The Debt Ceiling's Disruptive Impact: Evidence from Many Markets*

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Abstract

We show that the debt ceiling significantly impacts the duration of government liabilities through an unintended interaction of the Treasury's issuance rules and the debt ceiling constraint. During debt ceiling episodes, the Treasury systematically allows more bills to mature than it issues. In recent years, this force has induced fluctuations in bill supply greater than one percent of GDP. Exploiting this, we devise an instrument for the supply of bills and show that the debt ceiling has distorted convenience premia and the price of short-term investment-grade corporate credit. We attribute the Treasury's implicit decision to lengthen the duration of its liabilities as a response to an intermediation constraint.

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1 Introduction

Over the past fifteen years, the United States has undergone a series of debt ceiling crises, during which Congress has declined to raise the debt ceiling until the last hour. During and after these episodes, financial commentators, investors and even presidents have warned of the cataclysmic danger associated with a debt ceiling breach (Obama (2011)). Explicitly referencing "repeated debt limit standoffs and last-minute resolutions," both Moody's and Standard and Poor's downgraded the rating of U.S. Treasury debt (Standard & Poor's (2011); Fitch Ratings (2023)). Despite these momentous events, there is little extant work in the finance literature studying the debt ceiling's impact on financial markets (Benzoni et al. (2023); Gallagher and Collins (2016); Stein and Wallen (2023)).

We show that the debt ceiling greatly impacts the pricing of a range of financial assets outside of CDS and treasury markets, extending broadly to money and bond markets. These effects are long-lived and can be traced to the months before and after the debt ceiling is raised or breached.[1]

Unlike prior studies focused on sovereign default risk, we emphasize that the debt ceiling affects the duration of the government's liabilities. We show that the debt ceiling causes bill supply to decline in the months before the X-date through an unintended consequence of Treasury policy. The effects we document are quantitatively large. Recent debt ceiling episodes have been associated with declines in bill supply exceeding one percent of GDP. Since 2011, debt ceiling constraints have influenced Treasury issuance policy over a third of the time.

The debt ceiling is a constraint on the sum of the face values of all outstanding Treasury debt. Once the debt limit is reached, the Treasury cannot issue additional debt without redeeming or running off existing debt of equal value (USC 31 Section 3101). Separate from the debt ceiling, the Treasury pursues a policy of "regular and predictable" bond and note issuance. Historically and currently, this policy has implied that long-term bond issuance is exceptionally stable and highly autocorrelated from quarter to quarter. The Treasury considers adherence to this framework essential for maintaining credibility with market participants (Garbade (2007)). Since 2015, the Treasury has implemented this policy by scheduling bond and note issuance every three months for the following quarter. Because the Treasury has committed to this rule, long-term Treasury issuance reflects the history of issuance decisions rather than debt ceiling considerations.

We show that the debt ceiling constraint and regular and predictable long-term debt

[1] The date at which the Treasury no longer has enough cash to meet all its obligations is called the "X-date." This is the date the debt limit would be breached in the absence of a suspension or raise.

issuance interact to generate a negative bill supply shock. Once the debt ceiling constraint binds, if more bonds and notes are issued than mature, the Treasury *must* allow more bills to mature than it issues. Otherwise, the overall level of the public debt would rise, and the debt ceiling would be breached. We exploit this feature of Treasury issuance to construct an instrument called DCIV for total bill supply. Mechanically, our instrument takes the value that the Treasury is forced to run off in bills to keep the debt ceiling inviolate, given scheduled bond and note issuance.

Next, we demonstrate that the debt ceiling's impact on government debt maturity extends beyond periods when the ceiling binds, with significant effects both before and after. Since 2011, the United States Congress has frequently decided to suspend, instead of raise, the debt ceiling. During a debt ceiling suspension, the Treasury is free to issue debt in the amounts needed to cover its spending needs. However, once the suspension period ends, the debt ceiling "is reestablished at a level that accommodates federal spending during the suspension period" (Congressional Research Service (2022)).

However, to prevent the Treasury from circumventing debt ceiling constraints entirely, Congress has mandated that the Treasury's cash balance be no larger when the suspension expires than when the suspension was implemented. This is motivated by a desire to prevent the Treasury from issuing more debt than necessary during the suspension period and indefinitely delaying when the debt limit must be again raised or suspended (H.R. 601).

For much the same logic as DCIV, we show that this rule also systematically generates a negative bill supply shock. To fulfill its legal obligations while keeping bond and note issuance stable, the Treasury systematically cuts bill offerings over the quarter before a debt ceiling suspension ends. We exploit this to create a second instrument for Treasury bill issuance, the "suspension-end instrument."

While the debt ceiling is in effect, the Treasury's cash balance at the TGA systematically decreases as the Treasury funds its outlays by drawing down this cash. Once the debt ceiling period ends, the Treasury replenishes its cash reserves by issuing bills while maintaining regular and predictable bond and note issuance. We leverage this pattern to construct our third instrument for bill supply, the "post-suspension raise instrument."

To close this part of our analysis, we show that the dynamics we describe have become more pronounced since 2015 when the Treasury significantly increased its cash balance at the Treasury General Account (TGA). This change was motivated by the Treasury's fear of losing access to capital markets due to natural disasters or cyberattacks (U.S. Department of the Treasury (2015b)). Whatever its other effects, this change has dramatically increased the ability of the Treasury to operate at the debt ceiling constraint and systematically lengthen the duration of its liabilities.

We turn to examining the impact of our instruments on the convenience premia of Treasury securities. Our analysis shows that as the maturity structure of government debt warps during debt ceiling episodes, the term structure of convenience premia distorts in tandem. We then use our instruments to characterize the effect of a change in bill supply on the yields of short-term, investment-grade corporate bonds in both the primary and secondary markets. Our IV results imply that the secondary market yields of short-term investment-grade corporate bonds decline on the order of ten basis points, for a one percentage increase in the bill-to-GDP ratio. We find that the debt ceiling has had directionally consistent effects in the primary market.

Given these results, we seek to rationalize the Treasury's decision to commit to regular and predictable. Drawing on practitioner statements and historiographic accounts, we argue that the Treasury's decision to commit to regular and predictable reflects its mission to fulfill its mandate of "financing at lowest cost over time" in the presence of an intermediation constraint (Garbade (2015)). This argument aligns with prior research that finds that dealer compensation for interest rate risk significantly influences the terms the Treasury receives in the primary market (Lou et al. (2013)).

To our knowledge, prior work has not advanced the view that intermediation constraints are an essential determinant of government debt maturity. We interpret our results as evidence that the policies the Treasury adopts in response to intermediation constraints can affect the overall maturity structure of the public debt, at least during periods of binding debt limits.

Finally, we also view our results as evidence that political dysfunction, in the form of debt ceiling brinkmanship, has aggregate consequences for financial markets. Some have questioned why the political instability that followed the 2008 financial crisis has not had more apparent effects on financial markets or the broader economy (Cochrane et al. (2024)). Prior research on the debt ceiling has found negative but relatively modest impacts on financial intermediaries, with the costs borne mainly by those intermediaries and their end investors (Gallagher and Collins (2016)). We show that political dysfunction has had far-reaching consequences beyond these intermediaries.

Behind our results lies a fundamental irony. In the 1970s and 1980s, the Treasury adopted its regular and predictable issuance policy to stabilize treasury and corporate bond markets (Garbade (2007)). In an era of debt ceiling brinkmanship, regular and predictable issuance is now producing large and arguably undesirable effects. A policy designed to promote stability has instead become a source of instability.

2 Literature Review

Relatively few papers have examined the impact of the debt ceiling. The studies most relevant to our work include Gallagher and Collins (2016), Zivney and Marcus (1989), Allen et al. (2023), and Benzoni et al. (2023). Gallagher and Collins (2016) analyze the debt ceiling's effect on money market fund flows and suggest that repo rate fluctuations around the 2011 debt ceiling were due to a decline in collateral quality. Allen et al. (2023) examine the impact of government shutdowns on money market mutual funds, finding only minor effects. Benzoni et al. (2023) focus on the 2023 debt ceiling crisis and its impact on credit default swaps. Lastly, Zivney and Marcus (1989) study the brief technical default on U.S. Treasuries in 1979, when a computer error delayed payments to bondholders.

Stein and Wallen (2023) examine the impact of the debt ceiling on money market funds and the spread between T-bill rates and rates at the reverse repo facility. Our analysis differs from theirs by focusing primarily on how the debt ceiling affects the duration of Treasury liabilities rather than the effect of technical default risk on MMF demand for Treasuries. We include additional results in the appendix studying the debt ceiling's impact on MMF demand for treasuries. We extend the results in Stein and Wallen (2023) by demonstrating that Treasuries maturing after anticipated cash inflows to the Treasury (e.g., post-tax deadline dates) act as a safe harbor for MMFs. Additionally, we show that the debt ceiling's effect on MMF treasury demand is reflected in the relative pricing of fed funds and SOFR futures contracts.

In contrast to the academic literature, some market participants, including the Treasury, recognize the debt ceiling's influence on bill supply. Professional forecasters have an extremely precise understanding of the mechanics of how debt ceiling constraints can generate fluctuations in bill supply, including the differences between suspensions and raises and the role of the TGA cash balance (Wrightson ICAP (2014, 2015)). The Treasury itself has been aware of this since at least the November 2016 meeting of the Treasury Borrowing Advisory Committee, when an unnamed TBAC member raised the possibility that debt ceiling-induced fluctuations in bill supply could affect short-term funding markets (U.S. Department of the Treasury (2016)). Relative to practitioners, we operationalize debt ceiling regulations as instruments and examine their equilibrium effects on convenience premia and corporate credit markets.

Our paper also relates to the extensive literature on the impact of political uncertainty on financial markets. Pástor and Veronesi (2012) and Pástor and Veronesi (2013) provide theoretical analyses of how political uncertainty affects stock prices, sparking a large body of subsequent work too extensive to list here. Methodologically, the closest paper to ours is

Kelly et al. (2016), which leverages the exogenous timing of elections to identify the effects of political uncertainty on asset markets. Similarly, our paper exploits the implicit and explicit rules governing Treasury issuance to generate exogenous variation in the duration of the government's debt portfolio.

In addition, our work relates to the asset demand of financial intermediaries and the equilibrium effects on asset prices. He and Krishnamurthy (2013), Vayanos and Vila (2021) and He et al. (2017) study the impact of intermediary constraints on asset prices theoretically and empirically. Our findings are closely related to studies of the effects of intermediary frictions on Treasury market functionality, such as Duffie et al. (2023), Klingler and Sundaresan (2019), Duffie (2020), Du et al. (2023), Hanson et al. (2024), Jermann (2020) and He et al. (2022). Additionally, our work intersects with literature on the determinants of convenience premia, including Acharya and Laarits (2023), Binsbergen et al. (2022), Augustin et al. (2021) and Fleckenstein and Longstaff (2024).

Since we posit that the adoption of regular and predictable issuance stems from dealer constraints, our study aligns with research examining primary dealer behavior at auctions and how they are compensated for bearing interest rate risk (Fleming et al. (2024); Lou et al. (2013); Albuquerque et al. (2024)).

Our work also relates to research on how treasury supply impacts asset prices. Krishnamurthy and Vissing-Jorgensen (2012) provide indicative evidence that Treasury debt supply influences both sovereign and corporate debt pricing, while Greenwood et al. (2010) examine the effects of bill supply on corporate debt pricing. Our study closely aligns with Greenwood et al. (2015), who construct an instrument for bill supply based on Treasury cash needs around tax deadlines. Additionally, d'Avernas and Vendeweyer (2024) investigate how treasury supply affects the pricing of close substitutes, and Selgrad (2023) explores how quantitative easing-induced changes in Treasury supply impact corporate bond pricing through a portfolio substitution channel.

3 Data

In our analysis, we make use of multiple distinct datasets. These datasets record treasury and bond prices, auction data from the Treasury as well as other data gleaned from Treasury statements. We describe them each in detail in the sections below.

3.1 Bond Data

We use data from TRACE and Mergent/ FISD datasets to study the effects on bond markets. We obtain transaction-level data on corporate bonds from the WRDS Clean Standard TRACE file and agency bonds from the WRDS TRACE - Bond Trades (Agency) files, respectively, from January 1, 2011, to December 31, 2023[2]. Since there may be multiple transactions for a cusip on a particular transaction date, we aggregate intraday transactions on a trade date to the average yield weighted by the trade quantity for all transactions on that date. We then combine these with the maturity date and rating data from Mergent/FISD, merging on cusip and using the latest credit rating issued before the trade execution date. We drop transactions for which reported yield or maturity is not available.

We winsorize TRACE-reported yields for each investment grade, high-yield, and unrated corporate bond by year-quarter at the second and ninety-eighth percentiles. We split the corporate bond dataset into different subsamples based on credit ratings. Highly rated corporate bonds are AA- (Aa3 on the Moody's scale) or higher. A-rated include those rated A- (A3 on the Moody's scale) or higher. The summary statistics are reported in Table B.1.

3.2 Treasury Data

We combine our data on corporate bonds with data from the Treasury. First, we use daily data from Treasury Direct to construct the yield curve.

For the rest of our analysis, we use additional datasets from https://fiscaldata.treasury.gov, the Treasury's website. We access this data through the Treasury's API. First, we collect historical data on Treasury auctions. We collect this data for bills and longer-term instruments like bonds and notes. Our empirical analysis focuses on changes in the supply of bills caused by the interaction of regularly scheduled bond and note issuance. For this, we use data on bond and note auctions and the offerings at the Treasury's regularly scheduled weekly bill auctions.

Finally, we pull some additional ancillary data from the Treasury. This includes data about the Treasury's receipts and outlays. We use this data to investigate the timing and nature of flows into and out of the Treasury's cash account at the Fed. The precise timing of these flows is essential for justifying our claims that specific Treasury maturities are more or less exposed to the risk of delayed payment in the appendix.

[2]Part of the WRDS Bond Database, the WRDS Clean Standard TRACE file cleans the TRACE standard file, largely following the discussion of (Dick-Nielsen (2009, 2014)). See https://wrds-www.wharton.upenn.edu/pages/support/manuals-and-overviews/wrds-bond-return/cleaning-trace-data/wrds-clean-standard-trace-file/. From the agency dataset, we drop duplicates – determined by transactions that have the same cusip, trade execution date, reported price, yield and volume.

We also use the CRSP U.S. treasury database for some of our analyses. This dataset is widely used and contains information about outstanding U.S. Treasuries. We use this dataset to study the evolution of the bill supply of various maturities.

3.2.1 Auction Schedules

We collect Treasury schedules of future bond and note issuance. These schedules are contained in text form in quarterly Treasury refunding statements. In these statements, the Treasury has made explicit quantitative forecasts since 2015 of its future issuance path. Our reading is that years prior, it made qualitative assessments of the path of future bond and note issuance that were informative but inexact. For instance, this is the statement contained in the final refunding statement of 2014:

> Treasury expects to gradually decrease coupon auction sizes over the next quarter... The reductions in auction sizes will occur in shorter-dated coupons, specifically in 2- and 3-year securities... The magnitude and duration of offering-size reductions will depend on the pace and extent of fiscal improvement. Treasury will continue to monitor projected financing needs and will make adjustments as necessary.

In contrast, all refunding statements after this date contain enough information to exactly forecast treasury offering amounts at the instrument level. We provide the text we use from each subsequent refunding statement in Table A.3 to construct future scheduled issuance.

We plot the actual offering amounts of bonds and notes and the Treasury's quarterly forecasts of bonds and notes at auctions, which we reconstruct in Figure 4. In the left-hand panel, we plot offerings of two, three, five and seven-year notes. On the right panel, we plot offerings of ten-year notes and twenty and thirty-year bonds. The dots correspond to scheduled issuance, and the lines correspond to the actual issuance.

As is visually apparent, the Treasury almost always issues the amount it announces. That is, the dots almost always overlap with the line. Between 2015 and mid-2023, there were only two periods during which the Treasury deviated from its forecast. The first is during October and November of 2015. Due to concerns about violating the debt ceiling, the Treasury moved a two-year note auction scheduled for late October to early November[3] (this corresponds to the blue line dip and spike in the left-hand panel). The second was during the onset of the COVID-19 pandemic, when the Treasury increased auction sizes to accommodate unanticipated higher spending needs due to the onset of the COVID-19 pandemic.

[3] Note that this does not affect our instrument construction, because we use scheduled issuance.

3.2.2 Cash Balance Assumptions

In addition, we use the Treasury's end-of-quarter cash balance assumptions. These are estimates of how much the Treasury anticipates holding in cash at the TGA at the end of the quarter. These are taken from the Treasury's marketable borrowing estimates. These estimates are plotted in Figure 1.

3.3 Convenience Premia

We follow the approach and methodology described in Fleckenstein and Longstaff (2024) to estimate treasury convenience premia, defined as the difference between the yield implied by a treasury's intrinsic fair market value and the yield implied by its actual traded market price. Since treasuries are not entirely risk-free, the first step is to convert a treasury with coupon c and time to maturity T into a risk-free security, with coupon $c - s$ and early payment triggered with intensity λ, where s is the CDS spread on a treasury of maturity T. λ is the default intensity implicit in the CDS spread. In the absence of arbitrage, the price of this risk-free bond will be equal to the price of a portfolio comprising a long position in the treasury and the purchase of a CDS contract. The convenience premium is then defined as the difference in the yields to maturity of this synthetic risk-free bond, and the treasury

$$\text{Premium} = \text{YTM}\left(R(c - s, \lambda, T)\right) - \text{YTM}\left(P(c, T)\right) \tag{3.1}$$

where $R(c - s, \lambda, T)$ is the price of the synthetic risk-free bond, constructed as a portfolio of long position in the treasury and purchase of a CDS contract, and $P(c, T)$ is the market price of the treasury.

The risk-free discounting curve required to calculate $R(c - s, \lambda, T)$ is constructed from the term structure of repo OIS: fixed-for-floating interest rate swaps in which the floating rate is the overnight repo rate. From 2018 onwards, SOFR OIS rate data is used, and from 2014 to 2018, the repo OIS rates are inferred by adjusting the EFFR OIS rates down by a spread of 4.50 bps[4]. We estimate convenience premium for individual treasury bills, notes and bonds, traded over the sample period 2014 – 2023.

[4]For further discussion on the quantification of this adjustment, we refer the reader to Fleckenstein and Longstaff (2024)

4 Empirical Analysis

Our empirical analysis proceeds in two steps. First, we describe the institutional details of debt ceiling regulations and how we exploit these regulations to generate exogenous variation in bill supply. We then use our constructed instruments to study the effect of changes in bill supply on convenience premia and the the pricing of corporate bonds.

4.1 Debt Ceiling Dynamics

The date at which the Treasury no longer has enough cash to cover all its obligations is called the "X-date." At this date, the Treasury must prioritize payments to bondholders over its other obligations or enter technical default.

A sequence of events occurs before the X-date. When the Treasury can no longer issue additional debt, i.e., the level of outstanding debt is equal to the debt ceiling, the Treasury declares a "debt issuance suspension period." This reflects that the Treasury can no longer issue new debt on a net basis without breaching the debt ceiling.

However, upon declaration of a debt issuance suspension period, the Treasury immediately gains access to an array of accounting maneuvers termed "extraordinary measures" (Yellen (2023a)). By using these measures, the Treasury can gain a small amount of headroom, which it historically has used almost immediately to issue new debt and increase its cash balance at the TGA, the Treasury's cash account held at the New York Fed.

The crux is that once the Treasury has exhausted the headroom afforded by extraordinary measures, the Treasury can no longer issue new debt on a net basis. We call the periods after the exhaustion of extraordinary measures until the X-date periods during which the debt ceiling binds. The length of these periods is determined by two factors. The first is the difference between the Treasury's receipts and spending obligations. All else equal, if this is more negative, then the Treasury can go less time without issuing new debt on a net basis. The second determinant is the amount of cash in the TGA as of the first date that the debt ceiling bound. The larger this number, the longer the Treasury can meet its daily cash needs without issuing additional debt.

In Figure 1, we plot the evolution of the TGA cash balance since 2011. In light red, we shade areas during which the debt ceiling bound.[5] As is apparent visually, the red-shaded periods are associated with large declines in the TGA cash balance. These periods end when the cash balance reaches zero. The slope of the line is determined by the difference between receipts and outlays.

[5] Dates for each period can be found in Table A.1.

The debt ceiling can be raised or suspended when the X-date is reached. If it is raised, then the statutory limit of the debt ceiling is increased. If suspended, the debt ceiling is voided for a pre-determined amount of time and then reinstated at the end of the pre-determined period.

Besides periods during which the debt ceiling binds, two other periods are shaded in Figure 1. We shade the periods immediately following a debt ceiling suspension or raise in light yellow. These periods are associated with pronounced increases in the cash balance at the TGA, as the Treasury seeks to increase its cash balance following declines caused by the debt ceiling. In blue, we shade periods in the quarter before a debt ceiling suspension ends. These periods are associated with declines in the TGA cash balance.

4.1.1 Bill Supply

In Figure 2, we report the evolution of the ratio of outstanding T-bills to GDP since 2011. As in Figure 1, we shade periods during which the debt ceiling bound in light red, the quarter before a suspension end in blue, and the period immediately following a suspension end or raise in yellow.

We construct this series using data from Treasury auctions, as done in Greenwood et al. (2015). As of each date, we take the sum of the face value of all bills auctioned by the Treasury on that day or before that day that have yet to expire. In our series for bills, we include cash-management bills, which have become an increasingly important component of the Treasury's debt portfolio since 2020. Because there is within-week variation in the amount of outstanding bills as some bills settle and others are issued, we plot the total amount of outstanding bills as of each Monday. We then divide by the level of nominal GDP. We linearly interpolate quarterly GDP within the quarter to avoid discrete jumps in the bill-to-GDP ratio at quarter ends.

In Figure 2, it is visually apparent that these three sets of periods are associated not only with variation in the TGA cash balance but also with the bill-to-GDP ratio. The bill-to-GDP ratio tends to fall during the periods during which the debt ceiling binds (red), rise following a debt ceiling raise or suspension (yellow) and fall in the quarter before the end of a suspension (blue).

In Figure 3, we plot the change in bill supply throughout each episode. The color scheme is the same as the prior figure. What is apparent from this figure is that debt ceiling episodes are associated with large changes in bill supply, typically measured in the hundreds of billions of dollars. Since 2020, these effects have become even more pronounced and are associated with fluctuations on the order of a trillion dollars of Treasury bills.

In the following sections, we explain the economics behind these visual patterns, why these effects have become more pronounced in recent years and how we exploit the rules governing the Treasury's actions during debt ceiling episodes to generate exogenous variation in the duration of government liabilities.

4.1.2 Debt Ceiling Instrument (DCIV)

The debt ceiling is a constraint on the total face value of all outstanding government debt.

$$\sum_{i} \text{Face Value}_{i,t} \leq \text{Debt Ceiling}_t \tag{4.1}$$

By itself, the debt ceiling constraint only limits aggregate government debt supply from increasing and does not directly affect the duration of the government's debt portfolio. However, when Equation 4.1 holds with equality, it implies that every dollar in bond and note issuance must be matched by one dollar fewer in bills.

$$\Delta \sum_{i \in \{Bills\}} \text{Face Value}_{i,t} = -\Delta \sum_{i \notin \{Bills\}} \text{Face Value}_{i,t} \tag{4.2}$$

By itself, Equation 4.1 makes no strong predictions on the evolution of government debt during debt ceiling episodes since the Treasury could adjust bond, note and bill issuance during these periods.

However, the debt ceiling interacts with the Treasury's long-standing policy called "regular and predictable" issuance (Garbade (2007)). The Treasury issues a mix of long- and short-duration debt. Unlike the issuance of bills, the Treasury announces its anticipated schedule of offering amounts of notes and bonds in quarterly refunding statements.

