The Asymmetric Effects of Quantitative Tightening and Easing on Financial Markets*

Simon Lloyd† Daniel Ostry‡

October 31, 2023

Abstract

We study the asymmetric impact of US quantitative easing (QE) and tightening (QT) on financial markets using high-frequency large-scale asset purchase surprises around FOMC announcements. We document that QT surprises have larger and more persistent effects on US Treasury yields than QE shocks. Using a decomposition of bond yields, we show that this asymmetry arises from the differential effect of QT vs. QE surprises on expectations of future short-term rates (linked to the so-called signalling channel) at shorter maturities, and term premia (portfolio rebalancing channel) at longer maturities.

JEL Codes: E43, E44, E52, E58, G12.

Key Words: Bond yields; Decomposition; Monetary Policy; Quantitative Easing; Shocks.

*The views expressed here are those of the authors, and not necessarily those of the Bank of England.

†Bank of England and Centre for Macroeconomics. Email Address: simon.lloyd@bankofengland.co.uk.
‡Bank of England and Centre for Macroeconomics. Email Address: daniel.ostry@bankofengland.co.uk.

1 Introduction

Although large-scale asset purchases (LSAPs) are no longer a 'new' component of central-bank toolkits, the effects of Quantitative Easing (QE) policies enacted since the 2007-9 Global Financial Crisis are still debated (see Bhattarai and Neely, 2022, for a survey). Post-Covid, as policy-makers tighten their policy stance to guard against inflation, discussions around whether and how to go about Quantitative Tightening (QT) have been brought to the fore (e.g., Jefferson, 2023; Ramsden, 2023; Schnabel, 2023; Tenreyro, 2023). Understanding whether QT has equal and opposite effects to QE is therefore an important question.

In this paper, we build on recent developments in the identification of LSAP shocks, to provide a first answer. We focus on the daily-frequency effects of US QE and QT announcements on US Treasury yields. Since these changes in turn drive the transmission of monetary policy to the wider economy, the responses of asset prices in the days and months following FOMC announcements can therefore provide an initial indication as to whether policy has asymmetric effects.

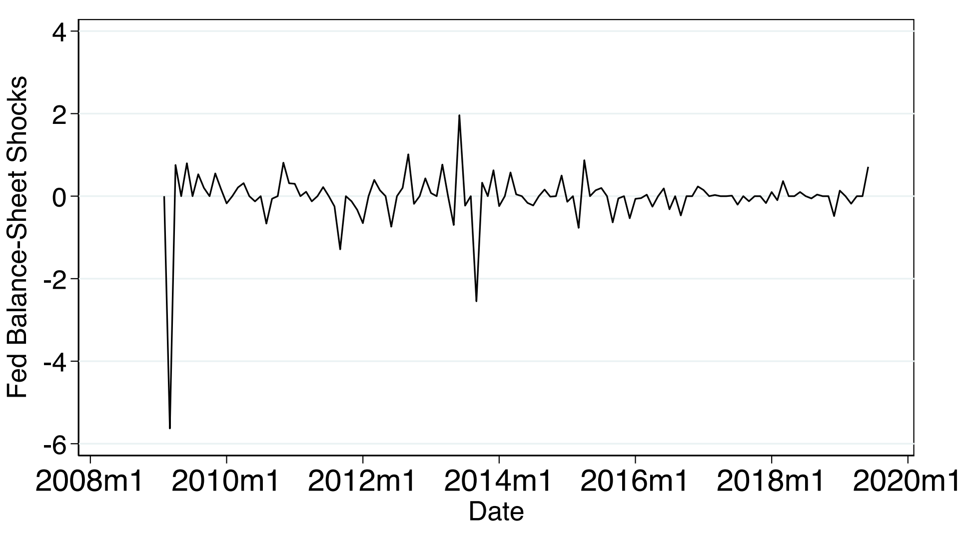
Using two approaches to classify QT and QE shocks, we document that QT surprises have larger and more persistent effects on yields than QE shocks of equal magnitude. To understand the mechanisms underpinning this, we then use a daily decomposition of Treasury yields into expectations of future short-term interest rates and term premia. At longer maturities, asymmetries occur because tightening surprises have differential effects on term premia to loosening surprises. At shorter maturities, asymmetries arise because surprises during periods of QT have larger and more persistent effects on expected future rates than surprises in times QE. We conclude by discussing the implications of these findings, using a simple equation characterising the term structure of interest rates.

