Post-FOMC Announcement Drift in U.S. Bond Markets.

Jordan Brooks\textsuperscript{1}  Michael Katz \textsuperscript{2}  Hanno Lustig \textsuperscript{3}

\textsuperscript{1}AQR
\textsuperscript{2}AQR
\textsuperscript{3}Stanford
Forecasting Short Rates

- after FOMC announcement, bond investors face forecasting problem:

\[ y_t^N = \frac{1}{N} \mathbb{E}_t^* \left[ \sum_{j=1}^{N} r_{t+j}^{N-j+1} \right] \]

where \( r_t^N \) denotes the log return on an \( N \)-period bond.

- (rational) expectations hypothesis: investors forecast short rates

\[ y_t^N = \frac{1}{N} \mathbb{E}_t \left[ \sum_{j=1}^{N} r_{t+j-1}^\$ \right] \]

- DGP for short rates: \( r_{t+1}^\$ = (1 - \phi)\theta + \phi r_t^\$ + u_{t+1} \)

- yield on \( N \)-period bond: \( (y_t^{N,RE} - \theta) = \frac{1}{N} \frac{1-\phi^N}{1-\phi} (r_t^\$ - \theta) \).
Response to 1 bps. shock to short rate. Holding period in months. Response for $\phi=0.9$: 
$$\frac{\Delta y_{t+k}^{N,RE}}{\Delta r_t^s} = \frac{1}{N} \frac{1-\phi_N}{1-\phi} \phi^k.$$
Response to 1 bps. shock to short rate. Response for $\phi=0.9$ (full line) and $\phi=0.95$ (dotted line).  
\[
\frac{\Delta y_{t+k}^{N,RE}}{\Delta r_t^s} = \frac{1}{N} \frac{1-\phi^N}{1-\phi} \phi^k.
\]
Term Structure of Yield Responses. $\phi = 0.9$. Maturity on horizontal axis in months.

$$\frac{\Delta y_{t+k}^{N,RE}}{\Delta r_t^S} = \frac{1}{N} \frac{1 - \phi^N}{1 - \phi} \phi^k.$$
Term Structure of Yield Responses. $\phi=0.9$ (bottom line) and $\phi=0.95$ (top line).

Maturity on horizontal axis in months. $\Delta y_{t+k}^{N,RE} = \frac{1}{N} \frac{1-\phi^N}{1-\phi} \phi^k$. 
Computing Impulse Responses of Yields to Mon. Surprises

- $y_t^k$: the par bond yield on Treasury bond with maturity $k$.
- regression of cumulative yield changes between $t - 1$ and $t + j - 1$ on the monetary policy surprise at $t$:

$$y_{τ_i+j}^k - y_{τ_i-1}^k = a_{k,j} + b_{k,j} (-Δr_{τ_i}^u) + ε_{τ_i+j}^{k,j}, j = 1, 2, \ldots \ .$$

where $τ_i \in τ$ is the date of one of the regularly scheduled FOMC meetings.

- news about FFR: innovation in FF futures (nearest contract) on announcement days

$$Δr_t^u = (f_t^0 - f_{t-1}^0) \frac{m}{m - t}.$$
Surprises on Scheduled FOMC Meeting Days: Lumpy FFR News

\[ \Delta r_t^u = \left( f_t^0 - f_{t-1}^0 \right) \frac{m}{m - t} \]

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>FOMC Scheduled</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obs</strong></td>
<td>6760</td>
<td>157</td>
</tr>
<tr>
<td><strong>Mean(abs)</strong></td>
<td>0.164</td>
<td>3.906</td>
</tr>
<tr>
<td><strong>Std</strong></td>
<td>1.849</td>
<td><strong>6.786</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Target Changes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obs</strong></td>
<td>6760</td>
<td>59</td>
</tr>
<tr>
<td><strong>Mean(abs)</strong></td>
<td>0.164</td>
<td>6.456</td>
</tr>
<tr>
<td><strong>Std</strong></td>
<td>1.849</td>
<td><strong>9.587</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>No Target Changes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obs</strong></td>
<td>6760</td>
<td>98</td>
</tr>
<tr>
<td><strong>Mean(abs)</strong></td>
<td>0.164</td>
<td>2.371</td>
</tr>
<tr>
<td><strong>Std</strong></td>
<td>1.849</td>
<td><strong>4.302</strong></td>
</tr>
</tbody>
</table>

