Asset Purchase Rules: How QE Transformed the Bond Market

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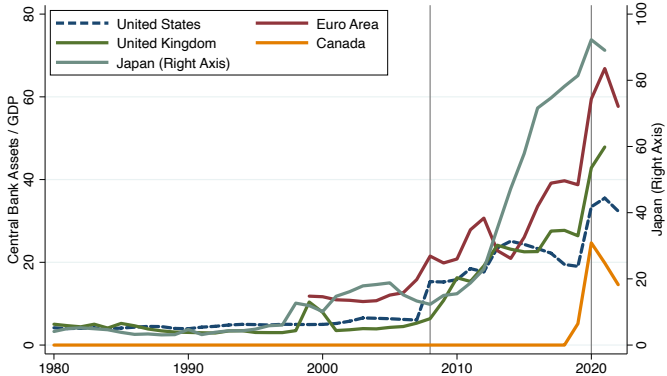
The new normal: Central banks in bond markets

- Central Banks balance sheets avg 50% of GDP, 30% of public debt outstanding
- Purchases occur in bad times: US 2008, Euro 2012/2015, COVID-19, ...



Quantitative easing and tightening as a dynamic state-contingent policy

- Market participants do not view QE/QT as one-off spot decisions, but have expectations on path of QE/QT depending on state of economy
- Significant impact on the level and dynamics of long-term rates

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- Market participants do not view QE/QT as one-off spot decisions, but have expectations on path of QE/QT depending on state of economy
- Significant impact on the level and dynamics of long-term rates
- Analogous to conventional monetary policy: the power of cyclical and predictable policy
- ...but different economic mechanisms

The Economics of Dynamic QE Policies

One-off purchase / static effect:

- Absorbing bond supply in a given period reduces the term premium $\rightarrow$ *lower yields after intervention*

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Dynamic policy: purchases in "bad times"

- *Insurance:* concentrate impact on highly valued states of the world
- *Crowding-in:* supports future safety of long-term bonds $\rightarrow$ makes investors more willing to invest today

$\rightarrow$ Potent because effects are priced in: *permanently lower and more stable long-term yields*

What We Do

Dynamic policy offers an account of the post-QE behavior of long-term bonds

- **At low frequency:**
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- **Tracing out the mechanism:**
  - Introduction of QE: yields drop as much as low-frequency change, but also *sharp decrease in long-horizon implied volatility*
  - Muted reactions to subsequent announcements
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- **Quantitative model:**
  - Quantity-based term structure model + purchase rule
  - Dynamic rule explains 2/3 of total effect of QE policies
  - Implies interest costs $\downarrow$ 0.5% GDP

Related Literature

- **Empirical effects of QE on Treasury yields**
  - Event studies: Krishnamurthy Vissing-Jorgensen (2011), Gagnon et al (2018), Haddad Moreira Muir (2023), Selgrad (2023),...
- **Empirical work on Treasury supply and Treasury yields**
  - Krishnamurthy Vissing-Jorgensen (2012), Greenwood Vayanos (2014), Jones (2024), Meaning Zhu (2011)
  - Demand for Treasury downward sloping, decreased supply lowers yields
- **Models of QE**
  - Vayanos Vila (2021), Greenwood Vayanos (2014), Haddad Sraer (2021), Curdia Woodford (2011), Gertler Karadi (2011, 2018), Sims Wu Zhang (2023), Ray Droste Gorodnichenko (2024), Acharya Rajan (2024)
- **Policy rules affect risk: standard monetary policy**
  - Cieslak Vissing-Jorgensen (2021), Campbell Pflueger Viceira (2020), King (2019), Bianchi Lettau Ludvigson (2022)
- **Our contribution** is to use combination of well-identified event studies, low frequency dynamics of yields, and model to understand policy rules applied to asset purchases

Framework

A Model of Quantity and the Yield Curve

Model similar to Vayanos Vila (2021), Greenwood Vayanos (2014)

- Two types of agents:
  - Inelastic investors (hold passively)
  - Active investors (risk averse):

$$Term\ Premium_t = (quantity\ of\ bonds)_t \times (risk\ of\ bonds)_t \times (price\ of\ risk)_t$$

$\rightarrow$ *Equilibrium*: active investors price bonds, larger term premium when supply large

The effect of one-off QE announcements

- **One-off announcement**: purchase bonds $\rightarrow$ push price up and yields down based on slope of investor demand curve

$$Term\ Premium_t = (quantity\ of\ bonds)_t \times (risk\ of\ bonds) \times (price\ of\ risk)$$

- *static effect*, asset quantity: expected reduction in net bond supply times the expected risk of the bond

Asset Purchase Rules

- **Purchase rule**: instead of "one-off" central banks purchase in bad times (crisis, recession, Treasury market dysfunction, etc).

