Unbundling Quantitative Easing: Taking a Cue from Treasury Auctions

Yuriy Gorodnichenko\textsuperscript{1} Walker Ray\textsuperscript{2}

\textsuperscript{1}UC Berkeley and NBER
\textsuperscript{2}UC Berkeley

July 8, 2019

NBER SI 2019
Policy Response to the Great Recession

Notes: Federal Reserve holdings of Treasuries (by maturity) and Mortgage-Backed Securities. Vertical lines indicate the start of LSAP programs. Source: FRED.
Policy Response to the Great Recession

Notes: Federal Reserve holdings of Treasuries (by maturity) and Mortgage-Backed Securities. Vertical lines indicate the start of LSAP programs. Source: FRED.
Policy Response to the Great Recession

Notes: Federal Reserve holdings of Treasuries (by maturity) and Mortgage-Backed Securities. Vertical lines indicate the start of LSAP programs. Source: FRED.
Policy Response to the Great Recession

Notes: Federal Reserve holdings of Treasuries (by maturity) and Mortgage-Backed Securities. Vertical lines indicate the start of LSAP programs. Source: FRED.
Policy Response to the Great Recession

Notes: Federal Reserve holdings of Treasuries (by maturity) and Mortgage-Backed Securities. Vertical lines indicate the start of LSAP programs. Source: FRED.
Did QE Work?

Bernanke: “QE works in practice but not in theory”
Did QE Work?

Bernanke: “QE works in practice but not in theory”
Did QE Work?

Bernanke: “QE works in practice but not in theory”

Standard macro-finance theory: no clear role for QE
How Did QE Work?

Possible channels:

• Forward guidance
  ▶ FOMC (Dec 16, 2008): “The Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time”

• “Delphic” effect
  ▶ Bernanke (Dec 1, 2008): “As you know, this extraordinary period of financial turbulence is now well into its second year.”

• Preferred habitat
  ▶ Bernanke (Dec 1, 2008): “The Fed could purchase longer-term Treasury or agency securities on the open market in substantial quantities. This approach might influence the yields on these securities.”

• And many more...
Testing the Channels

- Empirical difficulties: only a handful (3? 4?) of QE events

E.g. suppose the Chinese central bank announces $300 billion plan to buy Treasuries to commemorate anniversary
Testing the Channels

- Empirical difficulties: only a handful (3? 4?) of QE events
- Indirect approach: can we find natural experiments which rule out some channels?
Testing the Channels

- Empirical difficulties: only a handful (3? 4?) of QE events
- Indirect approach: can we find natural experiments which rule out some channels?
  - E.g. suppose the Chinese central bank announces $300 billion plan to buy Treasuries to commemorate anniversary
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

- Why Treasury auctions?
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

- Why Treasury auctions?
  1. Large volume ($150 billion auctioned monthly in recent years)
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

- Why Treasury auctions?

  1. Large volume ($150 billion auctioned monthly in recent years) ➞ comparable to QE
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

Why Treasury auctions?

1. Large volume ($150 billion auctioned monthly in recent years) $\Rightarrow$ comparable to QE

2. Information going back to 1979
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

Why Treasury auctions?

1. Large volume ($150 billion auctioned monthly in recent years)  
   \[\Rightarrow\] comparable to QE

2. Information going back to 1979  
   \[\Rightarrow\] many observations, study crisis vs. normal times
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

Why Treasury auctions?

1. Large volume ($150 billion auctioned monthly in recent years) ⇒ comparable to QE

2. Information going back to 1979 ⇒ many observations, study crisis vs. normal times

3. Specific maturities are spread in time
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

- Why Treasury auctions?
  1. Large volume ($150 billion auctioned monthly in recent years)  
     \[\Rightarrow\] comparable to QE
  2. Information going back to 1979  
     \[\Rightarrow\] many observations, study crisis vs. normal times
  3. Specific maturities are spread in time  
     \[\Rightarrow\] mimics targeted purchases in maturity space
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

Why Treasury auctions?

1. Large volume ($150 billion auctioned monthly in recent years) ⇒ comparable to QE

2. Information going back to 1979 ⇒ many observations, study crisis vs. normal times

3. Specific maturities are spread in time ⇒ mimics targeted purchases in maturity space

4. Institutional setup and auction timing (and futures prices)
What We Do: Treasury Auctions

- Use Treasury auctions to assess the role of preferred habitat theories in rationalizing QE effects

Why Treasury auctions?

