The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment

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What more can monetary policy do when:

- the fed funds rate is 0.18%
- reserves are over a trillion dollars?
One possible answer:
change in maturity structure of outstanding Treasury debt
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1) Is there evidence this made any difference historically?
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change in maturity structure of outstanding Treasury debt

1) Is there evidence this made any difference historically?
2) Is there reason to think it could work at the ZLB?
Maturity structure: December 31, 2006
Average maturity in weeks
Yield data

Use affine-term-structure model to summarize weekly bond yields in terms of 3 observable factors:

\[ f_t = \begin{bmatrix} \text{level} \\ \text{slope} \\ \text{curvature} \end{bmatrix} \]

\[ p_{nt} = \log \text{ price of } n\text{-period pure discount bond} \]

\[ p_{nt} = \bar{a}_n + \bar{b}_n f_t \]

\[ z_{nt} = \text{fraction of my portfolio in bond of maturity } n \]

\[ z_{nt} \bar{b}_{n-1} \varepsilon_{t+1} = \text{risk exposure} \]
Suppose a single mean-variance investor held all the publicly-held Treasury debt

\( \gamma = \) weight on variance in preferences

\[ E(\varepsilon_t \varepsilon_t') = \Sigma \Sigma' \]

\( q_t = \) equilibrium price of risk:

\[
q_t = \gamma \Sigma \Sigma' \sum_{n=2}^{N} z_{nt} \overline{b}_{n-1} \\
(3 \times 1)
\]
Excess holding returns

- Excess holding return
  e.g. hold 5 year bond over 1 year

\[ h_{5,1,t} = \log \frac{P_{4,t+1}}{P_{5,t}} - y_{1,t} \]
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\[ h_{5,t} = \log \frac{P_{4,t+1}}{P_{5,t}} - y_{1,t} \]

- Regression

\[ h_{nkt} = c_{nk} + \beta'_{nk} f_t + \gamma'_{nk} x_t + u_{nkt}. \]
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- Expectation hypothesis: excess holding returns are unpredictable
- ATSM: \( f_t \) contains all the information at \( t \)
Excess holding return regressions

<table>
<thead>
<tr>
<th>Regressors</th>
<th>6m over 3m</th>
<th>1yr over 6m</th>
<th>2y over 1y</th>
<th>5y over 1y</th>
<th>10y over 1y</th>
<th>10y over 1y</th>
</tr>
</thead>
<tbody>
<tr>
<td>$c, f^*_t$</td>
<td>0.357</td>
<td>0.356</td>
<td>0.331</td>
<td>0.295</td>
<td>0.331</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, z^A_t$</td>
<td>0.410</td>
<td>0.420</td>
<td>0.373</td>
<td>0.300</td>
<td>0.336</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.119)</td>
<td>(0.311)</td>
<td>(0.728)</td>
<td>(0.665)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, z^L_t$</td>
<td>0.428</td>
<td>0.501</td>
<td>0.524</td>
<td>0.398</td>
<td>0.357</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.008)</td>
<td>(0.006)</td>
<td>(0.035)</td>
<td>(0.196)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, z^{PC}_t$</td>
<td>0.368</td>
<td>0.361</td>
<td>0.333</td>
<td>0.297</td>
<td>0.334</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.007)</td>
<td>(0.062)</td>
<td>(0.098)</td>
<td>(0.051)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, v_t^*$</td>
<td>0.385</td>
<td>0.409</td>
<td>0.388</td>
<td>0.339</td>
<td>0.338</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.001)</td>
<td>(0.006)</td>
<td>(0.008)</td>
<td>(0.227)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, q_t^*$</td>
<td>0.444</td>
<td>0.568</td>
<td>0.714</td>
<td>0.617</td>
<td>0.549</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, z^{PC}_t, q_t^*$</td>
<td>0.452</td>
<td>0.571</td>
<td>0.717</td>
<td>0.618</td>
<td>0.550</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, v_t, q_t^*$</td>
<td>0.458</td>
<td>0.595</td>
<td>0.737</td>
<td>0.640</td>
<td>0.552</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>$c, f_t, z^A_t, z^L_t, q_t^*$</td>
<td>0.476</td>
<td>0.597</td>
<td>0.741</td>
<td>0.670</td>
<td>0.634</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.002)</td>
<td>(0.054)</td>
<td></td>
</tr>
</tbody>
</table>

$Z^A_t$: average maturity; $Z^L_t$: fraction 10 years; $Z^{PC}_t$: 3 principal components

$V_t$: Cochrane-Piazzesi; $q_t$: Treasury factors
Endogeneity

Goal: if maturities of outstanding debt change, how would yields change?
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Conventional regression

\[ f_t = c + \beta q_t + \varepsilon_t \]
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Concerns:

- Is \( f_t \) responding to \( q_t \), or is \( q_t \) responding to \( f_t \)?
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- Spurious regression
Yield factor forecasting regressions

Our approach:

\[ f_{t+1} = c + \rho f_t + \phi q_t + \epsilon_{t+1} \]
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- nonzero \( \phi \) does not reflect response of \( q_t \) to \( f_t \)
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Advantages:

- answers forecasting question of independent interest
- avoids spurious regression problem
- nonzero \( \phi \) does not reflect response of \( q_t \) to \( f_t \)
- estimate incremental forecasting contribution of \( q_t \) beyond that in \( f_t \)
Significance of Treasury factors

\[ f_{t+1} = c + \rho f_t + \phi q_t + \varepsilon_{t+1} \]

