Term Structure, Forecast Revision and the Signaling Channel of Monetary Policy

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Motivation

I emphasize two facts:

- Fact 1: monetary policy shocks affect interest rates at long horizons (10 years or more)
  - The prevailing theories: monetary policy has no long run effects
- Fact 2: the private sector's real GDP forecasts are revised upward in response to a monetary tightening
  - The prevailing theories: a monetary policy tightening should depress agents' beliefs

This Paper

1. Revisits the empirical evidences using an alternative identification strategy
   - Combines the Fed's information set to address a confounding problem

2. Proposes a theory to rationalize the aforementioned facts
   - Signaling channel of monetary policy Defense

Intuition

Central bank has superior information regarding the trend of the economy

Agents can not separate shocks to productivity trend from monetary shocks

An expansionary monetary surprise can be perceived as:

- First, Fed's endogenous response to a worse than expected drop in the trend of the economy
- Second, a pure expansionary monetary policy shock.

Agents apply the Bayes' rule to calculate the optimal weights that are assigned to both interpretations.

Relationship to the Literature

- *Signaling role of monetary policy*: Cukierman and Meltzer (1986), Ellingsen and Soderstrom (2001). Erceg and Levin (2003), Kozicki and Tinsley (2005) and Gurkaynak, Sack and Swanson (2005b), Baeriswyl and Cornand (2010), Tang (2015), Melosi (2017) and Nakamura and Steinsson (2017)
  - **This paper: micro-founded model to explain Fact 1 and Fact 2.**
- *Empirical Facts*: Kuttner (2001), Gurkaynak,Sack and Swanson (2005), Hanson and Stein (2015), Nakamura and Steinsson (2017), Campbell, Evans, Fisher and Justiniano (2012), Campbell, Fisher, Justiniano and Melosi (2016), Gilchrist, Lopez-Salido and Zakrajsek(2015), Romer and Romer (2000)
  - **This paper: new identification strategy that controls for Fed's information set**

Roadmap

- Empirical Facts
- New Keynesian model with asymmetric information
    - Rationalizes Fact 1 and Fact 2

Empirical Facts

Fact 1: Identification Strategy

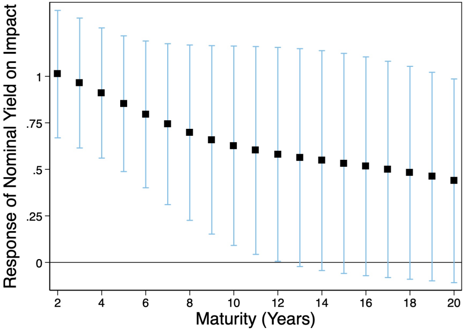
I run 2SLS:

$$Y^h_{t+1d} - Y^h_{t-1d} = \alpha^h + \beta^h \triangle MP_t + \gamma^h X_t + \varepsilon_{h,t},$$

- $\triangle MP_t$ denotes daily change in monetary instrument: three-month treasury bill rate around FOMC announcements.
- $\triangle MP_t$ is instrumented by HFI monetary surprises
- X_t: Greenbook forecasts
- $Y^h_{t+1d} - Y^h_{t-1d}$: changes in yields with maturity of **h years** around FOMC announcements.

I will show the estimated β^h.

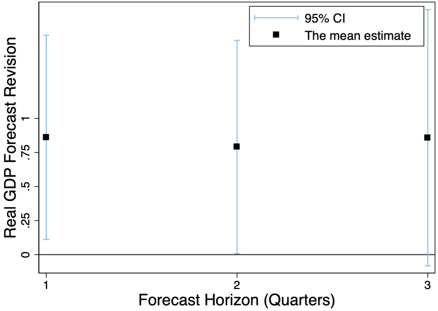
Fact 1: Impact Effect of Monetary Shocks on Yield Curve



- $\hat{\beta}_1^h$ is significant and persistent at long horizon and it decays over maturity