1. Large volume ($150 billion auctioned monthly in recent years) \(\Rightarrow\) comparable to QE

2. Information going back to 1979 \(\Rightarrow\) many observations, study crisis vs. normal times

3. Specific maturities are spread in time \(\Rightarrow\) mimics targeted purchases in maturity space

4. Institutional setup and auction timing (and futures prices) \(\Rightarrow\) high-frequency identification of demand shocks
We construct a new measure of Treasury demand shocks to study the preferred habitat channel
  ▶ Mini-QE shocks, unbundled from other channels
Preview: Main Findings

- We construct a new measure of Treasury demand shocks to study the preferred habitat channel
  - Mini-QE shocks, unbundled from other channels

- Relatively large surprise movements
  - One std. dev. shock of our measure moves yields by ≈ 2 bp
  - Compare to Bernanke’s speech on Dec 1, 2008: ≈ 9 bp
We construct a new measure of Treasury demand shocks to study the preferred habitat channel

- Mini-QE shocks, unbundled from other channels

- Relatively large surprise movements
  - One std. dev. shock of our measure moves yields by $\approx 2 \text{ bp}$
  - Compare to Bernanke’s speech on Dec 1, 2008: $\approx 9 \text{ bp}$

- Idiosyncratic shocks, mostly driven by institutional investors
Preview: Main Findings

- We construct a new measure of Treasury demand shocks to study the preferred habitat channel
  - Mini-QE shocks, unbundled from other channels

- Relatively large surprise movements
  - One std. dev. shock of our measure moves yields by $\approx 2$ bp
  - Compare to Bernanke’s speech on Dec 1, 2008: $\approx 9$ bp

- Idiosyncratic shocks, mostly driven by institutional investors

- Demand shocks have state-dependent effects on yield curve
  - More “localization” during financial disruptions
  - Confirms key prediction of preferred habitat models
Preview: Main Findings

- We construct a new measure of Treasury demand shocks to study the preferred habitat channel
  - Mini-QE shocks, unbundled from other channels
- Relatively large surprise movements
  - One std. dev. shock of our measure moves yields by $\approx 2$ bp
  - Compare to Bernanke’s speech on Dec 1, 2008: $\approx 9$ bp
- Idiosyncratic shocks, mostly driven by institutional investors
- Demand shocks have state-dependent effects on yield curve
  - More “localization” during financial disruptions
  - Confirms key prediction of preferred habitat models
- Quantitatively: preferred habitat can account for most of QE effects
The Treasury Primary Market

- 2-, 3-, 5-, and 7-year notes auctioned every month
- 10-year notes and 30-year bonds auctioned every Feb, May, Aug, and Nov; “reopenings” in other months
- “Regular and predictable”
Treasury Auctions: Participants

- Bidders by type:
  - Primary dealers
  - Direct bidders
  - Indirect bidders
Treasury Auctions: Participants

- Bidders by type:
  - Primary dealers
  - Direct bidders
  - Indirect bidders

- Bidding:
  - Competitive
  - Non-competitive
Treasury Auctions: Participants

- Bidders by type:
  - Primary dealers
  - Direct bidders
  - Indirect bidders

- Bidding:
  - Competitive
  - Non-competitive

- Who participates?
  - Investment Funds
  - Pension Funds and Insurance Companies
  - Depository Institutions
  - Individuals
  - Primary Dealers and Brokers
  - Foreign and International
  - Federal Reserve (SOMA)*
  - Other
Treasury Auctions: Timing

- $T_0$: Announcement
- Bidding opens

- $T_1$: Close
- Results

- $T_2$: Approx. 3 days

- $T_3$: Issuance

Approx. 5 days

< 30 min
Treasury Auctions: Timing

- $T_0$: Announcement
- Bidding opens
- $T_1$: Close
- $T_2$: Results
- $T_3$: Issuance