2 Average Effects of Asset-Purchase Surprises

To identify QT and QE shocks, we use the high-frequency LSAP surprises proposed and constructed by Swanson (2021). These shocks are estimated by decomposing monetary-policy surprises, measured from asset-price movements in 30-minute windows around FOMC announcements, into 3 distinct components: shocks to the level of the effective federal funds rate, forward-guidance shocks to the expected path of the federal funds rate, and LSAP shocks to the Federal Reserve's (Fed's) balance-sheet size.[1]

[1] Swanson (2021) finds that 3 factors explain 94% of variation in asset-price moves in the 30-minute windows around FOMC announcements from July 1991 to June 2019. The factors are then given an interpretation following a rotation that imposes that (i) the forward-guidance and LSAP factors have no contemporaneous influence on the federal funds rate and (ii) the variance of the LSAP factor is minimized from 1991 to 2008. A narrative check of the

Figure 1: Federal Reserve LSAP Surprises



Notes: LSAP surprise from Swanson (2021) over the period Dec 2008 to Jun 2019. Shocks reported in units of standard deviations.

Figure 1 plots the LSAP-surprise series from December 2008 (when LSAPs began) to June 2019 (the end of the available sample) in units of standard deviations. The most noticeable shock is the nearly-6 standard-deviation expansionary (negative) shock (policy looser than expected) near the start of the sample. It corresponds to the Fed's first LSAP programme (QE1), where it committed to purchase over \$1.1 trillion of long-term bonds. Conversely, the largest contractionary (positive) surprise (policy tighter than expected) is in mid-2013. This 2 standard-deviation move is associated with the 'Taper Tantrum'. While this event was not associated with any actual QT *ex post*, it had substantial effects on financial markets that lasted for some months. The surprises are somewhat more muted during the period in which the Fed carried out a passive balance-sheet unwind from October 2017 to June 2019, when they allowed assets on their balance sheet to mature. Nevertheless, there were some surprises, most clearly reflected in the 0.7 standard-deviation tightening in June 2019.

For the purposes of our empirical analysis, we use the LSAP surprises in Figure 1 as exogenous variation for identifying changes in bond yields due to QE and QT. To provide some benchmark against which to compare their potentially asymmetric effects, we first analyze the average effect of LSAP surprises on financial markets, using the following local-projection specification:

$$y_{M,t+h} - y_{M,t-1} = \alpha^h + \beta^h \varepsilon_t^{lsap} + \boldsymbol{\gamma}_k^h \mathbf{x}_t + u_t^h \tag{1}$$

where ε_t^{lsap} is the LSAP-surprise observed on $T = 85$ FOMC announcement days between

rotated factors lends support to the interpretation linking them to specific policies.

December 2008 and June 2019, and $h = 0, 1, ..., 50$ is the number of business days over which the dynamic response of the dependent variable $y_{M,t+h}$ is estimated.

In our setting, the dependent variable is a 10- or 2-year zero-coupon US Treasury yield from Gürkaynak, Sack, and Wright (2007), so $y_{M,t+h} - y_{M,t-1}$ ($M = 10, 2$) measures the yield change , in basis points, from the day prior to the FOMC announcement ($t - 1$) to the h-th day after ($t + h$). We focus on the 10-year yield, as it has been a key object of interest in the literature studying the financial-market effects of LSAPs. We additionally consider the 2-year tenor, which itself has been shown to move in response to LSAP announcements (e.g., Gagnon, Raskin, Remache, and Sack, 2011; Christensen and Rudebusch, 2012; Lloyd, 2017, 2020), to capture the central bank's broad focus on managing expectations of the short-rate path roughly two years into the future (e.g., Bernanke, Reinhart, and Sack, 2004; Gürkaynak, Sack, and Swanson, 2005; Swanson and Williams, 2014; Gertler and Karadi, 2015; Hanson and Stein, 2015).