$$Term\ Premium_t = (quantity\ of\ bonds)_t \times (risk\ of\ bonds)_t \times (price\ of\ risk)_t$$

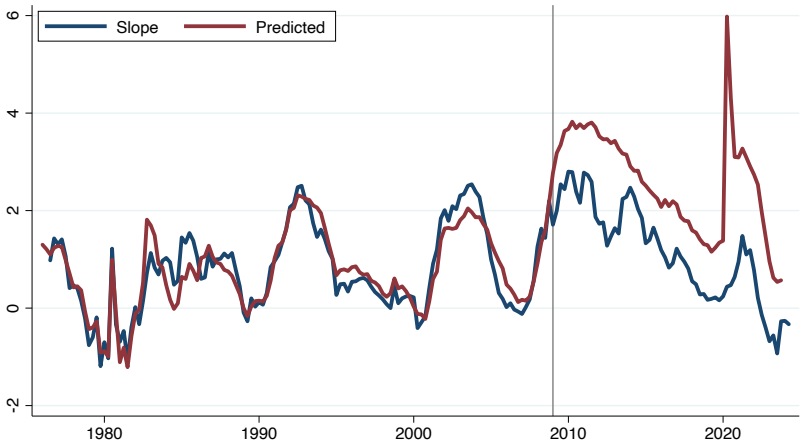
- *static effect*: expected reduction in net bond supply
- Insurance: absorb assets and lower term premium in highly valuable states of the world
- Crowding in: more stable long-term bonds increase investors' willingness to hold long-term bonds $\rightarrow$ (1) lowers the term premium, (2) stabilizes high frequency shocks

The Yield Curve After QE

The Yield Curve After QE

Slope: 10-year Treasury minus 2-year Treasury

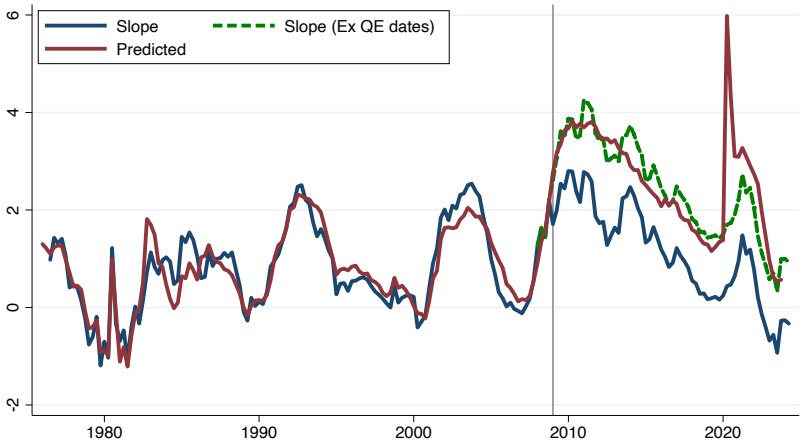
Predicted (1952-2007): using maturity-weighted debt to GDP, T-bill, unemployment



The Yield Curve After QE

Green: exclude changes in 10-year yield on QE announcement days

Predicted: using maturity-weighted debt to GDP, T-bill, unemployment



Slope of Yield curve vs. Debt Supply

	Slope of Yield Curve				Predicting Excess Bond Return			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pre	Full	Full	Full	Pre	Full	Full	Ful
ln(MWDGDP)	1.24***	0.53*	1.10***	1.25***	0.11***	0.07**	0.09**	0.11***
	(0.26)	(0.29)	(0.26)	(0.26)	(0.04)	(0.03)	(0.04)	(0.03)
Post 2008 Dummy			**-1.74*** **	1.25			-0.07	0.34
			(0.41)	(1.22)			(0.06)	(0.22)
ln(MWDGDP) × Post				**-1.95** **				-0.28**
				(0.79)				(0.14)
TBill	-0.32***	-0.22***	-0.30***	-0.28***	-0.00	0.00	0.00	0.00
	(0.04)	(0.05)	(0.04)	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)
Unemp	0.60***	0.41***	0.48***	0.42***	0.01	0.01	0.01	0.00
	(0.08)	(0.08)	(0.06)	(0.06)	(0.01)	(0.01)	(0.01)	(0.01)
Observations	227	288	288	288	227	284	284	284
R-squared	0.73	0.54	0.66	0.69	0.09	0.05	0.06	0.09

- Magnitudes consistent with term premia driving entirety of effect
- Using "net debt" only lowers gap by 30 bps, robust to many definitions of slope

Long-Term Treasuries less volatile Post QE

Implied volatility of 10-year Treasury down 17% since QE

	(1)	(2)	(3)	(4)
	Treas Fut.		Swaptions	
Option Maturity	1mo.	6mo.	1yr	5y
Post QE	-0.17***	-0.18***	-0.17***	-0.10***
	(0.04)	(0.05)	(0.04)	(0.03)
$log(VIX_t)$	0.59***	0.37***	0.29***	0.11***
	(0.05)	(0.05)	(0.05)	(0.03)
Observations	4,331	5,236	5,236	5,236
R-squared	0.59	0.32	0.28	0.15

What About ...