Fact 2: Impact Effects of Monetary Shocks on Real GDP Forecast Revisions

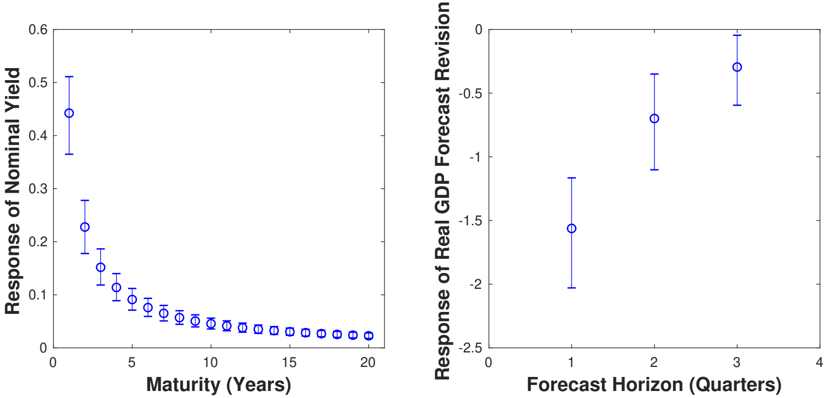
Regressions: $y_{t+j|t} - y_{t+j|t-1} = \alpha^j + \beta^j \widehat{\triangle MP}_t + \gamma^j X_t + v_{j,t}$, with $\triangle MP_t$ instrumented by cleaned HFI monetary surprises. Clean



- **Contractionary** monetary shocks are expected to have **expansionary** effects on impact.

The Model

Predictions of a Standard NK Model



Inconsistent with:

- Fact 1: monetary policy shocks have big impacts on interest rates at long horizons
- Fact 2: the private sector's real GDP forecasts are revised upward in response to a monetary tightening

Model Environment

1. A representative household makes consumption and labor supply decisions
2. Firms face monopolistic competition and prices are sticky à la Calvo
3. Central bank follows a Taylor rule
4. The key: information frictions
5. Shocks: monetary, technology (two types), preference and cost-push

Model: an Extension of the Basic NK Model

Productivity growth $\triangle a_t$ follows:

$$\triangle a_t = g_t + \varepsilon_t^a$$
$$g_t = \rho_g g_{t-1} + g^* + \varepsilon_t^g$$

Asymmetric Information:

- Private agents observe $\triangle a_t$ but cannot distinguish g_t with ε_t^a.
- The Fed has superior information
  - Romer and Romer (2000) More Arguments

Dynamic IS equation

Dynamic IS equation:

$$\hat{y}_t = \hat{y}_{t+1|t} - \left(i_t - \hat{\pi}_{t+1|t} - \rho_g \hat{g}_{t|t} + \triangle \delta_{t+1|t}\right) \quad (1)$$

where:

- $x_{t|t}$ denotes agent's expectation about variable x_t
- $\hat{x}_t$ denotes variable x_t in deviation from its balanced growth steady state
- δ_t preference shifter

New Keynesian Phillips Curve

New Keynesian Phillips Curve:

$$\hat{\pi}_t = \frac{\beta}{1+\omega\beta}\hat{\pi}_{t+1|t} + \frac{\omega}{1+\omega\beta}\hat{\pi}_{t-1} + \kappa\hat{y}_t + \varepsilon_t^{\pi} \tag{2}$$

Two missing equations:

- Central bank's reaction function i_t
- Agents' belief updating process for $\hat{g}_{t|t}$

Monetary Policy Rule:

Central bank follows a Taylor rule that keeps track of the efficient real interest rate

$$\hat{i}_t = \rho_m \hat{i}_{t-1} + (1-\rho_m)(\phi_r \hat{r}^e_t + \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t) + \varepsilon^m_t$$

where:

- $\hat{r}^e_t$ denotes the efficient real interest rate i.e. the real interest rate under flexible price and perfect information.
- belongs to the family of optimal simple rules: Woodford (2001)
- Curdia, Ferrero, Ng and Tambalotti (2015) show that this rule fits the U.S data well.
- Nevertheless, an alternative rule that responds to the central bank's forecast of real GDP growth gives similar results.

Monetary Policy Rule (Cont.):

But the Fed only observes g_t with noise and/or is subject to monetary shocks:

$$\hat{i}_t = \rho_m \hat{i}_{t-1} + (1-\rho_m)\Big(\phi_r \underbrace{(\rho_g \hat{g}_t + (1-\rho_d)\hat{\delta}_t)}_{r_t^e} + \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t\Big) + \varepsilon_t^m$$

where ε_t^m captures:

- the noise shock to the Fed $E^{fed}(g_{t+1}) - E^e(g_{t+1})$
- and unobserved deviation from policy rule

Thus, monetary policy is a noisy signal about $\hat{g}_t$.

