Unbundling Quantitative Easing: Taking a Cue from Treasury Auctions

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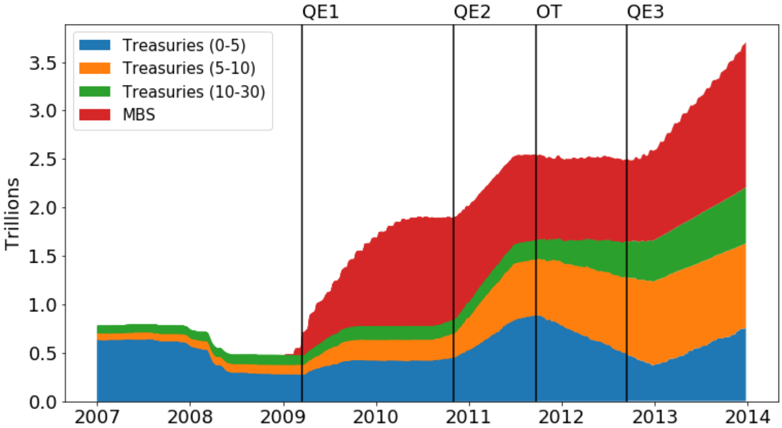
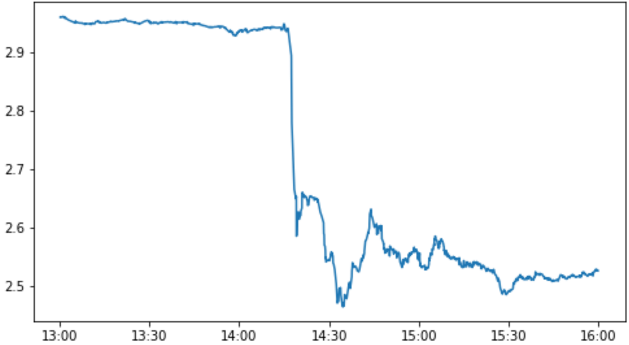
Policy Response to the Great Recession



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"



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
- 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

- Why Treasury auctions?

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

  2. Information going back to 1979
     $\Longrightarrow$ many observations, study crisis vs. normal times

  3. Specific maturities are spread in time
     $\Longrightarrow$ mimics targeted purchases in maturity space

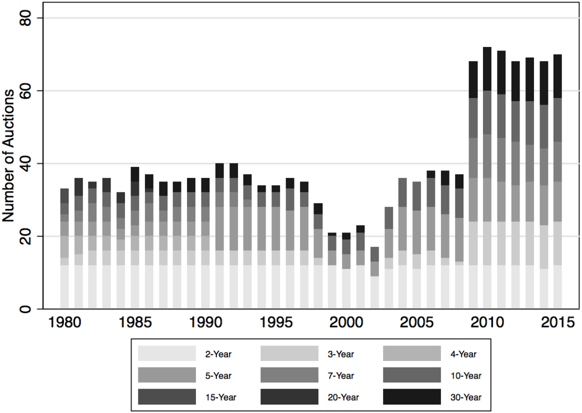
  4. Institutional setup and auction timing (and futures prices)
     $\Longrightarrow$ high-frequency identification of demand shocks

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
- 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

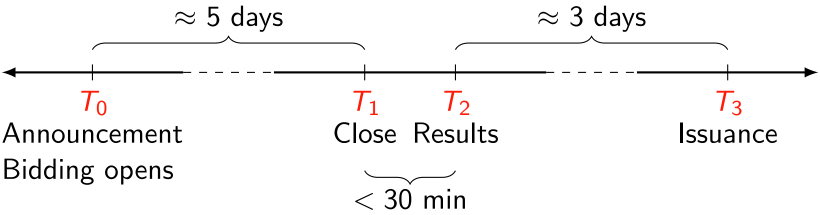
- 2-, 3-, 5-, and 7-year notes auctioned every month
- 10-year notes and 30-year bonds auctioned every Feb, May, Aug, and Nov; "reopenings" in other months
- "Regular and predictable"



Treasury Auctions: Participants

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



TREASURY OFFERING ANNOUNCEMENT [1]

