HIGH FREQUENCY IDENTIFICATION OF MONETARY NON-NEUTRALITY: THE INFORMATION EFFECT

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January 2018
The Question

How large are the effects of monetary policy on the real economy?

- Empirical challenge:
  - Monetary policy is endogenous
  - Example: Fed may wish to counteract a shock to the financial sector by lowering interest rates
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How large are the effects of monetary policy on the real economy?

- Empirical challenge:
  - Monetary policy is endogenous
  - Example: Fed may wish to counteract a shock to the financial sector by lowering interest rates

- Most common existing approach to identification:
  - Controlling for confounding variables
    (e.g., Romer-Romer 04, Christiano-Eichenbaum-Evans 99)

- Worry: Some endogeneity bias may remain (e.g., 9/11)
High Frequency Identification

- Discrete amount of monetary news at time of FOMC announcements
- Allows for discontinuity based identification
High Frequency Identification

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- Allows for discontinuity based identification
- We study the response of **real** interest rates to monetary news in the 30-minute window around FOMC announcements
  - Real yields and forwards (from TIPS)
High Frequency Identification

- Discrete amount of monetary news at time of FOMC announcements
- Allows for discontinuity based identification
- We study the response of real interest rates to monetary news in the 30-minute window around FOMC announcements
  - Real yields and forwards (from TIPS)
- Identifying assumption:
  - Unexpected changes in interest rates at these times are due to actions and statements of the Fed
  - Not a response to other events that occurred in this narrow window
Why Real Rates?

- What can response of real rates tell us?
  - Real rates affect output in all models (RBC and NK)
  - Controversy is over whether monetary policy affect real (as opposed to only nominal) rates

- Response of real interest rates measurable at high frequency
  - High frequency data key for discontinuity-based identification
  - Allows for greater precision than for variables that do not respond at high frequency (e.g., output and inflation)
**Main Empirical Findings**

1. Nominal and real rates move one-for-one several years into the term structure

2. Small response of break-even inflation

We show how under *conventional interpretation of monetary shocks*:

- Implies prices are very sticky (flat Phillips curve)
Main Empirical Findings

1. Nominal and real rates move one-for-one several years into the term structure
2. Small response of break-even inflation

We show how under conventional interpretation of monetary shocks:

- Implies prices are very sticky (flat Phillips curve)

3. But: Tightening of policy raises expected output growth (Blue Chip)
   - Inconsistent with standard models of monetary policy
   - Need new model of monetary policy with “information effects”
Fed Information Model

- FOMC announcements affect private sector beliefs...
  - Not only about monetary policy (conventional view)
  - But also about exogenous fundamentals (e.g. productivity)
    (as in Romer-Romer 00)

- New model of “Fed Information”
- Estimate large information effect
- 2/3 of shocks are changes in beliefs about exogenous fundamentals
- Fed has great deal of power over private sector beliefs
- Fed “fights against itself” by increasing pessimism when it unexpectedly loosens policy

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Related Literature

- **Fed information effect**
  - Empirical: Romer-Romer 00, Faust-Swanson-Wright 04, Campbell et al. 12
  - Theoretical: Cukierman-Meltzer 86, Ellingen-Soderstrom 01, Berkelmans 11, Melosi 16, Tang 15, Frankel-Kartik 15, Andrade et al. 16

- **High-frequency identification of monetary shocks**
  - Cook-Hahn 89, Kuttner 01, Cochrane-Piazzesi 02, Gurkaynak-Sack-Swanson 05, Hansen-Stein 15, Gertler-Karadi 15.

- **New Keynesian models of monetary policy:**
  - Rotemberg-Woodford 97, Clarida-Gali-Gertler 99, Woodford 03, Christiano-Eichenbaum-Evans 05
High Frequency Estimation of the Effects of Monetary Shocks
Forward Guidance

Fed uses post-meeting statements to manage expectations about what it is going to do in the future.

