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

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Abstract

We study the asymmetric impact of US quantitative tightening (QT) and easing (QE) on financial markets using high-frequency large-scale asset purchase surprises around FOMC announcements. We document that QT surprises have had larger and more persistent effects on US Treasury yields than QE surprises. 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.

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

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

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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 and the literature on QE is vast (see Bhattarai and Neely, 2022, for a survey). Post-Covid, as policymakers tighten policy 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), but the literature on QT is more limited (e.g., Bräuning, 2017; Smith and Valcarcel, 2023; D'Amico and Seida, 2024). Therefore, understanding whether QT has equal and opposite effects to QE is a pressing question.

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

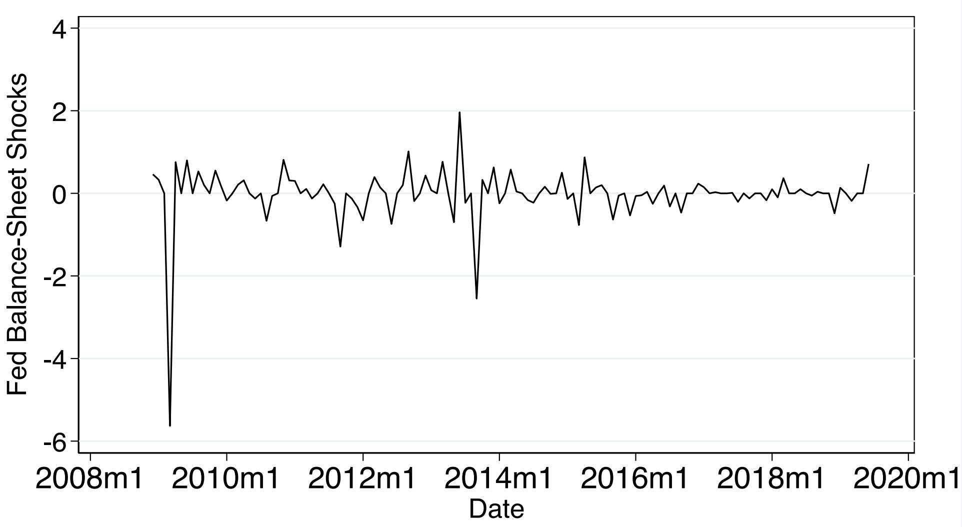
We document that QT surprises have larger and more persistent effects on US yields than QE shocks of equal magnitude. To understand the mechanisms underpinning this, we use a daily decomposition of Treasury yields into expectations of future short-term interest rates and term premia. Asymmetries are strongest, and most significant, at the two-year horizon. At this maturity, asymmetries arise because surprises during periods of QT have larger and more persistent effects on expected future rates than QE surprises. 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] Relative to other monetary surprises, these

[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), 2008:12-2019:06. Shocks reported in units of standard deviations.

series are preferable for our analysis given their mapping to specific policy tools—in particular, for isolating LSAP-driven moves.

Figure 1 plots the LSAP-surprises 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 purchased 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'—an event that was not associated with any actual tightening *ex post*.

In their study into QT, Smith and Valcarcel (2023) highlight two noteworthy periods of Fed policy. First, from 2017Q4 to 2019Q3, the Fed purchased fewer assets than were maturing. In this 'Asset-Runoff' phase, bank reserves and Fed assets declined. Second, from 2014Q4 to 2017Q3—the 'Full-Reinvestment' phase—reserves declined, but the Fed reinvested proceeds of maturing securities to keep asset holdings constant. The surprises in Figure 1 during these periods are somewhat more muted—consistent the finding in Smith and Valcarcel (2023) that QT-related events in the Full-Reinvestment phase generally lacked the large announcement effects that characterized QE. Nevertheless, over the two phases, there were some surprises—most clearly reflected in the 0.7 standard-deviation tightening in June 2019.

For our empirical analysis, we use the LSAP surprises in Figure 1 as exogenous variation to

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

identify 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 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.

Our dependent variables are 10- or 2-year zero-coupon US Treasury yields 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 Treasury yield to account for the pre-announcement stance of monetary policy.[2] β^h is the coefficient of interest, capturing the cumulative average causal effect of a 1 standard-deviation LSAP surprise on the h-day-ahead dependent variable.