Thus, we can rewrite Equation 4.2 as

$$\Delta \sum_{i \in \{Bills\}} \text{Face Value}_{i,t} = -\text{Net Scheduled Issuance of Bonds and Notes}_t \tag{4.3}$$

This expression is the heart of our instrument for the change in bill supply, which we call DCIV. However, for DCIV to be a valid instrument, net scheduled issuance *cannot* endogenously adjust to Treasury demand at the frequency of debt ceiling episodes. In the following paragraphs, we explain why instrument exogeneity is likely satisfied.

The key aspect of the Treasury forecasts is that the issued amount within maturity is highly autocorrelated, and the variance is small. From month to month, the variation in the announced offerings is minimal and frequently unchanged. The Treasury does not adjust its bond and note offerings during the debt ceiling but keeps issuance stable.

This policy rule interacts with the debt ceiling, a constraint on the total face value of debt outstanding. If the Treasury designs to keep bond and note issuance constant, it must allow more bills to mature than it issues when the debt ceiling constraint binds. Otherwise, the total face value of outstanding Treasury debt would rise, and the debt ceiling would be violated. This force gives rise to the persistent declines in the supply of bills observed in the red-shaded areas of Figure 2.

To take our instrument to the data, we still need to operationalize Equation 4.3. To construct an instrument for the change in aggregate bill supply, we must first aggregate the term in Equation 4.3 over time.

$$\sum_{t_0 \leq t' \leq t} \left(\Delta \sum_{i \in \{Bills\}} \text{Face Value}_{i,t'} \right) = - \sum_{t_0 \leq t' \leq t} \text{Net Schd. LT Debt Issuance}_{t'} \tag{4.4}$$

The last step in the construction of DCIV is to account for the fact that bill auctions and bond and note auctions are not necessarily held on the same day. Therefore, total bill supply will adjust on days different from days in which bonds and notes are auctioned. To account for this, we divide the right-hand side of Equation 4.4 by the number of bill auctions in a month and multiply by a bill auction day indicator.

$$\text{DCIV}_t = \sum_{t_0 \leq t' \leq t} \left(\frac{\text{Net Schd. LT Issuance Month}\,(t')}{\text{Number Bill Auctions Month}\,(t')} \times \mathbb{I}\left\{\text{Bill Auction Day}\right\}_{t'} \right) \tag{4.5}$$

A graphical representation of our instrument is given in Figure 5. The figure displays a hypothetical auction schedule over a month. During this month, a total of \$96 billion is auctioned at bond and note auctions. At the start of the month, DCIV = \$4. At each of the eight bill auctions, the value of DCIV increments by \$12 billion. This reflects that the Treasury must reduce bill supply by \$96 billion over the month. These reductions will occur by offering fewer bills on auction days. If the Treasury cut each auction amount by the same amount within a month, the offering amount at each bill auction would decrease by \$12 billion.

The final step in the construction of DCIV is to decide when the debt ceiling constraint bound. As alluded to above, this decision is complicated by the change in bill supply caused by the Treasury gaining access to extraordinary measures. Because of the increased headroom gained from extraordinary measures, bill supply tends to increase upon the declaration of a debt issuance suspension period. These dynamics can be seen in Figure 3.

In Figure 3, we plot the evolution of bill supply for each post-2015 episode. The y-axis corresponds to billions of dollars, and the x-axis corresponds to date. As in prior figures, the red-shaded areas correspond to what we classify as periods where the debt ceiling constraint bound. Suppose the previous debt ceiling episode was resolved by suspension. In that case, we begin the plot the quarter before the end of the suspension – in this case, extraordinary measures were declared at the end of the blue region. If the prior episode was resolved by raise, we begin at the date of the declaration of extraordinary measures itself.

As is clear graphically, in all but 2021, the declaration of extraordinary measures was followed by an immediate increase in bill supply for the reasons we have described. We call periods following this immediate increase until the debt ceiling was raised or suspended periods during which the debt ceiling bound, defined as the first instance in which bill supply declined after the declaration of a debt issuance suspension period until a subsequent raise or suspension.

To test the relevance of DCIV, we regress the level of bill supply in dollars on DCIV over each period during which the debt ceiling constraint bound. In all specifications, we include an episode fixed effect.

$$\text{Bill Supply}_t = \beta_0 + \beta_1 \text{DCIV}_t + \nu_{\text{episode}} + \varepsilon_t \tag{4.6}$$

The estimates from this regression are displayed in the first column of Table 2. We find that one dollar of scheduled bond and note issuance is associated with an eighty-three cent decline in the supply of bills. That the coefficient estimate is close to one is consistent with the economic intuition for our instrument. The regression provides strong evidence that our instrument is relevant: the t-stat is larger than eleven in magnitude, and the within-R^2 from this regression is nearly seventy percent. The high within-R^2 emphasizes that debt ceiling constraints are important in these periods, even relative to other documented determinants of variation in bill supply, such as seasonal issuance associated with the tax season.

We re-estimate Equation 4.6, using the bill-to-GDP ratio as the dependent variable. Coefficient results are listed in the fourth column of Table 2. While we provide estimates using dollar amounts because of their greater interpretability, in our empirical analysis we use the bill-to-GDP ratio following Krishnamurthy and Vissing-Jorgensen (2012). Our results are not sensitive to this choice.

4.1.3 Impact of End-of-Suspension Cash Regulations

Having shown how periods during which the debt ceiling binds affect bill supply, we now study other ways in which laws associated with the debt ceiling affect bill supply. The most straightforward way to end a debt ceiling standoff is to raise the statutory debt limit. However, since 2011, Congress has frequently elected to suspend the debt ceiling instead of raising it. This entails deeming that the debt ceiling is not in force for a pre-determined time. Once the suspension period ends, the debt ceiling "is reestablished at a level that accommodates federal spending during the suspension period" (Congressional Research Service (2022)). For example, if the suspension was scheduled to end on April 12 and, on that day, the level of debt was $15 trillion, the debt ceiling would come back into force on that day at that level.

When implementing debt ceiling suspensions, Congress has been careful to rule out a tactic that the Treasury could have used to delay the need for further raises or suspensions indefinitely. While the debt ceiling is suspended, the Treasury could issue debt solely to build its cash position in the TGA. Once the debt ceiling is increased, these bonds would have been counted towards the new level that "accommodates federal spending," However, if the TGA cash level was arbitrarily large, the Treasury could finance new expenditures indefinitely without the need to issue new net debt. This would render the debt ceiling toothless.

To forestall this possibility, Congress inserted language into laws governing suspensions by requiring that the Treasury have no more cash in the TGA than when the suspension was enacted (H.R. 601). This has meant the Treasury has had to reduce its cash holdings in the quarter leading up to the end of suspensions. We formalize this relationship in the "Suspension End Instrument."

$$\begin{aligned}&\text{Suspension End Instrument}_t\\&\quad=\sum_{t_0\le t'\le t}\left(\frac{\text{Cash}\,(t_0)-\text{Cash As Of Suspension}\,(t_0)}{\text{Number Bill Auctions Quarter}\,(t_0)}\times\mathbb{I}\left\{\text{Bill Auction Day}_{t'}\right\}\right)\end{aligned}\tag{4.7}$$

The only difference between Equations 4.5 and 4.7 is in the numerator of the first term inside the summation. In Equation 4.7, the numerator is the difference between the cash the Treasury has at the start of the quarter before the end of a suspension (t_0) and the cash level as of the start of the suspension. The numerator is the total amount in cash the Treasury needs to draw down to comply with the suspension-end cash regulations.[6]

In Figure 1, the blue periods are associated with large declines in the Treasury's cash balance. This is precisely due to end-of-suspension cash regulations. We observe that the Treasury tends to cut bill offerings in the quarter before the end of a suspension, which we call end-of-suspension periods. These are the shaded blue periods in Figure 2. This

[6]In 2021, the Treasury received a legal ruling from the Justice Department that allowed the Treasury to keep a "prudential buffer" after the end of a suspension. We discuss this in more detail and how we account for it in Section A.1 in the appendix.

classification is not subject to a look-ahead bias critique as the date at which a suspension expires is set by legal statute.

For the same logic as in DCIV, the Treasury effectuates the decline in its cash balance by cutting bill supply because it wants to keep bond and note issuance roughly constant. Like DCIV, we divide by the total number of bill auctions within a quarter and multiply by a bill auction indicator. This captures the fact that the Treasury accomplishes the drawdown in bill supply by cutting the number of bills at auction in the quarter before the end of the suspension.

To assess relevance, we regress bill supply on our instrument, as in Equation 4.6. We again find strong evidence for relevance. One dollar in cash above the level of the last suspension is associated with a fifty-eight cent decline in the level of bills. The t-stat is larger than eight in magnitude and the within-R^2 is larger than sixty-seven percent.

Despite the strong evidence for the relevance of our instrument overall, there are some episodes during which bill supply does not decline in line with the logic we have described. On average, the expenditures minus receipts of the Treasury have been negative over our sample. Therefore, if there is a difference between the cash level at time t_0 and the cash level as of the suspension, the Treasury can sometimes decrease its cash level purely by meeting its normal cash needs without retiring bills.

4.1.4 Post-Raise/Suspension TGA Buildup

As our final source of variation, we also study how bill supply changes after the ceiling is raised or suspended. The duration of debt ceiling episodes is determined by the amount of cash in the TGA as of the first date that the Treasury can no longer issue debt on a net basis. Debt ceiling episodes have typically ended when the Treasury's cash balance is near zero, meaning that any delay in raising or suspending the debt ceiling would result in a technical default.

This means that once the debt ceiling is lifted, the amount of cash in the TGA is typically near zero. As is the case for the prior two instruments, the Treasury does not adjust its bond and note issuance. Therefore, the Treasury relies on increased bill issuance to rebuild its cash balance. Exploiting this, we construct another instrument called "Post-Raise/Suspension TGA Cash Buildup Instrument," or TGAIV.

$$\begin{aligned} &\text{Post-Raise/ Suspension TGA Cash Buildup Instrument}_t \\ &\quad = \sum_{t_0 \leq t' \leq t} \left(\frac{\text{Cash}\,(t_0) - \text{Target Cash}\,(t)}{\text{Number Bill Auctions Quarter}} \times \mathbb{I}\left\{\text{BillAuctionDay}\right\}_{t'} \right) \end{aligned} \tag{4.8}$$

The variation we capture can be seen in both Figures 1 and 2. After a suspension or raise, the Treasury dramatically increases its cash balance (Figure 1). It effectuates this by issuing many bills (Figure 2).

The numerator of Equation 4.8 reflects the difference between the cash as of t_0, the date the debt ceiling is raised or suspended, and the target cash level of the Treasury. Our instrument is defined over a period from the debt ceiling raise until the Treasury first increases the TGA's cash level to within five percent of its cash balance assumptions.

The first series in Figure 1 consists of the actual cash balance assumptions taken from the Treasury's quarterly marketable borrowing estimates for the quarter following the raise/ suspension. This series corresponds to the dark dots connected by a dashed line. The dots closely follow the actual level of cash in the TGA, except during debt ceiling episodes, when sometimes a wide gap opens between the target and the actual cash level. This metric is not perfect, as the Treasury appears to adjust the target cash level slightly, considering the impact of the debt ceiling. When and to what degree they do this is not transparent. Therefore, we consider three other measures.

The second is the opening of the cash balance upon the initiation of extraordinary measures. This measure is also not bulletproof, as end-of-suspension cash regulations could affect the cash balance on the imposition of extraordinary measures. Our third measure is the cash balance assumptions for the quarter just *before* the raise or suspension. This measure is arguably less sensitive to concerns about the Treasury adjusting its target cash balance in response to debt ceiling dynamics. On the other hand, the unconstrained cash balance may increase or decrease over time.

Our last measure is a six-month rolling average of weekly outlays. We take this data from FRED. The rolling average is the orange line in Figure 1. As can be seen, the rolling orange line reasonably closely tracks the stated cash balance targets.

We deem that a period is a post-suspension or raise period from the date of a debt ceiling until the first date the Treasury's cash balance is within five percent of the stated cash balance assumptions. This rule is conservative. In 2018, this rule did not capture a sizable increase in bill supply after the 2018 debt ceiling suspension due to low cash balance assumptions. It also only partially captures the increase in bill supply after the 2023 debt ceiling suspension.

We re-estimate Equation 4.6 for TGAIV using each of the four possible measures. The results are contained in Table A.5. Again, we find strong evidence for relevance; the t-stats are all large and the within-R^2 is consistently very high. The smallest within-R^2 across all four models is larger than seventy-five percent, and the largest is eight-three percent. The magnitudes are typically not as close to one as in the first instrument; we attribute this to measurement error in the actual cash balance target.

In our analysis, we use the fourth instrument, which relies on the actual six-month rolling average of outlays to construct the cash target. We find this instrument has the highest level of statistical significance and within-R^2.

4.1.5 Unintended Consequences of Increasing the TGA Cash Balance

On May 6, 2015, the Treasury announced that it would increase its cash balance held in the TGA. This was motivated by concerns that the Treasury could lose access to capital markets in extreme weather like Superstorm Sandy or events similar to the September 11 terrorist attacks (U.S. Department of the Treasury (2015b)). The consequences of this change can be seen in Figure 1. Since 2015, there has been an upward trend in the level of the cash balance at the TGA. Before 2015, the level of cash in the TGA was consistently around $100 billion. As of the start of 2024, the cash balance at the TGA was over $750 billion.

However, this policy change has had an unintended effect. It has dramatically amplified the dynamics described in the prior sections. The Treasury can accommodate more significant spending needs within debt ceiling periods when the debt ceiling constraint binds. Before and after the debt ceiling periods, the Treasury is now forced to draw down a larger cash amount at the end of suspension periods and issue more bills to reach the target cash balance.

We quantify this effect in Table 1. For each of the three periods we study, we report the change in the level of cash at the TGA, the level of cash in the TGA, the change in bill supply and the change in cash level over the episode. We report this individually for each episode, the full sample average and pre- and post-2015 averages.

The first two lines of the panel, in accordance with Figure 1, show that the level of the cash balance has dramatically increased over time, as has the change in cash balance over episodes. In the pre-2015 sample for the second panel, there was a slight increase in the average level of the cash balance. However, in all cases, the change in the cash balance is in the single digits. Conversely, in all periods post-2015, the decline in the cash balance is considerably more significant than the last periods in our sample, frequently more than 200 billion dollars.

This larger shock to the cash balance is reflected in larger changes in the quantity of bills outstanding. Pre-2015, debt ceiling episodes were associated with a decline in the bill-to-GDP ratio of 0.34%. Since 2015, there has been a nearly one percent decrease on average. In the first episode of 2021, the bill-to-GDP ratio declined by 1.82%. The same dynamics observed in Panel B can also be seen in Panels A and C. The periods after debt ceiling suspension or raises (Panel C) have resulted in a greater than 1% increase in the bill-to-GDP ratio, with large effects also observed in the pre-suspension end period (Panel A).

Interestingly, we do not observe substantial increases in the length of debt ceiling periods themselves. This is likely due to a discrete post-pandemic increase in spending. As shown in Figure 1, weekly outlays increased at the start of the pandemic and have remained elevated. Based on these numbers, we calculate that debt ceiling constraints have affected Treasury issuance policy 34% of the time between the start of 2011 and mid-2023. 20% directly through debt ceiling periods, 7% through end-of-suspension periods and 7% for post-suspension raise periods. Since 2015, we see that the total duration, including all periods, has increased slightly and affected issuance 36% of the time, relative to 28% before 2015. This increase is partially driven by the greater frequency of debt ceiling suspensions in the later years of our sample.

4.2 Economic Interpretation of Treasury Issuance Rules

Our instrument satisfies exogeneity because the Treasury has committed to an issuance rule, and while it is not legally binding, violating this rule would negatively impact the Treasury's credibility among market participants. These concerns have led the Treasury to minimize the variability of its long-term debt issuance at the frequency of debt ceiling episodes. Importantly, this means that the actual path of long-term debt issuance depends on the history of past issuance decisions and is plausibly orthogonal to debt ceiling considerations.

The question of why the Treasury found it optimal to commit to this particular issuance rule remains. While we have no direct experimental or statistical evidence to this question, we offer our interpretation, drawing on other scholarship studying the history of Treasury policy and more recent Treasury statements. We emphasize that these arguments are not critical for our identification strategy.

Even a century ago, Treasury Secretary Andrew Mellon conceptualized debt management as "providing various types of securities suited to the needs of various classes of lenders, thereby obtaining funds for needed periods at minimum cost" (Simmons (1947)). One could interpret this as catering to the demand of preferred habitat investors and investors who demand money-like assets. Today, buy-and-hold investors on the secondary market often purchase coupon-bearing instruments after primary dealers have purchased them at auction. However, this process is a relatively recent innovation, and historically and in Mellon's time, long-term bonds were placed via subscription (Garbade (2015)).

In the 1930s, one of Mellon's successors tried and failed to auction long-term debt on an ad hoc basis. This attempt failed, partly because he "*necessarily relied on the willingness of* *large New York banks and securities dealers to underwrite and distribute what the Treasury was offering.*" In the 1970's, the Treasury finally established a successful auction program. Garbade writes, quoting from correspondence with market participants, that this attempt succeeded because "regular and predictable issuance... *gave dealers an incentive to invest in underwriting and distribution capabilities targeted at investors with recurring investment needs and particular maturity preferences*" (Garbade (2015)).[7]

While "regular and predictable" is often used as a short-hand for Treasury issuance policy, recent Treasury statements have enforced that the Treasury views its issuance policy of bills and coupon-bearing instruments as distinct. The regular and predictable framework applies to coupon issuance. At the same time, bills are a "stabilizer," and the Treasury is free to vary the supply of bills in significant quantities without adverse impacts on the credibility of its framework (U.S. Department of the Treasury (2015a)).

Primary dealers purchase substantial amounts of treasury debt at auction. Recent academic work has documented that yields at Treasury auctions are higher than in the secondary market, likely due to the limited capacity of primary dealers to hold interest rate risk on their balance sheets. (Lou et al. (2013); Fleming et al. (2024); Albuquerque et al. (2024)). Our reading of Lou et al. (2013) suggests that the price impact on yields at auction for compensating primary dealers for bearing interest risk are more pronounced for coupon-bearing instruments, likely because primary dealers are more exposed to interest rate risk as they warehouse long-duration treasuries on their balance sheets.

We view the accounts given by Garbade, Treasury statements, and academic literature as closely linked. Arguably, long-duration treasuries pose unique challenges for primary dealers. Holding thirty-year bonds exposes them to much greater duration risk than bills. Beyond this, the set of buy-and-hold bond investors is much smaller than bills, potentially making it more difficult for dealers to place. In both accounts given by Garbade, the emphasis is on incentivizing intermediaries to invest in the technology used to match Treasury issuance with end investors.

Based on this reasoning, we interpret the Treasury's "regular and predictable" policy as consistent with the Treasury fulfilling its mandate "to finance the government at lowest cost over time" in the presence of an intermediation friction. By committing to this rule, the Treasury ensures that end investors and primary dealers will have the funds to purchase Treasury securities. It also limits the time that primary dealers have to warehouse Treasury securities on their balance sheets, for which they demand compensation at auction for interest rate risk. While this policy rule has the negative side effect of distorting capital markets during debt ceiling episodes, minimizing capital market distortions is not an explicit goal of

[7]This quote is from Lou Crandall, whom we also thank for his helpful comments.

Treasury debt management, which is "to finance at lowest cost over time."

These observations are interesting because they suggest that a first-order concern of Treasury issuance is managing flows through dealers. Further, the policies that the Treasury has adopted to facilitate these flows can affect the overall maturity structure of the public debt, at least during debt ceiling episodes. To our knowledge, financial frictions like these do not enter into workhorse macro-finance models of public debt determination.

4.3 Convenience Premia

We now turn to examining how our instrument-driven variation in bill supply affects the term structure of convenience premia. To do this, we regress the daily average convenience premium of all treasuries within a given maturity bucket on the instrumented bill-to-GDP ratio, controls and an episode fixed effect. We include both on-the-run and off-the-run treasury bills in this average.

$$\text{Convenience Premium}_{t,m} = \beta \text{Bill / GDP}_t + \boldsymbol{\gamma}' \boldsymbol{X}_t + \eta_{e(t)} + \varepsilon_{t,m} \tag{4.9}$$

Our maturity buckets stretch from less than one month to maturity until 30 years to maturity. In all regressions, we use Newey-West standard errors to account for potential serial correlation.

In all regressions, we control for the level of the effective federal funds rate, the spread on a five-year US sovereign CDS, the level of the VIX, and the market return. In these choices, we largely follow the approach of Krishnamurthy and Vissing-Jorgensen (2012). However, unlike those authors, we do not control for the yield spread between ten-year and two-year Treasuries. As shown below, the variation we exploit also affects this spread, making it a bad control in our setting. We likewise do not use GDP growth, as it varies little and is frequently constant within the periods we consider.

We use the US Sovereign CDS spread in two ways. It first enters into our construction of convenience premia, as described in Section 3.3. We also include it as a control to soak up any residual variation in convenience premia generated by time-varying sovereign default risk. We include the VIX to account for general economic uncertainty and the federal funds rate as a proxy for the monetary policy stance.

Our baseline specification uses all three instruments, with the instrument used in our first stage constructed as

$$\begin{aligned}\text{Instrument}_t =& \text{DCIV}_t \times \mathbb{I}\left\{\text{Debt Ceiling Binds}\right\} \\ &+ \text{SEIV}_t \times \mathbb{I}\left\{\text{Suspension End Period}\right\} \\ &+ \text{TGAIV}_t \times \mathbb{I}\left\{\text{Post Suspension Raise}\right\}\end{aligned} \tag{4.10}$$

We refer to this as the "combined instrument" to distinguish it from using DCIV, SEIV or TGAIV alone.

The results from this regression are given in Table 3. As anticipated, we observe heterogeneous effects across the term structure of convenience premia. The largest effects are for bills that are very close to maturity. A one percentage point increase in the bill-to-GDP ratio depresses the convenience premium of treasuries with less than one month to maturity by 8.3 basis points. These effects taper off monotonically across the maturity structure of treasury debt. The average effect over all T-bills is a decline of 6.1 basis points. Bills with one to three months to maturity decline by 6.1 basis points, while bills with between six and twelve months experience only a 4.6 basis point decline in convenience premia.

There is a pronounced shift when crossing the threshold from bills to notes. The estimated effect drops from -4.6 to -0.38 basis points and is no longer significant. Further along the term structure, we find a statistically significant effect on the convenience premia of notes with maturities between two and three years, as well as between three and five years.

These effects at the long end of the term structure make sense when considering that our debt ceiling instrument exploits variation that comes from both decreasing the supply of bills and increasing the supply of notes. However, our other two instruments do not necessarily exploit the same variation. Those instruments exploit variation in bill supply associated with adjustments to the Treasury's cash balance and do not have strong implications for the supply of longer-maturity instruments. We, therefore, re-run the regression in Equation 4.9 with each instrument separately.

As expected, our results differ substantially at the long end of the yield curve when using different instruments. Neither specification using TGAIV or SEIV as an instrument alone has a statistically significant positive effect on Treasuries with more than one year to maturity. This is consistent with the fact that, during the pre- and post-period, the variation we exploit is not mechanically associated with changes in bond and note supply. The effect of TGAIV on bills is quantitatively similar to the estimate obtained from pooling all three instruments and using DCIV alone. The effect of SEIV alone is slightly attenuated, likely due to a weaker first stage.

We then examine the performance of DCIV. Despite the loss of observations, DCIV alone performs more strongly than the combined instrument, with estimated effects almost uniformly larger in magnitude. Bills with less than one month to maturity experience a nearly ten basis point decline in convenience premia. Unlike our baseline specification, we also observe stronger differences between the effects on bills and notes. A one percentage point increase in the bill-to-GDP ratio leads to a 3.1 basis point decline in the premia of bills with six to twelve months to maturity but is associated with a 2.8 basis point *increase* in the convenience premia of notes. Over the long end of the yield curve, we observe a consistent increase of approximately four basis points in bonds and notes.

