A Tale of Two Tightenings*

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Abstract

Balance sheet policy is now a prominent facet of monetary policy. Based on the U.S. experience between 2017 and 2019, Smith and Valcarcel (2023) show the first period of quantitative tightening (QT1) was markedly different from earlier balance sheet expansions. This paper provides evidence the Federal Reserve's second balance sheet unwind effort that began in 2022 (QT2) is strikingly different from QT1. We find substantial announcement effects during QT2 for various treasury yields and interest rate spreads, which are largely absent from QT1. While both episodes have experienced a similar percent reduction in reserve balances thus far, QT2 shows a stronger market response upon implementation. Not only are the underlying financial conditions different across the two periods, but the conduct of monetary policy in 2022 seems to be different as well. A clearer signaling mechanism for the expectations channel of monetary transmission takes place during QT2 than was apparent during QT1. The liquidity effects that seemed to be so important during QT1 have been largely attenuated during the second episode of balance sheet tightening.

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1 Introduction

In recent years, the Federal Reserve has engaged in two separate episodes of balance sheet unwind. The first one occurred between 2014-Q4 and 2019-Q3. The second began in 2022 and is still underway at the time of this writing. These balance sheet unwinds took the form of significant reductions of bank reserves—dubbed quantitative tightening (QT). The Federal Reserve's sequencing of policy actions in this first episode of quantitative tightening (QT1) was characterized by two distinct phases. From 2014-Q4 through 2017-Q3, the Federal Reserve reinvested proceeds of maturing securities. This *Full Reinvestment* phase resulted in declining reserves without a commensurate decline in asset holdings. Later on, beginning in 2017-Q4 until 2019-Q3, the Federal Reserve began purchasing fewer assets than were required to offset those that were maturing. This *Asset Runoff* phase of QT1 resulted in declines of both reserves and asset holdings.

Smith and Valcarcel (2023) show evidence that FOMC announcements in both phases of QT1 had little effect on broad and narrow financial conditions and point to important liquidity effects as the main transmission mechanism of reserves shocks between 2017 and 2019. This stands in stark contrast to the experience with balance sheet expansions between 2008 and 2014, when announcement effects were found to be the prime transmission mechanism.

Using a similar event study methodology, we find evidence of tightening in the two-day movements of treasury rates surrounding FOMC announcement dates during the QT2 period of 2022. We also find some heterogeneity in the two-day movements of corporate rates, where some announcements serve to raise rates while others are followed by drops in corporate yields. When cumulating the effects, the positive and negative responses of corporate yields largely offset each other. A plausible explanation is that heightened uncertainty about inflation and financial conditions in 2022—at a time when aggressive federal funds rate hikes might have been imperfectly priced in by financial markets—likely exacerbated volatility in rates, making it difficult to glean clear effects from these announcements.

We then extend the analysis in Smith and Valcarcel (2023) by netting out sustained increments in the federal funds rate, which are particularly prevalent in the second balance sheet unwind period. We repeat our event study for various spreads between treasury/corporate rates and the effective federal funds rate. We find only two announcement dates prior to 2020 have a significant two-day impact on interest rate spreads. One is the June 19, 2013, date associated with the *Taper Tantrum*. The other is June 14, 2017, which is the date Smith and Valcarcel (2023) broadly identify as a change in regime from the *"Full Reinvestment"* to the *"Asset Runoff"* phase of QT1. Importantly, none of the other FOMC dates between 2013 and 2017 elicit significant responses in treasury spreads.

Conversely, we find virtually all the FOMC announcements in the QT2 period exert a material and significant influence on yield spreads. We conclude QT1 and QT2 periods differ meaningfully in at least two aspects: (*i*) while QT1 took place during a period of relative calm in financial markets, there is substantial financial turbulence during QT2, and (*ii*) there seem to be material differences in the way monetary policy shocks are transmitted through FOMC announcements across the two periods. We find that the effects of QT1 on financial conditions manifested largely upon implementation, rather than announcement. On the other hand, QT2 announcements had large signaling effects. Our findings suggest the dominant mechanism of QT1 was liquidity effects, whereas the likely dominant mechanism of QT2 was one of market expectations.

We present evidence that the balance sheet unwind in the QT2 episode stands in stark contrast to the experience from QT1. First, QT2 shows larger signaling from announcement effects than QT1. There is ample evidence that quantitative easing (QE) announcements typically contained a large signaling component (Krishnamurthy and Vissing-Jorgensen, 2011). In this context, QT2 more closely resembles past evidence from QE than QT1. Second, while QT1 shows a strong negative relationship between banks' opportunity costs for holding reserves and reserve reductions, no similar dynamic is present in QT2. Third, we find that the previously found lack of announcement effects onto rates during QT1 extend to treasury and corporate spreads as well. Finally, we find robust evidence that the magnitude of the responses associated with implementation effects of QT2 overshadow those of QT1.

The rest of the paper is organized as follows. Section 2 outlines some background and discusses potential transmission mechanisms of balance sheet unwinds. Section 3 outlines possible liquidity effects and discusses the data. Section 4 conducts various event study analyses and presents contrasting evidence across the QT1 and QT2 periods. Section 5 provides exposition on dynamics of balance sheet management and outlines a strategy for the structural identification of shocks to the supply of reserves. Section 6 presents results from the analysis and provides elaboration on implementation effects of balance sheet policy. Section 7 concludes.

2 Background on Reserves Management

The size of central bank balance sheets is now an important facet of Federal Open Market Committee (FOMC) announcements. After the protracted ballooning of bank reserves that commenced in 2008 and lasted over half a decade—only to resume in response to the global pandemic—the Federal Reserve and the Bank of England began signaling an intent to eventually reduce their balance sheets (see Bailey, 2020; Powell, 2020).

When analyzing the effectiveness of balance sheet normalization, the attention of policymakers likely centers on its influence on the central bank's macroeconomic objectives. Therefore, balance sheet effects on financial conditions may take a back seat to the government directives of price stability and maximum employment. However, standard macroeconomic models generally predict that current financial conditions influence future spending and investment choices. Furthermore, there seems to be some empirical support for a non-negligible relationship between current financial conditions and future economic activity (Hatzius et al., 2010). While a direct examination of the link between balance sheet normalization and economic activity is clearly of interest, it is outside the scope of our work. Instead, we focus mainly on financial market effects for which there is high-frequency data available. This is essential for the identification strategies we employ, and it allows for a clearer comparison to the large literature that has studied the financial market effects of balance sheet expansion.[1]

Knowledge of the effects of unwinding the central bank's balance sheet is essential for informed decisions regarding the provision and withdrawal of policy accommodation via the central bank's balance sheet. While there is copious literature available on the effects of balance sheet expansions, literature on the effects of unwinding the balance sheet is far more incipient. A notable exception is Smith and Valcarcel (2023) who find that the unwind period between 2017 and 2019 had a contractionary effect on broad financial conditions and various market yields. Importantly, they show these effects manifested upon implementation rather than through FOMC announcements surrounding balance sheet reductions.

[1] Given the range of financial markets through which balance sheet normalization could operate, we study potential effects on a number of asset classes. Of course, not all asset prices may move in a synchronized manner, which impedes a clear assessment of the overall effects of a balance sheet unwind on financial conditions.

2.1 Balance Sheet Unwind Transmission Channels onto Financial Conditions

Smith and Valcarcel (2023) outline various transmission mechanisms, where balance sheet unwinds could affect market yields via similar channels to those of asset purchases, including signaling and duration effects. The signaling channel of asset purchases was advanced by Krishnamurthy and Vissing-Jorgensen (2011), Bauer and Rudebusch (2014), and Bhattarai et al. (2015). One of the main drivers of the observed reductions in longer-term yields following QE announcements was downward revisions to expectations for the future path of policy rates. Therefore, announcements of balance sheet reductions could prove a harbinger to credible upward revisions to expectations of the future path of policy rates.

Gagnon et al. (2011) associate the observed reductions in Treasury, mortgage, and corporate yields around large-scale asset purchase (LSAP) announcements to broad duration effects. The Federal Reserve's massive purchases represented a viable substitute to the amount of duration that the private sector was asked to bear. Balance sheet unwinds could effectively transfer that duration back onto investors' balance sheets, leading to higher risk- and term-premiums.[2] Therefore, reducing the balance sheet and transferring duration back to the private sector could raise short as well as longer-term interest rates across a range of assets. However, Krishnamurthy and Vissing-Jorgensen (2013) suggest the effects on rates might not be widespread. Instead, they might be limited to the source of the balance transfer so that shifting Treasuries and mortgage backed securities (MBS) balances back into private hands might have few spillovers—other than to Treasury and MBS rates.

We investigate the tightening effects the Federal Reserve's balance sheet policy may have had on various interest rates and interest rate spreads. We consider the effects from two angles: (*i*) two-day movements of various rates around announcement dates related to balance sheet management, and (*ii*) the flexible responses to exogenous shocks to reserve balances over the samples of interest. Our choice to center attention on shocks in bank reserves—a Federal Reserve liability—reflects the FOMC's own approach to balance sheet normalization. The June 14, 2017, *Policy Normalization Principles and Plans* noted that: "The Committee expects to learn more about the underlying demand for reserves during the process of balance sheet normalization." Therefore, balance sheet normalization in 2017—2019 was guided by how the relationship between reserve balances and short-term money market rates would

[2] Furthermore, increasing the public supply of Treasury and mortgage securities could lead to a reversal of any portfolio rebalancing effects, a channel postulated by Vayanos and Vila (2021). This mechanism was empirically emphasized by D'Amico et al. (2012), D'Amico and King (2013), Carpenter et al. (2015), and Ihrig et al. (2018).

evolve. The second episode of balance sheet normalization has some similarities as well as some points of distinction with the first one. The **Principles for Reducing the Size of the Federal Reserve's Balance Sheet**, released on January 26, 2022, states the *"The Committee will determine the timing and pace of reducing the size of the Federal Reserve's balance sheet so as to promote its maximum employment and price stability goals. The Committee expects that reducing the size of the Federal Reserve's balance sheet will commence after the process of increasing the target range for the federal funds rate has begun."*

In addition to various treasury and corporate rates, incorporating information on interest on reserves (IOR) could serve a dual purpose. First, it could help capture any liquidity effects upon normalization. Second, it would provide a viable control against the possibility of confounding identification with other developments shaping the Federal Reserve's balance sheet and financial markets. In addition to the approximately $700 billion decrease in reserve balances during the *Asset Runoff* period, other forces—namely the increase in Treasury bill supply—are also thought to have played a role in applying steady upward pressure to money-market rates leading up to September 2019 (Copeland et al., 2021).[3]

Reductions in reserves may put upward pressures on both the IOR and the federal funds rate via a classic liquidity effect. The model in Ireland (2014), argues arbitrage incentives should drive the federal funds rate toward the IOR regardless of the level of reserve balances. Thus, the Federal Reserve's 2008 adoption of interest payments on reserve balances could eliminate liquidity effects. Smith (2019), Martin et al. (2019), and Smith and Valcarcel (2023) find evidence that the FFR-IOR spread correlates negatively with reserves, indicating that liquidity effects remained under the Federal Reserve's operating framework after 2008—particularly during QT1.

[3]For instance, in a June 2018 press conference, Federal Reserve Chair Powell attributed the upward rate pressure not to declining reserve balances but instead noted: *I think there's a lot of probability on the idea of just high [Treasury] bill supply leads to higher repo costs, higher money market rates, and the arbitrage pulls up the federal funds rate toward IOR.* – (Powell, 2018).

3 Liquidity Effects in the Transmission of Balance Sheet Unwinds

In this paper, we note that liquidity effects encapsulated in the FFR-IOR spread seem to be largely absent during QT2. Figure 1 shows the FFR-IOR spread and reserves balances between August 2014 and February 2023. The vertical lines—demarcating the transition between the *"Full Reinvestment"* phase of the QT1 episode in September 2017 and the end of QT1 in September 2019—are informative. From October 2017 through September 2019 bank reserves declined from more than $2.0 trillion toward $1.4 trillion amid a more than $650 billion reduction in the Federal Reserve's asset holdings. The solid blue line in the chart shows the federal funds rate net of interest on reserves increased during this period. Between October 2017 and August 2019 there was a substantial hike in the FFR-IOR spread of 150 basis points. Smith and Valcarcel (2023) estimate this is the period during which the magnitude of the liquidity effect roughly doubles. The FFR-IOR spread experiences a subsequent hike of nearly 100 basis points in the month that followed.

3.1 Narrow Financial Conditions

In September 2019 the FFR-IOR spread peaked at around 150 basis points. The transition between 2019 and 2020 was fraught with adverse conditions on treasury repo markets. The top panel of Figure 2 shows the difference between the secured overnight financing rate and IOR, known as repo (SOFR-IOR) spread, experienced a dramatic hike of over 350 basis points on Sep. 17, 2019. The bottom panel of Figure 2 shows that the increase in the FFR-IOR spread takes place concurrently with what is commonly referred to as the *"repo rate shock."* Afonso et al. (2020) show that costly arbitrage in the reserves market led to the September 2019 repo rate spike. Copeland et al. (2021) conduct an intra-daily analysis with micro-level data (for the 10 largest bank holding companies) and they argue these large banks could have engaged in some degree of *reserve hoarding*. Anbil et al. (2021) find that market segmentation prevented arbitrage across repo markets, which likely exacerbated the September 2019 repo rate spike. The bottom panel of Figure 2 shows another hike of the FFR-IOR spread occurring on Mar. 17, 2020, which can be attributed to panic selling pressures across advanced sovereign bond markets caused by uncertainty surrounding the onset of the COVID-19 pandemic in the U.S. This became known as a global "dash-for-cash" by investors, which led to a temporary dislocation in market functioning and to central bank interventions. Barone et al. (2022) show this dash-for-cash shock occurred disproportionately in the U.S. Treasury market and was due to investors' selling pressures being broad-based. Figure 2 shows the dash-for-cash shock elicits a larger hike in the FFR-IOR spread than the (SOFR-IOR) spread.

Figure 3 shows the dash-for-cash in March 2020 saw a hike in the BBB corporate rate of over 200 basis points. The MBS rate seems to have been largely insulated from that shock. With the exception of the dash-for-cash shock, both the BBB and the MBS rates declined substantially between 2019 and 2021. Beginning in 2021, both rates began to increase moderately at first. This was a period where reserves were still expanding rapidly and important inflationary pressures were building. The beginning of 2022 marks the second episode of balance sheet unwind (see Figure 1). It is during this period that both the BBB and MBS rates experience a dramatic increase, more than doubling within the span of 10 months. By November 2022 both rates begin to decline almost in tandem with similar declines in broader financial conditions shown below.

3.2 Broad Financial Conditions

Figure 4 shows three measures of financial conditions. The Goldman Sachs Financial Conditions Indicator (GS-FCI) and the Bloomberg FCI are two global measures of broad financial conditions, and the VIX index is a narrower measure representing financial uncertainty in the equities market. Higher values of GS-FCI and VIX, and lower values of the Bloomberg FCI, indices represent more uncertainty or tightness in financial conditions. We invert the Bloomberg FCI in the chart for comparability purposes. March 2020 shows a peak in all three indices. The COVID expansion that followed seemed to, by and large, loosen financial conditions. Then, in January 2022 as the second QT episode gets underway, financial conditions tighten considerably throughout 2022, while the VIX index moves largely sideways.

