economic slack to prices

3. An **oil price component** unrelated to real variables

1. Rational Expectations Phillips curve

Standard features

A Stylised RE Model for Output and Inflation

$$
\begin{aligned}
y_t &= \mu_t^y + \psi_t^{PC} + \psi_t^y, \\
\pi_t &= \mu_t^\pi + \delta_\pi \psi_t^{PC} + \psi_t^\pi
\end{aligned}
$$

- μ's are random walk trends
- ψ's are AR(2) cycles
- ψ_t^{PC} is a solution to the following hybrid New Keynesian Phillips Curve

$$
\hat{\pi}_t = \sum_{i=1}^{2} \alpha_i \hat{\pi}_{t-i} + \beta \mathbb{E}_t \left[\hat{\pi}_{t+1} \right] + \gamma \hat{y}_t + v_t
$$

2. Trend Inflation and Long-run Expectations
Standard features

Stochastic Trend Inflation

Unit root trend inflation

$$\mu_t^\pi = \tau^\pi + \mu_{t-1}^\pi + u_t^\pi$$

Trend inflation corresponds to the long-run forecast for inflation, which implies

$$\lim_{h \to \infty} \mathbb{E}_t[\pi_{t+h}] = \lim_{h \to \infty} \left\{ h\tau^\pi + \mu_t^\pi \right\}$$

Reduced Form Representation – Trend & Cycle

$$
\begin{pmatrix} y_t \\ \pi_t \\ \mathbb{E}_t\left[\pi_{t+1}\right] - \tau^\pi \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ \delta_\pi & 1 \\ \delta_{exp,1} + \delta_{exp,2}L & 1 \end{pmatrix} \begin{pmatrix} \psi_t^{PC} \\ \mu_t^\pi \end{pmatrix} + \begin{pmatrix} \mu_t^y \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} \psi_t^y \\ \psi_t^\pi \\ 0 \end{pmatrix}
$$

1. Can accommodate different specifications for the Phillips Curve

2. An AR(1) ψ_t^{PC} would be the solution to a **purely forward** looking New-Keynesian Phillips Curve)

3. It also nests the **backwards looking** 'Old-Keynesian' Phillips curve connecting output gap and prices

3. Deviations from the Stylised Model
Non-standard features

Oil Prices and UoM Expectations
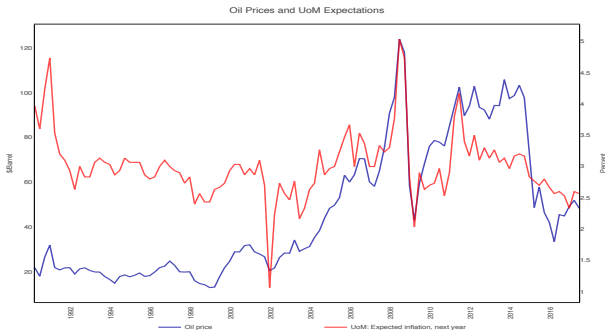
Energy Cycle (Coibion, Gorodnichenko, 2015)

- **Household** (and firms) expectations may be **not fully anchored**
- … and can respond to **oil and commodity** price changes
- (gasoline prices are among the most **visible prices**)
- (… that may follow a **global demand cycle)**

3. (More) Deviation from Textbook RE Model

Also allow for:

1. Expectational oil disturbances (**transitory disanchoring**)

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2. Time varying bias in expectations (**permanent disanchoring**)

3. (More) Deviation from Textbook RE Model

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1. Expectational oil disturbances (**transitory disanchoring**)