$\approx 5$ days

$\approx 3$ days

$\leq 30$ min
Treasury Auctions: Timing

$T_0$  
Announcement
Bidding opens

$\approx 5$ days

$T_1$  
Close

$T_2$  
Results

$\approx 3$ days

$T_3$  
Issuance

$< 30$ min
Treasury Auctions: Timing

$T_0$  Announcement
Bidding opens

$T_1$  $T_2$  $T_3$
Close  Results  Issuance

$\approx 5$ days  $\approx 3$ days

$< 30$ min
Treasury Auctions: Timing

- $T_0$: Announcement
- $T_1$: Bidding opens
- $T_2$: Close
- $T_3$: Results
- $\approx 5$ days
- $\approx 3$ days
- $< 30$ min

- Issue date
## TREASURY OFFERING ANNOUNCEMENT

**Term and Type of Security**
- 30-Year Bond

**Offering Amount**
- $16,000,000,000

**Currently Outstanding**
- $0

**CUSIP Number**
- 912810QS0

**Auction Date**
- August 11, 2011

**Original Issue Date**
- August 15, 2011

**Issue Date**
- August 11, 2011

**Maturity Date**
- August 15, 2041

**Dated Date**
- August 15, 2011

**Series**
- Bonds of August 2041

**Yield**
- Determined at Auction

**Interest Rate**
- Determined at Auction

**Interest Payment Dates**
- February 15 and August 15

**Accrued Interest from 08/15/2011 to 08/15/2011**
- None

**Premium or Discount**
- Determined at Auction

**Minimum Amount Required for STRIPS**
- $100

**Corpus CUSIP Number**
- 912803DT7

**Additional TINT(s) Due Date(s) and CUSIP Number(s)**
- August 15, 2041
- 912834KP2

**Maximum Award**
- $5,600,000,000

**Maximum Recognized Bid at a Single Yield**
- $5,600,000,000

**NLP Reporting Threshold**
- $5,600,000,000

**NLP Exclusion Amount**
- $0

**Minimum Bid Amount and Multiples**
- $100

**Competitive Bid Yield Increments**
- 0.001%

**Maximum Noncompetitive Award**
- $5,000,000

**Eligible for Holding in Treasury Direct Systems**
- Yes

**Eligible for Holding in Legacy Treasury Direct**
- No

**Estimated Amount of Maturing Coupon Securities Held by the Public**
- $24,430,000,000

**Maturing Date**
- August 15, 2011

**SOMA Holdings Maturing**
- $2,205,000,000

**SOMA Amounts Included in Offering Amount**
- No

**FIMA Amounts Included in Offering Amount**
- Yes

**Noncompetitive Closing Time**
- 12:00 Noon ET

**Competitive Closing Time**
- 1:00 p.m. ET
## TREASURY AUCTION RESULTS

<table>
<thead>
<tr>
<th>Term and Type of Security</th>
<th>30-Year Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUSIP Number</td>
<td>912810QS0</td>
</tr>
<tr>
<td>Series</td>
<td>Bonds of August 2041</td>
</tr>
</tbody>
</table>

| Interest Rate             | 3-3/4%   |
| High Yield\(^1\)          | 3.750%   |
| Allotted at High          | 41.74%   |
| Price                     | 100.00000|
| Accrued Interest per $1,000| None     |
| Median Yield\(^2\)        | 3.629%   |
| Low Yield\(^3\)           | 3.537%   |

| Issue Date                | August 15, 2011 |
| Maturity Date             | August 15, 2041 |
| Original Issue Date       | August 15, 2011 |
| Dated Date                | August 15, 2011 |

<table>
<thead>
<tr>
<th>Tendered</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive</td>
<td>$33,305,800,000</td>
</tr>
<tr>
<td>Noncompetitive</td>
<td>$14,855,600</td>
</tr>
<tr>
<td>FIMA (Noncompetitive)</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal(^4)</strong></td>
<td>$33,320,655,600</td>
</tr>
<tr>
<td>SOMA</td>
<td>$489,928,400</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$33,810,584,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tendered</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Dealer(^6)</td>
<td>$23,734,000,000</td>
</tr>
<tr>
<td>Direct Bidder(^7)</td>
<td>$6,567,000,000</td>
</tr>
<tr>
<td>Indirect Bidder(^8)</td>
<td>$3,004,800,000</td>
</tr>
<tr>
<td><strong>Total Competitive</strong></td>
<td>$33,305,800,000</td>
</tr>
</tbody>
</table>