Example: January 28, 2004

- No change in Fed Funds Rate, fully anticipated
- Unexpected change in Fed Funds Rate: 0 bp
- However, FOMC statement dropped the phrase: “policy accommodation can be maintained for a considerable period”
- Two- and five-year yields jumped 20-25 bp

(Discussed in Gurkaynak-Sack-Swanson 05)

Implication:

- Measures of monetary shock should incorporate “forward guidance”
We follow GSS 05 in basing policy indicator on changes in 5 interest rate futures:

- Fed Funds future for current month (scaled)
- Fed Funds future for month of next FOMC meeting (scaled)
- 3-month Eurodollar futures at horizons of 2Q, 3Q, 4Q

Policy News Shock:

- First principle component of change in these 5 interest rate futures over 30 minute window around scheduled FOMC announcements (also consider 1-day window)

(Similar to GSS 05 “path factor”)

Policy News Shock
DEPENDENT VARIABLES

- Nominal Treasury zero-coupon yields (Gurkaynak-Sack-Wright 07)
- Real TIPS zero-coupon yields (Gurkaynak-Sack-Wright 10)
  - TIPS started trading in 1997
- Daily data for sample period Jan-2000 to Mar-2014
  - Baseline sample drops 2008:07 - 2009:06
  - Results robust to including apex of crisis or ending sample in 2007
## Effects of Policy News Shock

<table>
<thead>
<tr>
<th></th>
<th>Nominal</th>
<th>Real</th>
<th>Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2Y Treasury Yield</strong></td>
<td>1.10</td>
<td>1.06</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.33)</td>
<td>(0.24)</td>
<td>(0.18)</td>
</tr>
<tr>
<td><strong>5Y Treasury Yield</strong></td>
<td>0.73</td>
<td>0.64</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(0.20)</td>
<td>(0.15)</td>
<td>(0.11)</td>
</tr>
<tr>
<td><strong>10Y Treasury Yield</strong></td>
<td>0.38</td>
<td>0.44</td>
<td>-0.06</td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td>(0.13)</td>
<td>(0.08)</td>
</tr>
<tr>
<td><strong>2Y Treasury Inst. Forward Rate</strong></td>
<td>1.14</td>
<td>0.99</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>(0.46)</td>
<td>(0.29)</td>
<td>(0.23)</td>
</tr>
<tr>
<td><strong>3Y Treasury Inst. Forward Rate</strong></td>
<td>0.82</td>
<td>0.88</td>
<td>-0.06</td>
</tr>
<tr>
<td></td>
<td>(0.43)</td>
<td>(0.32)</td>
<td>(0.15)</td>
</tr>
<tr>
<td><strong>5Y Treasury Inst. Forward Rate</strong></td>
<td>0.26</td>
<td>0.47</td>
<td>-0.21</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.17)</td>
<td>(0.08)</td>
</tr>
<tr>
<td><strong>10Y Treasury Inst. Forward Rate</strong></td>
<td>-0.08</td>
<td>0.12</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.12)</td>
<td>(0.09)</td>
</tr>
</tbody>
</table>

**TABLE 1**
Response of Interest Rates and Inflation to the Policy News Shock

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Two Empirical Issues

1. “Background noise”

2. Risk premia vs. Expected future short rates
## Background Noise

### TABLE 2
Allowing For Background Noise in Interest Rates

<table>
<thead>
<tr>
<th></th>
<th>Nominal</th>
<th>Real</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-Year Forward</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Policy News Shock, 30-Minute Window:
- **OLS**
  - Real: 0.12 [0.12, 0.36]
  - Nominal: -0.08 [-0.43, 0.28]
- **Rigobon**
  - Real: 0.11 [-0.13, 0.35]
  - Nominal: -0.12 [-0.46, 0.24]

#### Policy News Shock, 1-Day Window:
- **OLS**
  - Real: 0.15 [-0.10, 0.39]
  - Nominal: 0.05 [-0.20, 0.29]
- **Rigobon**
  - Real: -0.04 [-0.51, 0.45]
  - Nominal: -0.51 [-1.93, -0.08]

#### 2-Year Nominal Yield, 1-Day Window
- **OLS**
  - Real: 0.20 [0.02, 0.38]
  - Nominal: 0.18 [0.01, 0.35]
- **Rigobon (90% CI)**
  - Real: -0.04 [-4.57, 0.38]
  - Nominal: -0.51 [-10.00, -0.21]
Simple view: Effect of policy news shock on long-rates reflects change in future expected interest rates (“forward guidance”)

Could these instead be “risk premium” effects?

