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 the price of short-term investment grade corporate credit in both the primary and secondary markets. Our preferred IV specifications imply that a one hundred billion dollar decline in bill supply depresses corporate yields on the order of ten basis points.

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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 does have large impacts on 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 prior to 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 the bill-to-GDP ratio 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. The content of this policy is that four times a year the Treasury schedules its bond and note issuance for the following quarter. Importantly, the Treasury very rarely deviates from these announcements. In addition, the Treasury keeps scheduled note and bond issuance extremely stable across quarters (Garbade (2007)).

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

[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.

debt ceiling would be breached. We exploit this feature of Treasury issuance to construct an instrument, called DCIV, for total bill supply. Intuitively, 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 a larger amount of 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 prior to the end of a debt ceiling suspension. We exploit this to create a second instrument for the issuance of Treasury bills, which we call 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 continuing to maintain 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 greatly increased its cash balance at the Treasury General Account (TGA). This change was motivated by the Treasury's fear that it was vulnerable to losing access to capital markets due to natural disasters or cyberattacks (Carpenter (2015)). Ironically, it has greatly increased the ability of the Treasury to operate at the debt ceiling constraint and systematically lengthen the duration of its liabilities.

We 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 hundred billion dollar decline in bill supply. We find that the debt ceiling has had quantitatively similar effects in the primary market. In an ironic twist, the Treasury first adopted its policy of regular and predictable issuance, in part, due to concerns that Treasury auctions were disrupting corporate bond markets (Garbade (2007)). In an era of debt ceiling brinkmanship, regular and predictable issuance is now itself having large and, arguably, undesirable effects on corporate bond markets again.

We argue that the Treasury implicitly chooses to disrupt capital markets because the Treasury seeks to fulfill its mandate of "financing at lowest cost over time" in the presence of an intermediation constraint. We attribute the Treasury's decision to keep bond and note issuance stable during debt ceiling episodes to the limited capacity of primary dealers to bear interest rate risk. To prevent a deterioration in auction terms, the Treasury keeps bond and note issuance constant. We conjecture that if the Treasury were to reduce and then increase long-term debt issuance this would result in higher primary market yields. 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)).

Our results show that political dysfunction, in the form of debt ceiling brinkmanship, is having aggregate consequences for the U.S. economy. Prior work studying the debt ceiling has identified negative but relatively small effects on the operation of financial intermediaries. These costs are borne by those intermediaries and their end-investors. We show that political dysfunction has affected the cost of capital for firms themselves.

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.

In contemporaneous research, 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 some additional results studying the debt ceiling's impact on MMF demand for Treasuries in the appendix. In the appendix, we extend Stein and Wallen (2023) results by demonstrating that Treasuries maturing after anticipated cash inflows to the Treasury (e.g., post-tax deadline dates) act as 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.

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 both 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 work on 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 on the impact 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 yields, including Acharya and Laarits (2023), Binsbergen et al. (2022), Augustin et al. (2021) and Fleckenstein and Longstaff (2024).

Insofar as we rationalize the behavior of the Treasury as a response to the constrained capacity of primary dealers, our study is close to other work studying how primary dealers behave at auction and how primary dealers 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 descriptive 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

To study the effects on bond markets, we use data from TRACE and Mergent/ FISD datasets. 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, for the period January 1, 2011, to December 31, 2023[2]. Since there may be multiple transactions for a cusip on a particular transaction date, for each cusip, 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 data on maturity date and rating from Mergent/FISD, merging on cusip, and using the latest credit rating issued prior to the trade execution date. We drop transactions for which reported yield, or maturity is not available. We retain transactions for bonds with maturity up to three years and drop bonds which are very close (<4 weeks) to maturity.

We winsorize TRACE-reported yields for each of investment grade, high-yield, and unrated corporate bonds, by year-quarter, at the second and ninety-eighth percentile. We winsorize TRACE-reported yields for rated and unrated agency bonds at the second and ninety-eighth percentile. Since we are also interested in examining the movement in the spread of the reported yield over the implied effective fund rate, we calculate the implied EFFR yield to maturity for every cusip, using the daily prices of Fed Fund Futures from Bloomberg. We split the corporate bond dataset into different subsamples based on credit ratings. Highly rated corporate bonds are those rated AA- (Aa3 on the Moody's scale) or higher. A-rated include those rated A- (A3 on the Moody's scale) or higher. For Agency

[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.

debt, we include all ratings, which for our sample period comprises AA+, Aaa and Not Rated. The summary statistics are reported in Table 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 this exercise, we use data on the yields of bills.