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 15, 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 [2]	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 [3]	Yes
Noncompetitive Closing Time	12:00 Noon ET
Competitive Closing Time	1:00 p.m. ET

TREASURY AUCTION RESULTS

Term and Type of Security	30-Year Bond
CUSIP Number	912810QS0
Series	Bonds of August 2041
Interest Rate	3-3/4%
High Yield[1]	3.750%
Allotted at High	41.74%
Price	100.000000
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

	Tendered	**Accepted**
Competitive	$33,305,800,000	$15,985,160,000
Noncompetitive	$14,855,600	$14,855,600
FIMA (Noncompetitive)	$0	$0
Subtotal[4]	**$33,320,655,600**	**$16,000,015,600[5]**
SOMA	$489,928,400	$489,928,400
Total	**$33,810,584,000**	**$16,489,944,000**

	Tendered	**Accepted**
Primary Dealer[6]	$23,734,000,000	$10,921,532,000
Direct Bidder[7]	$6,567,000,000	$3,119,654,000
Indirect Bidder[8]	$3,004,800,000	$1,943,974,000
Total Competitive	**$33,305,800,000**	**$15,985,160,000**

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

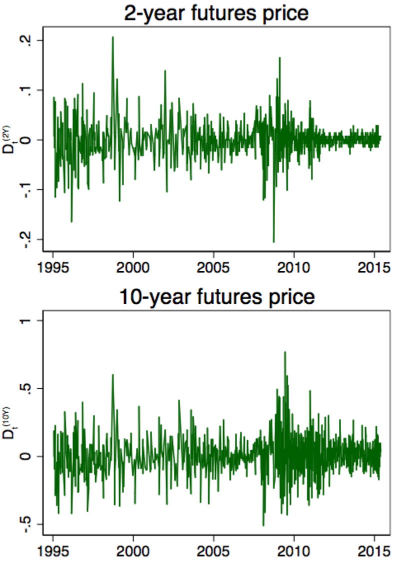
Constructing Treasury Demand Shocks

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

- 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

- **Identifying assumption**: supply factors (the amount on auction, security characteristics, etc) are fixed days before the close of the auction
- $\implies$ $D_t^{(m)}$ can only move in response to unexpected changes in demand conditions

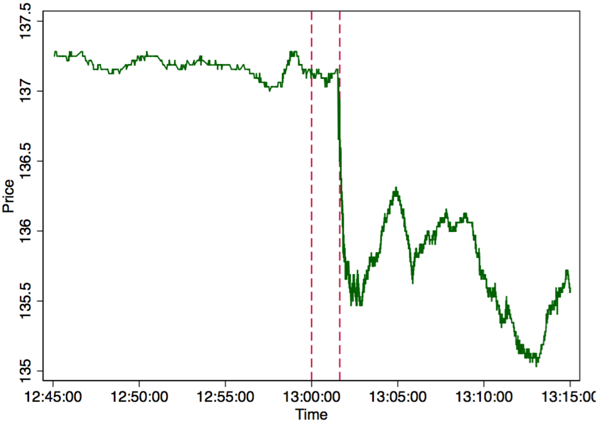
Demand Shocks Time Series



Demand Shock Descriptive Statistics

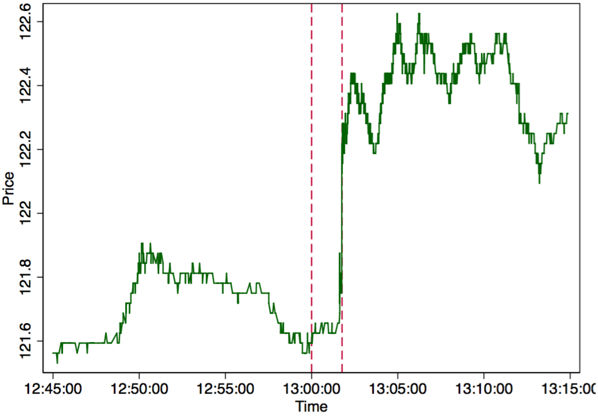
Maturity	Mean	Std. Dev.	N	Correlations			
				$D_t^{(2Y)}$	$D_t^{(5Y)}$	$D_t^{(10Y)}$	$D_t^{(30Y)}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$D_t^{(2Y)}$	-0.000	0.034	871	1.000			
$D_t^{(5Y)}$	0.002	0.092	871	0.866	1.000		
$D_t^{(10Y)}$	0.007	0.143	871	0.782	0.958	1.000	
$D_t^{(30Y)}$	0.006	0.245	871	0.672	0.848	0.922	1.000

What Determines Shocks?