These results are consistent with heterogeneous convenience services of treasury securities across maturities. Investors wanting to hold bills for their money-like properties cannot fully replicate these services by holding notes or bonds. Thus, although the total amount of treasury debt is unchanged, the convenience premia for bills, specifically, increases as they become scarcer. This interpretation is bolstered by the comparatively sharp discontinuity between the six to twelve-month and one to two-year maturity buckets.

In Table 3, we observe that the ten-to-twenty-year maturity bucket is the only category greater than two years that does not have an estimated coefficient between four and five. This may be due to the discontinuation of twenty-year auctions for a substantial portion of our sample. Motivated by this observation, we investigate whether the effects we document differ for on- versus off-the-run treasuries. Following Fleckenstein and Longstaff (2024), we define an on-the-run Treasury as the cusip most recently issued. The number of observations between these regressions can differ for two reasons. First, data for some cusips is missing on some days in Treasury Direct. Second, as already mentioned, the twenty-year bond was not issued for a significant portion of our sample.

The results from these tests, presented in Table A.4, are inconclusive. Our results differ across on- and off-the-run treasuries when using the combined instrument. However, when using DCIV alone, there are no apparent differences.

A consistent feature of our empirical results is the high R^2 from our regressions, often around 80%. It is striking that such a parsimonious model explains a large share of the variation in convenience premia during these episodes.

We use Newey-West standard errors in all specifications to account for potential serial correlation. Variation in our instrument is driven by the Treasury's bill auction schedule. There are bill auctions every week. Typically, the Treasury auctions bills on Mondays and Tuesdays, with settlements occurring on Thursdays of the same week. This weekly pattern of auctions and settlement drives the variation in our instrument. Our dependent variables appear to adjust almost immediately to the changes in T-bill supply induced by this process. This is different from Greenwood et al. (2015), who exploit lower frequency variation in bill supply driven by seasonal variation in cash needs attributable to the tax calendar.

Based on this reasoning, our primary econometric concern is autocorrelation in our instrument due to the weekly frequency of the Treasury auction schedule. Therefore, our baseline specifications use Newey-West standard errors with weekly lags. In the appendix, we assess the robustness of our results to longer lags, up to two months. Our interpretation of this exercise is that our main findings—particularly the performance of regressing convenience premia on the variation induced by DCIV—remain robust to lags of up to two months.

4.4 Effects on the Pricing of Corporate Debt

Prior work suggests that changes in the supply of treasury bills should affect the pricing of substitutes, particularly highly rated corporate debt (Krishnamurthy and Vissing-Jorgensen (2012), Greenwood et al. (2015)). Motivated by this evidence, we investigate to what degree fluctuations in bill supply associated with debt ceiling dynamics affect the pricing of corporate credit.

To assess whether debt ceiling-induced fluctuations in bill supply impact corporate credit pricing, we plot the evolution of investment-grade corporate bond yields around the 2017 debt ceiling increase. We focus on this event due to the absence of other major macroeconomic shocks that could confound a purely graphical analysis.

As shown in Figure 1, the September 2017 debt ceiling suspension was associated with an increase in the cash balance at the TGA from approximately 100 to 250 billion collars. To effectuate this increase, the treasury issued a large amount of bills, as can be seen in Figure 2. These mechanics are as we have described in earlier sections.

Figure 6 shows the evolution of corporate bond yields immediately following the suspension and the coinciding increase in bill supply. We observe sharp and heterogeneous effects on corporate bond yields. Within three months, yields on short-term investment-grade corporate credit rose by nearly twenty-five basis points. While similar effects appear across the term structure, they diminish for bonds with longer durations.

This visual pattern bolsters our argument that the effects we estimate are driven by changes in bill supply. The evolution of corporate yields is gradual, reflecting the measured increase in bill issuance. It also heterogeneously affects short-term investment-grade corporate bonds, which are exactly those that should be substitutable with treasury bills. In contrast, high-yield corporate bonds, shown in the lower panel, display no systematic movement.

Before the debt ceiling increase, short-term investment grade corporate bond yields show little movement. At first, this may seem puzzling, given our earlier arguments. However, the extent of the decline in bill supply depends on the magnitude of net scheduled bill issuance. In 2017, net scheduled long-term debt issuance was relatively small, as shown in Figure 3.

In the bottom panel of Figure 6, we plot the evolution of high-yield corporate bond yields. Since these bonds carry substantial credit risk and are less substitutable with Treasuries, we expect their yields to show less interpretable variation, if any, around the end of debt ceiling episodes. As anticipated, this expectation is borne out. Yields exhibit little fluctuation and do not display the clear pattern of increases observed for investment-grade credit.

We formalize the visual analysis from Figure 6 in Table 4, where we estimate the same regressions used for convenience premia but replace the dependent variable with investment-grade corporate bond yields.

$$\text{Yield}_{m,t} = \beta \text{Bill / GDP}_t + \boldsymbol{\delta}' \boldsymbol{X}_t + \gamma_{e(t)} + \epsilon_{m,t} \tag{4.11}$$

m indexes maturity to denote that we estimate these regressions over different maturity buckets. In the first stage, we instrument the bill-to-GDP ratio with our combined instrument. Yields are expressed in basis points. The average is weighted by transaction volume. We estimate this regression over all years 2015 and following. Because the Treasury did not publish explicit auction schedules prior to 2015, we are unable to construct DCIV for these years.

In all specifications, we include a battery of controls. We try hard to purge confounding variation from our empirical tests. As in our specifications studying convenience premia, we include controls to rule out that our results could be driven by other effects of the debt ceiling, for instance, time-varying default risk or general economic uncertainty.

As in Equation 4.9, we include as controls the VIX, the spread on a five-year US sovereign CDS, the federal funds rate and the market return. Even after including these controls, we still find that there are a few contemporaneous events that affect our estimates of credit spreads, which we also control for. Our debt ceiling events in 2021 are contemporaneous with the drawdown in the Federal Reserve's secondary market corporate credit facility (SMCCF). This directly affects spreads as it increases the supply of corporate bonds trading in secondary markets. To account for this, we control for cumulative SMCCF sales in all specifications.

Likewise, we find that the turmoil surrounding the failure of Silicon Valley Bank (SVB) significantly affects credit spreads in 2023. We include an indicator for the period after the failure of SVB to purge these effects. Finally, we also include an indicator for the September tax date taking the value one in the first two weeks of September. We find that seasonal variation in bill supply around this date specifically affects our estimates.

The regression results in Table 4 confirm our visual evidence, showing a pronounced increase in yields for short-term investment-grade corporate bonds. Specifically, yields rise by approximately 5.5 basis points for bonds with one month to one year to maturity and by 7.8 basis points for bonds with one to two years to maturity.

Somewhat more surprisingly, we observe pronounced effects for longer-term corporate bonds. The effect on bonds with maturities of seven to ten years is even larger in magnitude than for those with one to two years. As with our results for convenience premia, we hypothesize that this reflects the different types of variation exploited across instruments.

To test this hypothesis, we re-estimate the regression separately for each instrument. Consistent with our findings on convenience premia, we find that positive effects at the long end of the yield curve are driven by the post-instrument. In the post-period, when there are no restrictions on debt issuance, both notes and bills are often issued in positive amounts. In contrast, when examining DCIV specifically, we find that bill issuance is associated with an increase in yields for very short-term investment-grade corporate bonds but has no effect on longer-term yields. When using DCIV specifically, we observe increases in yields of twelve basis points, for a one-point increase in the bill-to-GDP ratio. This magnitude is close to that observed for convenience yields of similar maturity in Table 3.

As with our convenience premia regressions, we use Newey-West standard errors with lags up to one week.

4.5 Primary Market for Corporate Credit

To this point, our analysis has focused on secondary market prices. We have shown that the debt ceiling affects the prices of securities that have already been issued but have not studied whether the debt ceiling affects the cost of capital paid by issuers themselves.

We study this by estimating

$$\text{Primary Market Yield}_{i,t} = \beta \text{Bill-to-GDP Ratio} + \boldsymbol{\delta}' \boldsymbol{X}_t + \gamma_{e(t)} + \nu_{\text{rating}} + \xi_{i,t} \tag{4.12}$$

In the first stage, we instrument the bill-to-GDP ratio using the combined instrument. We include the same set of controls as when studying secondary market yields. These include controls for sovereign default risk, uncertainty and concurrent events that might affect our estimates. We do not separately estimate these effects using each instrument because there are relatively few investment-grade issuers that issue ultra-short corporate bonds with less than two years to maturity.

The results from this specification can be seen in Table 5. We find results consistent with the effects we documented in secondary markets. While these regression results align with our previous findings, some important caveats remain. Few investment-grade issuers offer very short-term debt, resulting in a limited number of observations and somewhat underpowered regression estimates. We include them because they are consistent with our prior estimates from the secondary market. Reassuringly, the only effects with meaningful magnitudes appear for bonds with high credit quality and short maturity, precisely those that should be substitutable with Treasury bills. The effects for lower credit quality debt and longer-term debt are insignificant, despite many more observations.

5 Conclusion

We show that the debt ceiling has large effects on money and bond markets. Different from prior literature, we do not focus on the risk of sovereign default. Instead, we show that the debt ceiling distorts the maturity structure of Treasury liabilities.

When the debt ceiling binds, the Treasury cannot issue more debt without redeeming or allowing to run off debt instruments of equivalent face value. In addition to this, the Treasury has a pre-scheduled and nearly constant schedule of bond and note issuance. Taken together, when the debt ceiling binds every dollar of net positive long-term debt issuance implies a dollar of net negative bill issuance. We exploit this to construct an instrument for net bill issuance. Our preferred IV specification implies that a one point increase in the bill-to-GDP ratio increases short-term investment-grade corporate bond yields on the order of ten basis points.

We show that these dynamics have been greatly amplified post-2015, which we attribute to an unintended consequence of Treasury policy changes. In 2015, the Treasury decided to hold much larger cash balances in the Treasury General Account at the New York Fed (U.S. Department of the Treasury (2015b)). This has greatly extended the period that the Treasury can operate under extraordinary measures without issuing new debt on a net basis. Interacting with the policy of regular and predictable issuance, this has resulted in periods where the Treasury has systematically increased the duration of its liabilities by running off bills and issuing bonds and notes.

We hope our study encourages further research on the role of Treasury rules in shaping the maturity structure of public debt and the economic forces behind those rules. We posit that the Treasury adopted its policy of regular and predictable issuance in response to intermediation constraints, aligning with narratives from historical and practitioner accounts. Our empirical results further suggest that rules designed to support dealers can have significant effects on debt maturity.

Beyond this, we highlight a deep irony. Regular and predictable issuance was adopted by the Treasury, in part, to promote stability in debt markets (Garbade (2007)). In an era of debt ceiling brinkmanship, regular and predictable has itself become destabilizing.

Figure 1
TGA Cash Balance

This figure displays the evolution of TGA cash balances from 2010 onwards. Four regions are shaded. The red-shaded region corresponds to periods after the declaration of a “debt issuance suspension period” and the exhaustion of extraordinary measures. The yellow-shaded regions are periods immediately following a debt ceiling suspension or raise. The blue-shaded areas are periods immediately before the expiration of a debt ceiling suspension when the treasury is legally obligated to reduce its cash balance. The dark blue line corresponds to the TGA’s cash balance. The orange line corresponds to a six month rolling average of the treasury’s weekly outlays. The remaining line corresponds to the treasury’s stated cash balance assumptions.

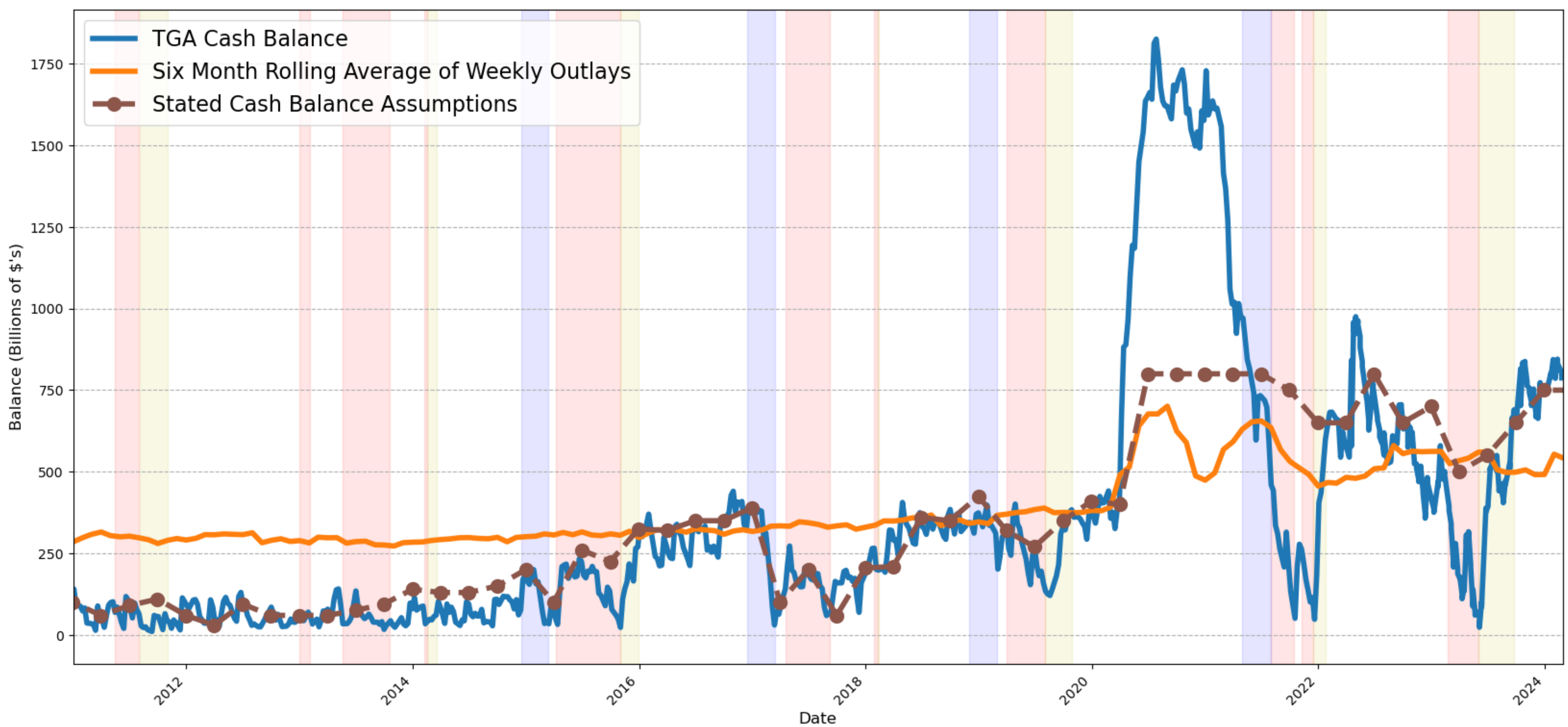


Figure 2
Evolution of Bills / GDP

This figure displays the evolution of the ratio of outstanding bills to GDP between 2011 and 2024. Four regions are shaded. The red-shaded region corresponds to periods after the declaration of a "debt issuance suspension period" and the exhaustion of extraordinary measures. The yellow-shaded regions are periods immediately following a debt ceiling suspension or raise. The blue-shaded areas are periods immediately before the expiration of a debt ceiling suspension when the treasury is legally obligated to reduce its cash balance.

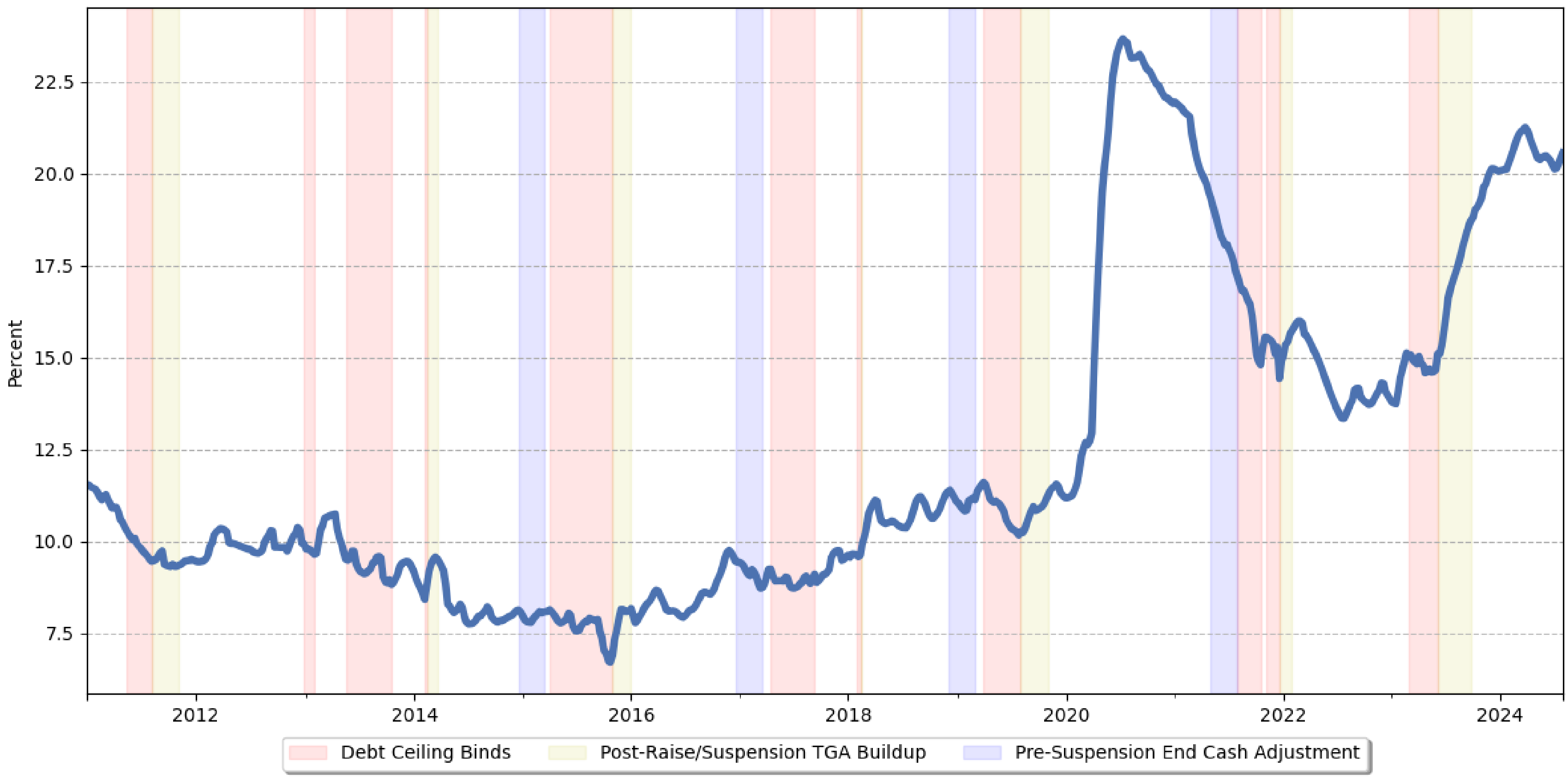


Figure 3
Headroom

This figure displays the evolution of bill supply in dollar amounts around each of of the post-2015 debt ceiling episodes. In all panels, the y-axis corresponds to billions of dollars. The x-axis corresponds to dates. The red-shaded region corresponds to periods after the declaration of a "debt issuance suspension period" and the exhaustion of extraordinary measures. The yellow-shaded regions are periods immediately following a debt ceiling suspension or raise. The blue-shaded areas are periods immediately before the expiration of a debt ceiling suspension when the treasury is legally obligated to reduce its cash balance.

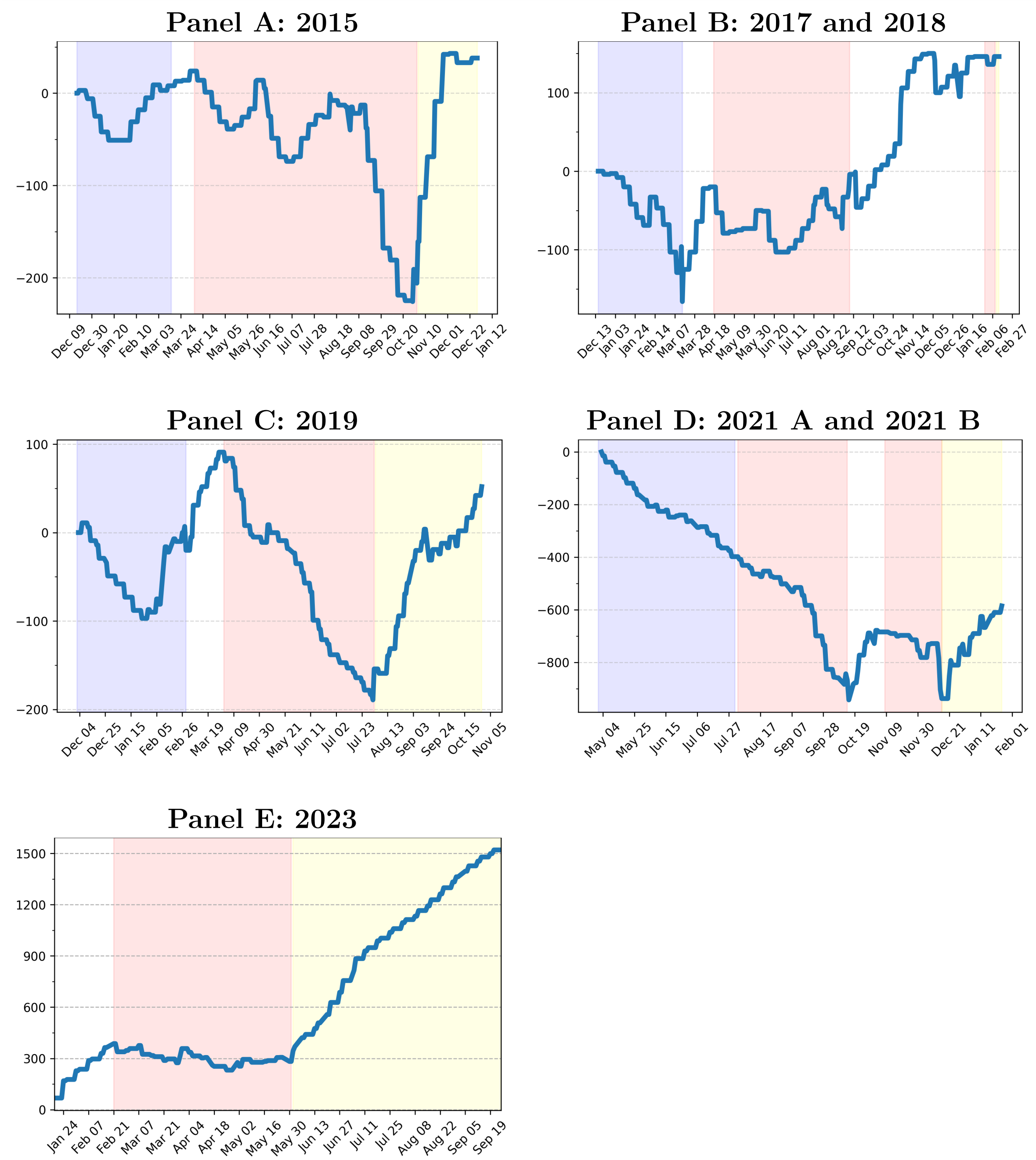
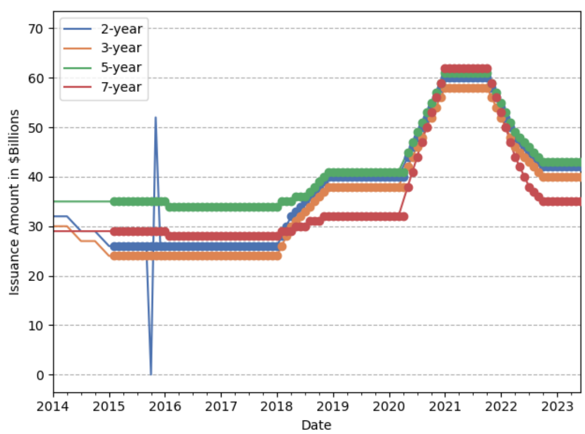


Figure 4
Auction Offering Actual and Scheduled Amounts

This figure reports the actual and scheduled path of bond and note issuance between 2014 and mid-2023. The dots correspond to the scheduled issuance within that quarter. The lines correspond to the path of actual issuance.