For the rest of our analysis, we use a bevy of 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 both bills as well as 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 as well as 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 important for justifying our claims that specific Treasury maturities are more or less exposed to the risk of delayed payment in the appendix.

For parts of our analysis, we also use the CRSP U.S. treasury database. 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 the path its future issuance. Our reading is that in 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 securitities... 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 subsequent to 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 that 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 corresponds 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 are 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.

3.2.2 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.

4 Empirical Analysis

Our empirical analysis proceeds in two major 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 the pricing of corporate bonds.

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

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 either prioritize payments to bondholders over its other obligations or enter technical default.

There is a sequence of events that occurs prior to the X-date. When the Treasury can no longer issue additional debt, i.e. the level of outstanding debt is equal to 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 is able to 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 is 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.[4] 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.

When the X-date is reached, the debt ceiling can either be raised or suspended. If it is raised, then the statutory limit of the debt ceiling is increased. If suspended, then 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, there are two other periods shaded in Figure 1. In light yellow, we shade the periods immediately following a debt ceiling suspension or raise. These periods are associated with pronounced increases in the cash

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

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 prior to the end of a debt ceiling suspension. 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 prior to 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 prior to 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. To avoid discrete jumps in the bill-to-GDP ratio at quarter ends, we linearly interpolate quarterly GDP within quarter.

In Figure 2, it is visually apparent that these three sets of periods are not only associated with variation in the TGA cash balance, but also 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 prior to the end of a suspension (blue).

In Figure 3, we plot the change in bill supply over the course of 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 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 at a quarterly frequency 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 paragraphs that follow, 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. Important for this setting, the Treasury does not choose to adjust its bond and note offerings during the debt ceiling, but rather 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 is was gives rise to the persistent declines in the supply of bills observed in the red-shaded areas of Figure 2.

We interpret this pattern as consistent with the Treasury fulfilling its mandate "to finance the government at lowest cost over time" in the presence of intermediation frictions. Most Treasury debt at auction is purchased by primary dealers. Prior work has documented that yields at Treasury auctions are higher than yields 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)).

We view near constant bond and note issuance as the Treasury's optimal issuance policy in the presence of intermediation frictions. Bills have little interest rate risk. The Treasury can issue a large quantity of bills without price impact in the primary market, because dealers are not exposed to interest rate risk. Conversely, the Treasury's ability to issue large quantities of bonds and notes is limited, because an increase in the interest rate risk primary dealers are asked to bear will cause the terms the Treasury gets at auction to deteriorate. Thus, our interpretation is that the Treasury keeps bond and note issuance constant because they cannot decrease and subsequently increase bond and note issuance without price impact, while they are able to do so for bills.

To take our instrument to the data, we still need to operationalize Equation 4.3. In practice, bond and note auctions are not held on the same day. To construct an instrument for the change in aggregate bill supply, we need to 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 one 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 course of 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 aluded 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. If the prior debt ceiling episode was resolved by suspension, we being the plot at the quarter prior to the end of the suspension – in this case extraodinary 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 a one dollar (exact to two decimal places) decline in the supply of bills. That the coefficient estimate is nearly exactly 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 twelve in magnitude and the within-R^2 from this regression is nearly sixty-six 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.

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. To most straightforward way to end a debt ceiling standoff is to raise the statutory debt limit. However, since 2011, the Congress has frequently elected to suspend the debt ceiling instead of raise it. This entails deeming that the debt ceiling is not in force for a pre-determined amount of 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 be 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 indefinitely delay the need for further debt ceilings raises or suspensions. While the debt ceiling is suspended, the Treasury could issue debt purely in order to build up 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). In effect, 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 what we call the "Suspension End Instrument."

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

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 prior to 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.[5]

In Figure 1, the blue periods are associated with large declines in the cash balance of the Treasury. This is precisely due to end-of-suspension cash regulations. We observe that the Treasury tends to cut bill offerings in the quarter prior to the end of a suspension, which we call end-of-suspension periods. These are the shaded blue periods in Figure A.1. This 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 that the Treasury accomplishes the drawdown in bill supply by cutting the number of bills at auction in the quarter prior to 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 an eighty-eight cent decline in the level of bills. The t-stat is nearly twenty and the within-R^2 is nearly seventy-two 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 the 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 cash balance of the Treasury is near zero, meaning that any delay in raising or suspending the debt ceiling would result in

[5] 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 this in Section A.1 in the appendix.

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, for short.