Response in bps. of U.S. Treasuries with Constant Maturity to 1 basis points (Kuttner) surprise in FFR after $k$ days. Sample consists of all 157 regularly scheduled FOMC meetings between 2-Nov-1988 and 29-Oct-2008. We plot 2-standard-error bands around the IR.

$$y_{\tau_i+j-1}^k - y_{\tau_i-1} = a_{k,j} + b_{k,j} \left(-\Delta r_{\tau_i}^u\right) + \varepsilon_{\tau_i+j}^k, j = 1, 2, \ldots$$
Response in bps. of U.S. Treasuries with Constant Maturity to 1 basis points (Kuttner) surprise in FFR after \( k \) days. Sample consists of all 59 target changes on regularly scheduled FOMC meetings between 2-Nov-1988 and 29-Oct-2008. We plot 2-standard-error bands around the IR.

\[
y^k_{\tau_i+j-1} - y_{\tau_i-1} = a_{k,j} + b_{k,j} \left(-\Delta r^u_{\tau_i}\right) + \epsilon^k_{\tau_i+j}, j = 1, 2, \ldots.
\]
Response of U.S. Treasuries with Constant Maturity to 1 basis points (Kuttner) surprise in FFR after $k$ days. Sample consists of all 157 regularly scheduled FOMC meetings between 2-Nov-1988 and and 29-Oct-2008.

$$y^k_{\tau_i+j-1} - y_{\tau_i-1} = a_{k,j} + b_{k,j} \left( -\Delta r^u_{\tau_i} \right) + \varepsilon^k_{\tau_i+j}, j = 1, 2, \ldots .$$
Response of U.S. Treasuries with Constant Maturity to 1 basis points (Kuttner) surprise in FFR after \( k \) days. Sample consists of all 59 regularly scheduled FOMC meetings between 2-Nov-1988 and and 29-Oct-2008.

\[
y^{k}_{\tau_{i+j-1}} - y_{\tau_{i-1}} = a_{k,j} + b_{k,j} (-\Delta r^{u}_{\tau_{i}}) + \varepsilon^{k,j}_{\tau_{i+j}}, j = 1, 2, \ldots
\]
Summary

- expectations hypothesis roughly holds on FOMC announcement day
- **puzzling post-announcement drift in yields after FOMC announcements**, especially at long end; contributes to
  - failure of expectations hypothesis
  - excess volatility of long bonds (*CS, 1988*)
  - excess sensitivity of long rates (*GSS, 2005; CP, 2002; HS 2015; GK, 2017*)
  - time-series momentum in fixed income (*MOP, 2012*)
- robust to controlling for
  1. ∆ in expectations about future path ✓
     \[
     y_{\tau_i+j-1}^k - y_{\tau_i-1} = a_{k,j} + \beta_{k,j} \left( -\Delta r_{\tau_i}^u \right) + \gamma_{4,j} \left( f_{\tau_i}^4 - f_{\tau_i-1}^4 \right) + \gamma_{8,j} \left( f_{\tau_i}^8 - f_{\tau_i-1}^8 \right) + \varepsilon_{\tau_i+j}^{k,j}, j = 1, 2, \ldots 
     \]
  2. ∆ in expectations of macro fundamentals ✓
  3. lagged FOMC announcements in window ✓
Summary

- **puzzling post-announcement drift in yields after FOMC announcements**, especially at long end; contributes to
  - failure of expectations hypothesis
  - excess sensitivity of long rates
  - time-series momentum in fixed income