- We argue not (see also Piazzesi-Swanson 08)
**FUTURE SHORT RATES OR RISK PREMIA?**

Three modes of attack:

1. Look directly at survey expectations (Blue Chip)
   - Not affected by risk premia since direct measure of expectations

2. Affine term structure model (Abrahams et al. 15)
   - Provides a decomposition into changes in expected future short rates and risk premia

3. Mean reversion
   - Do effects on long-term yields appear to mean revert over longer windows
Three modes of attack:

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### Survey Evidence on Risk Premia

**TABLE D.1**

Effects of Monetary Shocks on Survey Expectations

<table>
<thead>
<tr>
<th></th>
<th>Nominal</th>
<th>Real</th>
<th>Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 quarter</td>
<td>1.05</td>
<td>1.17</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>(0.73)</td>
<td>(0.78)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>2 quarters</td>
<td>1.18</td>
<td>1.63</td>
<td>-0.44</td>
</tr>
<tr>
<td></td>
<td>(0.75)</td>
<td>(0.60)</td>
<td>(0.31)</td>
</tr>
<tr>
<td>3 quarters</td>
<td>0.99</td>
<td>1.29</td>
<td>-0.30</td>
</tr>
<tr>
<td></td>
<td>(0.72)</td>
<td>(0.78)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>4 quarters</td>
<td>0.86</td>
<td>1.17</td>
<td>-0.32</td>
</tr>
<tr>
<td></td>
<td>(0.71)</td>
<td>(0.77)</td>
<td>(0.23)</td>
</tr>
<tr>
<td>5 quarters</td>
<td>0.73</td>
<td>0.59</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>(0.89)</td>
<td>(0.94)</td>
<td>(0.21)</td>
</tr>
<tr>
<td>6 quarters</td>
<td>1.84</td>
<td>1.60</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>(0.89)</td>
<td>(0.88)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>7 quarters</td>
<td>4.45</td>
<td>4.29</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>(1.91)</td>
<td>(1.99)</td>
<td>(0.27)</td>
</tr>
</tbody>
</table>
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## Affine Term Structure Model

### TABLE D.2
Response of Expected Future Short Rates and Risk Premia

<table>
<thead>
<tr>
<th></th>
<th>Expected Future Short Rates</th>
<th>Risk Premia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal</td>
<td>Real</td>
</tr>
<tr>
<td><strong>2Y Treasury Yield</strong></td>
<td>1.01</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td>(0.27)</td>
<td>(0.17)</td>
</tr>
<tr>
<td><strong>5Y Treasury Yield</strong></td>
<td>0.76</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>(0.16)</td>
<td>(0.12)</td>
</tr>
<tr>
<td><strong>10Y Treasury Yield</strong></td>
<td>0.50</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.08)</td>
</tr>
<tr>
<td><strong>2Y Treasury Forward Rate</strong></td>
<td>0.79</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>(0.24)</td>
<td>(0.22)</td>
</tr>
<tr>
<td><strong>3Y Treasury Forward Rate</strong></td>
<td>0.61</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.17)</td>
</tr>
<tr>
<td><strong>5Y Treasury Forward Rate</strong></td>
<td>0.36</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.08)</td>
</tr>
<tr>
<td><strong>10Y Treasury Forward Rate</strong></td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
</tr>
</tbody>
</table>

Decomposition of real and nominal term structure from Abrahams et al. (2015)
**Future Short Rates or Risk Premia?**