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

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 a large amount of 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 the period starting from the debt ceiling raise until the Treasury first increases the level of cash in the TGA to within five percent of its cash balance assumptions.

The first is the actual cash balance assumptions taken from the Treasury's quarterly marketable borrowing estimates for the quarter following the raise/ suspension. We plot the time series of these estimates in Figure 1, they correspond 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 actual cash level. This metric is not perfect, as the Treasury appears to slightly adjust the target cash level taking into account the impact of the debt ceiling. When and to what degree they do this is not totally transparent. Therefore, we consider three other measures.

The second is the opening cash balance on initiation of extraordinary measures. This measure is also not bulletproof, as the cash balance on the imposition of extraordinary measures could be affected by end-of-suspension cash regulations. 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 fairly 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 or raise until the first date at which the Treasury's cash balance is within five percent of the stated cash balance assumptions. This rule is conservative. In 2018, this rule does 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 in the final four columns of Table 2. We again find strong evidence for relevance; the t-stats are all large, and the smallest is greater than three in magnitude. The within-R^2 is consistently very high. The smallest within-R^2 across all four models is larger than 65%, and the largest is 72%. The magnitudes are not as close to one as in the first and second instruments, we attribute this to measurement error in the actual cash balance target.

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 the event of extreme weather like Superstorm Sandy or events similar to the September 11 terrorist attacks (Carpenter (2015)). 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. Prior to 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 a large, unintended effect. It has greatly amplified the dynamics described in the prior sections. Within debt ceiling periods, the Treasury is able to accomodate greater spending needs when the debt ceiling constraint binds. Before and after the debt ceiling periods themselves, 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 3. 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 and 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 the pre- and post-2015 averages.

The first two lines of the panel accord with Figure 1, the level of the cash balance has greatly increased over time as has the change in cash balance over episodes. In the pre-2015 sample for the second panel, there was actually a slight increase in the level of the cash balance on average. 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 larger, by the last periods in our sample frequently in excess of 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 subsequent to 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 can be seen 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, inclusive of all periods has increased slightly and affects issuance 36% of the time relative to 28% prior to 2015. This increase is partially driven by the greater frequency of debt ceiling suspensions in the later years of our sample.

4.2 Effects on the Pricing of Corporate Debt

Work in the finance literature suggests that changes in the supply of Treasury bills 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 corporate credit spreads.

To study this, we start by plotting the evolution of investment grade corporate debt rated AA and above and agency debt yields around the most recent debt ceiling raise in 2023 in Figure 6. In this figure, we plot the median spread over a version of the effective federal funds rate for transactions on that date for both kinds of bonds. For bonds that expire in month t', we calculate the implied federal funds rate from t to t' by using the forward rates taken from federal fund futures.[6]

[6]This approach is similar to that of Fleckenstein and Longstaff (2024) in that is uses derivatives based on federal funds futures to construct a risk-free discount rate curve.

There is an extremely striking visual pattern. The spread between agency and corporate debt significantly narrows over the course of April. The spread between agency and corporate debt is essentially zero over the course of May. During this period the quantity of bills substantially declines, increasing the prices of corporate debt. Once the debt ceiling is lifted in June, the spread between agency debt and corporate debt rapidly increases to levels consistent with early April. This reflects that after the debt ceiling is raised, the quantity of bills increases and the price of corporate debt rises again.

The last relevant part of this figure is the behavior of corporate spreads immediately prior to the debt ceiling raise, which occurred on June 3, 2023. On May 31, 2023, several days prior, the US House of Representatives passed the rule raising the statutory debt ceiling. It was passed by the Senate and signed subsequently. Arguably May 31 is when uncertainty about a debt ceiling raise was resolved. It is on this day that we first observe a pronounced increase in credit spreads. Credit spreads continue to widen in the post-period.

We formalize the visual analysis of Figure 6 in in Table 4. In this table, we report estimates from IV specifications where the second stage is given by

$$\text{Mean Spread}_i = \beta \text{Bill Supply}_t + \boldsymbol{\delta}' \vec{\text{Controls}}_t + \gamma_{episode} + \epsilon_t \tag{4.9}$$

In the first stage, we instrument Bill Supply_t by one of our three instruments. The left-hand side of the equation is a weighted average spread of the yield minus the effective federal rate expressed in basis points. As always, we use federal funds futures to account for the maturity of the bond. The average is weighted by transaction volume. The right-hand side is bill supply expressed in hundreds of billions of dollars. 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 years these years.

In all specifications, we include a battery of controls. We try hard to purge confounding variation from our empirical tests. We are particularly concerned about violations of instrument exogeneity. 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.