Returning to Figure 1, the (solid) blue line shows the FFR-IOR spread peaks at 150 basis points both during the repo rate and the dash-for-cash shocks. The solid black line also shows September 2019 constitutes the end of the first QT episode as reserves balances begin to increase by then. A steady increase in reserves begins shortly after the repo rate shock of September 2019. In March 2020, as the coronavirus spread across the globe, the FOMC initiated Treasury and agency MBS purchases at a rapid pace. The COVID-related expansion ultimately resulted in a near tripling of reserve balances between September 2019 and January 2022. Conversely, once the repo rate and the dash-for-cash shocks percolated through, the FFR-IOR spread remained relatively stable in this period—ranging a mere 50 basis points between March 2020 and September 2021.

That the FFR-IOR spread moved mostly sideways in the face of the remarkable COVID-related reserve expansion suggests a diminished liquidity effect from what was observed during QT1. Finally, Figure 1 reveals a descent from the all-time peak of $4.2 trillion of reserves balances begins in January 2022. By February 2023 (the time of this writing), reserve balances declined by $1.2 trillion. This is a 29% reduction in reserves from their peak. In terms of magnitude of the unwinds, this second episode of QT (a 29% reduction) seems to be on par with the 30% reduction during QT1. In levels, however, the QT2 reduction of $1.2 trillion in reserves balances is twice as large as the roughly $700 billion drawdown of reserves of QT1. Importantly, the Federal Reserve seems to have turned to a different regime of its managed rate in this period. In preparation for the second balance sheet unwind that began in January 2022, the IOR seems to have been set to consistently remain 7 basis points above the federal funds rate target. Therefore, the second unwind in reserves that began in January 2022 is taking place while the opportunity cost of holding those reserves is kept fixed with a -7 basis point FFR-IOR spread.[4]

There seems to be a key point of distinction between the two balance sheet unwind periods. While the percent reductions in reserves are similar (30% for QT1 and 29% for QT2), the FFR-IOR spread increased by 150 basis points during QT1 and it has remained fixed at -7 basis points during QT2. This suggests that the liquidity effect, which was an important transmission mechanism of the first balance sheet unwind period, is conspicuously absent from the second QT episode.

Another plausible mechanism of transmission could operate through FOMC announcements related to the management of the balance sheet. Announcement effects were found to be important in the forward guidance efforts of the various episodes of balance sheet expansions between 2008 and 2014. These investigations were typically conducted by event studies. We next turn to this type of analysis to determine whether announcement effects can be gleaned during the QT2 period.

[4] Sengupta et al. (2022) predict a more aggressive post-COVID-19 QT period—than the pre-COVID-19 period Smith and Valcarcel (2023) study—may have more portentous effects on financial conditions. Given the fixing of the FFR-IOR spread and the similar magnitude of percent reduction in reserves between QT2 and QT1 at the time of this writing, whatever aggressive response the Federal Reserve may have undertaken during QT2 seems to have been largely focused on the signaling mechanism thus far.

4 Contrasting the Federal Reserve's Management of Expectations Across the Two Unwind Episodes

We begin our analysis with an event study to detect whether announcement effects stemming from balance sheet unwinds had significant impact on various market yields. Importantly, we investigate whether QT1 and QT2 were different in this regard.

We distinguish between possible differences in announcements regarding tapering or slowing purchases, neutral reductions—where purchases are reduced to simply offset maturation ("Full Reinvestment")—and active reductions—where assets are allowed to roll off the balance sheet ("Asset Runoff"). We provide some narrative interpretation for our findings.

Smith and Valcarcel (2023) show that announcement effects surrounding the first QT episode stand in stark contrast to the experience with balance sheet expansion between 2008 and 2014. Following that paper, we select a set of 11 balance sheet announcements in which the Federal Reserve publicized plans and timelines for slowing and ultimately unwinding asset purchases in QT1 (See Table 1).[5] We then select a second set of five announcements from FOMC meeting minutes when information on balance sheet reductions in the January 2022—February 2023 period were provided by the Federal Reserve when engaging in its second bout of balance sheet unwind (See Table 2). While there were certainly more than five FOMC press releases in 2022, we concentrate only on those announcements when plans are laid out or material changes in the language are provided (e.g. a change in caps or pacing). Thus, we exclude the two summer announcements and the announcement late in December (nearing the holiday), which largely consisted of following through on previous communica-

[5] The set of events we investigate is by and large outlined by the Federal Reserve Board's chronology of Federal Reserve communication related to balance sheet normalization available at:
`https://www.federalreserve.gov/monetarypolicy/policy-normalization-discussions-communications-history.htm` and at: `https://www.federalreserve.gov/monetarypolicy/policy-normalization.htm`
Following Smith and Valcarcel (2023), we append two key announcements related to the tapering or slowing of asset purchases. While these two earlier announcements may fall outside the QT1 period, they may have helped shape market expectations on the eventual normalization effort, and they may also have caused large revisions to the expected path of future policy rates (Bernanke, 2017). Table 1 outlines the 11 dates that constitute our QT event study set. The first two events of May 22, 2013, and June 19, 2013, correspond to tapering announcements when the Committee revealed intentions to slow the pace of its asset purchases. The remaining nine events encompass the release of FOMC meeting minutes, FOMC statements, and speeches that publicized the Committee's discussions and plans specifically related to reducing the balance sheet.

tions.

There is a large literature that isolates the financial market effects of the Federal Reserve's balance sheet programs by studying the responses of asset prices in small windows around Federal Reserve announcements (including Gagnon et al., 2011; Krishnamurthy and Vissing-Jorgensen, 2011, 2013; Swanson, 2020, among others) for the QE period and Smith and Valcarcel (2023) for the QT1 period. This type of analysis assumes markets are efficient and forward looking and, thus, expectations of policy are already "priced in" before policymakers make any announcement. Based on this premise, it follows that any change in asset prices immediately after the announcement must reflect investor's revision of policy expectations, which should capture the surprise component of monetary policy. We focus our study on the announcement effects on various levels of Treasury yields, MBS, and corporate bond yields, as well as the foreign exchange value of the dollar, and the S&P 500 index. We also extend our analysis to the response of various interest rate spreads in a two-day window around Federal Reserve announcements with communication relevant to both the tapering and the unwinding of asset purchases. The two-day window allows for late-in-the-day announcement effects to fully reflect through to asset prices the following trading day. As Hanson and Stein (2015) argue, empirical evidence suggests that it often takes time for longer-term yields to fully react to FOMC announcements.

4.1 First Event of Balance Sheet Unwind: QT1

Table 3 replicates the event study conducted by Smith and Valcarcel (2023) and shows a limited response of Treasury yields to Federal Reserve announcements related to QT1. The bottom half of the table shows the cumulative responses of various treasury yields to the collective QT1 effort are largely insignificant across the *Full Reinvestment* and *Asset Runoff* phases of this first episode of balance sheet unwind. Notably, our regressions show significant increases in most yields when cumulating the two dates surrounding the *Taper Tantrum*. This seems sensible. Our focus on the cumulative increases in yields across all QT events could mask some degree of heterogeneity across announcement effects. The top of Table 3 shows the two-day change in Treasury yields over the 11 QT1 event days across the 1-, 3-, 5-, 10-, and 30-year sections of the yield curve and a row that registers the standard deviation of the two-day change in each of these yields between January 2008 and February 2023 (the end of our sample). The first two "*Taper Tantrum*" announcements, showed much larger responses than did any of the remaining announcements related to normalizing the balance sheet. None of the announcements (except the *Taper Tantrum* and the 30-year response in the transition to the *Asset Runoff*) reached the benchmark presented by the standard deviation of the two-day change over the long period since the Great Financial Crisis. The overall effect of the QT1 unwind announcements is quantitatively small and qualitatively ambiguous across the 1-, 3-, 5-, 10-, and 30-year sections of the yield curve.

Table 4 extends the analysis of Table 3 to the two-day change in MBS as well as the AAA and BBB corporate bond yields. The cumulative change in all of these yields is statistically insignificant across all 11 events. Changes in mortgage and corporate bond rates were unremarkable around the nine unwind announcements. Turning to MBS—a market that had the potential to be directly impacted by partially unwinding the Federal Reserve's MBS holdings—the two-day change in MBS rates around any of the nine unwind events fails to exceed the sample standard deviation of the two-day change in MBS yields of 0.10 percentage points. It is only during the *Taper Tantrum* dates that these yields exceed the long-run values of the standard deviation over the long sample. Smith and Valcarcel (2023) find that—while announcements related to tapering asset purchases led to a tightening in financial conditions—announcements related to shrinking the balance sheet and unwinding past purchases during the QT1 episode had no observable impact on financial markets.[6]

4.2 Second Event of Balance Sheet Unwind: QT2

We now turn attention to the second bout of balance sheet unwind, the QT2 episode that began in January 2022. Table 5 shows a preponderance of positive two-day changes of treasury yields in response to the five QT2 announcement dates we study. The bold underlined numbers correspond with two-day responses that exceed (in absolute value) the standard deviation of the two-day change in each of these yields between January 2008 and February 2023.

The first announcement on January 26, 2022, shows statistically significant increases in the short end of the yield curve (the 1-, 3-, and 5-year rates). The majority of announcements are qualitatively similar, showing increases (though sometimes not significant) in treasury yields. Cumulatively, all treasury yields increase surrounding QT2 announcements, particularly those around the middle of the yield curve. Table 6 shows relatively more heterogeneity

[6]These authors argue the taper announcements appear to have had large financial market effects, in part, because they led to an upward revision to expectations about future policy rates, consistent with the discussion in Bernanke (2017).

in the MBS and corporate rates. Some positive and some negative effects offset each other leading to no significant cumulative effects for these rates in QT2. This highlights the evident uncertainty in corporate rates in 2022—a period fraught with higher inflation and, overall, quite a different economic environment from that of QT1.

Another point of stark contrast between QT1 and QT2 is associated with the federal funds market. From December 2015—when the federal funds rate was lifted from its effective lower bound—until August of 2019, the end of QT1, the federal funds rate was gradually raised by a total of roughly 230 basis points. Most of that increase takes place during the *Asset Runoff* period between September 2017 and August 2019. During this two-year period, the FFR-IOR spread experiences a near three-fold increase. Conversely, the QT2 period saw a much more rapid hike in the federal funds rate of 450 basis points in about a year. Yet the FFR-IOR spread remained fixed at -7 basis points in all of 2022 (see Figures 4 and 3). Given these markedly different dynamics, we now repeat the time event analysis for interest rate spreads.

4.3 Announcement Effects on Interest Rate Spreads: QT1 vs. QT2

Table 7 shows the two-day change in treasury spreads (the difference between each treasury yield and the effective federal funds rate) during QT2. Between January 2008 and February 2023, the standard deviations of the rolling two-day changes in (1-yr - FFR), (3-yr - FFR), (5-yr - FFR), (10-yr - FFR), and (30-yr - FFR) spreads are 0.09, 0.10, 0.10, 0.11, and 0.10, respectively. The vast majority of announcement dates sees a magnitude change in these spreads that exceeds these benchmarks in absolute value. This is highlighted by the large number of underlined bolded values in the top half of the table. The treasury spread responses are largely congruent with our conclusions for the treasury yields during QT2. All of the dates except for the first one (January 26, 2022) show large negative two-day movements. The cumulative response of treasury spreads to QT2 announcements are large, negative, and statistically significant. Essentially, the same conclusions about corporate spreads (net of the federal funds rate) stem from Table 8.

Finally, Table 9 is the analog to Table 7 for treasury spreads during QT1. Cumulatively, QT1 announcements exert little influence on these spreads except during the *Asset Runoff* announcements, particularly following the June 14, 2017, announcement.[7] The only other announcement that seems to move these treasury spreads is June 19, 2013, the second taper

[7] A date that coincided with a 25 basis point hike in the target federal funds rate.

date. Table 10 shows the responses of corporate spreads (net of the federal funds rate) during QT1. A similar picture emerges with only the taper dates and the first *Asset Runoff* date showing significant announcement effects. Our results complement the findings in Smith and Valcarcel (2023)—who cite a lack of announcement effects for various yields during the QT1 episode—with our own findings here of a lack of announcement effects for interest rate spreads. A preponderance of evidence suggests that while the QT1 episode is largely devoid of announcement effects except during Taper, the same cannot be said of QT2. We show salient announcement effects on treasury rates in this period. Importantly, QT2 announcements lead to significant reductions in treasury and corporate spreads.

What might explain the differences in announcement effects between QT1 and QT2? Contrasting the Federal Reserve's balance sheet expansion announcements, communication surrounding QT1 was largely framed as an independent aspect of the stance of monetary policy. For example, in September 2017 when the Federal Reserve announced that it would begin reducing its balance sheet in October, Federal Reserve Chair Yellen qualified that, *"Our balance sheet is not intended to be an active tool for monetary policy in normal times."* Conversely, on January 26, 2022, as Chair Powell detailed the principles for the Federal Reserve's **Approach for Significantly Reducing the Size of the Federal Reserve's Balance Sheet**, he stated that, *"The Committee will determine the timing and pace of reducing the size of the Federal Reserve's balance sheet so as to promote its maximum employment and price stability goals [...] The Committee views changes in the target range for the federal funds rate as its primary means of adjusting the stance of monetary policy."* The implication is that balance sheet policy is now upgraded to be an active tool of policy with a role that is secondary to federal funds rate management. A shift in the emphasis surrounding signaling can also be gleaned by noticing that QT1 announcement dates were not as perfectly synchronized with FOMC dates as QT2 announcements have been thus far. This provides further contrast between the "under the radar" approach in QT1 and more active signaling in QT2.

Moreover, details on QT1 announcements may not have been explicit enough regarding the evolution of the balance sheet. For instance, the June 14, 2017, **Policy Normalization Principles and Plans** vaguely stated that, '*'the Federal Reserve's securities holdings will continue to decline in a gradual and predictable manner until the Committee judges that the Federal Reserve is holding no more securities than necessary to implement monetary policy efficiently and effectively."* On the other hand, QT2 announcements provide a comparatively clearer picture. For example, the Federal Reserve's **Plans for Reducing the Size of**

the Federal Reserve's Balance Sheet released on May 4 2022, provide explicit caps and pacing information on QT2 reserve reductions. stating: *"[...] for Treasury securities, the cap will initially be set at $30 billion per month and after three months will increase to $60 billion per month. The decline in holdings of Treasury securities under this monthly cap will include Treasury coupon securities and, to the extent that coupon maturities are less than the monthly cap, Treasury bills. For agency debt and agency mortgage-backed securities, the cap will initially be set at $17.5 billion per month and after three months will increase to $35 billion per month.*

QT1 and QT2 may not have taken markets entirely by surprise. Greenlaw et al. (2018) argue that the absence of any meaningful market reaction to QT1 announcements suggests that changes in expectations over the size of the balance sheet have little effect on financial markets. While this prediction might pan out when looking at QT1 in isolation, our results for QT2 suggest unwind announcements exert material signaling in rate spreads. We show differences in signaling and specificity accompanying unwind announcements in QT1 and QT2. Given balance sheet unwind efforts could have been anticipated, any effects from unwinding past asset purchases in QT1 and/or QT2 may not need to manifest themselves upon announcement to materialize themselves upon implementation, which we turn to in the next section.