Our controls $\mathbf{x}_t$ include the level and forward-guidance surprises from Swanson (2021) to account for other concurrent monetary-policy events, 5 daily lags of the dependent variable to control for macroeconomic conditions prior to the announcement, as well as 5 lags of the 1-year US Treasury yield to account for the overall stance of monetary policy prior to the announcement.[2] β^h is the coefficient of interest, capturing the average causal effect of a 1 standard-deviation LSAP surprise on the dependent variable, on impact when $h = 0$ and cumulated over horizons when $h > 0$.

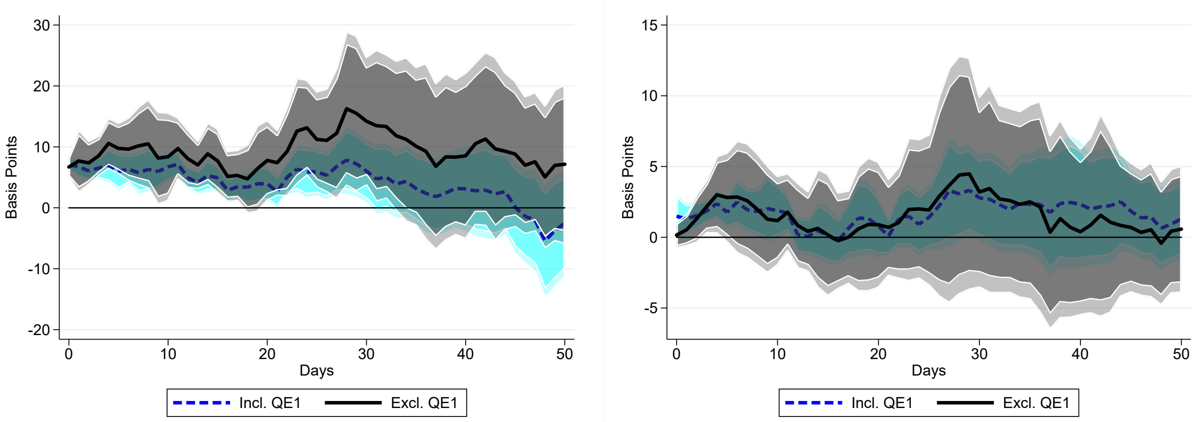
Figure 2 presents the estimated average effects $\hat{\beta}^h$ for the 50 business days after a shock. Figures 2a and 2b plot the responses of the 10- and 2-year yields, respectively. In both, we report two sets of coefficients: coefficients estimated using all LSAP surprises from December 2009 to June 2019 ('Incl. QE1') and coefficients estimated when we omit the largest shock in our sample—the March 2009 QE1 event ('Excl. QE1'). In both charts, positive values at near-term horizons imply that a surprise easing (i.e., a negative surprise) reduces 10-year Treasury yields on impact—and vice versa for a surprise tightening.

According to our estimates, and in line with the magnitudes reported in Swanson (2021), a one standard-deviation LSAP surprise is associated with an 8-10 basis point change in the 10-year yield in the days after an announcement. These effects are somewhat persistent, remaining positive and significant for around a month after the shock. Moreover, as noted by Swanson (2021), the effects of LSAP surprises on yields are even more persistent when excluding QE1. For this reason, to ensure our results around the asymmetric effects of QT and QE are not influenced by this, we henceforth only report results excluding QE1—although our

[2]The number of lags included in the baseline specification are informed by information criterion.

Figure 2: Average Response of 10- and 2-Year Treasury Yields to Fed LSAP Surprises

(a) 10-Year Yield (b) 2-Year Yield



Notes: Figure 2a presents the estimated average marginal effect of a 1 standard-deviation LSAP surprise on the h-day-ahead change in the 10-year US Treasury yield from regression (1) for $h = 0, 1, ..., 50$. Figure 2b plots corresponding results for the 2-year US Treasury Yield. 'Incl. QE1' denotes estimates using all data for the period 2008:12-2019:06. 'Excl. QE1' denotes estimates obtained when the QE1 shock in 2009:03 is excluded from the sample. Dark (light) bars represent 90% (95%) confidence bands, constructed from Newey and West (1987) standard errors with 12 lags.

headline conclusions are robust to their inclusion.