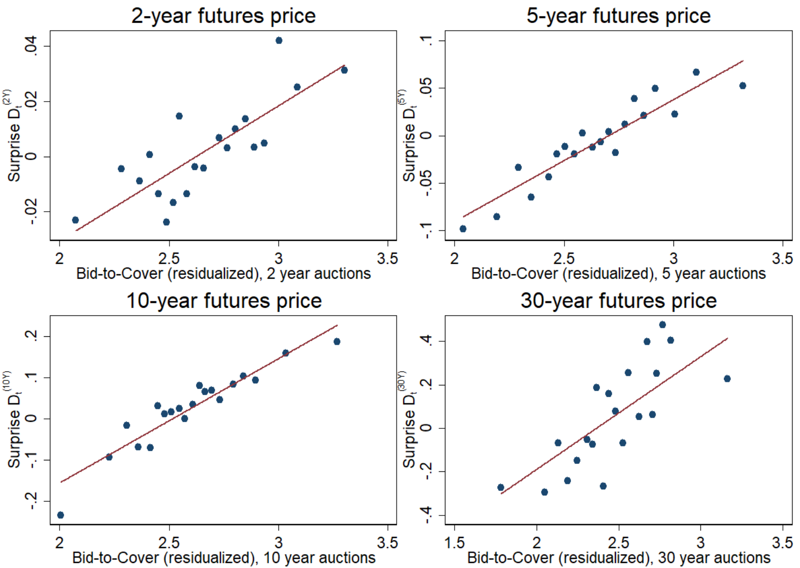
August 11, 2011. Financial Times: "An auction of 30-year US Treasury bonds saw weak demand... bidders such as pension funds, insurers and foreign governments shied away. 'There's not too many ways you can slice this one, it was a very poorly bid auction."'

What Determines Shocks?



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 dont get the opportunity to buy large amounts of paper outside the auctions and 'real money' were aggressive buyers."'

What Determines Shocks?



What Determines Shocks?

	D_t^{2Y}	D_t^{5Y}	D_t^{10Y}	D_t^{30Y}	Pool D_t
	(1)	(2)	(3)	(4)	(5)
	Total bid-to-cover ratio				
Bid-to-Cover	1.421***	1.402***	2.053***	2.108***	1.633***
	(0.240)	(0.224)	(0.206)	(0.532)	(0.136)
Observations	238	306	227	100	871
R^2	0.156	0.207	0.306	0.275	0.218
	Fraction accepted by bidder type				
Investment Funds	4.800***	3.401***	4.563***	6.436***	4.749***
	(0.908)	(0.854)	(0.902)	(1.462)	(0.494)
Foreign	2.797**	3.604***	5.173***	7.974***	4.393***
	(1.162)	(0.847)	(1.220)	(2.404)	(0.676)
Misc	4.815*	2.506**	0.034	0.853	2.353**
	(2.614)	(1.203)	(3.713)	(5.119)	(1.193)
Observations	174	241	201	84	700
R^2	0.214	0.128	0.287	0.391	0.191

Comovement: Debt Markets

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

Dep. variable: asset type	Estimate (s.e.)	N	R^2	Sample
	(1)	(2)	(3)	(4)
TLT	0.312***	662	0.679	2002-2015
	(0.016)			
SHY	0.022***	662	0.528	2002-2015
	(0.001)			
LQD	0.110***	662	0.544	2002-2015
	(0.008)			
Aaa†	-2.295***	871	0.173	1995-2015
	(0.212)			

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. persistence

Comovement: Equity Markets

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

Dep. variable: asset type	Estimate (s.e.)	N	R^2	Sample
	(1)	(2)	(3)	(4)
SPY	-0.020	871	0.005	1995-2015
	(0.018)			
IWM	-0.081***	706	0.034	2000-2015
	(0.024)			
SP500†	-0.072	871	0.004	1995-2015
	(0.064)			
Russell 2000†	-0.169**	871	0.013	1995-2015
	(0.069)			

Notes: dep. variable y_t is intraday change in asset, except for † denotes daily frequency. SPY: S&P500 ETF. IWM: Russell 2000 ETF.