5 The Propagating Effects of Balance Sheet Shocks

One advantage of event studies is that they allow for estimation of stock-level effects around well-delineated discrete episodes. Thus, they facilitate identification of the effects of announcements when information is distributed rapidly, for example in a post-FOMC meeting press release. Since event studies estimate the stock level effect in a very short window around the announcement, two implicit assumptions follow from these models: either (i) the immediate effect encapsulates the full dynamic of the response of interest or (ii) only the immediate effect matters and any subsequent lagging effects can be safely ignored.

However, the FOMC announcements we focus on involve a signaling of what the Federal Reserve intends to do, with implementation typically following the release of the policy statement. Unlike announcement effects, implementation effects can diffuse gradually over time. We pursue a flexible time-series approach to ascertain the effects on broad financial conditions and various financial yields. While identification is more challenging relative to event-study schemes, an advantage of this framework is that it accommodates the possibility of both gradual or rapid propagating effects from balance sheet shocks.

A flexible framework that allows for wide variation in the speed of accumulation/unwind of reserves seems warranted. As Smith and Valcarcel (2023) point out, the Federal Reserve had a deliberate strategy for the gradual normalization of its balance sheet in the 2017-2019 period. In contrast, expansion of the balance sheet in the first two quarters of 2020 was anything but moderate. We investigate whether the quantitative tightening that succeeded the massive balance sheet expansion in 2020 had gradual, or sudden, effects on financial conditions. We are also interested in gauging how persistent, or transitory, any financial market effects from unwinding asset holdings may have been. The persistence of the effects of the Federal Reserve's balance sheet policies has been investigated in several studies (Wright, 2012; D'Amico and King, 2013; Swanson, 2020; Smith and Valcarcel, 2023).

The end of the first episode of balance sheet unwind presided over a material increase in money-market rates amid sharp reductions in reserve balances, culminating in the *repo rate shock* of September 2019. In response to this tightening in money markets, the Federal Reserve initiated repo operations and outright purchases of Treasuries to once again begin increasing the supply of reserves. This marked the end of the QT1 episode. After the initial increase in the supply of reserves, at the end of 2019, the Federal Reserve conducted a massive acceleration of purchases during the COVID pandemic in 2020 that peaked in January 2022. The first month of 2022 marks the beginning of the QT2 episode. To capture the apparent interdependence between reserves and short-term interest rates, we include in our structural VAR model a measure of the short-term secured overnight financing rate net of the Federal Reserve's managed interest on reserves: the (SOFR-IOR) spread.

A number of factors provide distinction between QT1 and QT2. An important one is that, while the FFR-IOR spread was actively increasing during QT1—providing signal to financial markets—this spread is completely uninformative during QT2. Therefore, we focus on various other spreads covering short-term public debt, such as treasury rates as well as private debt, such as AAA, BBB, and MBS spreads.

Over the years, a number of studies have examined the effects of changes in central bank reserves on interest rates, financial markets, and the broader economy, which have generally employed monthly or quarterly data (see Strongin, 1995; Christiano et al., 1996; Iwata and Wu, 2006; Curdia and Woodford, 2016; Demiralp et al., 2019, among many others). When studying financial effects in structural VARs, employing a relatively higher frequency of analysis seems useful (Gertler and Karadi, 2015). Bernanke and Mihov (1998) consider biweekly data informed by operational concepts on the implementation of monetary policy. We conduct analysis at higher frequency than biweekly by leveraging the Federal Reserve Board's week-ending-Wednesday balance sheet data. We pursue a similar identification scheme as Smith and Valcarcel (2023) to extract the effects of reserve supply shocks—which are inexorably connected to the Federal Reserve's management of its balance sheet—from other forces, including fluctuations in interest rate spreads, financial conditions, and Treasury bill supply.

5.1 Identifying Restrictions

We consider both Federal Reserve liabilities and asset holdings in our analysis.[8] However, the core of our investigation is in the identification of exogenous shocks in the supply of reserves. We impose a block-triangular construct for the VAR, which requires attention to the order in which the variables enter the system. We place reserves balances first in our ordering on the basis of both institutional details surrounding the timing of Treasury auctions as well as the Federal Reserve's own conduct toward balance sheet policy.

We motivate our identifying assumptions based on the Federal Reserve's approach for implementing monetary policy and managing reserves since August 2014. From August 2014 until September 2019, when the QT1 episode ended, the Federal Reserve did not adjust reserve balances week-to-week in response to developments in money markets or broader financial conditions.[9] Likewise, during the QT2 episode that began January 2022, week-to-week reserve balances were not adjusted to primarily respond to affect short-term money markets. First, this can be gleaned by the FOMC's release on January 26, 2022, of its **Principles for Reducing the Size of the Federal Reserve's Balance Sheet,**[10] which states: *The Committee views changes in the target range for the federal funds rate as its primary means of adjusting the stance of monetary policy.* Second, inspection of Figures 1 or 2 reveal the FFR-IOR was kept fixed while reserves decreased rapidly during this period.

[8]We do this to contemplate multiple possible avenues through which the implementation of balance sheet reduction may impact financial markets. Material effects may ensue from reductions in asset holdings, such as those identified in Kandrac and Schlusche (2013), D'Amico and King (2013), and Christensen and Gillan (2022) upon the implementation of asset purchases.

[9]See description in Yellen (2017) of the Federal Reserve's balance sheet normalization strategy.

[10]`https://www.federalreserve.gov/newsevents/pressreleases/monetary20220126c.htm`

This allows us to treat the supply curve for reserves as perfectly inelastic (vertical) within the week, both during QT1 and QT2.

However, week-to-week movements in reserves could ensue not only from shifts in the reserve supply curve associated with balance sheet runoffs, but also from changes in Treasury bill supply, which could ultimately affect repo markets as well as broader financial conditions. Figure 5 shows that during the 2017-2019 *Asset Runoff* period, Treasury bills outstanding increased by nearly 30%. After this QT1 period ends, outstanding balances of Treasury bills rose from $2.5 Tn to over $5 Tn between March and June 2020—subsequently dropping over $1 Tn by the end of 2021. As Treasury supply rapidly increased in 2020 before subsiding by 2021, Treasury's general account (TGA) balance with the Federal Reserve also followed a similar pattern. During the *Asset Runoff* period as reserve balances were unwinding and Treasury supply increased by 30%, TGA balances with the Federal Reserve also increased at a similar pace. These dynamics would result in reserve reductions that would resemble, yet differ from, balance sheet unwinds. Namely, increases in bill supply could increase money market rates and increase TGA balances, while reducing reserve balances.[11]

Figure 6 highlights the COVID period generated a massive increase in TGA balances between March and June 2020, which was largely erased by December 2021. As both TGA balances and bank reserves rose massively during this period, movements in treasury bill supply are less likely to be conflated with the monetary management of the supply of reserves. By 2022, as reserves were steadily declining through the QT2 period, TGA balances increased by about 150% between January and April; followed by a larger magnitude reduction in the latter part of the year—largely arresting the initial hike. Dramatic gyrations in TGA balances during the COVID period and its aftermath likely stem from fiscal, rather than monetary policy. Nevertheless, changes in Treasury bill supply might confound the clean extraction of an exogenous reserve supply shock in our identification strategy. To control for this, we include TGA balances in our VAR and we order them below reserves. Crucially, we conduct analysis at weekly frequencies. Institutional realities in the execution of Treasury auctions severely limit the ability for the Treasury bill supply to contaminate our identification of innovations in reserves balances as exogenous reserve supply shocks.

[11] The settlement of Treasuries purchases ultimately involves debiting a reserve account and crediting the TGA account. Indeed, TGA fluctuations have been used as an instrument for exogenous changes in the supply of reserve balances to isolate liquidity effects in the Federal Reserve's pre-crisis regime for implementing monetary policy (Hamilton, 1997).

Historically, Treasury bill auctions are announced on Tuesdays providing details on the maturity and amount, which enables immediate trading and pricing of the new securities on a "when-issued" basis (Garbade and Ingber, 2005). Winning bidders, however, typically settle with the Treasury up to one week after the announcement. In its role as the fiscal agent for the U.S. Treasury, the Federal Reserve settles the auction by debiting the winning bidder's reserve account and crediting TGA. Any movement in the repo rate due to an announced increase in Treasury bill supply should have no effect on end-of-day Wednesday reserve balances within the current week. Therefore, any reduction in reserve balances stemming from an increase in Treasury bill supply should occur the following week (at the earliest). Droste et al. (2021) and Smith and Valcarcel (2023) utilize this same institutional mechanism to facilitate identification related to the Fed's LSAP programs and QT1, respectively.

5.2 The Structure

We order reserves ahead of: TGA balances; the secured overnight financing rate net of the interest on reserves; either an index of financial conditions or the price/yield of a particular asset, denoted by Z_t; and the Federal Reserve System Open Market Account (SOMA) holdings. We denote the VAR variables by $x_t = [(100 * log(RES_t); 100 * log(TGA_t); (SOFR_t - IOR_t); Z_t; (100 * log(SOMA_t)]'$ where SOFR is the secured overnight financing rate, a broad measure of Treasury repo rates constructed by the Federal Reserve Bank of New York, Z_t is either an index of financial conditions or the price/yield of a particular asset, $SOMA_t$ is the Federal Reserve's SOMA dollar-denominated assets acquired through open market operations and t is the value of each variable as of Wednesday each week. We model these variables as a VAR(p) on weekly data.

All of the structural VAR models we study in this paper consist of the same set of four core variables at a weekly frequency. For our benchmark model we choose the GS-FCI for the variable Z_t encapsulated in x_t. Then, additional variables are rotated in and out of the model one by one in place of Z_t.

We model these variables as a VAR(p):

$$\theta(L)x_t = e_t \tag{1}$$

where $\theta(L) = I_5 - \theta_1 L - \cdots - \theta_p L^p$ is a p-th order lag polynomial and e_t is a mean zero vector of reduced-form VAR residuals with a constant covariance matrix R.[12] We recover

[12]We also include a constant and dummy variables in the VAR to absorb typical month-, quarter-, year-end

the underlying structural VAR by specifying the linear mapping, $e_t = P\epsilon_t$, between e_t, the reduced-form VAR residuals, and ϵ_t, the structural shocks of interest, where P is block lower-triangular.[13]

6 Implementation Effects of QT1 and QT2

Figure 7 shows results for our benchmark specification.[14] Each column presents results from a different weekly sample corresponding to the two phases of QT1 (left and center columns) and the QT2 sample (the right column). The first row shows the responses to the operative shock. These are all responses to a negative one-standard-deviation-shock to the log of reserves balances. The benchmark model places the GS-FCI in place of Z_t. We show the GS-FCI responses on the next chart, when we cycle through various rates for Z_t. TGA balances respond sensibly in the opposite direction of tightening of reserves, with the *Asset Runoff* period showing the largest magnitude response. The repo (SOFR-IOR) spread increases in response to a tightening of reserves. This is consistent with findings in Smith and Valcarcel (2023). The spread response during QT2 is negative on impact but imprecisely estimated. Finally, the response of log SOMA balances looks small and fairly negligible during the *Full Reinvestment* phase of QT1. Conversely, there is a significantly negative response of SOMA balances during the tightening that took place in the *Asset Runoff* period, which follows the balance sheet dynamics that took place in the period. Finally, reserve shocks elicit a negative contraction of SOMA balances during QT2. The magnitude of the SOMA responses are quite similar across the *Asset Runoff* phase of QT1 and QT2.

Each row of Figure 8 shows impulse responses from a separately estimated structural VAR model where each variable is placed as Z_t and then re-estimated. The first row shows a negligible response of the GS-FCI to a negative reserve shock in the *Full Reinvestment* sample. However, when reserves tightening is accompanied by reductions on the asset side of the balance sheet—as was the case between October 2017 and August 2019—it leads to a tightening of financial conditions, consistent with findings by Smith and Valcarcel (2023).

as well as holiday dynamics. We use the AIC to select four lags.

[13] We conduct inference on our estimated constant-parameter impulse responses from a Bayesian perspective assuming a non-informative natural conjugate prior for θ and Σ such that the posterior distribution of θ and R are centered at their OLS estimates. We follow Koop and Korobilis (2010) when implementing this prior.

[14] AIC selected four lags for the benchmark specification. We keep the same number of lags for comparability purposes.

Our results show that the unwinding of reserves that took place during QT2 induced a more severe, though less persistent, tightening in the GS-FCI. The second row shows the Bloomberg FCI does not respond significantly during QT1, and it increases substantially in response to a negative shock to the supply of reserves in the QT2 period. The third row in the figure shows that during the *Full Reinvestment* sample the VIX index actually falls. The VIX index also falls on impact, and by a similar margin, in the *Asset Runoff* period, but is otherwise imprecisely estimated at all horizons beyond impact. The response is far larger and more significant during QT2, where volatility in equity markets increase following a restrictive shock in reserve balances.

The first three rows of Figure 8 paint a consistent picture. During the *Full Reinvestment* period—which was a time of relative calm in financial markets—reserve contractions do not necessarily tighten financial conditions. The *Asset Runoff* seems to be more contractionary for financial conditions, though sometimes the increases are imprecisely estimated. Finally, the QT2 period is unambiguously contractionary for broad financial conditions across the board. The last row of the figure reveals that a contraction in reserves is contractionary for the broad dollar index across all unwind episodes.

Figure 9 continues the analysis for yields in MBS, corporate rates, and equity markets. The first row shows an exogenous reserves tightening does not exert the expected contractionary response of an index of spot equities market such as the S&P500 index, during the *Full Reinvestment* period. However, the *Asset Runoff* period shows the expected contractionary response of the S&P500 index to a contractionary shock in reserves. The negative response of the S&P500 index during QT2 outpaces that of QT1. The second row shows a negligible response of the AAA yield during the first phase of QT1. In contrast, the *Full Reinvestment* phase of QT1 shows an increase in the AAA yield to a negative reserve supply shock. Notably, the QT2 response is more than twice as large as the one taking place during the second stage of QT1. The third row leads to similar conclusions for the BBB yield. The contractionary response during QT2 is larger than the ones occurring in either phase of QT1. The last row of the figure reveals that a contraction in reserves is contractionary for the MBS yield across all unwind episodes. The magnitude of the contractionary response is consistently larger in the QT2 episode than in either phase of QT1. The predominant conclusion we draw from Figure 8 and Figure 9 is that the *Asset Runoff* phase of QT1 and the QT2 period of balance sheet unwind served to generally tighten financial conditions broadly or narrowly. Importantly, we show that balance sheet unwind during the QT2 sample is far more contractionary than QT1.

Figure 10 shows responses of various treasury rates along the yield curve. The first two rows of the figure shows both the one- and five-year treasury yields increase following a contractionary reserves shock across the three samples. The impact responses during QT2 are higher than those of both phases of QT1. The third and fourth rows display rates on the longer end of the yield curve. The 10- and 30-year treasury yields seem to respond similarly to the shorter maturities. Inspecting the figure columnwise reveals that the responses remain consistently positive during the first phase of QT1. The *Asset Runoff* period shows hikes in all treasury yields throughout, but the magnitude of the responses increases at longer maturities. The responses during QT2 show the largest magnitude increases across the three subsamples for all rates, but only on impact and within the first few weeks post shock. Overall, the magnitudes of the responses of all treasury yields are higher during QT2 than during QT1 at short horizons. However, the QT1 responses are more precisely estimated. Smith and Valcarcel (2023) find similar dynamics in the treasury responses they investigate. These conclusions are qualitatively consistent with the broad financial conditions dynamic responses, and they highlight the marked differences across the two tightening episodes.