2. Time varying bias in expectations (**permanent disanchoring**)

3. Non-classical **measurement error** in the variables

A Sketch of the Model
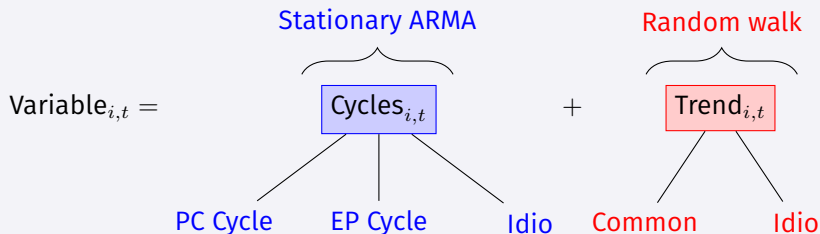
- Phillips Curve Cycle: Unemployment Rate, GDP, inflation expectations and inflation
- Energy Price Cycle: Oil prices, inflation expectations, and inflation
- Common Trend: Expectations and Inflation
- Note: We model survey's expectations (UoM and SPF)

$$\mathbb{E}^*[\pi_{t+1}] = \underbrace{\tau^\pi + \mu_t^\pi}_{\text{Common Trend with } \pi_t} + Cyclical + Idiosyncratic\ Trend$$

and assume that there is no idiosyncratic trend in π_t

Bringing the Model to the Data

Variable	Transform	Loads on		
		PC Cycle	EP Cycle	Common Trend
Unemployment Rate	Levels	✓	✗	✗
Gross Domestic Product	Levels	✓	✗	✗
WTI Spot Oil Price	Levels	✗	✓	✗
UoM: Expected Inflation	Levels	✓	✓	✓
SPF: Expected Inflation	Levels	✓	✓	✓
CPI: All Items	YoY	✓	✓	✓

Quarterly, sample: Q1-1984 to Q2-2017

Note: We include survey expectations to capture trend inflation

Model Restrictions

$$
\begin{pmatrix} u_t \\ y_t \\ oil_t \\ uom_t\{\pi\} \\ spf_t\{\pi\} \\ \pi_t \end{pmatrix} = \underbrace{\begin{pmatrix} \delta u & \gamma_u & \phi_u \\ \delta_y & \gamma_y & \phi_y \\ \delta_{oil} & \gamma_{oil} & \phi_{oil} \\ \delta_{uom} & \gamma_{uom} & \phi_{uom} \\ \delta_{spf} & \gamma_{spf} & \phi_{spf} \\ \delta_\pi & \gamma_\pi & \phi_\pi \end{pmatrix} \begin{pmatrix} \psi_t^{(PC)} \\ \psi_t^{(EP)} \\ \mu_t^\pi \end{pmatrix}}_{Common\ Components} + \underbrace{\begin{pmatrix} \psi_t^u \\ \psi_t^y \\ \psi_t^{oil} \\ \psi_t^\pi \\ \psi_t^{uom} \\ \psi_t^{spf} \end{pmatrix}}_{Idio\ Cycles} + \underbrace{\begin{pmatrix} \mu_t^u \\ \mu_t^y \\ \mu_t^{oil} \\ \mu_t^{uom} \\ \mu_t^{spf} \\ 0 \end{pmatrix}}_{Idio\ Trends}
$$

Model Restrictions

$$
\begin{pmatrix} u_t \\ y_t \\ oil_t \\ uom_t\{\pi\} \\ spf_t\{\pi\} \\ \pi_t \end{pmatrix} = \underbrace{\begin{pmatrix} 1 & 0 & 0 \\ \delta_y & 0 & 0 \\ 0 & 1 & 0 \\ \delta_{uom} & \gamma_{uom} & \phi_{uom} \\ \delta_{spf} & \gamma_{spf} & \phi_{spf} \\ \delta_\pi & \gamma_\pi & \phi_\pi \end{pmatrix} \begin{pmatrix} \psi_t^{(PC)} \\ \psi_t^{(EP)} \\ \mu_t^\pi \end{pmatrix}}_{Common\ Components} + \underbrace{\begin{pmatrix} \psi_t^u \\ \psi_t^y \\ \psi_t^{oil} \\ \psi_t^\pi \\ \psi_t^{uom} \\ \psi_t^{spf} \end{pmatrix}}_{Idio\ Cycles} + \underbrace{\begin{pmatrix} \mu_t^u \\ \mu_t^y \\ \mu_t^{oil} \\ \mu_t^{uom} \\ \mu_t^{spf} \\ 0 \end{pmatrix}}_{Idio\ Trends}
$$

- ϕ_{uom}, ϕ_{spf}, and ϕ_π are set to 1 over the standard deviation of the difference of the variable
- The shocks to all unobserved components are orthogonal