Signal Extraction: Intuition

HFI monetary surprise:

$$i_t - E(i_t|\{\Omega_t^p \backslash i_t\}) = (1-\rho_m)\phi_r\rho_g(g_t - E(g_t|\{\Omega_t^p \backslash i_t^s\})) + \varepsilon_t^m$$

An expansionary monetary surprise can be perceived as:

- First, Fed's endogenous response to a worse than expected drop in fundamental $(g_t - E(g_t|\{\Omega_t^p \backslash i_t^s\}))$
- Second, a pure expansionary monetary policy shock (ε_t^m).

Agents apply the Bayes' rule to calculate the optimal weights that are assigned to both interpretations.

Private Agent's Belief Updating Equation: an Example

Agent updates her belief about g_t using $\left(i_t^s, s_t\right)$ (for the purpose of illustration ignore a_t) together with prior belief $\hat{g}_{t-1}$:

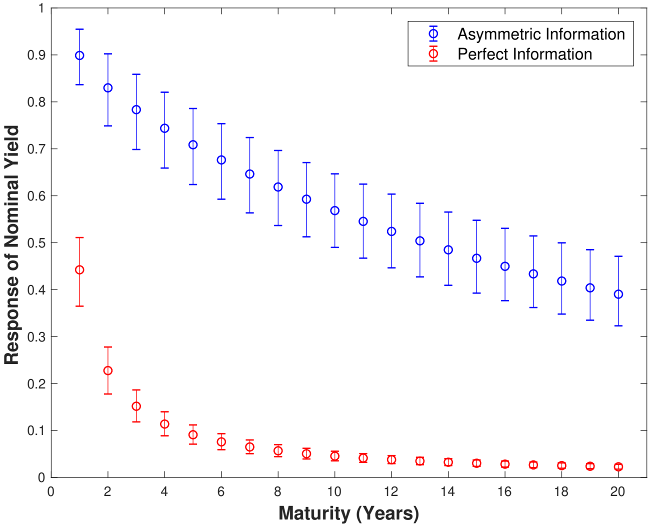
$$\hat{g}_{t|t} = (1 - K_1 - K_2)\hat{g}_{t|t-1} + K_1 s_t + K_2 i_t^s, \tag{3}$$

where:

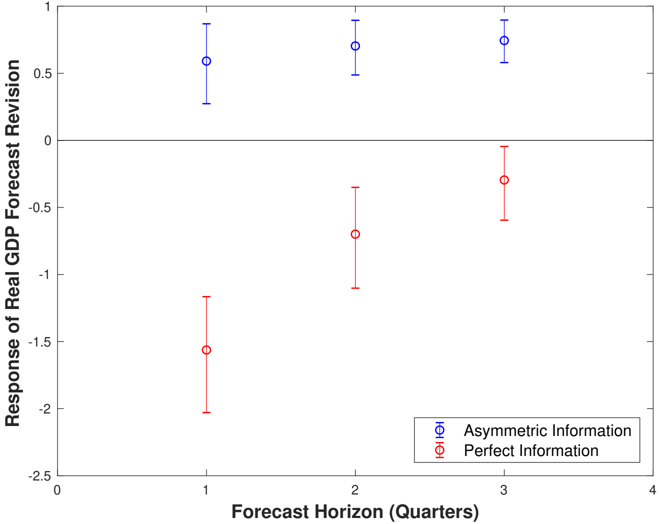
- $K_2 \equiv \frac{\sigma_p \Sigma}{\sigma_m \Sigma + \sigma_p \Sigma + \sigma_p \sigma_m^2}$ the kalman gain associated with i_t^s
- $K_1 \equiv \frac{\sigma_m \Sigma}{\sigma_m \Sigma + \sigma_p \Sigma + \sigma_p \sigma_m^2}$ the kalman gain associated with s_t
- Σ the prior variance.