Three modes of attack:

1. Look directly at survey expectations (Blue Chip)
   - Not affected by risk premia since direct measure of expectations

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3. Mean reversion
   - Do effects on long-term yields appear to mean revert over longer windows
# Mean Reversion

## Table D.3

<table>
<thead>
<tr>
<th>Horizon (Trading Days)</th>
<th>Real Yields</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-Year</td>
</tr>
<tr>
<td>1</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>(0.28)</td>
</tr>
<tr>
<td>5</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td>(0.64)</td>
</tr>
<tr>
<td>10</td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td>(0.55)</td>
</tr>
<tr>
<td>20</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>(0.95)</td>
</tr>
<tr>
<td>60</td>
<td>1.96</td>
</tr>
<tr>
<td></td>
<td>(2.13)</td>
</tr>
<tr>
<td>125</td>
<td>6.16</td>
</tr>
<tr>
<td></td>
<td>(2.86)</td>
</tr>
<tr>
<td>250</td>
<td>9.58</td>
</tr>
<tr>
<td></td>
<td>(2.92)</td>
</tr>
</tbody>
</table>
Policy news shock has:

- Large and persistent effects on real rates
  ...that do not appear to arise from risk premia
- Small effects on expected inflation
Interpretation
Fed affects nominal rates

→ change in nominal rates affects real rates

→ change in real rates affects output and inflation
What Can Real Interest Rates Tell Us?

Fed affects nominal rates

→ change in nominal rates affects real rates

→ change in real rates affects output and inflation

- 2nd step (real rates → output) common to RBC and NK models
- 1st step (nominal rates → real rates) more controversial

Our results provide direct evidence on 1st step
Euler equation:

\[ \hat{y}_t = E_t \hat{y}_{t+1} - \sigma (\hat{t}_t - E_t \hat{\pi}_{t+1}) \]

\[ \rightarrow \hat{x}_t = E_t \hat{x}_{t+1} - \sigma (\hat{t}_t - E_t \hat{\pi}_{t+1} - \hat{r}_t^n) \]

where \( \hat{x}_t = y_t - y_t^n \)

Phillips curve:

\[ \hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \zeta \hat{x}_t \]
Solving Forward

Solve forward Euler equation (assuming $r^n_t$ unchanged) to get

$$\hat{x}_t = -\sigma \sum_{j=0}^{\infty} E_t \hat{x}_{t+j} - E_{t+j} \hat{\pi}_{t+j+1} = -\sigma \hat{r}_t$$

Solve forward the Phillips curve:

$$\hat{\pi}_t = \kappa \zeta \sum_{j=0}^{\infty} \beta^j E_t \hat{x}_{t+j}$$

Combine these two:

$$\hat{\pi}_t = -\kappa \zeta \sigma \sum_{j=0}^{\infty} \beta^j E_t \hat{r}^\ell_{t+j}$$
What Real Rates Tell Us

\[ \hat{\pi}_t = -\kappa \zeta \sigma \sum_{j=0}^{\infty} \beta^j E_t \hat{r}_{t+j} \]

1. Small response of inflation relative to response of real rates implies:
   - Large amounts of nominal and real rigidities (small \( \kappa \zeta \))
   - Small value of intertemporal elasticity of substitution (small \( \sigma \))
   (or both)

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**What Real Rates Tell Us**

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   - Large amounts of nominal and real rigidities (small \( \kappa \zeta \))
   - Small value of intertemporal elasticity of substitution (small \( \sigma \))
   (or both)

2. Output should fall!
TABLE 3
Response of Expected Growth over Next Year for Different Sample Periods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy News Shock</td>
<td>1.01</td>
<td>1.04</td>
<td>0.95</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>(0.32)</td>
<td>(0.35)</td>
<td>(0.32)</td>
<td>(0.63)</td>
</tr>
<tr>
<td>Observations</td>
<td>120</td>
<td>90</td>
<td>52</td>
<td>30</td>
</tr>
</tbody>
</table>
SCATTER PLOT: EXPECTED GROWTH

Figure 2: Binned Scatter Plot for Expected Output Growth Regression
Is this Crazy?