- **Transmission to broader assets**
  - similarly strong effects for mortgage rates / MBS $\approx$ -130 bps
  - positive but imperfect pass through to corporate bonds $\approx$ -105 bps: $\rightarrow$ AAA-Treasury spread high despite elevated supply (Krishnamurthy Vissing-Jorgensen 2012)

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- **Zero lower bound**
  - replace short rate by shadow rate from Taylor rule
  - markets priced fast liftoff: Fed Funds Futures and Caplets in Mertens and Williams (2021)
- **Other trends** (post-crisis, secular stagnation)
  - Staggered introduction of asset purchase policies internationally: panel w/ time fixed effects

Slope of the yield Curve: International Evidence

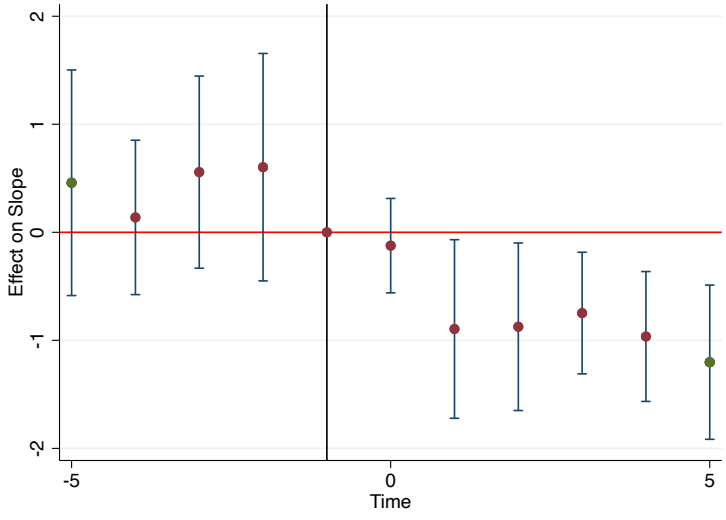
- In the U.S., QE is a post-2008 phenomenon
- Staggered introduction of asset purchase policy throughout the world
  - Japan 2001
  - US 2008, UK 2009
  - Euro area: GIIPS 2010-2012, rest of Euro area 2015
  - Canada, Australia 2020
  - Norway, not so far
- Sample starts in 1985, 10-year bond yields, annual frequency

Slope of the yield Curve: International Evidence

$post_{i,t} = 1$ after central bank first introduces purchases

	(1)	(2)	(3)	(4)	(5)	(6)
$post_{i,t}$	-0.77***	1.15**	0.92	-0.68**	1.41***	1.33
	(0.14)	(0.58)	(0.81)	(0.26)	(0.47)	(0.86)
$ln(Debt/GDP)$	1.67***	2.92***	2.89***	0.91	2.45***	2.45***
	(0.48)	(0.70)	(0.67)	(0.58)	(0.57)	(0.56)
$ln(Debt/GDP) \times post_{i,t}$		-2.37***	-2.22***		-2.36***	-2.31***
		(0.78)	(0.77)		(0.73)	(0.73)
Inflation	-0.02	0.01	0.00	0.07	0.07	0.06
	(0.04)	(0.04)	(0.05)	(0.09)	(0.09)	(0.10)
Inflation $\times post_{i,t}$			0.31***			0.13
			(0.07)			(0.11)
Unemp	0.18***	0.19***	0.20***	0.15**	0.14**	0.15*
	(0.04)	(0.04)	(0.05)	(0.07)	(0.06)	(0.08)
Unemp $\times post_{i,t}$			-0.03			-0.02
			(0.04)			(0.06)
N	515	515	515	515	515	515
Groups	16	16	16	16	16	16
R^2	0.192	0.247	0.258	0.580	0.623	0.624
Time FE	No	No	No	Yes	Yes	Yes

Slope of the yield Curve: International Evidence



Absorbing supply shocks: high-frequency evidence

Prediction: bond market less sensitive to supply shocks

- Treasury funding news
  - sensitivity to issuance news *falls by 2/3 post QE*
- Treasury auctions
  - volatility of 10 year yields around auctions *falls by 1/2 post QE*

Taking Stock

After introduction of QE:

- Long-term Treasury yields appear persistently low
- Change not explained by direct shift in net supply of debt
- Yields much less sensitive to total debt supply
- Implied volatility persistently low
- Bond market less sensitive to supply and demand shocks

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Next, zoom in on QE announcements as well identified days QE news revealed