In contrast, the average effects on the 2-year yield are more muted and less persistent. Nevertheless, LSAP surprises do exert some significant impact on 2-year yields in the few days after an announcement.

3 Assessing the Asymmetric Effects of QE and QT

To assess the distinct effects of QT and QE, we adapt regression (1) by interacting the LSAP-surprise ε_t^{lsap} with an indicator variable $\mathbb{1}_t^{QT}$ that equals 1 if the surprise is characterized as a QT shock, and 0 if it is classified as a QE shock:

$$y_{M,t+h} - y_{M,t-1} = \alpha^h + \beta^h \varepsilon_t^{lsap} + \delta^h \left(\varepsilon_t^{lsap} \times \mathbb{1}_t^{QT}\right) + \theta^h \mathbb{1}_t^{QT} + \boldsymbol{\gamma}_k^h \mathbf{x}_t + u_t^h \tag{2}$$

where we extend the controls $\mathbf{x}_t$ used in regression (1) to also include interactions between the QT indicator and the level and forward-guidance surprises.

In regression (2), the coefficient β^h measures the marginal effect of LSAP surprises that are classified as QE events (i.e., when $\mathbb{1}_t^{QT} = 0$), while $\beta^h + \delta^h$ measures the marginal effect of surprises classified as QT events. In our analysis, we discuss both the magnitudes of the overall marginal effects (i.e., β^h and $\beta^h + \delta^h$), which capture the overall economic significance of our results, as well as the statistical significance of the difference in magnitudes (i.e., δ^h).

We adopt two different approaches to classifying QT and QE shocks: (1) classifying events using the *sign* of the surprise; and (2) where we classify events according to the *date* of the surprise.

3.1 Tightening vs. Loosening Surprises

Figures 3a and 3b report results when QT shocks are classified as any LSAP surprise that is positive (i.e., $\mathbb{1}_t^{QT} = 1$ if $\varepsilon_t^{lsap} > 0$ and 0 otherwise). This scheme ensures that QT shocks are 'tightening surprises' from the perspective of markets. The estimated coefficients clearly indicate that tightening (QT) and loosening (QE) LSAP surprises have asymmetric effects on long-term Treasury yields. Figure 3a shows that loosening surprises have a limited and very short-lived effect on 10-year Treasury yields. Point estimates even turn significantly negative from around 35 days onward, implying that yields eventually *increase* following a loosening surprise. In contrast, tightening surprises significantly increase 10-year yields. The effect grows over time and results in a cumulative increase in Treasury yields of near-40bp that does not reverse even 50 days after the initial announcement.

In the case of 2-year yields, Figure 3b shows that the effects of tightening and loosening surprises are more symmetric, although the on-impact response of QT announcements is slightly larger.

3.2 Easing vs. Tightening Periods

While the QE-QT classification scheme based on the *sign* of surprises ensures that QT shocks are indeed perceived tightenings, it may place greater emphasis on tightening surprises during periods of financial stress (e.g., by including the 'Taper Tantrum'). So, although this scheme may be representative of the asymmetric effects of QT in stress periods, it may overstate asymmetries for QT conducted in calmer times. Given this caveat, we also classify events according to their timing.

