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Back to Normal? Assessing the Effects of the Federal Reserve's Quantitative Tightening

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Abstract

We study the effects of the Federal Reserve's two Quantitative Tightening (QT) programmes implemented over the last decade. We use a high frequency identification strategy to distinguish between conventional monetary policy shocks, Treasury borrowing announcement shocks and the unwinding of the balance sheet. Further, we analyse both QT announcements and operations. Our results show that the Fed was successful in muting the signalling effect of its Balance Sheet Policy (BSP) announcements, as statements not containing quantitative information about QT did not impact significantly asset prices. Conversely, communications disclosing information over the size and the pace of QT had an effect on financial markets. We also find that QT operations have a significant and persistent deflationary effect on interest rates and asset prices. A 1-trillion USD reduction in securities holdings by the Fed is associated with an increase in 10-year Treasury yields by 2 percentage points. While the contractionary effects of QT have so far been at least partially offset by liquidity operations that have expanded the supply of reserves, our results suggest that balance sheet reductions entail in principle strong negative effects on financial markets. Although QT does not represent in the policymakers' view the primary tool to achieve price stability, it is yet far from running quietly in the background of the monetary policy stance.

JEL Codes: E52, E58.
Keywords: *Quantitative Tightening, Central Bank Balance Sheet, Unconventional Monetary Policy, Local Projections.*

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1 Introduction

In response to the 2021-2022 inflationary surge, most global central banks have tightened monetary policy, by raising interest rates and gradually shrinking their balance sheets. This return to conventional monetary policy has been relatively homogeneous across central banks, as interest rate hikes have been predominant in most advanced economies. In addition to abandoning the post-GFC zero interest rate policy, some central banks have also started reducing the size of their balance sheets, thus partially offsetting the unconventional Quantitative Easing (QE) policies implemented after the Great Recession and in the wake of the 2020 pandemic crisis. As interest rates lifted above the lower bound, policymakers have explicitly regarded them as the main tool employed in the fight against inflation (Yellen, 2017; Schnabel, 2023b; Tenreyro, 2023), thus relegating Balance Sheet Policy (BSP) to a background role. While the reversing of Large Scale Asset Purchases (LSAP's) is mostly targeted towards influencing the long-term supply of reserves, its implementation can be expected to also have a direct impact on the Treasury market and spillovers across different asset classes via portfolio rebalancing and the drain on reserve supply.

This paper takes an empirical stand on the financial market impact of both balance sheet reductions implemented by the Federal Reserve before (2017-2019) and after (2022-2024) the COVID-19 pandemic. By using daily and weekly data to recover the effects of QT, we estimate impulse responses of asset prices, short- and long-run risk free rates and credit spreads to QT announcements and operations. We expand on the existing literature by employing a high-frequency identification strategy that disentangles BSP announcement shocks from conventional interest rate policy shocks. Additionally, by resorting to a recently developed identification strategy, we explicitly account for the developments of fiscal policy and their effects on the Treasury market during and after the pandemic.

We find that the Fed's communication strategy achieved its goal of limiting the signalling effect of its BSP announcements. Evidence of this can be found in the fact that, except for the "taper tantrum" episode in June 2013, BSP communications not involving quantitative information over the size of QT operations do not have an effect on interest rates and asset prices. On the other hand, our results underscore that QT announcements actually containing quantitative information about balance sheet reduction can impact financial markets. In line with previous literature, we show that BSP works also when the policy rate leaves the Effective Lower Bound (ELB) and financial markets are not in distress, thus implying that influencing the term structure of interest rates at different maturities represents in principle a feasible option in the policymakers' toolbox also in standard circumstances, as central bank intervention can affect portfolio rebalancing between securities of different maturities.

On the operations side, our results indicate that actual QT actions, in the form of a reduction in System of Open Market Accounts (SOMA) holdings of Treasury securities, have a strong, significant and persistent effect in raising short and long-run risk-free rates and increasing Treasury market volatility. We estimate that a 1-trillion reduction in SOMA holdings is associated with a 2% increase in the yield of 10-year Treasury securities over the medium term. The impact of QT on the Treasury market is directly driven by the decrease in demand for Treasuries by the Federal Reserve, as well as by the decrease in the supply of reserves, which causes agents to rebalance their portfolio away from less liquid assets such as stocks and long-maturity bonds. The latter channel also plays a pivotal role in deflating the stock market, increasing its volatility and tightening credit conditions to the private nonfinancial sector.

Although policymakers regard the interest rate as the main tool to employ in the fight for price stability, thus assigning QT to the background role of targeting the interbank supply of reserves, our results show that the unwinding of LSAP has sizeable contractionary effects on asset prices. While the Fed has been successful at not attaching a signalling effect to its BSP communication, announcements regarding the size of the reduction of the balance sheet have been quickly internalised by markets. Moreover, the decrease in the supply of reserves has brought significant downward pressure on asset prices. In sum, despite the

attempts to focus on interest rate movements and leave QT in the background, by minimising its expected effects on financial markets, we show that unwinding the balance sheet has far-reaching effects on a broad class of asset prices. Therefore, although the effects of QT have so far been offset by opposite movements in other components of the Fed's balance sheet that have expanded the reserve supply, a balance sheet reduction can in principle impact financial stability.

The remainder of this paper falls into four sections. The next one summarises the main stylised facts regarding the implementation of QT in the United States, as well as the recent developments in the literature on the implementation and the effects of Central Bank balance sheet reductions. Section 3 discusses briefly the effects of QT announcements. Section 4 estimates the effects of QT operations on money and capital markets. Finally, section 5 draws conclusions and discusses the policy implications of the findings.

2 Reversing Unconventional Balance Sheet Policies

2.1 Phases of QT

Over the last decade, the Federal Reserve has twice implemented a reduction of its balance sheet. Figure 1 provides a stylised timeline with the main milestones of the Fed's BSP over the last ten years, whereas Figure 2 displays the evolution of the Federal Reserve's total assets and of the Federal Funds rate. A more detailed breakdown of the Fed's balance sheet by its main components is shown in Figure 3.

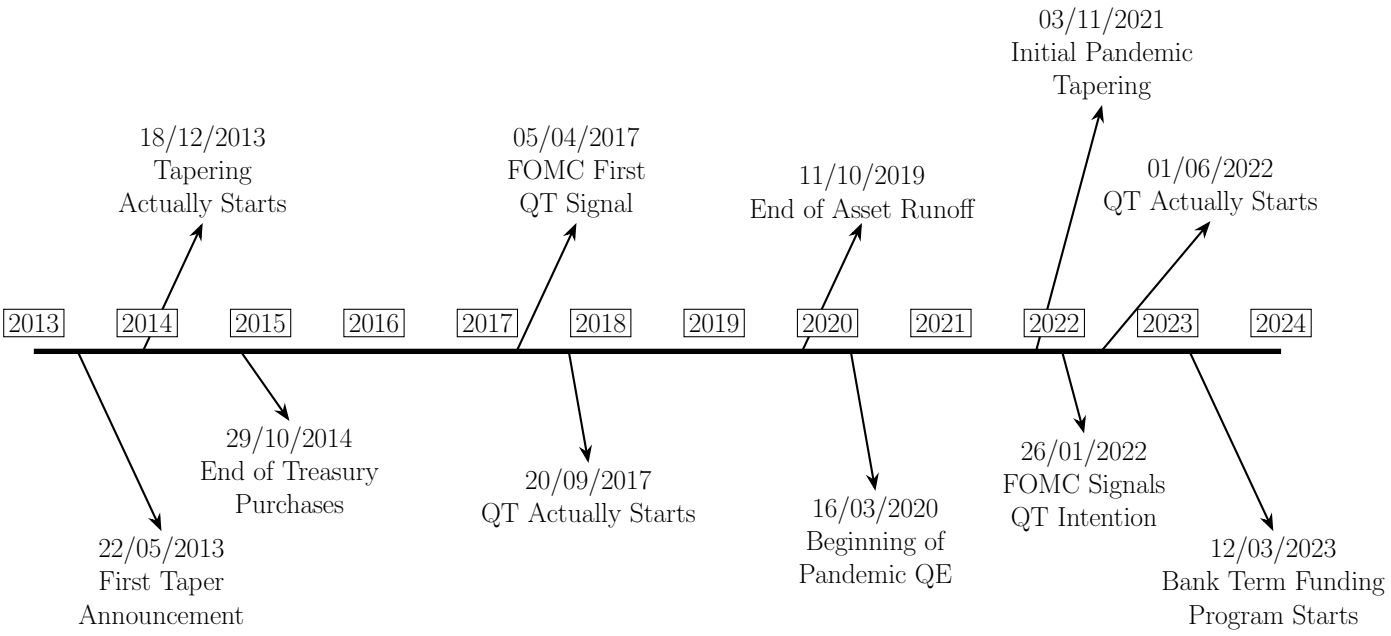

Figure 1. Timeline of the key events relating to Quantitative Tightening I (2017-2019) and Quantitative Tightening II (2022-2024) by the Federal Reserve. Sources: Smith and Valcarcel (2023), Vaille (2023) and author's identification.

The first communication regarding a possible slowdown in Treasury purchases of QE III by the Fed took place in late May 2013 and was associated with widespread tensions in the bond and stock markets. In the aftermath of this event, also known as "taper tantrum", the Federal Open Market Committee (FOMC) had decided to hold the total level of assets on the Fed's balance sheet constant for about four years. As a result, the first QT operation was particularly cautious. The unwind episode started in 2017 and occurred in a context of general monetary tightening. In September 2017, the Fed started decreasing its assets by reducing reinvestments of principal payments from maturing Treasuries and MBS/Agency debt at a monthly pace of $6 billion and $4 billion, respectively. From the beginning of 2018, the total figure

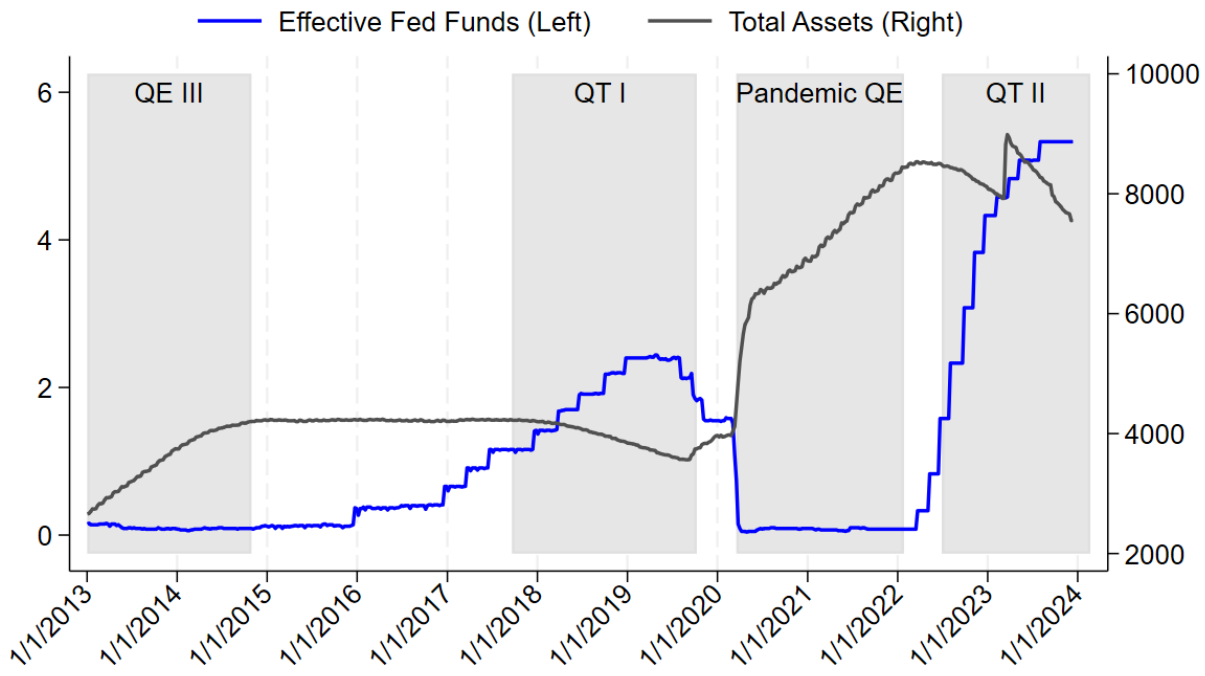

Figure 2. Effective Federal Funds rate and Federal Reserve total assets (USD billions). Source: Federal Reserve Board.

of monthly caps on reinvestments would be eventually raised in steps of $10 billion every quarter, until reaching the maximum amount of $30 billion per month at the end of the same year. However, as shown in Figure 2, this first unwinding episode lasted less than two years. While bond and equity markets did not react too adversely to the reversal of the LSAP's by the Fed, sudden tensions in the interbank overnight market in end-September 2019 prompted a swift reaction from the monetary authority, with an injection of liquidity in money markets and the eventual suspension of the QT programme (Figure 3).

The unfolding of the global COVID-19 pandemic was met with a firm monetary response, with the return of the Federal Funds rate to the ELB and a resumption of LSAP's. A first emergency measure of outright purchases of $500 billion in Treasury securities and $200 billion in MBS and Agency debt was deliberated in mid-March 2020. Subsequently, the Fed's balance sheet was further expanded by almost $3500 billion over the following two years. Only in November 2021 the FOMC decided for a tapering of the pandemic QE programme. The subsequent balance sheet normalisation (QT II), deliberated in January 2022 and started in June 2022, was undertook in a context of aggressive monetary tightening, in response to the post-pandemic global inflationary surge. The second QT episode has been characterised by the firm decision to decrease Treasury holdings by $30 billion per month and after three months to increase the amount to $60 billion, whereas the initial decrease in MBS holdings was of $17.5 billion per month, to be raised to $35 billion per month after three months. The banking crisis unfolding in March 2023 did not prompt the FOMC to suspend the second QT episode, but rather triggered a substantial liquidity intervention in the interbank market, with the unveiling of the Bank Term Funding Program (BTFP) directed to depository institutions facing liquidity issues.

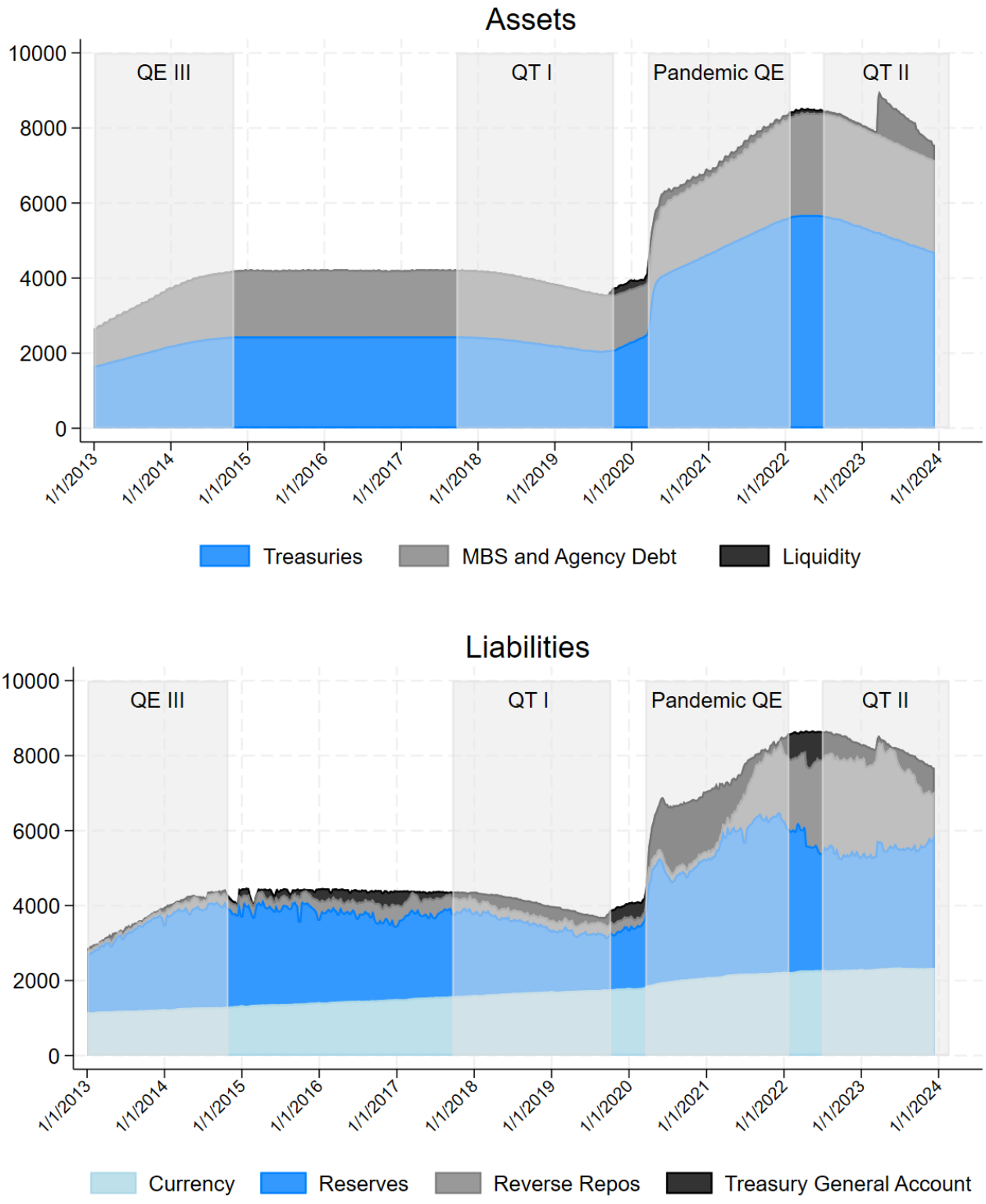

Figure 3. Selected assets and liabilities of the Federal Reserve's balance sheet (USD billions). Treasuries include Bills, Notes and Bonds held by the System of Open Market Accounts (SOMA). Liquidity includes repurchase agreements, rescue operations and targeted lending programs to the banking sector, including the Bank Term Funding Program (BTFP). Source: Federal Reserve Board.

2.2 Channels of Transmission

On the communication side, the transparency of the Fed's strategy allows to clearly understand the purpose of the BSP actions, so to identify their expected *a priori* effect on financial markets. Since the first long-term balance sheet normalisation plan was set out by the FOMC in May 2014, the Fed's communication has always made it clear that the reduction in holdings of Treasuries was not a proper monetary policy tool intended to achieve the inflation and output gap targets:

"The Committee affirms that changing the target range for the federal funds rate is its primary means of adjusting the stance of monetary policy."

(Federal Reserve, 2014)

This key concept was further reasserted by the Fed Chair Yellen during a FOMC press conference in June 2017, by explaining that QT is not to be thought as a QE working in reverse. The FOMC's intention and expectation, as stated in press conferences and minutes, has been to carry out the unwinding of the balance sheet without having any significant impact on financial markets:

"[...] the plan is one that is consciously intended to avoid creating market strains and to allow the market to adjust to a very gradual and predictable plan. My hope and expectation is that when we decide to go forward with this plan, that there will be very little reaction to it, that it's clear how we intend to proceed, and that this is something that will just run quietly in the background over a number of years, leading to a reduction in the size of our balance sheet and in the outstanding stock of reserves."

(Yellen, 2017)

And the Fed's focus on conventional interest rate policy as the primary and only tool employed in the pursuit of price stability did not change, but was rather reiterated in the aftermath of the pandemic:

"[FOMC] participants reaffirmed that changes in the target range for the federal funds rate are the Committee's primary means for adjusting the stance of monetary policy."

(Federal Open Market Committee, 2022)

In the light of the FOMC's communication strategy, it is clear that policymakers do not envisage QT as an unconventional restrictive policy working as a symmetric QE in reverse. While LSAP's represent an unconventional tool that operates when the policy rate hits the ELB or when financial markets are distressed, the unwinding of the balance sheet is rather viewed as a quiet background operation aimed at supporting the functioning of the main conventional monetary policy tool, the Federal Funds Rate. To analyse the channels by which QT can affect financial markets and the real economy, we first take a step back and review the channels of transmission of QE, so to discuss which of those can be relevant for the transmission of QT as well.

It is consensus that the unconventional policy of QE mainly operates through four channels. Firstly, in the portfolio balance channel, Treasury purchases drive down yields across the whole term structure and reduce term premia (Bernanke et al., 2004, 2010). This effect can further be reinforced in case of preferred-habitat[1] (Vayanos and Vila, 2021) because the non-substitutability of securities with different maturities causes a segmentation of the term structure (D'Amico and King, 2013). The working of the portfolio balance channel has recently been further explored by Christensen and Krogstrup

[1] I.e. agents have a preference for a specific maturity over the whole spectrum.

(2019), who show that asset purchases are financed by central bank reserves trigger a bank portfolio rebalancing effect that further adds upward pressure on asset prices. Secondly, according to the signalling channel, LSAP's are a tool by which central banks reinstate their commitment towards achieving their macroeconomic targets, thus also signalling to market participants lower future rates than previously anticipated (Bernanke et al., 2004; Bauer and Rudebusch, 2014). Moreover, in the information channel, the decision to undertake unconventional policies may disclose to market participant new information on the state of the economy, thus influencing agents' risk taking behaviour. Finally, we have the liquidity Channel, in which central bank purchases are able to restore proper market functioning by decreasing liquidity premia (Joyce et al., 2010).

In addition to the channels mentioned above, Bernanke et al. (2004) suggest a channel where the issuance of reserves allows the central bank to substitute seignorage for tax revenue, thus relaxing the Government's consolidated resource constraint. A related argument is set forth by Reis (2017), who shows that in the presence of Government default risk, issuing nominally default-free reserves to purchase risky government bonds reduces risk premia. Overall, this aligns with the default risk channel discussed by Krishnamurthy and Vissing-Jorgensen (2011).

In the case of QT we can exclude with certainty the existing of a signalling channel, because the Fed made it clear in its communication that QT is not directly related to the commitment to price stability and thus cannot be regarded as a first measure of monetary policy "hawkishness", as this role belongs to the Fed Funds rate. On the other hand, the information channel can potentially operate. A good state of confidence of policymakers on the liquidity and stability of financial markets can be inferred from the choice to implement and possibly expand the unwinding of the balance sheet. This effect can invite markets to take up more risk, thus boosting asset prices, reducing volatility and compressing risk premia, including corporate credit spreads. The unwinding of the balance sheet is predicted to lower the liquidity of financial markets and especially of the Treasury market. While this effect can certainly be expected, it is far from the Fed's financial stability mandate to cause a liquidity crisis or to impair the smooth functioning of financial markets. Hence, we argue that the liquidity channel does not apply for the transmission of QT: in case the balance sheet unwind caused market stress, as in September 2019, QT operations would be immediately suspended.

In conclusion, the portfolio balance channel remains the principal mean by which QT can affect financial markets and the only one that can potentially work in a symmetric fashion to QE. While the FOMC likely anticipates this effect to arise, the increase in long-term interest rates is not envisaged by the FOMC as the key tool to price stability, but rather as a secondary mechanism occurring against the backdrop of the policy rate tightening. Moreover, the Fed opted for a passive implementation of QT, by ceasing reinvestments of maturing securities, instead of engaging in actual Treasury sales. This decision has likely been taken to minimise the footprint of QT operations on the yield curve: while the Fed gradually withdraws its demand from the Treasury and MBS market, it attempts not to distort the maturity structure of outstanding securities by actively selling its holdings.

Since, in the policymakers' intentions, the conventional QE transmission channels only marginally work for the operation of QT, the rationale for unwinding central bank balance sheets has to be sought elsewhere. In the implementation of monetary policy, the balance sheet reduction is closely linked to the long-run supply of reserves (Schnabel, 2023a; Borio, 2023). Prior to the Global Financial Crisis (GFC), monetary policy was usually conducted in a scarce-reserve supply framework. Conventional monetary policy is conducted by setting a target range for the interest rate in the interbank market for reserves, and ensuring the interest rate remains within this target range by affecting the reserve supply (Lopez-Salido and Vissing-Jorgensen, 2023). With the policy rate stuck at the ELB and implementation of LSAP's, monetary policy implementation shifted to an ample-supply of reserves setting (Afonso et al., 2020; Ihrig et al., 2020), where a constant and permanent excess supply of reserves in the interbank market made the overnight liquidity conditions relatively inelastic to shifts in reserve supply. Therefore, after the GFC, paying

interests on reserves became the main tool by which monetary policy achieves its operational target for the policy rate.

In this framework, the primary goal of QT resides in shrinking the supply of reserves, so to make the interbank overnight rate more responsive to monetary policy operations and therefore allow a better transmission of interest rate hikes to the whole economy. It is therefore in the light of long-run interbank reserve supply targeting that QT should be thought. As QT has been implemented with different goals compared to QE, the present empirical work is directed at evaluating the effects of QT through the lens of portfolio rebalancing and the supply of reserves in the interbank market.

2.3 Literature

While the literature analysing the effects of LSAP's is wide and well developed, there are relatively few studies investigating the impact of balance sheet reductions. This reflects the limited historical sample of QT implementation: the only two tightening episodes implemented in the last decade took place very recently and researchers are still working on a thorough and robust assessment. The present paper therefore is related to these early attempts to provide a rigorous analysis of the financial market impacts of QT announcements and operations.

Starting from the analysis of QT announcements, a first study of the Fed's QT I (2013-2019) programme has been carried out by Smith and Valcarcel (2023). While the inquiry is restricted to the first tightening episode, the identification of a sufficient amount of tightening events ensures the meaningfulness of the estimation. Following the use in the QE literature, the shocks are identified using a narrative approach (Neely and Fawley, 2013), by defining a dummy variable that takes value one on each day an announcement is made, and zero otherwise. As customary in the estimation of QE events, they regress the two-day change in the dependent variable (interest rates on Treasuries at various maturities, stock prices and other risk premia) centered on announcement date on the announcement dummy. This approach is standard in order to capture the full effect of asset price adjustments (Hanson and Stein, 2015). The results by Smith and Valcarcel (2023) show that, in contrast to QE announcements, QT I statements by the Fed have no effect on the dependent variables. On the other hand, they find that the tapering announcements of QE in mid-2013 had a strong effect in raising interest rates on Treasuries, depressing asset prices, widening risk premia and reducing market liquidity. Similar evidence is brought forth by Vaille (2023), who expand the analysis above to the post-pandemic QT programme, by employing the same narrative methodology but augmenting the regressions with macroeconomic surprises and Federal Funds futures as control variables. They also find no effect of QT announcements during both balance sheet unwinds, whereas the contractionary impact of tapering announcements remains robust.

An alternative approach is taken by Lloyd and Ostry (2024), resorting to the identification strategy proposed by Swanson (2021) that isolates the surprise components of QE (2008-2012) and QT I (2013-2019) announcements by the Fed. The methodology entails 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 its expected path, and LSAP shocks to the Fed's balance sheet size. The authors proceed by means of local projections to estimate the dynamic response of 2-year and 10-year Treasury yields up to 50 days after the BSP announcement. They find that both have a contractionary effect on the 10-year maturity. They uncover an asymmetric impact on 2-year yields: QT shocks attain stronger effects by raising expectations of future rates. Thus, the authors find that QT announcements are actually carrying signalling effect. However, the main issue with the approach adopted in the paper regards the identification strategy. In the estimation of QT surprises, all BSP events are treated equally, without differentiating between tapering and tightening. In addition, the latter are not divided between events actually communicating the magnitude of QT and announcements simply stating the Fed's commitment to tighten the balance sheet. Moreover, it is arguable whether the signalling effect of QT exists at all on narrative grounds,

as official Fed communication seems to shut off this channel *a priori*. Hence, it is not straightforward whether this approach actually disentangles the signalling effect from the portfolio balance effect in QT surprises.

In another contribution, D'Amico and Seida (2024) estimate the unexpected component of LSAP and QT announcements by using Survey of Primary Dealers (SPD) data. Moreover, they exploit the operational details of every programme implemented by the Fed to compute the local supply surprise effects relative to specific maturities. Their results show that both QE and QT I have a significant impact on Treasury yields over the sample 2009-2019. This result is interesting as it shows that BSP announcements keep having effect also after that the policy rate leaves the ELB. The authors provide the existence of frictions, specifically liquidity constraints in the private sector's balance sheet, as main explanation for the finding. In the light of these results, the lack of effect of QT announcements found in the previous literature can be explained by the fact that BSP communications relative to the unwind could have been anticipated by financial markets. As the methodology by D'Amico and Seida (2024) only identifies surprises relative to announced changes in the quantities of securities held by the Fed, it does not focus on estimating the signalling effect of announcements that do not specify quantities.

Moving outside of the U.S., instead, a broader comparison of QT announcements by different central banks is carried out by Du et al. (2024), who assess the impacts of all QT programmes implemented by global central banks of seven advanced economies over the last decade. They assess announcements using the standard narrative event-study approach employed by Smith and Valcarcel (2023). Their findings highlight that QT announcements involving the actual size of the balance sheet unwinds have an effect on financial markets. Conversely, announcements merely involving discussions on balance sheet reductions fail to have an impact. These results show some similarity with D'Amico and Seida (2024), underscoring how BSP announcements involving actual quantitative plans tend to influence financial markets. Taken together, the results provided in the two papers indicate that a policy aimed at directly affecting long-run interest rates works effectively both on and off the ELB, via the portfolio balance channel and possible preferred habitat by market participants. This set of results cannot be interpreted as driven by a signalling effect, since the Fed clearly stated that BSP is not directly related to the monetary policy stance, but rather from the actual market anticipation of the effects of QT operations.

Regarding the analysis of the effects of QT operations, instead, to the best of our knowledge there are only two contributions estimating the impact of the unwinding of the Fed's balance sheet on financial markets. The first study is by Smith and Valcarcel (2023) and it only relates to the QT I (2017-2019) experience by the Fed. The authors run a time-varying (TV) SVAR (Primiceri, 2005), where the shocks are identified using a Cholesky orthogonalisation. The authors order the variables in the TV-SVAR as follows: first reserves, then the SOFR-IOR spread and the Federal Funds-IOR spread, then the dependent variable consisting of the asset price of interest. The last variable in the VAR ordering, that is therefore endogenous to the four shocks enumerated above, is the total amount of SOMA holdings. This identification strategy is based on the assumption that, with an ample supply of reserves, the monetary authority does not systematically intervene on the reserve supply to offset shocks to autonomous liquidity factors (Ihrig et al., 2020). Therefore, exogenous changes in the amount of reserves can be treated as stemming from the unwind of the Fed's balance sheet. While this approach is well-grounded on theory, it falls short on at least two aspects. Firstly, it does not control for conventional monetary policy shocks that can affect the dynamics of reserves in interbank markets. Secondly, by assumption it neglects liquidity operations and other balance sheet components by the Fed as a source of reserve supply. Since at least liquidity operations (as shown in Figure 3) have been significant during the last QT phase, this approach is no longer viable to explore the post-pandemic QT experience.