Comovement: Inflation and Commodities

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

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

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

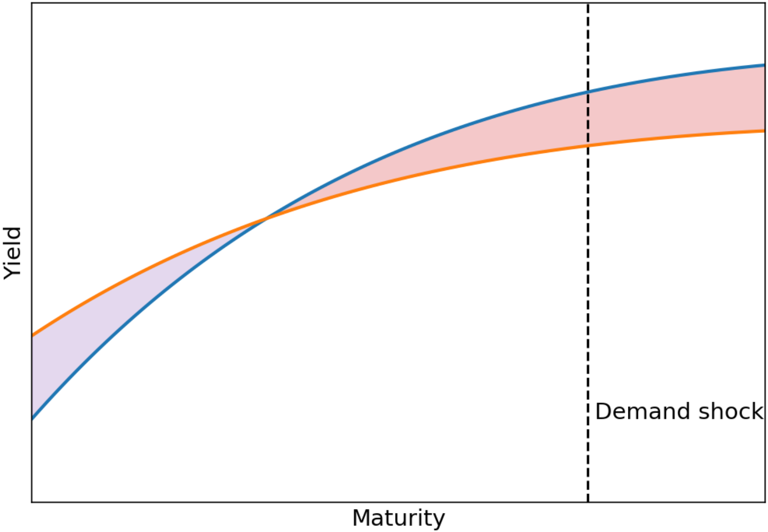
Comovement: Spreads and CDS

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

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

Notes: dep. variable y_t is intraday change in asset, except for † denotes daily frequency.

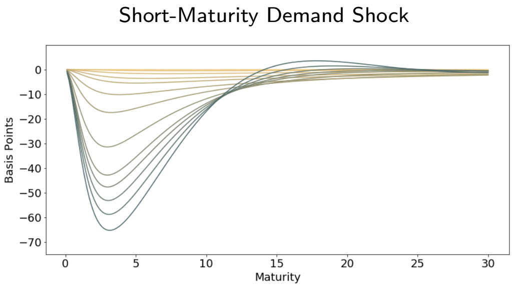
Comovement Across Maturities

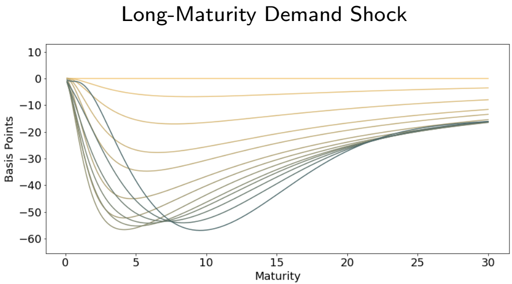


Preferred Habitat Model

- 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



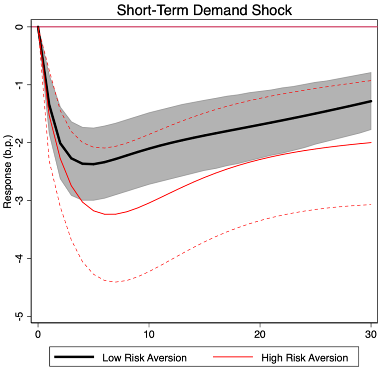


Empirical Specification

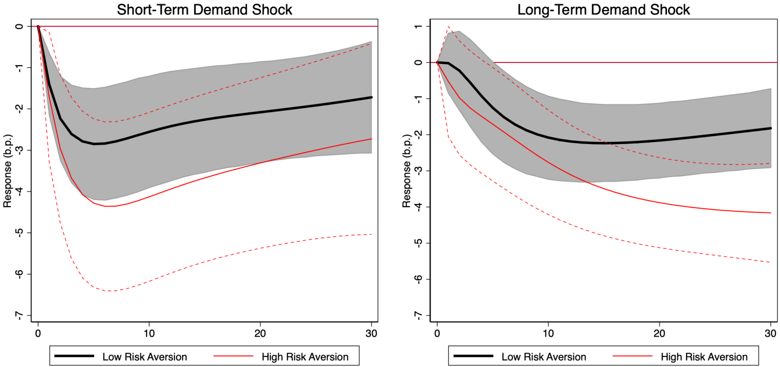
Hypothesis: effects of demand shocks become more localized when bond markets are disrupted