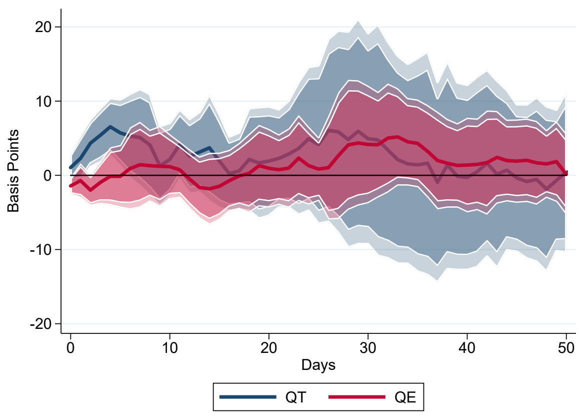
Figures 3c and 3d present results when QT shocks are classified as any LSAP surprise (positive or negative) that occurred during the October 2017 to June 2019 period, when the Fed was explicitly undertaking QT via a passive balance-sheet unwind (i.e., $\mathbb{1}_t^{QT} = 1$ between October 2017 and 2019, and 0 prior to October 2017).[3] While this classification allows us to assess the impact of surprises during the QT period—which may be useful for tailoring the size of future QT policies—it assigns other notable 'tightening surprises', like the 2013 Taper Tantrum, to the easing period and so treats it symmetrically other QE announcements. All else equal, this may lead this classification to underestimate the differences between QT and QE.

[3]For the results presented here, we continue to drop the March 2009 QE1 announcement from our sample.

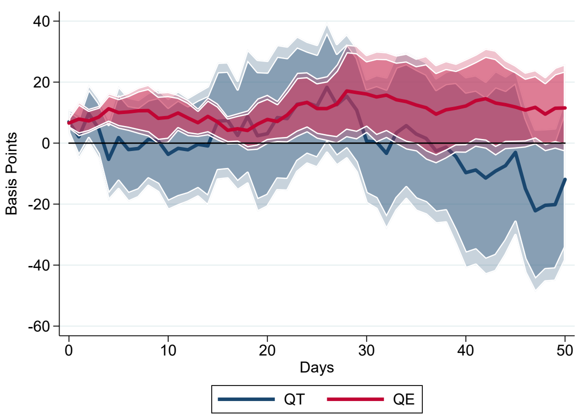
Figure 3: Asymmetric Response of 10- and 2-Year Treasury Yields to QE and QT

(a) 10-Year Yield to QE and QT Surprises

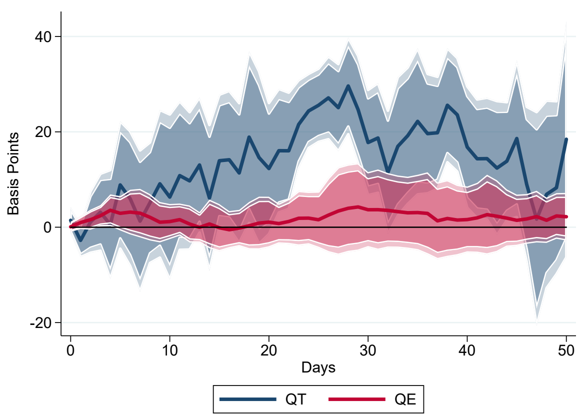
(b) 2-Year Yield to QE and QT Surprises



(c) 10-Year Yield to Surprises in QE and QT Periods



(d) 2-Year Yield to Surprises in QE and QT Periods



Notes: Figure 3a presents the estimated average marginal effect of a 1 standard-deviation QE (red) and QT (blue) LSAP surprise on the h-day-ahead change in the 10-year US Treasury yield. Figure 3b presents the corresponding marginal effects for the 2-year yield. Figure 3c (Figure 3d) presents the estimated average marginal effect of a 1 standard-deviation LSAP surprise on the h-day-ahead change in the 10-year (2-year) US Treasury yield during the Fed's easing ('QE') period (2008:12-2017:09) and tightening ('QT') period (2017:10-2019:06). Coefficients estimated using data for the period 2008:12-2019:06 (excl. QE1 announcement) in regression (2) for $h = 0, 1, ..., 50$. Dark (light) bars represent 90% (95%) confidence bands, constructed from Newey and West (1987) standard errors with 12 lags.

Consistent with this, Figure 3c shows that the effects of LSAP surprises on the 10-year yield are not significantly different. However, there are significant differences in the response of the 2-year yield. While surprises in easing periods have no clear significant effect at this tenor, Figure 3d shows that surprises in the tightening period did have significant effects on the 2-year yield—effects that are significantly different to those in the easing period. Our estimates suggest that, one month after the announcement, a 1 standard-deviation surprise in the tightening period had around a 30bp cumulative effect on the 2-year yield one.