- Maybe not
- When Fed raises rates, people may conclude that economy is stronger than they thought
Is this Crazy?

- Maybe not
- When Fed raises rates, people may conclude that economy is stronger than they thought
- Fed has little private data, but hundreds of PhD economists
- Following Romer-Romer 00, we call this the **Fed Information Effect**
**THE ROLE OF FED INFORMATION**

Conventional interpretation of monetary shocks:

- Fed conveying information **only** about its own future policy

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Conventional interpretation of monetary shocks:

- Fed conveying information **only** about its own future policy
  - Public learning about policy maker’s preferences
  - Public learning about how policy maker thinks the world works
    (but not updating own beliefs about how world works)
The Role of Fed Information

Conventional interpretation of monetary shocks:

- Fed conveying information only about its own future policy
  - Public learning about policy maker’s preferences
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    (but not updating own beliefs about how world works)

Fed information view:

- Fed conveys information about its own future policy
  but also about current and future exogenous shocks
Conventional interpretation of monetary shocks:
- Fed conveying information only about its own future policy
  - Public learning about policy maker’s preferences
  - Public learning about how policy maker thinks the world works (but not updating own beliefs about how world works)

Fed information view:
- Fed conveys information about its own future policy but also about current and future exogenous shocks
  - Suppose Fed tightens policy ...
  - Public infers that Fed is more optimistic about economic outlook ...
  - Public updates its own assessment of economic outlook in response
**How to Model Fed Information?**

- Which fundamentals should Fed be modeled as affecting beliefs about?
- Prior literature assumes Fed signals through actions
  - Very limited signal space
  - Literature about limits to Feds ability to signal
Which fundamentals should Fed be modeled as affecting beliefs about?

Prior literature assumes Fed signals through actions
  - Very limited signal space
  - Literature about limits to Feds ability to signal

Recent empirical evidence makes clear that Fed can signal with statements (forward guidance)
  - Could signal about anything at any horizon
  - Very high dimensional!

Crucial to find a parsimonious specification
How we Model Fed Information

Conventional view of monetary policy shocks:

- Fed conveying information about future monetary policy

\[ \hat{x}_t = -\sigma \sum_{j=0}^{\infty} E_t (\hat{\eta}_{t+j} - \hat{\pi}_{t+j+1} - \hat{r}_{t+j}^n) \]

Fed Information Case:

- Fed conveys information about future monetary policy but also about current and future natural rates of interest

\[ \hat{x}_t = -\sigma \sum_{j=0}^{\infty} E_t (\hat{\eta}_{t+j} - \hat{\pi}_{t+j+1} - \hat{r}_{t+j}^n) \]
**How we Model Fed Information**

Conventional view of monetary policy shocks:

- Fed conveying information about future monetary policy

\[
\hat{x}_t = -\sigma \sum_{j=0}^{\infty} E_t(\hat{i}_{t+j} - \hat{\pi}_{t+j+1} - \hat{r}_{t+j}^n)
\]

Fed Information Case:

- Fed conveys information about future monetary policy but also about current and future natural rates of interest

\[
\hat{x}_t = -\sigma \sum_{j=0}^{\infty} E_t(\hat{i}_{t+j} - \hat{\pi}_{t+j+1} - \hat{r}_{t+j}^n)
\]

In simple model: \[r_{t+j}^n = \sigma^{-1}(E_t y_{t+j+1}^n - y_{t+j}^n)\]
Fed Information Effect

Why model Fed info this way?