Our event study analysis in previous sections investigated the responses of interest rate spreads to announcements surrounding the two QT episodes. We now investigate these spread responses in a VAR context. Figure 11 shows responses of the 1-year, 5-year, 10-year, and 30-year yields net of the federal funds rate. The responses of all these spreads to a negative one-standard-deviation shock in the log of reserve balances are negligible during both phases of QT1. This supports the conclusions from our event study that spreads did not respond to announcement effects during QT1. In contrast, the spread responses are significantly larger during QT2. All four treasury-federal funds rate spreads increase within the first four weeks in response to a tightening shock. All responses subsequently turn negative roughly after the first month post shock. This would suggest that negative reserve shocks may affect the level and the slope of the yield curve. On impact, the yield curve tilts counterclockwise—where the treasury spreads increase—and following this dynamic after the first month treasury spreads begin to decline, which could be indicative of an eventual clockwise rotation. The negative responses of these treasury spreads largely complement those conclusions from our event study analysis.[15]

[15] The important caveat—as was raised in earlier sections—when contrasting stock-level vs. propagation effects suggests caution when quantitatively comparing the the two-day movements in these treasury spreads and their counterpart VAR responses. For example, Table 7 and the right column of Figure 11 show a different sign of the treasury spread responses. Table 7 shows generally a negative response of these treasury

Finally, Figure 12 shows the responses of the spreads between the corporate (AAA and BBB) yields, the MBS rate, and the federal funds rate. The responses of these spreads during the *Full Reinvestment* phase of QT1 are small, negative, and often not significant at short horizons. Conversely—except for the (AAA-FFR) spread—negative reserve shocks significantly increase these spreads in the *Asset Runoff* phase of QT1. Once again, there is a greater response of interest rate spreads during QT2. In the first month following the shock, the AAA and MBS spread responses are substantially larger in QT2 than in the second phase of QT1. This also holds for the (BBB-FFR) spread, though the response is imprecisely estimated. The last row also shows the spread between the BBB yield and the 20-year treasury rate. While this is a less conventional spread to draw inference from, we want to inspect a yield spread that jointly captures both risk and term premia. A qualitatively similar picture to other spread responses emerges here as well. There is a small negative response during the *Full Reinvestment* phase of QT1 that is dominated by a positive response during the *Asset Runoff* phase of QT1. The positive (BBB-TR20yr) spread response is somewhat larger but less persistent during QT2.[16]

spreads. This suggests an underreaction of the treasury yields relative to the federal funds rate between one day prior to the announcement and the day after. On the other hand, the VAR responses show an increase in spreads during the first week *following* the shock. The implication is that whatever degree of underreaction might take place within the first couple of days of the FOMC announcement seems to resolve itself rather quickly so that the treasury yield responds more than the federal funds rate within the first week following the shock. In many cases, the positive spread response persists for the first four weeks before eventually turning negative. Figure 12 shows largely similar dynamics for other spreads of private debt.

[16]We also considered the spread between the BBB corporate yield and other treasury maturities: the 5-year, 10-year, and 30-year treasury rates. The responses of all these spreads during the Full Reinvestment phase of QT1 are negligible. Conversely, the *Asset Runoff* phase of QT1 shows negative reserve shocks uniformly increase these spreads. The evidence surrounding QT2 is more mixed. On the shorter end of the yield curve, the (TR5yr - FFR) and the (TR10yr - FFR) spreads respond negatively on impact before quickly rising within the first four to six weeks post shock. On the other hand, on the longer end of the yield curve, the (TR20yr - FFR) and the (TR30yr - FFR) spreads experience a sharper and more rapid increase during QT2 than during QT1. These responses are available upon request.

7 Concluding Remarks

At the time of this writing a second bout of balance sheet unwind (QT2) is underway. Some notable features underline a sharp distinction between the Federal Reserve's QT1 and QT2 efforts. First, QT1 ensued at a materially slower pace than QT2. While the former experienced a 30% reduction in a two-year span, the latter saw that same magnitude reduction inside a single year. Second, the balance sheet normalization in QT1 took place against a backdrop of relative calm, whereas QT2 ensues amid financial strain and severe inflationary pressures.

Furthermore, liquidity effects may have played a more prominent role during QT1—when the FFR-IOR spread was allowed to increase substantially—than in QT2. The lack of an opportunity cost of reserves channel in QT2 seems to have ensued by design as the Federal Reserve has kept this spread fixed over the period.

In addition to differences in the liquidity effect, we also show the QT1 period is largely devoid of announcement effects on both yields and yield spreads. A stark difference on announcement effects emerges for the more recent QT2 period. We present evidence suggesting that the strength of signaling and duration effects are less pronounced during QT1 than in QT2. These effects emphasize the role of expectations and, therefore, our evidence in favor of these channels primarily stems from event studies around policy announcements. The difference between the two events could originate in part from the concerted effort of the FOMC to divorce expectations of future rate increases from unwinding the balance sheet in QT1, especially after the "taper tantrum" episode. The approach seemed to be gradual so as not to disturb financial markets. Conversely, QT2 ensues at a time of financial strain and it less likely the Federal Reserve's balance sheet management is now proceeding "under the radar."

Finally, we find evidence of contractionary effects on financial conditions, interest rates and yield spreads stemming from implementation of balance sheet unwinds. The responses during QT2 are generally larger and more significant than those of QT1. We conclude the larger impact of QT2 may be partly due to the combination of implementation effects and expectations management. Remarkably, the Federal Reserve has managed this even while maintaining the opportunity cost of holding reserves fixed during this period. Presumably, the Federal Reserve could use the FFR-IOR spread as an added tool should the need for a more aggressive credit contraction and rapid tightening arise in the future.

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Table 1: Announcements Surrounding First Quantitative Tightening Episode[a]

Date	Announcement	Description
May 22, 2013[b]	Taper	Bernanke says tapering could begin "in the next few meetings"
Jun 19, 2013[c]	Taper	Bernanke states that tapering could be appropriate "later this year"
May 21, 2014[d]	Unwind - *Full Reinvestment*	Minutes signal beginning of balance sheet normalization planning
Jul 9, 2014[d]	Unwind - *Full Reinvestment*	Minutes discuss gradual approach to ceasing asset reinvestments
Aug 20, 2014[d]	Unwind - *Full Reinvestment*	Minutes offer details on balance sheet normalization planning
Sep 17, 2014[d]	Unwind - *Full Reinvestment*	FOMC releases *Policy Normalization Principles and Plan*
Jan 12, 2017[e]	Unwind - *Full Reinvestment*	Three Fed speeches discuss normalizing the balance sheet
Apr 5, 2017[d]	Unwind - *Full Reinvestment*	Minutes signal phasing out reinvestments "later this year"
May 24, 2017[d]	Unwind - *Full Reinvestment*	Minutes detail plan for phasing out reinvestment
Jun 14, 2017[c]	Unwind - *Asset Runoff*	FOMC releases asset runoff plan, announces that runoff will begin "this year"
Sep. 20, 2017[c]	Unwind - *Asset Runoff*	FOMC announces that asset runoff will begin next month

[a] *Source: Smith and Valcarcel (2023).*
[b] *Source: The Economic Outlook Congressional Hearings, 113th Congress, Joint Economic Committee.*
https://www.govinfo.gov/content/pkg/CHRG-113shrg81472/pdf/CHRG-113shrg81472.pdf
[c] *Source: FOMC Meeting Meeting calendars, statements, and minutes (2016-2021).*
https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm
[d] *Source: Federal Reserve History of the FOMC's Policy Normalization Discussions and Communications.*
https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm
[e] *Source: Ben Bernanke's Brookings Blog Shrinking the Fed's balance sheet.*
https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm

Table 2: Announcements Surrounding Second Quantitative Tightening Episode

Date	Announcement	Description
Jan 26, 2022[a]	Unwind	Minutes issues "Principles for Reducing the Size of the Federal Reserve's Balance Sheet"
Mar 16, 2022[a]	Unwind	Reducing Fed's securities holdings in a "predictable manner"
May 4, 2022[a]	Unwind	FOMC adopts "Plans for Reducing the Size of the Federal Reserve's Balance Sheet"
Sep 21, 2022[a]	Unwind	Caps on Treasury securities and MBS redemptions double in September
Nov 2, 2022[a]	Unwind	FOMC agrees to continue reducing the Federal Reserve's securities holdings.

[a] *Source: FOMC Meeting Meeting calendars, statements, and minutes (2022).*
https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm

Table 3: Announcement Effects on Treasury Yields: QT1[a]

		Two-Day Change in Yields (pp)				
Date	Announcement	1-yr.	3-yr.	5-yr.	10-yr.	30-yr.
May 22, 2013	Taper	0.00	0.03	0.07	**0.08**	0.06
Jun 19, 2013	Taper	0.01	**0.14**	**0.24**	**0.21**	**0.15**
May 21, 2014	Unwind - *Full Reinvestment*	0.00	0.03	0.04	0.04	0.05
Jul 9, 2014	Unwind - *Full Reinvestment*	-0.01	-0.06	-0.04	-0.03	0.00
Aug 20, 2014	Unwind - *Full Reinvestment*	-0.01	0.05	0.05	0.01	-0.02
Sep 17, 2014	Unwind - *Full Reinvestment*	-0.01	0.06	0.07	0.03	0.00
Jan 12, 2017	Unwind - *Full Reinvestment*	0.00	0.01	0.01	0.02	0.03
Apr 5, 2017	Unwind - *Full Reinvestment*	0.02	-0.02	-0.01	-0.02	0.00
May 24, 2017	Unwind - *Full Reinvestment*	0.02	-0.03	-0.06	-0.04	-0.03
Jun 14, 2017	Unwind - *Asset Runoff*	-0.01	-0.02	-0.03	-0.05	**-0.09**
Sep 20, 2017	Unwind - *Asset Runoff*	0.00	0.04	0.05	0.03	-0.01
Standard Deviation of Two-day Changes in Treasury Yields[b]		1-yr.	3-yr.	5-yr.	10-yr.	30-yr.
		0.04	0.06	0.07	0.07	0.07
		Cumulative Response (pp)				
Event Study Regressions		1-yr.	3-yr.	5-yr.	10-yr.	30-yr.
All QT1 Events[c]		0.01	0.23	**0.39***	0.28	0.14
		(0.14)	(0.20)	(0.22)	(0.22)	(0.22)
Only Taper Events[d]		0.01	**0.17****	**0.31*****	**0.29*****	**0.21****
		(0.06)	(0.08)	(0.09)	(0.10)	(0.09)
Only Full Reinvestment Events[e]		0.01	0.04	0.06	0.01	0.03
		(0.11)	(0.16)	(0.18)	(0.18)	(0.17)
Only Asset Runoff Events[f]		-0.01	0.02	0.02	-0.02	-0.10
		(0.06)	(0.08)	(0.09)	(0.10)	(0.09)

[a] *Source: Smith and Valcarcel (2023).*

[b] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023.

[c] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury yield and QT_t is a dummy variable, which takes a value of 1/11 on the dates listed above.

[d] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury yield and QT_t is a dummy variable, which takes a value of 1/2 on the first two dates above that were related to tapering.

[e] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury yield and QT_t is a dummy variable, which takes a value of 1/7 on the seven dates above that were related to the *Full Reinvestment* period.

[f] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury yield and QT_t is a dummy variable, which takes a value of 1/2 on the last two dates above that were related to the *Asset Runoff* period.

Notes: OLS standard errors are reported in parenthesis. Sample Period: January 2008 – February 2023. Observations: 5518. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 4: Announcement Effects on Securities Yields: QT1

		Two-Day Change in Securities Yields (pp)		
Date	Announcement	MBS yield	AAA yield	BBB yield
May 22, 2013	Taper	**0.19**	0.04	0.05
Jun 19, 2013	Taper	**0.29**	**0.20**	**0.26**
May 21, 2014	Unwind - *Full Reinvestment*	0.02	0.06	0.05
Jul 9, 2014	Unwind - *Full Reinvestment*	-0.05	0.00	-0.01
Aug 20, 2014	Unwind - *Full Reinvestment*	-0.01	-0.03	-0.03
Sep 17, 2014	Unwind - *Full Reinvestment*	0.02	0.00	0.01
Jan 12, 2017	Unwind - *Full Reinvestment*	0.03	0.03	0.01
Apr 5, 2017	Unwind - *Full Reinvestment*	0.00	-0.01	-0.01
May 24, 2017	Unwind - *Full Reinvestment*	-0.04	-0.03	-0.02
Jun 14, 2017	Unwind - *Asset Runoff*	-0.03	-0.08	**-0.08**
Sep 20, 2017	Unwind - *Asset Runoff*	0.03	-0.02	-0.01
Standard Deviation of Two-day Changes in Securities Yields[a]		MBS yield	AAA yield	BBB yield
		0.10	0.08	0.07
		Cumulative Response (pp)		
Event Study Regressions		MBS yield.	AAA yield.	BBB yield.
All QT1 Events[b]		0.46	0.16	0.21
		(0.35)	(0.28)	(0.22)
Only Taper Events[c]		**0.48*****	**0.25****	**0.30*****
		(0.15)	(0.12)	(0.09)
Only Full Reinvestment Events[d]		-0.02	0.02	0.00
		(0.28)	(0.22)	(0.18)
Only Asset Runoff Events[e]		0.00	-0.11	-0.09
		(0.15)	(0.12)	(0.09)

[a] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023.
[b] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security yield and QT_t is a dummy variable, which takes a value of 1/11 on the dates listed above.
[c] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security yield and QT_t is a dummy variable, which takes a value of 1/2 on the first two dates above that were related to tapering.
[d] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security yield and QT_t is a dummy variable, which takes a value of 1/7 on the seven dates above that were related to the *Full Reinvestment* period.
[e] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security yield and QT_t is a dummy variable, which takes a value of 1/2 on the last two dates above that were related to the *Asset Runoff* period.
Notes: OLS standard errors are reported in parentheses. Sample Period: January 2008 – February 2023. Observations: 5518.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 5: Announcement Effects on Treasury Yields: QT2

Date	Announcement	Two-Day Change in Yields (pp)				
		1-yr.	3-yr.	5-yr.	10-yr.	30-yr.
Jan 26, 2022	Unwind	**0.10**	**0.15**	**0.10**	0.03	-0.03
Mar 16, 2022	Unwind	0.02	**0.10**	0.07	0.05	0.01
May 4, 2022	Unwind	**-0.08**	-0.04	0.00	**0.08**	**0.12**
Sep 21, 2022	Unwind	**0.05**	**0.18**	**0.16**	**0.13**	0.06
Nov 2, 2022	Unwind	0.03	**0.15**	**0.09**	0.07	0.04
Standard Deviation of Two-day Changes in Treasury Yields[a]		1-yr.	3-yr.	5-yr.	10-yr.	30-yr.
		0.04	0.06	0.07	0.07	0.07
		Cumulative Response (pp)				
Event Study Regressions		1-yr.	3-yr.	5-yr.	10-yr.	30-yr.
All QT2 Events[b]		0.12	**0.54*****	**0.42*****	**0.36****	0.20
		(0.09)	(0.13)	(0.15)	(0.15)	(0.15)

[a] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023.

[b] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury yield and QT_t is a dummy variable, which takes a value of 1/5 on the dates listed above.