4 Decomposing the Drivers of Asymmetries

Both of these classification approaches highlight important asymmetries in the effects of QE and QT on financial markets. In either case, albeit at different tenors, they indicate that QT shocks have larger and more persistent effects on Treasury yields than equal-sized QE shocks.

To understand the economic mechanisms underpinning these differences, we use a decomposition of M-period government bond yields $y_{M,t}$ into expectations of future short-term rates $exp_{M,t}$ and term premia $tp_{M,t}$:

$$y_{M,t} = \underbrace{\frac{1}{M}\sum_{m=0}^{M-1} y^e_{1,t+m}}_{\equiv exp_{M,t}} + tp_{M,t} \tag{3}$$

This decomposition has been widely used by academics and policymakers to understand the channels through which LSAPs can influence the real economy (e.g., Bernanke, 2010). Indeed, changes in expectations have been linked to a 'signalling channel', through which LSAP announcements influence expected future rates, and changes in term premia have been linked to the, so-called, 'portfolio rebalancing channel', whereby LSAPs influence the compensation investors demand for holding Treeasuries.

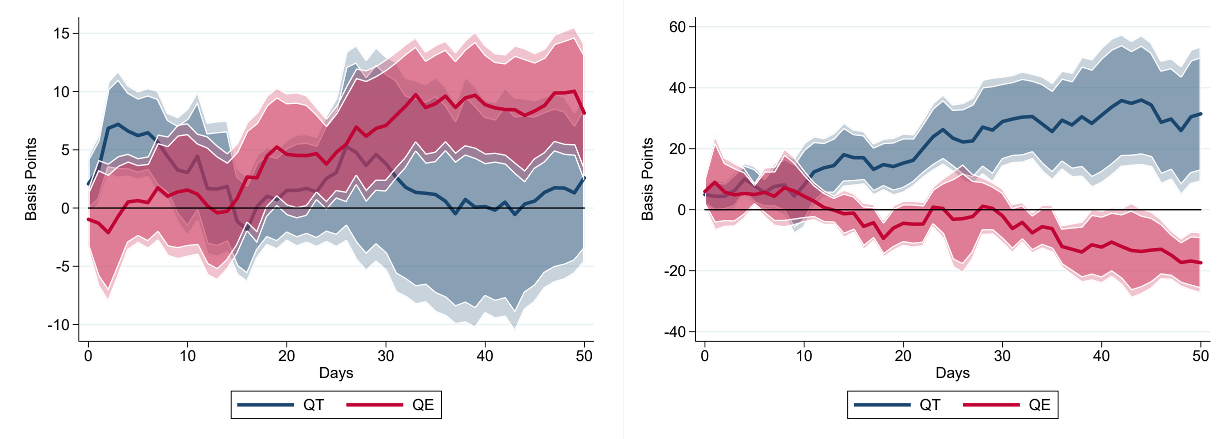
For our purposes, we use the empirical decomposition of US Treasury yields into expectations and term premia from Adrian, Crump, and Moench (2013), which is available at daily frequency. Using this data, we re-estimate regression (2) using each component of the Treasury yield as the dependent variable. In turn, we focus on the drivers of the asymmetric results presented in Section 3.

We first analyze the drivers of asymmetries in the 10-year yield when QT and QE are classified according to the *sign* of LSAP surprises. Figure 4 plots the average response of the 10-year expectations (Figure 4a) and term premium (Figure 4b) components to tightening and loosening surprises. Strikingly, the results highlight that differences in the response of the 10-year

Figure 4: Asymmetric Response of 10-Year Treasury-Yield Components to Fed Loosening (QE) and Tightening (QT) LSAP Surprises

(a) Expected Future Short-Term Interest Rates

(b) Term Premium



Notes: Figure 4a presents the estimated average marginal effect of a 1 standard-deviation QE (red) and QT (blue) LSAP surprise on the h-day-ahead change in the expectation component of the 10-year US Treasury yield from regression (2) for $h = 0, 1, ..., 50$ and estimated using data for the period 2008:12-2019:06 (excl. QE1 announcement). Figure 4b presents the corresponding marginal effects for the term premium component of the 10-year yield. Dark (light) bars represent 90% (95%) confidence bands, constructed from Newey and West (1987) standard errors with 12 lags.

yield to QE and QT surprises are linked with asymmetries in the response of term premia. The estimated responses of the 10-year expectations component do not significantly differ.