- robust to controlling for
  1. $\Delta$ in expectations about future path ✓
  2. $\Delta$ in expectations of macro fundamentals ✓
     \[
     y_{\tau_i+j-1}^k - y_{\tau_i-1}^k = a_{k,j} + \beta_{k,j} \left(-\Delta r_{\tau_i}^u\right) + \sum_l \gamma_{k,j}^l \Delta \mathbb{F}_{\tau_i}^l(x) + \varepsilon_{\tau_i+j}^{k,j}, j = 1, 2, \ldots.
     \]
  3. lagged FOMC announcements in window ✓

- not robust to including unscheduled FF Target changes
  - (bad) news is revealed about macro-fundamentals
Mechanism: Mutual Fund Flows
Mechanism: Mutual Fund Investors help the Fed

- **less sophisticated capital**: pay attention to fixed income performance and sell (buy) only *after FF rate change*
  - persistent, large flows out of fixed income MFs after surprise Fed Funds rate increases; larger rate increases induce larger outflows
    - MF investors subject to *sticky and extrapolative* expectations
  - MF managers forced to sell Treasurys
  - evidence of flow-induced price pressure in Treasury markets

- slow-moving **sophisticated capital**: arbitrage capital is not leaning against the wind
  - rate changes $\sim$ Treasury supply shocks (similar to evidence from index additions/deletions and Treasury auctions)
Response of U.S. gov’t bond MF returns in bps to 1 bps surprise in FFR (Target Changes) after \( k \) days:

\[
    r_{\tau_i \to \tau_i+j-1}^k = a_{k,j} + b_{k,j} \left( -\Delta r_{\tau_i}^u \right) + \varepsilon_{\tau_i+j-1,j}^k, \; j = 1, 2, \ldots
\]

- same-day return response is \(-1.48\) bps per bps of surprise
- 5-year duration for MFs: approx. \(0.30\) bps response of yields, consistent with the response of 6-year Treasury yield
- 50-day return response is \(12.86\) bps per bps surprise \(>> 7.55 = 5 \times 1.51\) bps response implied by 6-year Treasury yield (see CS, 2007)
Predicting U.S. Mutual Fund Returns

<table>
<thead>
<tr>
<th>All Government Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  5  10  20  50  100</td>
</tr>
<tr>
<td>1  5  10  20  50  100</td>
</tr>
<tr>
<td>-0.72 -1.86 -0.83 -2.64 -7.36 -8.10</td>
</tr>
<tr>
<td>(0.97) (1.20) (1.25) (1.97) (3.08) (3.39)</td>
</tr>
<tr>
<td>0.02 0.11 0.01 0.04 0.15 0.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intermediate Short Government Bonds 1yr &lt; x &lt; 5yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  5  10  20  50  100</td>
</tr>
<tr>
<td>1  5  10  20  50  100</td>
</tr>
<tr>
<td>-0.34 -1.32 -0.68 -2.94 -7.94 -7.92</td>
</tr>
<tr>
<td>(0.70) (1.10) (1.38) (1.85) (3.34) (3.35)</td>
</tr>
<tr>
<td>0.01 0.07 0.01 0.06 0.17 0.11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intermediate Government Bonds 5yrs &lt; x &lt; 10yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  5  10  20  50  100</td>
</tr>
<tr>
<td>1  5  10  20  50  100</td>
</tr>
<tr>
<td>-0.81 -2.14 -1.16 -6.55 -10.76 -8.13</td>
</tr>
<tr>
<td>(1.13) (1.18) (1.70) (3.23) (4.67) (3.93)</td>
</tr>
<tr>
<td>0.02 0.11 0.01 0.12 0.15 0.07</td>
</tr>
</tbody>
</table>

Target Changes only. Forecasting of $k$-day ahead cumulative log returns.