Motivated by these considerations, we include the VIX and US Sovereign CDS spread as a control in all specifications. By including the VIX, a measure of the future expected volatility on stocks, our aim is to control for the possibility that the debt ceiling separately affects corporate credit spreads through economic uncertainty. By including the spread on a US Sovereign CDS, we hope to control for the impact of time-varying US default risk during these periods.

We also include controls for the spread between the ten-year and two-year Treasury yield and quarterly GDP growth. These controls are both intended to proxy for economic conditions that could affect corporate credit spreads. To proxy for the stance of monetary policy, we include the federal funds rate. Finally, to proxy for overall market conditions we also control for the monthly market return.

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 find that in the 2017 episode, there was a period during which the bill-to-GDP ratio did not evolve as our instrument would predict, due to the confounding effects of a September tax date (this can be seen in Figure 3). We also include a control for September 2017 for this reason.

We find consistent results from two of our instruments and substantially different results from the third. Our suspension-end instrument implies that a one hundred billion dollar increase in short-dated treasuries raises average spreads by 12.43 basis points, the coefficient on DCIV is insignificant and close to zero, whereas the post-suspension raise instrument implies that spreads increase by 9.75 basis points. Our reading of the literature is that our estimates from the first and third instruments are relatively large. In contrast, the null estimate from DCIV itself is relatively small.

There are two potential explanations for the null estimate on DCIV itself, the second of which we find more compelling, in that it also explains the relatively large estimates for the first and third instruments.

The first explanation is that we have not adequately controlled for economic uncertainty, default risk or some other latent economic variable. While this is possible, our null result is remarkably robust to the addition of control variables, including sovereign CDS spreads and the VIX. This result is also robust to the inclusion of the MOVE index, a variant of the VIX based on the bond market, instead of the equity market. We have also included a variety of controls designed to proxy for Federal Reserve actions and the changing stance of monetary policy, including explicit controls for Fed purchases and sales of corporate bonds through the SMCCF.

A second alternative is that the impact of the debt ceiling on bill supply are largely anticipated. The date at which a debt ceiling suspension ends is perfectly forecastable, as it is set by law. As argued in later sections, asset prices react to news about the debt ceiling in ways that indicate that market participants have a sophisticated understanding of the impact of the debt ceiling on treasuries and the repo market. In contrast, the duration of a debt ceiling episode is uncertain, because it is subject to unanticipated shocks to Treasury tax collections (Yellen (2023a), IRS (2023)), which can prolong or shorten the length of time the Treasury can forgo positive debt issuance on a net basis.

Anticipatory effects also explain why our estimates from the suspension end instrument are also larger than expected. In part, market participants anticipate a future decline in bill supply and this is encoded in the estimates from the suspension-end instrument. Because the end dates of debt ceiling standoffs are not known with certainty, there is arguably less scope for anticipatory effects. However, as noted above, there is some evidence for anticipatory effects in Figure 6, where there is pronounced increase in credit spreads on the date that the House of Representatives passed the latest debt ceiling suspension, the day before the suspension was signed into law.

To further rule out that our results are driven by omitted variables or some other violation of the exclusion restriction, we plot a graphical illustration of the reduced form of our suspension-end instrument episode-by-episode in Figure 7. On the y-axis we plot the median spread of corporate bond yields and on the x-axis we plot our instrument.

There is a strong negative relationship between our instrument and median spreads in each of the four suspension-end episodes. What is striking is the stability of this negative relationship across episodes and the strong linearity, even in the absence of controls. Reassuringly, because this is prior to the start of a debt issuance suspension period, these periods arguably occur prior to sovereign default concerns becoming first order.

4.2.1 2017 Experiment

A critical reader might still argue that our results are driven by default risk or some other omitted variable. As a final argument, we study the extended 2017 episode, during which there were two debt ceiling events. During March 2017, the Treasury first invoked extraordinary measures. However, after the destruction of Hurricane Harvey, Congress passed a law appropriating money for disaster relief and temporarily suspending the debt ceiling. However, as part of this law, in a section entitled "Restoring Congressional Authority Over the National Debt", Congress expressly forbade the Treasury from increasing its cash balances at the Treasury General Account. This was intended to ensure that the Treasury could not use the period of the debt ceiling suspension to evade Congressional action on the debt ceiling by issuing a huge amount of additional debt, greatly increasing the cash available to it and forestalling the need for Congress to lift the debt ceiling. We quote the exact bill language below:

> Prohibition on creation of cash reserve during extension period. – The Secretary of the Treasury shall not issue obligations during the period specified in section 101(a) for the purpose of increasing the cash balance above normal operating balances in anticipation of the expiration of such period.