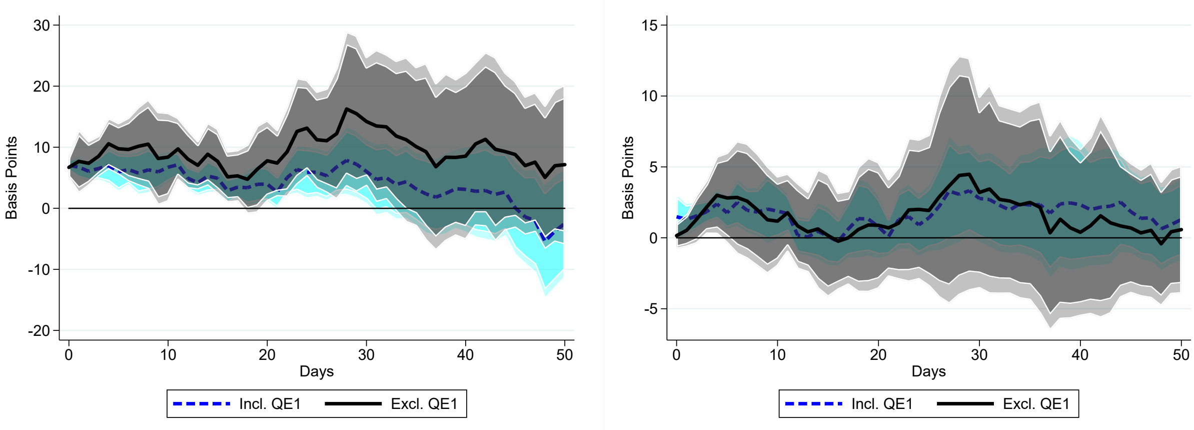
Figure 2a and 2b present the estimated average effects $\hat{\beta}^h$ for 10- and 2-year yields, respectively. In both, we report two sets of coefficients: coefficients estimated using all LSAP surprises from December 2008 to June 2019 ('Incl. QE1') and coefficients estimated when we omit the largest 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

[2]The number of lags included 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: Estimated average marginal effect of 1 standard-deviation LSAP surprise on h-day-ahead US Treasury yields from regression (1), $h = 0, 1, ..., 50$. 'Incl. QE1' uses all data for 2008:12-2019:06. 'Excl. QE1' excludes QE1 shock (2009:03) from sample. Dark (light) shadings represent 90% (95%) confidence bands, constructed from Newey and West (1987) standard errors with 12 lags.

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 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 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 also extend the controls $\mathbf{x}_t$ to 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 QE LSAP surprises (i.e., when $\mathbb{1}_t^{QT} = 0$), while $\beta^h + \delta^h$ measures the marginal effect of QT surprises. We discuss both the magnitudes of the overall marginal effects (i.e., β^h and $\beta^h + \delta^h$), which reflect the overall economic significance of our results (for a given sized surprise), as well as the statistical significance of the difference in magnitudes (i.e., δ^h).

We classify QT and QE events based on the *date* of the surprise.[3] In our baseline, we define QT events as surprises occurring during the Asset-Runoff phase (i.e., $\mathbb{1}_t^{QT} = 1$ from October 2017, 0 otherwise), when Fed asset holdings declined. We also consider an alternative 'normalization period' spanning both the Full-Reinvestment and Asset-Runoff phases (i.e., $\mathbb{1}_t^{QT} = 1$ from October 2014).

Figures 3a and 3b present results when QT events occur in the Asset-Runoff phase only. While the effects of QE and QT shocks are not significantly different at the 10-year maturity, there are significant differences at the 2-year tenor. QE surprises have no clear significant effect at this tenor, but Figure 3b shows that QT surprises 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. In contrast, a 1 standard-deviation QE surprise is associated with an insignificant response in the 2-year yield of around 5bp—although differences are less economically significant when accounting for the fact that the surprises themselves were around 4 times more volatile in the QE period vs. QT.