- Tractable with forward guidance shocks
- Optimal monetary policy for Fed to track natural rate of interest
- Natural to think of monetary policy as revealing information about natural rate of interest
Estimation
Augmented New Keynesian model:
- Internal habit
- Lagged term in Phillips curve

Monetary policy with Fed information:

\[ \hat{i}_t - E_t \hat{\pi}_{t+1} = \bar{r}_t + \phi_\pi \hat{\pi}_t \]

where \( \bar{r}_t \) follows AR(2)

Strength of Fed Information:

\[ E_t \hat{r}^n_{t+j} = \psi E_t \bar{r}_{t+j} \]

Here \( \psi \) governs strength of Fed information
Estimation Approach

- Simulated method of moments
- High frequency moments:
  - Real yields and forwards (2, 3, 5, and 10-year)
  - Break-even inflation (2, 3, 5, and 10-year)
  - Output growth expectations from Blue Chip
    (monthly responses of 0 qtr to 7 qtr ahead output growth)
- Weighting matrix:
  - Diagonal: Inverse of standard deviations of moments
  - Off-Diagonal: Zero
- Bootstrap standard errors
Estimation Approach

- Estimate key parameters:
  - Slope of Phillips curve ($\kappa \zeta$)
  - Information content of shocks ($\psi$)
  - Dynamics of shock ($\bar{r}_t$ assumed to be AR(2))

- Fix other parameters:
  - $\beta = 0.99$, $\sigma = 0.5$, $b = 0.9$, $\omega = 2$ (standard values)
  - $\phi_\pi = 0.01$ (guarantees determinacy)
Intuition

- What identifies parameters?
  - Path of $\hat{r}_t^{n+j}$ (and thereby strength of Fed information effects) pinned down by survey data on $E_t y_{t+j}$
  - Nominal/real rigidity pinned down by response of inflation ($\pi_t$) relative to $(r_t - r_t^n)$

\[
\hat{\pi}_{t+i} = -\kappa\zeta\sigma \sum_{j=0}^\infty \beta^j E_{t+i}(\hat{r}_{t+i+j}^l - \hat{r}_{t+i+j}^{n^l})
\]
Results
**Large Information Effect**

![Graph showing Natural Interest Rate and Real Interest Rate over quarters](image)

- **Natural Interest Rate**
- **Real Interest Rate**

Quarters: 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40

Nakamura and Steinsson (Columbia)  
Monetary Shocks  
January 2018  
38 / 51
Model Matches Interest Rates and Inflation

- Real Interest Rate
- Nominal Interest Rate
- Inflation

Quarters

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Expected Growth Rises

Nakamura and Steinsson (Columbia)

Monetary Shocks

January 2018
**Phillips Curve**

- Lots of rigidity: Phillips curve very flat
  (in line with recent estimates...)
  - $\kappa \zeta \approx 10^{-4}$
- Shutting down information effect leads to underestimate of slope of the Phillips curve

$$\hat{\pi}_{t+i} = -\kappa \zeta \sigma \sum_{j=0}^{\infty} \beta^j E_{t+i}(\hat{r}^l_{t+i+j} - \hat{r}^{nl}_{t+i+j})$$
MASSIVE EFFECTS ON EXPECTED OUTPUT

Nakamura and Steinsson (Columbia)  Monetary Shocks  January 2018
Fed action signals high future growth
But this doesn’t mean Fed causes high future growth
Fed action signals high future growth
But this doesn’t mean Fed causes high future growth
Changes in non-monetary fundamentals would have occurred anyway!
To assess the causal effect of monetary policy on output, we need to think carefully about the counterfactual
Is this Causal Effect?

- Fed action signals high future growth
- But this doesn’t mean Fed *causes* high future growth
- Changes in non-monetary fundamentals would have occurred anyway!
- To assess the *causal effect* of monetary policy on output, we need to think carefully about the counterfactual

Proposed counterfactual:
- People learn about productivity changes when they happen
- Expect productivity to follow random walk
Causal Effect with Fed Information

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Causal Effect of Monetary Policy

Fed information can have a *causal* effect on output

But it differs from effect on expected output

(most of which would have occurred anyway)

Causal effect of information:

- Good news about future boosts demand today
- Due to internal habit (capital another channel)
- Leads natural rate of output to *rise*
We estimate strong support for two channels of monetary policy:

- Conventional channel: high interest rate gap lowers output
- Information channel: Positive news about the future raises output

Information effect outweighs conventional channel for our shocks

Unexpected monetary contraction can raise output

Fed fighting against itself
If monetary contractions are expansionary and vice versa then is monetary economics turned on its head?
If monetary contractions are expansionary and vice versa then is monetary economics turned on its head?