As can be seen in Figure 2, bill supply did not dramatically increase after the suspension in August 2017. However, after the debt ceiling was lifted in February 2018, there was a much sharper increase bill supply, which can be seen in the aforementioned figure. After the second episode, there were no such restrictions on the cash balance in the TGA.

We plot the spreads over the effective funds rate for both agency and IG corporate around the 2017 event in Figure 8, there is no sharp increase in yields after the first suspension, which we interpret as being due to the lack of change in bill supply. However, after the second debt ceiling when the Treasury was not constrained from increasing its offerings, we see a sharp increase in yields on impact for both agency and IG corporate debt as well as an increase in the spread between these two debt instruments. Further, these increases are large.

We view this as extremely clean evidence for our proposed mechanism. If the effects we document were driven by disaster risk, the resolution of uncertainty or some other dark matter then we would expect to see movement in yields after both episodes. However, because we only see movements in the second period, when the Treasury was not constrained from issuing additional bills, this corroborates our claim that bill supply drives the changes we see in yields and spreads.

4.2.2 Additional Evidence for Anticipation

A implicit question raised in our analysis is to what extent the shocks associated with the debt ceiling are anticipated or unanticipated. First, it is the case that there is substantial uncertainty about the timing of a potential debt ceiling breach. In the most recent debt ceiling episode, even the Treasury itself expressed substantial uncertainty about the timing of the X-date (Yellen (2023a)) This uncertainty is primarily due to uncertainty about the total tax receipts that would flow into the Treasury's balance sheet. In 2023, the Treasury gave a wide range between June and late summer during which a debt ceiling breach could occur.

With these caveats, we view the evidence as consistent with market participants having substantial foreknowledge of debt ceiling dynamics. We base this on several results. First, we investigate the evolution of the yield curve around the election of Kevin McCarthy to the speaker of the House of Representatives in 2024. Kevin McCarthy was elected as speaker on January seventh on the fifteenth ballot with 216 votes, one greater than the 215 threshold needed.[7]

We plot the change in the yield curve for very short-term treasuries before and after the start of the series of votes that eventually elected Kevin McCarthy in Figure 9. Voting started on January 3, 2023 and ended on January 7, a Saturday. We use December 30 and January 9 to accommodate holidays and weekends. As is visually apparent, there was a distinct increase in the yields on treasurys expiring before the last possible date at which the debt ceiling breach could occur (estimated to be in September) and no such increase for treasuries following the last date of a potential debt ceiling breach.

We find additional evidence for a high degree of anticipation by examining the behavior of futures markets in Section B.5 in the appendix. While these two strands of evidence do not directly show that investors anticipate the effect of the debt ceiling on the Treasury maturity structure, surveys by the Congressional research service of market participants indicate that market participants were aware of these dynamics as early as 2015 (Congressional Research Service (2022)).

5 Effects on the Cost of Capital

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 shown evidence that the debt ceiling has an effect on the cost of capital paid by issuers themselves.

We study this by estimating

$$\text{Primary Market Spread}_{i,t} = \beta \text{Bill-to-GDP Ratio} + \boldsymbol{\delta}' \vec{\text{Controls}} + \gamma_{e(t)} + \xi_{i,t} \tag{5.1}$$

where, in the first stage, we instrument the Bill-to-GDP ratio with

$$\begin{aligned} \text{Instrument}_t = & \ \mathbb{I}\left\{\text{Debt Ceiling Period}_t\right\} \times \text{DCIV}_t \\ & + \mathbb{I}\left\{\text{Pre-Suspension-End-Period Period}_t\right\} \times \text{SEIV}_t \\ & + \mathbb{I}\left\{\text{Post-Suspension Raise Period}_t\right\} \times \text{TGAIV}_t \end{aligned} \tag{5.2}$$

We use all three instruments because of the relatively small amount of short-dated investment grade corporate bond issuance. Corporate issuers who desire to issue relatively

[7] The close margin and extended voting was widely seen as a harbinger of future dysfunction.

short-term debt instruments frequently do so by issuing in the commercial paper market. We do not have access to disaggregated commercial paper issuance by issuer, as we do with corporate bond issuance. For these data availability considerations, we focus on the primary market for corporate bonds. However, even after pooling across all episodes, we only have 91 instances in which investment-grade corporate issuers issued debt with a maturity of two years or less.