The second empirical study on QT operations, Du et al. (2024), relies on a 7-country sample of advanced economies. However, it estimates the effects of QT operations by only focussing on the asset price changes in the neighbourhood of the day on which QT operations actually started. For the US, the authors

emphasise a difference between QT I and QT II: during the former episode, the decline in the reserve supply was more tightly linked to the changes in SOMA holdings, for the reasons outlined in the previous sections. During the latter, instead, QT failed to bring about a decline in the supply of reserves, due to liquidity interventions, Government spending and a decline in overnight Reverse Repo balances. While this semi-descriptive evidence is insightful for comparison between the two QT programmes and QE, it cannot fully capture the truly dynamic effects of balance sheet reductions, nor assess their persistence.

The present paper brings forth several contributions to the existing studies. Firstly, starting from a framing of the shrinking of central bank balance sheet in the context of monetary policy implementation with an ample supply of reserves, we first re-assess the effects of tapering and QT announcements by the Fed. Our innovation rests in estimating the impact of BSP announcements while also controlling for conventional interest rate shocks, fiscal policy announcement shocks and the general macroeconomic outlook. In fact, while LSAP's are an unconventional monetary policy tool that is mainly employed when the policy rate reaches the ELB, the shrinking of central bank balance sheets takes place simultaneously with conventional monetary policy. Therefore, to isolate the pure effect of QT announcements on asset prices, we need to disentangle the impacts of unexpected changes in the Federal Funds rate.

Moreover, due to the specific characteristics of the historical sample, we decide to employ two further controls. In response to the COVID-19 pandemic, the U.S. Government enacted a bold fiscal stimulus that was financed by issuing debt securities, and a relatively loose fiscal stance was also maintained in the aftermath of the post-pandemic recovery. The resulting significant shift in the supply of Treasury securities (Figure 4) is likely to have had an impact on asset prices. We therefore decide to control for this factor in our investigation of the effects of QT. In doing so, we are the first to explicitly control for the supply effects of Government borrowing shocks using the methodology recently developed by Phillot (2021). Our second control relates macroeconomic surprises and the general economic outlook. The period of the global pandemic was characterised by wild fluctuations in output growth, a rapid increase in inflation and heightened policy uncertainty. While in normal times these background factors can have a negligible effect on asset prices on policy announcement days, we argue that during the pandemic and its aftermath such strong shifts in market expectations are potential confounders for the identification of the impact of QT announcements.

Subsequently, we estimate the financial market impact of QT operations by the Fed during both the QT I (2017-2019) and QT II (2022-2024) episodes. We do so by estimating impulse responses of selected asset prices to changes in SOMA holdings using local projections (Jordà, 2005). Also in this instance, we control for monetary and fiscal policy shocks that took place simultaneously with QT operations, as well as changes in the macro outlook and liquidity operations by the Federal Reserve. As mentioned in this section and in the previous one, the supply of reserves since 2019 has been consistently influenced by long-term loans to depository institutions by the Fed and by Government borrowing and expenditure via the Treasury General Account (TGA). The mutating structure of the Fed's liabilities (Figure 3) implies that the two aforementioned factors need to be accounted for when estimating the response of asset prices to a decrease in SOMA holdings by the Fed.

3 Data & Methodology

3.1 Assessing QT Announcements

We start by assessing the financial market impact of QT announcements. We rely on a daily dataset from January 2013 to February 2024. Following the convention in the QE literature (Neely and Fawley, 2013; Gagnon et al., 2011; Krishnamurthy and Vissing-Jorgensen, 2011), we identify balance sheet Easing, Tapering and Tightening announcements by the federal reserve using a narrative approach. We define a dummy variable taking value 1 on announcement day and zero otherwise. The narrative identification

of announcements relating to the first tapering and QT experience (2013-2019) are reported in Table 1. Identified announcements relating to the pandemic QE experience, as well as of the subsequent tapering and balance sheet tightening are reported in Table 2. As customary practice when assessing unconventional monetary policy announcements (Rogers et al., 2014; Gagnon et al., 2011; Smith and Valcarcel, 2023), we regress the changes of our dependent variable of interest y_t on a two-day window centered on announcement day, i.e. $\Delta y_t := y_{t+1} - y_{t-1}$. The baseline specification is displayed in Equation 1.

$$\Delta y_t = \beta_4 Taper1_t + \beta_2 QT1_t + \beta_1 QE_t + \beta_5 Taper2_t + \beta_3 QT2_t + \gamma' X_t + u_t \tag{1}$$

Where the QE_t, $Taper1_t$, $Taper2_t$, $QT1_t$ and $QT2_t$ denote dummy variables for the announcements relating to the pandemic QE programme (2020), the first (2013) and the second (2021) taperings of LSAP's and the first (2017-2019) and second (2022-2024) balance sheet reductions. Moreover, the vector γ contains a series of loadings estimating the effects of a series of control variables contained in the matrix X_t and described later in this section. We are primarily concerned with examining the effect of BSP announcements on three sets of dependent variables:

- **Treasury Market**: 10-Year and 3-Month Treasury Yields, 10-Year Treasury term premium, 10-Year Treasury Bid-Ask Spread, ICE BofAML MOVE index (indicator of US Treasury market volatility) and Bloomberg Treasury market liquidity index (GVLQUSD)[2].
- **Asset Prices**: S&P 500, S&P Banks and Regional Banks, Federal Reserve Board's measure of the Broad Dollar Index, Gold and Brent Spot Prices.
- **Spreads & Premia**: Moody's Seasoned BAA spread over the 10-Year Treasury, CBOE VIX (indicator of US equity market volatility), Bloomberg MBS index average yield-to worst (LUMSYW), Bloomberg global bond return index (LEGATRUU) and Bloomberg global financial stress index (RFSITOTL).

The first set of indicators is chosen to gauge the effects of announcements of risk-free rates, the term structure and the liquidity of Government debt markets, which is affected directly by the shift in supply of Government debt security triggered by QT. The second set relates to a broad class of asset prices that are generally sensitive to monetary policy shocks (Rigobon and Sack, 2004; Bekaert et al., 2014). The third set of dependent variables comprises corporate investment-grade bond and Mortgage-Backed Security spreads over the risk-free rates. Moreover, it includes global measures of bond market returns and financial stress to assess the international spillovers of QT. Data on asset prices and bond yields has been retrieved from Datastream. The source of the daily nominal Broad Dollar Index is the Federal Reserve Board. Finally, all Bloomberg indexes have been retrieved from the Bloomberg terminal.

In order to disentangle the effects of unconventional BSP announcements from other shocks taking place simultaneously and that could act as confounding factors for our analysis, we decide to account for conventional monetary policy decisions that took place contemporaneously with the shrinking of the Federal Reserve's balance sheet. In fact, as argued in Section 2, QT is not designed to be an unconventional monetary policy working as a QE in reverse, but rather as a background operation targeting the long-run level of reserves in the interbank market. As QE is conceived as an unconventional monetary policy that is enacted at the ELB, that is when the conventional tool - the policy rate - is no more available, announcements of LSAP's by the Fed do not overlap by construction with changes in the Federal Funds rate. Conversely, as shown in Figure 2, the Fed has in both occasions shrunk its SOMA holdings of Treasuries and MBS while simultaneously implementing conventional interest rate policy.

[2]Defined as the average yield deviation relative to a fitted yield curve across US Treasuries with maturity beyond 1 year

To account for this, we construct a daily time series of Federal Funds shocks using the methodology by Cochrane and Piazzesi (2002). We regress the change in the Federal Funds target range on the intraday change in the 3-Month LIBOR rate around the FOMC decision date. Since the LIBOR rate has been phased out since end 2021 (LeSueur, 2021), we replace it starting from June 2021 with the newly-introduced benchmark AMERIBOR rate by the American Financial Exchange (AFX). Overall, both unsecured money market rates prove to be relevant instruments for the identification of the monetary policy shocks in the sample, as the Olea and Pflueger (2013) robust F-Statistic rejects the null hypothesis of weak instrument at the 5% significance level.

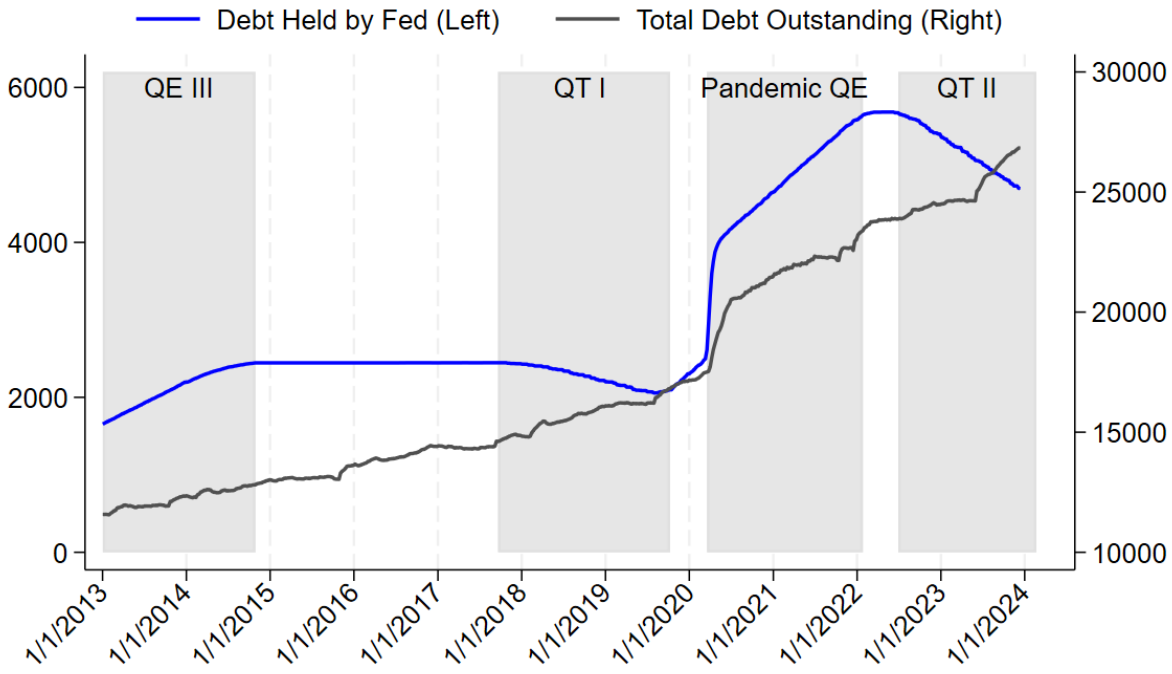

Figure 4. SOMA holdings of Government debt securities and total marketable Government debt securities outstanding (USD billions). Sources: Federal Reserve Board and US Treasury.

Additionally, we also account for Treasury borrowing surprises, that may constitute a relevant confounding factor for the purpose of the present analysis. Indeed, in response to the COVID-19 pandemic, the US Government responded with a sizeable fiscal stimulus which was primarily financed by issuing new debt (Figure 4). As news about the increase in Treasury supply caused by changes in Government borrowing can have an effect on interest rates and asset prices, we decide to control for them by employing the novel methodology developed by Phillot (2021). This approach relies on daily U.S. Treasury auction data, by instrumenting the net amount of debt securities offered on every auction with the intraday change in Treasury futures on the day that the auction is announced. This methodology therefore yields a measure of the unexpected amount of debt securities supplied by the Treasury at every auction. Phillot (2021) finds that these shocks have a strong effect on financial markets, by shifting the yield curve upwards, raising stock prices and corporate bond yields. Given the potential overlap between fiscal announcement shocks and BSP announcements by the Fed, we argue that this set of shocks needs to be accounted for in order to recover the true effect of QT announcements.

Finally, we add to our baseline specification a further set of control variables to account for other systematic factors that could affect fluctuations in the dependent variables. Firstly, we control for the macroeconomic

Date	Event	Description
22/05/2013	Bernanke Speech	FOMC could slow down purchases
19/06/2013	Bernanke Speech	FOMC plans to taper purchases
18/12/2013	FOMC Statement	Tapering of MBS and long maturity Treasuries starts
21/05/2014	FOMC Minutes Released	Begin of long-term normalisation plan
09/07/2014	FOMC Minutes Released	Discussion of gradual asset reinvestments
15/07/2014	Yellen Speech	Further reductions in pace of asset purchases planned
20/08/2014	FOMC Minutes Released	Details on normalisation plan set out
17/09/2014	FOMC Statement	Policy normalization principles and plan released
29/10/2014	FOMC Statement	Treasury purchases ending that month
12/01/2017	Bernanke Speech	Discussion on balance sheet normalisation
05/04/2017	FOMC Minutes Released	Members agree on gradually reducing reinvestments
24/05/2017	FOMC Minutes Released	Details of phasing out reinvestments
14/06/2017	FOMC Statement	Balance sheet normalisation expected in the year
20/09/2017	FOMC Statement	Balance sheet normalisation starting in October
19/12/2018	Powell Speech	Asset runoff on automatic pilot
11/10/2019	FOMC Statement	End of Asset Runoff

Table 1. Pre-pandemic (2013-2019) Tapering and Tightening announcements by the Federal Reserve. Sources: Smith and Valcarcel (2023) and Vaille (2023).

Date	Event	Description
16/03/2020	FOMC Statement	Pandemic purchases of Treasuries and MBS start
23/03/2020	FOMC Statement	Broadening of Treasury and MBS purchase programme
10/06/2020	FOMC Minutes Released	QE will continue at current pace
22/09/2021	FOMC Statement	First discussion of reducing Treasury purchases
03/11/2021	FOMC Statement	Initial tapering of pandemic QE
15/12/2021	FOMC Statement	Further tapering implemented
26/01/2022	FOMC Statement	First announcement of QT
16/02/2022	FOMC Minutes Released	Members show unanimous support for QT
02/03/2022	Powell Speech	Semiannual Monetary Policy Report to the Congress
21/03/2022	Powell Speech	"Restoring price stability"
06/04/2022	FOMC Minutes Released	Agreement on monthly caps on reinvestments
04/05/2022	FOMC Statement	QT schedule released
25/05/2022	FOMC Minutes Released	Follow up on QT plans details
22/06/2022	Powell Speech	Semiannual Monetary Policy Report to the Congress
26/08/2022	Powell Speech	"Monetary policy and price stability"
30/11/2022	Powell Speech	"Inflation and the labour market"
07/03/2023	Powell Speech	Semiannual Monetary Policy Report to the Congress
21/06/2023	Powell Speech	Semiannual Monetary Policy Report to the Congress

Table 2. Post-pandemic (2020-2023) Easing, Tapering and Tightening announcements by the Federal Reserve. Source: author's identification based on Vaille (2023).

outlook by adding the CITIFX economic surprise index retrieved from Datastream and the GDPNow Atlanta Fed nowcast for the current quarter.[3] Additionally, we control for global market risk aversion by also including the two-days lagged VIX and market liquidity conditions as measured by the (two days lagged) spread between the three-month T-bill and the three-month Overnight Swap Index rate (OIS), as employed by Fratzscher et al. (2018). We also include 'day-of-week' dummy variables to capture seasonal effects and three event-specific dummy variables designed to capture extraordinary events that affected asset prices abnormally during the sample period. The first of these dummies (COVID) takes value of one during the first week of March 2020 and zero otherwise, to proxy the financial panic that triggered a sell-off and a flight to quality during the early spread of the COVID-19 pandemic. The second dummy (CEIL) variable takes value of one during the month of May 2023 and zero otherwise. It is designed to proxy the uncertainty during the last phases of the negotiations over the raising of the U.S. debt ceiling. It covers the temporal period during which temporary extraordinary measures enacted by the Treasury (May 1st) until its resolution (June 1st), when the Fiscal Responsibilities Act was passed by the Senate. The last of our event-specific dummy variables (SVB) controls for the five largest bank failures of 2023. [4] It takes value of one on each day a bankruptcy was announced and the day before, and zero otherwise.

In addition to the aforementioned specification, our inquiry makes use of a second model that exploits the granularity of all the BSP communications by the Fed identified in Table 1 and Table 2. We do so by regressing the asset price change y on every single announcement ANN_t^j, each of which is estimated with a different coefficient β_j. The specification also includes the same control variables adopted in the baseline Equation 1.

$$\Delta y_t = \sum_{j=1}^{K} \beta_j ANN_t^j + \gamma' X_t + u_t \tag{2}$$

This regression is aimed at testing the heterogeneous impacts of QT communications, by inspecting whether every single event was associated with specific effects in the relevant asset markets.

3.2 Assessing QT Operations

Besides analysing the impact of the Fed's BSP communications on financial markets, we also study the effects of QT actions. In fact, while efficient markets should quickly price in information relative to any policy communication as soon as it is released, the presence of liquidity constraints allows for BSP to have an effect also when it is fully anticipated (D'Amico and King, 2013). For this reason, we investigate the presence of liquidity effects on both money markets and capital markets brought about by the reduction of the central bank's balance sheet.

We study the impact of the unwinding of the Fed's balance sheet by estimating impulse responses via direct projections (Jordà, 2005). We define QT operations as the net cumulative negative changes in SOMA holdings of Treasury securities, MBS and agency debt. The sample used for estimation consists of weekly time series of the Fed's balance sheet components. We employ end-of-week stocks instead of weekly averages in order to avoid confounding lead-lag relations. Dependent variables on asset prices and yields that come at daily frequency are therefore converted to weekly by averaging lagged observations starting on Wednesdays.

$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h' \Xi_t + \gamma' X_t + u_{t+h}, \qquad h \in \{1, 20\} \tag{3}$$

[3] Since the GDPNow indicator is not released regularly at daily frequency, we interpolate it linearly.

[4] Chronologically, Silvergate Bank (March 8th), Silicon Valley Bank (March 10th), Signature Bank (March 12th), Credit Suisse (March 19th) and First Republic Bank (May 1st).

The sample starts on the first week of January 2013 and ends on the last week of February 2024. Our baseline empirical specification takes the form shown in Equation 3, where the dependent variable of interest y_t^j is regressed on the matrix Ξ_t containing six different shocks ξ_t^j: in addition to QE and QT operations identified above, we also include QT (tapering and tightening) and QE announcement shocks, Federal Funds and Treasury borrowing shocks identified in the previous section. While impulse responses to the latter four shocks are not the primary object of interest of this paper,[5] we employ these shocks in Section 5.4 to estimate Forecast Error Variance Decompositions (FEVD's) of dependent variables.

In the baseline model, we include a matrix of controls X_t, which includes the same variables used for assessing announcements in Section 4, plus the total amount of federal debt held by the public, weekly liquidity operations implemented by the Fed, Overnight Reverse Repurchase agreements (ONRRP)[6] and the TGA. Similarly to the analysis of announcements, the amount of Government debt holdings by the private sector is included to control for the shift in supply for Treasury securities issued during the pandemic, which may have decreased the liquidity of the Treasury market. The inclusion of outright loans by the Fed to depository institutions is added to control for a counfounding factor that brought about an increase in the supply of reserves while QT was taking shape in the first half of 2023. A similar argument applies for the ONRRP balance and the TGA (Figure 3). This ensures that reductions in SOMA holdings are linked one-to-one to reductions in reserves. Finally, in order to account for residual correlation, our IRF estimation employs Newey and West (1987) standard errors up to lag 3. We estimate impulse responses up to a 20-week horizon.

In a similar fashion to our analysis of QT announcements, we group the dependent variables of the regressions into three categories. The first one relates to the Treasury market and includes yields on 10-Year Treasury notes, 3-Month Treasury bills, their difference which is taken as a proxy for the term premium, and the MOVE index, measuring volatility in the Treasury market. The second set of dependent variables regards risky assets, thus including the S&P 500 and its volatility (VIX), as well as the spread of BAA corporate bonds on 10-Year Treasuries, the MBS yield-to-worst and the interest rate on 30-year mortgages. The last set proxies the international spillovers of QT, as it includes the Broad Dollar Index, the Global Financial Stress index and the Global Bond Return Index.

4 Effects of QT Announcements

4.1 Baseline Results

The results of our baseline specifications are displayed in Tables 3, 4 and 5. The event dummies are reported in the table according to their chronological order. Coefficient estimates for macroeconomic surprises, GDP nowcast, VIX and the 3-month OIS spread have been omitted in order to ease reading of the tables.

4.1.1 Treasury Market

Table 3 shows that the first set of tapering announcements (TAPER1) had a significant contractionary impact on the Treasury market, by raising the yield on 10-year notes by almost 7 basis points and by increasing the MOVE index by 4 points. A 6 basis points increase was also recorded in the term premium. This finding mostly relates to the "taper tantrum" episode in May 2013, when Fed communication about a possible end to QE triggered widespread tensions on financial markets. Conversely, we find virtually

[5] These IRF's can be helpful in assessing the persistence of shocks, we argue however that estimation on weekly data is dominated by short-run noise and the exclusion restriction is unlikely to hold, thus responses lack a clear causal interpretation. These are however reported in Appendix A1, A2 and A3 as a diagnostic check.

[6] The ONRRP facility, introduced in late 2013, allows non-bank money market institutions that do not have access to the Fed's Term Deposit Facility (TDF) to lend overnight their excess reserves (Afonso et al., 2022). This device ensures that the effective Federal Funds rate does not deviate significantly from its target.

no statistically significant effects across the board of subsequent announcements relating to the first QT I episode (variable QT1). We speculate that these events might have been anticipated by market participants and that they did not carry any signalling effect, since the transparent communication by the Fed actually set the path for a smooth and gradual decrease in SOMA holdings.

Regarding the pandemic QE programme, our results suggest that the emergency LSAP launched in mid-March 2023 by the Fed was associated with a strong negative information effect. Its effects are those characteristic of a flight to quality, with a rebalancing towards risk-free assets: this causes a fall in 3-month Government bond yields by 5 basis points, a 35 basis points compression of the bid-ask spread, a 13-point decrease in Treasury bond volatility and an increase in liquidity of these assets by 0.3 points. Moreover, the results show no significant effects on the Treasury market of announcements relating to the tapering of the pandemic QE (variable TAPER2). The opposite pattern of findings seems to hold for the second tightening episode: there is instead some effect associated to the post-pandemic tightening announcements (QT2), which are showed to increase the yields on 10-year and 3-month Treasuries by 5 basis points and 2 basis points, respectively. Other Treasury market variables seem to be not impacted by QT II.

Federal Funds shocks (FF SHOCKS) have a standard textbook contractionary impact in size and magnitude on the Treasury market. Estimates are however not significant at the 10% level due to the sizeable standard errors. We also show that Treasury borrowing announcement shocks (TR SHOCKS) strongly raise Government bond volatility (MOVE) by 13 points and widen the bid-ask spread by 41 basis points, thus suggesting that in the sample period the additional Treasury supply by the Government has also impacted significantly the market. Moreover, our finding that borrowing shocks decrease the term premium can be explained by a shift in the maturity structure of securities issued by the Treasury. Finally, we notice how the mid-March 2020 COVID panic brought a strong flight to quality across the board, with a strong decrease in Treasury yields. Similarly, the 2023 banking crisis episodes were also associated with a relative rebalancing towards safer assets, although smaller in magnitude than the March 2020 rout. By contrast, the May 2023 debt ceiling stand-off also brought about an effect on short and long-run Treasury yields by approximately 4 basis points, but failed to have further effects on the Treasury market markets.

4.1.2 Stock Market, Exchange Rate & Commodities

In Table 4, the first Tapering announcements also caused a significant 0.4% appreciation of the Dollar and a 1.4% fall in the spot gold price, thus showing that the "taper tantrum" had an effect also outside of the Treasury market. On the other hand, the results show no significant effects on the stock market of announcements relating to the tapering of the pandemic QE, as well as announcements in both QT episodes had no impact on the stock market and on other assets.

Regarding the pandemic QE programme, our results suggest that the emergency LSAP launched in mid-March 2023 by the Fed was associated with a strong negative information effect. Its effects are those characteristic of a flight to quality: a sudden increase in investor risk aversion triggers a sell-off of risky assets (2% decrease in the S&P500 stock market index, 6.3% decrease in the S&P Banks index and 5.3% decrease in the Regional Banks index). While investors rebalance off stocks, thus making their price fall, an increased demand for safe USD-denominated assets and gold makes their price soar by 0.5% and 2%, respectively. The 5% decrease in the spot Brent price is also symptomatic of an expected global economic slowdown. It is worth stressing that these effect already take care of the idiosyncratic COVID panic happening in mid-March 2020, as well as of macroeconomic surprises and pre-existing market distress. Hence, the strong negative information effect has to be ascribed specifically to QE announcements.

As Fed Funds and Treasury borrowing shocks are concerned, contractionary effects on the stock market are expected, although large standard error do not allow to recover a statistically significant impact. The

	10Y Tr.	3M Tr.	10Y-3M Tr.	MOVE	10Y Bid-Ask	Tr. Liquidity
TAPER1	0.067**	0.005	0.062**	4.188*	-0.003	0.039
	(0.029)	(0.014)	(0.029)	(2.296)	(0.068)	(0.040)
QT1	-0.002	0.006	-0.008	-0.296	0.020	-0.059*
	(0.024)	(0.012)	(0.024)	(1.882)	(0.055)	(0.033)
QE	-0.036	-0.048***	0.012	-12.933***	-0.349***	-0.299***
	(0.036)	(0.018)	(0.036)	(2.863)	(0.084)	(0.050)
TAPER2	0.023	0.006	0.017	-5.256	-0.117	-0.037
	(0.041)	(0.020)	(0.041)	(3.243)	(0.095)	(0.057)
QT2	0.047**	0.020*	0.027	0.002	0.020	0.020
	(0.023)	(0.011)	(0.023)	(1.795)	(0.053)	(0.032)
FF SHOCKS	0.145	0.127	0.018	-1.032	0.231	0.383
	(0.191)	(0.094)	(0.192)	(15.153)	(0.468)	(0.267)
TR SHOCKS	-0.158*	0.018	-0.176*	13.970*	0.412*	-0.066
	(0.092)	(0.046)	(0.093)	(7.382)	(0.232)	(0.130)
SVB	-0.120***	-0.040***	-0.080***	13.762***	0.027	0.092***
	(0.023)	(0.011)	(0.023)	(1.798)	(0.053)	(0.032)
COVID	-0.171***	-0.277***	0.106***	14.502***	-0.147**	0.216***
	(0.025)	(0.013)	(0.026)	(2.012)	(0.059)	(0.035)
CEIL	0.038**	0.041***	-0.003	-0.564	-0.017	-0.028
	(0.016)	(0.008)	(0.016)	(1.251)	(0.039)	(0.022)
Constant	-0.000	0.008***	-0.009*	1.920***	-0.007	0.026***
	(0.005)	(0.002)	(0.005)	(0.393)	(0.012)	(0.007)
N	2486	2486	2486	2419	2153	2533
adj. R^2	0.032	0.290	0.034	0.076	0.009	0.040

Table 3. Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	S&P 500	Banks	Reg. Banks	Dollar	Gold	Brent
TAPER1	-0.004	-0.002	0.002	0.004**	-0.014**	-0.010
	(0.006)	(0.010)	(0.009)	(0.002)	(0.005)	(0.020)
QT1	-0.002	0.002	0.002	-0.000	-0.006	-0.009
	(0.005)	(0.008)	(0.007)	(0.002)	(0.004)	(0.016)
QE	-0.020***	-0.063***	-0.053***	0.005**	0.020***	-0.051**
	(0.007)	(0.013)	(0.011)	(0.002)	(0.007)	(0.025)
TAPER2	0.012	0.022	0.019	-0.002	-0.001	0.003
	(0.008)	(0.014)	(0.013)	(0.003)	(0.008)	(0.028)
QT2	-0.001	0.005	-0.001	0.001	-0.002	0.018
	(0.005)	(0.008)	(0.007)	(0.001)	(0.004)	(0.016)
FF SHOCKS	-0.017	-0.006	-0.031	0.012	-0.004	-0.111
	(0.039)	(0.068)	(0.060)	(0.012)	(0.035)	(0.133)
TR SHOCKS	-0.026	-0.046	-0.044	0.011*	0.027	-0.048
	(0.019)	(0.033)	(0.029)	(0.006)	(0.017)	(0.063)
SVB	-0.008*	-0.102***	-0.045***	0.001	0.014***	-0.047***
	(0.005)	(0.008)	(0.007)	(0.001)	(0.004)	(0.018)
COVID	-0.023***	-0.074***	-0.067***	0.000	0.002	-0.104***
	(0.005)	(0.009)	(0.008)	(0.002)	(0.005)	(0.018)
CEIL	0.000	0.005	0.001	0.000	-0.003	-0.001
	(0.003)	(0.006)	(0.005)	(0.001)	(0.003)	(0.011)
Constant	-0.000	0.001	0.001	0.000	-0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.000)	(0.001)	(0.003)
N	2521	2515	2517	2459	2694	2575
adj. R^2	0.010	0.089	0.047	0.002	0.009	0.016

Table 4. Other assets: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	BAA-10Y	VIX	OIS	Global Bond	MBS	Global Stress
TAPER1	-0.012	0.105	-0.009	-2.389**	0.072**	0.179
	(0.018)	(0.943)	(0.017)	(0.929)	(0.032)	(0.135)
QT1	-0.010	0.007	-0.004	-0.290	0.007	-0.017
	(0.014)	(0.773)	(0.014)	(0.761)	(0.027)	(0.111)
QE	0.027	7.445***	0.023	0.205	-0.342***	0.459***
	(0.022)	(1.177)	(0.022)	(1.157)	(0.040)	(0.169)
TAPER2	0.014	-2.268*	-0.013	-0.306	0.022	-0.294
	(0.025)	(1.333)	(0.025)	(1.312)	(0.046)	(0.191)
QT2	-0.019	0.414	0.026*	-1.531**	0.045*	0.018
	(0.014)	(0.738)	(0.014)	(0.726)	(0.025)	(0.106)
FF SHOCKS	0.351***	4.961	-0.201*	-8.620	-0.017	1.748*
	(0.116)	(6.228)	(0.115)	(6.132)	(0.214)	(0.892)
TR SHOCKS	0.028	0.214	-0.042	-0.039	-0.105	0.324
	(0.056)	(2.997)	(0.056)	(2.909)	(0.103)	(0.429)
SVB	0.104***	1.516**	-0.006	2.706***	-0.116***	0.534***
	(0.014)	(0.738)	(0.014)	(0.727)	(0.025)	(0.106)
COVID	0.169***	5.354***	0.002	4.554***	-0.123***	1.466***
	(0.015)	(0.827)	(0.015)	(0.814)	(0.028)	(0.118)
CEIL	-0.006	-0.042	-0.012	-1.004**	0.035**	-0.029
	(0.010)	(0.491)	(0.010)	(0.483)	(0.018)	(0.070)
Constant	-0.015***	1.054***	0.006*	0.282*	0.006	0.088***
	(0.003)	(0.157)	(0.003)	(0.149)	(0.005)	(0.023)
N	2478	2542	2486	2693	2491	2541
adj. R^2	0.083	0.054	0.095	0.021	0.044	0.072

Table 5. Spreads & premia: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

only marginally significant effect regards a 1% appreciation of the Dollar to Treasury supply shocks, likely caused by an inflow of fund into these assets. In addition, we notice how the mid-March 2020 COVID panic brought a collapse in stock and oil prices, likely to be related to worsening of the macroeconomic outlook. A similar effect, although smaller in magnitude, was associated with the March 2023 banking crisis. Finally, we notice that US debt ceiling negotiations had no influence on stock markets, exchange rates and commodities.