Notes: OLS standard errors are reported in parentheses. Sample Period: January 2008 – February 2023. Observations: 5518. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 6: Announcement Effects on Securities Yields: QT2

		Two-Day Change in Securities Yields (pp)		
Date	Announcement	MBS yield	AAA yield	BBB yield
Jan 26, 2022	Unwind	0.05	-0.01	0.00
Mar 16, 2022	Unwind	0.01	**-0.15**	**-0.18**
May 4, 2022	Unwind	0.03	**0.15**	**0.13**
Sep 21, 2022	Unwind	**0.11**	0.08	**0.10**
Nov 2, 2022	Unwind	0.06	0.08	**0.08**
Standard Deviation of Two-day Changes in Securities Yields[a]		MBS yield	AAA yield	BBB yield
		0.10	0.08	0.07
		Cumulative Response (pp)		
Event Study Regressions		MBS yield	AAA yield	BBB yield
All QT2 Events[b]		0.26	0.15	0.12
		(0.23)	(0.19)	(0.15)

[a] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023.

[b] Coefficients β^{QT} from the regression: $\Delta y_t = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t is the two-day change in the security yield and QT_t is a dummy variable, which takes a value of 1/5 on the dates listed above.

Notes: OLS standard errors are reported in parentheses. Sample Period: January 2008 – February 2023. Observations: 5518. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 7: Announcement Effects on Treasury Spreads: QT2

		Two-Day Change in Treasury Spreads (pp)[a]				
Date	Announcement	1-sp.	3-sp.	5-sp.	10-sp.	30-sp.[b]
Jan 26, 2022	Unwind	**0.10**	**0.15**	0.10	0.03	-0.03
Mar 16, 2022	Unwind	**-0.23**	**-0.15**	**-0.18**	**-0.20**	**-0.24**
May 4, 2022	Unwind	**-0.58**	**-0.54**	**-0.50**	**-0.42**	**-0.38**
Sep 21, 2022	Unwind	**-0.70**	**-0.57**	**-0.59**	**-0.62**	**-0.69**
Nov 2, 2022	Unwind	**-0.72**	**-0.60**	**-0.66**	**-0.68**	**-0.71**
Standard Deviation of Two-day Changes in Treasury Spreads[c]		1-sp.	3-sp.	5-sp.	10-sp.	30-sp.
		0.09	0.10	0.10	0.11	0.10
		Cumulative Response (pp)				
Event Study Regressions		1-sp.	3-sp.	5-sp.	10-sp.	30-sp.
All QT2 Events[d]		**-2.13*****	**-1.71*****	**-1.83*****	**-1.89*****	**-2.05*****
		(0.19)	(0.22)	(0.23)	(0.23)	(0.23)

[a]Treasury spreads denote the differences between the relevant Treasury yields and the federal funds rate.

[b] 1-sp. = (1-yr - FFR) spread, 3-sp. = (3-yr - FFR) spread, 5-sp. = (5-yr - FFR) spread, 10-sp. = (10-yr - FFR) spread, 30-sp. = (30-yr - FFR) spread.

[c] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023.

[d] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury spread and QT_t is a dummy variable, which takes a value of 1/5 on the dates listed above.

Notes: OLS standard errors are reported in parentheses. Sample Period: January 2008 – February 2023. Observations: 5518. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 8: Announcement Effects on Securities Spreads: QT2

Date	Announcement	Two-Day Change in Securities Spreads (pp)[a]		
		MBS yield-sp.	AAA yield-sp.	BBB yield-sp.[b]
Jan 26, 2022	Unwind	0.05	-0.01	0.00
Mar 16, 2022	Unwind	**-0.25**	**-0.40**	**-0.43**
May 4, 2022	Unwind	**-0.47**	**-0.35**	**-0.37**
Sep 21, 2022	Unwind	**-0.64**	**-0.67**	**-0.66**
Nov 2, 2022	Unwind	**-0.69**	**-0.67**	**-0.67**
Standard Deviation of Two-day Changes in Securities Spreads[c]		MBS yield-sp.	AAA yield-sp.	BBB yield-sp.
		0.13	0.12	0.11
		Cumulative Response (pp)		
Event Study Regressions		MBS yield-sp.	AAA yield-sp.	BBB yield-sp.
All QT2 Events[d]		**-1.99*****	**-2.11*****	**-2.13*****
		(0.29)	(0.26)	(0.24)

[a] Securities spreads denote the differences between the relevant securities yields and the federal funds rate.

[b] MBS yield-sp. = (MBS - FFR) spread, AAA yield-sp. = (AAA - FFR) spread, BBB yield-sp. = (BBB - FFR) spread.

[c] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023

[d] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security spread and QT_t is a dummy variable, which takes a value of 1/5 on the dates listed above.

Notes: OLS standard errors are reported in parentheses. Sample Period: January 2008 – February 2023. Observations: 5518. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 9: Announcement Effects on Treasury Spreads: QT1

		Two-Day Change in Treasury Spreads (pp)[a]				
Date	Announcement	1-sp.	3-sp.	5-sp.	10-sp.	30-sp.[b]
May 22, 2013	Taper	0.01	0.04	0.08	0.09	0.07
Jun 19, 2013	Taper	0.03	**0.16**	**0.26**	**0.23**	**0.17**
May 21, 2014	Unwind - *Full Reinvestment*	0.00	0.03	0.04	0.04	0.05
Jul 9, 2014	Unwind - *Full Reinvestment*	-0.01	-0.06	-0.04	-0.03	0.00
Aug 20, 2014	Unwind - *Full Reinvestment*	-0.01	0.05	0.05	0.01	-0.02
Sep 17, 2014	Unwind - *Full Reinvestment*	-0.01	0.06	0.07	0.03	0.00
Jan 12, 2017	Unwind - *Full Reinvestment*	0.00	0.01	0.01	0.02	0.03
Apr 5, 2017	Unwind - *Full Reinvestment*	0.02	-0.02	-0.01	-0.02	0.00
May 24, 2017	Unwind - *Full Reinvestment*	0.02	-0.03	-0.06	-0.04	-0.03
Jun 14, 2017	Unwind - *Asset Runoff*	**-0.26**	**-0.27**	**-0.28**	**-0.30**	**-0.34**
Sep 20, 2017	Unwind - *Asset Runoff*	0.00	0.04	0.05	0.03	-0.01
Standard Deviation of Two-day Changes in Treasury Spreads[c]		1-sp.	3-sp.	5-sp.	10-sp.	30-sp.
		0.09	0.10	0.10	0.11	0.10
			Cumulative Response (pp)			
Event Study Regressions		1-sp.	3-sp.	5-sp.	10-sp.	30-sp.
All QT1 Events[d]		-0.21	0.01	0.17	0.06	-0.08
		(0.29)	(0.33)	(0.35)	(0.35)	(0.34)
Only Taper Events[e]		0.04	0.20	**0.34****	**0.32****	**0.24***
		(0.12)	(0.14)	(0.15)	(0.15)	(0.14)
Only Full Reinvestment Events[f]		0.01	0.04	0.06	0.01	0.03
		(0.23)	(0.26)	(0.28)	(0.28)	(0.27)
Only Asset Runoff Events[g]		**-0.26****	**-0.23***	-0.23	**-0.27***	**-0.35****
		(0.12)	(0.14)	(0.15)	(0.15)	(0.15)

[a] Treasury spreads denote the differences between the relevant Treasury yields and the federal funds rate.

[b] 1-sp. = (1-yr - FFR) spread, 3-sp. = (3-yr - FFR) spread, 5-sp. = (5-yr - FFR) spread, 10-sp. = (10-yr - FFR) spread, 30-sp. = (30-yr - FFR) spread.

[c] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023.

[d] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury spread and QT_t is a dummy variable, which takes a value of 1/11 on the dates listed above.

[e] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury spread and QT_t is a dummy variable, which takes a value of 1/2 on the first two dates above that were related to tapering.

[f] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury spread and QT_t is a dummy variable, which takes a value of 1/7 on the seven dates above that were related to the *Full Reinvestment* period.

[g] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the n-year constant maturity Treasury spread and QT_t is a dummy variable, which takes a value of 1/2 on the last two dates above that were related to the *Asset Runoff* period.

Notes: OLS standard errors are reported in parentheses. Sample Period: January 2008 – February 2023. Observations: 5518. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Table 10: Announcement Effects on Securities Spreads: QT1

Date	Announcement	Two-Day Change in Securities Spreads (pp)[a]		
		MBS yield-sp.	AAA yield-sp.	BBB yield-sp.[b]
May 22, 2013	Taper	**0.20**	0.05	0.06
Jun 19, 2013	Taper	**0.31**	**0.22**	**0.28**
May 21, 2014	Unwind - *Full Reinvestment*	0.02	0.06	0.05
Jul 9, 2014	Unwind - *Full Reinvestment*	-0.05	0.00	-0.01
Aug 20, 2014	Unwind - *Full Reinvestment*	-0.01	-0.03	-0.03
Sep 17, 2014	Unwind - *Full Reinvestment*	0.02	0.00	0.01
Jan 12, 2017	Unwind - *Full Reinvestment*	0.03	0.03	0.01
Apr 5, 2017	Unwind - *Full Reinvestment*	0.00	-0.01	-0.01
May 24, 2017	Unwind - *Full Reinvestment*	-0.04	-0.03	-0.02
Jun 14, 2017	Unwind - *Asset Runoff*	**-0.28**	**-0.33**	**-0.33**
Sep 20, 2017	Unwind - *Asset Runoff*	0.03	-0.02	-0.01
Standard Deviation of Two-day Changes in Securities Spreads[c]		MBS yield-sp.	AAA yield-sp.	BBB yield-sp.
		0.13	0.12	0.11
		Cumulative Response (pp)		
Event Study Regressions		MBS yield-sp.	AAA yield-sp.	BBB yield-sp.
All QT1 Events[d]		0.24	-0.06	-0.01
		(0.43)	(0.38)	(0.35)
Only Taper Events[e]		**0.51*****	**0.28***	**0.33****
		(0.18)	(0.16)	(0.15)
Only Full Reinvestment Events[f]		-0.02	0.02	0.00
		(0.34)	(0.31)	(0.28)
Only Asset Runoff Events[g]		-0.25	**-0.36****	**-0.34****
		(0.18)	(0.16)	(0.15)

[a] Securities spreads denote the differences between the relevant securities yields and the federal funds rate.

[b] MBS yield-sp. = (MBS - FFR) spread, AAA yield-sp. = (AAA - FFR) spread, BBB yield-sp. = (BBB - FFR) spread.

[c] Standard deviations of Rolling Two-Day Changes for the Sample: January 2008 – February 2023.

[d] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security spread and QT_t is a dummy variable, which takes a value of 1/11 on the dates listed above.

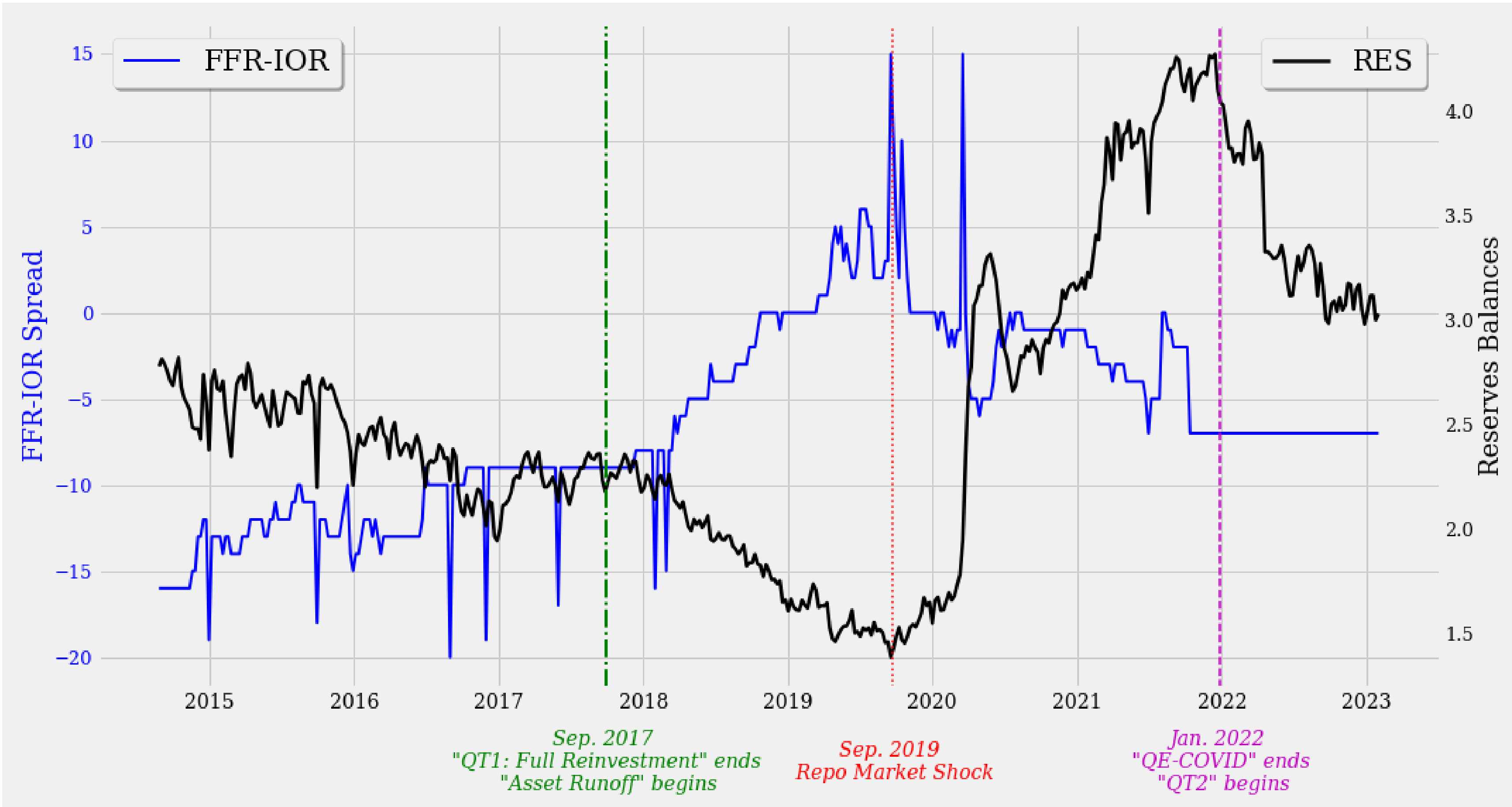
[e] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security spread and QT_t is a dummy variable, which takes a value of 1/2 on the first two dates above that were related to tapering.

[f] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security spread and QT_t is a dummy variable, which takes a value of 1/7 on the seven dates above that were related to the *Full Reinvestment* period.

[g] Coefficients β^{QT} from the regression: $\Delta y_t^n = \beta^{QT} QT_t + \varepsilon_t$, where Δy_t^n is the two-day change in the security spread and QT_t is a dummy variable, which takes a value of 1/2 on the last two dates above that were related to the *Asset Runoff* period.