Bayesian Estimation

Metropolis-Within-Gibbs Algorithm

The algorithm is structured in two blocks (**priors are diffuse or weakly informative**):

- The **first block** uses a Metropolis step for the **estimation of the state-space parameters**

- The **second block** uses a Gibbs step to draw the **unobserved states** conditional on the model parameters

Trends & Cycles in US Inflation

Common Cycles

Output Gap
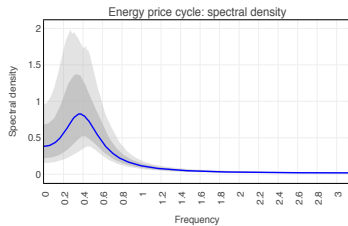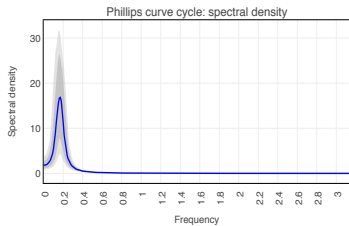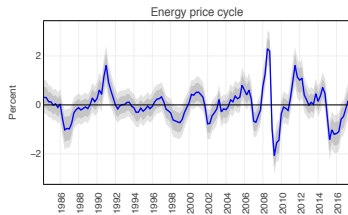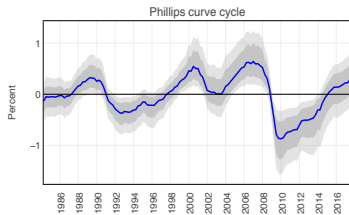
Output gap as a percentage of potential GDP

Historical Decomposition of the Cycles

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SPF: Expected CPI

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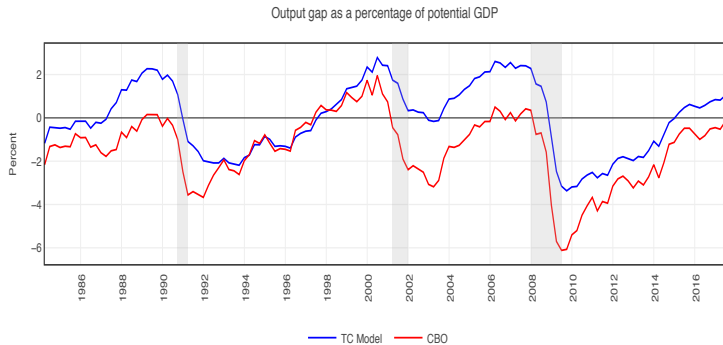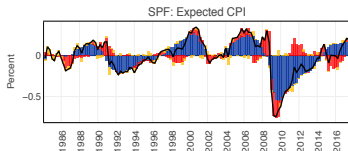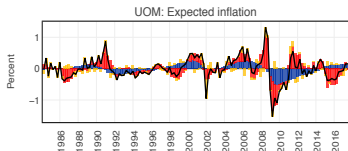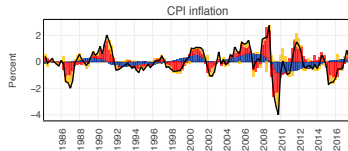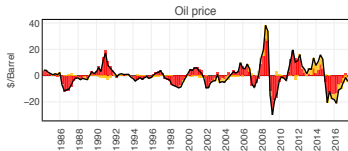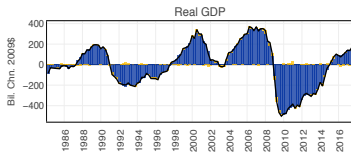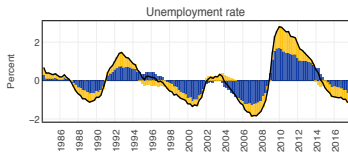
Phillips curve | Energy price cycle | Idiosyncratic cycle | Total cycle