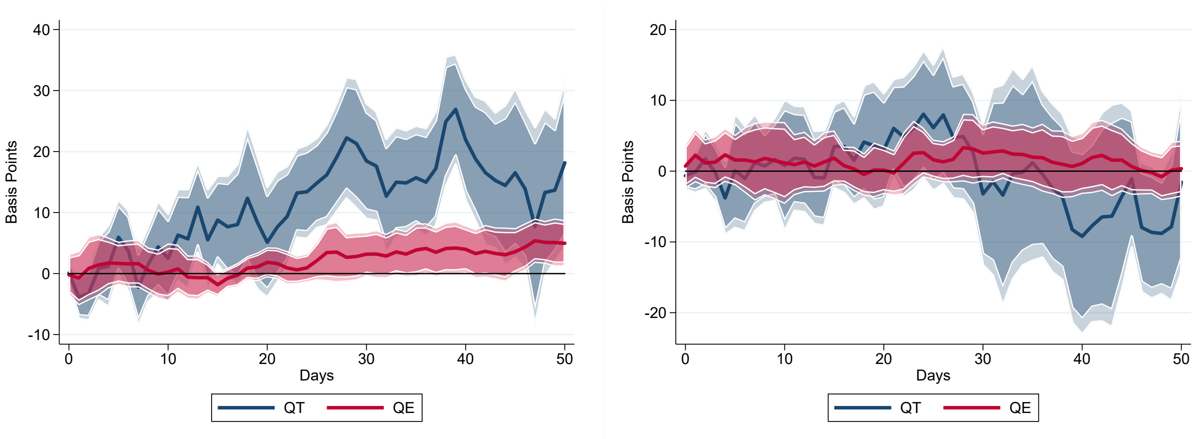
To the extent that the QE/QT classification based on the *sign* of surprises reflects the effects of QT during periods of stress, this finding highlights an important risk for policymakers to consider when going about QT. In particular, surprise tightenings, at times of market uncertainty, could lead to outsized responses in term premia.

Second, we decompose the drivers of asymmetries in the 2-year yield when QT and QE events are classified according to the *timing* of the surprise. Figure 5 plots the responses of the 2-year expectation (Figure 5a) and term premium (Figure 5b). While the responses of the term premium are statistically indistinguishable, there are significant asymmetries in the response of 2-year-ahead expectations. Like the 2-year yield, the response of the 2-year expectation is larger and more persistent to LSAP surprises during periods of QT than QE.

This results follows from the term-structure equation (3). The effective lower bound (ELB) on short-term policy rates (i.e. $y_{1,t+m} \geq \underline{y}$ for all t, m) places an ELB on expected future short rates (i.e., $exp_{M,t} \geq \underline{y}$ for all t, M). To the extent that the ELB binds more at shorter maturities (i.e., for low M), it follows that the ELB can limit the efficacy of the signalling channel in response to QE surprises, as policymakers cannot signal a path for short term rates that goes below the ELB in any future period.

Figure 5: Asymmetric Response of 2-Year Treasury-Yield Components in QE and QT Periods

(a) Expected Future Short-Term Interest Rates (b) Term Premium



Notes: Figure 5a (Figure 5b) presents the estimated average marginal effect of a 1 standard-deviation LSAP surprise on the h-day-ahead change in the expectation (term premium) component of the 2-year US Treasury yield during the Fed's easing ('QE') period (2008:12-2017:09) and tightening ('QT') period (2017:10-2019:06). Coefficients estimated using data for the period 2008:12-2019:06 (excl. QE1 announcement) in regression (2) for $h = 0, 1, ..., 50$. Dark (light) bars represent 90% (95%) confidence bands, constructed from Newey and West (1987) standard errors with 12 lags.