$r^k_{\tau_i+1\rightarrow\tau_i+j-1} = a^k_{j} + b^k_{j} \left(-\Delta r^u_{\tau_i}\right) + \varepsilon^k_{\tau_i+j}, j = 1, 2, \ldots$

- 10 bps surprise: investors realize 73.6 bps in incremental return over 50 days by going long or short in these government bond funds or 3.68% per annum.
- the maximum (annualized) SR increases from buy-and-hold SR of 0.408 to 0.98 at the 50-day horizon $0.98 = \frac{\sqrt{SR^2_{bah} + R^2_k}}{\sqrt{1-R^2_k}},$ where $R^2 = 0.15$.
- 50-day window maximizes predictability, in line with time-series momentum
Response of U.S. mutual fund flows to 100 bps (Kuttner) surprise in FFR after $k$ months. Only target changes. Aggregate Fund flows are divided by aggregate TNA.

total outflow after 12 months as % of TNA in response to 1 std surprise (10 bps):

1.  8% of all gov bond MFs (or $ 128 billion in 2017.Q2)
2.  up to 2% of corporate bond MFs (or $ 48 billion in 2017.Q2)
3.  up to 10% of mortgage MFs
Impulse Response of U.S. Mutual Fund Flows: No Target Changes

Response of U.S. mutual fund flows to 100 basis points (Kuttner) surprise in Federal Funds Rate after $k$ months. No target changes. Aggregate Fund flows are divided by aggregate TNA.
Inelastic Demand for Treasurys

- Fed engineers ‘exogenous shock to net supply’
- 10% outflow reduces cumulative log return between 51.9 and 62.1 bps
  - Assume duration of 5 years
- 10% outflow increases Treasury yields by 10.38 to 12.42 bps
- The implied semi-elasticity of Treasury yields is
  
  \[ 0.089 = \frac{0.001038}{0.011} \]

1% increase in supply increases yields by 8.9 bps per annum
1. **sticky expectations**: only fraction $1 - \lambda$ of MF investors updates

\[ y_{t,N,mf}^i = \frac{1}{N} \mathbb{E}_{t-l(i)}^i \left[ \sum_{j=1}^{N} r_{t+j-1}^s \right] , \]

$t - l(i)$ denotes last update of her short rate forecasts.

(Mankiw and Reiss, 2002; Coibion and Gorodnichenko, 2015)

2. **extrapolation**: MF investors put too much weight on current short rate

\[ r_{t+1}^s = (1 - \phi_{mf}) \theta + \phi_{mf} r_t^s + u_{t+1}, \ \phi_{mf} > \phi \]

(Cieslak, 2018; BSV, 1998; FLM, 2010)
Sticky and Extrapolative Expectations Hypothesis

- The average ‘target’ nominal yield desired by MF investors is given by:

\[
y^N, mf_t - \theta = \frac{1}{N} \sum_{j=0}^{\infty} \frac{(\lambda)^j (1 - \lambda) (1 - \phi^N_mf)}{1 - \phi_{mf}} \phi^j (r^$ t-j - \theta).
\]

- when \(\lambda = 0\), \(y^{N, RE}_t - \theta = \frac{1}{N} \frac{1 - \phi^N_mf}{1 - \phi_m} (r^$ t - \theta)

- The impulse response of the average ‘target’ yield to a short rate shock \(k\) periods ago is given by:

\[
\frac{\Delta y^N, mf_{t+k}}{\Delta r^$ t} = \phi^k \frac{1}{N} \frac{(1 - \lambda) (1 - \phi^N_mf) \left(1 - (\lambda(\frac{\phi_mf}{\phi}))^{k+1}\right)}{(1 - \phi_{mf})(1 - \lambda(\frac{\phi_mf}{\phi}))} > \frac{1}{N} \frac{1 - \phi^N_mf}{1 - \phi_m} \phi^k.
\]
Impulse Response of Yields – Sticky Expectations Hypothesis

Response in bps. in REH Model (full line) and Sticky EH Model (dotted line) to a 1 bps shock. $\phi = 0.9$ and $\phi_{mf} = 0.995$. $\lambda$ is equal to 0.90 (daily frequencies).
Conclusion

- target rate changes by FOMC induce failure of expectations hypothesis:
  - expectations hypothesis seems to hold on FOMC announcement days
  - substantial post-FOMC-announcement drift in Treasury markets
  - drift contributes to failure of expectations hypothesis: long rates too sensitive to short rates

- less sophisticated investors pay attention to FF rate changes:
  - sticky expectations
  - extrapolative expectations

- more sophisticated investors do not readily absorb increased supply