Discovering the Rule: QE Announcements

Discovering the Rule: QE Announcements

Cumulative event-study response across QE announcements

	(1) 1M	(2) 3M	(3) 6M	(4) 1Y	(5) 2Y	(6) 3Y	(7) 5Y	(8) 7Y	(9) 10Y	(10) 20Y	(11) 30Y
QE Event	-0.10	-0.06	-0.32**	-0.37**	-0.51**	-0.58**	-1.09***	-1.34***	**-1.39*** **	-0.90***	-0.76***
	(0.26)	(0.19)	(0.16)	(0.17)	(0.20)	(0.22)	(0.25)	(0.25)	(0.24)	(0.24)	(0.23)
N	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848
R^2	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00

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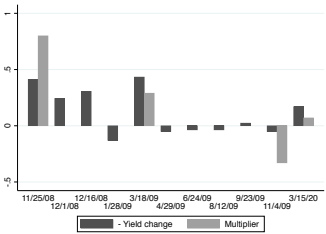
	(0.26)	(0.19)	(0.16)	(0.17)	(0.20)	(0.22)	(0.25)	(0.25)	(0.24)	(0.24)	(0.23)
N	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848	3,848
R^2	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00

- Response larger than implied by static view:

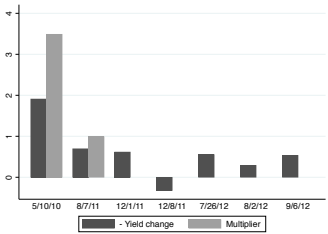
10-year yield: supply regression coefficient $\times$ Amount purchased $\approx -30bps$

Subsequent Announcements

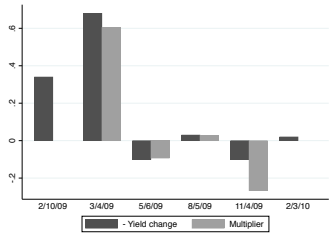
A. US QE1 and COVID-19



B. ECB Purchases



C. Bank of England QE



- Initial announcements very powerful
- Later announcements much weaker
- Different from policy much weaker

Option Price Response to announcements: Implied Vol

- Implied volatility of long-term rates across horizons (options on Futures, Swaptions)
- Option prices reveal state-contingent policy (Haddad Moreira Muir 2024)

	(1)	(2)	(3)	(4)	(5)	(6)
	10yr Treas Fut.			Swaptions (10yr tenor)		
Option Maturity	1 mo	3 mo	6 mo	1Y	5Y	10Y
QE Event	-38.14**	-39.63***	-31.86**	-34.88***	-39.76***	-38.54***
	(16.82)	(11.34)	(14.75)	(11.76)	(12.39)	(11.28)
N	3,092	3,960	3,695	3,960	3,695	3,960
R^2	0.00	0.00	0.01	0.00	0.01	0.00

Strength of yield response associated w reductions in long-term vol across announcements

Rule News

Strong learning at initial announcements does not rule out future updates about purchase rules

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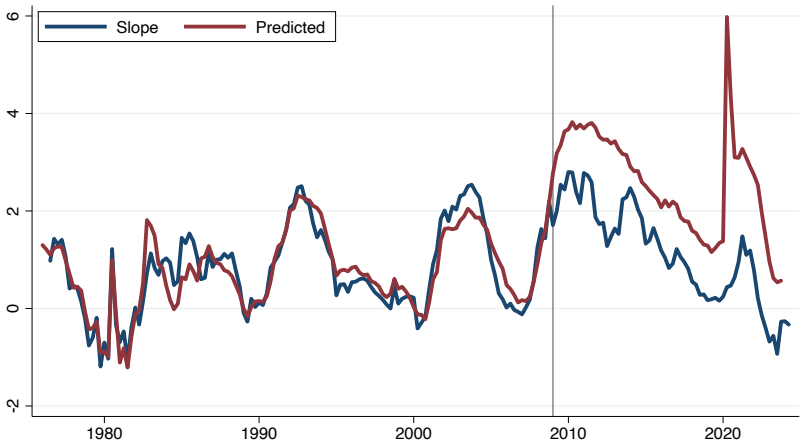
- **Taper tantrum** (2013): fear of a roll back of QE policies $\rightarrow$ increased yields and downside risk

- **Corporate bond interventions** (March 2020): extending the scope of asset purchases $\rightarrow$ decreased yields and downside risk

The Yield Curve After QE

Slope: 10-year Treasury minus 2-year Treasury

Predicted: using maturity-weighted debt to GDP, T-bill, unemployment



Quantifying the Effect of the Asset Purchase Rule

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- **Pre-QE model (Greenwood Vayanos)**
  - Dynamics of state variables $X_t = [r_{f,t}, s_t]'$ estimated in VAR from 1952-2007
  - Calibrate fraction of inelastic investors and active investor's risk aversion to match yield levels and sensitivities $y_t^{(n)} = A(n) + B(n)'X_t$