Historical Decomposition of the Cycles

Common Trend and Inflation
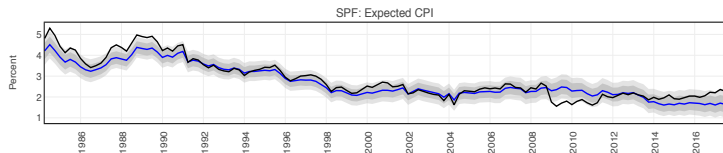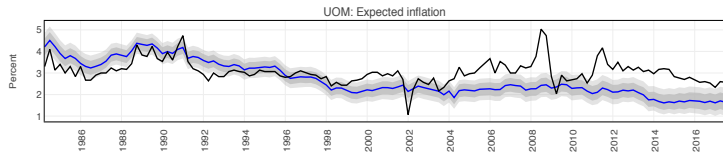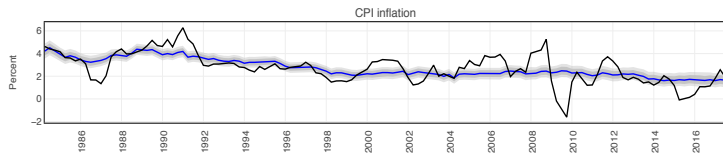
Common Inflation Trend and 10-year Expectations

Long-term expectations for CPI inflation
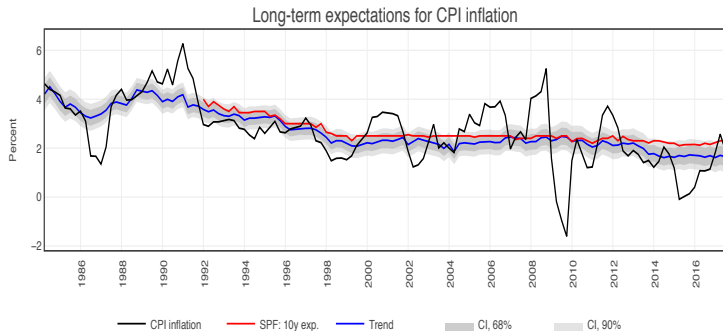
Idiosyncratic Trends
(warning: are two different axis)

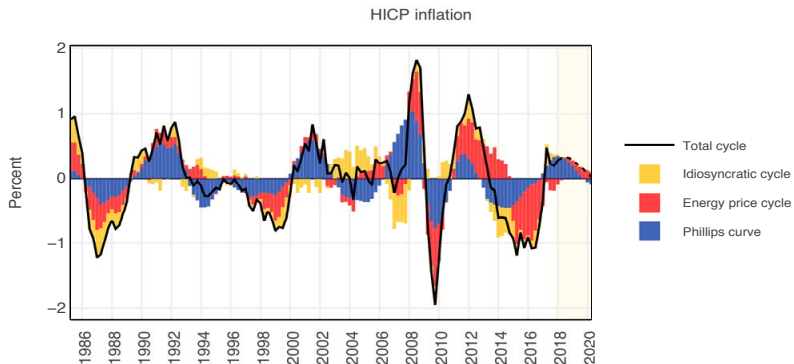Idiosyncratic trends
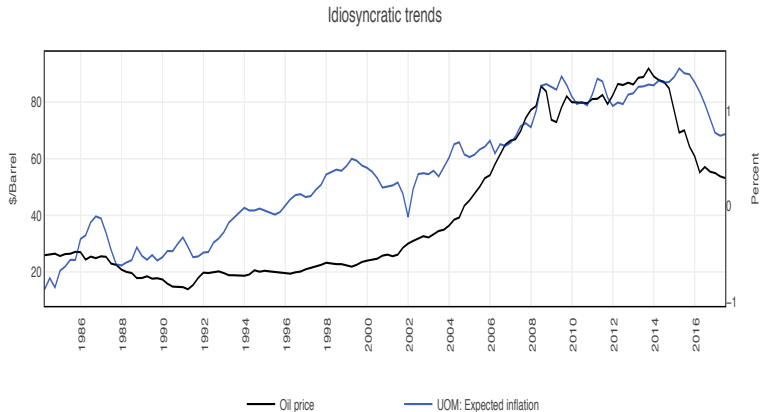
Trends & Cycles in Euro Area Inflation
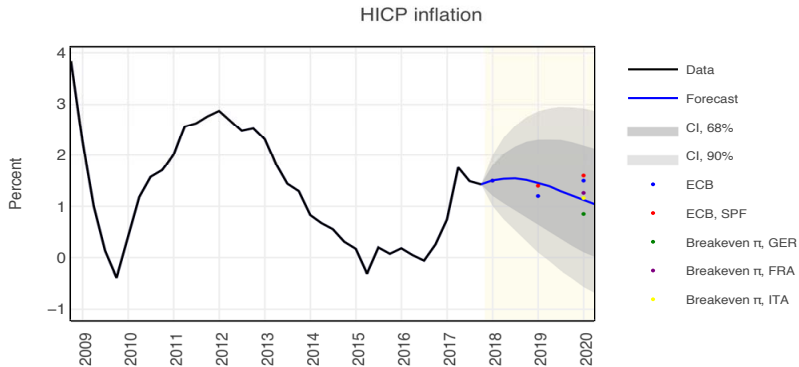
Trend Inflation
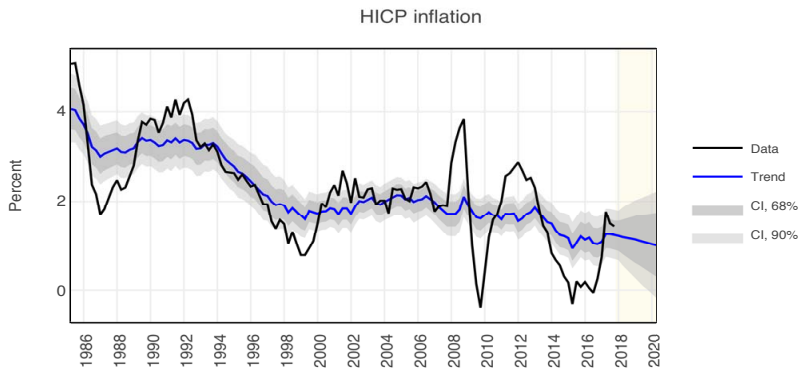
HICP inflation