1. All tenders at lower yields were accepted in full.
2. Awards to combined Treasury Direct systems = $5,358,600.
3. 50% of the amount of accepted competitive tenders was tendered at or below that yield.
4. Non-Primary dealer submitters bidding for their own house accounts.
5. Foreign and International Monetary Authorities placing bids through the Federal Reserve Bank of New York.
6. Bid-to-Cover Ratio: $33,320,655,600/$16,000,015,600 = 2.08
Treasury Futures

- Traded on Chicago Mercantile Exchange
  - Contracts introduced in 70s and 80s
  - High volume (millions of contracts traded every day)
  - Intraday data (1995-present)

- Four main types of contracts
  - 2-year (remaining maturity 1 year 9 months to 2 years)
  - 5-year (4 years 2 months to 5 years 3 months)
  - 10-year (6 years 6 months to 10 years)
  - 30-year (at least 15 years)

- Match futures contracts to auctioned securities
  - E.g. 10-year futures matched to 7-year auction
Treasury Futures

- Traded on Chicago Mercantile Exchange
  - Contracts introduced in 70s and 80s
  - High volume (millions of contracts traded every day)
  - Intraday data (1995-present)

- Four main types of contracts
  - 2-year (remaining maturity 1 year 9 months to 2 years)
  - 5-year (4 years 2 months to 5 years 3 months)
  - 10-year (6 years 6 months to 10 years)
  - 30-year (at least 15 years)

- Match futures contracts to auctioned securities
  - E.g. 10-year futures matched to 7-year auction
Constructing Treasury Demand Shocks

\[ D_t^{(m)} = \left( \log P_{t,post}^{(m)} - \log P_{t,pre}^{(m)} \right) \times 100 \]

- Shocks constructed from intraday window on auction dates
  - \( t \): date of auction
  - \( m \): maturity
  - \( P_{t,pre}^{(m)}, P_{t,post}^{(m)} \): futures price 30 mins before the auction closes, and 30 mins after results are released
Constructing Treasury Demand Shocks

$$D_t^{(m)} = \left( \log P_{t,\text{post}}^{(m)} - \log P_{t,\text{pre}}^{(m)} \right) \times 100$$

- Shocks constructed from intraday window on auction dates
  - $t$: date of auction
  - $m$: maturity
  - $P_{t,\text{pre}}^{(m)}, P_{t,\text{post}}^{(m)}$: futures price 30 mins before the auction closes, and 30 mins after results are released

- **Identifying assumption**: supply factors (the amount on auction, security characteristics, etc) are fixed days before the close of the auction

- $D_t^{(m)}$ can only move in response to unexpected changes in demand conditions
Demand Shocks Time Series

2-year futures price

5-year futures price

10-year futures price

30-year futures price
## Demand Shock Descriptive Statistics

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>N</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>$D_t^{(2Y)}$</td>
<td>-0.000</td>
<td>0.034</td>
<td>871</td>
<td>1.000</td>
</tr>
<tr>
<td>$D_t^{(5Y)}$</td>
<td>0.002</td>
<td>0.092</td>
<td>871</td>
<td>0.866</td>
</tr>
<tr>
<td>$D_t^{(10Y)}$</td>
<td>0.007</td>
<td>0.143</td>
<td>871</td>
<td>0.782</td>
</tr>
<tr>
<td>$D_t^{(30Y)}$</td>
<td>0.006</td>
<td>0.245</td>
<td>871</td>
<td>0.672</td>
</tr>
</tbody>
</table>
August 11, 2011. Financial Times: “An auction of 30-year US Treasury bonds saw weak demand... bidders such as pension funds, insurers and foreign governments shied away. ‘There’s not too many ways you can slice this one, it was a very poorly bid auction.’”
December 12, 2010. Financial Times: “Large domestic financial institutions and foreign central banks were big buyers at an auction of 30-year US Treasury bonds on Thursday. ‘Investors weren’t messing around...You don’t get the opportunity to buy large amounts of paper outside the auctions and ‘real money’ were aggressive buyers.’”
What Determines Shocks?

2-year futures price

5-year futures price

10-year futures price

30-year futures price
What Determines Shocks?