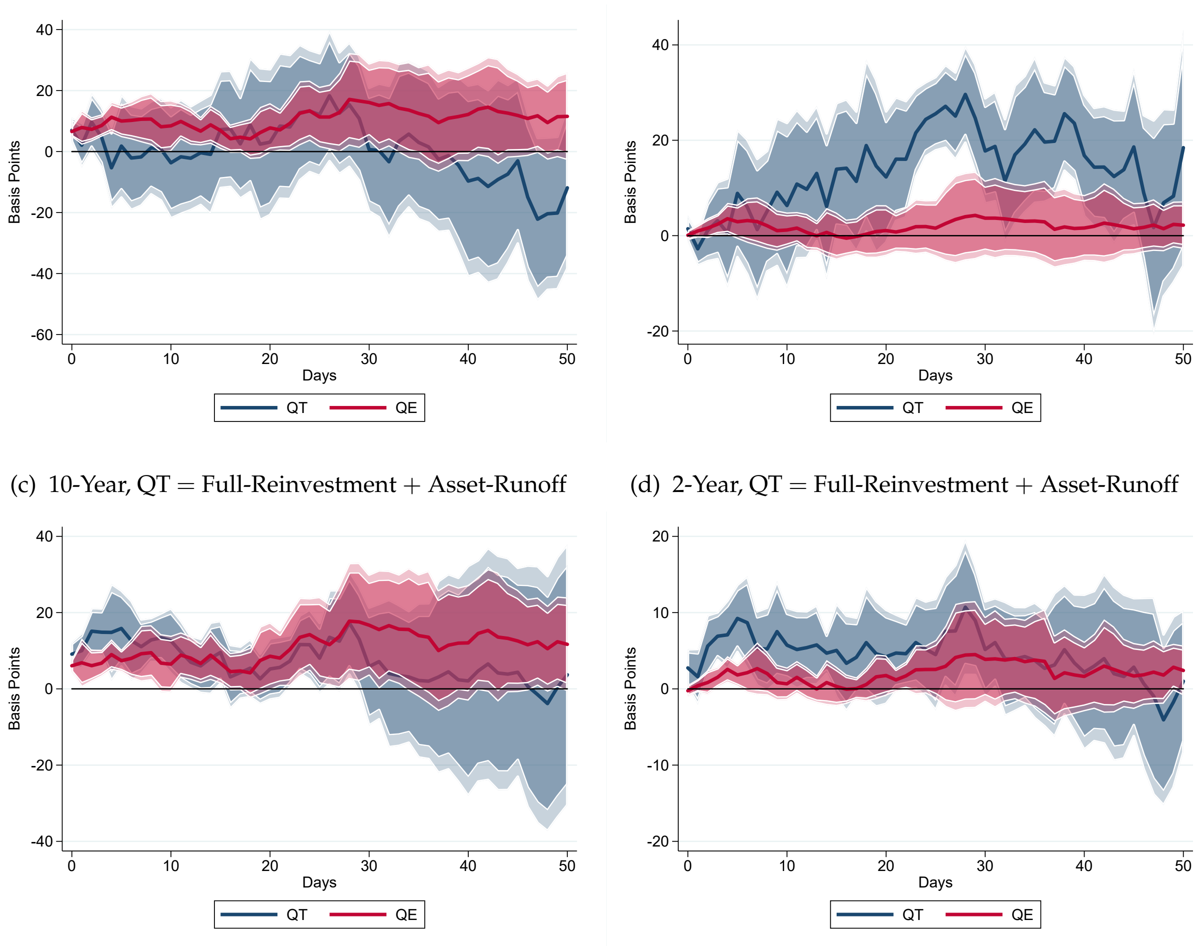
Figures 3c and 3d present results for the normalization period, classified as any LSAP surprise that occurred during both the Full-Reinvestment *and* Asset-Runoff phases. Differences at the 10-year maturity remain statistically indistinguishable, though there remain some significant differences at the 2-year maturity—with QT surprises having larger effects than equal-sized QE surprises in the near term. However, the differences are much less marked than for the Asset-Runoff phase alone, corroborating the finding of others that the majority of QT's effects occurred when Fed actually reduced its asset holdings (e.g., Smith and Valcarcel, 2023; D'Amico and Seida, 2024). Nevertheless, the fact our results indicate that QT surprises since 2017 have had larger and more persistent effects on 2-year Treasury yields than equal-sized QE shocks suggests that QT announcement surprises can have disproportionate effects on financial markets—effects that policymakers may wish to avoid.

4 Decomposing the Drivers of Asymmetries

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

[3] Although we attain similar qualitative results using an alternative rule, in which QE/QT events are classified according to the *sign* of the surprise, we do not report these. QT has distinct institutional features to QE. But, by labelling positive surprises in QE periods as QT, a sign-based classification will ignore these, and so is unlikely to reliable inform conclusions about QE vs. QT.

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



(a) 10-Year Yield, QT = Asset-Runoff

(b) 2-Year Yield, QT = Asset-Runoff

(c) 10-Year, QT = Full-Reinvestment + Asset-Runoff

(d) 2-Year, QT = Full-Reinvestment + Asset-Runoff

Notes: Estimated average marginal effect of a 1 standard-deviation QE (red) and QT (blue) LSAP surprise on the h-day-ahead US Treasury yields. Estimates use data for 2008:12-2019:06 (excl. QE1 announcement) in regression (2) for $h = 0, 1, ..., 50$. When QT = (Full-Reinvestment +) Asset-Runoff, $\mathbb{1}_t^{QT} = 1$ from 2017:10 (2014:10). Dark (light) shadings represent 90% (95%) confidence bands, constructed from Newey and West (1987) standard errors with 12 lags.