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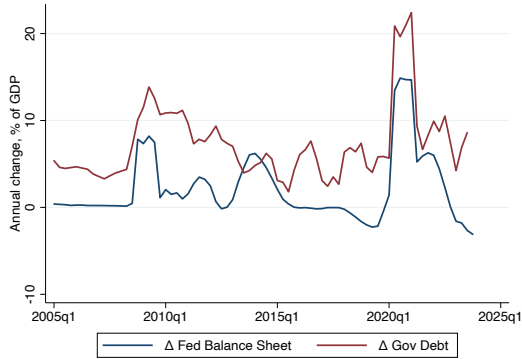
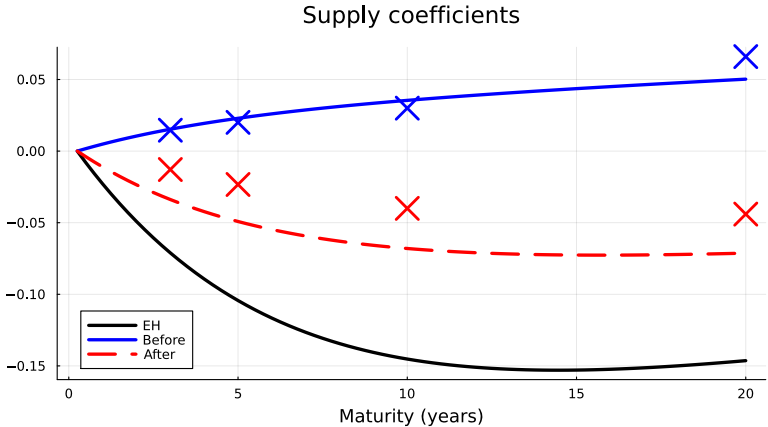
  - Calibrate fraction of inelastic investors and active investor's risk aversion to match yield levels and sensitivities $y_t^{(n)} = A(n) + B(n)'X_t$
- **Purchase rule** $qe_t = a + b'X_t$ **:** buy $1/3$ of supply deviations ($a = b_r = 0, b_s = 1/3$)



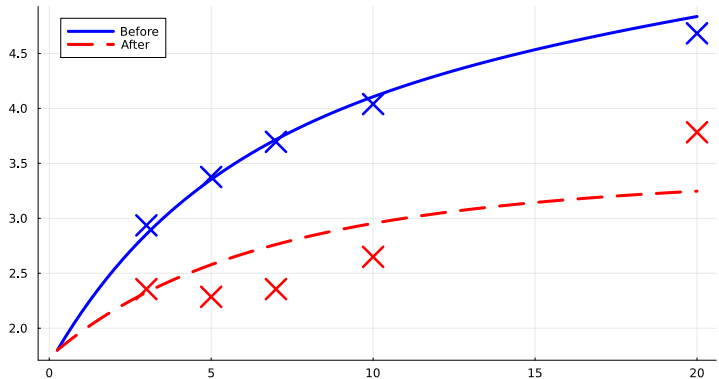
Stabilization of Yields

QE rule lowers sensitivity of yields to supply $B(n)$ substantially, as in the data ("X")



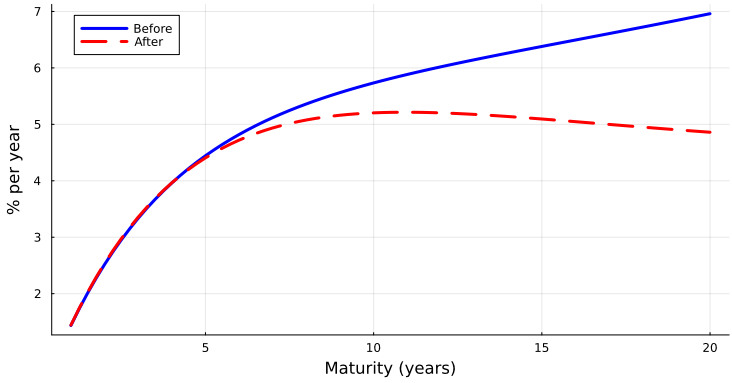
Effect of Introducing the Purchase Rule

Switch to QE rule in period with elevated supply



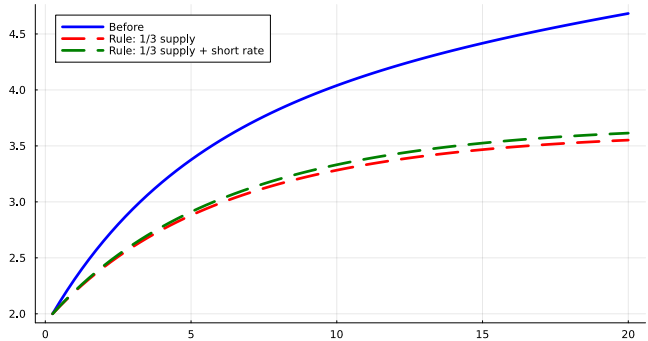
- QE rule lowers 10-year yield by 115bps: 75bps from rule vs. 40bps from realized purchases