No!

Most monetary policy is systematic

- Rules based on public information
- No information effect
"Contractionary" Shock: Info vs. No Info

Output Growth

No information effect
With information effect

Quarters

Nakamura and Steinsson (Columbia)
## Improved Fit to Stock Prices

### TABLE 5
Response of Stock Prices

<table>
<thead>
<tr>
<th></th>
<th>Stock Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response in the Data</td>
<td>-6.5</td>
</tr>
<tr>
<td></td>
<td>(3.9)</td>
</tr>
<tr>
<td>Response in the Model</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>-6.8</td>
</tr>
<tr>
<td></td>
<td>[-11.5, -1.6]</td>
</tr>
<tr>
<td>No Fed Information Effect</td>
<td>-11.1</td>
</tr>
<tr>
<td></td>
<td>[-19.4, -2.5]</td>
</tr>
</tbody>
</table>
CONCLUSION

Fed has enormous power over real interest rate

- Nominal and real rates move together several years into term structure
- But output growth expectations rise in response to tightening!

Evidence for two channels:

- Conventional sticky price channel
- Information effect
Extra Slides
IDENTIFICATION BY HETEROSEDASTICITY

Policy news shock ($\Delta i_t$) and other variables of interest ($\Delta s_t$) affected by monetary shock ($\epsilon_t$) and other shocks ($\eta_t$)

$$\Delta i_t = \alpha_i + \epsilon_t + \beta_i\eta_t$$

$$\Delta s_t = \alpha_s + \gamma\epsilon_t + \beta_s\eta_t$$

Two regimes:
- “Treatment” sample: FOMC announcements (R1)
- “Control” sample: Other 30-minute/1-day windows (R2)

Identification assumption:

$$\sigma_{\epsilon,R1} > \sigma_{\epsilon,R2} \quad \text{while} \quad \sigma_{\eta,R1} = \sigma_{\eta,R2}$$
Identification by Heteroskedasticity

\[ \Delta i_t = \alpha_i + \epsilon_t + \beta_i \eta_t \]
\[ \Delta s_t = \alpha_s + \gamma \epsilon_t + \beta_s \eta_t \]

Given this identification assumption, we have:

\[ \gamma = \frac{\text{cov}_{R1}(\Delta i_t, \Delta s_t) - \text{cov}_{R2}(\Delta i_t, \Delta s_t)}{\text{var}_{R1}(\Delta i_t) - \text{var}_{R2}(\Delta i_t)} \]

- If no background noise, you could just run a regression
- Intuitively, OLS adjusted for “normal” covariance between \( \Delta s_t \) and \( \Delta i_t \)
If Fed information is important, contractionary monetary policy shocks should occur when Fed is more optimistic than private sector policy news shock:

$$
\text{policy news shock}_t = \alpha + \beta \left( \Delta y_{t,q}^{GB} - \Delta y_{t,q}^{BC} \right) + \varepsilon_t,
$$

Nakamura and Steinsson (Columbia)
If Fed information is important, contractionary monetary policy shocks should occur when Fed is more optimistic than private sector:

\[
policy \text{ news shock}_t = \alpha + \beta \left( \Delta y_{t,q}^{GB} - \Delta y_{t,q}^{BC} \right) + \epsilon_t,
\]

If private sector learns from Fed, this difference should narrow after announcement:

\[
\left[ \left( \Delta y_{t+1,q}^{GB} - \Delta y_{t+1,q}^{BC} \right) - \left( \Delta y_{t,q}^{GB} - \Delta y_{t,q}^{BC} \right) \right] = \alpha + \beta \text{policy news shock}_t + \epsilon_{t+1}
\]
**TABLE G.1**