Note: Quarterly year-on-year HICP and trend. Forecast period is indicated with a shaded area, and goes from Q4-2017 to Q1-2020. Source: Authors' calculations, AWM, ECB.

Historical Decomposition of the Inflation Cycle

Note: Quarterly year-on-year HICP cycle. Forecast period is indicated with a shaded area, and goes from Q4-2017 to Q1-2020. Source: Authors' calculations, AWM, ECB.

Euro Area – Forecast

HICP inflation

Note: Quarterly year-on-year HICP cycle. Forecast period is indicated with a shaded area, and goes from Q4-2017 to Q1-2020. Source: Authors' calculations, AWM, ECB.

Conclusions

- The **Phillips Curve** well identified and **fairly stable** since the early 1980s

- **Not** always the **dominant component**

- Large **oil price fluctuations** can **move consumers' expectations** away from the real-nominal relationship

- **Euro Area**: high probability of inflation below 1.6% in 2019
  - trend expectations in line with last ten years
  - oil price pressures will remain subdued
  - the economy will start slowing down in the second part of 2018

Appendix – Model diagnostics

Priors and Posteriors
(Maximum) Frequency and Persistence
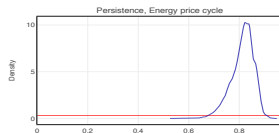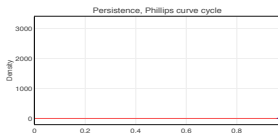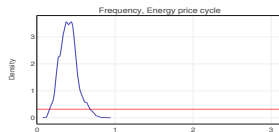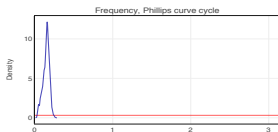
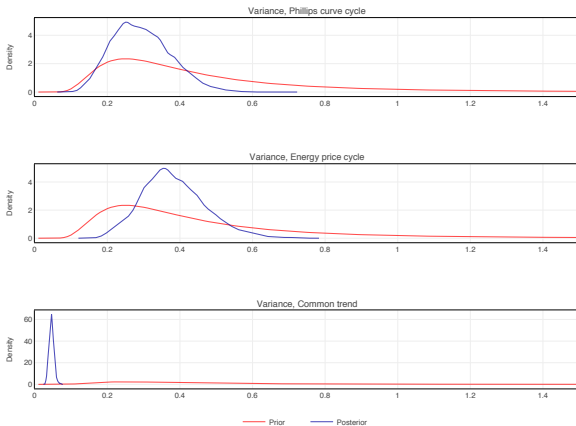| Prior	Density
Frequency	Uniform(ξ, π)
Persistence	Uniform$(\xi, 0.97)$
Variance	Inverse-Gamma$(3, 1)$