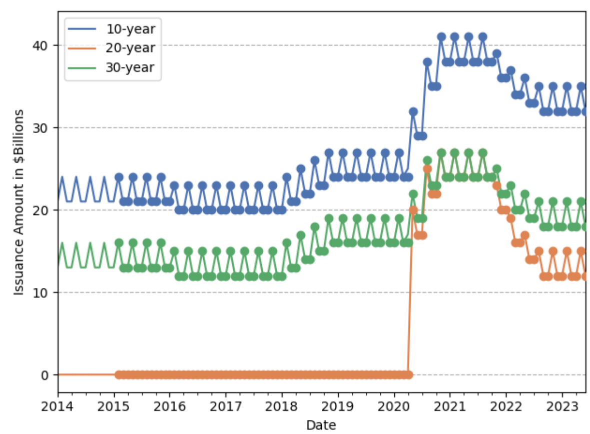


Figure 5
DCIV

This figure illustrates the construction of DCIV, given a hypothetical auction schedule. In this month, there is $96 billion dollars total of scheduled bond and note issuance, spread out across four bond and note auctions. In addition there are eight bill auctions. The initial value of the instrument is $4. Every day that there is a scheduled bill auction, the value of the instrument increases by $96 / 8. At the start of the next month, assuming the debt ceiling constraint is still in effect, the value of the instrument would start at $100.

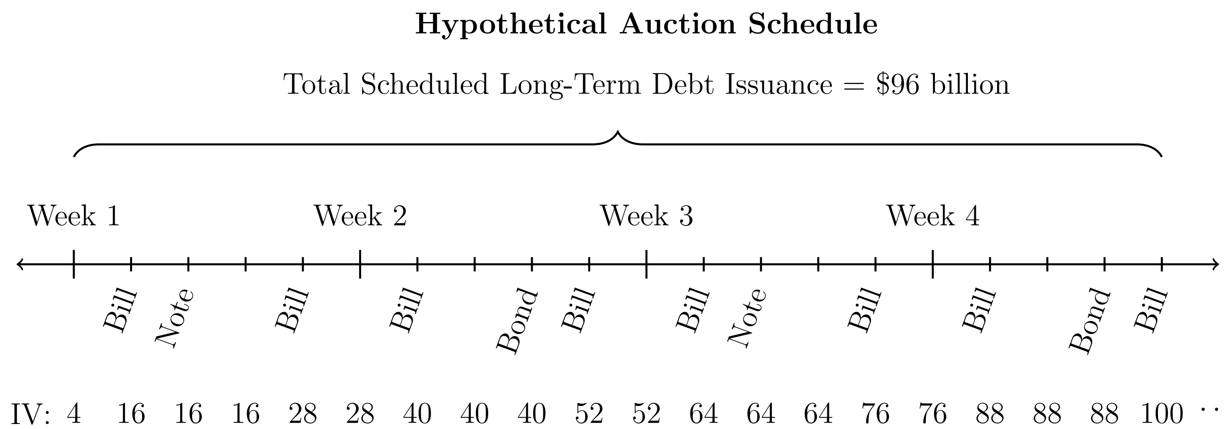
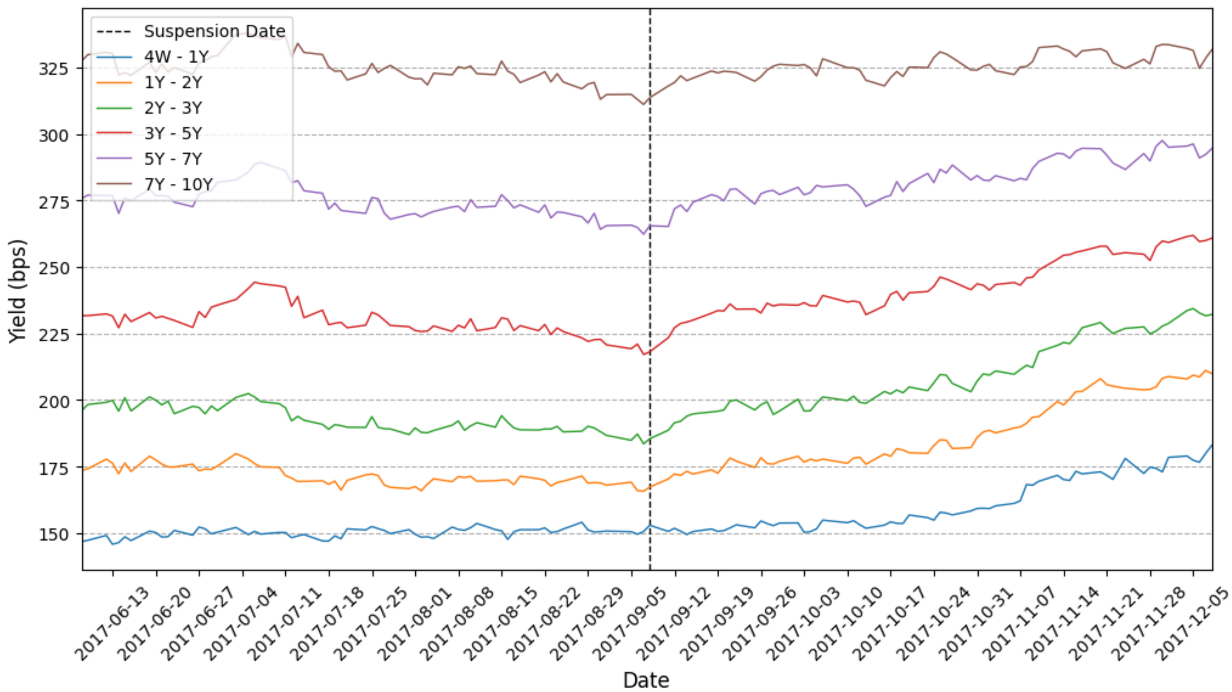


Figure 6
2017 Episode and Effect on Corporate Yields

In this figure, we plot the evolution of investment-grade and high-yield corporate bond yields for the three months before and after the 2017 debt ceiling suspension in early September. The suspension date is marked with a horizontal dashed line. Each remaining plotted line corresponds to the average bond yield within the indicated maturity bucket.

Panel A: Investment Grade Corporate Bonds



Panel B: High Yield Corporate Bonds

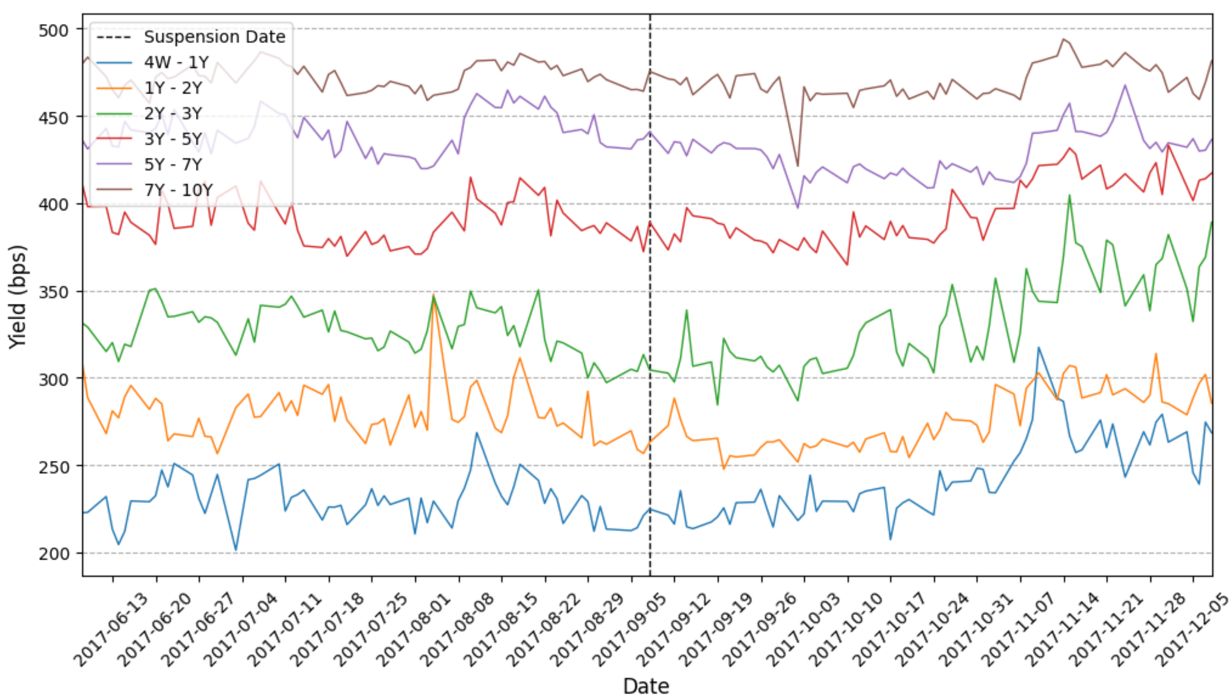


Table 1
Debt Ceiling Episode Summary Statistics

We report summary statistics for debt ceiling episodes for pre-suspension end periods, debt ceiling periods and post-raise or suspension periods in the first, second and third panel respectively. For each of these panels we report the cash balance at the TGA for the outset of the event and end of the event respectively. We also report the change in the Bill to GDP ratio in percent and the change quantity of bills outstanding in billions of dollars. For both of these calculations we include cash management bills. In the last line we report the days in the episode. In the rightmost panel, we report averages for the pre-2015, post-2015 sample and full sample. For these averages, we treat the following as single episodes: 2013 A, 2013 B and 2014; 2017 and 2018; and 2021 A and 2021 B. We explain in Section A.2 why we group episodes in this manner.

	Episode											Sub-Samples		
	2011	2013 A	2013 B	2014	2015	2017	2018	2019	2021 A	2021 B	2023	Pre-2015	Post-2015	All
Panel A: Pre-Suspension End														
Cash Balance Outset ($B)					169.5	378.14		344.87	970.72					
Cash Balance End ($B)					27.96	76.97		290.67	501.18					
Δ Cash Balance ($B)					-141.54	-301.17		-54.21	-469.54				-193.29	-138.06
Δ Bills / GDP (%)					-0.04	-0.57		0.01	-2.14				-0.55	-0.39
Δ Bills Outstanding ($B)					8.0	-166.0		-20.0	-398.0				-115.2	-82.29
Days in Episode					87	89		88	88				70	50
Panel B: Debt Ceiling Period														
Cash Balance Outset ($B)	69.07	58.77	34.22	35.67	51.52	141.25	265.89	334.01	459.4	263.02	508.29			
Cash Balance End ($B)	66.96	56.9	31.87	42.58	22.89	51.97	202.64	117.63	72.46	58.29	22.89			
Δ Cash Balance ($B)	-2.11	-1.86	-2.35	6.91	-28.63	-89.27	-63.25	-216.38	-386.94	-204.73	-485.39	0.3	-294.92	-210.57
Δ Bills / GDP (%)	-0.79	-0.3	0.01	0.39	-1.24	-0.14	-0.01	-1.33	-1.82	-0.5	-0.33	-0.34	-1.07	-0.87
Δ Bills Outstanding ($B)	-124.0	-21.0	-85.0	69.0	-230.0	15.98	0.0	-245.0	-469.0	-253.0	-11.0	-80.5	-238.41	-193.29
Days in Episode	78	35	150	7	210	144	11	123	73	38	100	135	139	138
Panel C: Post-Raise or Suspension														
Cash Balance Outset ($B)	52.07			33.15	25.15		198.58	133.67		42.11	71.22			
Cash Balance End ($B)	61.03			136.08	315.26		206.49	393.74		619.7	465.12			
Δ Cash Balance ($B)	8.97			102.93	290.11		7.91	260.07		577.59	393.9	55.95	305.92	234.5
Δ Bills / GDP (%)	-0.11			0.52	1.05		-0.0	1.3		1.73	1.08	0.2	1.03	0.8
Δ Bills Outstanding ($B)	2.0			99.0	199.0		0.0	206.0		352.0	356.0	50.5	222.6	173.43
Days in Episode	91			28	56		1	85		39	25	59	41	46

Table 2
Endogenous Regressor on Instrument

This table presents regressions of the endogenous regressor on each of our instruments: DCIV, SEIV, and TGAIV. In the first three specifications, the dependent variable is the dollar amount of bill supply. In the next three, the dependent variable is the bill-to-GDP ratio.

Dependent Variables:	Bill Supply ($100B)			Bill-to-GDP Ratio		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Debt Ceiling Instrument	-0.8254***			-0.0044***		
	(-11.72)			(-13.78)		
End-of-Suspension Instrument		-0.5836***			-0.0033***	
		(-8.222)			(-8.804)	
Post-Raise/Suspension Instrument			-1.751***			-0.0062***
			(-10.05)			(-11.97)
Fixed-Effects						
Episode	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics						
Observations	512	244	205	512	244	205
R^2	0.99796	0.99875	0.99437	0.99134	0.99438	0.99063
Within R^2	0.68637	0.67304	0.82630	0.53951	0.46730	0.78149

Newey-West (L=5) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 3
Convenience Premia (Part I of II)

This table presents regression results of convenience premia on the instrumented bill-to-GDP ratio. Each of the four panels uses a different instrument for the Bill-to-GDP ratio, indicated in bold. Columns represent the averages within the specified maturity range. In all specifications, we control for the effective federal funds rate, US sovereign CDS spread, level of the VIX and market return. We use Newey-West standard errors with one-week lags and report t-stats in parentheses.

	Convenience Premia (Basis Points)											
Maturity:	All TBill	0-1M	1-3M	3-6M	6-12M	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y
	Panel A: Combined Instrument											
Bill / GDP	-6.140**	-8.296***	-6.070**	-5.652*	-4.615**	-0.3755	0.5533	1.097**	1.110**	0.4931	0.2512	0.9906
	(-2.248)	(-2.700)	(-2.231)	(-1.909)	(-2.127)	(-0.3834)	(0.8480)	(2.025)	(2.395)	(1.035)	(0.3724)	(1.050)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects												
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics												
Observations	943	943	943	943	943	943	943	943	943	943	943	943
R^2	0.90855	0.87619	0.89236	0.88802	0.93638	0.95669	0.95736	0.94674	0.93666	0.93738	0.88337	0.85808
Within R^2	0.65510	0.38226	0.63561	0.68953	0.70166	0.70192	0.73610	0.76826	0.75889	0.70873	0.50842	0.34747
	Panel B: Debt Ceiling Instrument (DCIV)											
Bill / GDP	-7.809***	-9.741***	-9.171***	-7.570***	-3.147*	2.776***	4.344***	4.905***	4.881***	4.033***	2.781*	4.949**
	(-3.062)	(-3.033)	(-3.316)	(-2.877)	(-1.813)	(2.991)	(3.504)	(4.028)	(4.209)	(2.988)	(1.664)	(2.017)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects												
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics												
Observations	496	496	496	496	496	496	496	496	496	496	496	496
R^2	0.95512	0.91455	0.94131	0.95366	0.97413	0.97404	0.96500	0.95127	0.92505	0.91033	0.82703	0.75782
Within R^2	0.83849	0.55804	0.81198	0.88017	0.88774	0.83681	0.80336	0.82205	0.79810	0.72381	0.47158	0.31679

Continued on next page

Table 3 (Part II of II)

	Convenience Premia (Basis Points)											
Maturity:	All TBill	0-1M	1-3M	3-6M	6-12M	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y
	Panel C: Post-Raise/Suspension Instrument (TGAIV)											
Bill / GDP	-2.981**	-7.068**	-1.788	-0.6941	-3.185***	-2.161*	-1.553**	-0.6737	0.4059	0.2307	0.1051	0.6253
	(-2.321)	(-2.290)	(-1.301)	(-0.6337)	(-2.917)	(-1.956)	(-2.189)	(-1.091)	(0.8468)	(0.5205)	(0.1916)	(0.7724)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects												
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics												
Observations	204	204	204	204	204	204	204	204	204	204	204	204
R^2	0.69243	0.70170	0.52920	0.64095	0.87266	0.92101	0.96917	0.97696	0.98437	0.98572	0.91600	0.89137
Within R^2	0.24681	0.11525	0.24349	0.36136	0.42924	0.64497	0.83188	0.87379	0.91201	0.91976	0.89302	0.83840
	Panel D: End of Suspension Instrument (SEIV)											
Bill / GDP	-1.026	-3.138	0.0355	-0.4538	-1.024	-1.978	-0.8379	-1.798	-3.449**	-4.059***	-2.039	-1.917
	(-0.8407)	(-1.467)	(0.0383)	(-0.3870)	(-0.7897)	(-1.464)	(-0.8174)	(-1.476)	(-2.568)	(-3.181)	(-1.357)	(-1.195)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects												
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics												
Observations	243	243	243	243	243	243	243	243	243	243	243	243
R^2	0.89669	0.84449	0.92798	0.92215	0.90697	0.87843	0.87080	0.84600	0.89434	0.94359	0.96685	0.97663
Within R^2	0.06699	0.08988	0.04412	0.16695	0.27140	0.36508	0.25463	0.10746	0.07262	0.05349	0.12674	0.21815

Table 4
Effect of Bill Supply Shocks on the Pricing of Corporates

This table reports estimates from instrumental variable regressions of the yield of investment-grade corporate bonds. In the first panel, we use all three instruments; in the bottom three panels, we use only the indicated instrument. In all specifications, we control for the effective federal funds rate, US sovereign CDS spread, level of the VIX, market return, cumulative SMCCF sales, a Silicon Valley Bank crisis indicator, and a September tax date indicator. We use Newey-West standard errors with one-week lags and report t-stats in parentheses.

	Corporate Bond Yields											
	1M-1Y	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	1M-1Y	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y
	Panel A: Combined Instrument						**Panel B: Debt Ceiling Instrument (DCIV)**					
Bill / GDP	5.492***	7.794***	1.834	4.863*	8.724***	10.29***	11.88**	8.657	-7.925	0.4836	-5.622	2.522
	(2.945)	(3.200)	(0.7634)	(1.880)	(2.646)	(3.493)	(2.472)	(1.148)	(-0.9965)	(0.0576)	(-0.5465)	(0.2473)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects												
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics												
Observations	943	943	943	943	943	943	496	496	496	496	496	496
R^2	0.99476	0.98681	0.98189	0.97430	0.91567	0.95864	0.99400	0.98002	0.97487	0.96255	0.88639	0.93303
Within R^2	0.07551	0.13257	0.12622	0.11400	0.08616	0.14922	0.04682	0.10087	0.15293	0.11292	0.05770	0.12929
	Panel C: Post-Raise/Suspension Instrument (TGAIV)						**Panel D: End of Suspension Instrument (SEIV)**					
Bill / GDP	8.175***	9.612***	9.745***	6.836**	16.38***	16.17***	-14.08	8.940	8.497	-0.3306	46.27	24.50
	(3.603)	(3.324)	(2.648)	(2.090)	(3.166)	(4.364)	(-1.462)	(0.7457)	(0.9835)	(-0.0283)	(1.543)	(1.593)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects												
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics												
Observations	204	204	204	204	204	204	243	243	243	243	243	243
R^2	0.99640	0.99306	0.98667	0.98246	0.92942	0.97587	0.98759	0.98305	0.97451	0.97914	0.91165	0.96966
Within R^2	0.22052	0.35509	0.02758	0.16511	0.11244	0.21338	0.15085	0.05124	0.08958	0.24479	-0.11552	-0.00573

Table 5
Corporate Bond Yields in the Primary Market

This table reports regression results from regressing the yield that corporate issuers receive in the primary market, net of the yield for a treasury of similar maturity in basis points. We estimate this regression over the four indicated samples: short-term ($\leq$ 2 years) IG, all other short-term corporate debt, long-term IG and all other long-term corporate debt. In all specifications, we control for the effective federal funds rate, US sovereign CDS spread, level of the VIX, market return, cumulative SMCCF sales, a Silicon Valley Bank crisis indicator and a September tax date indicator. We cluster at the week level and report t-stats in parentheses.

Dependent Variable:	Offering Yield (Basis Points)			
Maturity:	2 Years or Less		More than 2 Years	
Rating:	IG	Ex. IG	IG	Ex. IG
Model:	(1)	(2)	(3)	(4)
Variables				
Bill-to-GDP Ratio	2.340*	-0.1736	0.0925	-0.1455
	(1.873)	(-0.6915)	(1.600)	(-0.7977)
Controls	Yes	Yes	Yes	Yes
Fixed-Effects				
Rating	Yes	Yes	Yes	Yes
Episode	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	89	1,155	3,268	1,689
R^2	0.48065	0.18091	0.55753	0.38000
Within R^2	0.10681	0.00629	0.00880	0.00521

Clustered (Week) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

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INTERNET APPENDIX

Table of Contents

A Instrument Construction

A.1 2021 Justice Department Legal Ruling

The Bipartisan Budget Act of 2019 that suspended the debt limit till July 31, 2021, was signed into law on August 2, 2019. The debt limit would be reset on August 1, 2021, at the then prevailing level, however, new debt issued during the suspension period would count towards the reset limit, only if, per section 301(c) of the Act, "... the issuance of such obligation was necessary to fund a commitment incurred pursuant to law by the Federal Government that required payment before August 1, 2021." Previous Acts that suspended the debt limit contained similar provisions, and had been interpreted by the Treasury as a requirement to bring down the cash balances on the reset date, to the same level or lower than the cash balance as of the suspension. The cash balance on August 2, 2019 was $118 bn. With substantially higher weekly spending requirements in 2021 compared to 2019, the Treasury sought the opinion of the Department of Justice on whether it could approach the 2021 reset date with a cash balance which was more in line with its usual post 2015 practice of keeping a prudential buffer for anticipated weekly federal outlays adjusted for uncertainties, and which it estimated at $465 bn. The Justice Department opined that they could, stating in their memorandum opinion, "We do not read section 301(c) to prevent Treasury from applying to the forthcoming debt limit the debt it plans to issue to provide a prudential buffer of funds raised for pre-August 1 expenses, even if some or all of that buffer remains unspent at the end of the debt-limit suspension." The opinion further stated "A prudential buffer is a reasonable response to the uncertainties in the government's expenses that the Department must cover through the end of the suspension period, and we see no basis for concluding that Congress forbade that practice."

A.2 Event Classification

The Treasury has issued explicit quantitative forecasts of the path of future bond and note issuances only since 2015. Therefore, we can construct DCIV only for episodes from 2015 onwards. Further, in 2015, the Treasury changed its cash management policy to keep a higher prudential balance. Prior to 2015, as is seen in 1, the cash balance at the TGA was much lower. Hence, neither the suspension end instrument, nor the post-suspension raise instrument, is meaningful prior to 2015. Our instrumental variables regression focuses on the post-2015 episodes.