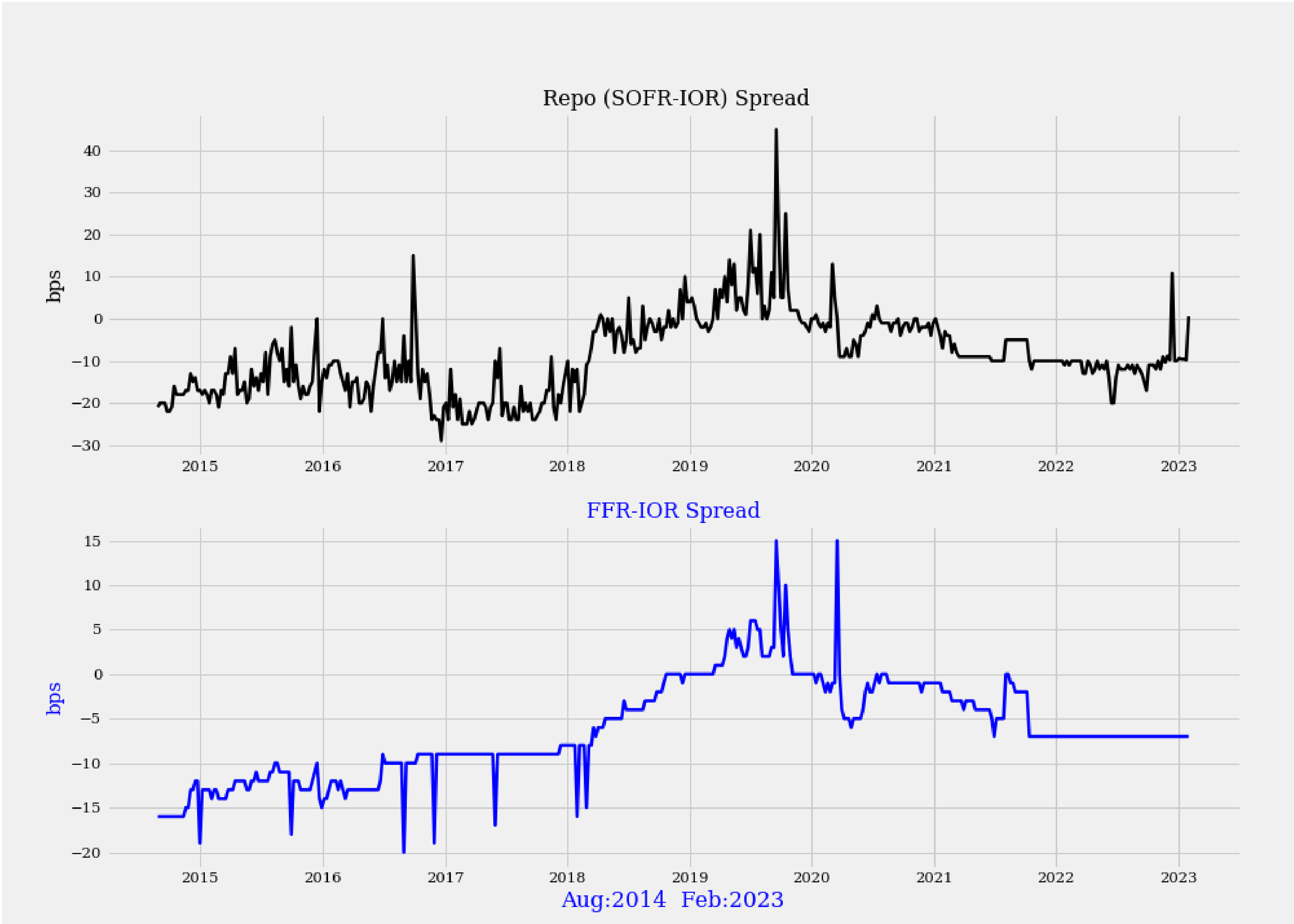
Notes: OLS standard errors are reported in parentheses. Sample Period: January 2008 – February 2023. Observations: 5518. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Figure 1: A Regime Change in the Opportunity Cost of Holding Bank Reserves



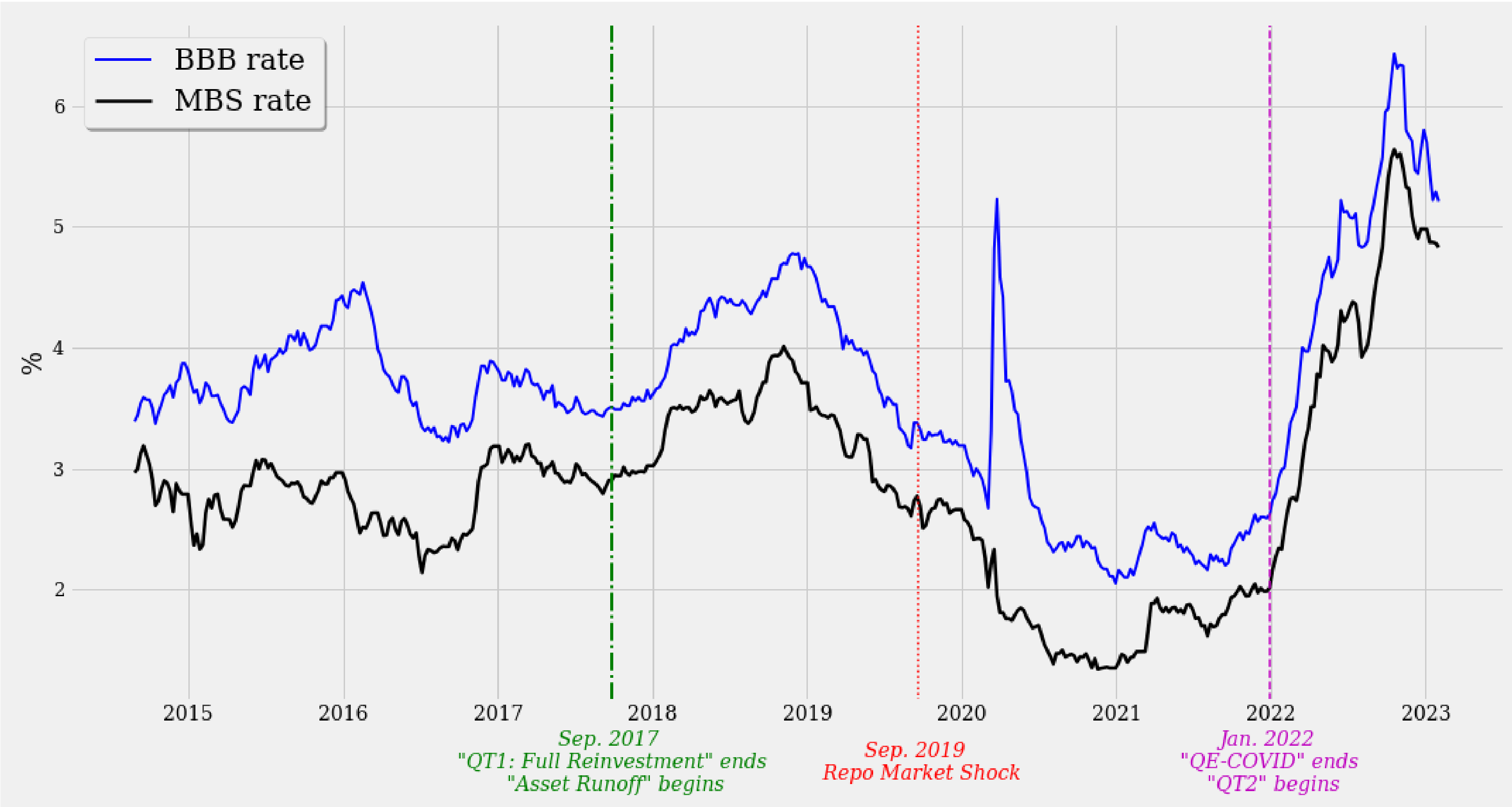
Note: The (solid) blue line denotes the spread between the federal funds rate and the interest rate paid on reserves. The (solid) black line shows bank reserve balances (in $Tn) between August 2014 and February 2023. The weekly sample is EOP for week-ending-Wednesday. The first vertical (dashed) line corresponds with the beginning of the *Asset Runoff* phase of the first episode of balance sheet unwind period (2017-Q3). The (dotted) vertical line in the middle of the chart denotes the *Repo Shock* of September 2019. This date ended the QT1 period and began a new balance sheet expansion mostly in the COVID-19 period. Finally, the rightmost (dashed) vertical line denotes the end of the COVID-19 expansion and the beginning of the new unwind period QT2.

Figure 2: Spreads in the Repo Money and the Federal Funds Markets Surrounding the Two QT Episodes



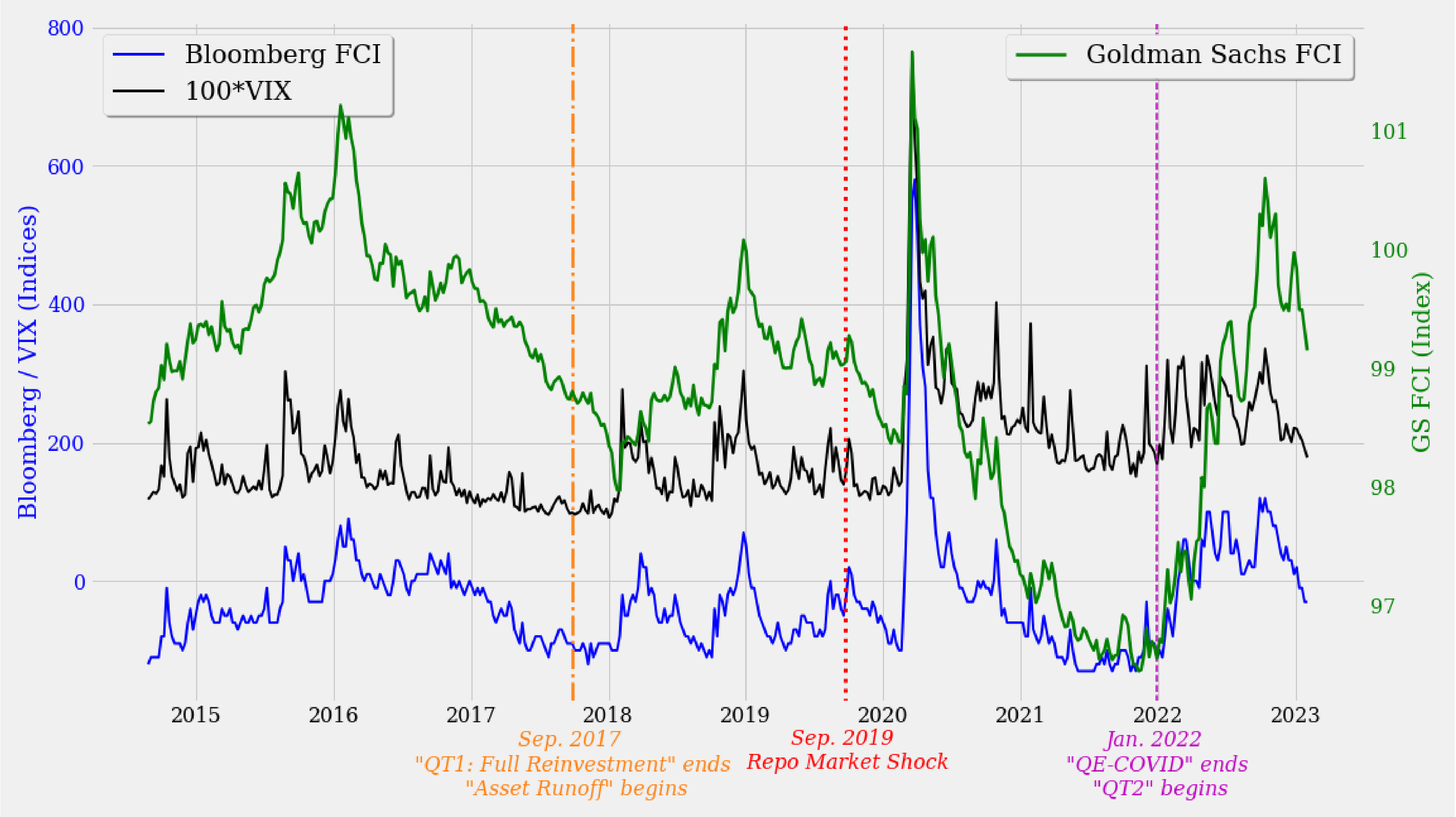
Note: End of period (EOP) sample for week-ending-Wednesday spanning August 27, 2014—February 1, 2023.

Figure 3: Rates on Private Debt Surrounding the Two QT Episodes



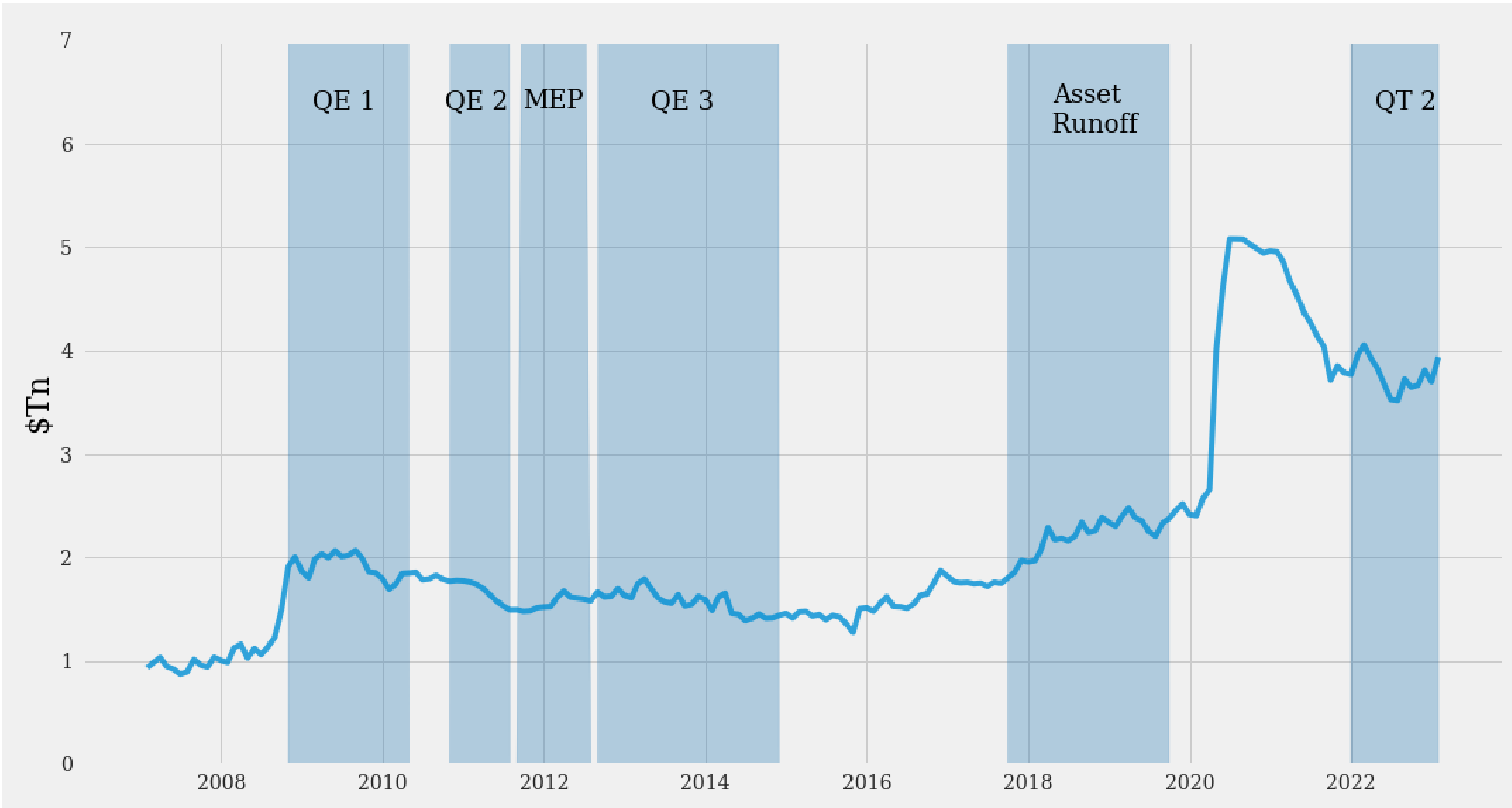
Note: The weekly sample is EOP for week-ending-Wednesday spanning August 27, 2014—February 1, 2023.