4.1.3 Spreads & Premia

In Table 5, the tapering of QT1 had a significant adverse impact on global bond returns and MBS spreads, thus showing how the adverse reaction by the markets to the unexpected tapering intentions by the Fed was not confined to the Treasury market. Apparently, rising concerns about credit risk also caused investors to pull funds out of international bond and MBS holdings, thus pushing up their yields. After this temporary inconvenience, however, subsequent announcements regarding the first balance sheet unwinding episode registered no relevant movements in risk premia and spreads. In addition, the negative information effect of the pandemic QE programme, already evident from the previous tables, can also be noticed in the increase in stock volatility (VIX) by 7.5 points and global financial stress by 0.5 points. On the other hand, the MBS yield to worst decreased by 34 basis points during the LSAP announcements, possibly reflecting expectations of the Fed's intervention. Regarding the tapering of the pandemic LSAP and the subsequent balance sheet unwinding, evidence is somehow mixed. The only marginally significant effect of the TAPER2 variable regards a 2.3-point decrease in the VIX, which does not carry a direct interpretation. QT2 records instead a moderate contractionary impact on MBS spreads, rising by 4.5 basis points, and the Global Bond Return Index, declining by 1.6 points.

A significant effect of conventional monetary policy shock is instead found on the corporate BAA spread, which widens by 35 basis points, the OIS spread decreasing by 20 basis points and a 1.75-point increase in the global financial stress index. This result is consistent with the literature on the international spillovers of US monetary policy (Georgiadis, 2016). Also in the case of Treasury shocks, large standard error do not allow to recover a statistically significant effect in Table 5. In fact, similarly to Phillot (2021), we also find a widening of corporate BAA spreads, although not significant at the 10% level. Finally, we notice how the mid-March 2020 COVID panic brought a widening in BAA corporate spreads, increase in stock volatility and global financial stress. Similarly, the 2023 banking crisis episodes were also associated with a relative rebalancing off riskier assets, although smaller in magnitude than the March 2020 rout. By contrast, the May 2023 Treasury debt ceiling stand-off failed to have further effects on financial markets other than the Treasury market.

Taking stock of this first set of result, we may summarise them into the following key points. Firstly, we confirm the existence of a significant contractionary effect of the first tapering episode, mostly associated with the "taper tantrum" of June 2013. Secondly, the first QT experience had no impacts on financial markets, while the second QT marginally raised the 10-year Government bond yields by 5 basis points. Thirdly, the pandemic QE was associated with a significant negative information effect, which increased agents' risk aversion and thus prompted a portfolio rebalancing toward risk-free assets, making their yields fall. Fourthly, conventional monetary policy shocks and Treasury borrowing announcements had the textbook contractionary effects, although many of these are not significant at the 10% level because of the high standard errors. Finally, both the outbreak of the 2020 pandemic and the March 2023 banking crisis were associated with the classical flight to quality symptoms, with a fall in stock prices, a widening in risk premia and a rebalancing towards risk-free and more liquid assets. The May 2023 negotiations over the lifting of the debt ceiling instead only raised short- and long-term Treasury yields.

4.2 Robustness Checks

In order to assess the robustness of our main findings on QT announcement episodes, we perform a series of checks. First, we run the regressions by omitting the COVID, CEIL and SVB dummies and the controls for macroeconomic surprises. Second, we define QT shocks as dummies equal to one three days after the QT announcement, to account for a 'placebo effect' of QT shocks. We employ the weekly economic index developed by Lewis et al. (2022), instead of the CITIFX economic surprise index and the Atlanta Fed GDPNow. Third, we run the baseline specification displayed in Tables 3, 4 and 5 using Newey and West (1987) standard errors. Finally, we also include as additional control the overall level of outstanding Government debt securities[7] (see Figure 4). The rationale for this last control lies in the fact that the Government debt rose considerably after the pandemic. As a consequence, QT announcements taking place with different stocks of Government debt securities outstanding can be expected to have different effects. The results of the robustness checks are reported in Appendix A4. Overall, the underlying pattern of findings displayed in this section does not change when the robustness checks are implemented. Moreover, we find no evidence of placebo effect when the new set of treatment dummies is employed.

4.3 Granular Effects of QT Announcements

We now delve deeper into the granularity of different BSP announcements. We assess the individual effect of every single announcement episode by the Fed, by regressing the change in asset prices and yields on a dummy for every different announcement that took place over the sample. We also include the same control variables that we employed in the baseline specification. This new set of results is shown in Tables 6, 7 and 8, where each communication event is reported along with its date and the nature of the communication itself. Fed chair speeches where balance sheet policy is mentioned along with conventional monetary tightening are marked as "Tightening/General".

4.3.1 Treasury Market

The results concerning the Treasury market are reported in Table 6. The first element that emerges from this new regression is the stark effect of the "taper tantrum" event on June 19th 2013, when remarks by Fed Chair Ben Bernanke about a tapering of QE by end-2013 caught markets by surprise, raising the yield on 10-year Treasuries by 21 basis points and the MOVE index by 16 points. Conversely, other QT I announcements did not achieve significant movements in asset prices, except for the Treasury liquidity index. In a similar way, the tapering of the last LSAP was largely anticipated by markets and therefore entailed no significant consequences on asset prices.

In QT II, we observe a substantial heterogeneity among the effects of different events. Most communications did not significantly move asset prices: the only exceptions relate to general speeches by the Fed chair, which contained a consistent discussion of the monetary policy stance in addition to mentioning balance sheet policy. In particular, the speeches by Powell on March 2nd and 21st 2022 raised the 10-year yields by 14 and 23 basis points, respectively, whereas the speeches held on June 22nd and November 30th of the same year both decreased it by 22 basis points. We claim that the signalling effect of these communications stems from the general discussion about monetary policy and not from the balance sheet policy. Other non-informative statements about QT do not achieve any significant asset price movements.

On the other hand, the only other "pure" tightening announcements that were associated with some significant effect were those occurring on April 6th, May 4th and May 25th 2022. In the first of these

[7]The total amount of Government debt outstanding can be classified into two broad categories: federal debt held by the public and intra-governmental holdings. The former stock can be further divided into SOMA holdings and debt held by the private sector. The latter quantity is the one employed as a control in this paper. The data comes from the US Treasury Debt to the Penny dataset.

Date	Event	10Y Tr.	3M Tr.	10Y-3M Tr.	MOVE	10Y Bid-Ask	Tr. Liq.
22/05/2013	Taper	0.084	0.017	0.067	9.384*	0.006	0.005
19/06/2013	Taper	0.213***	0.006	0.207***	16.192***	0.017	0.167*
18/12/2013	Taper	0.093	-0.002	0.095	0.378	-0.077	0.025
21/05/2014	Tighten	0.044	0.008	0.036	-0.836	0.068	-0.074
09/07/2014	Tighten	-0.026	-0.002	-0.024	1.527	-0.071	-0.051
15/07/2014	Tighten	-0.001	-0.003	0.002	-0.850	0.048	0.166*
20/08/2014	Tighten	0.014	-0.002	0.016	-0.845	-0.025	-0.115
17/09/2014	Tighten	0.033	0.008	0.025	-4.028	0.144	0.068
29/10/2014	Tighten	0.023	-0.003	0.026	-3.977	0.111	0.026
12/01/2017	Tighten	0.020	0.017	0.004	2.022	-0.163	0.008
05/04/2017	Tighten	-0.017	0.009	-0.026	4.472	0.146	-0.260***
24/05/2017	Tighten	-0.036	0.027	-0.063	-0.616	-0.007	0.000
14/06/2017	Tighten	-0.046	0.027	-0.073	0.812	0.133	-0.087
20/09/2017	Tighten	0.034	0.008	0.026	-0.722	0.040	-0.269***
19/12/2018	Tighten	-0.029	0.003	-0.032	0.977	-0.180	0.103
11/10/2019	Ease	0.085	-0.019	0.104	-0.946	0.291*	-0.069
16/03/2020	Ease	0.049	-0.142***	0.191**	-27.039***	-0.561***	-0.545***
23/03/2020	Ease	-0.103	-0.078**	-0.025	-20.339***	-0.994***	-0.685***
10/06/2020	Ease	-0.180**	-0.015	-0.165**	-4.742	-0.183	0.062
22/09/2021	Taper	0.080	0.001	0.079	-0.748	-0.212	0.053
03/11/2021	Taper	-0.016	-0.006	-0.010	-6.295	-0.071	-0.082
15/12/2021	Taper	0.001	0.006	-0.004	-8.471	-0.066	-0.084
26/01/2022	Tighten	0.029	0.010	0.019	2.949	-0.061	0.077
16/02/2022	Tighten	-0.080	-0.039	-0.042	3.994	0.034	0.019
02/03/2022	Tighten/General	0.139**	0.062*	0.077	-1.133	0.047	0.048
21/03/2022	Tighten/General	0.229***	0.071*	0.158**	13.037**	-0.003	0.005
06/04/2022	Tighten	0.122*	0.037	0.085	7.624	-0.081	-0.006
04/05/2022	Tighten	0.088	-0.061*	0.149**	-2.630	0.396**	0.094
25/05/2022	Tighten	-0.010	0.011	-0.021	-6.837	0.082	-0.036
22/06/2022	Tighten/General	-0.221***	-0.052	-0.169**	-10.993*	-0.389**	0.200**
26/08/2022	Tighten/General	0.084	0.068	0.016	3.346	0.115	-0.004
30/11/2022	Tighten/General	-0.219***	-0.046	-0.173**	-9.958*	-0.037	0.009
07/03/2022	Tighten/General	0.122	0.190***	-0.068	-12.550**	-0.352**	-0.023
21/06/2023	Tighten/General	0.063	0.018	0.045	-5.420	-0.043	-0.063

Table 6. Treasury market: impact of all announcements relating to BSP. OLS standard errors not displayed. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Date	Event	S&P 500	Banks	Reg. Banks	Dollar	Gold	Brent
22/05/2013	Taper	-0.012	-0.014	-0.015	0.003	0.011	-0.030
19/06/2013	Taper	-0.040***	-0.014	-0.016	0.017***	-0.069***	-0.027
18/12/2013	Taper	0.015	0.019	0.025	0.005	-0.033**	0.015
21/05/2014	Tighten	0.010	0.012	0.014	0.000	-0.000	0.002
09/07/2014	Tighten	0.000	-0.005	-0.008	-0.000	0.013	-0.017
15/07/2014	Tighten	0.001	-0.004	0.009	0.002	-0.006	-0.001
20/08/2014	Tighten	0.005	0.018	0.019	0.003	-0.014	0.002
17/09/2014	Tighten	0.006	0.018	0.019	0.003	-0.008	-0.008
29/10/2014	Tighten	0.004	0.009	0.008	0.003	-0.025	-0.003
12/01/2017	Tighten	-0.001	-0.006	-0.003	-0.009	0.004	0.008
05/04/2017	Tighten	-0.002	-0.003	-0.004	0.000	-0.004	0.008
24/05/2017	Tighten	0.007	-0.005	-0.006	-0.003	0.004	-0.022
14/06/2017	Tighten	-0.004	-0.003	-0.009	0.002	-0.009	-0.033
20/09/2017	Tighten	-0.003	0.014	0.011	0.003	-0.015	0.016
19/12/2018	Tighten	-0.033**	-0.028	-0.022	-0.003	0.008	-0.047
11/10/2019	Ease	0.009	0.017	0.017	-0.004	-0.001	-0.007
16/03/2020	Ease	-0.076***	-0.122***	-0.114***	0.016***	-0.003	-0.126**
23/03/2020	Ease	0.055***	0.016	0.047**	0.004	0.078***	-0.021
10/06/2020	Ease	-0.068***	-0.162***	-0.161***	0.006	0.007	-0.048
22/09/2021	Taper	0.020	0.056**	0.053**	-0.003	-0.018	0.035
03/11/2021	Taper	0.012	0.001	-0.008	-0.000	0.000	-0.039
15/12/2021	Taper	0.006	0.011	0.013	-0.004	0.016	0.015
26/01/2022	Tighten	-0.009	-0.012	-0.006	0.007	-0.029**	0.023
16/02/2022	Tighten	-0.022	-0.031	-0.032	-0.002	0.023	-0.029
02/03/2022	Tighten/General	0.011	0.039	0.017	0.001	-0.005	0.052
21/03/2022	Tighten/General	0.009	0.018	0.020	-0.001	0.001	0.062
06/04/2022	Tighten	-0.006	-0.026	-0.020	0.006	0.004	-0.081
04/05/2022	Tighten	-0.007	-0.003	0.008	0.002	0.002	0.066
25/05/2022	Tighten	0.027*	0.050**	0.034	0.001	-0.009	0.030
22/06/2022	Tighten/General	0.006	-0.014	-0.021	0.001	-0.006	-0.026
26/08/2022	Tighten/General	-0.042***	-0.048*	-0.041*	0.003	-0.012	-0.010
30/11/2022	Tighten/General	0.028**	0.007	-0.003	-0.013***	0.030**	0.056
07/03/2022	Tighten/General	-0.008	0.047*	-0.002	0.007	-0.036***	0.002
21/06/2023	Tighten/General	-0.002	-0.034	-0.026	-0.001	-0.012	-0.014

Table 7. Other assets: impact of all announcements relating to BSP. OLS standard errors not displayed. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Date	Event	BAA-10Y	VIX	OIS	Global Bond	MBS	Global Stress
22/05/2013	Taper	-0.037	0.537	-0.013	-0.129	0.104	0.673**
19/06/2013	Taper	0.011	3.938*	-0.006	-9.162***	0.243***	0.825**
18/12/2013	Taper	-0.078*	-2.168	-0.012	-2.696	0.074	-0.421
21/05/2014	Tighten	0.024	-1.181	-0.019	-1.199	0.015	-0.191
09/07/2014	Tighten	0.024	0.326	-0.006	-0.229	-0.015	0.153
15/07/2014	Tighten	-0.015	-0.852	0.012	-0.962	0.022	0.030
20/08/2014	Tighten	-0.046	-0.695	-0.006	-1.414	-0.005	-0.055
17/09/2014	Tighten	-0.017	-0.917	-0.010	-1.514	0.024	-0.212
29/10/2014	Tighten	-0.039	0.079	0.006	-2.471	0.014	-0.117
12/01/2017	Tighten	0.016	-0.267	-0.021	2.963	0.030	-0.201
05/04/2017	Tighten	0.014	0.247	-0.012	-0.423	0.005	0.088
24/05/2017	Tighten	0.025	-0.991	0.001	-0.277	-0.025	-0.091
14/06/2017	Tighten	-0.026	0.286	-0.014	0.121	-0.005	0.096
20/09/2017	Tighten	-0.035	-0.838	0.005	-1.982	0.045	-0.076
19/12/2018	Tighten	0.016	3.331	0.012	1.830	0.001	0.461
11/10/2019	Ease	-0.048	-3.043	0.019	-0.704	0.044	-0.344
16/03/2020	Ease	0.130***	21.500***	0.092**	-5.958**	-0.355***	1.964***
23/03/2020	Ease	-0.073*	-1.388	0.008	4.583**	-0.906***	-1.135***
10/06/2020	Ease	0.105**	13.628***	0.004	2.951	-0.189**	1.389***
22/09/2021	Taper	-0.025	-5.067**	-0.021	-1.607	0.081	-0.448
03/11/2021	Taper	0.020	-0.528	-0.003	0.419	-0.009	-0.179
15/12/2021	Taper	0.049	-1.159	-0.004	0.326	-0.007	-0.261
26/01/2022	Tighten	-0.058	0.209	0.002	-3.987*	0.060	0.043
16/02/2022	Tighten	0.123***	3.147	0.043	2.561	-0.040	0.254
02/03/2022	Tighten/General	-0.018	-2.096	0.030	-4.512**	0.130	0.012
21/03/2022	Tighten/General	-0.093**	-0.794	-0.043	-5.224**	0.177**	-0.096
06/04/2022	Tighten	0.010	0.532	0.022	-3.253	0.083	0.423
04/05/2022	Tighten	0.040	2.869	0.102**	-1.771	0.036	0.177
25/05/2022	Tighten	-0.097**	-1.161	0.052	-0.215	-0.060	-0.238
22/06/2022	Tighten/General	0.061	-0.088	-0.047	5.947***	-0.181**	0.235
26/08/2022	Tighten/General	-0.021	4.738*	-0.066	-2.672	0.102	0.408
30/11/2022	Tighten/General	0.027	-1.729	0.066	7.600***	-0.238***	-0.260
07/03/2022	Tighten/General	-0.113**	-0.950	0.033	-5.423**	0.211**	-0.477
21/06/2023	Tighten/General	-0.007	-1.158	-0.080*	-1.644	0.084	-0.051

Table 8. Spreads & premia: impact of all announcements relating to BSP. OLS standard errors not displayed. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

dates, the FOMC agreed on monthly caps of about $60 billion for Treasury securities and about $35 billion for MBS. This statement was associated with a 12 basis points increase in 10-year yields. The second date, entailing the release of the QT schedule, caused a decrease of 3-month yields by 6 basis points, and a significant increase in the term premium by 15 basis points. This result provides a first corroboration of the evidence provided in previous research on QT, showing that the release of quantitative information over future balance sheet dynamics is quickly priced in financial markets, thus causing movements in the yield curve.

4.3.2 Stock Market, Exchange Rate & Commodities

In Table 7 we see that the first tapering communication event in June 2013 generated high volatility across asset classes, by appreciating the Dollar, causing the gold price and the stock market to fall by 7% and 4%, respectively. On the other hand, similarly to the results reported earlier in this section, the first QT experience and the tapering of the 2020 LSAP did not register significant financial market movements.

By contrast, looking at the granularity of the announcements relative to the pandemic QE we notice a strong heterogeneity among the effects. In fact, while the inauguration of the pandemic LSAP on March 16th 2020 and its prorogation on June 10th 2020 were associated with a stock market fall (7.6% and 6.8%, respectively), the Easing announcement on March 23rd was accompanied by a stock market rally by 5.5%. Different explanations for these results are possible. For instance, unobserved financial markets expectations about the size of these programs could explain the difference in the signs of the effects. However, it is also likely that the negative information effect prevailed on the former dates, whereas positive signalling was dominant in the latter announcement.

Finally, we have a look at the events concerned with the last QT experience. We see that, coinciding with the release of FOMC minutes including the follow-up details on the QT plan, the announcement on May 25th, 2022 obtained moderately expansionary effects on the stock market (soaring by 2.7%). This positive movement is likely to be originated from the markets expecting a tighter balance sheet unwinding schedule than announced. On the other hand, other QT2 communications did not achieve relevant effects.

4.3.3 Spreads & Premia

Firstly, in accordance with the findings shown in the previous two tables, we see in Table 8 that the "taper tantrum" on June 19th, 2013 was associated with an increase in stock volatility, a widening of MBS spreads and strong international spillovers, with global bond returns falling and global financial stress rising significantly. Other relevant findings in the table relate to the QE announcements on March 16th and June 10th, 2020, dominated by the rebalancing effect off stocks and corporate bonds, already observed in Table 5. Significant "pure" QT2 events, i.e. not concerning also forward guidance on conventional monetary policy, are the communications on February 16th and May 25th, 2022, achieving a widening of 12 basis points and a compression of 10 basis points of the BAA corporate spread, respectively.

Diving into the granularity of QT communications allows us to confirm and expand on the current evidence presented in the early literature on QT announcement. Similarly to D'Amico and Seida (2024) and Du et al. (2024), we find that only informative QT announcements, i.e. those involving actual quantities have an effect on prices. Therefore, a credible and detailed communication about BSP can affect rates at various maturities also when the policy rate is off the ELB, as markets are able to internalise in prices the information released by policymakers about future balance sheet dynamics. On the other hand, we confirm that non-informative (i.e. non-quantitative) QT announcements carry no effect over future monetary policy plans, consistently with the findings by D'Amico and Seida (2024) and Du et al. (2024). While this result is not surprising in the light of the communication strategy by the Federal Reserve, it highlights how policymakers have been successful at disconnecting BSP from the monetary policy stance,

thus carrying out QT without disturbing financial markets.

5 Effects QT Operations

5.1 Effects on Interbank Market

Having ascertained that the Fed was successful in not assigning a signalling effect to its BSP communications, we move to assess the financial market impact of of the actual QT operations. As exposed in section 2, the primary goal of QT rests in decreasing the reserve supply. This is therefore the first area of interest that we assess, by estimating the effect of QT operations on the total amount of bank reserves and on the spread between the Secured Overnight Financing Rate (SOFR) and the interest rate paid on reserves (IOR) by the Fed. The difference between the two rates is an indicator of the demand pressure in the interbank market (Smith and Valcarcel, 2023). As the shift from the scarce to the ample supply of reserves paradigm occurred, saturation of the interbank market entailed a flattening of the demand curve for overnight reserves. To illustrate this stylised fact, we perfom a back-of-envelope estimation of the liquidity effect in the interbank market along the lines of Lopez-Salido and Vissing-Jorgensen (2023). We perform of a 208-observation window rolling regression of the simple model illustrated in Equation 4:

$$FF_t - IOR_t = \alpha + \beta \log(RES_t) + u_t \tag{4}$$

Where the overnight interbank funding spread, defined as difference between the effective Federal Funds rate and the interest rate paid on reserves by the Fed, is regressed on a constant and on the log of reserves outstanding. The β coefficient represents the elasticity of demand for overnight reserves. We plot our estimate for β in blue in Figure 5. This shows to have increased in absolute value while matching a decrease in the reserve supply. Historically, the estimated elasticity reached its all-time low simultaneously with the reserve supply in mid-September 2019. This event corresponded to a liquidity crisis of the interbank market, which prompted the Fed to suspend QT I (Acharya et al., 2023). As the reserve supply reached a new local minimum in March 2023, simultaneously with the banking crisis, also the estimated reserve elasticity showed an inflection, after which it soared again with the new increase in reserves caused by the Fed's liquidity intervention with the implementation of the BTFP.

Our first set of results, reported in Figure 6 is therefore concerned with the interbank market effects of the unwinding of the balance sheet. We show that a 1-trillion USD decrease in SOMA holdings of Treasuries and MBS attains an almost one-to-one decrease in the supply of reserves, which also shrink by approximately by 1 trillion after about one month. As suggested by Figure 3 and Figure 5, QT was indeed successful in decreasing the actual supply of reserves, although this result was offset by liquidity operations, Government spending and a decrease in the ONRRP balances which injected reserves in the interbank market.

Figure 6 also shows how, *ceteris paribus*, the drain on reserves brought about by QT operations does not put pressure on the interbank spread, which remains unaffected by the decrease in SOMA holdings. We interpret this result by considering a possible "kink" in the demand curve for reserves, which gives rise to two different regimes. In the first one, when the supply of reserves is abundant (i.e. in most of the sample period), marginal changes in reserves do not affect the SOFR-IOR spread. Conversely, when the reserve supply is below a certain threshold, reserve demand actually bites and changes in the reserve supply are able to influence the interbank market spread. Alternative nonlinear specifications[8] reported

[8]Either by considering percentage variations in SOMA holdings from a benchmark or by restricting the definition of QT operations to the periods of actual unwinds.

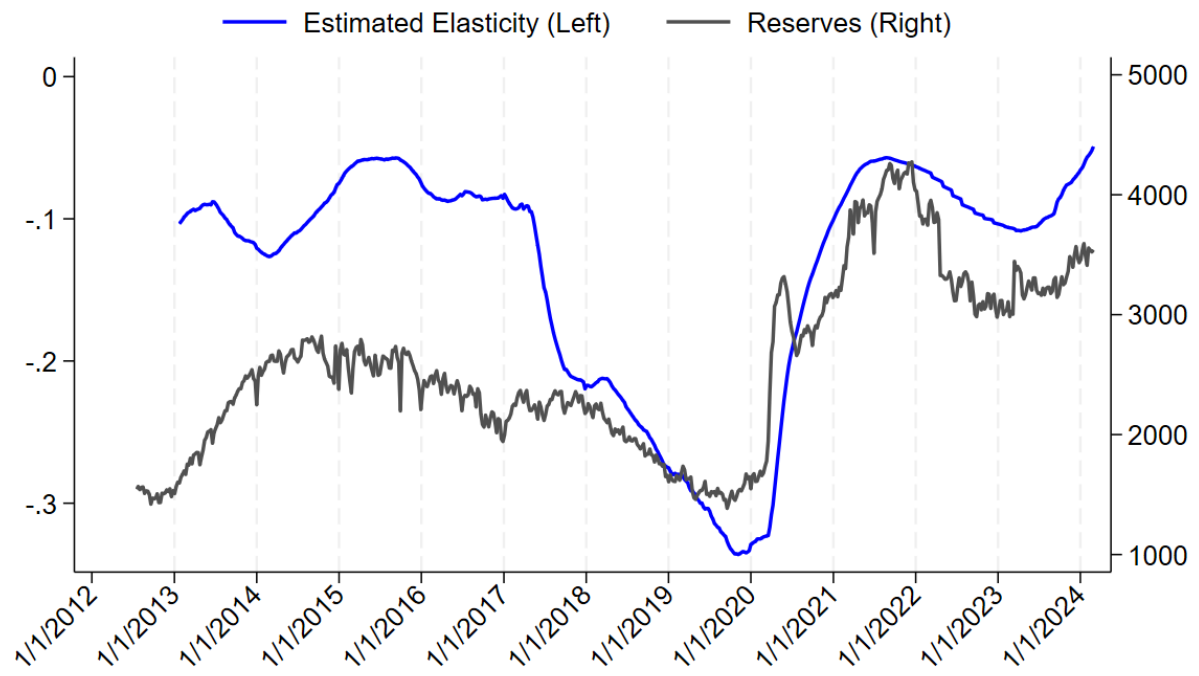

Figure 5. Estimated elasticity of demand for reserves in the interbank market and total reserves outstanding (USD billions). Sources: author's estimation and Federal Reserve Board.

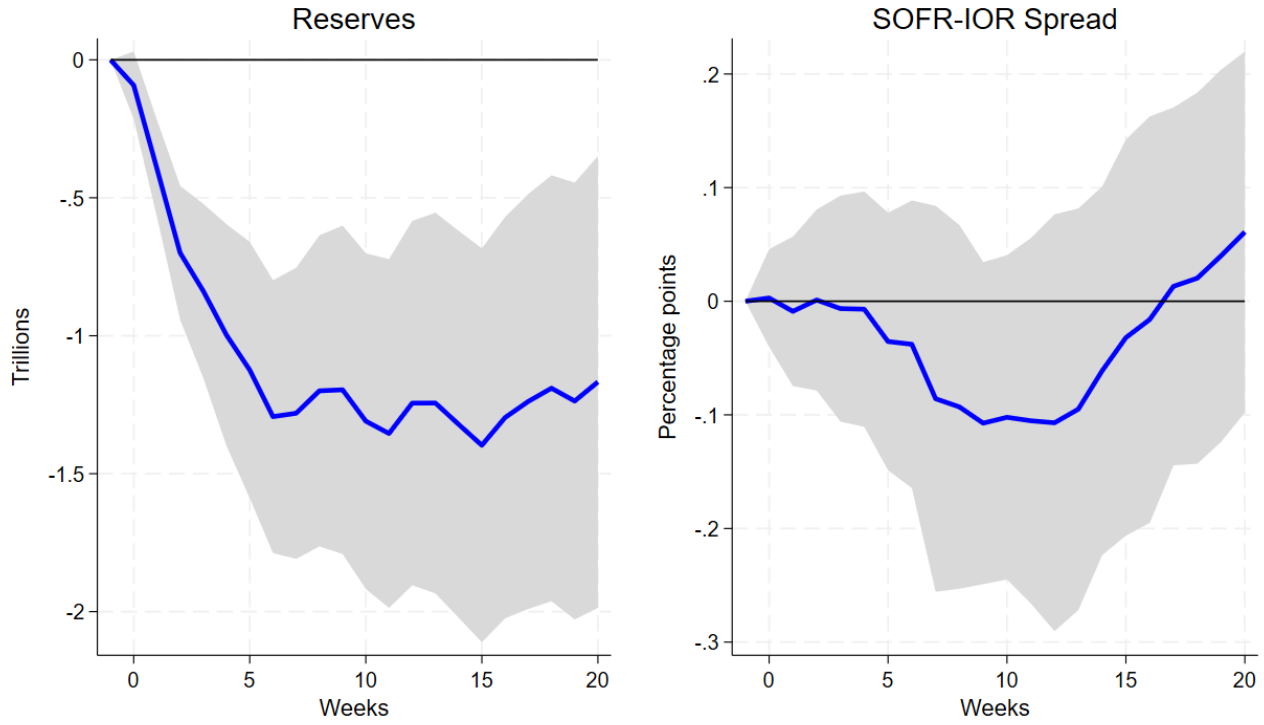

Figure 6. Money market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

in Appendix A5 seem to support this hypothesis by showing changes in SOMA holdings actually have a significant tightening effect on the interbank market.

5.2 Effects on Asset Prices

Having ascertained the normal functioning of QT on the interbank market for reserves, we move on to the analysis of how QT operations affect financial asset prices, spreads and premia. We recall that this can occur through two channels: the indirect effect caused by a decrease in the reserve supply that causes a rebalancing off other assets and the direct effect caused by decrease in the demand for Treasury securities and MBS by the Fed (Christensen and Krogstrup, 2019).