The suspensions in 2017 and 2018 can be viewed as one long episode. While it was not expected that the Treasury would exhaust its borrowing capacity before October, Hurricane

Harvey precipitated the passage of a relief package, and an extension on the debt ceiling was passed along with the package, to suspend the limit for a short period, till December 8, 2017. On February 9, 2018, the ceiling was suspended till March 1, 2019. Thus this episode has one pre-suspension end period, leading up to the reset on March 16, 2017, and one post-raise period, after the February 9 suspension.

The debt ceiling episode of 2021 followed a suspension in 2019. The ceiling was raised twice - on October 14 by $480 bn, and then on December 16, by $2.5 trn. Since the limit was increased and not suspended on October 14, which was effectively an interim measure, we have only one pre-suspension end period for this episode. The October 14 raise was only meant to be a temporary relief to fund outlays till December, and the limit was shortly reached again. Therefore, we have only one post-raise period for 2021, after the December 16 increase.

A.3 Tables

Table A.1
Debt Limit Suspensions Since 2011

Between 2013 and 2019, debt suspensions, rather than increases, have been the preferred mode of dealing with debt limit episodes. When the limit is suspended for a fixed period, it need not be addressed for this interval, and upon the end of the suspension period, statutory debt limit is reset at the prevailing debt level on the date following the suspension. To prevent overborrowing in the suspension period, legislations permitting the suspension include language that prevents the treasury from increasing debt issuances in the suspension period "for the purpose of increasing the cash balance above normal operating balances in anticipation of the expiration of such period" (Sec 902, from the Bipartisan Budget Act 2015). The table below provides details for each suspension since 2011. Data is taken from Congressional Research Service reports, and press releases of the treasury

Year	Reset Date	Debt on reset ($ tn)	Cash on reset ($ bn) [1]	Extra-ordinary Measures Initiated [2]	Headroom created ($bn) [3]	Act	Date bill signed into law	Cash on suspension ($bn) [4]	Suspended till	Other events
2012-2013	Dec 31	16.4	92.7	Dec 31	200	No Budget No Pay Act, 2013	Feb 4	60.1	May 18, 2013	Tax filings delayed by 8 days in Jan
2013	May 19	16.7	34.2	May 20	NA	Continuing Appropriations Act, 2014	Oct 17	46.3	Feb 7, 2014	Low deficit compared to previous years; special dividends of $ 66bn from Fannie Mae & Freddie Mac in June
2014	Feb 8	17.2	34.1	Feb 10	NA	Temporary Debt Limit Extension Act	Feb 15	33.2	Mar 15, 2015	Tax refund season implied a shorter period to X date
k 2015	Mar 16	18.1	34.2	Mar 16	283	Bipartisan Budget Act of 2015	Nov 2	22.9	Mar 15, 2017	Increase in target cash balance to $ 150bn in May
2017	Mar 16	19.8	23.4	Mar 16	330	Continuing Appropriations Act, 2018	Sep 8	52.0	Dec 8, 2017	Hurricane Harvey in Aug 2017
2018	Dec 9	20.5	69.1	Dec 11	243	Bipartisan Budget Act of 2018	Feb 9	202.6	Mar 1, 2019	

Year	Reset Date	Debt on reset ($ tn)	Cash on reset ($ bn) [1]	Extra-ordinary Measures Initiated [2]	Headroom created ($bn) [3]	Act	Date bill signed into law	Cash on suspension ($bn) [4]	Suspended till	Other events
2019	Mar 2	21.2	201.6	Mar 4	338	Bipartisan Budget Act of 2019	Aug 2	117.6	Jul 31, 2021	High budget deficit in 2019 reduced time to X date
2023	Jan 19	31.4	455.6	Jan 19	357	Fiscal Responsibility Act of 2023	Jun 3	233.7	Jan 1, 2025	Weather related tax filing delays

Data in this table is based on information in the Congressional Research Service Report titled "The Debt Limit Since 2011" available at https://crsreports.congress.gov/product/pdf/R/R43389, letters from the Treasury Secretary to the Congress available at https://home.treasury.gov/policy-issues/financial-markets-financial-institutions-and-fiscal-service/debt-limit, and daily treasury statements available at https://fiscaldata.treasury.gov/datasets/daily-treasury-statement/operating-cash-balance.

[1] Opening cash balance, immediately following the reset date, in the Federal Reserve Account (till Oct'2011)/ Treasury General Account (from Oct'2011 onwards).

[2] Date of declaration of Debt Issuance Suspension Period by the Treasury, i.e. the Treasury declares it will be unable to fully invest the Civil Service Retirement and Disability Fund (CSRDF) and the Postal Service Retiree Health Benefits Fund (PSRHBF).

[3] Sum of initial estimates of headroom created by one time measures with respect to CSDRF and PSRBHF, and by the suspension of the daily reinvestment of the Treasury securities held by the Government Securities Investment Fund (G Fund) and the Exchange Stabilization Fund. Estimates are taken from the description of extraordinary measures outlined in the letters by the Treasury Secretary to the Congress. See https://home.treasury.gov/policy-issues/financial-markets-financial-institutions-and-fiscal-service/debt-limit.

[4] Opening cash balance in the Federal Reserve Account/ Treasury General Account, immediately following suspension.

Table A.2
Debt Limit Increases Since 2011

Year	Limit reached	Debt ($ tn)	TGA Cash ($ bn)	Extra-ordinary Measures Initiated [1]	Headroom created ($bn)	Act	Date bill signed into law	New Debt Limit ($tn)	Cash on Increase ($bn)	Other events
2011	May 16	14.3	127.5 [2]	May 16	NA	Budget Control Act, 2011	Aug 2	16.4 [3]	52.1 [4]	
2021	Aug 1	28.4	459.4	Aug 2	341 [5]	S.1301 (Oct) [6]; PL. 117-73 (Dec)	Oct 14; Dec 16	28.9 (Oct); 31.4 (Dec)	46.5 (Oct); 58.2 (Dec)	Higher Cash balances to deal with Covid-19 pandemic; Infrastructure Act passed in November reduced headroom

Data in this table is based on information in the Congressional Research Service Report titled "The Debt Limit Since 2011" available at https://crsreports.congress.gov/product/pdf/R/R43389, letters from the Treasury Secretary to the Congress available at https://home.treasury.gov/policy-issues/financial-markets-financial-institutions-and-fiscal-service/debt-limit, and daily treasury statements available at https://fiscaldata.treasury.gov/datasets/daily-treasury-statement/operating-cash-balance.

[1] Date of declaration of Debt Issuance Suspension Period by the Treasury, i.e. the Treasury declares it will be unable to fully invest the Civil Service Retirement and Disability Fund (CSRDF) and the Postal Service Retiree Health Benefits Fund (PSRHBF).

[2] Opening cash balance of the Federal Reserve Account on May 17.

[3] Increase of $2.1 tn in 3 steps from Aug 2 to Jan 28.

[4] Opening cash balance of the Federal Reserve Account on Aug 3.

[5] Sum of estimates of headroom created by one time measures with respect to CSDRF and PSRBHF, which would have been available at the end of September, and by the suspension of the daily reinvestment of the Treasury securities held by the Government Securities Investment Fund (G Fund) and the Exchange Stabilization Fund. Estimates are taken from the description of extraordinary measures outlined in the Aug 2 letter by the Treasury Secretary to the Congress. See https://home.treasury.gov/system/files/136/Description-of-Extraordinary-Measures-Aug2021.pdf.

[6] $480 bn increase in October.

Date & Link	Coupon Forecast	TIPS Forecast
May 2023	Anticipated future auction sizes in table format	"Over the May 2023 – July 2023 quarter, Treasury intends to maintain the May 10-year TIPS reopening auction size at $15 billion, maintain the June 5-year TIPS reopening auction size at $19 billion, and maintain the July 10-year TIPS new issue auction size at $17 billion."
February 2023	Anticipated future auction sizes in table format	"Treasury intends to maintain the February 30-year TIPS new issue auction size at $9 billion, maintain the March 10-year TIPS reopening auction size at $15 billion, and maintain the April 5-year TIPS new issue auction size at $21 billion."
November 2022	Anticipated future auction sizes in table format	"Treasury intends to maintain the November 10-year TIPS reopening auction size at $15 billion, increase the December 5-year TIPS reopening auction size to $19 billion (a $1 billion increase from the June reopening auction size and consistent with the $1 billion increase in the October 5-year TIPS new issue), and maintain the January 10-year TIPS new issue auction size at $17 billion."
August 2022	Anticipated future auction sizes in table format	"Over the next refunding quarter, Treasury intends to maintain the August 30-year TIPS reopening auction size at $8 billion, increase the September 10-year TIPS reopening auction size to $15 billion (a $1 billion increase from the May reopening auction size), and increase the October 5-year TIPS new issue auction size to $21 billion (a $1 billion increase from the April new issue auction size)."
May 2022	Anticipated future auction sizes in table format	"Over the next refunding quarter, Treasury intends to maintain the May 10-year TIPS reopening auction size at $14 billion; increase the June 5-year TIPS reopening auction size to $18 billion, a $1 billion increase from the December reopening auction size; and increase the July 10-year TIPS new issue auction size to $17 billion, a $1 billion increase from the January new issue auction size."
February 2022	Anticipated future auction sizes in table format	"Over the next refunding quarter, Treasury intends to maintain the February 30-year TIPS new issue auction size at $9 billion and the March 10-year TIPS reopening auction size at $14 billion. Treasury expects to increase the April 5-year TIPS new issue auction size to $20 billion, which reflects a $1 billion increase from October."

November 2021	Anticipated future auction sizes in table format	Since January 2021, Treasury has increased TIPS new issue and reopening auction sizes in all tenors by $1 billion each month in order to stabilize the share of TIPS as a percent of total marketable debt outstanding. Treasury intends to maintain the 10-year TIPS reopening auction size of $14 billion for November, the same size as the September reopening. Consistent with the $1 billion increase in the October new issue 5-year TIPS, the December 5-year TIPS reopening will be $17 billion. This will result in $17 billion greater total gross issuance of TIPS in CY 2021 compared to CY 2020. In January 2022, Treasury will maintain the 10-year TIPS new issue auction size of $16 billion, the same size as the July 2021 new issue. At current auction sizes, total gross issuance of TIPS would increase by $5 billion in CY 2022 compared to CY 2021.
August 2021	"Treasury does not anticipate making any changes to nominal coupon and FRN auction sizes over the next quarter."	Since January 2021, Treasury has increased TIPS auction sizes in all tenors (new issues and reopenings) by around $1 billion each month, amid solid demand, in order to stabilize the percent of TIPS to total marketable debt outstanding. This gradual increase will continue with a $1 billion increase in the August 30-year reopening compared to its respective issuance size last year, in the September 10-year reopening compared to the May reopening, and in the October 5-year new issue compared to the April new issue.
May 2021	"Treasury is announcing that it anticipates no changes to nominal coupon and FRN auction sizes over the upcoming May to July 2021 quarter."	"Since January 2021, Treasury has increased TIPS auction sizes in all tenors (new issues and reopenings) by $1 billion. This gradual increase will continue with $1 billion increases in the May 10-year reopening and the June 5-year reopening compared to their respective issuance sizes last year, and the July 10-year new issue compared to the January new issue. Any additional issuance size changes will be announced quarterly in subsequent refunding statements. While flexibility will be maintained to adjust TIPS issuance at each refunding quarter, we continue to expect total gross issuance of TIPS to increase by $10 billion to $20 billion in CY 2021."
February 2021	Anticipated future auction sizes in table format	Consistent with its guidance in the November 2020 refunding statement, Treasury anticipates continuing to gradually increase TIPS issuance across all tenors in CY 2021. This gradual increase began with a $1 billion increase in the January 10-year new issue and will continue with $1 billion increases in the February 30-year new issue, the March 10-year reopening, and the April 5-year new issue, compared to their respective issuance sizes last year. Additional issuance size changes will be announced quarterly in subsequent refunding statements. While flexibility will be maintained to adjust TIPS issuance at each refunding quarter, we continue to expect total gross issuance of TIPS to increase by $10 billion to $20 billion in CY 2021.

November 2020	Anticipated future auction sizes in table format	"Treasury anticipates gradually increasing TIPS issuance across all tenors in CY 2021. This change will begin with a $1 billion increase in the January 10-year new issue, and will be announced quarterly in subsequent refunding statements."
August 2020	Anticipated future auction sizes in table format	"Over the next refunding quarter, Treasury expects to maintain TIPS issuance sizes at $7 billion for the August 30-year TIPS reopening, $12 billion for the September 10-year TIPS reopening, and $17 billion for the October 5-year TIPS. Treasury will continue to closely monitor TIPS market conditions and assess supply and demand dynamics when considering how best to meet future financing needs."
May 2020	Anticipated future auction sizes in table format	"Over the next refunding quarter, Treasury expects to maintain TIPS issuance sizes at $12 billion for the May 10-year TIPS reopening, $15 billion for the June 5-year TIPS reopening, and $14 billion for the July 10-year TIPS. Treasury will continue to closely monitor TIPS market conditions and assess supply and demand dynamics when considering how best to meet future financing needs."
February 2020	"Treasury intends to maintain coupon issuance sizes at current levels over the coming quarter"	Over the next refunding quarter, Treasury expects to maintain TIPS issuance sizes at $8 billion for the February 30-year TIPS, $12 billion for the March 10-year TIPS reopening, and $17 billion for the April 5-year TIPS. These auctions will complete the calendar enhancements and auction size increases to maintain TIPS share of outstanding debt that were announced in November 2018. Treasury will continue to closely monitor TIPS market conditions and assess supply and demand dynamics when considering how best to meet future financing needs.
November 2019	"Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	"Treasury continues to implement the enhancements to the TIPS program announced in November 2018. Over the next refunding quarter, Treasury expects to increase the August TIPS 30-year reopening auction size to $7 billion, to increase the September 10-year TIPS reopening auction size to $12 billion, and to introduce the new October 5-year TIPS at an auction size of $17 billion, consistent with the sizing of the most recent April 5-year TIPS auction. The increase in TIPS issuance is consistent with Treasury's prior guidance on this matter."

August 2019	"Treasury is announcing no increase to nominal coupon and FRN auction sizes over the upcoming quarter, and currently anticipates no further changes in issuance sizes for nominal coupon and FRNs for the remainder of the 2019 calendar year."	"Treasury continues to implement the enhancements to the TIPS program announced in November 2018. Over the next refunding quarter, Treasury expects to increase the August TIPS 30-year reopening auction size to $7 billion, to increase the September 10-year TIPS reopening auction size to $12 billion, and to introduce the new October 5-year TIPS at an auction size of $17 billion, consistent with the sizing of the most recent April 5-year TIPS auction. The increase in TIPS issuance is consistent with Treasury's prior guidance on this matter."
May 2019	"Based on our current forecast, Treasury is announcing no increase to nominal coupon and FRN auction sizes over the coming quareter, and anticipates no further changes for the remainder of FY 2019."	"Treasury continues to implement the enhancements to the TIPS program announced in November 2018. Over the next refunding quarter, Treasury expects no change in the May TIPS 10-year reopening size, an increase in the June TIPS 5-year reopening auction size to $15 billion, and an increase in the July 10-year TIPS new issue to $14 billion. The increase in TIPS issuance is consistent with ongoing market participant feedback and the Treasury Borrowing Advisory Committee's recommendation to maintain TIPS' share of outstanding debt around current levels."
February 2019	"Based on our current forecast, Treasury is announcing no increase to nominal coupon and FRN auction sizes over the coming quarter"	"We anticipate gradual increases in TIPS auction sizes commencing with a $1 billion increase in the February 30-year and April 5-year TIPS auctions. Increasing the auction size of the 30-year TIPS in February and the 5-year TIPS in April is consistent with our desire to maintain liquidity in those tenors, given the previously announced changes to the auction calendar. The overall increase in TIPS issuance anticipated in 2019 will be focused largely on the new 5-year maturity in October and reflects Treasury's increased borrowing needs."
November 2018	"Based on our current forecast, Treasury is announcing additional modest increases to nominal coupon auction sizes and FRNs over the upcoming quarter. Over the next two months, Treasury anticipates increasing the sizes of the 2-, 3-, and 5-year note auctions by $1 billion per month. As a result, the size of 2-, 3-, and 5-year note auctions will increase by $2 billion, respectively, by the end of January. In addition, Treasury will increase the auction size of the next 2-year FRN auction by $1 billion in November. Finally, Treasury will increase auction sizes by $1 billion to each of the next 7- and 10-year notes and the 30-year bond auctions in November, and hold the auction sizes steady at that level through January. All changes are applicable to subsequent new issues and reopenings. In total, these adjustments will result in an additional $27 billion of new issuance for the upcoming quarter, which is slightly lower than the $30 billion increase announced in August."	See lengthy description and corresponding table at link.

August 2018	"Based on our current forecast, Treasury is announcing additional modest increases to nominal coupon auction sizes and FRNs over the upcoming quarter. Over the next three months, Treasury anticipates increasing the sizes of the 2-, 3-, and 5-year note auctions by $1 billion per month. As a result, the size of 2-, 3-, and 5-year note auctions will increase by $3 billion, respectively, by the end of October. In addition, Treasury will increase the auction size of the next 2-year FRN auction by $1 billion in August. Finally, Treasury will increase auction sizes by $1 billion to each of the next 7- and 10-year notes and the 30-year bond auctions in August, and hold the auction sizes steady at that level through October. All changes are applicable to subsequent new issues and reopenings. In total, these adjustments will result in an additional $30 billion of new issuance for the upcoming quarter, which is slightly higher than the $27 billion increase in May through July.	"Auction sizes for TIPS will remain unchanged over the next quarter."
May 2018	Based on our current forecast, Treasury is announcing additional modest increases to nominal coupon and FRN auction sizes over the upcoming quarter. Over the next three months, Treasury anticipates increasing the sizes of the 2- and 3-year note auctions by $1 billion per month. As a result, the size of 2- and 3-year note auctions will each increase by $3 billion by the end of July. In addition, Treasury will increase the auction size of the next 2-year FRN auction by $1 billion in May. Finally, Treasury will increase auction sizes by $1 billion for each of the next 5-, 7-, and 10-year notes and the 30-year bond auctions in May. All changes are applicable to subsequent new issues and reopenings. In total, these adjustments will result in an additional $27 billion of new issuance for the upcoming quarter. These nominal coupon and FRN auction size increases are smaller than the total increases of $42 billion announced in January 2018 for the months of February through April 2018.	"Auction sizes for TIPS will remain unchanged over the next quarter."
February 2018	Over the next quarter, Treasury anticipates increasing the sizes of the 2- and 3-year note auctions by $2 billion per month. As a result, the size of 2- and 3-year note auctions will increase by $6 billion by the end of the quarter. In addition, Treasury will increase the auction size of the next 2-year FRN auction by $2 billion in February. Finally, Treasury will increase auction sizes by $1 billion to each of the next 5-, 7-, and 10-year notes and the 30-year bond auctions starting in February. All changes are applicable to subsequent new issues and reopenings. In total, these adjustments will result in an additional $42 billion of new issuance for the upcoming quarter.	"Auction sizes for TIPS will remain unchanged over the next quarter."
November 2017	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
August 2017	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	

May 2017	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
February 2017	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
November 2016	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
August 2016	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
May 2016	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
February 2016	"Accordingly, Treasury is announcing reductions of $1 billion to each of the next 5-year, 7-year, 10-year, and 30-year nominal coupon offering sizes, for both new issues and reopenings. In aggregate, relative to what would have been issued under the previous schedule, nominal coupon issuance will be reduced by $12 billion over the upcoming quarter. These adjustments will begin with the 10- and 30-year nominal note and bond auctions being announced today. Auction sizes for Floating Rate Notes (FRNs) will remain unchanged."	Treasury is also announcing downward adjustments to the offering sizes for all TIPS tenors over the next quarter. Specifically, Treasury is announcing reductions of $2 billion to each of the next 5-year, 10-year, and 30-year TIPS offering sizes, for new issues and reopenings. In aggregate, relative to what would have been issued under the previous schedule, TIPS issuance will be reduced by $6 billion over the upcoming quarter. This downward adjustment will begin with the 30-year TIPS security auctioned on February 18, 2016.
November 2015	"Based on current fiscal forecasts, Treasury intends to maintain coupon, TIPS, and FRN issuance sizes at current levels over the upcoming quarter."	"Based on current fiscal forecasts, Treasury intends to maintain coupon, TIPS, and FRN issuance sizes at current levels over the upcoming quarter."
August 2015	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
May 2015	"Based on current fiscal forecasts, Treasury intends to maintain coupon issuance sizes at current levels over the upcoming quarter."	
February 2015	"Based on current fiscal forecasts, coupon auction sizes will remain steady going forward."	

A.4 Figures

Figure A.1
Headroom, Supply and the Statutory Limit

In this figure, we plot the evolution of important quantities during debt ceiling episodes. In all panels, the blue line corresponds to bill supply. The dotted orange line corresponds to all marketable securities, including bonds, notes and bills. The grey line corresponds to bonds and dotted pink line to notes. The solid red line corresponds to estimates of the headroom as released by the treasury, which could differ from actual headroom from day-to-day.