Volatility of Bond Returns



- *Model:* Volatility of 10-year $\downarrow 10\%$, 20-year $\downarrow 30\%$
- *Data:* Implied vol of 10-year $\downarrow 30 - 40\%$ on announcement, long-run $\downarrow 17\%$

Alternative Rule: Purchase when rates are low



- Rule: 1/3 supply + purchase when short rate low: buy 10% GDP for a 1% drop in rates
- Makes long-term bonds slightly *riskier*: when rates go up, and long-term bond prices fall, you also unwind purchases and thus amplify price decline

Some More Questions

- Which sources of fluctuations in long rates do market participants expect Fed to offset?
  - Financial sector imbalances, market functioning
  - Rest-of-the-world move away from Treasuries
  - Supply shocks in recessions (2008, 2020) vs normal times
  - ZLB
- Which sources of fluctuations *should* the Fed offset?
  - Costs and limits of QE policies
  - Optimal policy in a second-best world
- What happens if QE policies suffer large losses?
  - Rate increases of 2022

Conclusion

QE as a policy rule

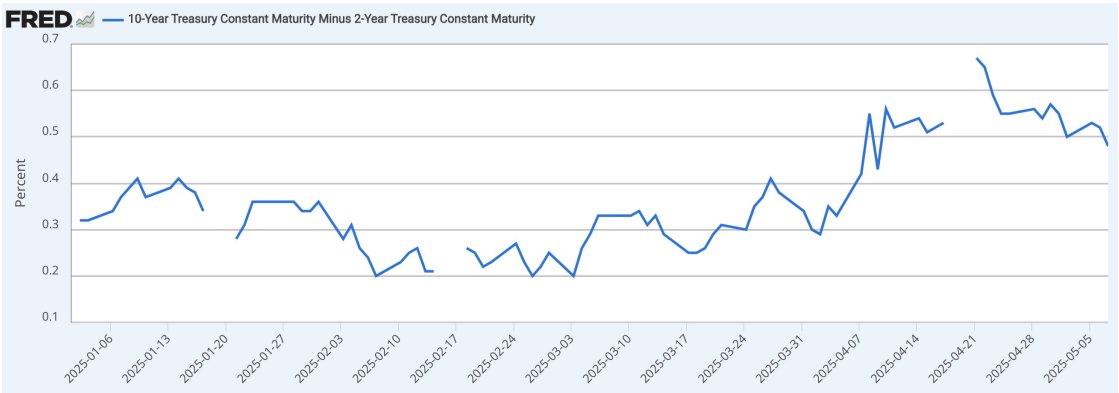
- QE now routine tool used in countercyclical way
- Buying in bad times creates extra safety and crowding in
- Large effects on both level of long-term yields and their dynamics
- Simple model with rule can explain decline in long-term rates by 100-150 bps, reduction in volatility, and is consistent with announcement effects

Pass-through to other assets

VARIABLES	(1) Treas	(2) Corp: Aaa	(3) Corp: Baa	(4) Mortgage
ln(MWDGDP)	1.10***	0.76**	0.65*	0.57**
	(0.26)	(0.33)	(0.35)	(0.24)
Post 2008 Dummy	-1.74***	-1.17**	-0.87	-1.31***
	(0.41)	(0.54)	(0.58)	(0.37)
TBill	-0.30***	-0.26***	-0.21***	-0.19***
	(0.04)	(0.06)	(0.06)	(0.04)
Unemp	0.48***	0.51***	0.63***	0.42***
	(0.06)	(0.07)	(0.08)	(0.06)
$ln(\sigma_t)$		0.60**	0.90***	
		(0.25)	(0.28)	
Observations	288	285	285	211
R-squared	0.66	0.59	0.59	0.51

- Yields in macro-relevant assets similarly lower after QE policies were enacted
- Suggests strong pass-through

What Next?


FRED
10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity
Percent
0.7
0.6
0.5
0.4
0.3
0.2
0.1
2025-01-06
2025-01-13
2025-01-20
2025-01-27
2025-02-03
2025-02-10
2025-02-17
2025-02-24
2025-03-03
2025-03-10
2025-03-17
2025-03-24
2025-03-31
2025-04-07
2025-04-14
2025-04-21
2025-04-28
2025-05-05

Pass-through around QE announcements

VARIABLES	(1) Treas (10 yr)	(2) Treas (20 yr)	(3) Aaa	(4) Baa	(5) MBS	(6) MBS: Ginnie Mae
QE Event	-1.39***	-0.90***	-0.49**	-0.62**	-1.62***	-1.17***
	(0.25)	(0.24)	(0.25)	(0.24)	(0.30)	(0.40)
Observations	4,046	4,046	4,046	4,046	4,040	3,536
R-squared	0.01	0.00	0.00	0.00	0.01	0.00