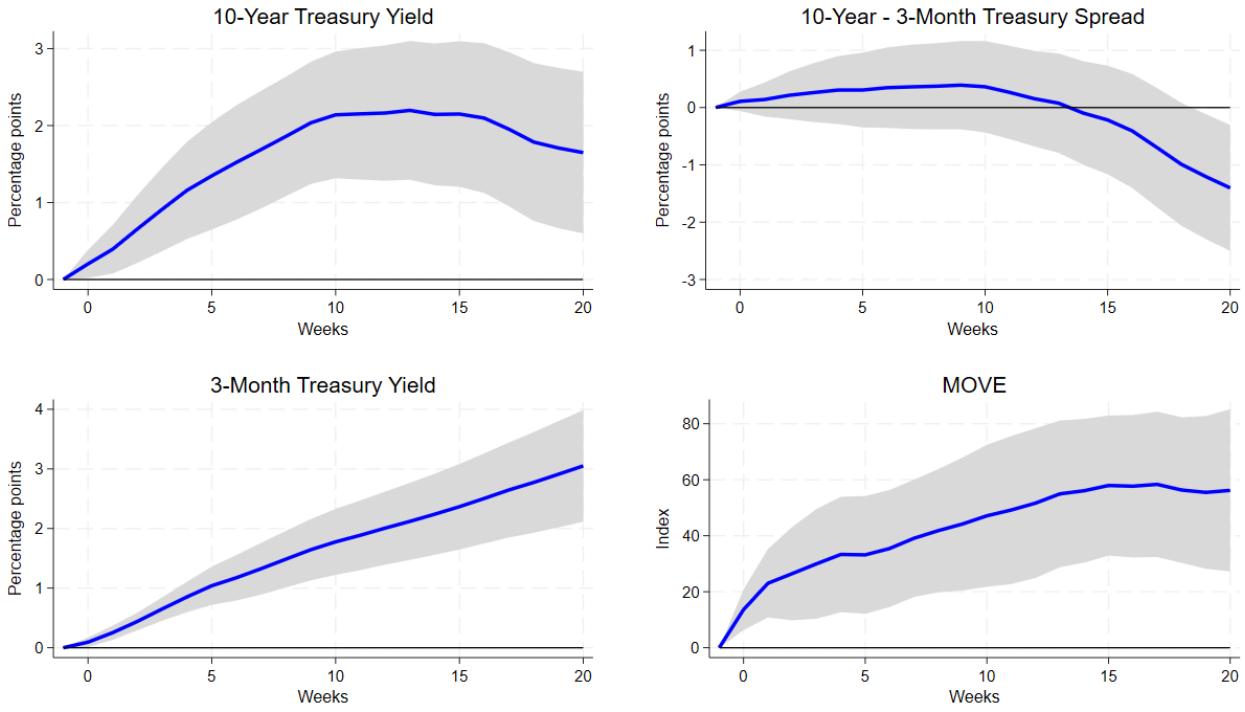

Figure 7. Treasury market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

The responses of the Treasury market to QT operations are shown in Figure 7. We find that the asset runoff of the Fed's balance sheet has a sizeable and persistent effect on both long-term interest rates. After two months, a 1 Trillion USD decrease in SOMA holdings increases the yield on 10-year Treasuries by approximately 2 percentage points. This implies that the net balance sheet operations by the Fed as of end-2023 have brought about a total increase of 2.6 percentage points in the 10-Year Government bond yield. While other factors such as monetary policy shocks, risk aversion, inflation and growth expectations may have played a larger role in raising the long-term risk-free rate, these results highlight the non-negligible role played by the Federal Reserve in the Treasury market, as also suggested by Figure 4. This hypothesis is further confirmed by the significant and permanent increase in Treasury volatility by approximately 50 points caused by the unwinding of the Fed's balance sheet after four month. Our results further show that the effect of QT operations on 3-month Treasury yields are similar in magnitude to those on 10-year Treasuries up to four months, and stronger afterwards. This implies that QT operations do not raise the term premium, but rather cause a parallel upward shift of the whole yield curve at least in the short term. This result may depend on the maturity structure of securities maturing off SOMA

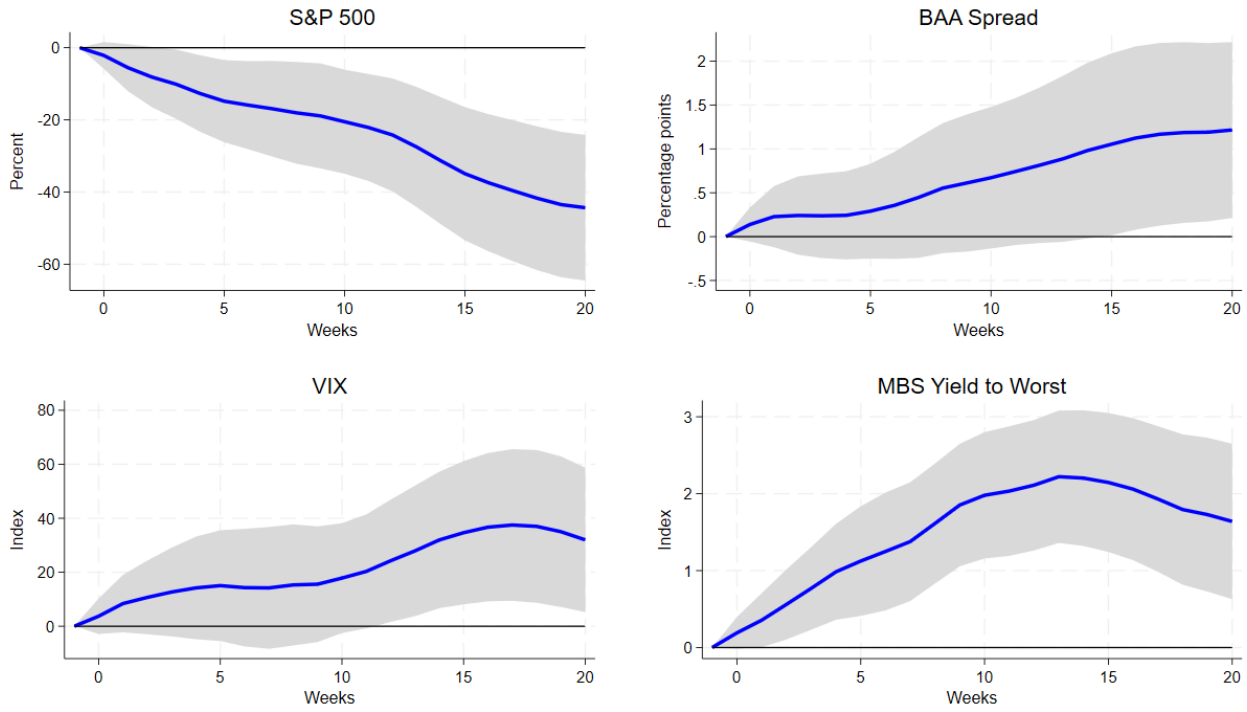

Figure 8. Stock market and corporate spreads: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

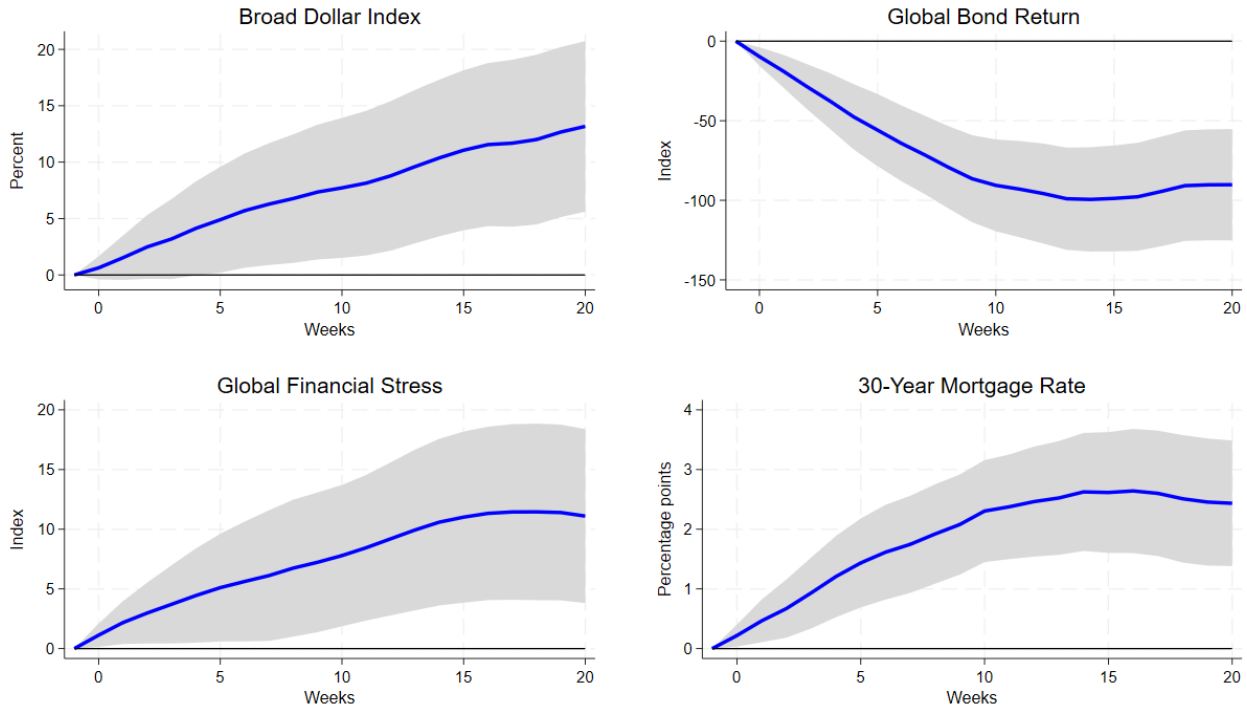

Figure 9. Other assets: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

holdings, a shift in investor maturity preferences during balance sheet unwinds or a change in the maturity structure of debt issued by the Treasury.

Figure 8 shows the effects of QT operations on selected risky assets. We uncover a significant contractionary effect on all risky assets across the board, thus highlighting how the drain on reserves is able to indirectly affect a broad class of assets. A 1-trillion decrease in SOMA holdings is found to cause an overall 20% decrease on the stock market after two months, which increases up to 40% after five months. Our estimates closely align with the 25% fall experienced by the S&P index between December 2021 and June 2022, which occurred with a simultaneous decrease by approximately 1 trillion in the balance of reserves outstanding. The depressive effects on the stock market are complemented by a moderate but persistent increase in stock volatility (VIX). QT operations are also found to permanently affect the private credit market. Shrinking the Fed's balance sheet by 1 trillion increases the spread between corporate BAA bonds and 10-year Treasuries by 1 percentage point, the MBS yield to worst by 2 percentage points and the interest rate on 30-year mortgages by 2.5 percentage points after four months (Figure 9).

Figure 9 also reports the IRF's relative to the international spillovers to QT. We find that a 1-trillion decrease in SOMA holdings is associated a 10% appreciation in the Broad Dollar Index after 5 months. The response of the Global Bond Return index is somewhat stronger and quicker, displaying a permanent 100-point reduction after 4 months. This suggests that the increase in the 10-Year U.S. Government bond yields, that can be regarded as the safe asset *par excellence* at the global level, has triggered a similar increase in the yields of non-U.S. securities, due to portfolio rebalancing. The resulting Dollar appreciation can be explained by an inflow into U.S. assets due to higher yields. We also document a 10-point increase in the global financial stress index, caused by the downward pressure that portfolio rebalancing exerts on assets worldwide.

From these findings it emerges that the unwinding actions of LSAP's in the United States has far-reaching implications for a wide class of assets. The Treasury and the MBS markets are directly impacted by the gradual withdraw of the demand for those assets by the Federal Reserve. Additionally, the decrease in reserve supply directly affects banks behaviour via portfolio rebalancing, thus depressing the stock market and tightening credit conditions for the private nonfinancial sector. From an international dimension, QT by the Fed has been associated with a strong contractionary effect on global bond yields, an appreciation of the US Dollar in effective terms and a rise in global financial stress.

5.3 Robustness Checks

As customary in the literature, to corroborate our findings we run a series of robustness checks. Firstly, We re-estimate the IRF's using the bias correction by Herbst and Johannsen (2024). Subsequently, we test for a non-linear specification by estimating IRF's of asset prices to a decrease in the logarithm of SOMA holdings. A second type of nonlinearity is investigated by defining QT operations as the percentage decrease in SOMA holdings from their maximum amounts reached in January 2018 and in January 2022 for QT I and QT II, respectively. This specification aims to ascertain that the effects of the balance sheet unwind are stable and do not depend on the level of the balance sheet itself. Overall, the results shown in this section do not change radically when the alternative specifications are implemented[9].

5.4 Decomposing Forecast Errors

As a final exercise, we estimate Forecast Error Variance Decompositions (FEVD's) of the IRF's computed in the previous subsection. The goal of this analysis is to inquire into which shocks contributed the

[9]The main differences relates to the effect on term premium and on the overall effects on asset prices that appear muted. The bias correction does not change significantly the shape of the IRF's of asset prices. Moreover, the difference between the baseline results and those obtained under the two nonlinear specifications is minimal.

most to the variance of the dependent variables. In fact, as established in the previous two sections, non-informative QT announcements carry no deflationary impact on asset prices, whereas QT operations have a robust and permanent effect on the Treasury market. These results, however, provide little insight on with how much information each shock contributes to the dependent variable. In principle, shocks that do not generate a significant response in the target variable may nevertheless explain a significant portion of its forecast errors. For this reason, we take the decompositions of forecast errors to analyse what portion of the variation of the dependent variables is explained by what shocks. To estimate FEVD's of IRF's estimated via local projections, we employ the R-squared based method developed by Gorodnichenko and Lee (2020). This approach consists a two-stage procedure. Firstly, we use the baseline LP specification in Equation 3 to compute the forecast error

$$\hat{u}_{t+h|t-1} \equiv (y_{t+h} - y_{t-1}) - \mathcal{P}[y_{t+h} - y_{t-1}|\Omega_{t-1}] \tag{5}$$

of the endogenous variable y_t at every projection horizon h. The forecast error at every projection horizon h, as defined in Equation 5 as the actual difference between the cumulative variation of the dependent variable up to lag $h+1$ and its projected value conditional on the information set at time $t-1$, i.e. $\mathcal{P}[y_{t+h} - y_{t-1}|\Omega_{t-1}]$, is subsequently regressed on all the present and past realisations ξ^j_{t+h} of a shock ξ^j_t from the matrix Ξ_t:

$$\hat{u}_{t+h|t-1} = \delta_{\xi^j,0}\xi^j_{t+h} + \delta_{\xi^j,1}\xi^j_{t+h-1} + ... + \delta_{\xi^j,h}\xi^j_t + \tilde{v}_{t+h|t-1} \tag{6}$$

where $\tilde{v}_{t+h|t-1}$ is the error term due to innovations orthogonal to the shocks Ξ_{t+h} $(h \in 0, H)$ and the info set Ω_{t-1}. Consequently, the R-squared of Equation 6 represents portion of forecast error variance explained by the shock ξ^j_t at projection horizon h. The presence of the error term $\tilde{v}_{t+h|t-1}$ implies that the sum of the portions of forecast error variance explained by every shock does not necessarily sum up to 1. Conversely, the imperfect in-sample orthogonality of the shocks implies that the sum of shares of forecast error variance explained can potentially exceed 1.

Figure 10 presents the FEVD's of four selected asset prices over the same sample where the local projections where estimated. We focus on 3-month and 10-year Treasury yields, stock market prices and the Broad Dollar Index, as these asset prices are of primary concern from the policy perspective and for which forecast error variance decompositions have an immediate interpretation.

As a first remark, it is noteworthy that the six shocks identified in this paper are only able explain about 25% of the forecast error variance of 10-Year Treasury yields, stock prices and the Dollar. These results are coherent with the notion that the three asset prices are mostly driven by long-term fundamentals, such as productivity growth, the macroeconomic outlook and expectations over the long-run real interest rate. For this reason, conventional monetary policy shocks, fiscal policy announcements and unconventional BSP announcements and operations can only explain up to one quarter of the forecast error variance for the long-run risk-free rate. On the other hand, the six monetary/fiscal/BSP shocks are able to account for about 70% the forecast error variance of 3-Month Treasury yields after three months. This result is not surprising, considering that the short-run risk-free rate depends more closely on monetary policy and money market liquidity conditions.

By looking at the individual shocks, we systematically find an asymmetry between QE and QT. Shocks related to LSAP's (both announcements and operations) in all four assets explain larger shares of forecast errors than shocks relative to QT announcements and operations. Remarkably, half of the variance of the forecast error of the 3-month yields relates to QE shocks and 20% of the error variance of stock prices relates to QE operations. Moreover, we find that QE operations typically explain larger shares of forecast errors than QE announcements.

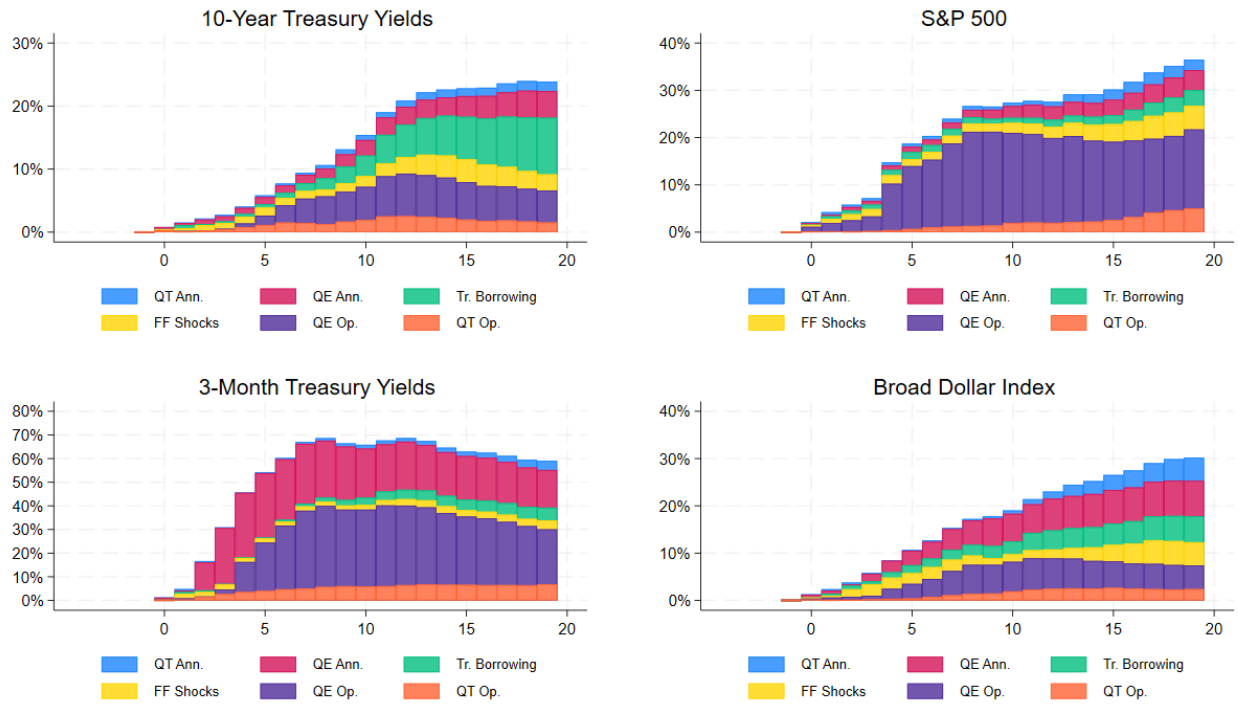

Figure 10. Forecast Error Variance Decompositions of selected dependent variables. Estimation performed using the R^2-based method by Gorodnichenko and Lee (2020). The y-axis displays the percentage of the forecast error variation of the dependent variable explained by every shock.

Federal Funds shocks play a negligible role in explaining the forecast error of the short-run interest rate. However, they have small but relevant share (approximately 2% to 5%) in 10-year yields, in the stock market and the Dollar. This finding entails a theoretical explanation: shocks in the risk-free rate that discounts expected profits can indeed be a source of asset price volatility. In the latter instance, instead, shocks in the Uncovered Interest Parity (UIP) condition are expected to be a source of variation in exchange rates. Moreover, while interest rates and the stock prices seem to be primarily driven by one or two main shocks, such as QE announcements, QE operations and Treasury borrowing, the forecast error for the Dollar index seems to be driven by the six shocks in approximately equal proportions.

Finally, if is worth mentioning that Treasury borrowing shocks play a pivotal role in the FEVD of 10-Year Government bond yields, by explaining a share of up to 10% of the forecast error towards the end of the projection. This substantiates the hypothesis that Government borrowing announcements contribute significantly to the volatility of the long-run risk-free interest rate, thus echoing the findings by Phillot (2021).

6 Conclusions

The evidence presented in this paper suggests that the Fed's communication strategy has been successful in depriving its BSP announcements of a signalling effect, given the lack of significant financial market movements associated with non-informative announcements about QT. At the same time, however, announcement events involving quantitative information over the reduction of SOMA holdings actually affect asset prices, as financial markets are able to internalise in prices the information about expected balance sheet reductions. We may therefore conclude that, among the transmission channels of QE, the portfolio balance channel also works symmetrically for the transmission of QT. This finding reinforces the evidence supplied in the earlier contributions (D'Amico and Seida, 2024; Du et al., 2024) on the effects of QT and entails a first policy implication: forward guidance on BSP can represent an effective tool to influence interest rates at different maturities, as quantitative communications on balance sheet movements work also when the policy rate is off the ELB and financial markets are not in distress. While it remains uncertain whether affecting specific segments of the yield curve can be a useful or desirable policy action to be carried out in normal times, BSP remains nevertheless as a further available instrument in the new toolbox of the monetary policymakers (Bernanke, 2020).

Moreover, the implementation of QT has strong deflationary consequences on interest rates and asset prices. QT actions bring forth this effect through two channels. Firstly, the decrease in the reinvestments of principal payments from maturing SOMA holdings implies a fall in the demand for Treasury and MBS securities, which raises their yields at all maturities. Secondly, the shrinking of SOMA holdings entails a reduction in the supply of reserves on the liability side of the Fed's balance sheet. The drain in reserves prompts a portfolio rebalancing off riskier and less liquid assets such as stocks and corporate bonds, thus making their prices fall. This mechanisms affects a broad spectrum of financial assets, both in the domestic and in the foreign market. In addition, the effect of QT on the Treasury market is particularly powerful, as it causes an upward shift of the yield curve and a persistent increase in Treasury volatility.

Although QT is conceived by policymakers as a secondary tool operating in the background, it actually has robust contractionary effects on asset prices and potentially the real economy. While these effects can likely be expected on the prior grounds of economic theory, they show that QT ends up working at least partially as a QE in reverse, despite this does not seem to be part of the policymakers' intentions. It remains therefore an open question whether the Fed will be able to shrink the supply of reserves back to the pre-pandemic level: in the light of the evidence provided in this paper, interbank reserves cannot be reduced without obtaining a parallel deflationary effect on the bond and equity markets, which can in principle constitute a threat to financial stability if carried over a long period of time. Overall, our results represent a companion to those by Acharya et al. (2023), who also show how maturity and liquidity

transformation activities by banks make reductions in the supply of reserves harder to achieve after prolonged expansions of the central bank's balance sheet. Taken at face value, the emerging evidence is suggesting that LSAP's might be overall irreversible: a sizeable expansion in the supply of reserves triggers a fundamental shift in the balance sheet composition of the banking system and permanently drives asset prices upward, and any subsequent shrinkage of reserves cannot be achieved without a commensurate negative effect on money and capital markets.

So far the unwinding of the Fed's Treasury purchases has not destabilised markets, as the drain in reserves brought about by the reduction in SOMA holdings has been offset by opposite movements in other components on the Fed's balance sheet. In fact, as shown in Figure (3), the liquidity operations starting in March 2023 with the BTFP have brought about an expansion in the Fed's assets that has temporarily counterbalanced the reduction in SOMA holdings. On the liability side, instead, a shrinkage of overnight money market lending through the ONRRP facility and a surge in Government net spending that has depleted the TGA have caused the reserve supply to increase, *ceteris paribus*. Thus, the overall reserve supply has not changed significantly, while we have rather witnessed a shift in the composition of the Fed's balance sheet.

As the balance sheet normalization is still underway, our results suggest that continuing the implementation of QT represents an increasing policy challenge. While financial markets in general are negatively affected by the asset runoff, the Treasury market in particular might be put under strain. In fact, with Government borrowing projected to increase in the medium term, the private sector capacity to absorb the Treasury supply might sooner or later result impaired. Against this backdrop, as Du et al. (2024) aptly state, QT has so far not had the effect of "paint drying", and it could potentially evolve into watching water boil.

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A1 Appendix I - Impulse Responses to QT announcements

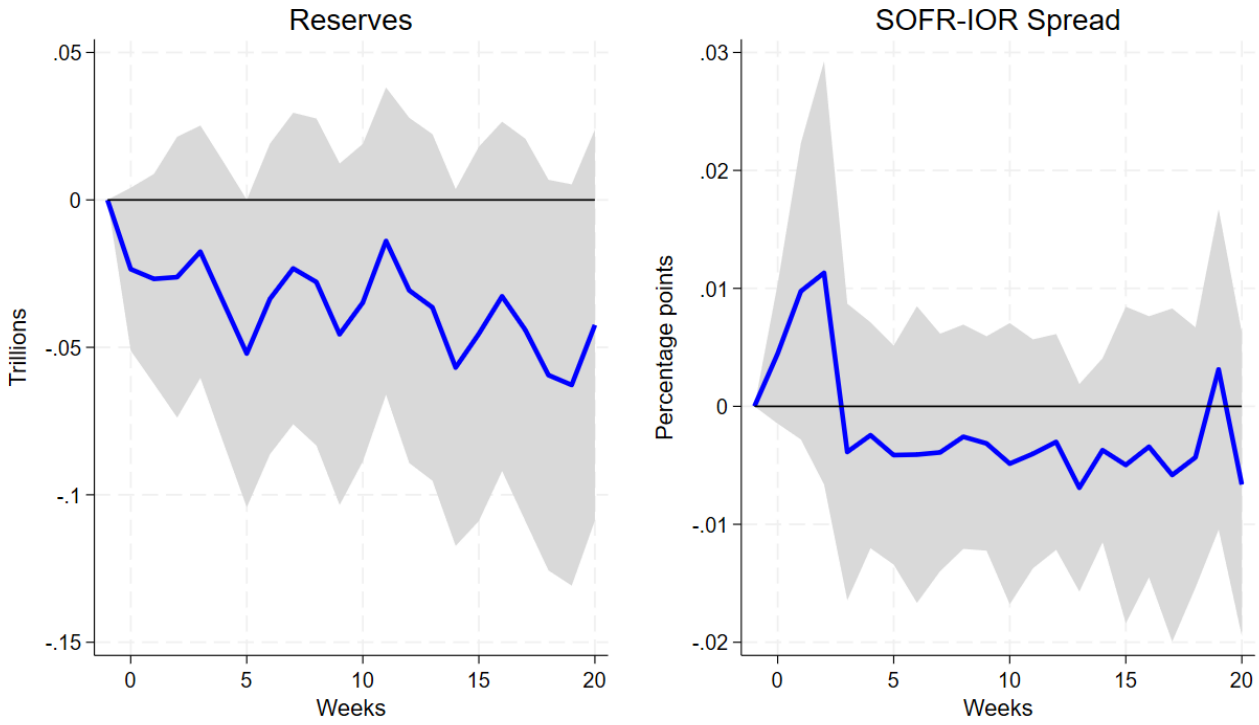

Figure 11. Money market: impulse responses to a QT announcement event. 90% Newey and West (1987) confidence bands displayed.

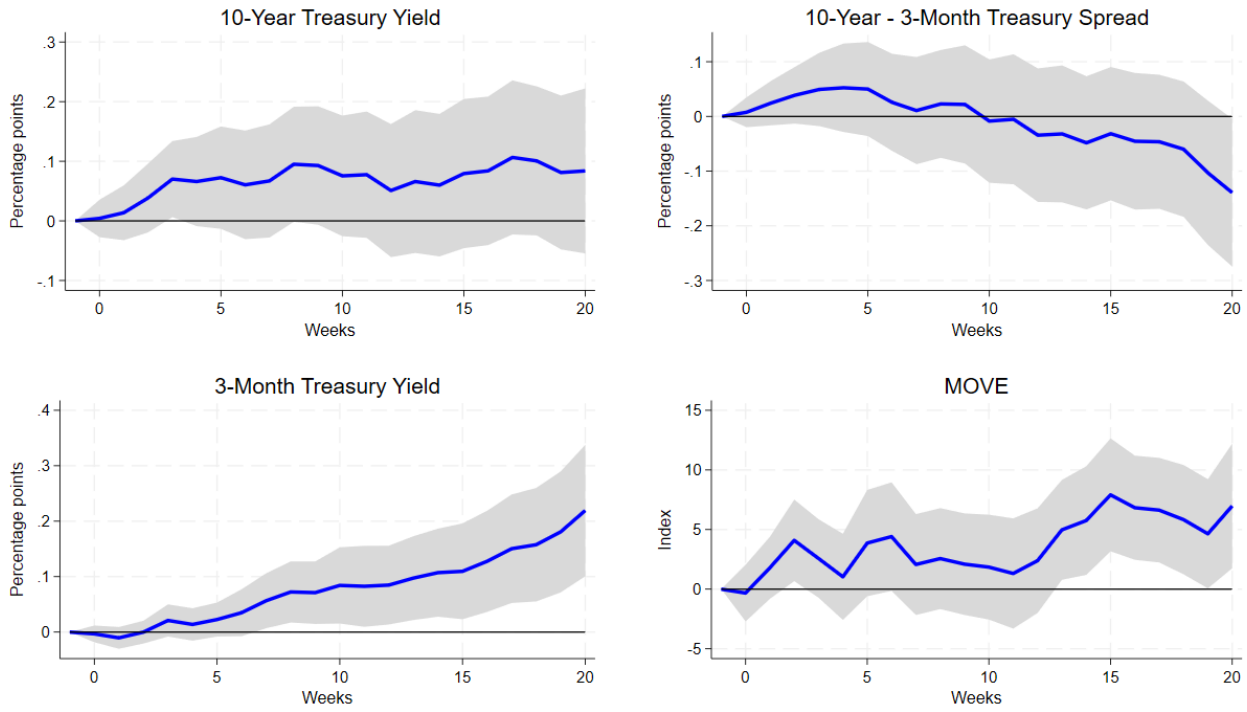

Figure 12. Treasury market: impulse responses to a QT announcement event. 90% Newey and West (1987) confidence bands displayed.