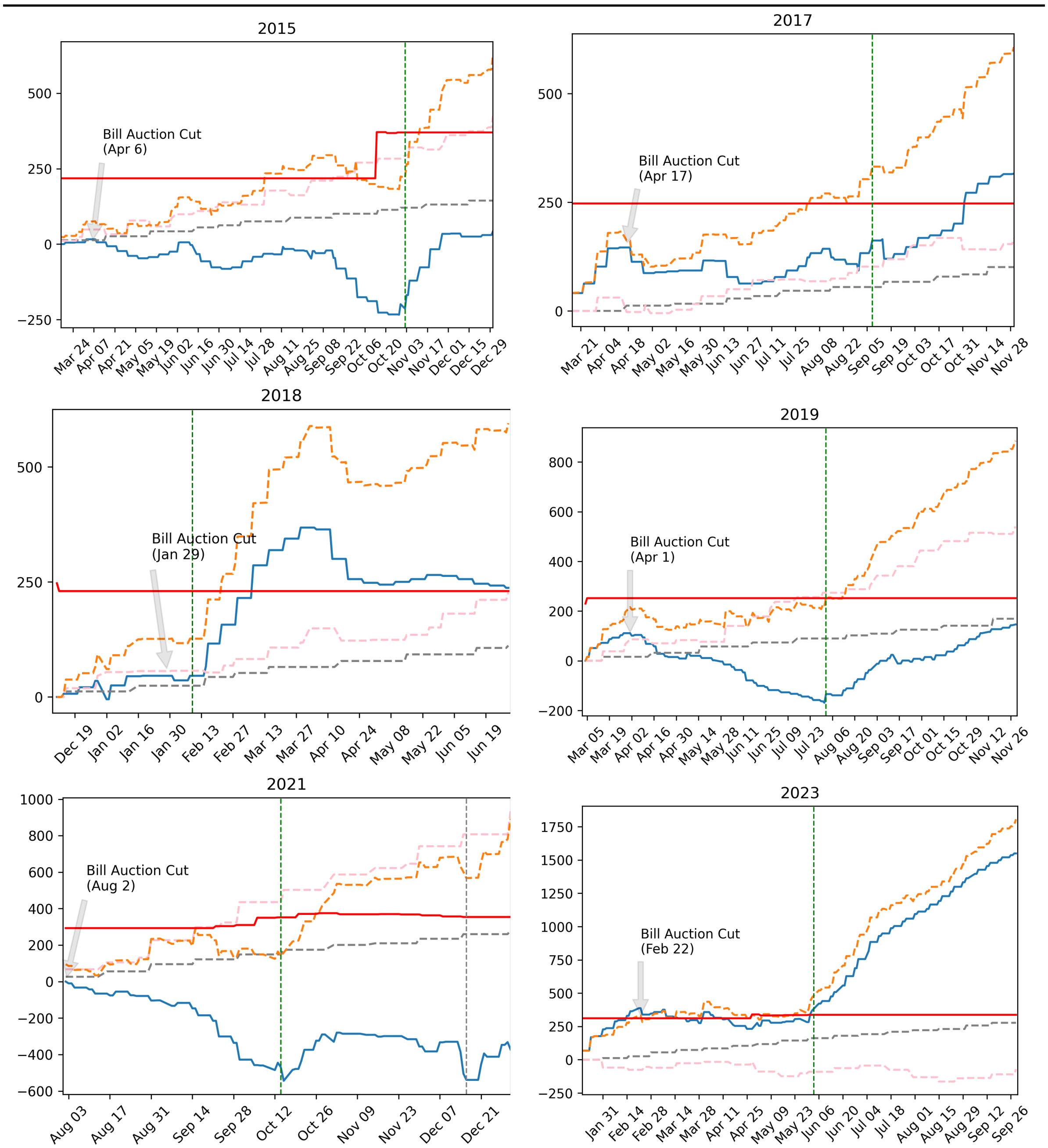
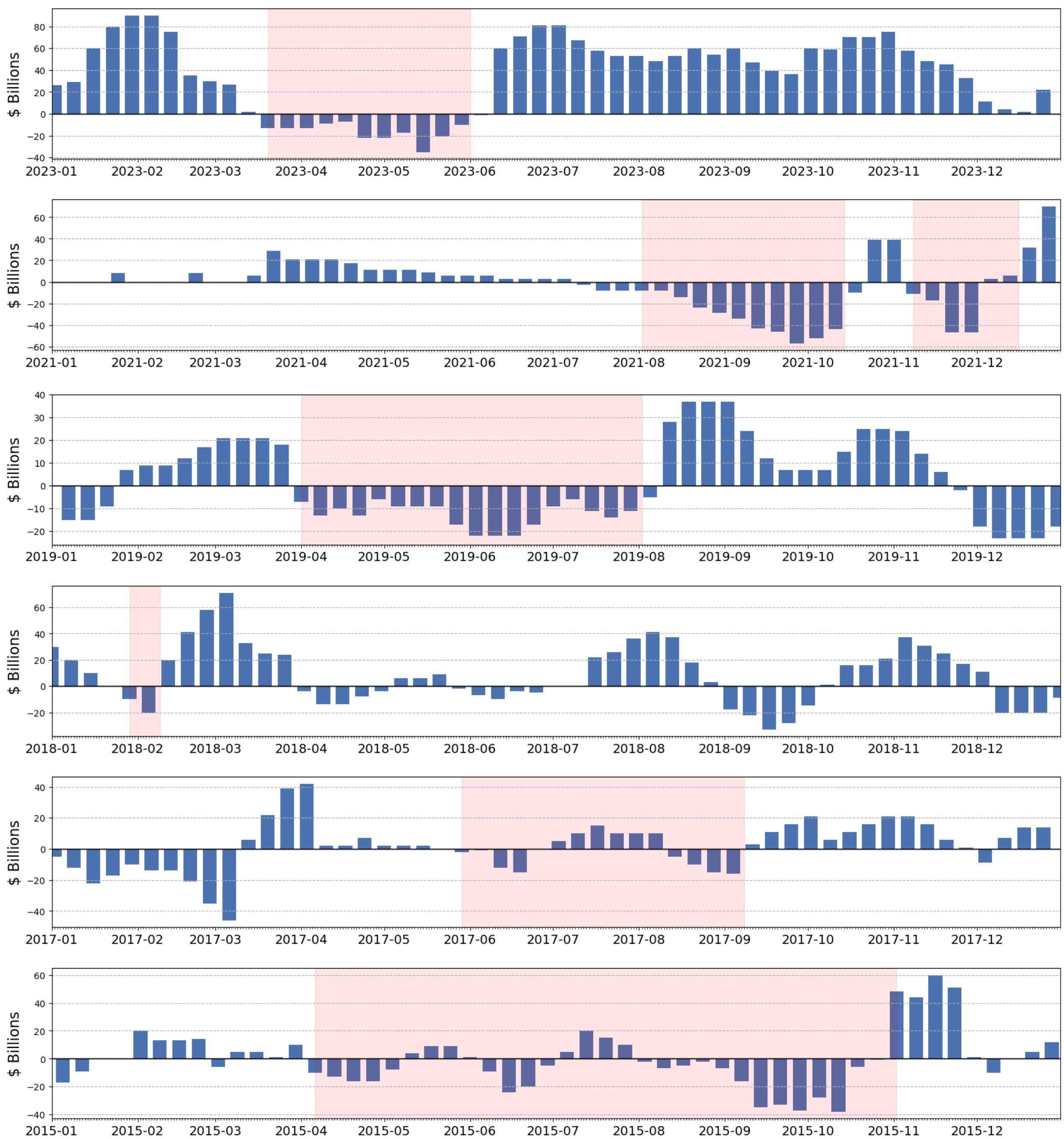


Figure A.2
Net Offering Amounts 2023

This figure displays the evolution of offering amounts by auction week. The shaded areas correspond to periods we deem the debt ceiling to have bound, defined as all weeks following the first week the treasury cut net offering amounts after the declaration of a "debt issuance suspension period" until the debt ceiling was raised or suspended.



B Additional Results

Table A.4
Convenience Premia Notes & Bonds On- versus Off-Run

This table shows the results from regressing the convenience yield of off-the-run versus on-the-run treasuries on the instrumented Bill-to-GDP ratio.

	Convenience Premia (Basis Points)													
Maturity:	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y
Panel A: Combined Instrument														
	On-Run							Off-Run						
Bill / GDP	2.126**	2.068**	2.033***	1.440*	1.713**	1.086	1.954*	-0.3897	0.5550	1.098**	1.118**	0.4927	0.2251	0.9692
	(2.308)	(2.447)	(2.936)	(1.920)	(1.969)	(1.389)	(1.873)	(-0.3980)	(0.8501)	(2.024)	(2.407)	(1.030)	(0.3347)	(1.030)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects														
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics														
Observations	727	711	707	721	733	311	928	943	943	943	943	943	943	943
R^2	0.88095	0.87684	0.85441	0.86979	0.89288	0.81929	0.84903	0.95668	0.95726	0.94663	0.93656	0.93741	0.88169	0.85873
Within R^2	0.31340	0.39223	0.41712	0.37086	0.32255	0.73407	0.35375	0.70178	0.73562	0.76783	0.75878	0.70882	0.50855	0.34715
Panel B: Debt Ceiling Instrument (DCIV)														
	On-Run							Off-Run						
Bill / GDP	4.249***	3.788***	4.146***	3.684***	3.254***	-2.284**	6.336**	2.755***	4.347***	4.908***	4.899***	4.050***	2.792*	4.913**
	(3.223)	(3.080)	(4.697)	(4.305)	(2.879)	(-2.080)	(2.315)	(2.974)	(3.504)	(4.020)	(4.216)	(2.995)	(1.674)	(2.008)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects														
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics														
Observations	398	384	378	392	396	146	488	496	496	496	496	496	496	496
R^2	0.85716	0.85069	0.79036	0.78916	0.84438	0.74013	0.73515	0.97408	0.96490	0.95111	0.92492	0.91019	0.82398	0.75896
Within R^2	0.43346	0.55425	0.60045	0.56981	0.44910	0.67756	0.29159	0.83690	0.80285	0.82152	0.79795	0.72431	0.47278	0.31717

Table A.5

Post-Raise / Suspension Instrument – Alternative Specifications

This table reports four variations of the regression of the endoegenous regressor on our instrument. We use one of our versions of our instrument as indicated in the table.

- V1 – actual cash balance assumptions for the quarter following the raise or suspension.
- V2 – cash balance upon the intiation of extraordinary measures.
- V3 – Cash balance assumptions for the quarter before the raise or suspension.
- V4 – six-month rolling average of outlays.

Dependent Variables:	Bill Supply ($100B)				Bill-to-GDP Ratio			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Post-Raise/Suspension Instrument	-1.451***	-1.287***	-1.286***	-1.751***	-0.0051***	-0.0045***	-0.0045***	-0.0062***
	(-9.289)	(-6.341)	(-8.185)	(-10.05)	(-10.52)	(-6.825)	(-9.036)	(-11.97)
Instrument Version	V1	V2	V3	V4	V1	V2	V3	V4
Fixed-Effects								
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics								
Observations	205	205	205	205	205	205	205	205
R^2	0.99407	0.99198	0.99358	0.99437	0.98997	0.98692	0.98902	0.99063
Within R^2	0.81709	0.75266	0.80202	0.82630	0.76600	0.69493	0.74386	0.78149

Newey-West (L=5) co-variance matrix, t-stats in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

C Robustness Checks

C.1 Alternative Clustering

In the tables below, we present regression results using alternative clustering.

Table A.6
Convenience Premium Regressions – Combined Instrument with Alternative Newey West Lags

This table reports alternative clustering for the regression specified in Equation 4.9, using the combined instrument to instrument the bill-to-GDP ratio. We present five sets of estimates using Newey West errors with the indicated lags. The final panel uses the lags selected by our statistical software.

Maturity:	All TBill	0-1M	1M-3M	3M-6M	6M-12M	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	10Y-20Y	20Y-30Y
Bill / GDP	-6.140**	-8.296***	-6.070**	-5.652*	-4.615**	-0.3755	0.5533	1.097**	1.110**	0.4931	0.2512	0.9906
	(-2.248)	(-2.700)	(-2.231)	(-1.909)	(-2.127)	(-0.3834)	(0.8480)	(2.025)	(2.395)	(1.035)	(0.3724)	(1.050)
NW Lag						L=5						
Bill / GDP	-6.140*	-8.296**	-6.070*	-5.652	-4.615*	-0.3755	0.5533	1.097	1.110*	0.4931	0.2512	0.9906
	(-1.854)	(-2.312)	(-1.846)	(-1.572)	(-1.746)	(-0.3160)	(0.6948)	(1.644)	(1.956)	(0.8497)	(0.3086)	(0.8595)
NW Lag						L=10						
Bill / GDP	-6.140*	-8.296**	-6.070*	-5.652	-4.615	-0.3755	0.5533	1.097	1.110	0.4931	0.2512	0.9906
	(-1.679)	(-2.083)	(-1.682)	(-1.421)	(-1.578)	(-0.2838)	(0.5996)	(1.378)	(1.612)	(0.7062)	(0.2685)	(0.7358)
NW Lag						L=20						
Bill / GDP	-6.140*	-8.296**	-6.070*	-5.652	-4.615*	-0.3755	0.5533	1.097	1.110	0.4931	0.2512	0.9906
	(-1.822)	(-2.261)	(-1.824)	(-1.545)	(-1.691)	(-0.2998)	(0.5588)	(1.230)	(1.393)	(0.6223)	(0.2616)	(0.7186)
NW Lag						L=40						
Bill / GDP	-6.140***	-8.296***	-6.070***	-5.652*	-4.615	-0.3755	0.5533	1.097*	1.110**	0.4931	0.2512	0.9906
	(-2.646)	(-2.700)	(-2.952)	(-1.655)	(-1.619)	(-0.3231)	(0.8107)	(1.934)	(2.291)	(1.348)	(0.2882)	(0.7868)
NW Lag	L=3	L=5	L=2	L=8	L=14	L=9		L=6		L=2	L=13	L=14
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Episode FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	943	943	943	943	943	943	943	943	943	943	943	943
R^2	0.90855	0.87619	0.89236	0.88802	0.93638	0.95669	0.95736	0.94674	0.93666	0.93738	0.88337	0.85808
Within R^2	0.65510	0.38226	0.63561	0.68953	0.70166	0.70192	0.73610	0.76826	0.75889	0.70873	0.50842	0.34747

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A.7
Convenience Premium Regressions – DCIV with Alternative Newey West Lags

This table reports alternative clustering for the regression specified in Equation 4.9, using DCIV to instrument the bill-to-GDP ratio. We present five sets of estimates using Newey West errors with the indicated lags. The final panel uses the lags selected by our statistical software.

Maturity:	All TBill	0-1M	1M-3M	3M-6M	6M-12M	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	10Y-20Y	20Y-30Y
Bill / GDP	-7.809***	-9.741***	-9.171***	-7.570***	-3.147*	2.776***	4.344***	4.905***	4.881***	4.033***	2.781*	4.949**
	(-3.062)	(-3.033)	(-3.316)	(-2.877)	(-1.813)	(2.991)	(3.504)	(4.028)	(4.209)	(2.988)	(1.664)	(2.017)
NW Lag						L=5						
Bill / GDP	-7.809***	-9.741**	-9.171***	-7.570**	-3.147	2.776***	4.344***	4.905***	4.881***	4.033**	2.781	4.949*
	(-2.596)	(-2.557)	(-2.818)	(-2.453)	(-1.548)	(2.594)	(2.910)	(3.267)	(3.397)	(2.424)	(1.401)	(1.709)
NW Lag						L=10						
Bill / GDP	-7.809**	-9.741**	-9.171**	-7.570**	-3.147	2.776**	4.344**	4.905***	4.881***	4.033**	2.781	4.949
	(-2.217)	(-2.196)	(-2.417)	(-2.102)	(-1.327)	(2.397)	(2.567)	(2.744)	(2.791)	(2.001)	(1.245)	(1.538)
NW Lag						L=20						
Bill / GDP	-7.809**	-9.741**	-9.171**	-7.570*	-3.147	2.776**	4.344**	4.905**	4.881**	4.033*	2.781	4.949
	(-2.023)	(-2.062)	(-2.192)	(-1.919)	(-1.219)	(2.565)	(2.454)	(2.416)	(2.386)	(1.731)	(1.193)	(1.519)
NW Lag						L=40						
Bill / GDP	-7.809***	-9.741***	-9.171***	-7.570**	-3.147	2.776***	4.344***	4.905***	4.881***	4.033***	2.781	4.949**
	(-3.062)	(-4.807)	(-2.946)	(-2.563)	(-1.617)	(4.009)	(4.054)	(4.332)	(4.529)	(3.956)	(1.599)	(2.017)
NW Lag	L=5	L=0		L=8		L=1	L=3	L=4		L=2	L=6	L=5
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Episode FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	496	496	496	496	496	496	496	496	496	496	496	496
R^2	0.95512	0.91455	0.94131	0.95366	0.97413	0.97404	0.96500	0.95127	0.92505	0.91033	0.82703	0.75782
Within R^2	0.83849	0.55804	0.81198	0.88017	0.88774	0.83681	0.80336	0.82205	0.79810	0.72381	0.47158	0.31679

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A.8

Convenience Premium Regressions – TGAIV with Alternative Newey West Lags

This table reports alternative clustering for the regression specified in Equation 4.9, using TGAIV to instrument the bill-to-GDP ratio. We present five sets of estimates using Newey West errors with the indicated lags. The final panel uses the lags selected by our statistical software.

Maturity:	All TBill	0-1M	1M-3M	3M-6M	6M-12M	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	10Y-20Y	20Y-30Y
Bill / GDP	-2.981**	-7.068**	-1.788	-0.6941	-3.185***	-2.161*	-1.553**	-0.6737	0.4059	0.2307	0.1051	0.6253
	(-2.321)	(-2.290)	(-1.301)	(-0.6337)	(-2.917)	(-1.956)	(-2.189)	(-1.091)	(0.8468)	(0.5205)	(0.1916)	(0.7724)
NW Lag	L=5											
Bill / GDP	-2.981**	-7.068**	-1.788	-0.6941	-3.185**	-2.161	-1.553*	-0.6737	0.4059	0.2307	0.1051	0.6253
	(-2.108)	(-2.160)	(-1.189)	(-0.5533)	(-2.495)	(-1.636)	(-1.950)	(-0.9633)	(0.7663)	(0.4765)	(0.1691)	(0.6524)
NW Lag	L=10											
Bill / GDP	-2.981**	-7.068**	-1.788	-0.6941	-3.185**	-2.161	-1.553*	-0.6737	0.4059	0.2307	0.1051	0.6253
	(-2.083)	(-2.218)	(-1.254)	(-0.5099)	(-2.239)	(-1.344)	(-1.712)	(-0.8737)	(0.7412)	(0.4767)	(0.1673)	(0.5923)
NW Lag	L=20											
Bill / GDP	-2.981*	-7.068**	-1.788	-0.6941	-3.185*	-2.161	-1.553	-0.6737	0.4059	0.2307	0.1051	0.6253
	(-1.923)	(-2.466)	(-1.231)	(-0.4274)	(-1.957)	(-1.063)	(-1.368)	(-0.7017)	(0.6279)	(0.5001)	(0.1759)	(0.5653)
NW Lag	L=40											
Bill / GDP	-2.981**	-7.068***	-1.788	-0.6941	-3.185***	-2.161**	-1.553***	-0.6737	0.4059	0.2307	0.1051	0.6253
	(-2.093)	(-3.854)	(-1.238)	(-0.6337)	(-4.247)	(-2.084)	(-2.613)	(-1.316)	(0.9313)	(0.5073)	(0.1799)	(0.9777)
NW Lag	L=15	L=126	L=18	L=5	L=1	L=4	L=2		L=3	L=6	L=7	L=2
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Episode FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	204	204	204	204	204	204	204	204	204	204	204	204
R^2	0.69243	0.70170	0.52920	0.64095	0.87266	0.92101	0.96917	0.97696	0.98437	0.98572	0.91600	0.89137
Within R^2	0.24681	0.11525	0.24349	0.36136	0.42924	0.64497	0.83188	0.87379	0.91201	0.91976	0.89302	0.83840

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A.9
Convenience Premium Regressions – SEIV with Alternative Newey West Lags

This table reports alternative clustering for the regression specified in Equation 4.9, using SEIV to instrument the bill-to-GDP ratio. We present five sets of estimates using Newey West errors with the indicated lags. The final panel uses the lags selected by our statistical software.

Maturity:	All TBill	0-1M	1M-3M	3M-6M	6M-12M	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	10Y-20Y	20Y-30Y
Bill / GDP	-1.026	-3.138	0.0355	-0.4538	-1.024	-1.978	-0.8379	-1.798	-3.449**	-4.059***	-2.039	-1.917
	(-0.8407)	(-1.467)	(0.0383)	(-0.3870)	(-0.7897)	(-1.464)	(-0.8174)	(-1.476)	(-2.568)	(-3.181)	(-1.357)	(-1.195)
NW Lag	L=5											
Bill / GDP	-1.026	-3.138	0.0355	-0.4538	-1.024	-1.978	-0.8379	-1.798	-3.449**	-4.059***	-2.039	-1.917
	(-0.7131)	(-1.276)	(0.0341)	(-0.3253)	(-0.6477)	(-1.217)	(-0.6926)	(-1.238)	(-2.167)	(-2.729)	(-1.232)	(-1.082)
NW Lag	L=10											
Bill / GDP	-1.026	-3.138	0.0355	-0.4538	-1.024	-1.978	-0.8379	-1.798	-3.449*	-4.059**	-2.039	-1.917
	(-0.6295)	(-1.123)	(0.0324)	(-0.2928)	(-0.5535)	(-1.034)	(-0.5973)	(-1.048)	(-1.829)	(-2.360)	(-1.154)	(-1.016)
NW Lag	L=20											
Bill / GDP	-1.026	-3.138	0.0355	-0.4538	-1.024	-1.978	-0.8379	-1.798	-3.449	-4.059**	-2.039	-1.917
	(-0.5697)	(-0.9977)	(0.0295)	(-0.2860)	(-0.5135)	(-0.9215)	(-0.5132)	(-0.9007)	(-1.578)	(-2.080)	(-1.061)	(-0.9159)
NW Lag	L=40											
Bill / GDP	-1.026	-3.138	0.0355	-0.4538	-1.024	-1.978	-0.8379	-1.798	-3.449***	-4.059***	-2.039*	-1.917*
	(-0.7131)	(-0.9545)	(0.0322)	(-0.4971)	(-1.638)	(-1.403)	(-0.8693)	(-1.476)	(-2.738)	(-3.379)	(-1.680)	(-1.696)
NW Lag	L=10	L=45	L=27	L=2	L=0	L=6	L=4	L=5	L=4		L=2	L=1
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Episode FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	243	243	243	243	243	243	243	243	243	243	243	243
R^2	0.89669	0.84449	0.92798	0.92215	0.90697	0.87843	0.87080	0.84600	0.89434	0.94359	0.96685	0.97663
Within R^2	0.06699	0.08988	0.04412	0.16695	0.27140	0.36508	0.25463	0.10746	0.07262	0.05349	0.12674	0.21815

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

D Money Market Mutual Fund Treasury Demand

We then study a second channel, the *payment delay channel*. The debt ceiling's approach triggers a shift in the composition of the portfolios of money market mutual funds (MMFs). This shift, in equilibrium, affects the prices of other assets in MMF portfolios. A defining feature of money market mutual funds is that they are required to meet investor redemptions on demand and face dire consequences if they "break the buck," meaning they allow net asset value to fall below 1$ per share. Consequently, money market funds are particularly sensitive to the risk that a debt ceiling breach might result in a delay in payment to the holders of treasuries.

Exploiting the timing of payments of liabilities and payouts of assets on the U.S. Treasury's balance sheet, we show that MMFs judiciously choose the vintage of treasuries that they hold when the X-date is imminent. MMFs disproportionately hold treasuries that expire immediately following net inflows or before net outflows from the treasury's cash account, ensuring that the treasuries in their portfolios will not be subject to payment delays.

We show evidence that, in equilibrium, MMF substitution across ultra-short maturity treasuries causes disjointedness in the yield curve. As MMFs hold huge amounts of ultra-short maturity treasuries that are not subject to the risk of delayed payment, this puts downward pressures on the prices of those T-bills specifically. This results in massive differences for the yields of T-bills maturing just one week from each other.

However, substituting across treasury maturities by itself cannot fully compensate for the massive decline in the quantity of T-bills held by MMFs. MMFs are also forced to substitute across asset classes. MMFs typically hold a small number of assets in their portfolio. Besides treasuries, the modal fund's portfolio is nearly completely comprised of repurchase agreements and agency debt. Before the debt ceiling was resolved, MMFs greatly increased the quantities of repurchase agreements in their portfolios and only slowly unwound them ex post.

This compositional shift manifested as a large lending supply shock in the market for repurchase agreements. As MMFs increased the total amount of repurchase agreements that they held, this placed downward pressure on the repo rate.

To quantify the magnitude of this effect, we use form N-MFP filings from the Securities and Exchange Commission. MMFs are required to report their holdings at a monthly frequency, including the terms, collateral and borrower of repurchase agreements. Using within-lender-by-borrower variation, we show that the repo rate declined by 1.5 basis points in May relative to January for government funds. After the debt ceiling was raised and the treasury began issuing large amounts of treasuries to rebuild its cash balances, the repo rate consequently increased.

There is significant heterogeneity across MMFs. A subset of funds, called prime funds, hold little treasury debt and a significant amount of corporate debt. These funds experienced the least pressure to substitute away from treasuries. We show that repurchase agreements in which a prime fund was the lender *did not* exhibit the same downward pattern we document for the aggregate repo market.

To close our analysis of the market for repurchase agreements, we investigate the evolution of the futures-implied path of the repo rate and federal funds rate. We find substantial evidence that investors in futures markets anticipated the dynamics of the repo rate around the debt ceiling. We show that the forward curve-implied SOFR spot rate was first less than and then greater than the forward curve-implied Federal Funds spot rate. As the expected X-date varied, we find similar variation in the date at which the ordinal ranking of the two spot rates changes.

D.1 Data

D.1.1 Holdings

We use Form N-MFP holdings to study the holdings of Money Market Mutual funds. Since 2010, MMFs have been required to disclose their monthly holdings.

When MMFs submit these filings, they provide detailed information both about the overall state of their business and their portfolios. The topline information includes both the overall size of the assets under management and the fund's cash position.