Greenbook versus Blue Chip Forecasts

<table>
<thead>
<tr>
<th>Horizon (q):</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta )</td>
<td>1.19</td>
<td>1.01</td>
<td>1.21</td>
<td>1.00</td>
<td>1.20</td>
<td>1.89</td>
<td>3.10</td>
<td>1.88</td>
</tr>
<tr>
<td>(0.55)</td>
<td>(0.74)</td>
<td>(0.69)</td>
<td>(0.77)</td>
<td>(0.90)</td>
<td>(1.10)</td>
<td>(1.14)</td>
<td>(1.64)</td>
<td></td>
</tr>
<tr>
<td>( N )</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>66</td>
<td>42</td>
<td>22</td>
</tr>
</tbody>
</table>

**Does Fed Relative Optimism Explain Monetary Shocks?**

**Does Fed Relative Optimism Reverse in Response to Monetary Shocks?**

<p>| ( \beta ) | -4.07 | -0.45 | -0.87 | -0.46 | -1.66 | -3.58 | -1.34 | -3.04 |
| (1.80)     | (1.53) | (1.30) | (1.08) | (1.11) | (1.31) | (1.30) | (2.44) |
| ( N )    | 89 | 89 | 89 | 89 | 76 | 55 | 32 | 8 |</p>
<table>
<thead>
<tr>
<th></th>
<th>$\psi$</th>
<th>$\kappa \zeta \times 10^{-5}$</th>
<th>$\rho_1$</th>
<th>$\rho_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td>0.68</td>
<td>11.2</td>
<td>0.90</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>[0.33, 0.84]</td>
<td>[0.0, 60.2]</td>
<td>[0.83, 0.96]</td>
<td>[-0.69, 0.89]</td>
</tr>
<tr>
<td><strong>No Information</strong></td>
<td>0.00</td>
<td>3.4</td>
<td>0.90</td>
<td>0.79</td>
</tr>
<tr>
<td>$\psi = 0$</td>
<td>--</td>
<td>[0.0, 24.1]</td>
<td>[0.83, 0.96]</td>
<td>[-0.69, 0.89]</td>
</tr>
<tr>
<td><strong>Full Information</strong></td>
<td>0.99</td>
<td>563</td>
<td>0.90</td>
<td>0.79</td>
</tr>
<tr>
<td>$\psi = 0.99$</td>
<td>--</td>
<td>[0, 12538]</td>
<td>[0.82, 0.96]</td>
<td>[-0.67, 0.89]</td>
</tr>
<tr>
<td><strong>Lower IES</strong></td>
<td>0.67</td>
<td>13.7</td>
<td>0.90</td>
<td>0.79</td>
</tr>
<tr>
<td>$\sigma = 0.25$</td>
<td>[0.25, 0.89]</td>
<td>[0.0, 94.6]</td>
<td>[0.83, 0.96]</td>
<td>[-0.69, 0.89]</td>
</tr>
<tr>
<td><strong>Higher IES</strong></td>
<td>0.68</td>
<td>8.2</td>
<td>0.90</td>
<td>0.79</td>
</tr>
<tr>
<td>$\sigma = 1$</td>
<td>[0.42, 0.81]</td>
<td>[0.0, 44.0]</td>
<td>[0.83, 0.96]</td>
<td>[-0.69, 0.89]</td>
</tr>
<tr>
<td><strong>No Habits</strong></td>
<td>1.00</td>
<td>1000</td>
<td>0.90</td>
<td>0.79</td>
</tr>
<tr>
<td>$b = 0$</td>
<td>[0.92, 1.00]</td>
<td>[0, 43236]</td>
<td>[0.83, 0.96]</td>
<td>[-0.69, 0.89]</td>
</tr>
</tbody>
</table>