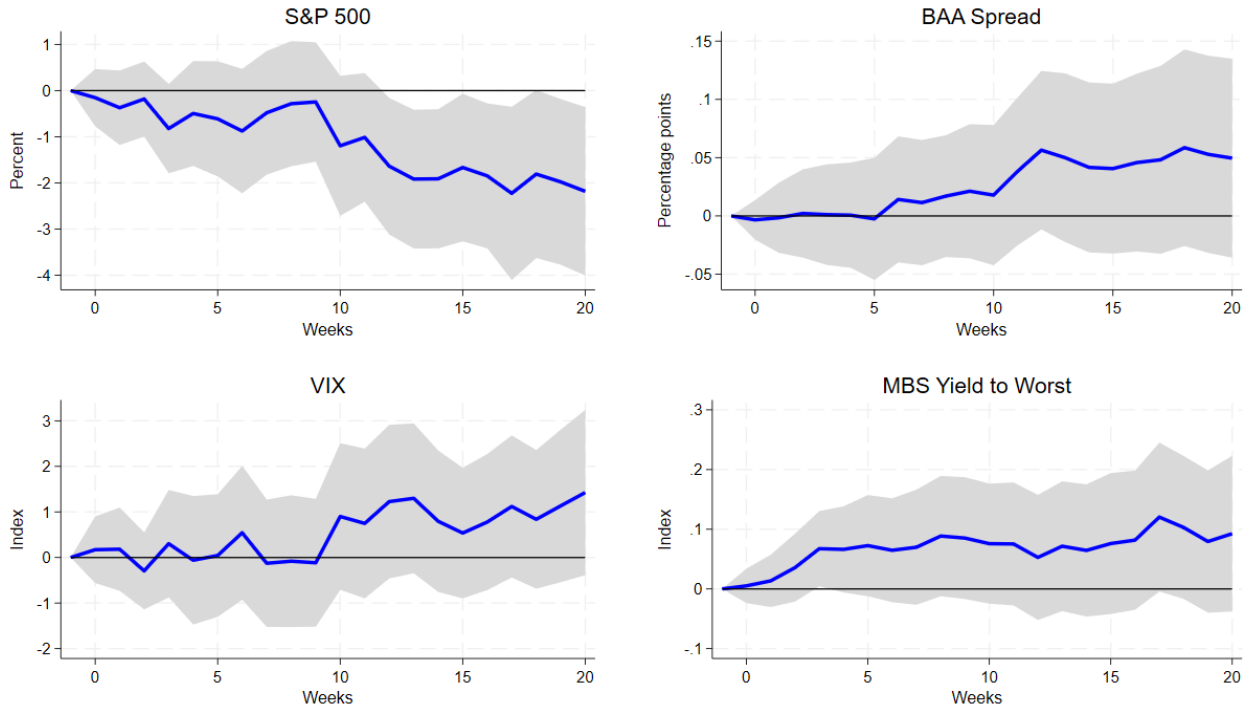

Figure 13. Other assets I: impulse responses to a QT announcement event. 90% Newey and West (1987) confidence bands displayed.

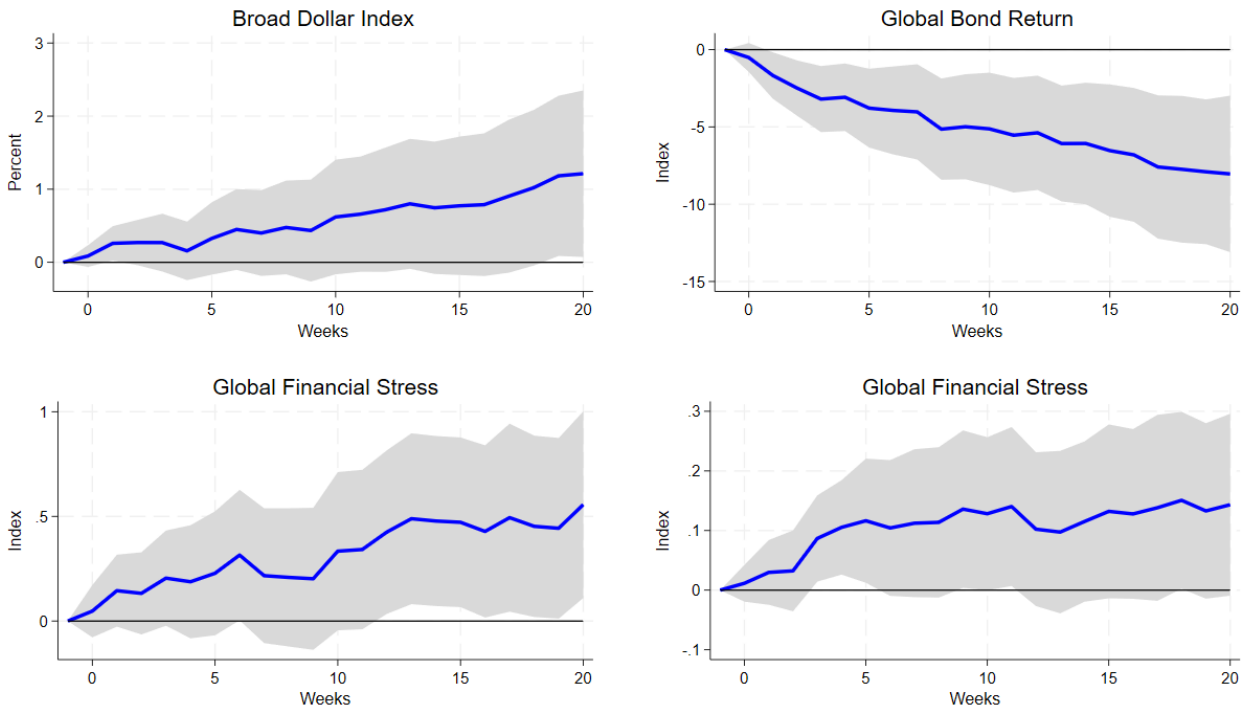

Figure 14. Other assets II: impulse responses to a QT announcement event. 90% Newey and West (1987) confidence bands displayed.

A2 Appendix II - Impulse Responses to Federal Funds Shocks

Figure 15. Money market: impulse responses to a Federal Funds shock. 90% Newey and West (1987) confidence bands displayed.

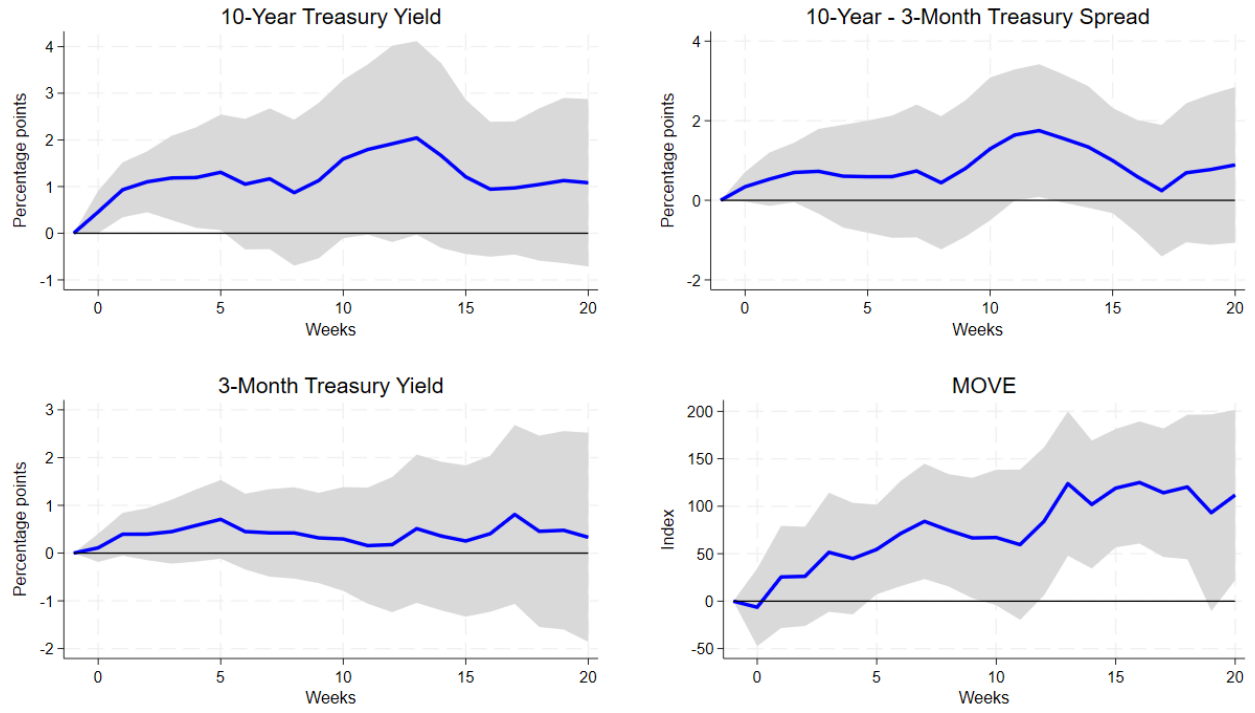

Figure 16. Treasury market: impulse responses to a Federal Funds shock. 90% Newey and West (1987) confidence bands displayed.

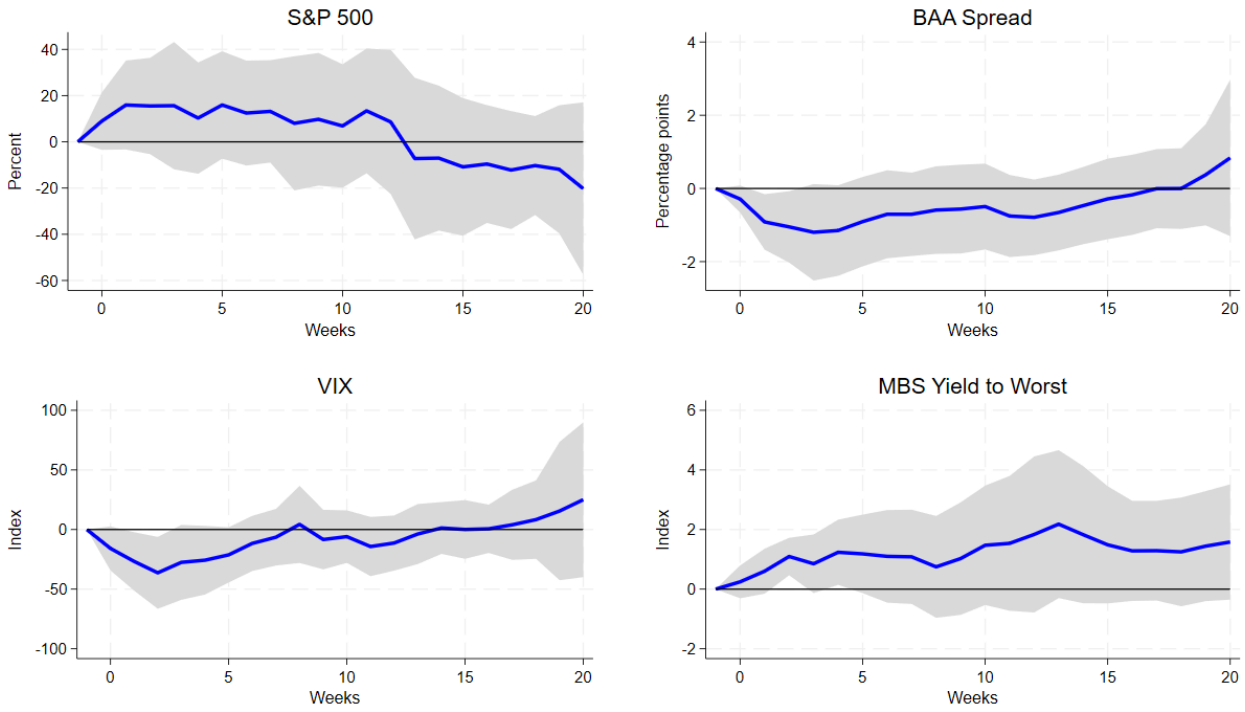

Figure 17. Other assets I: impulse responses to a Federal Funds shock. 90% Newey and West (1987) confidence bands displayed.

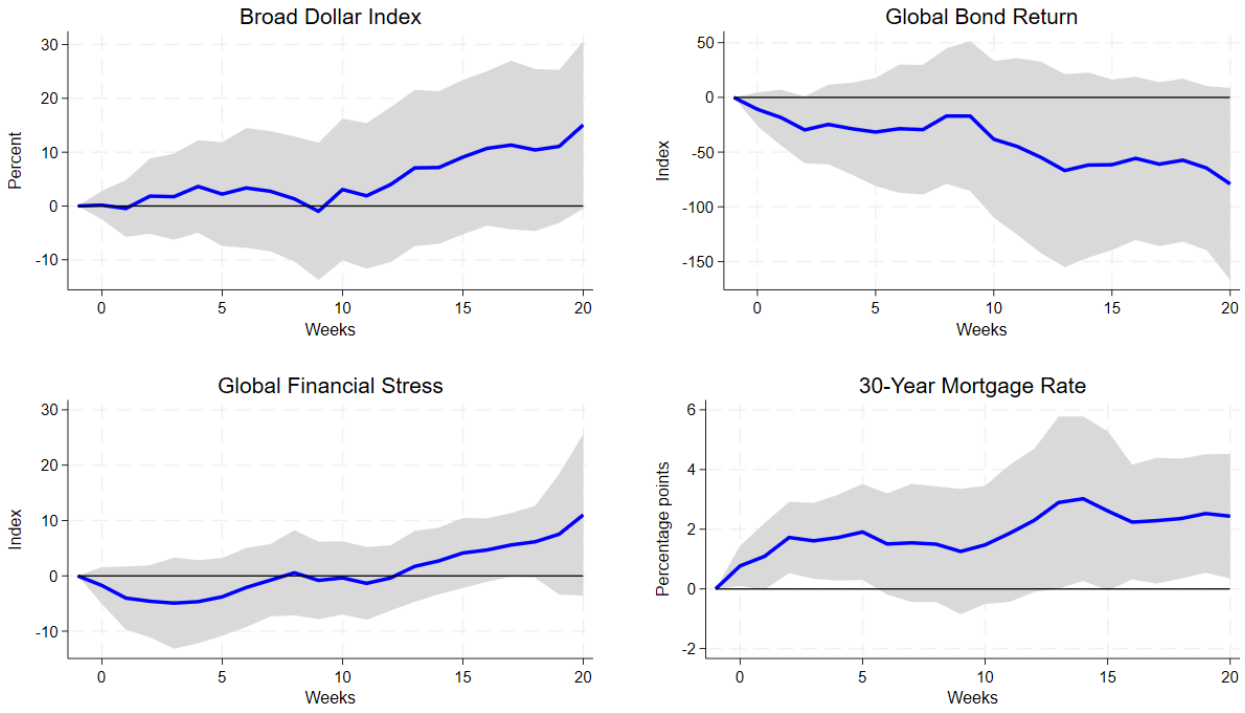

Figure 18. Other assets II: impulse responses to a Federal Funds shock. 90% Newey and West (1987) confidence bands displayed.

A3 Appendix III - Impulse Responses to Treasury borrowing shocks

Figure 19. Money market: impulse responses to a 1-billion USD increase in Government borrowing. 90% Newey and West (1987) confidence bands displayed.

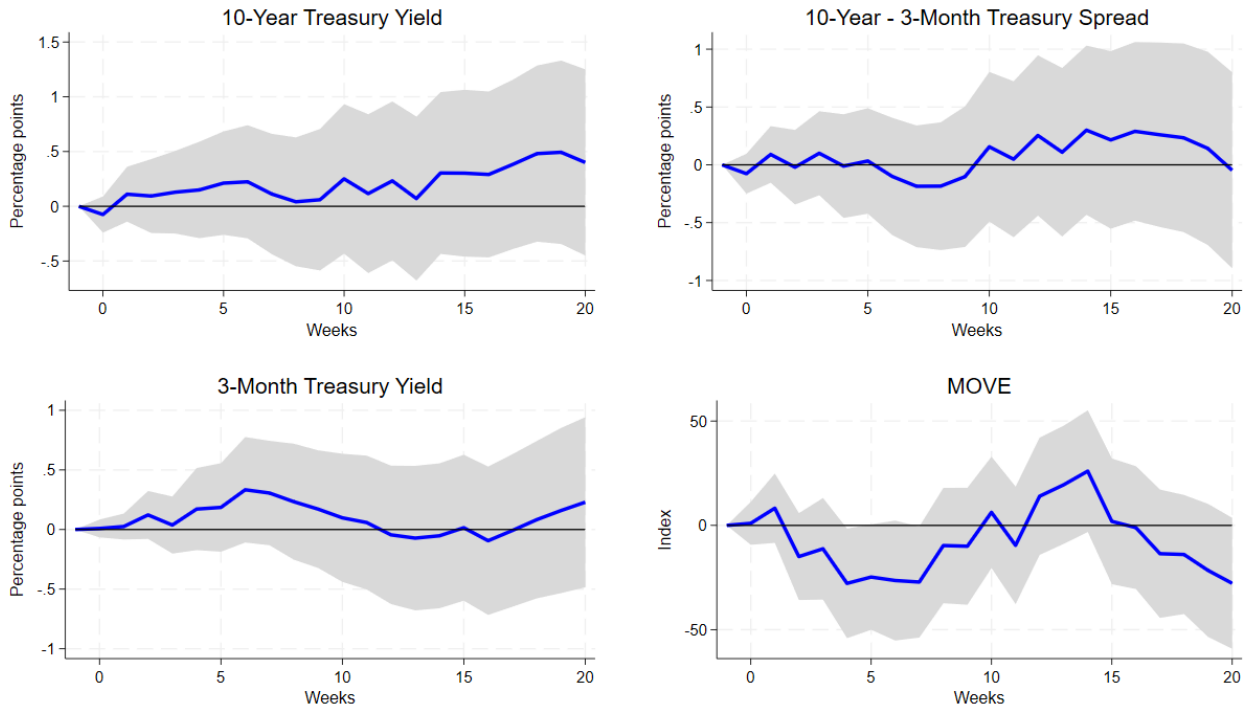

Figure 20. Treasury market: impulse responses to a 1-billion USD increase in Government borrowing. 90% Newey and West (1987) confidence bands displayed.

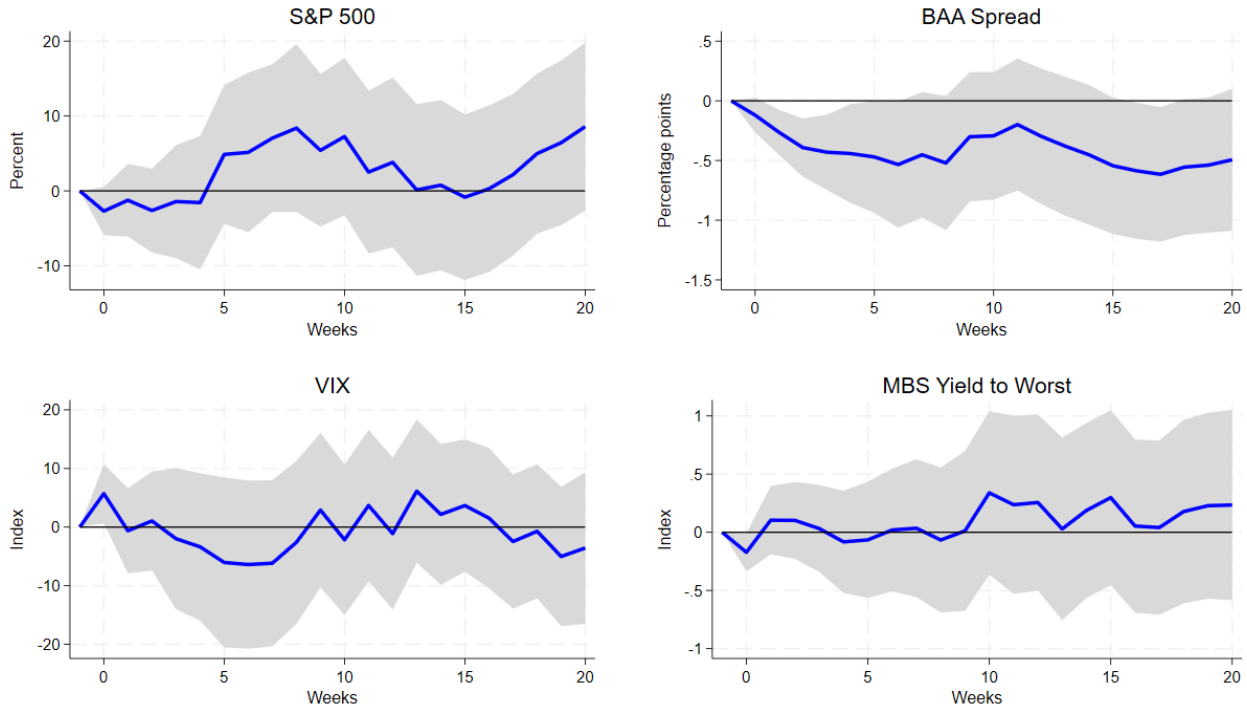

Figure 21. Other assets I: impulse responses to a 1-billion USD increase in Government borrowing. 90% Newey and West (1987) confidence bands displayed.

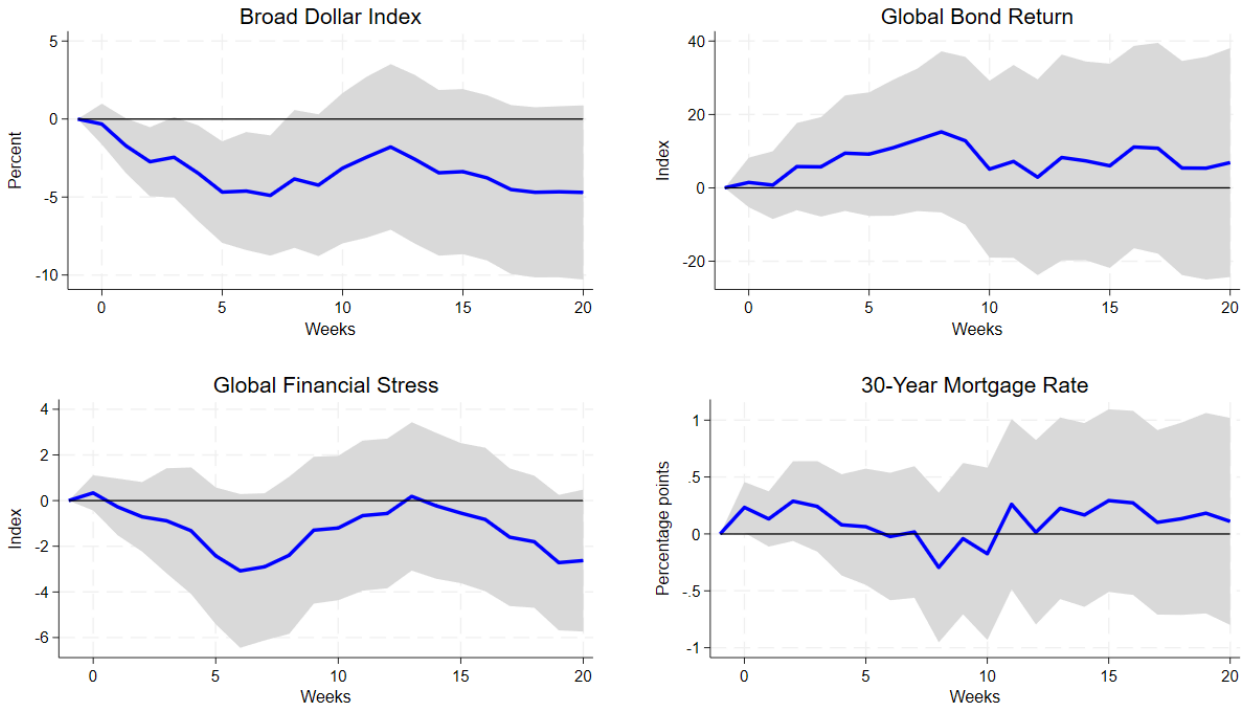

Figure 22. Other assets II: impulse responses to a 1-billion USD increase in Government borrowing. 90% Newey and West (1987) confidence bands displayed.

A4 Appendix IV - Robustness Checks: QT Announcements

A4.1 Newey-West Standard Errors

	10Y Tr.	3M Tr.	10Y-3M Tr.	MOVE	10Y Bid-Ask	Tr. Liquidity
QE	-0.036	-0.046**	0.010	-12.989**	-0.349	-0.297*
	(0.053)	(0.020)	(0.060)	(5.717)	(0.258)	(0.158)
QT1	0.001	0.006*	-0.005	-0.277	0.025	-0.063
	(0.010)	(0.004)	(0.013)	(0.868)	(0.040)	(0.043)
QT2	0.029	0.015	0.014	-1.689	-0.015	0.027
	(0.038)	(0.020)	(0.030)	(2.291)	(0.057)	(0.020)
TAPER1	0.009	0.001	0.008	-0.070	0.017	0.010
	(0.018)	(0.004)	(0.015)	(0.565)	(0.031)	(0.054)
TAPER2	0.026	0.006*	0.020	-5.230***	-0.116***	-0.040
	(0.025)	(0.004)	(0.024)	(1.996)	(0.040)	(0.038)
FF SHOCKS	0.081	0.156	-0.076	8.235	0.216	0.476*
	(0.217)	(0.119)	(0.186)	(19.588)	(0.600)	(0.245)
TR SHOCKS	-0.142	0.038	-0.181	18.382**	0.538**	-0.098
	(0.111)	(0.042)	(0.113)	(7.397)	(0.254)	(0.142)
SVB	-0.123***	-0.052	-0.071*	15.937***	0.002	0.095***
	(0.029)	(0.044)	(0.038)	(3.478)	(0.083)	(0.026)
COVID	-0.172***	-0.275***	0.102***	14.640**	-0.143**	0.219***
	(0.019)	(0.032)	(0.040)	(5.736)	(0.058)	(0.071)
CEIL	0.041***	0.026**	0.015	-1.899	-0.039	-0.021*
	(0.012)	(0.011)	(0.012)	(1.428)	(0.024)	(0.012)
Constant	-0.002	0.011**	-0.013	2.498***	-0.016	0.026
	(0.009)	(0.005)	(0.010)	(0.752)	(0.017)	(0.018)
N	1718	1718	1718	1718	1718	1718
adj. R^2						

Table 9. Treasury market: impact of QE, Tapering I & II, QT I & II announcements. Newey-West standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	S&P 500	Banks	Reg. Banks	Dollar	Gold	Brent
QE	-0.020	-0.064	-0.054	0.005*	0.021	-0.047*
	(0.024)	(0.039)	(0.042)	(0.003)	(0.015)	(0.025)
QT1	-0.002	0.002	0.002	0.000	-0.007**	-0.012
	(0.004)	(0.005)	(0.005)	(0.001)	(0.003)	(0.008)
QT2	-0.000	0.002	-0.004	0.001	-0.004	0.011
	(0.006)	(0.010)	(0.007)	(0.002)	(0.005)	(0.013)
TAPER1	0.003	0.001	0.005	0.001***	0.001	-0.009*
	(0.003)	(0.005)	(0.005)	(0.000)	(0.003)	(0.005)
TAPER2	0.013***	0.023*	0.019	-0.002**	-0.001	0.002
	(0.003)	(0.014)	(0.014)	(0.001)	(0.008)	(0.017)
FF SHOCKS	-0.019	-0.005	-0.043	0.010	-0.023	-0.132
	(0.064)	(0.076)	(0.073)	(0.017)	(0.036)	(0.122)
TR SHOCKS	-0.050**	-0.072*	-0.065**	0.019**	0.013	-0.117**
	(0.022)	(0.040)	(0.030)	(0.007)	(0.018)	(0.059)
SVB	-0.008	-0.110***	-0.051***	0.002*	0.015***	-0.047***
	(0.005)	(0.016)	(0.008)	(0.001)	(0.004)	(0.011)
COVID	-0.023*	-0.075***	-0.068***	0.000	0.003	-0.103**
	(0.012)	(0.026)	(0.022)	(0.002)	(0.007)	(0.049)
CEIL	-0.001	-0.002	-0.002	0.000	-0.005***	0.001
	(0.002)	(0.007)	(0.003)	(0.001)	(0.002)	(0.006)
Constant	0.001	0.002	0.002	-0.000	-0.000	0.004
	(0.002)	(0.003)	(0.003)	(0.001)	(0.002)	(0.009)
N	1718	1718	1718	1718	1718	1718
adj. R^2						

Table 10. Other assets: impact of QE, Tapering I & II, QT I & II announcements. Newey-West standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	BAA-10Y	VIX	OIS	Global Bond	MBS	Global Stress
QE	0.027	7.206*	0.029*	0.301	-0.341**	0.418
	(0.045)	(4.340)	(0.015)	(1.304)	(0.167)	(0.512)
QT1	-0.010	0.145	-0.002	-0.460	0.009	-0.016
	(0.010)	(0.436)	(0.004)	(0.587)	(0.008)	(0.068)
QT2	-0.013	0.158	0.014	-1.015	0.031	0.004
	(0.020)	(0.609)	(0.017)	(1.181)	(0.038)	(0.081)
TAPER1	0.012	-0.468	-0.005	-0.943***	0.008	0.004
	(0.010)	(0.356)	(0.007)	(0.264)	(0.009)	(0.091)
TAPER2	0.014	-2.282**	-0.011**	-0.435	0.025	-0.310***
	(0.019)	(1.159)	(0.005)	(0.585)	(0.026)	(0.068)
FF SHOCKS	0.365**	5.958	-0.221	-5.605	-0.103	2.031
	(0.150)	(9.221)	(0.174)	(8.802)	(0.255)	(1.830)
TR SHOCKS	0.088	3.235	-0.022	-2.203	-0.091	0.718*
	(0.082)	(3.922)	(0.043)	(3.632)	(0.107)	(0.435)
SVB	0.111***	1.711***	-0.005	2.768***	-0.113***	0.620***
	(0.019)	(0.624)	(0.036)	(0.988)	(0.024)	(0.114)
COVID	0.170***	5.241***	0.003	4.688***	-0.124***	1.450***
	(0.043)	(1.866)	(0.014)	(0.651)	(0.040)	(0.467)
CEIL	-0.000	-0.016	-0.023	-1.269***	0.040***	-0.048
	(0.012)	(0.331)	(0.016)	(0.451)	(0.012)	(0.052)
Constant	-0.015	0.891**	0.005	0.487	0.003	0.072
	(0.015)	(0.355)	(0.005)	(0.481)	(0.017)	(0.067)
N	1718	1718	1718	1718	1718	1718
adj. R^2						