Money Market Mutual funds fall into several categories depending on their holdings. "Government" funds hold treasuries, agency debt and repurchase agreements collateralized by treasuries. In contrast, "prime" funds hold a much broader set of assets, including corporate debt, and much smaller quantities of treasuries. A third group, municipal MMFs, mostly hold municipal bonds and other tax-advantaged debt instruments.

Each submission to the SEC contains detailed information about yields and quantities of the securities held in each MMF portfolio. MMFs sometimes revise their filings to the SEC in subsequent months. In our analysis, we use the last submitted filing for a given report date.

For some additional tests reported in the appendix, we use flow of funds data. This data contains aggregated holdings for groups of financial institutions. Unlike Form N-MFP filings, this data has the benefit of seeing broader changes in the composition of portfolios outside of the MMF sector. Unfortunately, these holdings are highly aggregated, so we cannot see the holdings of individual funds. In addition, flow of funds is only reported at a quarterly frequency, not monthly.

D.1.2 Rates and Futures

Finally, we collect data on rates and futures from two sources. Historical data for the effective federal funds rate and repo rate is taken from the New York Fed. We access this data at the following URL `https://www.newyorkfed.org/markets/reference-rates/` and download data for both secured and unsecured overnight rates. We use the series on the effective federal funds rate (EFFR) and secured overnight financing rate (SOFR) for some of the figures below. In addition to data on spot rates, we also collect data on SOFR and Federal Funds futures. This data is taken from Bloomberg.

D.2 Evidence from the Yield Curve

The date that the treasury is no longer able to meet all of its obligations is referred to as the "X-date". Both the implications and timing of this date are highly uncertain. The implications of this date are unknown because the treasury has several possible courses of action. Which course it would take in the event of reaching the X-date without a debt ceiling raise is unknown.

The two primary alternatives are either entering technical default or payment prioritization. Payment prioritization would involve the treasury continuing to pay bondholders, while not meeting other treasury obligations. This path is politically fraught, as it would potentially involve the treasury forgoing payment to recipients of social programs and military veterans.

The second alternative is to enter technical default, where the payments to some bondholders would be delayed until the debt ceiling is lifted. This path likewise is fraught for the treasury. In fact, the treasury, due to a computer error, delayed payments to bondholders in 1979 and entered technical default. This resulted in large increases in the yields of some treasuries (Zivney and Marcus (1989)).

In letters to Congress stating the treasury's status in 2023, Secretary Yellen declined to clarify which course of action the treasury might pursue, instead using the boilerplate language (Yellen (2023b)):

> If Congress fails to increase the debt limit, it would cause severe hardship to American families, harm our global leadership position, and raise questions about our ability to defend our national security interests.

Apart from whatever course of action the treasury decided upon, ex ante, whether it could actually commit to payment prioritization is highly unclear. Halting payments to veterans or social security recipients while continuing to pay bondholders would likely lead to substantial political pressure for the treasury to reverse its stated policy.

The second primary uncertainty surrounding the X-date is its timing. When the X-date materializes depends on the sequence of incoming treasury receipts and outlays. Receipts are extremely lumpy, with the largest receipts incoming through tax payments during April, however, a significant portion of the treasury's total receipts materializes at other discrete dates throughout the year. Treasury outlays are somewhat less lumpy, but still display significant variation from day to day.

In the same letters to Congress, Secretary Yellen emphasized both the inherent uncertainty of the X-date and that it could materialize as early as June 1. However, if the treasury's resources were sufficient to meet outlays in early June this would likely tide the treasury over until treasury received substantial receipts on June fifteenth from late tax filers and on July first from the sale of treasury assets through a special provision made available during debt ceiling crises. Had treasury made it through June, these additional payments could have staved off the X-date until late July or even early August.

On May 1, Secretary Yellen wrote to Congress saying that the treasury's fiscal position had substantially deteriorated and that it was now highly likely that the X-date would occur in June (Yellen (2023b)). This deterioration was primarily due to lower-than-expected tax receipts during the April tax filing season. Depressed tax receipts were in turn likely due to the IRS granting weather-related tax filing delays to several states, including California, that were hit by severe storms (IRS (2023)). The specific event that would trigger the X-date are payments to social security and Medicare recipients as well as defense contractors in the first two weeks of June. Thus, it was virtually certain that the X-date would materialize in early June and not late May.

The first part of our analysis turns to the evolution of the yield curve around these dates. Figure B.1 plots the short end of the yield curve over May 2023. The first line is the blue line, indicating the yield curve the day before Secretary Yellen's letter. Yields in June and later are elevated relative to May, but the difference between June and later months is insubstantial. In contrast, for all yield curves corresponding to weeks after May 1, we document a substantial increase in the yields for all securities maturing in June specifically.[8]

This increase in yields is not surprising. However, what is more surprising is the pronounced *decline* in yields for securities maturing in the first week of July and the last week of May. This figure suggests to the authors that certain kinds of financial institutions strongly

[8] In the data appendix we show yield curves from May 1 and May 2, confirming that this change occured the day that Secretary Yellen's letter was released. The increase in June yields from May 1 to May 2 was first documented by Benzoni et al. (2023).

desire to hold extremely short-dated maturities of treasury bills. However, these same funds do not want to hold June bills specifically, perhaps due to the potential risks of delayed payment that would occur in the event of technical default.

This interpretation is highly dependent on the specific institutional details of the debt ceiling. The X-date could not occur before June 1, due to large outflows from the treasury cash account falling after this date and not before. Further, as we discuss next, the treasury would likely be able to pay bondholders of treasuries maturing in early July without delay because of new borrowing authority acquired under treasury accounting rules.

This sharp discontinuity in early July is plausibly due to rules governing investments in the Civil Service Retirement and Disability Fund (CSRDF) and Postal Service Retiree Health Benefits Fund (PSRHBF). The savings from these funds are invested in special-issue treasury securities. Importantly, these securities count against the debt limit. On June 30, nearly 150 billion in securities held by the CSRDF and PSRHBF would have expired. During this period, the treasury could have elected not to reinvest those securities, freeing up nearly 150 billion in additional borrowing capacity. This additional borrowing capacity could then have been used to issue additional debt, the proceeds of which could have been used to pay both maturing debt and other treasury obligations (Yellen (2023a)).

D.3 Evidence from MMF Holdings

The observation that the yield curve changes in a way consistent with high demand from investors who prefer to hold short-term securities, but strongly dislike the possibility of delayed payment motivates turning our analysis to examine money market mutual funds. Money market mutual funds are special in two respects. First, they are required to redeem investor shares on demand and face dire consequences if they allow net asset value to fall below 1$. Largely because of this, they hold extremely safe debt that they are able to easily liquidate in case of redemptions.

This feature arguably makes money market mutual funds particularly sensitive to the risk of delayed payments. If MMFs were subject to large redemptions but were unable to offload securities that the treasury had ceased to honor, this would potentially be fatal for the MMF. Further, MMFs are so-called "preferred habitat investors". Not only do they hold safe debt, they also tend to hold very short-term debt. They particularly hold large amounts of treasury bills.

We conjectured that the pronounced kink in the yield curve in early July was due to the presence of some investors who particularly desired to hold short-dated treasuries that were not exposed to the risk of payment delays. Given these features of MMFs, it seems plausible that these funds are one such class of investors. We verify this in three ways by turning to the Form N-MFP holdings data.

First, in Figure B.2 we plot the dollar amount of MMF holdings of treasury bonds by maturity date. The green line records holdings as of the end of April. The pattern of May holdings is very striking. MMFs hold huge amounts of treasuries maturing in May. But they hold very few treasuries expiring in June, July, August or September. The end-May holdings are starkly different. MMFs increased their holdings in the first week of July, exactly where we observed a large downward divot in the yield curve. They also increase their holdings in other periods of the summer months, except the first two weeks of June which are the most likely dates at which a technical default would occur.

We formalize this analysis in Figure B.3 where we estimate the following regression:

$$\begin{aligned}\text{Dollar Value}_{imt} = \sum_{t'} \beta_{t'} \left(\mathbb{I}\left\{\text{Report Date May}\right\}_t \times \mathbb{I}\left\{\text{Maturity Week}\right\}_{t'}\right) \\ + \gamma \text{Total Portfolio Value}_{mt} + \eta \text{Weeks to Maturity}_{it} + \nu_{im}\end{aligned} \tag{D.1}$$

The specification regresses the dollar value of an MMF (m) holdings in security i at time t on dummies for the week that the maturity expires interacted with an indicator for whether the holdings data are from May 2023. We also include fixed effects for the number of weeks the security is from maturity and MMF-by-security fixed effects. This regression is estimated on data from 2023. Unlike the purely visual analysis the weeks-to-maturity fixed effects allow us to control for the money market mutual funds typically hold large amounts of treasuries very close to maturity. Consistent with our prior two analyses, we find that there is a large upward spike in the holdings of MMFs for treasuries that expire exactly during the first week of July. There is a smaller, but pronounced, increase in holdings of securities that expire in the week following the June 15th tax deadline. This tax deadline is the other period in June during which the treasury is assured of receiving large amounts of cash onto its balance sheet.

Our analysis so far is subject to a substantial critique. While our evidence clearly indicates that MMFs alter their portfolio choice for a few days around June 1 and that this change is associated with changes to the yield curve, it is unclear that this effect is very large. Because these bonds are so close to maturity, the actual impact of even a substantial difference in yields is not very large to the holder.

Our next results show that MMFs make large changes to their portfolios over much longer time horizons. This can first be seen in Figure B.4. We plot the aggregate treasury holdings across all MMFs by the months from maturity of the treasury debt. So, for example, MMF holdings in April (green line) of treasury debt that matures in May would fall under the first bin. Likewise, MMF holdings in January (orange line) expiring in February would also fall under the first bin.

The figure makes clear how irregular the patterns we observed in Figure B.2 are compared to a more typical month, January. Relative to January, there are much higher one-month-ahead holdings in April, but much lower two, three, and four-month ahead holdings. Consistent with MMFs limiting their exposure to treasuries that expire in the summer. Conversely, May exhibits much lower one-month-ahead holdings than January, but somewhat more similar holdings than April for months two, three and four.

We corroborate this analysis in Table B.3. In this table, we estimate the regression:

$$\text{Portfolio Share X Months Ahead}_{it} = \sum_t \beta_t \mathbb{I}\left\{\text{Month}\right\}_t + \gamma' \text{Controls}_{it} + \nu_i \tag{D.2}$$

We estimate this regression for portfolio shares one, two, three, four and five months ahead. This expression allows us to trace out the dynamics of portfolio holdings changes as summer and prospective X-date approaches.

Our regression results are strongly consistent with the visual evidence from Figure B.4. The results indicate that, from as early as February, MMFs adjusted their portfolios to have much less weight on treasuries maturing in the summer months.

D.4 Impact on Market for Repurchase Agreements

Besides treasuries, MMFs hold a variety of other short-term assets. This can be seen visually in Figure B.5. In this figure, we plot the share of each asset class across all MMFs by date from July 2022 to December 2023. As can be seen, repurchase agreements collateralized by treasuries constitute a huge proportion of MMF assets. Further, there is significant visual evidence that the proportion of this kind of repurchase agreement increases exactly as the share of treasuries reaches its nadir in May 2023.

We formalize these results in B.4. In this table we estimate the regression

$$\text{Portfolio Share Category}_{it} = \sum_t \beta_t \mathbb{I}\left\{\text{Month}\right\}_t + \nu_i \tag{D.3}$$

This regression regresses the fund (i) at time (t) portfolio share for four asset classes, each corresponding to a different column in the table. We report results for treasury debt, repurchase agreements collateralized by treasuries, agency debt and "other instruments." Other instruments is a blanket designation that, among other asset classes, includes corporate bonds. In all regressions we include fund effects, (ν_i), so we are implicitly comparing variation within the same fund.

The results in Table B.4 are consistent with the visual evidence presented in Figure B.5. Relative to January, MMFs hold significantly less treasury debt in March, April and May. After the bill to raise the debt ceiling passes the house on June 1, the relationship flips. MMFs then hold much more treasury debt in the second half of the year. The opposite relationship is true for repurchase agreements collateralized by treasuries. MMFs hold significantly more treasury debt in March, April and May than they do in January. They then hold significantly less in August through December. We observe similar relationships for agency debt. After the debt ceiling is raised, MMFs hold substantially less agency debt than they did relative to January.

We do not see a strong pattern of substitution for "other instrument." In Figure B.8 in the appendix, we show that there is visual evidence that MMFs increased the dollar amount of their holdings in "other instrument" in May, specifically. However, this pattern is not driven by corporate bonds, and instead by forward settling repurchase agreements.

In addition to variation across time, there is also significant variation across MMFs. So-called "government" MMFs hold almost exclusively treasuries and repurchase agreements collateralized by treasuries. In contrast, "prime" MMFs hold relatively small amounts of treasuries and significantly higher amounts of other assets, such as corporate debt. This can be seen in the second panel of Figure B.5. It is visually apparent that the green section, corresponding to the share of the portfolio invested in treasuries, is much smaller than the unconditional average for every month in 2023. Prime funds still hold relatively large amounts of repurchase agreements collateralized by treasuries, but do not display the same pattern of substituting towards and then away from these repurchase agreements. Because of this, we reason that prime funds were under much less pressure to substitute away from treasuries and increase the share of repurchase agreements relative to all other funds.

To test the effects of this on the market for repurchase agreements, we exploit that the MMF holdings data contains lender-by-borrower data for repurchase agreements held by MMFs. We then estimate the following regression:

$$\text{spread}_{ijt} = \sum_t \left(\beta_t \text{Month} + \gamma_t \text{Month} \times \mathbb{I}\left\{\text{Prime Fund}\right\}\right) + \nu_{ij} \tag{D.4}$$

Here i indexes lender, j borrower and t time. We regress the repo rate, in basis points, on month dummies, month dummies interacted with whether the fund is a prime fund and borrower-by-lender fixed effects. The two sets of coefficients from this regression can be seen in Figure B.6. We estimate this regression over the entirety of 2023. January 2023 is the excluded group.

The results from this figure show that over the first half of 2023 the rate on repurchase agreements declined by 1.5 basis points when a government MMF was the lender, comparing within the same borrower-lender pair. However, there was no such downward pressure for prime MMFs. Over the second half of 2023, after the debt ceiling is resolved, we see the opposite pattern. There is a significant increase in the repo rate for both prime and government MMFs.

We interpret this finding through the lens of a lending supply shock. As MMFs substitute away from treasury debt, they increase their holdings of repurchase agreements. Since MMFs are lenders in the repo market, this means that the supply of loanable funds increases dramatically. This lending supply shock drives down the interest rate that borrowers pay. However, prime MMFs are under no such pressure to increase their holdings of repurchase agreements, as they hold very little treasury debt to begin with. This means that there is no such similar downward pressure on the repo rate where a prime MMF is a lender.

Once the debt ceiling was raised, there was a substantial increase in bill supply. The treasury issued a substantial amount of additional bills, apparently to raise the cash balance in the TGA to approximately $800 billion. The dynamics of the cash balance can be seen in Figure 1 in the appendix. After the debt ceiling was raised, the dynamics are reversed. MMFs absorb large amounts of new issuance, which crowds out the portfolio share dedicated to repurchase agreements. These dynamics can be seen in Figure B.5. This then took the form of a negative lending supply shock in the repo market. The rate to borrow in the repo market increased uniformly for both prime and government MMFs. It is interesting to note that when there was downward pressure on the repo rate, prime MMFs appear not to have lowered the repo rate to the same extent as other funds. However, when there is upward pressure on the repo rate they raise the repo rate symmetrically.

D.5 Futures Market

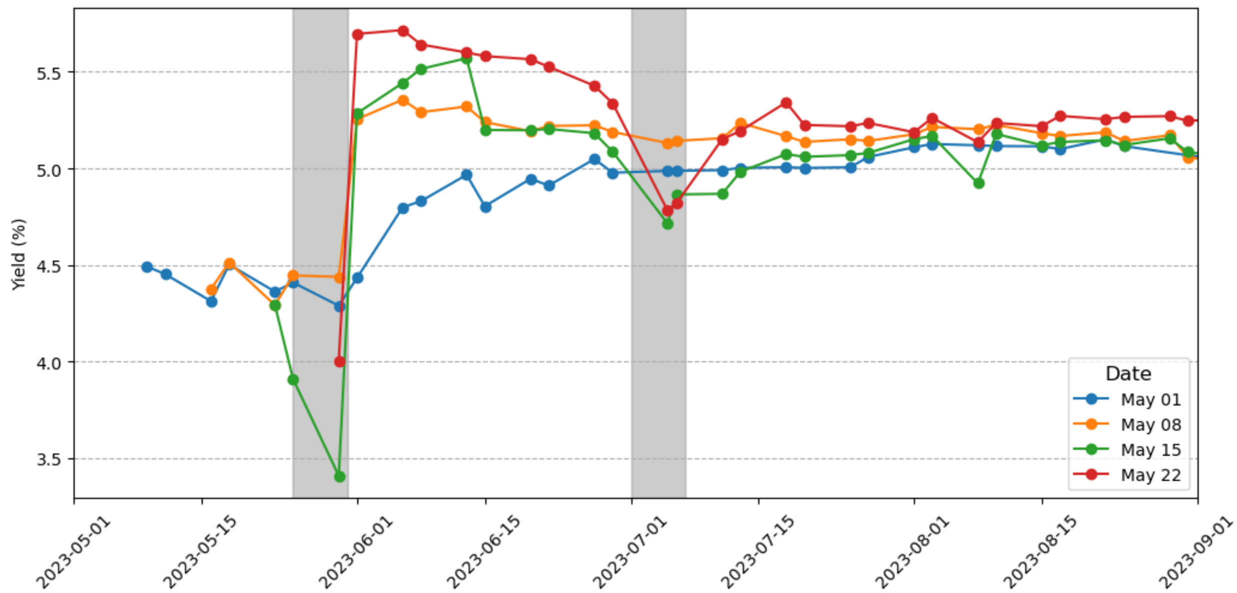
As a final note, these dynamics of negative and then positive bill supply shocks affecting the repo rate appear to have been anticipated by investors in the futures market. This can be seen visually in Figure B.7. In the top-right panel, we plot the forward curve constructed from both fed funds futures and SOFR futures. Notice that from January to September, the forward rate implied by SOFR futures is less than the forward rate implied by fed funds futures. In September, the relationship flips and the futures-implied SOFR rate becomes greater than that of the implied federal funds rate.[9]

In the second panel, we reconstruct the SOFR and Fed Funds forward curve five months

[9] This pattern was first noted by the rates strategist Rishi Mishra in a Bloomberg article from January 10, 2023 (Alloway (2023)).

Figure B.1
Yield Curves Around the X-date

This figure displays the yield curve as of four days in May. These yield curves are calculated using data on bills from treasury direct. The x-axis denotes the date that the bill matures. The y-axis denotes the yield in percent. The last week of May and first week of July are shaded. Each line corresponds to a specific data that the yield curve was constructed as of. For example, the red line shoes the yield curve as of May 22, 2023.



later, on May 8. The month at which the SOFR and Fed Funds switch their ordinal ranking is now one month earlier (this can also be seen in the third panel, which plots the difference). These patterns are consistent with futures investors recognizing that before the X-date, the repo rate would be depressed and that after the X-date the repo rate would rise relative to the federal funds rate. In fact, the realized difference between SOFR and the effective funds rate did reflect these dynamics. In the early part of the year the difference is negative and then positive, on average, by the last quarter.

D.6 Figures

Figure B.2
Money Market Mutual Fund Holdings

This figure displays the proportion that each vintage of treasury maturity comprises of MMF portfolios at each date. The green line denotes denotes reported holdings as of end-May 2023. The blue line denotes holdings as of end-June 2023.

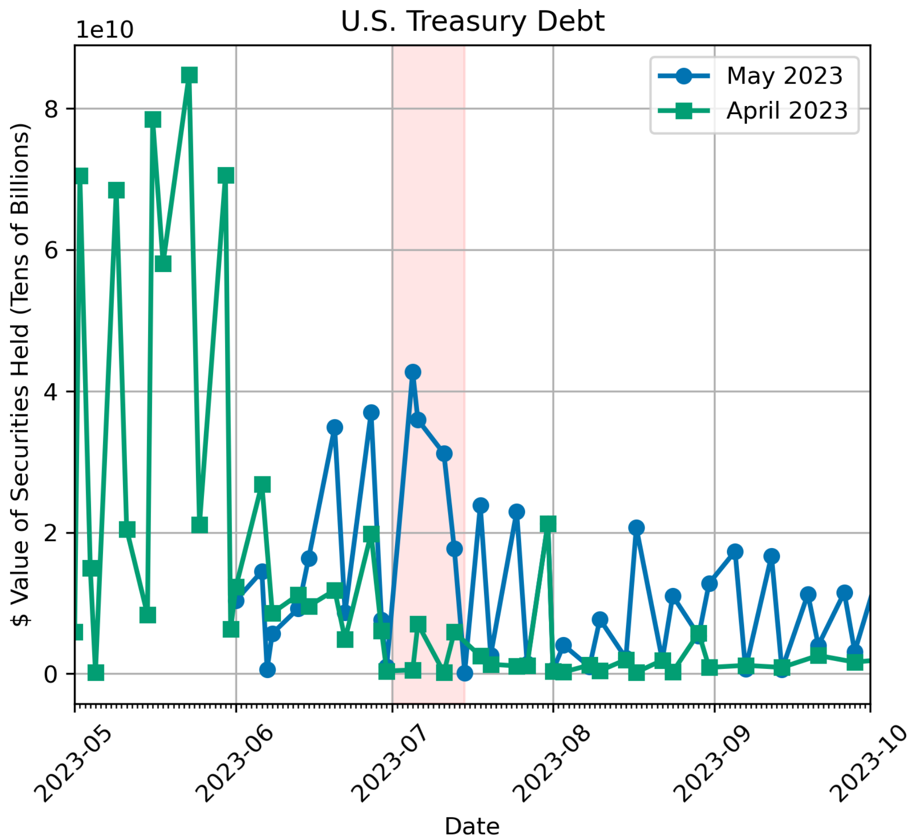


Figure B.3
Money Market Mutual Fund Holdings Coefficient Plot

The plot shows coefficients from the following regression:

$$\text{Dollar Value}_{imt} = \sum_{t'} \beta_{t'} \left(\mathbb{I}\left\{\text{Report Date May}\right\}_t \times \mathbb{I}\left\{\text{Maturity Week}\right\}_{t'} \right) + \gamma \text{Total Portfolio Value}_{mt} + \eta \text{Weeks to Maturity}_{it} + \nu_{im}$$

This regression is estimated over MMF holdings over the course of 2023. We control for the total value of the MMF's portfolio and the number of weeks to maturity. We include cusip fixed effects.