Figure 4: Financial Conditions Surrounding the Two QT Episodes



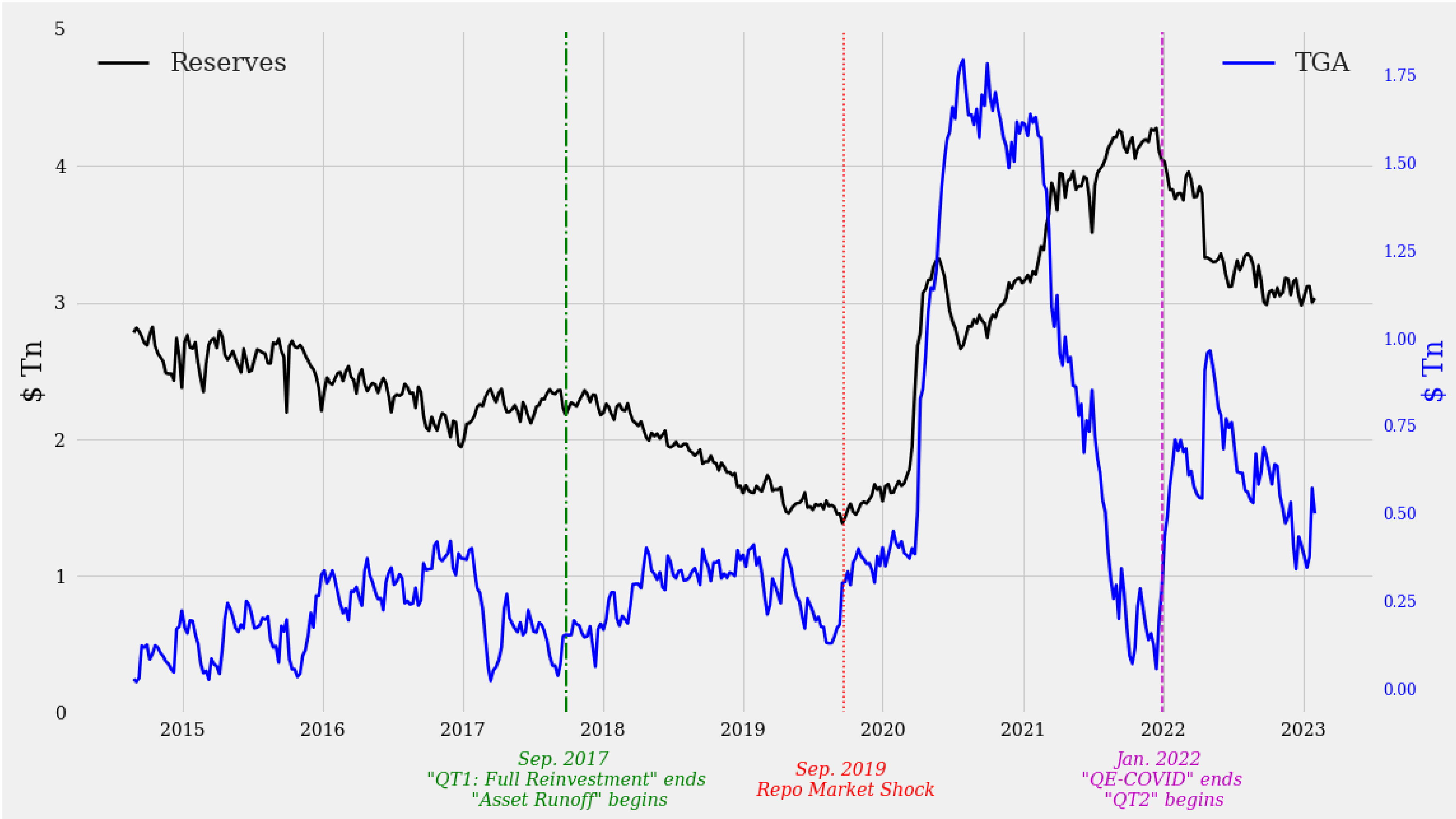
Note: The (solid) green line shows the Goldman Sachs Financial Conditions Indicator pinned to the right axis. Higher values of the GS-FCI correspond to a tightening in financial conditions. The Bloomberg FCI and the VIX index are scaled on the left axis. The (solid) black line shows the VIX index—which is rescaled x100 for comparability purposes—where higher values constitute higher levels of financial uncertainty in equity market. Lower(higher) values of the Bloomberg FCI denote tighter(looser) financial conditions. The solid blue line denotes the negative values of the Bloomberg index so that high values correspond to tighter financial conditions for comparability with the GS-FCI and VIX.

Figure 5: Marketable Treasury Bill Outstanding: 2007–2023



Note: Week-ending-Wednesday data spans January 1, 2007—February 1, 2023.

Figure 6: Bank Reserves and TGA Balances: 2014–2023



Note: Week-ending-Wednesday sample spanning August, 27, 2014—February 1, 2023.

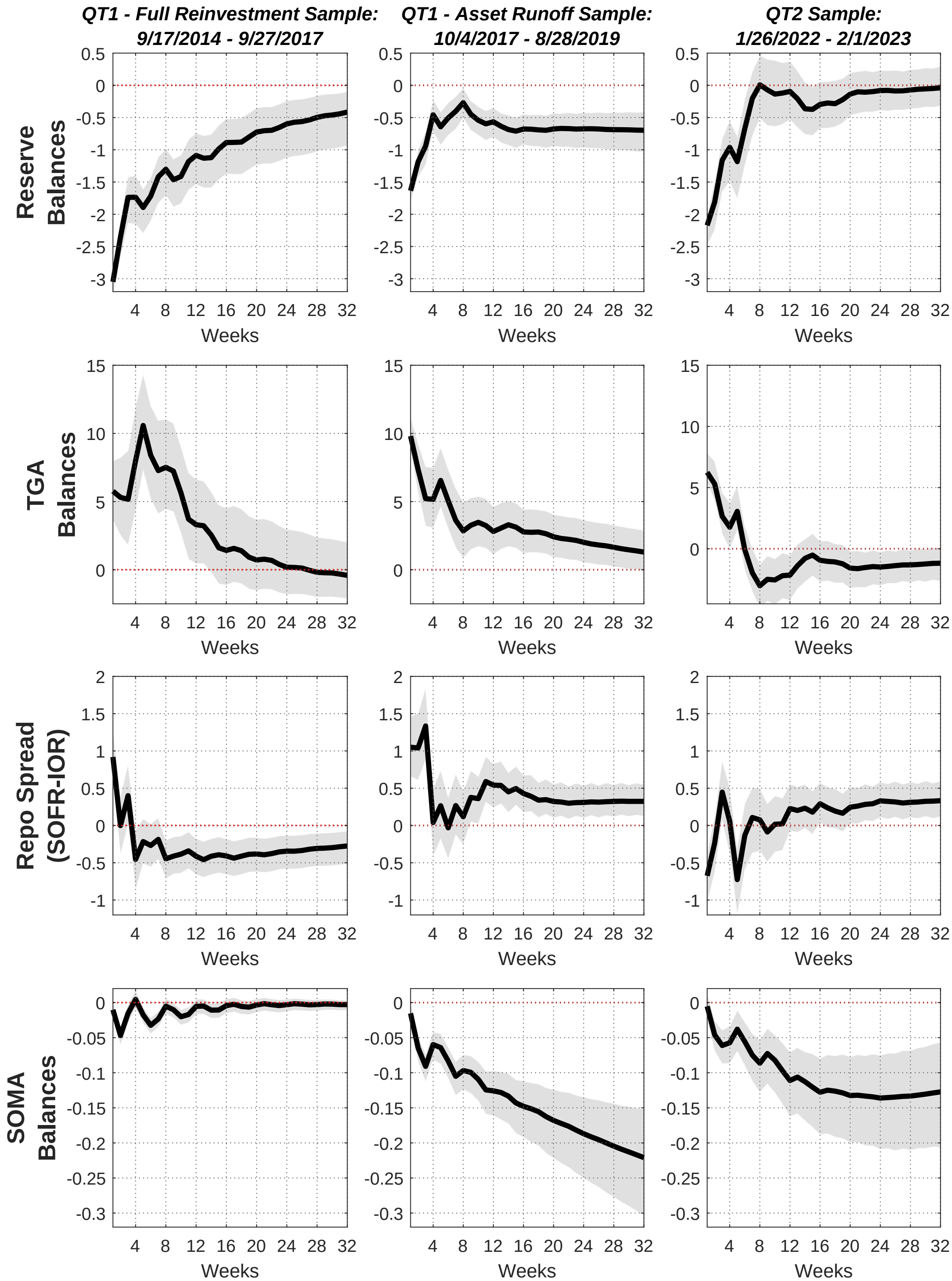


Figure 7: Responses of Individual Yields and Assets to a Negative 1 sd Reserve Supply Shock

Note: Each column shows impulse responses from the benchmark structural VAR model in each of the three samples for all the variables except Z_t, which is shown in subsequent figures. The solid lines denote the empirical point estimate to a one-standard-deviation shock and the shaded areas denote the 16% - 84% probability interval of the posterior distribution.

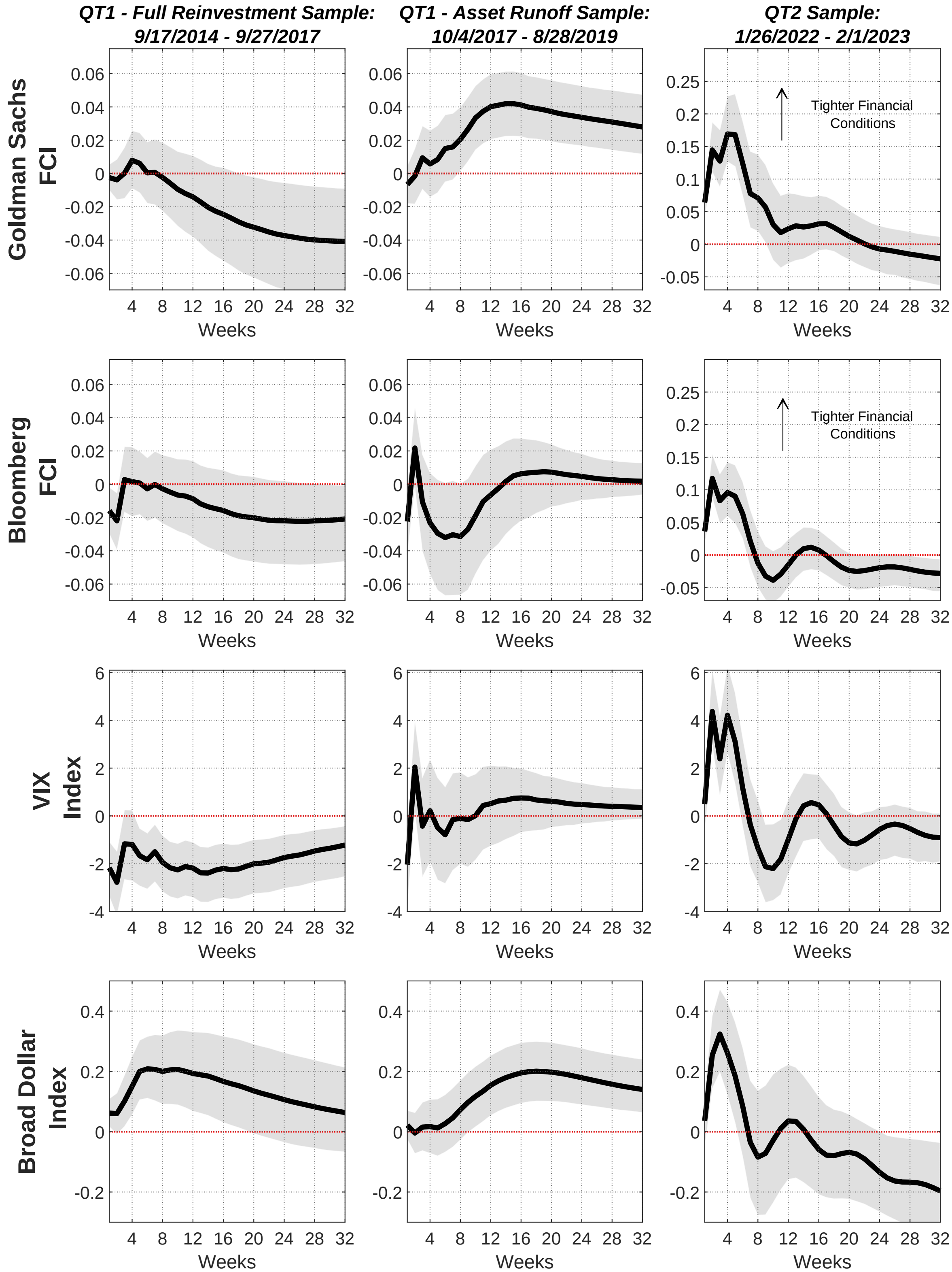


Figure 8: Responses of Various Broader Financial Condition Indices to a Negative 1 sd Reserve Supply Shock

Note: Each row shows impulse responses from a separately estimated structural VAR model. The solid lines denote the empirical point estimate to a one-standard-deviation shock and the shaded areas denote the 16% - 84% probability interval of the posterior distribution.