By using all three instruments in a single specification we increase statistical power. As in prior specifications, we include a battery of controls to account for sovereign default risk, uncertainty and concurrent events that might affect our estimates.

The results from this specification can be seen in Table 5. We find results consistent with the effects we documented in secondary markets. The estimated effect is somewhat smaller, which we hypothesize is due to including corporate debt within IG that is relatively less substitutable with treasury debt than AA and above corporate debt, which is what we used in our prior analysis. We do not restrict to AA and above due to too few observations. Debt both within IG with maturity longer than two years and high-yield corporate debt are not systematically affected by variation in bill supply, consistent with them being highly imperfect substitutes to bills.

6 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 one hundred billion dollars of net negative bill issuance lowers 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 (Carpenter (2015)). 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 view our results as important for two outstanding questions in the finance literature. First, the future of the treasury market structure. By moving to an exchange-based market structure, the Treasury could arguably alleviate some of the constraints it faces. In principle, this might reduce the distortions associated with debt ceiling episodes.

In the absence of larger changes to the treasury market structure, we hope that our results prompt a larger reevaluation of the Treasury's policy of "regular and predictable" bond and note issuance. In the seventies and early eighties, the Treasury adjusted its policy from "tactical" issuance, where it held large and unannounced auctions. At least in part, this change was motivated by the turbulence these auctions induced in corporate bond markets (Garbade (2007)). Now, as was then, the Treasury's policy rules are causing undesirable distortions in capital and money markets. As debt ceiling showdowns promise to be a regular feature of future policy disputes, these distortions are likely to also be a regular feature of future policy disputes.

Finally, there is some debate within finance academia as to why greater political dysfunction in the Western world since the financial crisis has not been associated with effects on financial markets. We show that in at least one instance, political dysfunction has disrupted the orderly conduct of financial markets and distorted the supply of credit to firms.

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.