- High frequency response also in line with a high degree of pass through

Model Intuition

- Treasury risk-premia depends on covariance with arbs equilibrium portfolio

$$E_t[r_{\tau,t+1}] + \frac{1}{2}\text{Var}_t(r_{\tau,t+1}) - r_t = \gamma \text{Cov}_t(r_{\tau,t+1}, (S_t - qe_t)r_{t+1}^{port}),$$

- Static effect of purchase: qe lowers risk premia, raises bond prices
- Dynamic effects when qe_t state-dependent
  1. Insurance: qe_t buys in highly valued states of the world
  2. Crowding in: lower vol of r_{t+1}^{port} by stabilizing, arb is willing to take more risk. Lowers sensitivity of bond prices to all shocks

Market Malfunction Shocks

- Duffie (2023), BIS market committee group (2023): market malfunction as rational for central bank asset purchases
- Follow He Nagel Song (2022) and model sudden large sales by inelastic investors that intermediaries must absorb
- QE policy can completely offset these shocks, and their ex-ante pricing consequences by committing to absorb these assets
- But stabilizing policy also calls for quick resale of the assets when shock dissipates
  - in line with the BoE response to the 2022 mini-budget debacle (bonds stayed about 3 months in BOE balance sheet)
  - inconsistent with Fed behavior after GFC and Covid (e.g. 2024 balance sheet roughly 2*2019 balance sheet)

A Model of Quantity and the Yield Curve

Model as in Greenwood Vayanos (2014), Haddad Sraer (2020), Vayanos Vila (2021)

- Two types of agents:
  - Inelastic investors (hold passively)
  - Active investors (risk averse):

$$E_t[r_{\tau,t+1}] + \frac{1}{2}\sigma^2_{\tau,t+1} - r_t = \gamma s_t \mathsf{Cov}_t\left(r_{\tau,t+1}, r_{p,t+1}\right)$$

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$\rightarrow$ *Equilibrium*: active investors price bonds, require larger term premium when supply large

$$y_{\tau,t} - y^{s=0}_{\tau,t} = \gamma E_t\left[\sum_{j=0}^{\tau} s_{t+j}\mathsf{cov}_{t+j}\left(r_{\tau-j,t+j+1}, r_{p,t+j+1}\right)\right]$$

The effect of one-off QE announcements

- **One-off announcement**: effect on yields $\Delta y^{qe}_{\tau,t}$ of buying $\{qe_{t+j}\}^{\tau}_{j=0}$ bonds proportional to

$$-\sum_{j=0}^{\tau} E_t[qe_{t+j}]E_t[\mathsf{cov}_{t+j}^{(\tau-j,p)}]$$

For a one-off announcement that changes the part of asset purchases

- *static effect*, asset quantity: expected reduction in net bond supply times the expected risk of the bond

Asset Purchase Rules

- **Purchase rule**: effect on yields $y^{qe}_{\tau,t} - y^{qe=0}_{\tau,t}$ of buying $\{qe_{t+j}\}_{j=0}^{\tau}$ bonds proportional to

$$-\sum_{j=0}^{\tau}\left(E_t[qe_{t+j}]E_t[\text{cov}^{(\tau-j,p)}_{t+j,qe}] + cov_t(qe_{t+j}, \text{cov}^{(\tau-j,p)}_{t+j,qe}) + E_t\left[s_{t+j}\left(\text{cov}^{(\tau-j,p)}_{t+j} - \text{cov}^{(\tau-j,p)}_{t+j,qe}\right)\right]\right.$$

For a rule leaning against the term premium as in the data:

- *static effect*, asset quantity: expected reduction in net bond supply
- *Insurance*, asset quantity: absorb assets from active investors and lower term premium in highly valuable states of the world
- *Crowding in*, asset risk: more stable long-term bonds make active investors trade more aggressively $\rightarrow$ (1) lowers the term premium, (2) stabilizes high frequency shocks

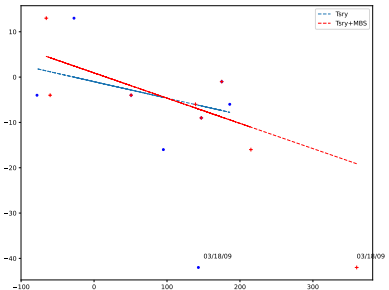
Slope of Yield curve vs. Debt Supply. Adding Vol