<table>
<thead>
<tr>
<th>Bid-to-Cover</th>
<th>$D_{t}^{2Y}$</th>
<th>$D_{t}^{5Y}$</th>
<th>$D_{t}^{10Y}$</th>
<th>$D_{t}^{30Y}$</th>
<th>Pool $D_{t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bid-to-cover ratio</td>
<td>1.421***</td>
<td>1.402***</td>
<td>2.053***</td>
<td>2.108***</td>
<td>1.633***</td>
</tr>
<tr>
<td></td>
<td>(0.240)</td>
<td>(0.224)</td>
<td>(0.206)</td>
<td>(0.532)</td>
<td>(0.136)</td>
</tr>
<tr>
<td>Observations</td>
<td>238</td>
<td>306</td>
<td>227</td>
<td>100</td>
<td>871</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.156</td>
<td>0.207</td>
<td>0.306</td>
<td>0.275</td>
<td>0.218</td>
</tr>
</tbody>
</table>
### What Determines Shocks?

<table>
<thead>
<tr>
<th></th>
<th>$D_t^{2Y}$</th>
<th>$D_t^{5Y}$</th>
<th>$D_t^{10Y}$</th>
<th>$D_t^{30Y}$</th>
<th>Pool $D_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bid-to-Cover</strong></td>
<td>1.421***</td>
<td>1.402***</td>
<td>2.053***</td>
<td>2.108***</td>
<td>1.633***</td>
</tr>
<tr>
<td></td>
<td>(0.240)</td>
<td>(0.224)</td>
<td>(0.206)</td>
<td>(0.532)</td>
<td>(0.136)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>238</td>
<td>306</td>
<td>227</td>
<td>100</td>
<td>871</td>
</tr>
<tr>
<td><strong>$R^2$</strong></td>
<td>0.156</td>
<td>0.207</td>
<td>0.306</td>
<td>0.275</td>
<td>0.218</td>
</tr>
</tbody>
</table>

#### Total bid-to-cover ratio

<table>
<thead>
<tr>
<th><strong>Fraction accepted by bidder type</strong></th>
<th>Investment Funds</th>
<th>Foreign</th>
<th>Misc</th>
<th>Observations</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bid-to-Cover</strong></td>
<td>4.800***</td>
<td>3.401***</td>
<td>2.797**</td>
<td>174</td>
<td>0.214</td>
</tr>
<tr>
<td></td>
<td>(0.908)</td>
<td>(0.854)</td>
<td>(1.162)</td>
<td>(2.614)</td>
<td></td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>241</td>
<td>201</td>
<td>84</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td><strong>$R^2$</strong></td>
<td>0.128</td>
<td>0.287</td>
<td>0.391</td>
<td>0.191</td>
<td></td>
</tr>
</tbody>
</table>
**Comovement: Debt Markets**

The model is:

\[ y_t = \alpha + \phi D_t + \varepsilon_t \]

<table>
<thead>
<tr>
<th>Dep. variable: asset type</th>
<th>Estimate (s.e.)</th>
<th>N</th>
<th>( R^2 )</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLT</td>
<td>0.312*** (0.016)</td>
<td>662</td>
<td>0.679</td>
<td>2002-2015</td>
</tr>
<tr>
<td>SHY</td>
<td>0.022*** (0.001)</td>
<td>662</td>
<td>0.528</td>
<td>2002-2015</td>
</tr>
<tr>
<td>LQD</td>
<td>0.110*** (0.008)</td>
<td>662</td>
<td>0.544</td>
<td>2002-2015</td>
</tr>
<tr>
<td>Aaa†</td>
<td>-2.295*** (0.212)</td>
<td>871</td>
<td>0.173</td>
<td>1995-2015</td>
</tr>
</tbody>
</table>

Notes: dep. variable \( y_t \) is intraday change in asset, except for † denotes daily frequency. TLT: long-term Treasury ETF. SHY: short-term Treasury ETF. LQD: corporate bond ETF.
## Comovement: Equity Markets

$$y_t = \alpha + \phi D_t + \varepsilon_t$$

<table>
<thead>
<tr>
<th>Dep. variable: asset type</th>
<th>Estimate (s.e.)</th>
<th>N</th>
<th>$R^2$</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPY</td>
<td>-0.020 (0.018)</td>
<td>871</td>
<td>0.005</td>
<td>1995-2015</td>
</tr>
<tr>
<td>IWM</td>
<td>-0.081*** (0.024)</td>
<td>706</td>
<td>0.034</td>
<td>2000-2015</td>
</tr>
<tr>
<td>SP500†</td>
<td>-0.072 (0.064)</td>
<td>871</td>
<td>0.004</td>
<td>1995-2015</td>
</tr>
<tr>
<td>Russell 2000†</td>
<td>-0.169** (0.069)</td>
<td>871</td>
<td>0.013</td>
<td>1995-2015</td>
</tr>
</tbody>
</table>