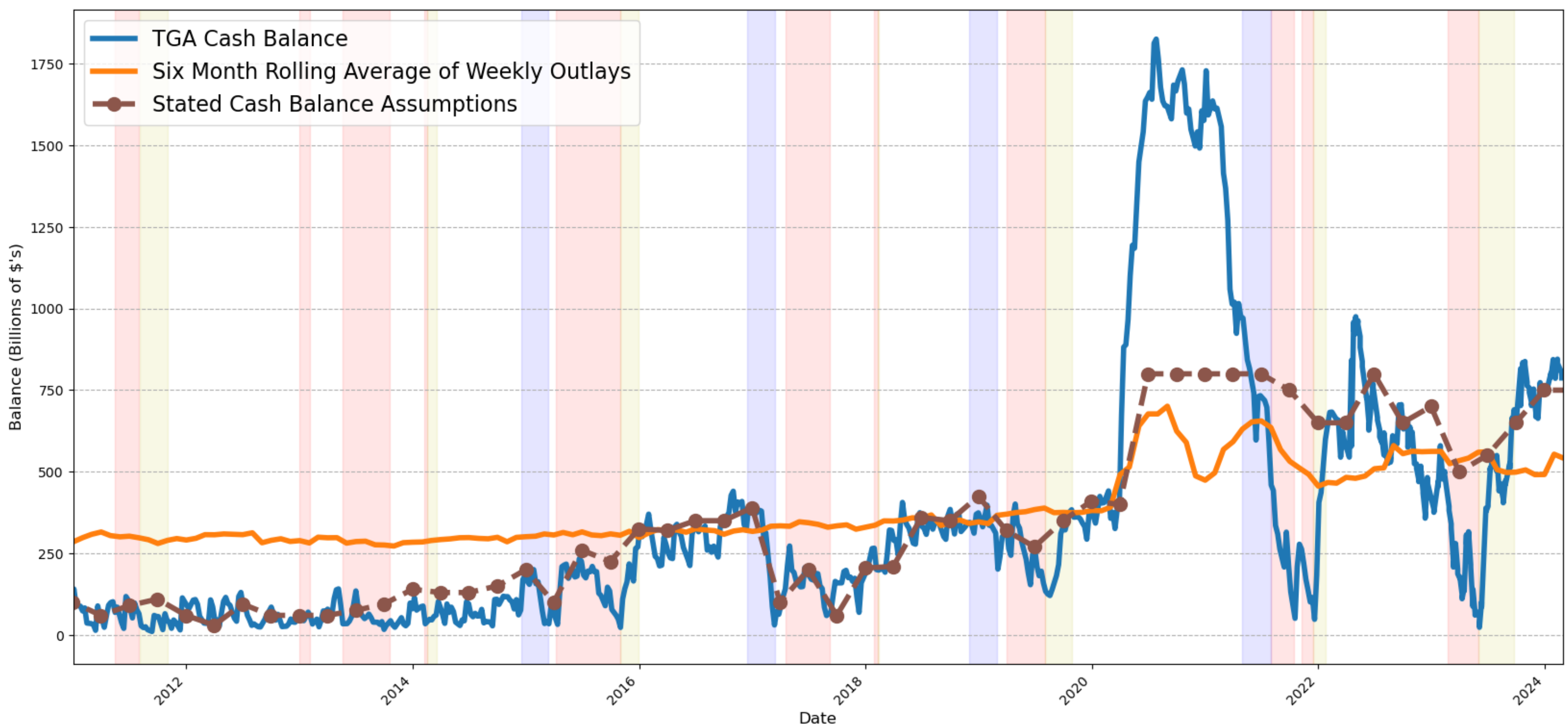


Figure 2
Evolution of Bills / GDP

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.

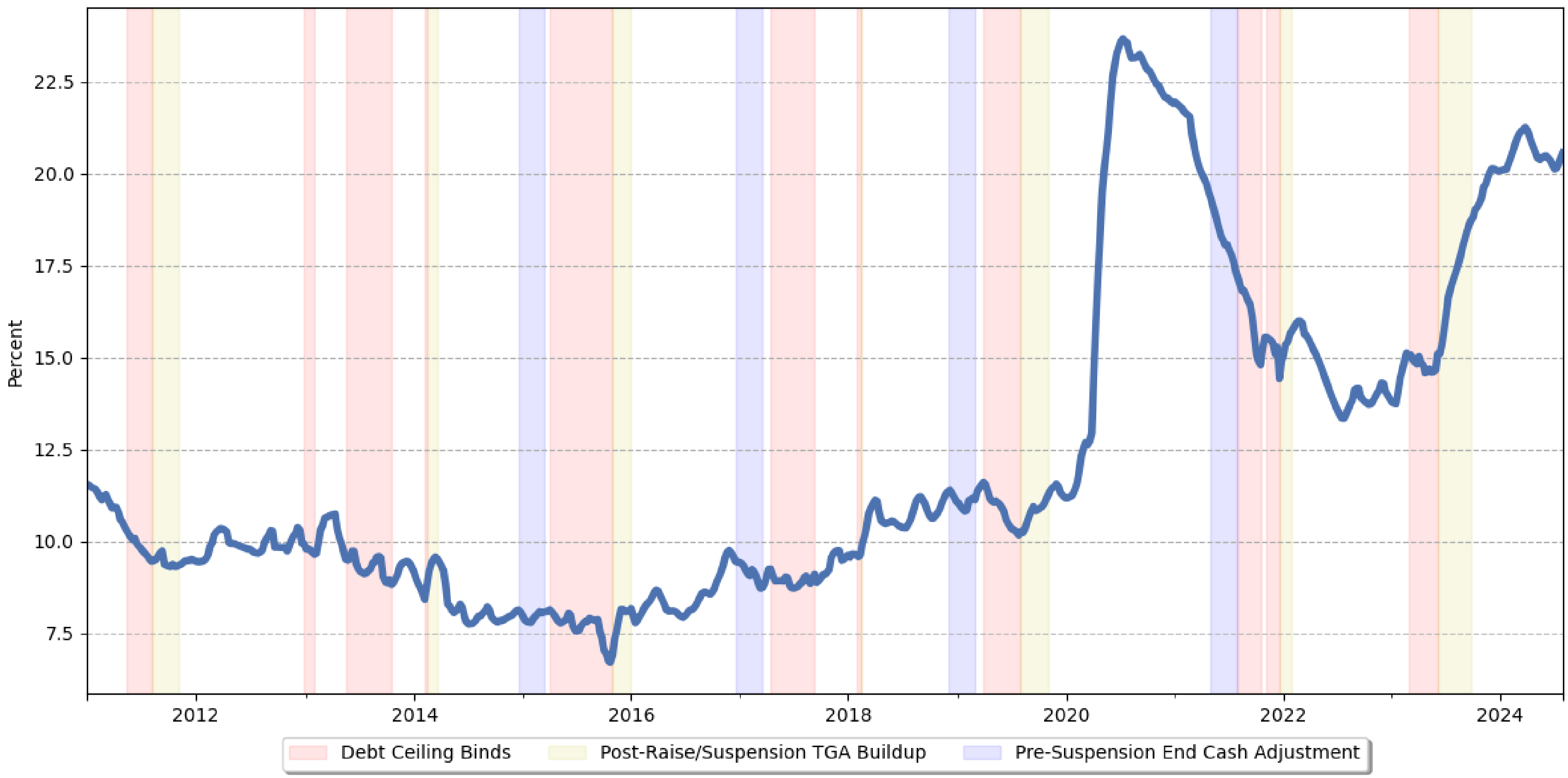


Figure 3
Headroom

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.