Table 11. Spreads & premia: Treasury market: impact of QE, Tapering I & II, QT I & II announcements. Newey-West standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A4.2 Control: Government Debt

	10Y Tr.	3M Tr.	10Y-3M Tr.	MOVE	10Y Bid-Ask	Tr. Liquidity
QE	-0.033	-0.036*	0.003	-12.844***	-0.355***	-0.287***
	(0.038)	(0.019)	(0.038)	(2.967)	(0.087)	(0.054)
QT1	0.003	0.011	-0.008	-0.212	0.023	-0.059
	(0.025)	(0.013)	(0.025)	(1.943)	(0.057)	(0.036)
QT2	0.027	0.007	0.019	-1.795	-0.010	0.019
	(0.022)	(0.011)	(0.022)	(1.702)	(0.050)	(0.031)
TAPER1	0.011	0.007	0.004	0.014	0.013	0.016
	(0.043)	(0.022)	(0.043)	(3.336)	(0.098)	(0.061)
TAPER2	0.024	-0.000	0.024	-5.328	-0.112	-0.047
	(0.043)	(0.022)	(0.043)	(3.345)	(0.098)	(0.061)
FF SHOCKS	0.084	0.168	-0.084	8.410	0.209	0.488
	(0.209)	(0.106)	(0.209)	(16.370)	(0.481)	(0.300)
TR SHOCKS	-0.140	0.045	-0.185	18.474**	0.534**	-0.091
	(0.115)	(0.058)	(0.115)	(9.012)	(0.265)	(0.165)
SVB	-0.125***	-0.059***	-0.066**	15.844***	0.006	0.088**
	(0.026)	(0.013)	(0.026)	(2.064)	(0.061)	(0.038)
COVID	-0.170***	-0.267***	0.097***	14.748***	-0.148**	0.227***
	(0.027)	(0.013)	(0.027)	(2.083)	(0.061)	(0.038)
CEIL	0.038**	0.017*	0.021	-2.030	-0.033	-0.030
	(0.018)	(0.009)	(0.018)	(1.443)	(0.042)	(0.026)
Constant	-0.009	-0.012**	0.002	2.175***	-0.003	0.004
	(0.009)	(0.005)	(0.009)	(0.704)	(0.021)	(0.013)
N	1718	1718	1718	1718	1718	1718
adj. R^2	0.037	0.334	0.039	0.100	0.008	0.046

Table 12. Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	S&P 500	Banks	Reg. Banks	Dollar	Gold	Brent
QE	-0.020**	-0.064***	-0.054***	0.005*	0.021***	-0.043
	(0.008)	(0.014)	(0.012)	(0.002)	(0.007)	(0.029)
QT1	-0.003	0.002	0.002	0.000	-0.007*	-0.010
	(0.005)	(0.009)	(0.008)	(0.002)	(0.004)	(0.019)
QT2	0.000	0.002	-0.005	0.001	-0.004	0.008
	(0.005)	(0.008)	(0.007)	(0.001)	(0.004)	(0.017)
TAPER1	0.003	0.001	0.005	0.001	0.001	-0.006
	(0.009)	(0.016)	(0.014)	(0.003)	(0.007)	(0.033)
TAPER2	0.013	0.023	0.019	-0.002	-0.001	-0.001
	(0.009)	(0.016)	(0.014)	(0.003)	(0.007)	(0.033)
FF SHOCKS	-0.020	-0.006	-0.043	0.010	-0.023	-0.127
	(0.044)	(0.077)	(0.069)	(0.014)	(0.036)	(0.160)
TR SHOCKS	-0.051**	-0.072*	-0.065*	0.019**	0.012	-0.114
	(0.024)	(0.043)	(0.038)	(0.007)	(0.020)	(0.088)
SVB	-0.008	-0.110***	-0.051***	0.002	0.015***	-0.049**
	(0.006)	(0.010)	(0.009)	(0.002)	(0.005)	(0.020)
COVID	-0.023***	-0.075***	-0.068***	0.000	0.003	-0.100***
	(0.006)	(0.010)	(0.009)	(0.002)	(0.005)	(0.020)
CEIL	-0.000	-0.001	-0.002	0.000	-0.005	-0.003
	(0.004)	(0.007)	(0.006)	(0.001)	(0.003)	(0.014)
Constant	0.002	0.002	0.002	0.000	-0.000	-0.005
	(0.002)	(0.003)	(0.003)	(0.001)	(0.002)	(0.007)
N	1718	1718	1718	1718	1718	1718
adj. R^2	0.011	0.104	0.057	0.003	0.010	0.020

Table 13. Other assets: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	BAA-10Y	VIX	OIS	Global Bond	MBS	Global Stress
QE	0.020	7.403***	0.028	0.314	-0.336***	0.425**
	(0.024)	(1.293)	(0.018)	(1.238)	(0.044)	(0.187)
QT1	-0.014	0.234	-0.002	-0.454	0.012	-0.012
	(0.016)	(0.847)	(0.012)	(0.811)	(0.029)	(0.122)
QT2	-0.007	0.014	0.014	-1.025	0.027	-0.001
	(0.014)	(0.742)	(0.010)	(0.710)	(0.025)	(0.107)
TAPER1	0.008	-0.352	-0.005	-0.936	0.010	0.008
	(0.027)	(1.453)	(0.020)	(1.391)	(0.050)	(0.210)
TAPER2	0.019	-2.414*	-0.010	-0.444	0.022	-0.315
	(0.027)	(1.458)	(0.020)	(1.396)	(0.050)	(0.211)
FF SHOCKS	0.356***	6.197	-0.222**	-5.589	-0.098	2.039**
	(0.134)	(7.132)	(0.097)	(6.829)	(0.244)	(1.031)
TR SHOCKS	0.084	3.360	-0.022	-2.195	-0.088	0.722
	(0.074)	(3.927)	(0.053)	(3.759)	(0.134)	(0.568)
SVB	0.116***	1.585*	-0.005	2.760***	-0.116***	0.615***
	(0.017)	(0.899)	(0.012)	(0.861)	(0.031)	(0.130)
COVID	0.165***	5.387***	0.003	4.697***	-0.120***	1.456***
	(0.017)	(0.908)	(0.012)	(0.869)	(0.031)	(0.131)
CEIL	0.006	-0.194	-0.023***	-1.281**	0.036*	-0.055
	(0.012)	(0.629)	(0.009)	(0.602)	(0.022)	(0.091)
Constant	0.002	0.452	0.006	0.457	-0.007	0.056
	(0.006)	(0.307)	(0.004)	(0.294)	(0.010)	(0.044)
N	1718	1718	1718	1718	1718	1718
adj. R^2	0.101	0.053	0.160	0.025	0.048	0.081

Table 14. Spreads & premia: Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A4.3 No Macroeconomic Controls

	10Y Tr.	3M Tr.	10Y-3M Tr.	MOVE	10Y Bid-Ask	Tr. Liquidity
QE	-0.032	-0.055***	0.023	-14.645***	-0.324***	-0.315***
	(0.036)	(0.020)	(0.036)	(2.881)	(0.082)	(0.050)
QT1	-0.000	0.010	-0.010	-0.129	0.017	-0.056*
	(0.024)	(0.013)	(0.024)	(1.920)	(0.055)	(0.033)
QT2	0.021	0.022*	-0.000	-0.809	-0.011	0.032
	(0.021)	(0.011)	(0.021)	(1.662)	(0.048)	(0.029)
TAPER1	0.068**	0.003	0.064**	4.397*	-0.007	0.042
	(0.029)	(0.016)	(0.029)	(2.344)	(0.067)	(0.040)
TAPER2	0.023	0.003	0.021	-5.412	-0.116	-0.037
	(0.041)	(0.023)	(0.041)	(3.314)	(0.095)	(0.057)
FF SHOCKS	0.274	0.335***	-0.061	-11.408	0.332	0.224
	(0.192)	(0.106)	(0.193)	(15.415)	(0.462)	(0.266)
TR SHOCKS	-0.135	0.033	-0.168*	12.041	0.430*	-0.078
	(0.093)	(0.051)	(0.093)	(7.523)	(0.229)	(0.129)
Constant	0.004	0.018***	-0.014***	0.867***	0.007	0.017***
	(0.003)	(0.002)	(0.003)	(0.262)	(0.008)	(0.004)
N	2605	2605	2605	2533	2258	2651
adj. R^2	0.003	0.075	0.011	0.033	0.007	0.023

Table 15. Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	S&P 500	Banks	Reg. Banks	Dollar	Gold	Brent
QE	-0.017**	-0.060***	-0.051***	0.005**	0.022***	-0.054**
	(0.007)	(0.013)	(0.011)	(0.002)	(0.007)	(0.025)
QT1	-0.003	0.002	0.002	-0.000	-0.007	-0.008
	(0.005)	(0.009)	(0.008)	(0.002)	(0.004)	(0.016)
QT2	-0.001	-0.008	-0.009	0.001	-0.002	0.007
	(0.004)	(0.008)	(0.007)	(0.001)	(0.004)	(0.014)
TAPER1	-0.005	-0.001	0.002	0.004**	-0.014***	-0.009
	(0.006)	(0.011)	(0.009)	(0.002)	(0.005)	(0.020)
TAPER2	0.013	0.024	0.020	-0.002	-0.001	0.004
	(0.008)	(0.015)	(0.013)	(0.003)	(0.008)	(0.028)
FF SHOCKS	0.000	0.051	0.019	0.012	-0.006	-0.030
	(0.039)	(0.070)	(0.061)	(0.012)	(0.035)	(0.132)
TR SHOCKS	-0.024	-0.034	-0.036	0.011*	0.024	-0.036
	(0.019)	(0.034)	(0.030)	(0.006)	(0.017)	(0.063)
Constant	0.001	0.001	0.001	0.000	0.000	-0.002
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
N	2637	2634	2636	2575	2813	2675
adj. R^2	0.000	0.006	0.006	0.004	0.006	0.000

Table 16. Other assets: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	BAA-10Y	VIX	OIS	Global Bond	MBS	Global Stress
QE	0.049**	5.806***	0.032	-0.190	-0.344***	0.343**
	(0.022)	(1.169)	(0.022)	(1.146)	(0.040)	(0.170)
QT1	-0.014	0.246	-0.002	-0.309	0.009	-0.003
	(0.015)	(0.779)	(0.014)	(0.764)	(0.026)	(0.113)
QT2	0.001	-0.035	0.011	-0.963	0.022	0.046
	(0.013)	(0.674)	(0.012)	(0.661)	(0.023)	(0.098)
TAPER1	-0.016	0.313	-0.006	-2.358**	0.073**	0.186
	(0.018)	(0.951)	(0.018)	(0.933)	(0.032)	(0.139)
TAPER2	0.016	-2.495*	-0.007	-0.375	0.022	-0.319
	(0.026)	(1.345)	(0.025)	(1.318)	(0.046)	(0.196)
FF SHOCKS	0.224*	0.870	-0.208*	-12.094**	0.079	0.640
	(0.119)	(6.256)	(0.115)	(6.133)	(0.213)	(0.911)
TR SHOCKS	0.007	0.019	-0.020	-0.526	-0.089	0.204
	(0.058)	(3.016)	(0.056)	(2.915)	(0.103)	(0.439)
Constant	-0.001	0.091	0.006***	-0.079	0.006	0.029*
	(0.002)	(0.102)	(0.002)	(0.095)	(0.004)	(0.015)
N	2597	2661	2605	2812	2610	2659
adj. R^2	0.000	0.014	0.076	0.002	0.029	0.005

Table 17. Spreads & premia: Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A4.4 LMS - Weekly Economic Index

	10Y Tr.	3M Tr.	10Y-3M Tr.	MOVE	10Y Bid-Ask	Tr. Liquidity
QE	-0.036	-0.048***	0.012	-12.921***	-0.350***	-0.298***
	(0.036)	(0.018)	(0.036)	(2.863)	(0.084)	(0.050)
QT1	-0.002	0.006	-0.008	-0.296	0.021	-0.059*
	(0.024)	(0.012)	(0.024)	(1.882)	(0.055)	(0.033)
QT2	0.047**	0.020*	0.027	-0.011	0.017	0.019
	(0.023)	(0.011)	(0.023)	(1.799)	(0.053)	(0.032)
TAPER1	0.067**	0.005	0.062**	4.196*	-0.003	0.039
	(0.029)	(0.014)	(0.029)	(2.296)	(0.068)	(0.040)
TAPER2	0.023	0.006	0.017	-5.250	-0.126	-0.038
	(0.041)	(0.020)	(0.041)	(3.251)	(0.096)	(0.057)
FF SHOCKS	0.143	0.125	0.018	-0.949	0.219	0.386
	(0.191)	(0.094)	(0.192)	(15.154)	(0.468)	(0.267)
TR SHOCKS	-0.158*	0.018	-0.176*	14.001*	0.414*	-0.064
	(0.092)	(0.046)	(0.093)	(7.383)	(0.232)	(0.130)
SVB	-0.119***	-0.039***	-0.080***	13.745***	0.029	0.092***
	(0.023)	(0.011)	(0.023)	(1.798)	(0.053)	(0.032)
COVID	-0.170***	-0.276***	0.106***	14.487***	-0.149**	0.215***
	(0.025)	(0.013)	(0.026)	(2.014)	(0.059)	(0.035)
CEIL	0.038**	0.041***	-0.003	-0.546	-0.017	-0.027
	(0.016)	(0.008)	(0.016)	(1.250)	(0.039)	(0.022)
Constant	0.000	0.008***	-0.008	1.911***	-0.014	0.025***
	(0.005)	(0.003)	(0.005)	(0.432)	(0.013)	(0.007)
N	2486	2486	2486	2419	2153	2533
adj. R^2	0.032	0.290	0.034	0.076	0.009	0.039

Table 18. Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	S&P 500	Banks	Reg. Banks	Dollar	Gold	Brent
QE	-0.020***	-0.063***	-0.053***	0.005**	0.020***	-0.050**
	(0.007)	(0.013)	(0.011)	(0.002)	(0.007)	(0.025)
QT1	-0.002	0.002	0.002	-0.000	-0.006	-0.009
	(0.005)	(0.008)	(0.007)	(0.002)	(0.004)	(0.016)
QT2	-0.001	0.006	-0.001	0.001	-0.003	0.021
	(0.005)	(0.008)	(0.007)	(0.001)	(0.004)	(0.016)
TAPER1	-0.004	-0.001	0.002	0.004**	-0.014**	-0.010
	(0.006)	(0.010)	(0.009)	(0.002)	(0.005)	(0.020)
TAPER2	0.013	0.024*	0.020	-0.003	-0.001	0.009
	(0.008)	(0.015)	(0.013)	(0.003)	(0.008)	(0.028)
FF SHOCKS	-0.016	-0.003	-0.029	0.012	-0.004	-0.102
	(0.039)	(0.068)	(0.060)	(0.012)	(0.035)	(0.133)
TR SHOCKS	-0.026	-0.046	-0.044	0.011*	0.027	-0.049
	(0.019)	(0.033)	(0.029)	(0.006)	(0.017)	(0.063)
SVB	-0.008*	-0.102***	-0.046***	0.001	0.014***	-0.049***
	(0.005)	(0.008)	(0.007)	(0.001)	(0.004)	(0.017)
COVID	-0.023***	-0.074***	-0.067***	0.000	0.002	-0.103***
	(0.005)	(0.009)	(0.008)	(0.002)	(0.005)	(0.018)
CEIL	0.000	0.005	0.001	0.001	-0.003	0.000
	(0.003)	(0.006)	(0.005)	(0.001)	(0.003)	(0.011)
Constant	0.001	0.002	0.002	-0.000	-0.001	0.006
	(0.001)	(0.002)	(0.002)	(0.000)	(0.001)	(0.004)
N	2521	2515	2517	2459	2694	2575
adj. R^2	0.011	0.089	0.047	0.004	0.009	0.018

Table 19. Other assets: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	BAA-10Y	VIX	OIS	Global Bond	MBS	Global Stress
QE	0.026	7.405***	0.023	0.242	-0.342***	0.449***
	(0.022)	(1.178)	(0.022)	(1.155)	(0.040)	(0.168)
QT1	-0.010	0.012	-0.004	-0.312	0.007	-0.013
	(0.014)	(0.774)	(0.014)	(0.759)	(0.027)	(0.111)
QT2	-0.024*	0.443	0.024*	-1.381*	0.044*	-0.002
	(0.014)	(0.740)	(0.014)	(0.726)	(0.025)	(0.106)
TAPER1	-0.011	0.081	-0.009	-2.398***	0.072**	0.177
	(0.017)	(0.945)	(0.017)	(0.926)	(0.032)	(0.135)
TAPER2	0.004	-2.307*	-0.016	0.019	0.021	-0.349*
	(0.025)	(1.338)	(0.025)	(1.312)	(0.046)	(0.191)
FF SHOCKS	0.340***	4.705	-0.204*	-8.300	-0.020	1.668*
	(0.115)	(6.238)	(0.115)	(6.117)	(0.214)	(0.891)
TR SHOCKS	0.031	0.152	-0.041	-0.133	-0.105	0.333
	(0.056)	(3.002)	(0.056)	(2.902)	(0.103)	(0.429)
SVB	0.106***	1.567**	-0.005	2.649***	-0.115***	0.549***
	(0.014)	(0.740)	(0.014)	(0.725)	(0.025)	(0.106)
COVID	0.165***	5.384***	0.000	4.677***	-0.123***	1.451***
	(0.015)	(0.829)	(0.015)	(0.812)	(0.028)	(0.118)
CEIL	-0.006	-0.098	-0.012	-1.010**	0.034*	-0.034
	(0.009)	(0.491)	(0.009)	(0.482)	(0.018)	(0.070)
Constant	-0.023***	1.065***	0.003	0.536***	0.005	0.050**
	(0.003)	(0.174)	(0.003)	(0.165)	(0.006)	(0.025)
N	2478	2542	2486	2693	2491	2541
adj. R^2	0.096	0.051	0.096	0.026	0.044	0.074

Table 20. Spreads & premia: Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A4.5 Placebo Effect

	10Y Tr.	3M Tr.	10Y-3M Tr.	MOVE	10Y Bid-Ask	Tr. Liquidity
QE	-0.036	-0.048***	0.012	-12.933***	-0.349***	-0.299***
	(0.036)	(0.018)	(0.036)	(2.863)	(0.084)	(0.050)
QT1	-0.002	0.006	-0.008	-0.296	0.020	-0.059*
	(0.024)	(0.012)	(0.024)	(1.882)	(0.055)	(0.033)
QT2	0.047**	0.020*	0.027	0.002	0.020	0.020
	(0.023)	(0.011)	(0.023)	(1.795)	(0.053)	(0.032)
TAPER1	0.067**	0.005	0.062**	4.188*	-0.003	0.039
	(0.029)	(0.014)	(0.029)	(2.296)	(0.068)	(0.040)
TAPER2	0.023	0.006	0.017	-5.256	-0.117	-0.037
	(0.041)	(0.020)	(0.041)	(3.243)	(0.095)	(0.057)
FF SHOCKS	0.145	0.127	0.018	-1.032	0.231	0.383
	(0.191)	(0.094)	(0.192)	(15.153)	(0.468)	(0.267)
TR SHOCKS	-0.158*	0.018	-0.176*	13.970*	0.412*	-0.066
	(0.092)	(0.046)	(0.093)	(7.382)	(0.232)	(0.130)
SVB	-0.120***	-0.040***	-0.080***	13.762***	0.027	0.092***
	(0.023)	(0.011)	(0.023)	(1.798)	(0.053)	(0.032)
COVID	-0.171***	-0.277***	0.106***	14.502***	-0.147**	0.216***
	(0.025)	(0.013)	(0.026)	(2.012)	(0.059)	(0.035)
CEIL	0.038**	0.041***	-0.003	-0.564	-0.017	-0.028
	(0.016)	(0.008)	(0.016)	(1.251)	(0.039)	(0.022)
Constant	-0.000	0.008***	-0.009*	1.920***	-0.007	0.026***
	(0.005)	(0.002)	(0.005)	(0.393)	(0.012)	(0.007)
N	2486	2486	2486	2419	2153	2533
adj. R^2	0.032	0.290	0.034	0.076	0.009	0.040

Table 21. Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	S&P 500	Banks	Reg. Banks	Dollar	Gold	Brent
QE	-0.020***	-0.063***	-0.053***	0.005**	0.020***	-0.051**
	(0.007)	(0.013)	(0.011)	(0.002)	(0.007)	(0.025)
QT1	-0.002	0.002	0.002	-0.000	-0.006	-0.009
	(0.005)	(0.008)	(0.007)	(0.002)	(0.004)	(0.016)
QT2	-0.001	0.005	-0.001	0.001	-0.002	0.018
	(0.005)	(0.008)	(0.007)	(0.001)	(0.004)	(0.016)
TAPER1	-0.004	-0.002	0.002	0.004**	-0.014**	-0.010
	(0.006)	(0.010)	(0.009)	(0.002)	(0.005)	(0.020)
TAPER2	0.012	0.022	0.019	-0.002	-0.001	0.003
	(0.008)	(0.014)	(0.013)	(0.003)	(0.008)	(0.028)
FF SHOCKS	-0.017	-0.006	-0.031	0.012	-0.004	-0.111
	(0.039)	(0.068)	(0.060)	(0.012)	(0.035)	(0.133)
TR SHOCKS	-0.026	-0.046	-0.044	0.011*	0.027	-0.048
	(0.019)	(0.033)	(0.029)	(0.006)	(0.017)	(0.063)
SVB	-0.008*	-0.102***	-0.045***	0.001	0.014***	-0.047***
	(0.005)	(0.008)	(0.007)	(0.001)	(0.004)	(0.018)
COVID	-0.023***	-0.074***	-0.067***	0.000	0.002	-0.104***
	(0.005)	(0.009)	(0.008)	(0.002)	(0.005)	(0.018)
CEIL	0.000	0.005	0.001	0.000	-0.003	-0.001
	(0.003)	(0.006)	(0.005)	(0.001)	(0.003)	(0.011)
Constant	-0.000	0.001	0.001	0.000	-0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.000)	(0.001)	(0.003)
N	2521	2515	2517	2459	2694	2575
adj. R^2	0.010	0.089	0.047	0.002	0.009	0.016

Table 22. Other assets: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	BAA-10Y	VIX	OIS	Global Bond	MBS	Global Stress
QE	0.027	7.445***	0.023	0.205	-0.342***	0.459***
	(0.022)	(1.177)	(0.022)	(1.157)	(0.040)	(0.169)
QT1	-0.010	0.007	-0.004	-0.290	0.007	-0.017
	(0.014)	(0.773)	(0.014)	(0.761)	(0.027)	(0.111)
QT2	-0.019	0.414	0.026*	-1.531**	0.045*	0.018
	(0.014)	(0.738)	(0.014)	(0.726)	(0.025)	(0.106)
TAPER1	-0.012	0.105	-0.009	-2.389**	0.072**	0.179
	(0.018)	(0.943)	(0.017)	(0.929)	(0.032)	(0.135)
TAPER2	0.014	-2.268*	-0.013	-0.306	0.022	-0.294
	(0.025)	(1.333)	(0.025)	(1.312)	(0.046)	(0.191)
FF SHOCKS	0.351***	4.961	-0.201*	-8.620	-0.017	1.748*
	(0.116)	(6.228)	(0.115)	(6.132)	(0.214)	(0.892)
TR SHOCKS	0.028	0.214	-0.042	-0.039	-0.105	0.324
	(0.056)	(2.997)	(0.056)	(2.909)	(0.103)	(0.429)
SVB	0.104***	1.516**	-0.006	2.706***	-0.116***	0.534***
	(0.014)	(0.738)	(0.014)	(0.727)	(0.025)	(0.106)
COVID	0.169***	5.354***	0.002	4.554***	-0.123***	1.466***
	(0.015)	(0.827)	(0.015)	(0.814)	(0.028)	(0.118)
CEIL	-0.006	-0.042	-0.012	-1.004**	0.035**	-0.029
	(0.010)	(0.491)	(0.010)	(0.483)	(0.018)	(0.070)
Constant	-0.015***	1.054***	0.006*	0.282*	0.006	0.088***
	(0.003)	(0.157)	(0.003)	(0.149)	(0.005)	(0.023)
N	2478	2542	2486	2693	2491	2541
adj. R^2	0.083	0.054	0.095	0.021	0.044	0.072

Table 23. Spreads & premia: Treasury market: impact of QE, Tapering I & II, QT I & II announcements. OLS standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A5 Appendix V - Robustness Checks: QT Operations