<table>
<thead>
<tr>
<th></th>
<th>( F ) test</th>
</tr>
</thead>
<tbody>
<tr>
<td>level</td>
<td>3.256</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
</tr>
<tr>
<td>slope</td>
<td>4.415</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td>curvature</td>
<td>2.672</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
</tr>
</tbody>
</table>
Quantitative illustration

- Fed sells all Treasury securities < 1 year, and uses proceeds to buy up long-term debt
- E.g. in Dec. 2006, the effect would be to sell $400B short-term securities and buy all bonds > 10 year
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<thead>
<tr>
<th></th>
<th>φ′; Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>level</td>
<td>0.005 (0.112)</td>
</tr>
<tr>
<td>slope</td>
<td>−0.250 (0.116)</td>
</tr>
<tr>
<td>curvature</td>
<td>−0.073 (0.116)</td>
</tr>
</tbody>
</table>

- Δ: average change in qₜ
Impact on yield curve 1-month ahead
Financial Crisis and Zero Lower Bound
Zero Lower Bond

- Short term yields near zero
- Longer term yields considerable fluctuation.
- Explanation: when escape from ZLB (with a probability), interest rates will respond to $f_t$ as before
Parsimonious Model of ZLB

- Same underlying factors $f_t$

\[ f_{t+1} = c + \rho f_t + \Sigma u_{t+1} \]

same $(c, \rho, \Sigma)$
Parsimonious Model of ZLB

- Same underlying factors $f_t$

$$f_{t+1} = c + \rho f_t + \Sigma u_{t+1}$$

same ($c, \rho, \Sigma$)

- Once escape from ZLB

$$\tilde{y}_{1t} = a_1 + b'_1 f_t$$

$$\tilde{p}_{nt} = \bar{a}_n + \bar{b}'_n f_t$$

$\bar{a}_n$ and $\bar{b}_n$ calculated from the same difference equations
Parsimonious Model of ZLB

- At ZLB

\[ y_{1t}^* = a_1^* \]

\[ p_{nt}^* = \bar{a}_n^* + \bar{b}_n^* f_t. \]

\( \pi^Q \): probability still at ZLB next period

No-arbitrage: Can calculate \( \bar{b}_n^* \) (how bond prices load on factors at ZLB) as functions of \( \bar{b}_n \) (how they’d load away from the ZLB) along with \( \pi^Q \) (probability of remaining at ZLB), \( \rho \) (factor dynamics), and \( \Lambda \) (risk parameters).
Parsimonious Model of ZLB

Assume: \((c^Q, \rho^Q, a_1, b_1, \Sigma)\) as estimated pre-crisis
\[\Rightarrow (\bar{a}_n, \bar{b}_n) \text{ same as before}\]

Estimate two new parameters \((a_1^*, \pi^Q)\) to describe 2009:M3-2010:M7 data from

\[Y_{2t} = A_2^\dagger + B_2^\dagger Y_{1t} + \varepsilon_t^e\]

- \(Y_{1t} = 6\)-month, 2-year, 10-year
- \(Y_{2t} = 3\)-month, 1-year, 5-year, 30-year
- \(A_2^\dagger, B_2^\dagger\) functions of \((c^Q, \rho^Q, a_1, b_1, \Sigma)\) and \((a_1^*, \pi^Q)\)
- Estimation method: minimum chi square (Hamilton and Wu, 2010)
Parameter estimates for ZLB

Slightly better fit if allow new value for $a_1$ after escape from ZLB

$5200a_1^* = 0.068$ (ZLB = 0.07% interest rate)

$\pi^Q = 0.9907$ (ZLB may last 108 weeks)

$5200a_1 = 2.19$ (compares with $5200a_1 = 4.12$ pre-crisis–
market expects lower post-ZLB rates than seen pre-crisis)
Actual and fitted values
Factor Loadings
One-month-ahead predicted effect of Fed swapping short-for long-term
One-month-ahead predicted effect of Fed swapping short-for long-term

Note: quantitative easing has almost identical effect as swapping maturities at the ZLB

Hamilton and Wu (UCSD)
## Comparison of alternative estimates

<table>
<thead>
<tr>
<th>Study</th>
<th>Measure</th>
<th>Original estimates</th>
<th>Hamilton-Wu estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gagnon, et. al.</td>
<td>10 yr yield</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Greenwood-Vayanos</td>
<td>5yr-1yr spread</td>
<td>39</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>20yr-1yr spread</td>
<td>74</td>
<td>25</td>
</tr>
<tr>
<td>D’Amico-King</td>
<td>10yr yield</td>
<td>67</td>
<td>14</td>
</tr>
<tr>
<td>Deutsche Bank</td>
<td>10yr yield</td>
<td>20</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 5: Comparison of different estimates of the effect of replacing $400 billion in long-term debt with short-term debt.
Effect of buying intermediate- instead of long-term debt
Combined effect of Fed’s QE2 and Treasury operations

Average maturity of publicly-held Treasury debt

Long-term publicly-held Treasury debt as a percent of total publicly-held Treasury debt
Why the Fed and not the Treasury?

- Possible tool for signaling future short rate plans
- Far from ideal instrument in normal times