Notes: dep. variable $y_t$ is intraday change in asset, except for † denotes daily frequency. SPY: S&P500 ETF. IWM: Russell 2000 ETF.
\[ y_t = \alpha + \phi D_t + \varepsilon_t \]

<table>
<thead>
<tr>
<th>Dep. variable: asset type</th>
<th>Estimate (s.e.)</th>
<th>N</th>
<th>( R^2 )</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>10Y Inflation Swap†</td>
<td>-0.172</td>
<td>618</td>
<td>0.003</td>
<td>2004-2015</td>
</tr>
<tr>
<td></td>
<td>(0.131)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2Y Inflation Swap†</td>
<td>0.044</td>
<td>618</td>
<td>0.000</td>
<td>2004-2015</td>
</tr>
<tr>
<td></td>
<td>(0.229)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLD</td>
<td>0.021</td>
<td>595</td>
<td>0.004</td>
<td>2004-2015</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCI†</td>
<td>0.008</td>
<td>871</td>
<td>0.000</td>
<td>1995-2015</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: dep. variable \( y_t \) is intraday change in asset, except for † denotes daily frequency. GLD: Gold bullion ETF. GSCI: S&P Commodity Index.
Comovement: Spreads and CDS

\[ y_t = \alpha + \phi D_t + \varepsilon_t \]

<table>
<thead>
<tr>
<th>Dep. variable: asset type</th>
<th>Estimate (s.e.)</th>
<th>N</th>
<th>( R^2 )</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Baa-Aaa(^\dagger)</td>
<td>-0.056 (0.074)</td>
<td>871</td>
<td>0.001</td>
<td>1995-2015</td>
</tr>
<tr>
<td>Auto CDS(^\dagger)</td>
<td>-3.254 (5.796)</td>
<td>627</td>
<td>0.000</td>
<td>2004-2015</td>
</tr>
<tr>
<td>Bank CDS(^\dagger)</td>
<td>0.426 (0.450)</td>
<td>627</td>
<td>0.004</td>
<td>2004-2015</td>
</tr>
<tr>
<td>3-month LIBOR-OIS(^\dagger)</td>
<td>-0.002 (0.002)</td>
<td>630</td>
<td>0.006</td>
<td>2003-2015</td>
</tr>
<tr>
<td>VIX(^\dagger)</td>
<td>0.058 (0.082)</td>
<td>871</td>
<td>0.001</td>
<td>1995-2015</td>
</tr>
</tbody>
</table>

Notes: dep. variable \( y_t \) is intraday change in asset, except for \(^\dagger\) denotes daily frequency.
Comovement Across Maturities
Comovement Across Maturities

![Graph showing yield vs maturity with a demand shock at a certain maturity.](image-url)
Comovement Across Maturities
Comovement Across Maturities

- Yield vs. Maturity
- Demand shock

Graph showing the relationship between yield and maturity, with a vertical dashed line indicating a demand shock.
Comovement Across Maturities
Comovement Across Maturities

Yield

Maturity

Demand shock
Preferred Habitat Model

- What does theory tell us?
  - [Vayanos and Vila (2009), Greenwood and Vayanos (2014), Ray (2019)]

- Formalized preferred habitat:
  - Clientele investors with maturity-specific demand
  - Short-lived arbitrageurs with imperfect risk-bearing capacity
  - Sources of risk: “fundamental” (including the short-term rate) and “idiosyncratic” demand shocks
Preferred Habitat Model

- **What does theory tell us?**
  - [Vayanos and Vila (2009), Greenwood and Vayanos (2014), Ray (2019)]

- **Formalized preferred habitat:**
  - Clientele investors with maturity-specific demand
  - Short-lived arbitrageurs with imperfect risk-bearing capacity
  - Sources of risk: “fundamental” (including the short-term rate) and “idiosyncratic” demand shocks

- **Prediction:** state-dependent effects, localization when bond markets are disrupted
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

**Short-Maturity Demand Shock**

**Long-Maturity Demand Shock**
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
State-Dependent Yield Curve Response