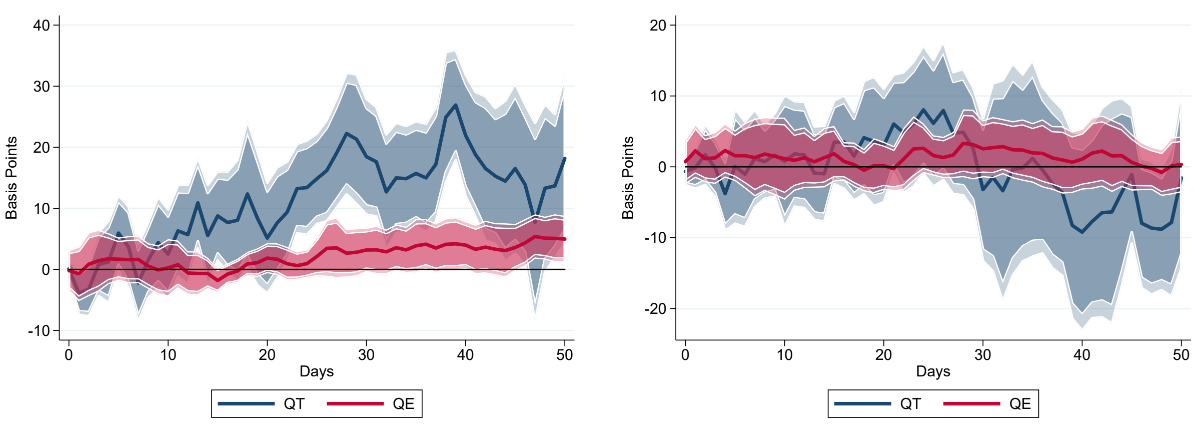
$exp_{M,t}$ and term premia $tp_{M,t}$:

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

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). 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

Figure 4: Asymmetric Response of 2-Year Treasury-Yield Components in QE and QT Periods

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



Notes: Estimated average marginal effect of a 1 standard-deviation LSAP surprise on the h-day-ahead expectation (term premium) component of 2-year US Treasury yield QE (2008:12-2017:09) and QT (Asset-Runoff: 2017:10-2019:06) periods. Estimates use data for 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.

demand for holding Treasuries.

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. Based on the asymmetries found in Section 3, we focus on the 2-year tenor during the Asset-Runoff phase only.

Figures 4a and 4b plot the responses of 2-year expectations and term premia, respectively. While the term premium responses are statistically indistinguishable, there are significant asymmetries in the response of expectations. Like the 2-year yield, the response of the 2-year expectation is larger and more persistent to LSAP surprises during the Asset-Runoff phase of QT than equal-sized QE events.

This results follows from the term-structure equation (3). The effective lower bound (ELB) on short-term policy rates ($y_{1,t+m} \geq \underline{y}$ for all t, m) places an ELB on expected future short rates ($exp_{M,t} \geq \underline{y}$ for all t, M). To the extent that the ELB binds more at shorter maturities (for low M), it follows that, at a given maturity M, 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. So, while signalling can be an important for QE announcements, by increasing the relevance of changes in longer-maturity expectations for the current stance of policy, the ELB also constrains the relevance of changes in expectations at a given maturity.

An implication of this result is that LSAP surprises during times of tightening can have larger effects on expectations of future rates *at a given maturity*—as Figure 4a 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 post-2017 had larger and more persistent causal effects on US Treasury yields than equal-sized QE surprises. 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.

While an analysis of the daily-frequency financial-market effects of QE and QT does not provide the full story (e.g., D'Amico and Seida, 2024, discuss the role of an additional supply-effect channel), it does provide an initial indication about the potentially asymmetric effects of QT vs. QE on the real economy. 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.

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.

BRÄUNING, F. (2017): "The liquidity effect of the Federal Reserve's balance sheet reduction on short-term interest rates," Current Policy Perspectives 18-1, Federal Reserve Bank of Boston.

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.

D'AMICO, S. AND T. SEIDA (2024): "Unexpected Supply Effects of Quantitative Easing and Tightening," *The Economic Journal*, 134, 579–613.

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.

SMITH, A. L. AND V. V. VALCARCEL (2023): "The financial market effects of unwinding the Federal Reserve's balance sheet," *Journal of Economic Dynamics and Control*, 146, S0165188922002858.

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.