VARIABLES	(1) Slope Pre	(2) Slope	(3) Slope	(4) Slope	(5) Ex Ret Pre	(6) Ex Ret	(7) Ex Ret	(8) Ex Ret
ln(MWDGDP)	1.26***	0.52*	1.12***	1.29***	0.11***	0.07**	0.09**	0.11***
	(0.26)	(0.30)	(0.25)	(0.25)	(0.04)	(0.03)	(0.04)	(0.03)
Post 2008 Dummy			-1.98***	1.22			-0.07	0.36*
			(0.41)	(1.22)			(0.07)	(0.22)
ln(MWDGDP) $\times$ Post				-2.11***				-0.28**
				(0.79)				(0.14)
TBill	-0.38***	-0.23***	-0.41***	-0.39***	0.00	0.01	0.00	0.01
	(0.06)	(0.07)	(0.06)	(0.06)	(0.01)	(0.01)	(0.01)	(0.01)
Unemp	0.56***	0.40***	0.44***	0.37***	0.01	0.01	0.01	0.00
	(0.09)	(0.08)	(0.06)	(0.06)	(0.02)	(0.01)	(0.01)	(0.01)
σ(1yr rate)	0.54	0.18	0.83**	0.88**	-0.02	-0.06	-0.04	-0.03
	(0.36)	(0.46)	(0.36)	(0.35)	(0.07)	(0.07)	(0.07)	(0.07)
Observations	219	280	280	280	219	278	278	278
R-squared	0.74	0.54	0.68	0.71	0.10	0.05	0.06	0.10

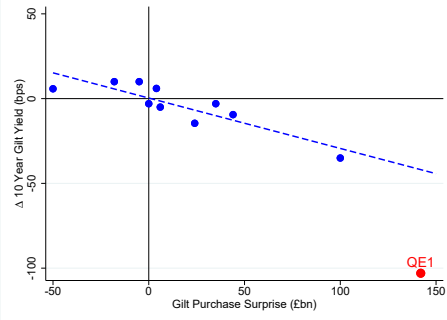
- Magnitudes consistent with term premia driving entirety of effect
- Using "net debt" only lowers gap by $\approx$ 30 bps

Subsequent Announcements: Surprises

Fed QE



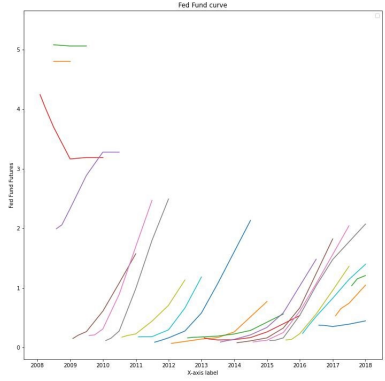
Bank of England



- Early announcement specially powerful even when accounting for quantity surprises
- Quantity surprises from D'Amico Seida (2024) and Busseto et al. (2022)

Zero Lower Bound

- replace short rate by shadow rate from Taylor rule
- markets priced fast liftoff: Fed Futures and Caplets in Mertens and Williams (2021)



Price Impact of Supply Shocks: Treasury Funding News

- In the first week of each quarter Treasury announces borrowing plans
- On Monday total issuance. On Wednesday maturities
- We construct a proxy for this news as follows:
  - Compute Maturity-Weighted Issuance over GDP

$$MWI_t = \frac{\sum_i DebtIssued_{t,i} * Maturity_{t,i}}{GDP_{t-1}}$$

  - Compute future changes in MWI_t as proxy for change in borrowing plans
  - Idea is that yields should respond only to the piece of the change learned during the announcement

$$MWI_{t+\Delta} - MWI_t = x_{t-} + news_t + \epsilon_{t+\Delta}$$

with $E_t[\epsilon_{t+\Delta}] = 0$

Price Impact of Supply Shocks: Treasury Auctions

- Regress change in slope of the yield curve in this 3-day interval on refunding news

	(1)	(2)	(3)	(4)
ΔMWI	**0.69*** **	**0.69*** **	**1.03*** **	**1.04*** **
	(0.24)	(0.24)	(0.35)	(0.35)
ΔMWI × Post-2008	**-0.59** **	**-0.59** **	**-0.74***	**-0.76***
	(0.27)	(0.27)	(0.40)	(0.40)
Post-2008	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
R^2	0.0009	0.0012	0.0010	0.0013
N	7606	7606	7606	7606
Quarter FE	No	Yes	No	Yes
Horizon (qtrs)	4	4	2	2

Crowding in: Evidence from Treasury Auctions

- Absolute change in 10-year yield in 1h30 around Treasury auctions

	$\lvert\Delta y^{(10)}\rvert$	$\lvert\Delta y^{(10)}\rvert$
Auction	**0.0085*** **	**0.0086*** **
	(0.0020)	(0.0019)
Auction × Post-2008	**-0.0046** **	**-0.0048** **
	(0.0022)	(0.0020)
Post-2008	-0.0034***	-0.0031***
	(0.0004)	(0.0004)
VIX		0.0004***
		(0.0000)
ΔVIX		0.0004***
		(0.0002)
Intercept	0.0144***	0.0062***
	(0.0003)	(0.0007)
R^2	0.0199	0.0683
No. observations	7393	7136