Priors and Posteriors
Variance of Shocks to the Components

Prior	Density
Frequency	Uniform(ξ, π)
Persistence	Uniform$(\xi, 0.97)$
Variance	Inverse-Gamma$(3, 1)$

Factor Loadings

Coefficients for CPI inflation, Phillips curve cycle

Coefficients for CPI inflation, Energy price cycle
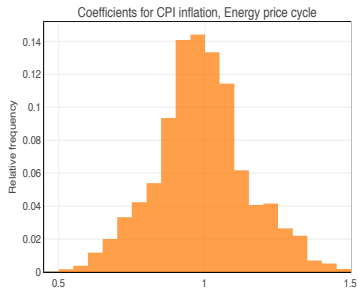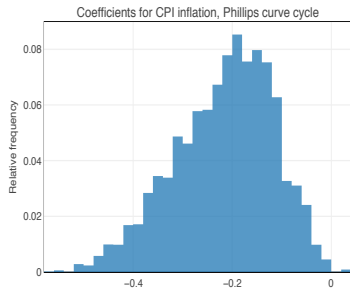
Out-of-Sample Forecast Evaluation
Root Mean Squared Forecast Error
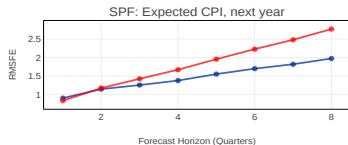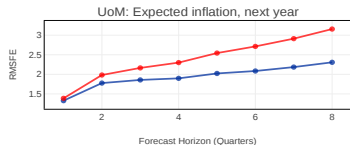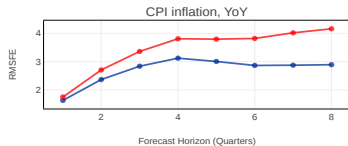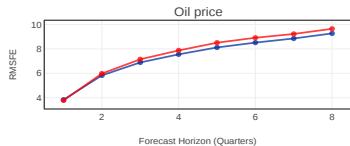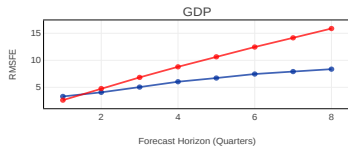
Relative Root Mean Squared Errors

Horizon	Variable	TC Model	BVAR	UC-SV
h=1	Unemployment rate	0.83	**0.65**	x
	Real GDP	1.00	**0.92**	x
	Oil price	**1.02**	1.08	x
	CPI Inflation	0.92	**0.91**	1.00
	UOM: Expected inflation	**0.97**	1.03	x
	SPF: Expected CPI	**0.95**	1.10	x
h=2	Unemployment rate	0.85	**0.68**	x
	Real GDP	1.03	**0.91**	x
	Oil price	**1.04**	1.18	x
	CPI Inflation	**0.87**	1.00	0.99
	UOM: Expected inflation	**0.95**	1.09	x
	SPF: Expected CPI	**0.95**	1.24	x
h=4	Unemployment rate	0.89	**0.79**	x
	Real GDP	1.09	**0.97**	x
	Oil price	**1.04**	1.26	x
	CPI Inflation	**0.81**	1.13	0.98
	UOM: Expected inflation	**0.93**	1.14	x
	SPF: Expected CPI	**0.87**	1.35	x
h=8	Unemployment rate	**0.93**	0.97	x
	Real GDP	**1.17**	1.18	x
	Oil price	**1.04**	1.39	x
	CPI Inflation	**0.79**	1.07	0.96
	UOM: Expected inflation	**0.92**	1.30	x
	SPF: Expected CPI	**0.84**	1.39	x