- 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 $\hat{\beta}^{(m)}$



IV specification: bid-to-cover as instruments for demand shocks D_t

Policy Implications

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?

$$\begin{aligned}\Delta R_t &= f\left(QE_t\right) \\ &= f\left(X_1(QE_t), X_2(QE_t), \ldots, X_k(QE_t)\right) \\ &\approx \alpha_1 X_{1,t} + \alpha_2 X_{2,t} + \ldots + \alpha_k X_{k,t} + \varepsilon_t\end{aligned}$$

- where
  - $X_{1,t}$ is preferred habitat
  - $X_{2,t}$ is forward guidance
  - ...
  - $X_{k,t}$ is the k^{th} theory of how QE works
- Observe ΔR_t
- Our results can be used to estimate $\widehat{\alpha_1 X_{1,t}}$

Quantitative Implications for QE

Table: Response of 5-year Treasury yield

Date	Intraday Window	2-day Window
Nov 25, 2008		-23
Dec 1, 2008	-9.2	-28
Dec 16, 2008	-16.8	-15
Jan 28, 2009	3.1	28
Mar 18, 2009	-22.8	-26
Cumulative	-45.0	-74

Units: basis points. Intraday change from Chodorow-Reich (2014). 2-day change from Krishnamurthy and Vissing-Jorgensen (2011).

events

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
- $\widehat{\alpha_1 X_{1,t}}$ estimate:
  - Unit shock to the bid-to-cover ratio ($\approx$ \$30 billion) $\implies$ 3.3 bp decline in yields during crisis
  - Hence, \$300 billion shock $\implies$ 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
- 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

Treasury Auctions: Descriptive Statistics

	Mean	Std. Dev.
Offering Amount (billions)	22.03	9.36
Total Tendered (billions)	61.46	32.04
Bid-to-Cover	.62	0.49
Direct Bidders	0.24	0.18
Indirect Bidders	0.50	0.16
Primary Dealers	1.98	0.35
Fraction Accepted		
Dealers	0.58	0.14
Investment Funds	0.20	0.13
Foreign	0.20	0.09

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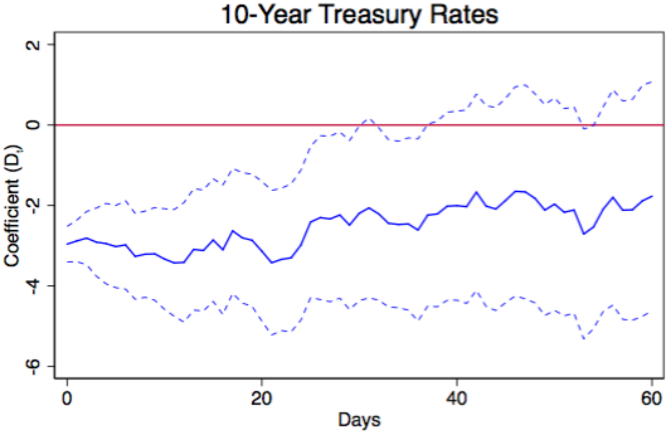
Persistence of the Response

$$R_{t+h} - R_{t-1} = \alpha^{(h)} + \phi^{(h)} D_t + \varepsilon_t^{(h)}$$



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QE Event Dates

Date	Event
Nov 25, 2008	FOMC announced purchases of $100 billion in GSE debt and $500 billion in MBS
Dec 1, 2008	Chairman Bernanke stated that the Fed could purchase long-term Treasuries
Dec 16, 2008	FOMC announced possible purchases of long-term Treasuries
Jan 28, 2009	FOMC announced it is ready to expand agency debt and MBS purchases, and to begin purchasing long-term Treasuries
Mar 18, 2009	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

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