A5.1 QT Operations: Alternative Definition

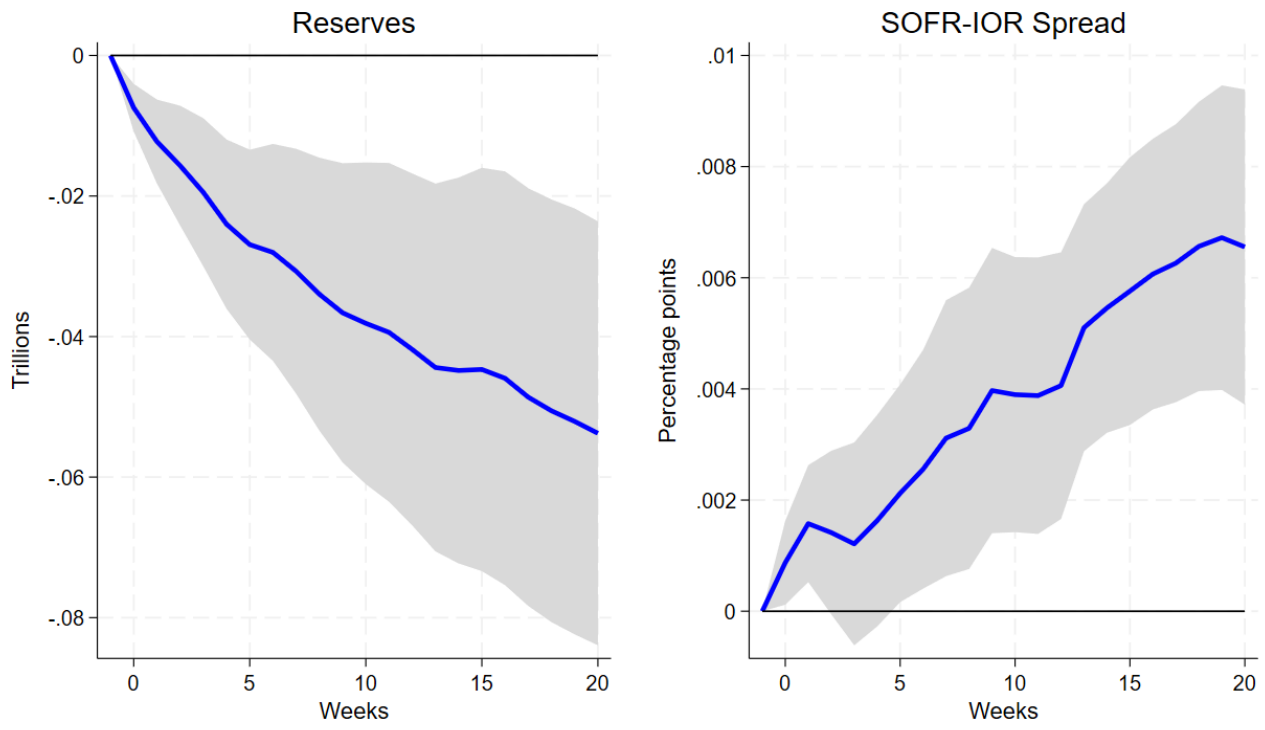

Figure 23. Money market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

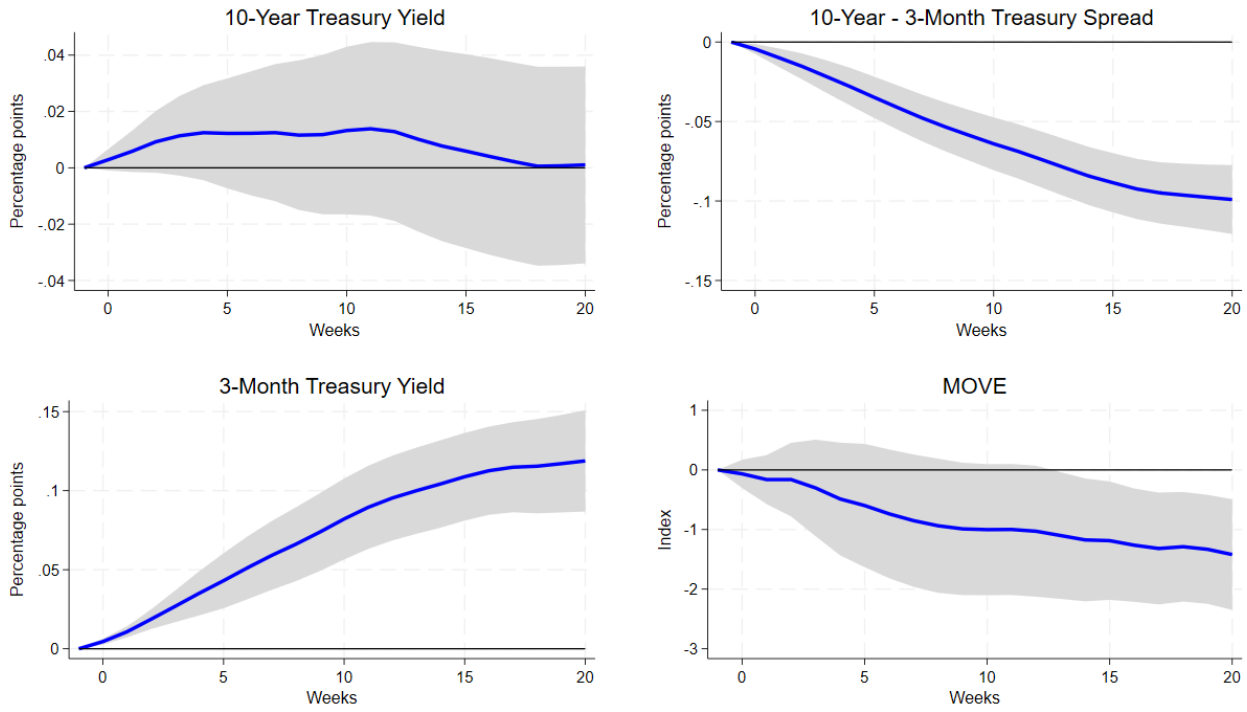

Figure 24. Treasury market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

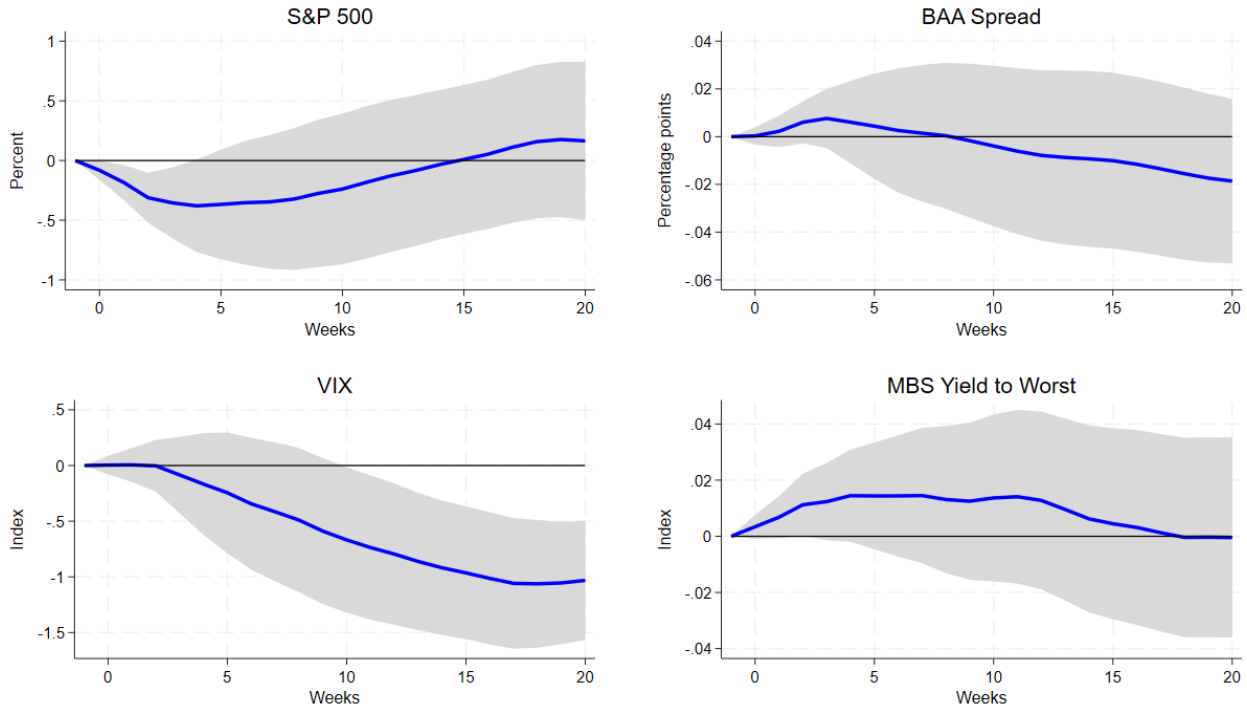

Figure 25. Other assets I: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

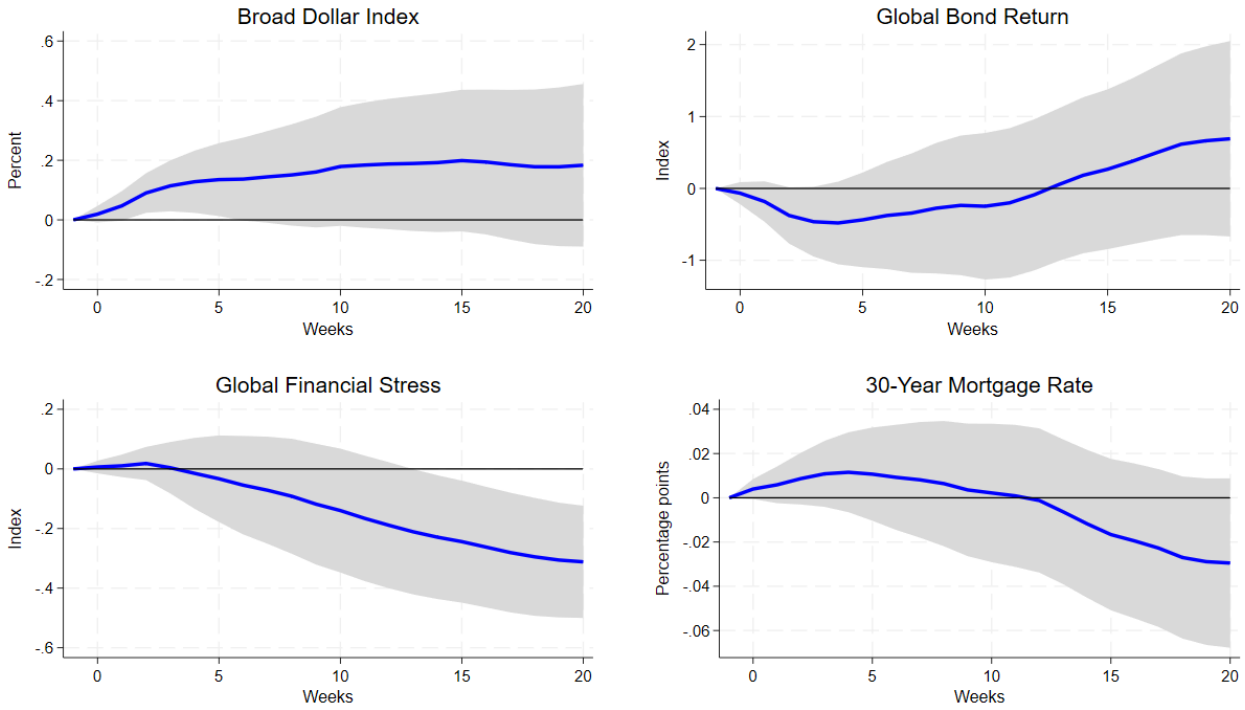

Figure 26. Other assets I: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

A5.2 Bias Correction

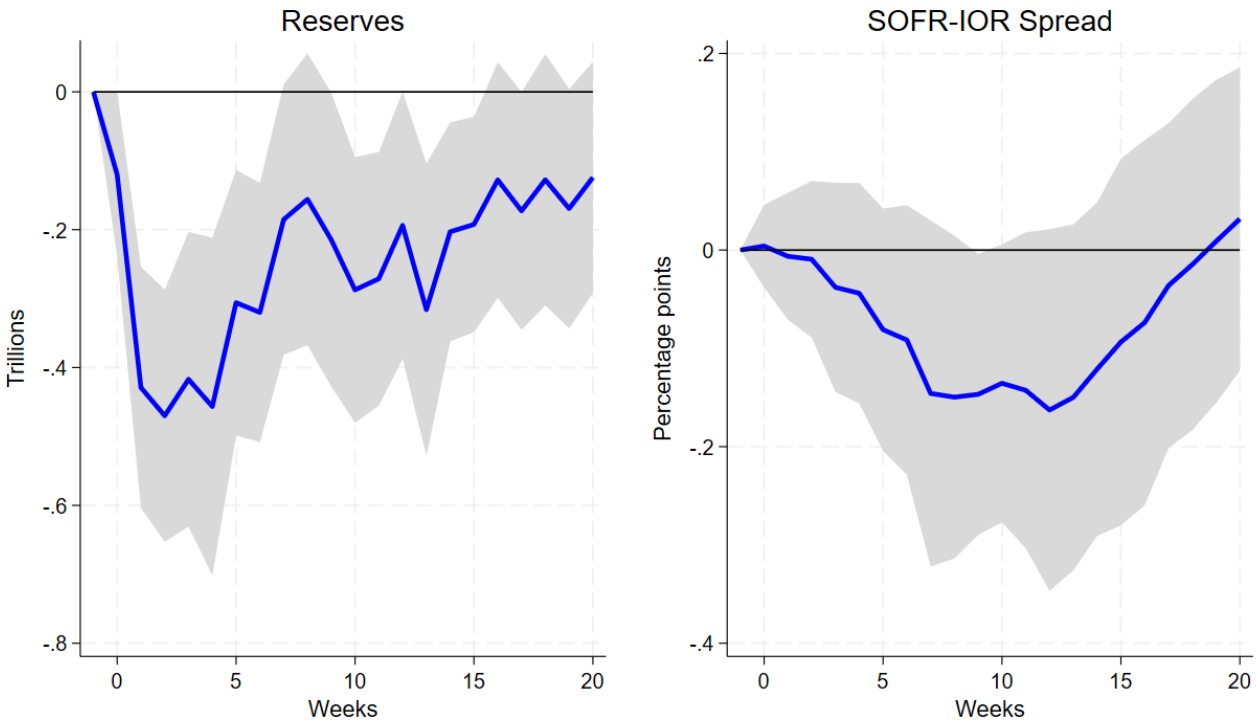

Figure 27. Money market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

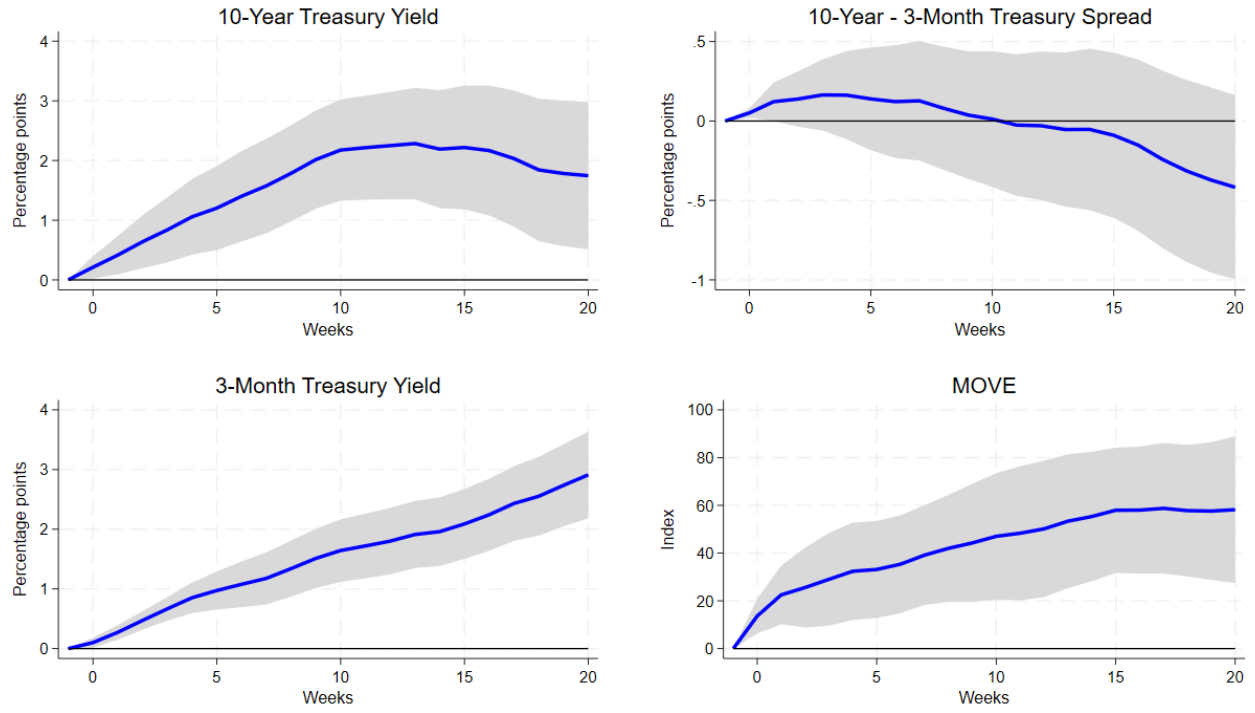

Figure 28. Treasury market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

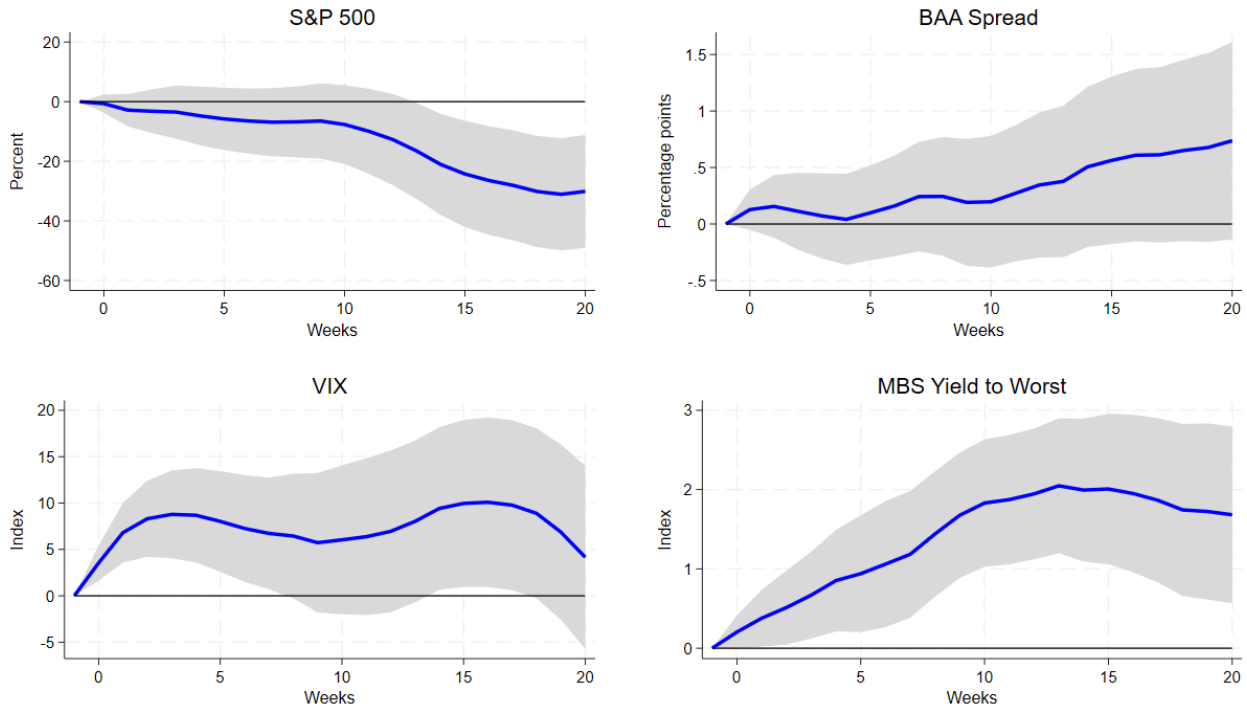

Figure 29. Other assets I: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

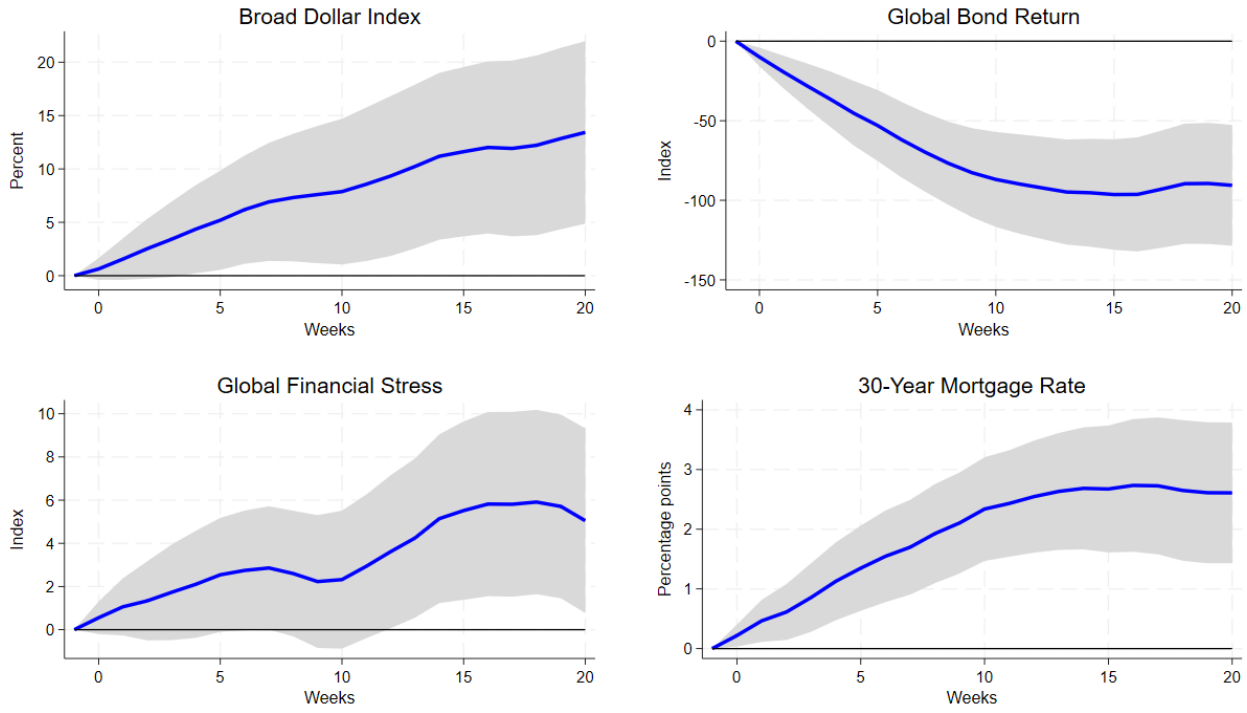

Figure 30. Other assets II: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

A5.3 LMS - Weekly Economic Index

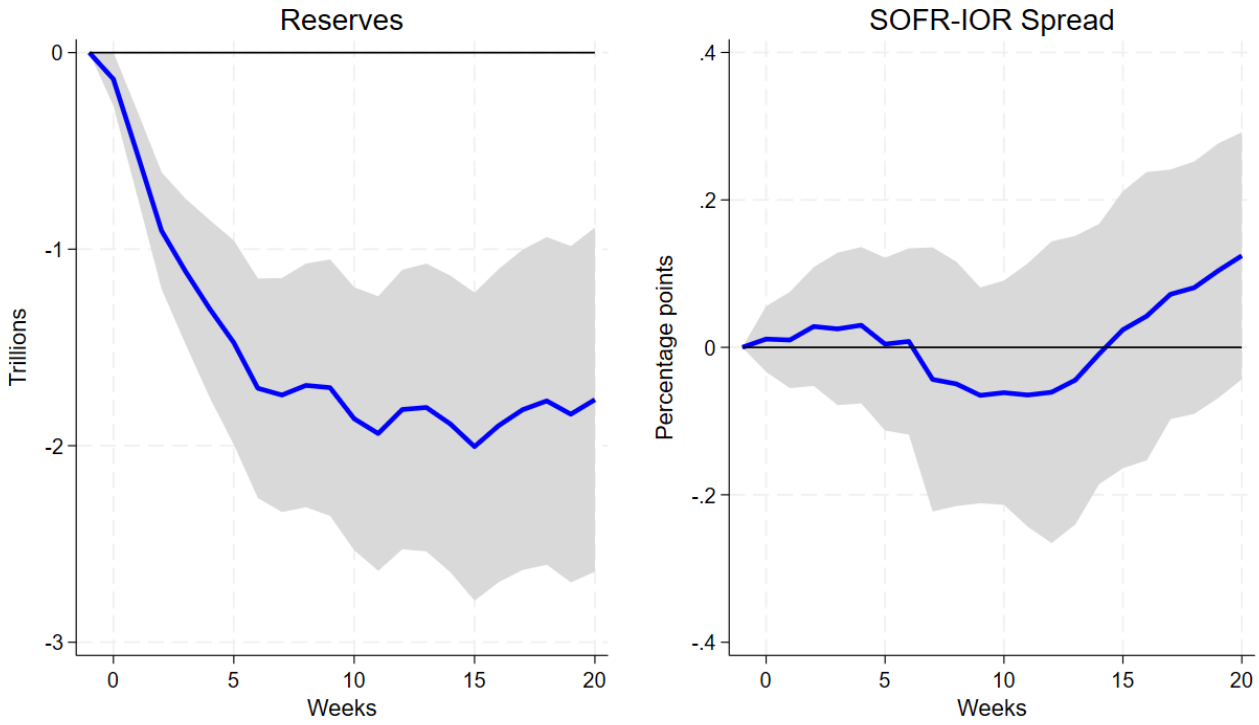

Figure 31. Money market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

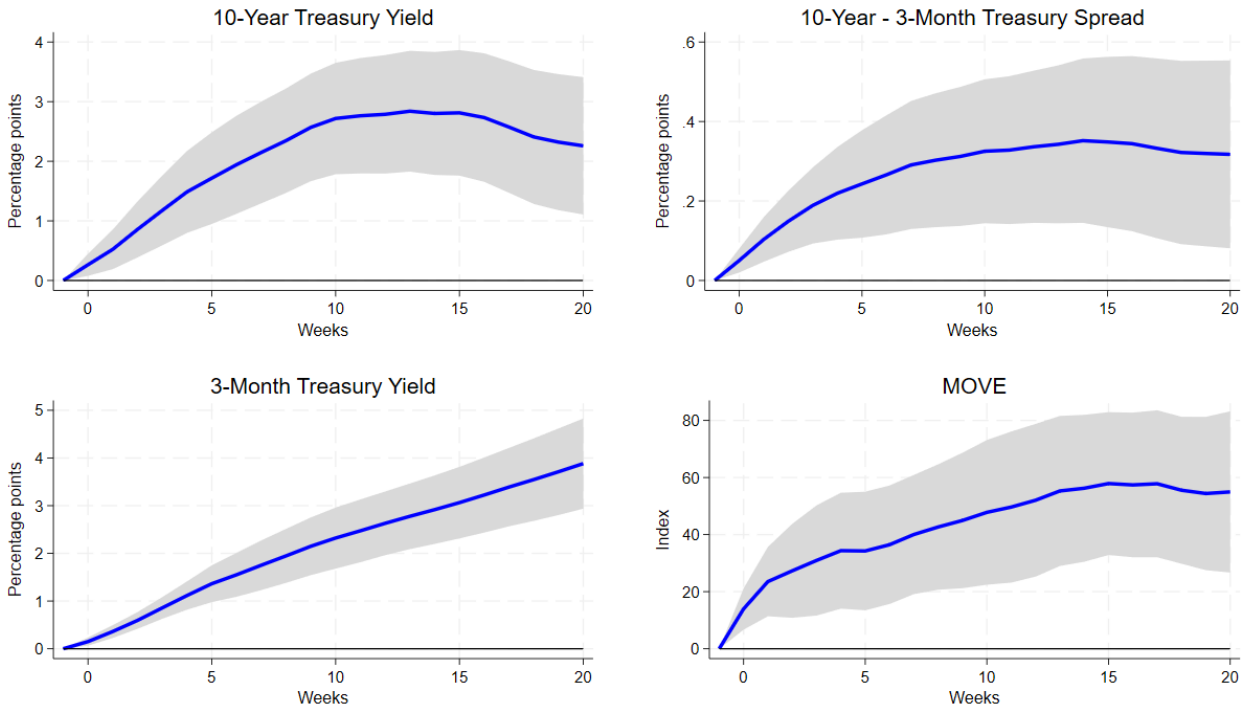

Figure 32. Treasury market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

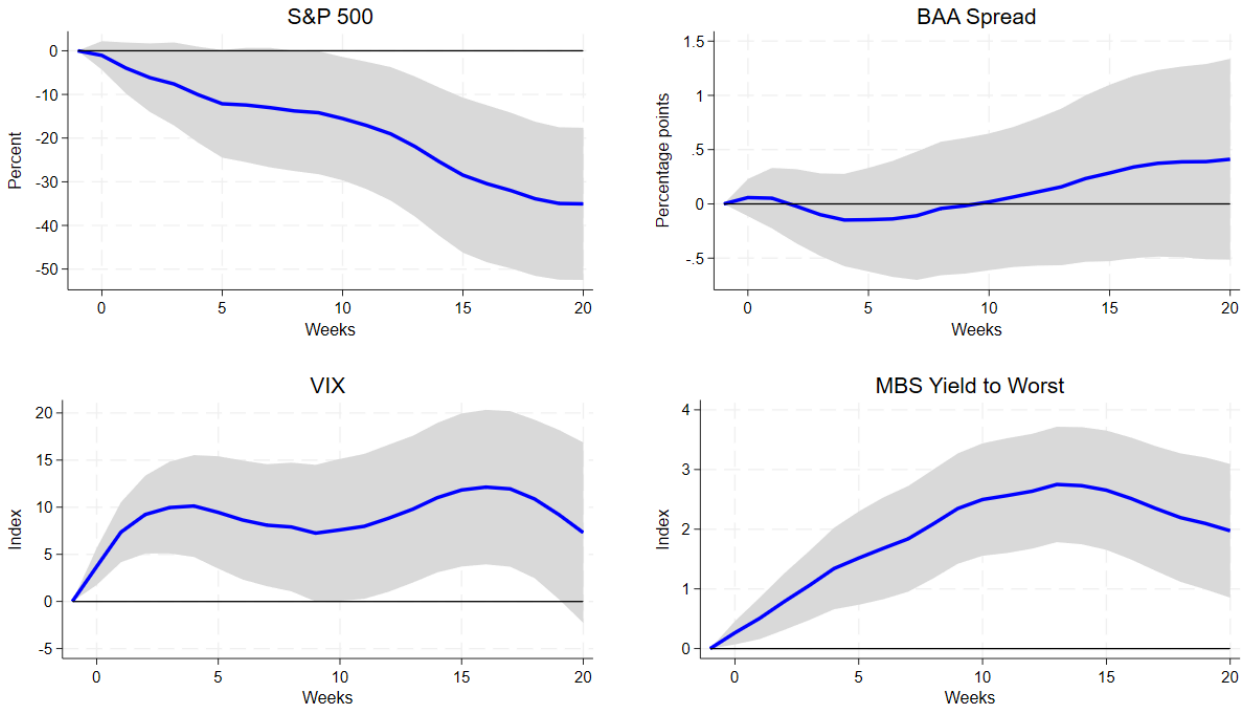

Figure 33. Other assets I: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

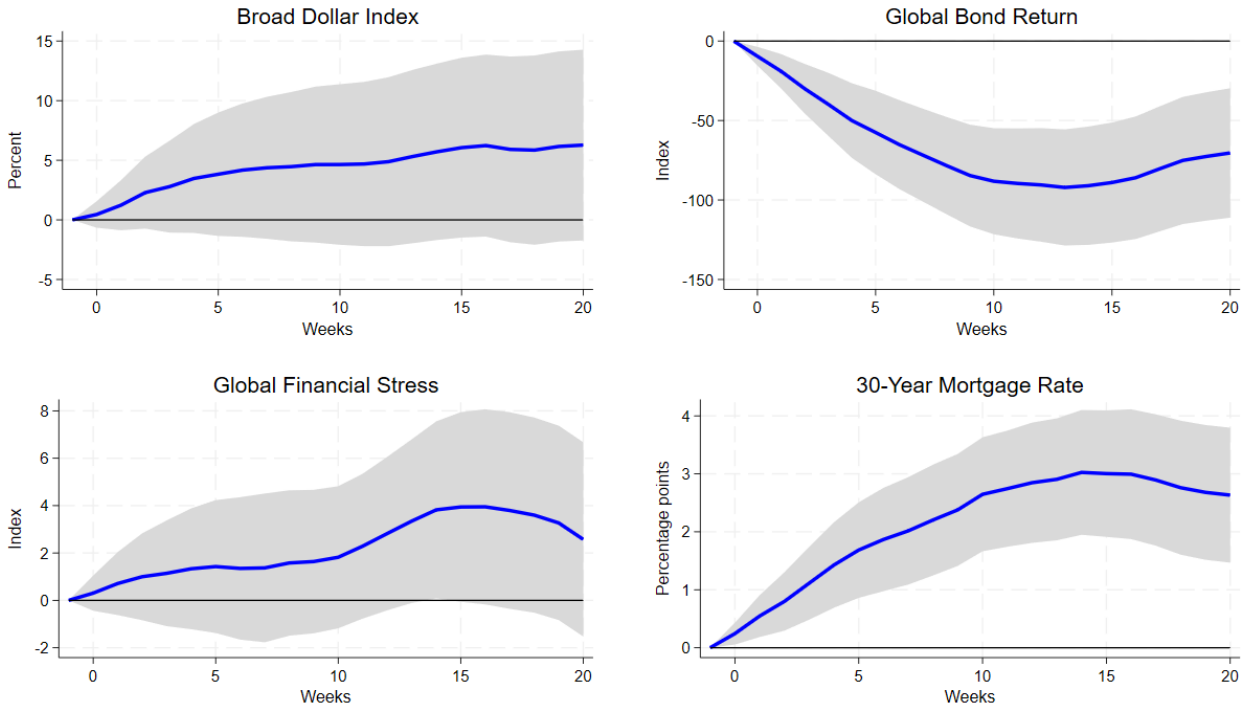

Figure 34. Other assets II: impulse responses to a 1-trillion decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