Short-Maturity Demand Shock

Long-Maturity Demand Shock
Empirical Specification

**Hypothesis:** effects of demand shocks become more localized when bond markets are disrupted

- Estimate:

  \[
  \Delta R_t^{(m)} = \alpha^{(m)} + \beta^{(m)} D_t + \varepsilon_t^{(m)}
  \]

  - \(t\): date of auction
  - \(m\): maturity
  - \(\Delta R_t^{(m)}\): change in \(m\)-year yield (daily, Gurkaynak-Sack-Wright)
  - \(D_t\): demand shock corresponding to auction
Empirical Specification

**Hypothesis:** effects of demand shocks become more localized when bond markets are disrupted

- **Estimate:**
  \[
  \Delta R_t^{(m)} = \alpha^{(m)} + \beta^{(m)} D_t + \varepsilon_t^{(m)}
  \]
  - \( t \): date of auction
  - \( m \): maturity
  - \( \Delta R_t^{(m)} \): change in \( m \)-year yield (daily, Gurkaynak-Sack-Wright)
  - \( D_t \): demand shock corresponding to auction

- **Compare \( \hat{\beta}^{(m)} \) for different samples:**
  - Auctions of different maturities (short vs. long)
  - Different financial regimes (normal vs. crisis, Romer-Romer)
Yield Curve Response $\hat{\beta}^{(m)}$
Yield Curve Response $\hat{\beta}(m)$
Yield Curve Response $\hat{\beta}^{(m)}$

IV specification: bid-to-cover as instruments for demand shocks $D_t$
Can QE target long-term rates relative to short-term rates?

- During financial crises: yes, by buying long-term securities
- During normal times: unlikely
  - Entire term structure will move
  - Largest effects may be for maturities not directly purchased
Can QE target long-term rates relative to short-term rates?

- During financial crises: yes, by buying long-term securities
- During normal times: unlikely
  - Entire term structure will move
  - Largest effects may be for maturities not directly purchased

Can QE move the entire term structure of interest rates?

- During normal times: probably
- During financial crises: unlikely
  - But purchases across the entire term structure may be effective
Quantitative Implications for QE

- Our goal was to study one channel of QE: preferred habitat
- Can we say anything about quantitative importance vs. other channels?

\[ \Delta R_t = f(QE_t) \]

\[ = f(X_1(QE_t), X_2(QE_t), \ldots, X_k(QE_t)) \]

\[ \approx \alpha_1 X_{1,t} + \alpha_2 X_{2,t} + \ldots + \alpha_k X_{k,t} + \varepsilon_t \]

- where
  - \( X_{1,t} \) is preferred habitat
  - \( X_{2,t} \) is forward guidance
  - \( \ldots \)
  - \( X_{k,t} \) is the \( k^{th} \) theory of how QE works
Quantitative Implications for QE

- Our goal was to study one channel of QE: preferred habitat
- Can we say anything about quantitative importance vs. other channels?

\[
\Delta R_t = f(QE_t)
= f(X_1(QE_t), X_2(QE_t), \ldots, X_k(QE_t))
\approx \alpha_1 X_{1,t} + \alpha_2 X_{2,t} + \ldots + \alpha_k X_{k,t} + \varepsilon_t
\]

- where
  - \(X_{1,t}\) is preferred habitat
  - \(X_{2,t}\) is forward guidance
  - \(\ldots\)
  - \(X_{k,t}\) is the \(k^{th}\) theory of how QE works

- Observe \(\Delta R_t\)
- Our results can be used to estimate \(\hat{\alpha}_1 X_{1,t}\)
Quantitative Implications for QE

Table: Response of 5-year Treasury yield

<table>
<thead>
<tr>
<th>Date</th>
<th>Intraday Window</th>
<th>2-day Window</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 25, 2008</td>
<td></td>
<td>-23</td>
</tr>
<tr>
<td>Dec 1, 2008</td>
<td>-9.2</td>
<td>-28</td>
</tr>
<tr>
<td>Dec 16, 2008</td>
<td>-16.8</td>
<td>-15</td>
</tr>
<tr>
<td>Jan 28, 2009</td>
<td>3.1</td>
<td>28</td>
</tr>
<tr>
<td>Mar 18, 2009</td>
<td>-22.8</td>
<td>-26</td>
</tr>
<tr>
<td>Cumulative</td>
<td>-45.0</td>
<td>-74</td>
</tr>
</tbody>
</table>