An implication of this result is that LSAP surprises during times of tightening can have larger effects on expectations of future rates—as Figure 5a demonstrates. Therefore, policymakers seeking to limit the real economic costs of QT may wish to guard against the risk that communications about LSAP reversals are misinterpreted by, or surprise, market participants.

5 Conclusion

In this paper, we have documented that QT surprises have larger and more persistent causal effects on US Treasury yields than QE shocks. Using a decomposition of bond yields, we have shown that this asymmetry arises from the differential effect of QT vs. QE surprises on expectations of future short-term rates at shorter maturities, and term premia at longer maturities.

While an analysis of the daily-frequency financial-market effects of QE and QT does not provide the full story, it does provide an initial indication about the potentially asymmetric effects of QT vs. QE on the real economy. And, to the extent that policymakers wish to minimise the real economic costs of future tightening, our results imply that opportune timing and careful communication may be particularly important. In times of financial market stress, QT surprises risk resulting in outsized moves in long-maturity term premia; and in calmer times, QT surprises can have larger effects on medium-term rate expectations.

References

ADRIAN, T., R. CRUMP, AND E. MOENCH (2013): "Pricing the term structure with linear regressions," *Journal of Financial Economics*, 110, 110–138.

BERNANKE, B. S. (2010): "Opening remarks: the economic outlook and monetary policy," *Proceedings - Economic Policy Symposium - Jackson Hole*, 1–16.

BERNANKE, B. S., V. R. REINHART, AND B. P. SACK (2004): "Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment," *Brookings Papers on Economic Activity*, 35, 1–100.

BHATTARAI, S. AND C. J. NEELY (2022): "An Analysis of the Literature on International Unconventional Monetary Policy," *Journal of Economic Literature*, 60, 527–597.

CHRISTENSEN, J. H. E. AND G. D. RUDEBUSCH (2012): "The Response of Interest Rates to US and UK Quantitative Easing," *Economic Journal*, 122, 385–414.

GAGNON, J., M. RASKIN, J. REMACHE, AND B. P. SACK (2011): "The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases," *International Journal of Central Banking*, 7, 3–43.

GERTLER, M. AND P. KARADI (2015): "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, 7, 44–76.

GÜRKAYNAK, R. S., B. P. SACK, AND E. T. SWANSON (2005): "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements," *International Journal of Central Banking*, 1.

GÜRKAYNAK, R. S., B. P. SACK, AND J. H. WRIGHT (2007): "The U.S. Treasury yield curve: 1961 to the present," *Journal of Monetary Economics*, 54, 2291–2304.

HANSON, S. AND J. STEIN (2015): "Monetary policy and long-term real rates," *Journal of Financial Economics*, 115, 429–448.

JEFFERSON, P. N. (2023): "Implementation and Transmission of Monetary Policy," Speech at the H. Parker Willis Lecture, Washington and Lee University, Lexington, Virginia.

LLOYD, S. P. (2017): "Unconventional Monetary Policy and the Interest Rate Channel: Signalling and Portfolio Rebalancing," Cambridge Working Papers in Economics 1735, Faculty of Economics, University of Cambridge.

——— (2020): "Estimating nominal interest rate expectations: Overnight indexed swaps and the term structure," *Journal of Banking & Finance*, 119.

NEWEY, W. AND K. WEST (1987): "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, 55, 703–08.

RAMSDEN, D. (2023): "Quantitative tightening: the story so far," Speech at the Money, Macro and Finance Society, London.

SCHNABEL, I. (2023): "Quantitative tightening: rationale and market impact," Speech at the Money Market Contact Group Meeting, Frankfurt am Main.

SWANSON, E. T. (2021): "Measuring the effects of federal reserve forward guidance and asset purchases on financial markets," *Journal of Monetary Economics*, 118, 32–53.

SWANSON, E. T. AND J. WILLIAMS (2014): "Measuring the Effect of the Zero Lower Bound on Medium- and Longer-Term Interest Rates," *American Economic Review*, 104, 3154–85.

TENREYRO, S. (2023): "Quantitative easing and quantitative tightening," Speech at the SES Annual Conference, Glasgow.