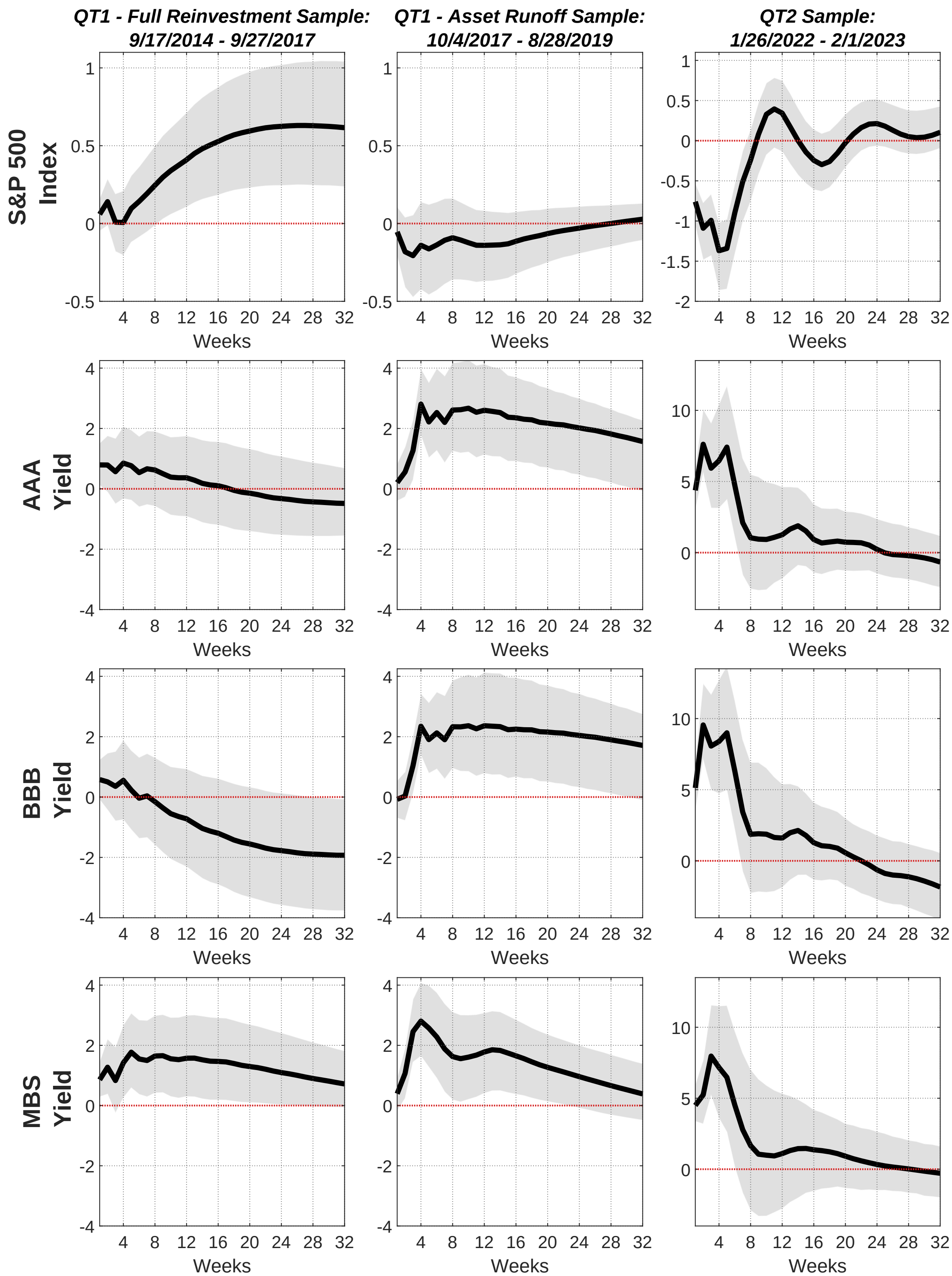


Figure 9: Responses of Various Narrow Financial Condition Measures to a Negative 1 sd Reserve Supply Shock

Note: Each row shows impulse responses from a separately estimated structural VAR model. The solid lines denote the empirical point estimate to a one-standard-deviation shock and the shaded areas denote the 16% - 84% probability interval of the posterior distribution.

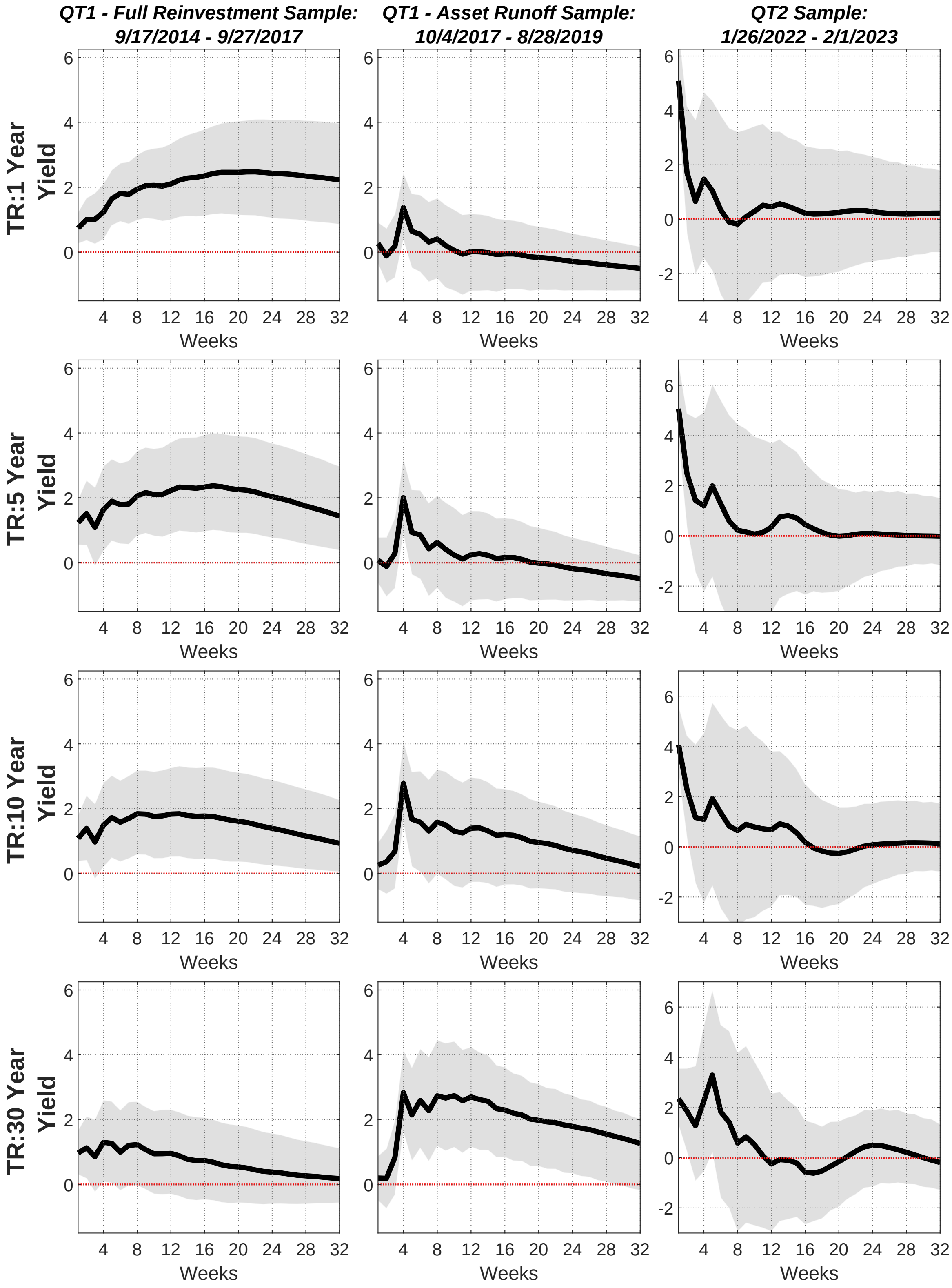


Figure 10: Responses of Various Treasury Yields to a Negative 1 sd Reserve Supply Shock

Note: Each row shows impulse responses from a separately estimated structural VAR model. The solid lines denote the empirical point estimate to a one-standard-deviation shock and the shaded areas denote the 16% - 84% probability interval of the posterior distribution.

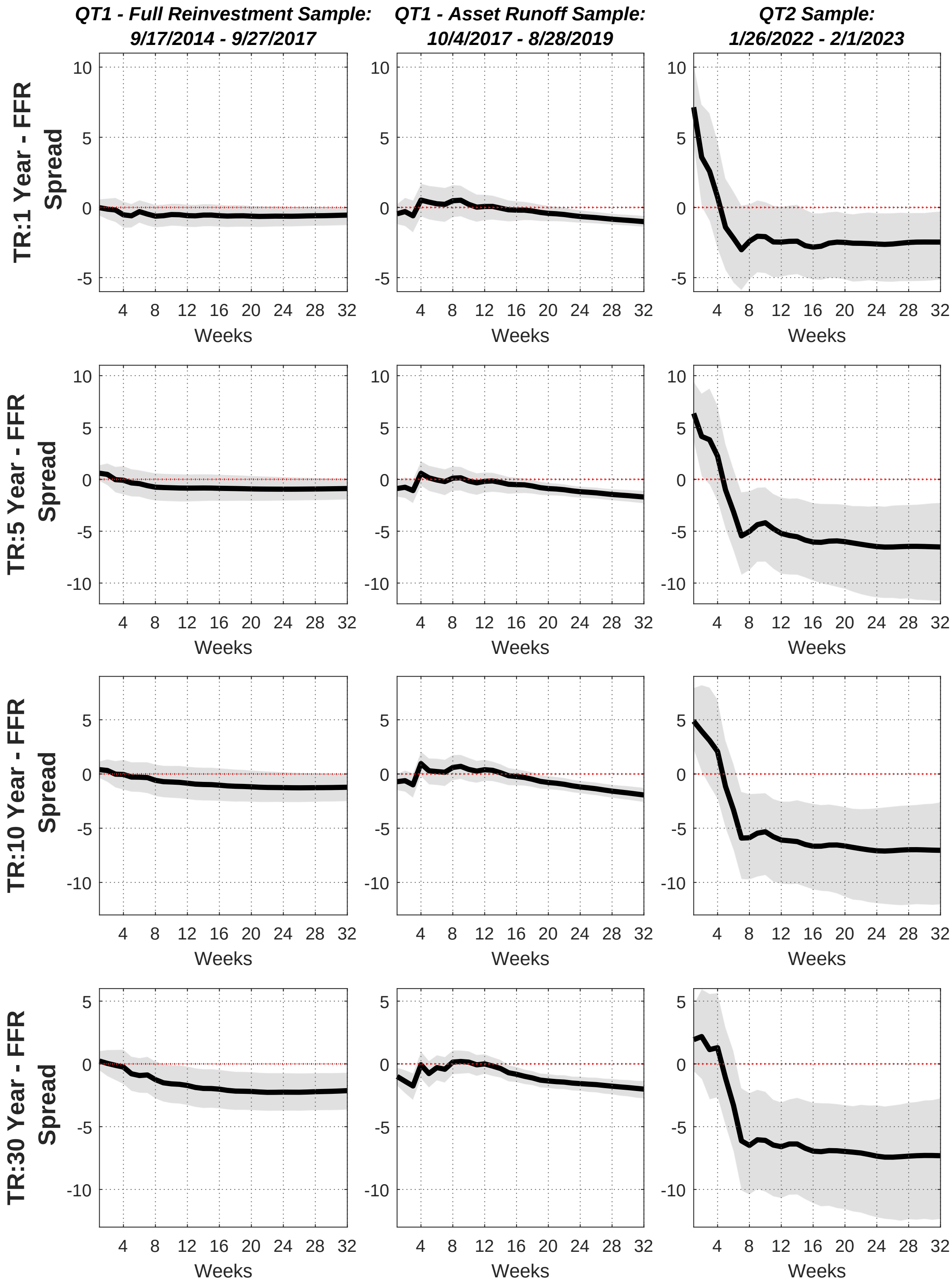


Figure 11: Responses of Various Treasury Spreads to a Negative 1 sd Reserve Supply Shock

Note: Each row shows impulse responses from a separately estimated structural VAR model. The solid lines denote the empirical point estimate to a one-standard-deviation shock and the shaded areas denote the 16% - 84% probability interval of the posterior distribution.

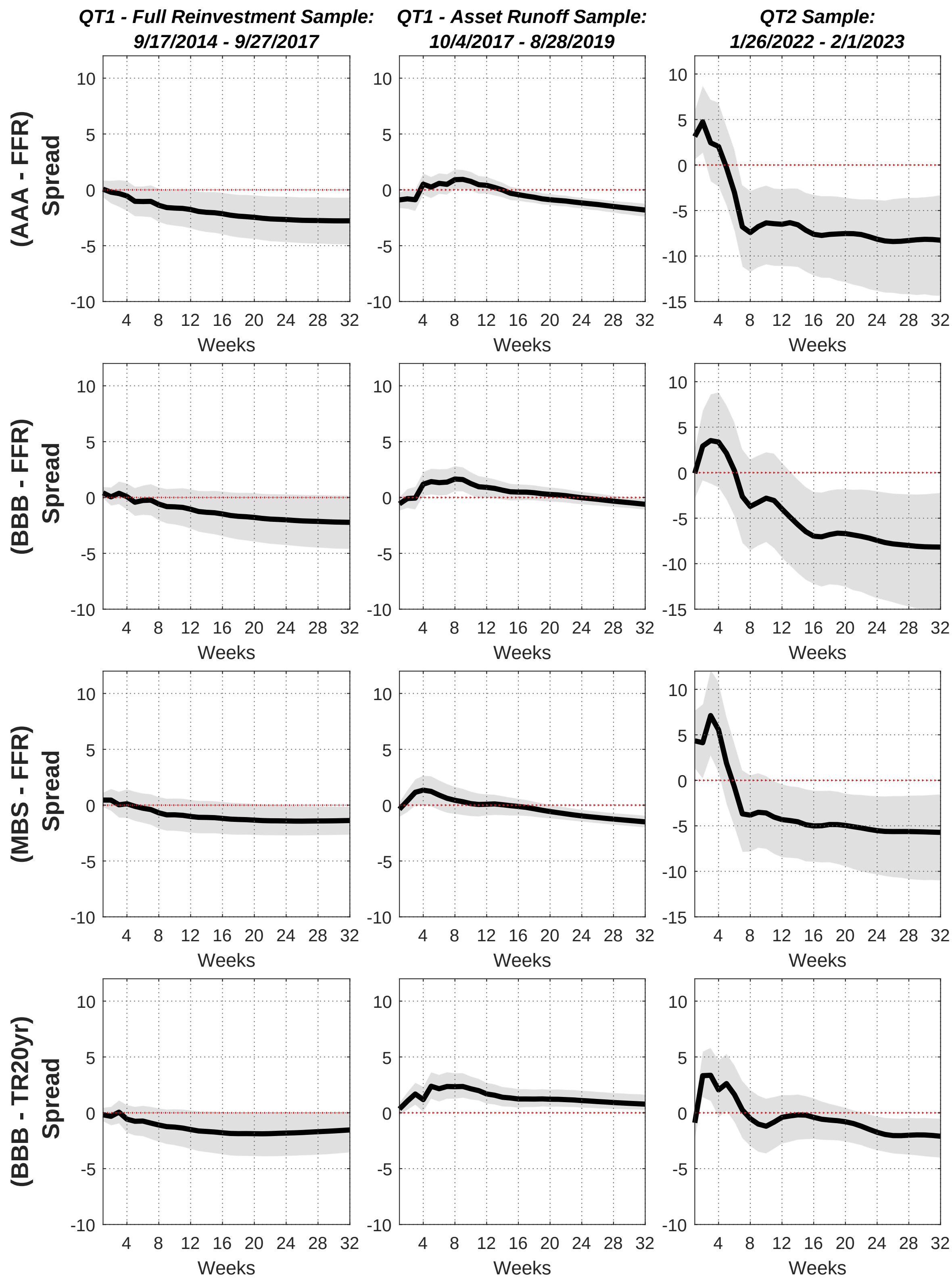


Figure 12: Responses of Various Spreads to a Negative 1 sd Reserve Supply Shock

Note: Each row shows impulse responses from a separately estimated structural VAR model. The solid lines denote the empirical point estimate to a one-standard-deviation shock and the shaded areas denote the 16% - 84% probability interval of the posterior distribution.