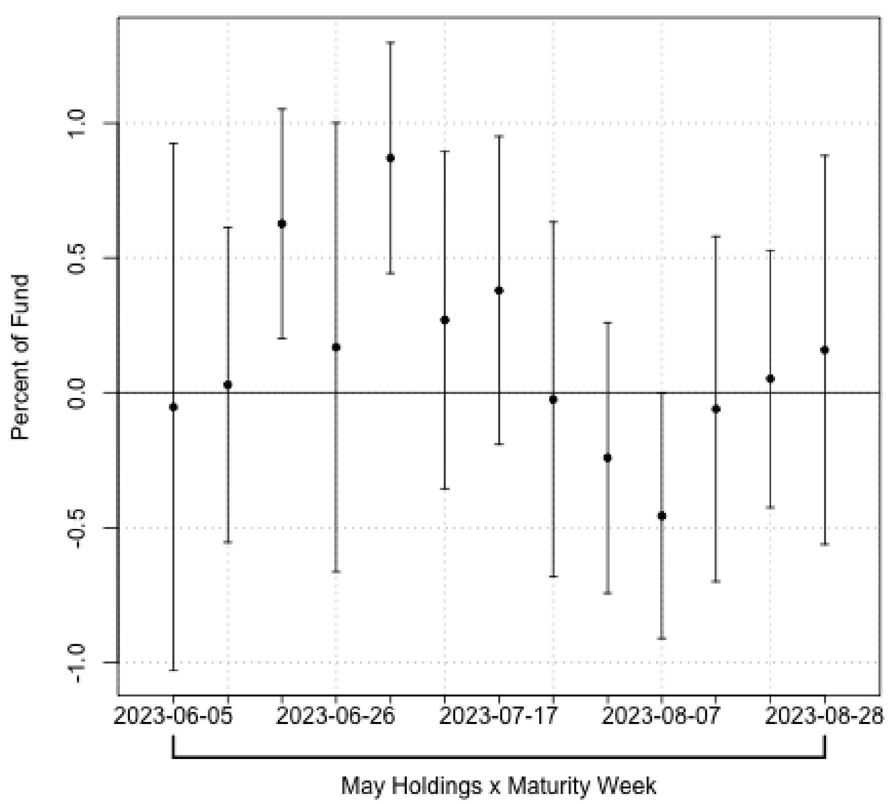


Figure B.4
Money Market Mutual Fund Holdings

This figure shows the dollar value of treasury securities held by money market mutual funds as of each month. The horizontal axis denotes the month to maturity of the securities. For example, the point corresponding to the x-tick "1" for the green line (holdings as of January) are securities expiring in Februrary. The point corresponding to the same x-tick for the green line (holdings as of April) records securities expiring in May. All holdings are as off the end-of-month.

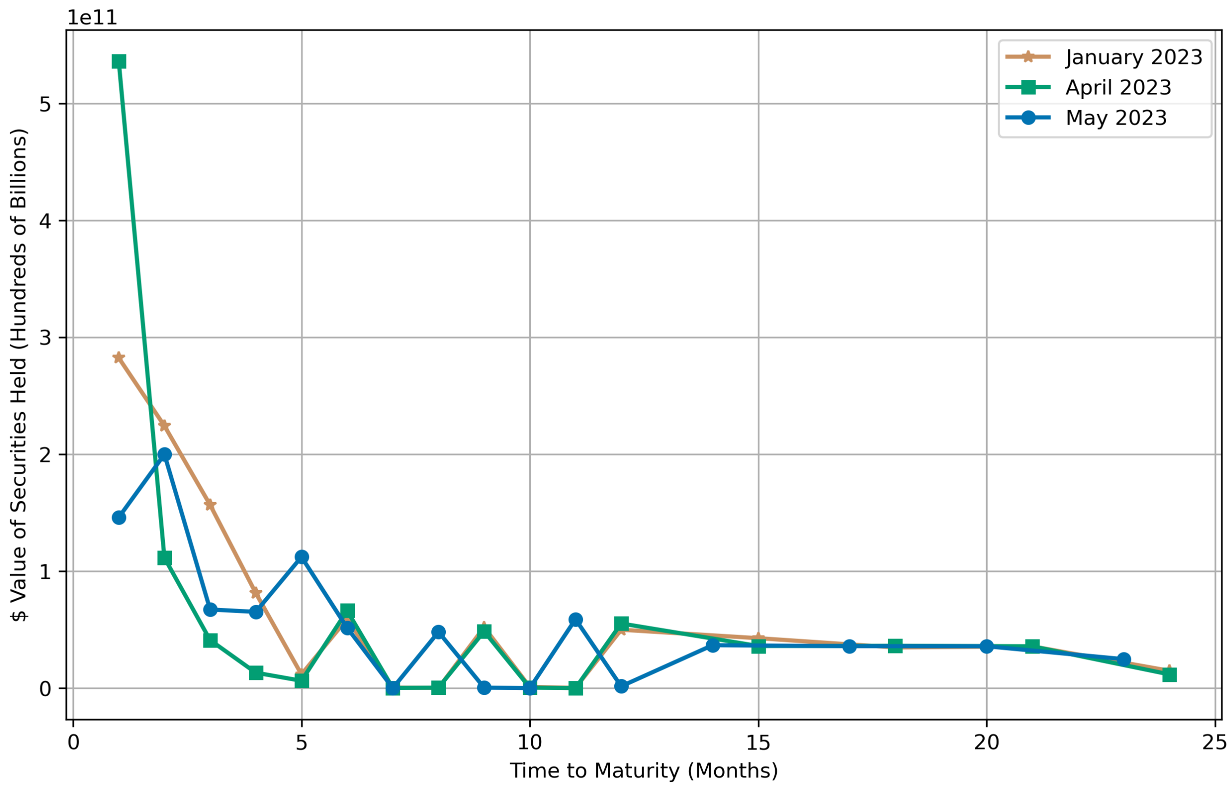


Figure B.5
Evolution of Money Market Mutual Fund Holdings

This figure displays the evolution of of the composition of MMF portfolios by investment type over 2023. The x-axis is date and the y-axis is the share of the portfolio which ranges from zero to one.

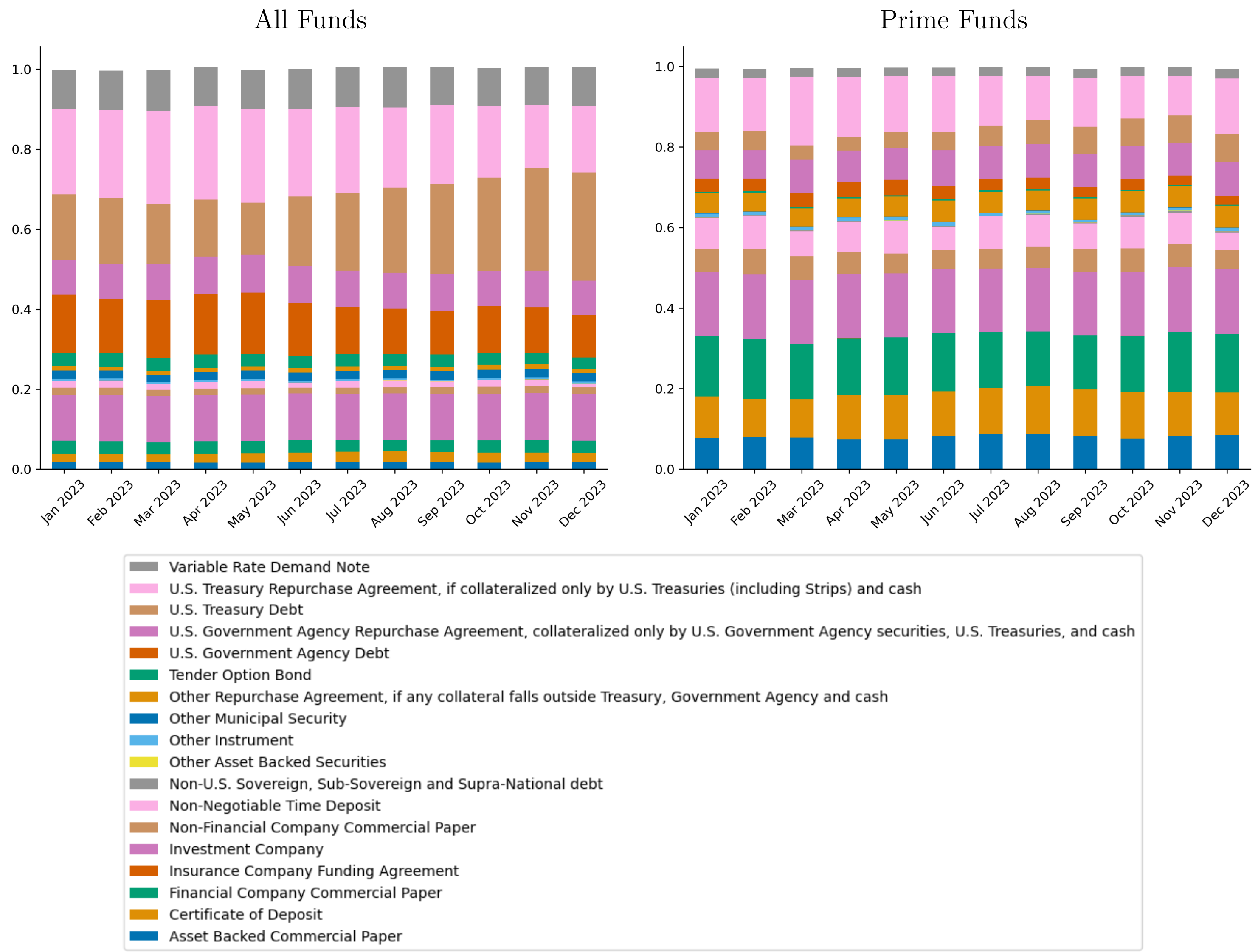


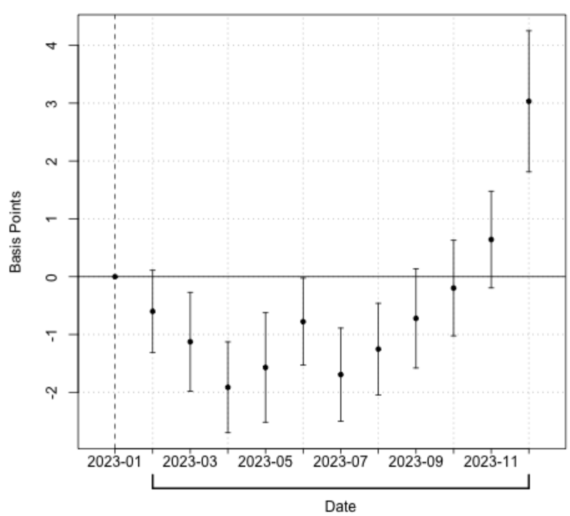
Figure B.6
Repo Rates

This table displays coefficients from the regression

$$\text{spread}_{ijt} = \sum_t \left(\beta_t \text{Month} + \gamma_t \text{Month} \times \mathbb{I}\left\{\text{Prime Fund}\right\}\right) + \nu_{ij}$$

The left-hand panel displays the coefficients from the time dummies (β_t) and the right-hand panel displays the coefficients from the interaction terms (γ_t). We include borrower-by-lender fixed effects ν_{ij}. The dependent variable is the spread between the repo rate and the effective federal funds rate.

Time Dummies (β_t)



Interaction Terms (γ_t)

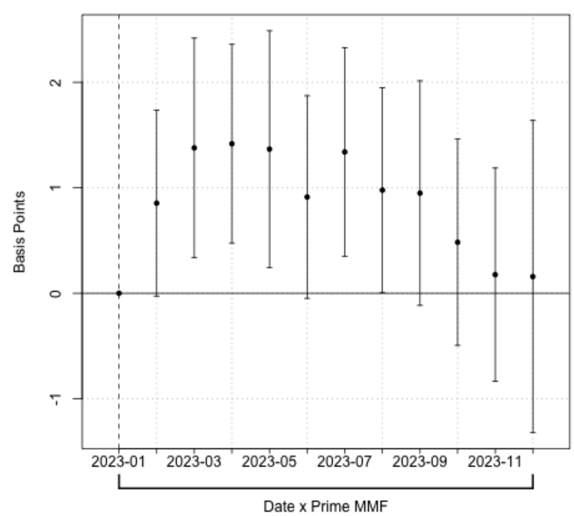


Figure B.7
Actual and Futures-Implied Evolution of the Repo Rate

This figure displays the actual and futures-implied paths of the federal funds rate and repo rates. The upper-left panel displays the forward curve constructed from Federal Funds and SOFR futures. The upper-right panel also displays the forward curve constructed from both types of futures, but constructed separately at January 9, 2023 and May 8, 2023 and focused on May to December. The bottom left panel shows the difference between the forward rates constructed from the two futures from May to December. And the final panel displays the actual difference between SOFR and the effective federal funds rate over the course of 2023.

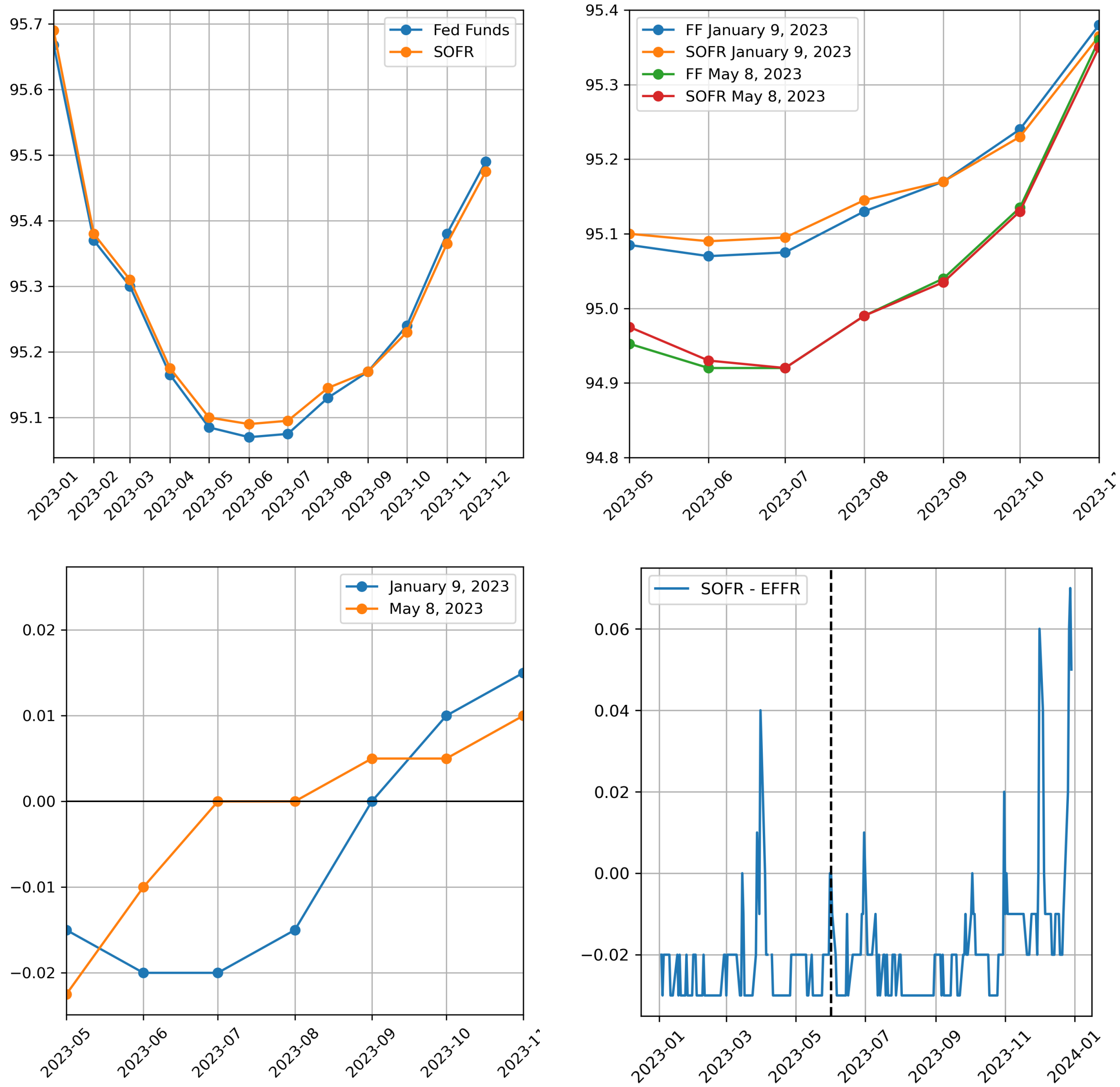
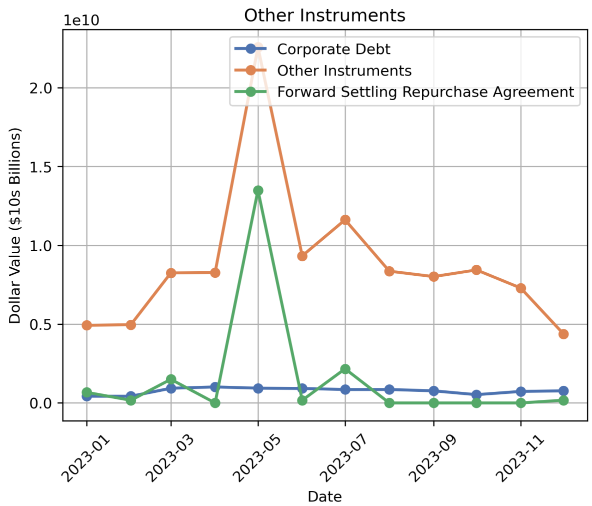


Figure B.8
MMF Holdings

This figure displays a breakdown of MMF holdings within the category of "other instrument". The left-hand side panel shows that most of the variation in other instrument is driven by the subcategory "Forward Settling Repurchase Agreement." The right-hand side panel zooms in on corporate debt holdings and shows there is time variation in holdings over the course of 2023, albeit much smaller.



D.7 Tables

Table B.1
Bond Transaction Summary Statistics

This table presents summary statistics for the corporate bond transactions in our sample. We split the summary statistics into agency debt, investment grade (IG) corporate debt and A-rated corporate debt. For each category we report the transaction counts by month as well as the median, median and standard deviation of the spread expressed in basis points.

	Agency Debt			IG Corporate Debt			A-Rated Corporate Debt		
	$\leq$ 1 year	1-2 years	2-3 years	$\leq$ 1 year	1-2 years	2-3 years	$\leq$ 1 year	1-2 years	2-3 years
Traded quantity									
Total (bn)	698	1,003	1,067	2,917	3,160	3,276	2,045	2,185	2,125
Mean (mn)	2.93	3.72	4.19	2.25	1.92	1.95	2.53	2.22	2.19
Median (mn)	0.75	1.00	0.88	0.50	0.44	0.45	0.60	0.54	0.54
SD (mn)	4.87	6.85	8.94	4.34	3.83	4.10	4.65	4.18	4.16
Spread over EFFR (bps)									
Mean (bps)	-1.81	2.49	12.27	41.64	49.35	67.10	25.66	26.44	38.75
Median (bps)	5.11	18.13	32.09	40.57	57.62	76.57	30.44	43.83	60.39
SD (bps)	61.38	83.75	84.55	108.24	117.52	121.57	103.76	118.75	124.52

Table B.2
Summary Statistics – Treasury Repo Market

This table displays summary statistics for repurchase agreements in which a MMF in our sample is a lender. All columns, except for "Count" are expressed in millions of dollars.

Month	Count	Mean	Std	25%	Median	75%	Total
Jan	1089	381.81	773.73	25.00	125.00	475.14	415786.03
Feb	1126	373.87	686.03	25.00	126.25	465.78	420977.85
Mar	1183	397.77	724.98	32.77	135.00	480.50	470560.46
Apr	1202	425.22	728.50	33.76	151.00	500.00	511114.62
May	1233	462.05	836.18	34.20	170.00	500.00	569708.78
Jun	1198	461.60	815.43	29.25	156.50	500.00	553002.03
Jul	1225	487.38	907.31	33.10	175.00	500.00	597035.04
Aug	1326	466.33	871.07	29.40	154.00	500.00	618352.98
Sep	1351	471.35	867.43	30.00	175.00	500.00	636792.84
Oct	1425	453.10	830.28	30.00	158.28	500.00	645670.72
Nov	1553	462.43	875.25	25.00	155.51	500.00	718158.33
Dec	1488	469.69	890.06	25.00	157.00	500.00	698893.42

Table B.3
Evolution of Bill Holdings First-Half 2023

In this table we display estimates from regressiong the MMF-level treasury portfolio share "X" months ahead

$$\text{Portfolio Share X Months Ahead}_{it} = \sum_t \beta_t \mathbb{I}\left\{\text{Month}\right\}_t + \gamma' \text{Controls}_{it} + \nu_i$$

where we control for the total bill supply within a month and the size of the MMFs portfolio. We also include fund fixed effects. We estimate this expression on reported MMF holdings from 2023. Each column corresponds to a value of $X \in \{1, 2, 3, 4, 5\}$, i.e. portfolio holdings between one and five months ahead.

Dependent Variable:	Portfolio Share X Months Ahead				
Months Ahead	One	Two	Three	Four	Five
Model:	(1)	(2)	(3)	(4)	(5)
Variables					
February 2023	1.317	1.080	-2.585***	-0.5129**	-0.2407*
	(1.108)	(1.373)	(-4.601)	(-2.085)	(-1.951)
March 2023	-4.149***	1.791	-2.593***	-0.8807***	3.783***
	(-2.773)	(1.525)	(-4.039)	(-3.216)	(4.140)
April 2023	-0.4657	-4.974***	-4.396***	2.580***	-0.1646
	(-0.1743)	(-3.759)	(-6.556)	(2.872)	(-1.037)
May 2023	-12.57***	-3.474**	1.023	-0.0843	1.788***
	(-3.830)	(-2.236)	(0.8392)	(-0.2696)	(3.565)
Controls					
Portfolio Size	Y	Y	Y	Y	Y
Fixed-Effects					
Fund ID	Yes	Yes	Yes	Yes	Yes
Fit Statistics					
Observations	1,001	1,001	1,001	1,001	1,001
R^2	0.81422	0.71431	0.50231	0.32760	0.36701
Within R^2	0.04911	0.04024	0.06782	0.05609	0.08270

Clustered (Fund ID) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.4
Evolution of Holdings by Category 2023

This table display coefficients from regression of the portfolio share on month dummies. This regressions are estimated on 2023 data.

$$\text{Portfolio Share Category}_{it} = \sum_t \beta_t \mathbb{I}\left\{\text{Month}\right\}_t + \nu_i$$

In all regressions we include fund fixed effects. The dependent variable is in percent.

Dependent Variables:	Treasury Debt	Treasury Repo	Agency Debt	Other Inst.
Model:	(1)	(2)	(3)	(4)
Variables				
February	0.1144	0.7093**	-0.9113***	-0.0391
	(0.5832)	(2.138)	(-2.858)	(-0.9486)
March	-1.500***	2.027***	-0.0182	-0.0219
	(-4.867)	(4.423)	(-0.0468)	(-0.5721)
April	-2.260***	1.928***	0.4476	-0.0100
	(-5.734)	(4.134)	(0.9843)	(-0.2532)
May	-3.290***	1.856***	0.6290	0.0284
	(-5.395)	(3.265)	(1.160)	(0.5140)
June	0.9452**	0.5020	-1.377***	-0.0016
	(2.245)	(0.8917)	(-2.768)	(-0.0408)
July	2.852***	0.0993	-2.839***	-0.0326
	(5.534)	(0.1976)	(-5.097)	(-0.6036)
August	4.848***	-1.514***	-3.155***	-0.0506
	(7.933)	(-2.651)	(-5.543)	(-0.9872)
September	5.877***	-1.799***	-3.628***	-0.0815
	(9.234)	(-2.965)	(-5.832)	(-1.193)
October	6.712***	-3.680***	-2.815***	-0.0621
	(10.11)	(-5.289)	(-4.452)	(-0.8640)
November	8.971***	-5.791***	-3.257***	-0.0258
	(11.21)	(-7.503)	(-4.832)	(-0.3191)
December	10.13***	-5.024***	-3.925***	-0.0405
	(11.28)	(-6.535)	(-5.367)	(-0.4529)
Fixed-Effects				
Fund ID	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	3,900	3,900	3,900	3,900
R^2	0.92958	0.93324	0.91671	0.99348
Within R^2	0.23625	0.12338	0.07601	0.00399

Clustered (Fund ID) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Figure B.9
Yield Curve around Kevin McCarthy Speaker Vote

This figure displays variation in the yield curve at the start of 2023, when Kevin McCarthy endured fifteen votes before becoming speaker of the house. There is a pronounced increase in yields for bills expiring before the end of the summer, when the X-date was widely projected to occur.