A5.4 Logarithms

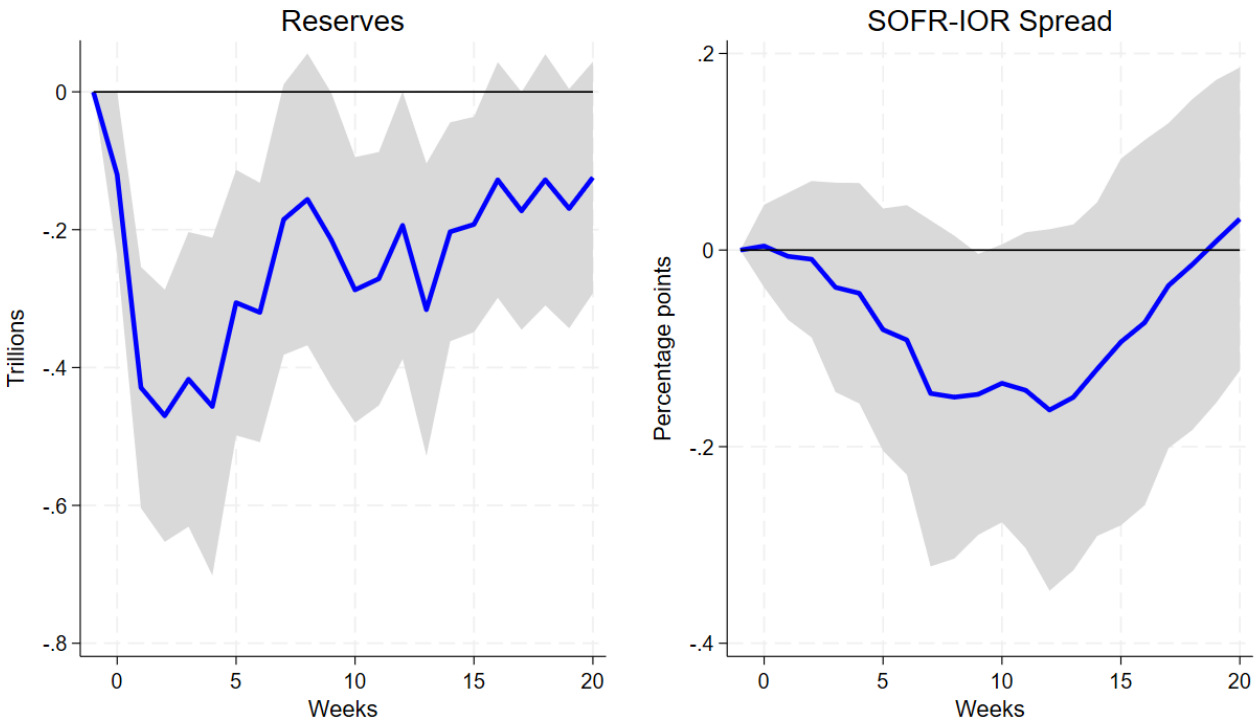

Figure 35. Money market: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

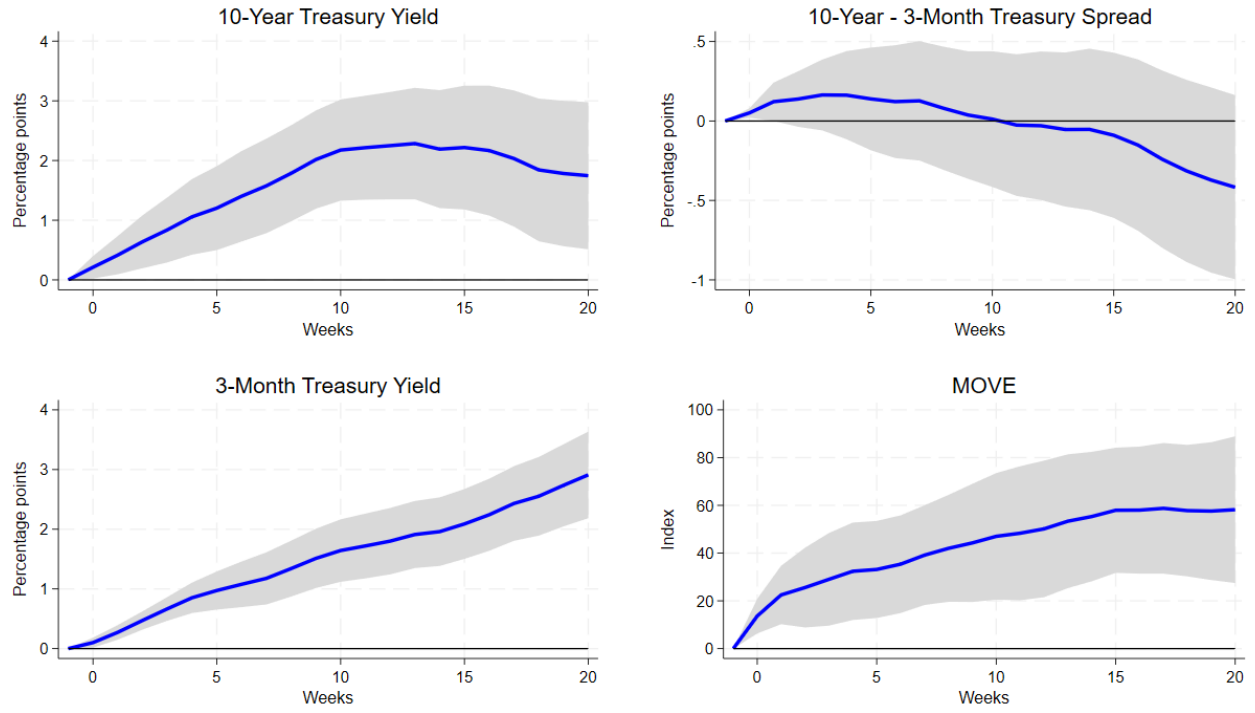

Figure 36. Treasury market: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

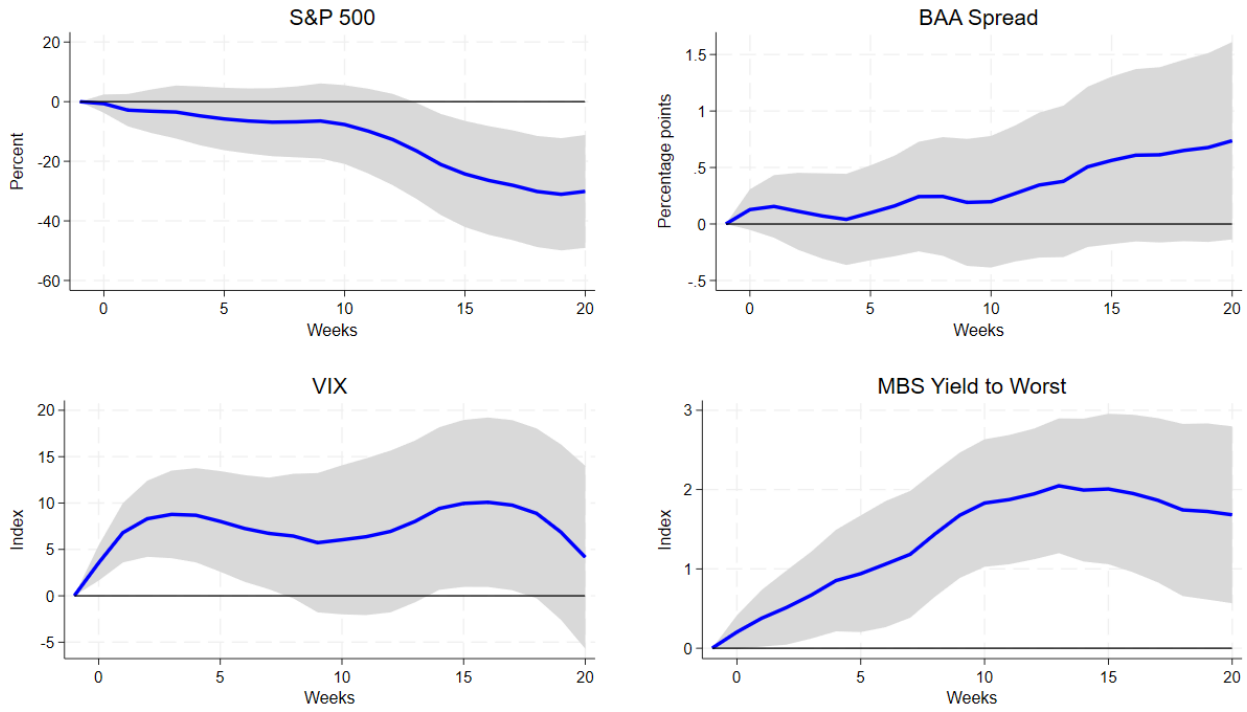

Figure 37. Other assets I: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

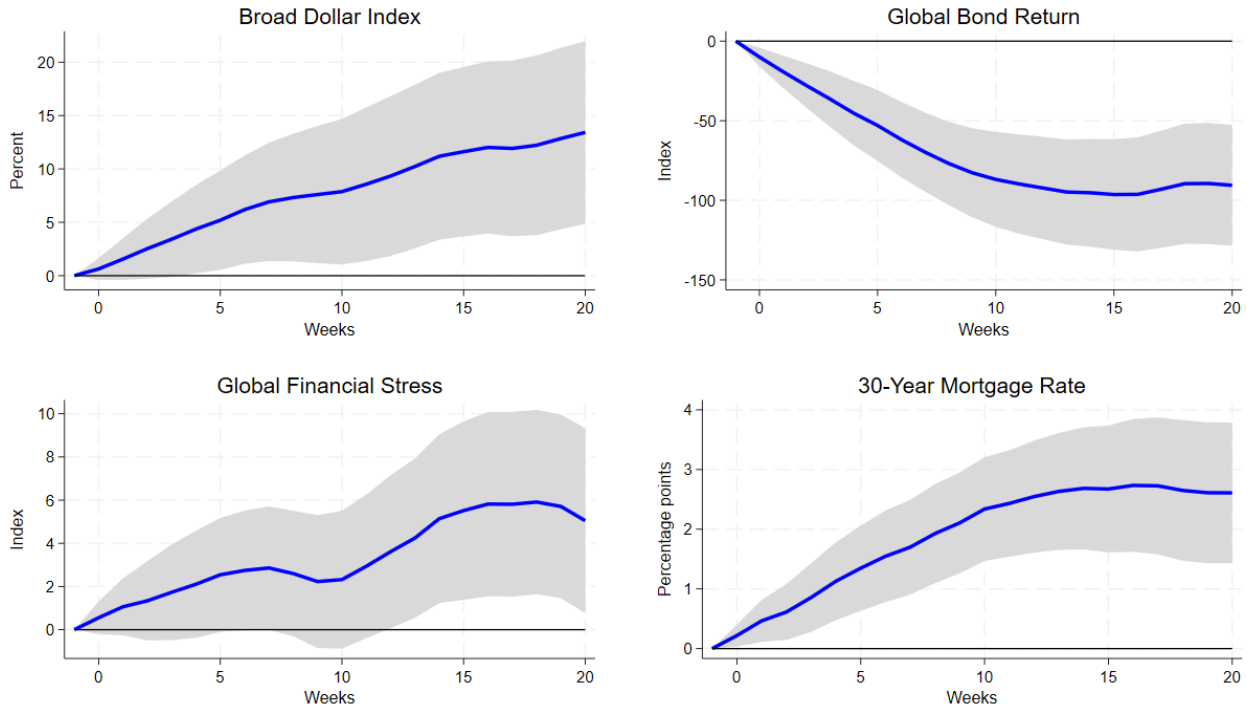

Figure 38. Other assets II: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

A5.5 Percentage Variation from Maximum

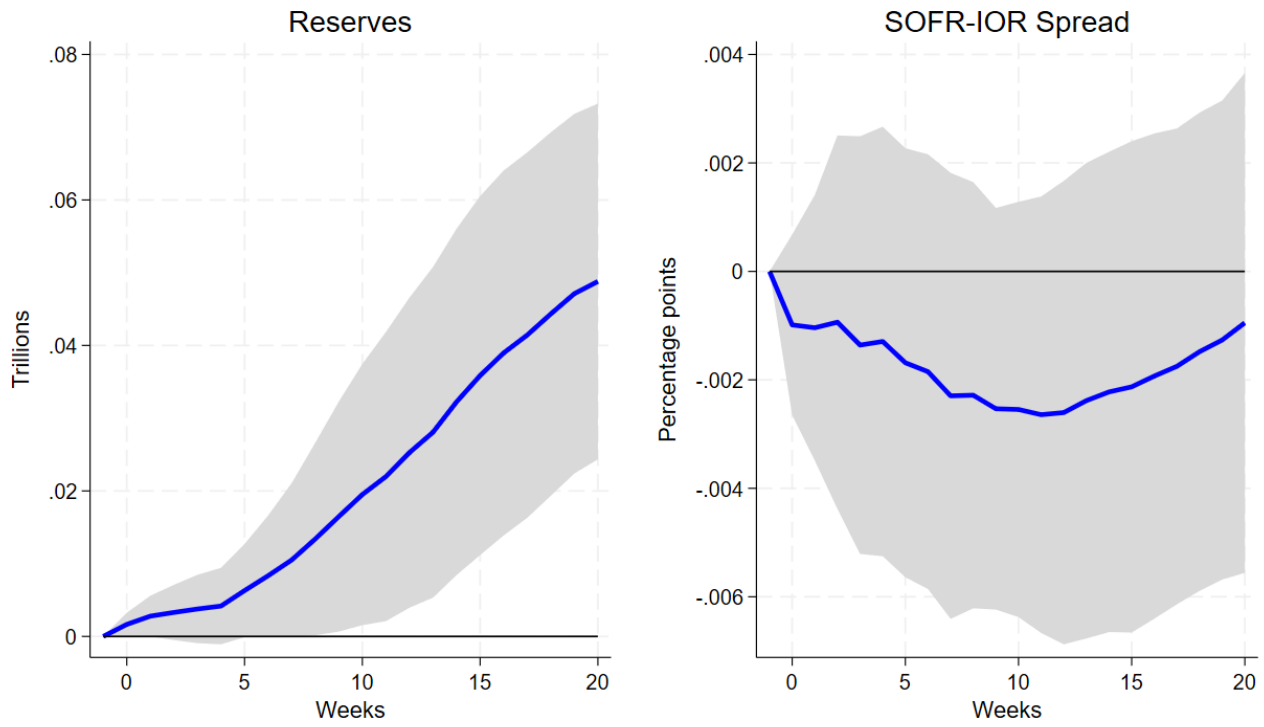

Figure 39. Money market: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

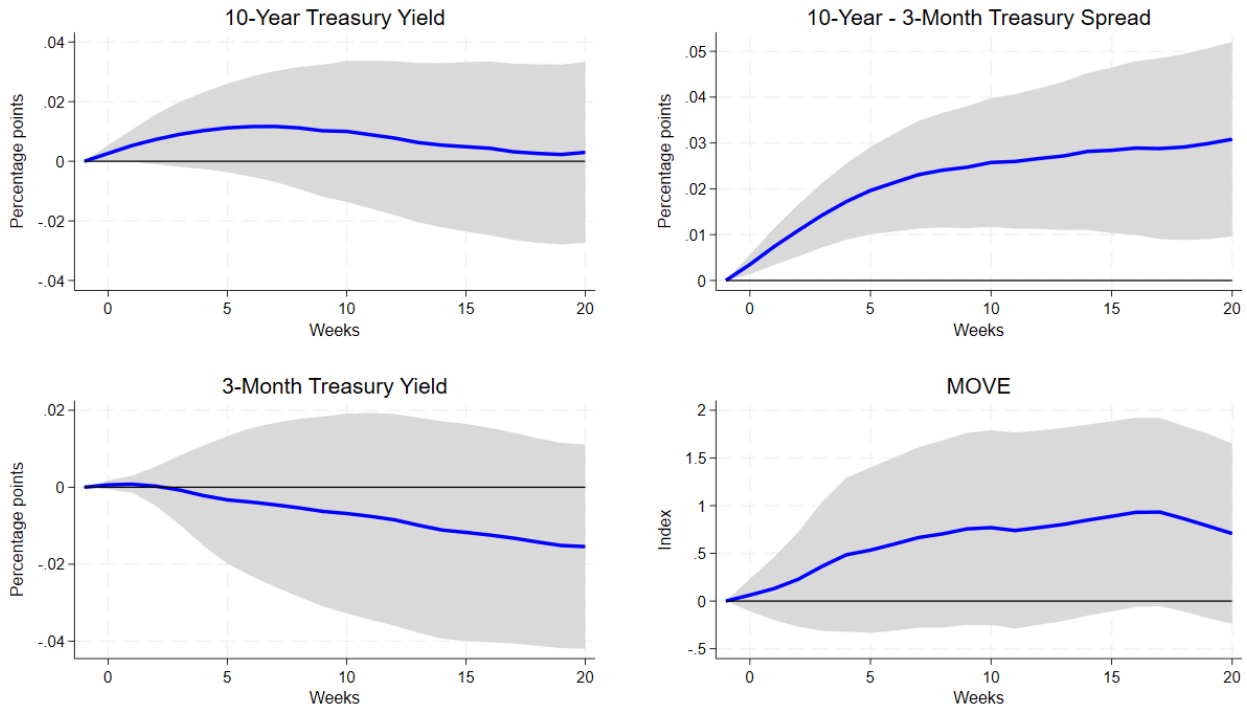

Figure 40. Treasury market: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

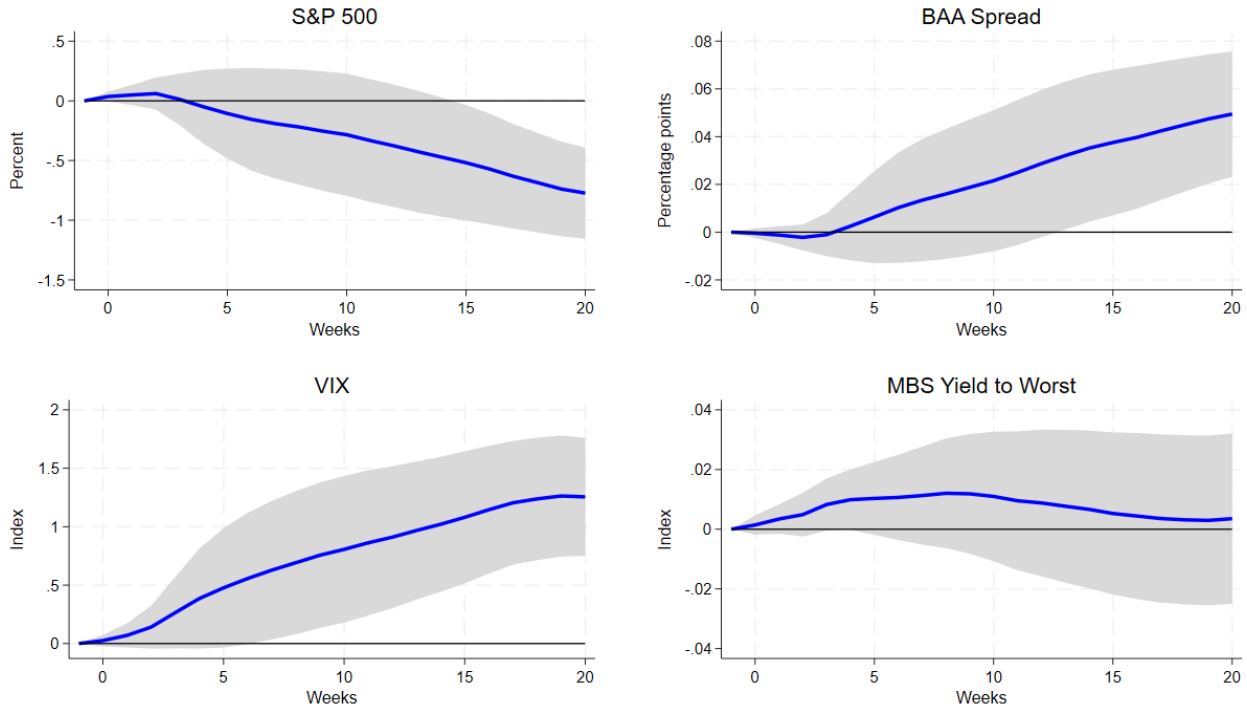

Figure 41. Other assets I: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

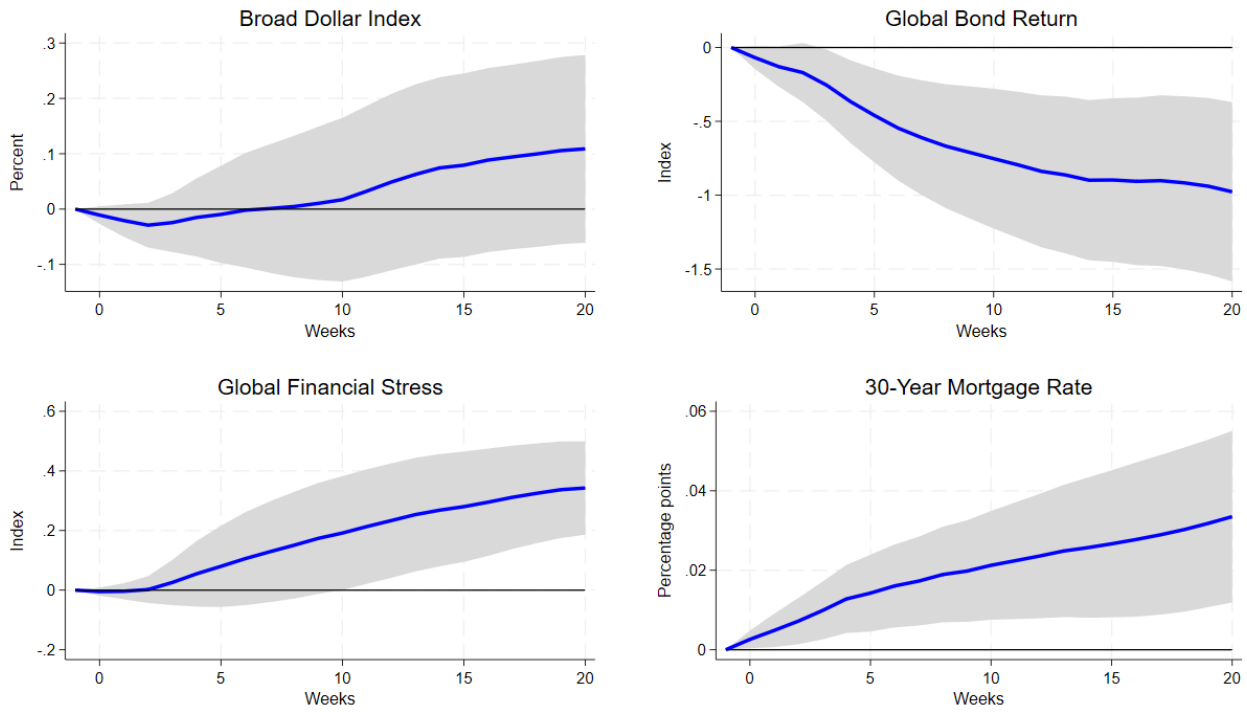

Figure 42. Other assets II: impulse responses to a 1% decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

A5.6 State Dependence (STLP)

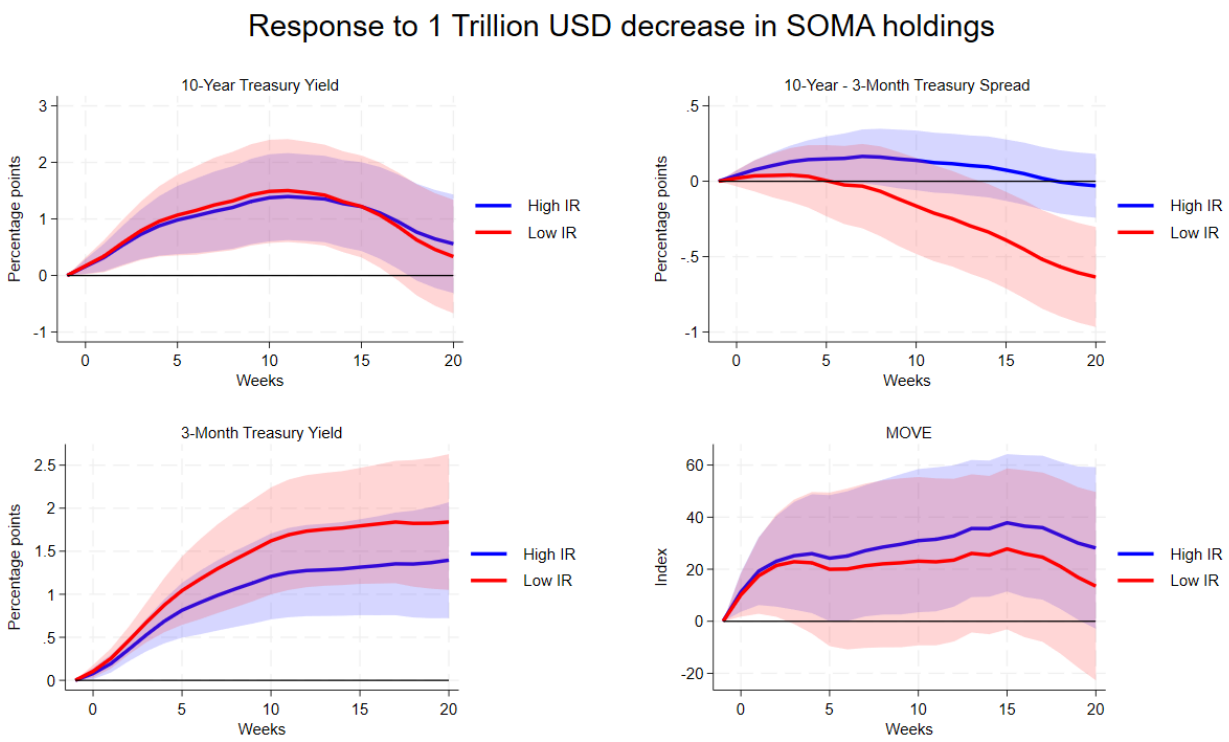

Figure 43. Treasury market: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

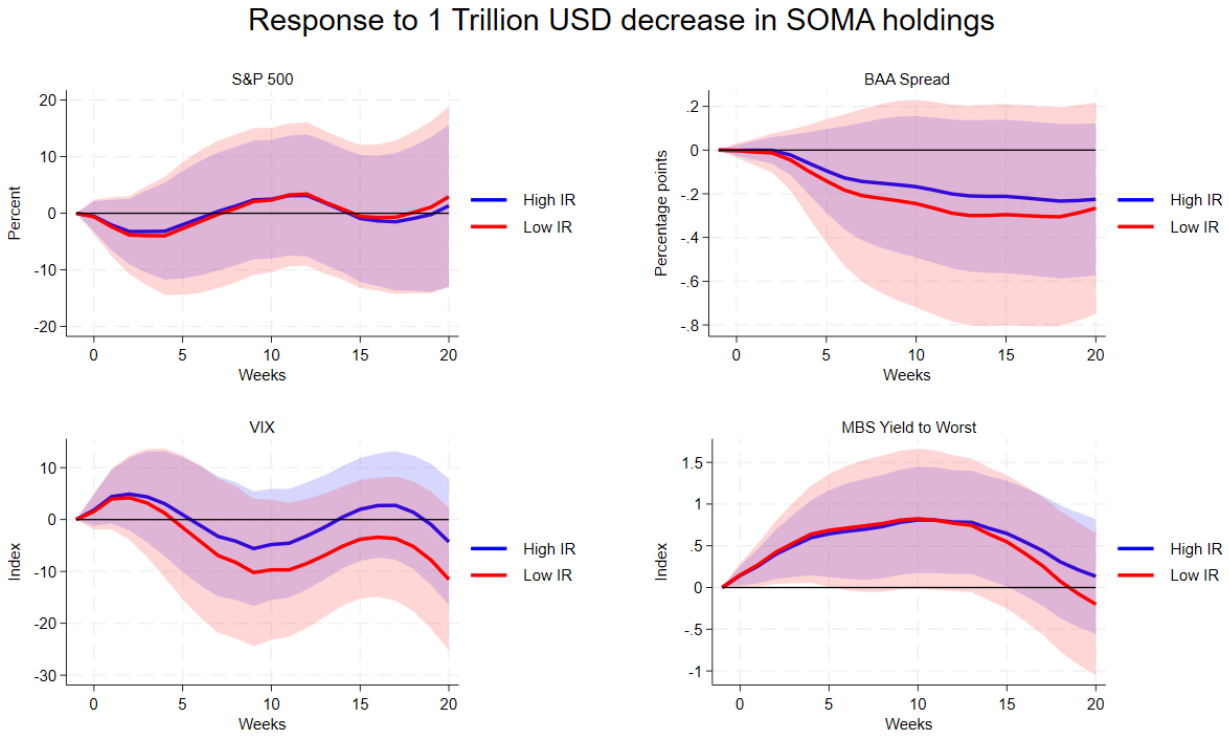

Figure 44. Other assets: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.

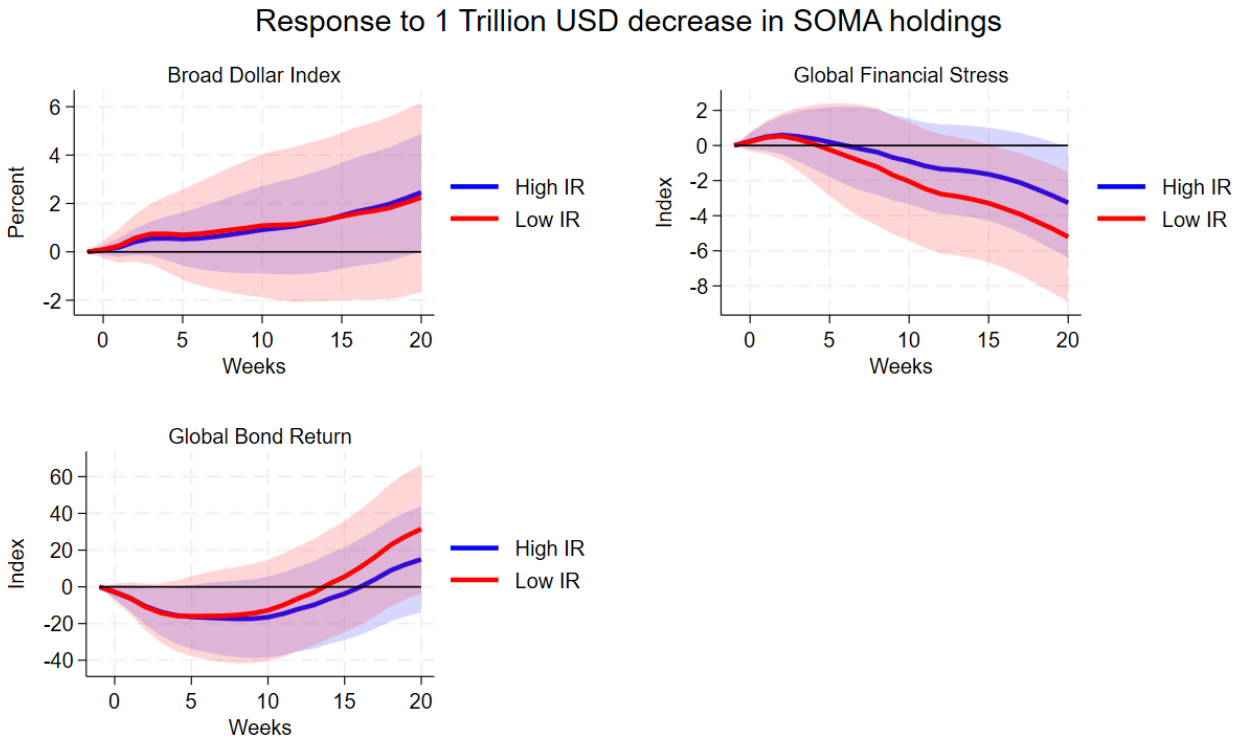

Figure 45. Other assets: impulse responses to a 1-trillion USD decrease in SOMA holdings. 90% Newey and West (1987) confidence bands displayed.