In response to a positive monetary surprise: $\frac{\partial \hat{g}_{t|t}}{\partial i_t^s} = K_2$

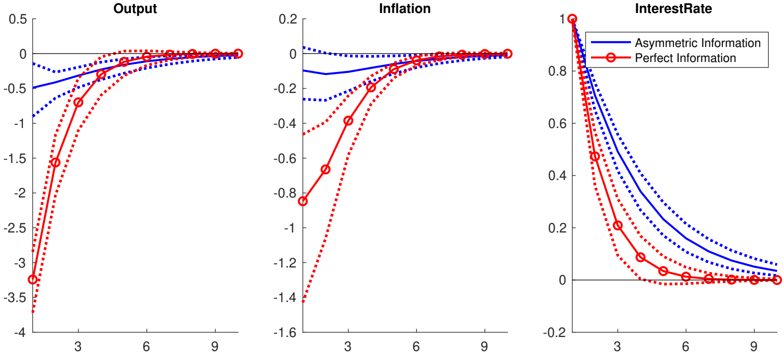
Estimation Results I: Impact Effects on Yield



Estimation results II: Impact Effects on Real GDP Forecast Revisions



Implication: IRFs



Discussion: How Plausible is the Estimated Degree of Information Friction

Table: Model Simulation: Romer and Romer (2000)

Regressions: $y_{t+h} = \alpha + \beta^P E_t^P(y_{t+h}) + \beta^F E_t^F(y_{t+h}) + e_t$

	Model Simulations			Romer and Romer (2000)		
Forecast Horizon h	$\hat{\beta}^P$	$\hat{\beta}^F$	RMSFE	$\hat{\beta}^P$	$\hat{\beta}^F$	RMSFE
Real GDP						
1 Quarter	-0.04 (0.27)	1.00 (0.36)	0.79 (0.08)	0.56 (0.53)	0.81 (0.52)	-
2 Quarters	-0.11 (0.64)	1.00 (0.73)	0.94 (0.07)	0.66 (0.53)	1.07 (0.66)	-
3 Quarters	-0.18 (1.16)	0.98 (1.10)	0.97(0.06)	0.40 (0.28)	0.99 (0.44)	-
4 Quarters	-0.16 (1.95)	0.94 (1.54)	0.99 (0.05)	-1.07 (0.55)	2.33 (0.46)	-
Inflation						
1 Quarter	-0.02 (0.57)	0.97 (0.71)	0.95 (0.06)	0.39 (0.42)	0.57 (0.38)	0.72
2 Quarters	-0.10 (0.92)	1.07 (1.05)	0.97 (0.04)	-0.48 (0.33)	1.33 (0.29)	0.76
3 Quarters	-0.15 (1.30)	1.05 (1.34)	0.99 (0.04)	-0.65 (0.31)	1.55 (0.29)	0.74
4 Quarters	-0.19 (1.71)	0.99(1.69)	0.99 (0.03)	-0.72 (0.36)	1.53 (0.32)	0.70

These evidence suggest that the implied degree of information asymmetry in the model is realistic.

Conclusion

A NK model with asymmetric information, in which the Fed has superior information about news shock predicts:

- Fact 1: monetary shocks affect long-term rates.
- Fact 2: professional forecasters revise downward their forecasts of RGDP in response to expansionary monetary shocks
- In the presence of information channel, monetary policy is less effective.

A Defense of the Assumption

1. Romer and Romer (2000) regressions
2. HFI monetary surprises are predictable
3. Real life events:
   - Uncertainty before FOMC's September meeting in 2015, fed funds target **unchanged** $\Rightarrow$ the S&P500 of the U.S. stock market **dropped** by 1.6%
   - Europe on March 10th 2016, the ECB **cut** its main interest rate from 0.05% to 0% $\Rightarrow$ the market responded negatively, Frankfurt closed **down** 2.3%, Paris ended 1.7% **lower** and the FTSE 100 **slid** 1.8%

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Cleaning HFI Monetary Surprises

- I clean the HFI monetary surprises in the spirit of Romer and Romer (2004) (the same approach is taken by Miranda-Agrippino (2016) and Miranda-Agrippino and Ricco (2017).
- Particularly, I project HFI monetary surprises onto the Fed's internal forecasts of inflation, real output growth, the unemployment rate and the change in forecasts since the previous meeting.
- The residuals are the cleaned HFI monetary surprises

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