Quantitative Implications for QE

\[ \Delta R_t \approx \alpha_1 X_{1,t} + \alpha_2 X_{2,t} + \ldots + \alpha_k X_{k,t} + \varepsilon_t \]

- Total observed response \( \Delta R_t \in [45, 74] \) bp
Quantitative Implications for QE

\[ \Delta R_t \approx \alpha_1 X_{1,t} + \alpha_2 X_{2,t} + \ldots + \alpha_k X_{k,t} + \varepsilon_t \]

- Total observed response \( \Delta R_t \in [45, 74] \) bp

- \( \alpha_1 X_{1,t} \) estimate:
  - Unit shock to the bid-to-cover ratio (\( \approx \$30 \) billion) \( \Rightarrow \) 3.3 bp decline in yields during crisis
  - Hence, $300 billion shock \( \Rightarrow \) 33 bp [23 bp, 48 bp] decline
Quantitative Implications for QE

\[ \Delta R_t \approx \alpha_1 X_{1,t} + \alpha_2 X_{2,t} + \ldots + \alpha_k X_{k,t} + \varepsilon_t \]

- Total observed response \( \Delta R_t \in [45, 74] \) bp
- \( \hat{\alpha}_1 X_{1,t} \) estimate:
  - Unit shock to the bid-to-cover ratio (\( \approx \$30 \) billion) \( \Rightarrow \) 3.3 bp decline in yields during crisis
  - Hence, \$300 billion shock \( \Rightarrow \) 33 bp [23 bp, 48 bp] decline
- Consistent with the view that the net effect of other channels is small
Concluding Remarks

- We use Treasury auctions to better understand QE
  - Rule out alternative channels, focus on preferred habitat
  - Benefits: lots of data
  - We confirm key predictions of preferred habitat models: strong localized effect of demand shocks during financial disruptions
Concluding Remarks

- We use Treasury auctions to better understand QE
  - Rule out alternative channels, focus on preferred habitat
  - Benefits: lots of data
    - We confirm key predictions of preferred habitat models: strong localized effect of demand shocks during financial disruptions
- QE works through preferred habitat
  - Quantitative significance of other channels on net is small
- QE is an effective tool during financial crises, but less likely to be so in normal times
APPENDIX
<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offering Amount (billions)</td>
<td>22.03</td>
<td>9.36</td>
</tr>
<tr>
<td>Total Tendered (billions)</td>
<td>61.46</td>
<td>32.04</td>
</tr>
<tr>
<td>Bid-to-Cover</td>
<td>.62</td>
<td>0.49</td>
</tr>
<tr>
<td>Direct Bidders</td>
<td>0.24</td>
<td>0.18</td>
</tr>
<tr>
<td>Indirect Bidders</td>
<td>0.50</td>
<td>0.16</td>
</tr>
<tr>
<td>Primary Dealers</td>
<td>1.98</td>
<td>0.35</td>
</tr>
<tr>
<td>Fraction Accepted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dealers</td>
<td>0.58</td>
<td>0.14</td>
</tr>
<tr>
<td>Investment Funds</td>
<td>0.20</td>
<td>0.13</td>
</tr>
<tr>
<td>Foreign</td>
<td>0.20</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Persistence of the Response

\[ R_{t+h} - R_{t-1} = \alpha^{(h)} + \phi^{(h)} D_t + \varepsilon^{(h)} \]
# QE Event Dates

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 25, 2008</td>
<td>FOMC announced purchases of $100 billion in GSE debt and $500 billion in MBS</td>
</tr>
<tr>
<td>Dec 1, 2008</td>
<td>Chairman Bernanke stated that the Fed could purchase long-term Treasuries</td>
</tr>
<tr>
<td>Dec 16, 2008</td>
<td>FOMC announced possible purchases of long-term Treasuries</td>
</tr>
<tr>
<td>Jan 28, 2009</td>
<td>FOMC announced it is ready to expand agency debt and MBS purchases, and to begin purchasing long-term Treasuries</td>
</tr>
<tr>
<td>Mar 18, 2009</td>
<td>FOMC announced it will purchase $300 billion in long-term Treasuries, along with an additional $750 billion in agency MBS and $100 billion in agency debt</td>
</tr>
</tbody>
</table>