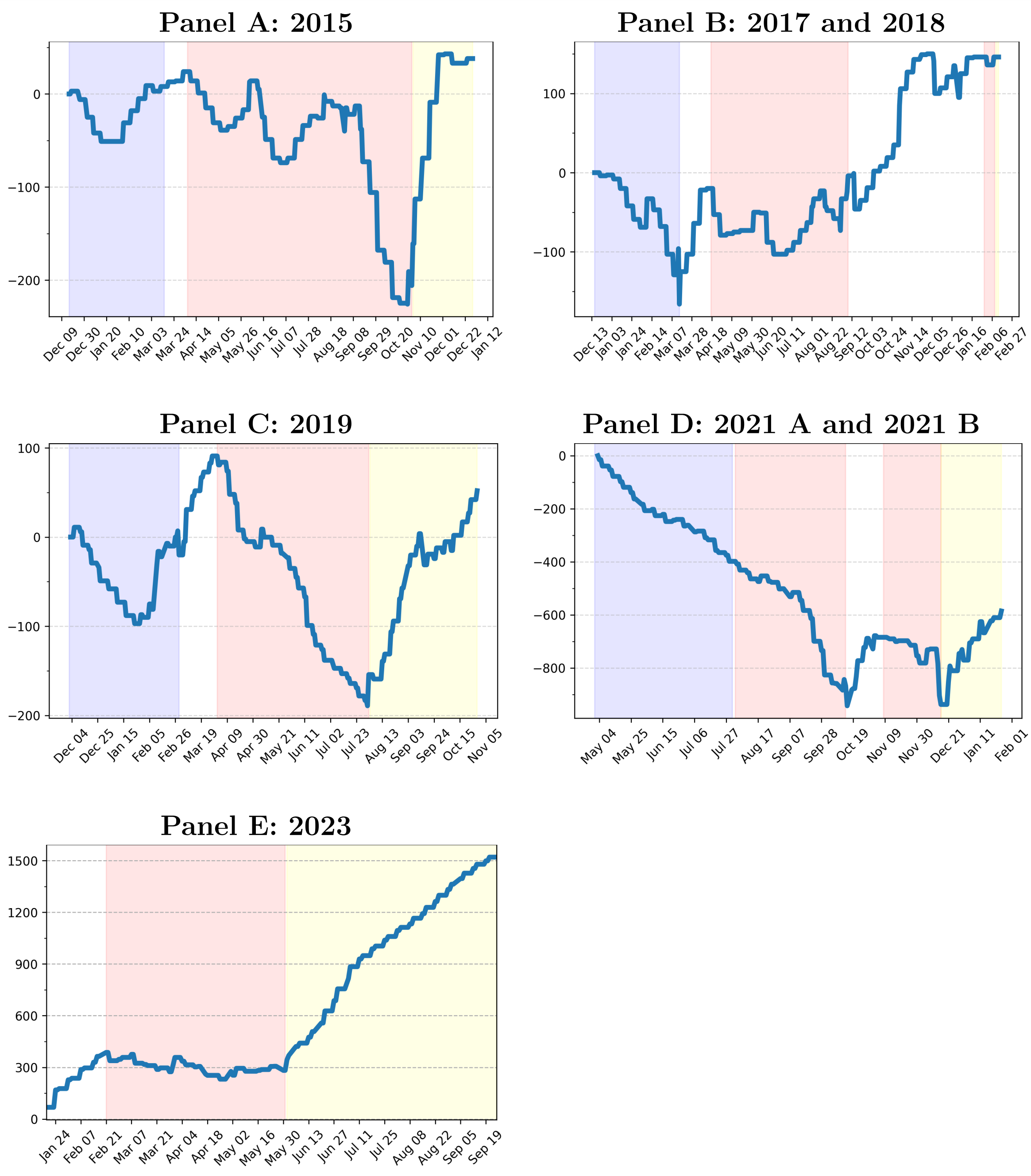


Figure 4
Auction Offering Actual and Scheduled Amounts

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.

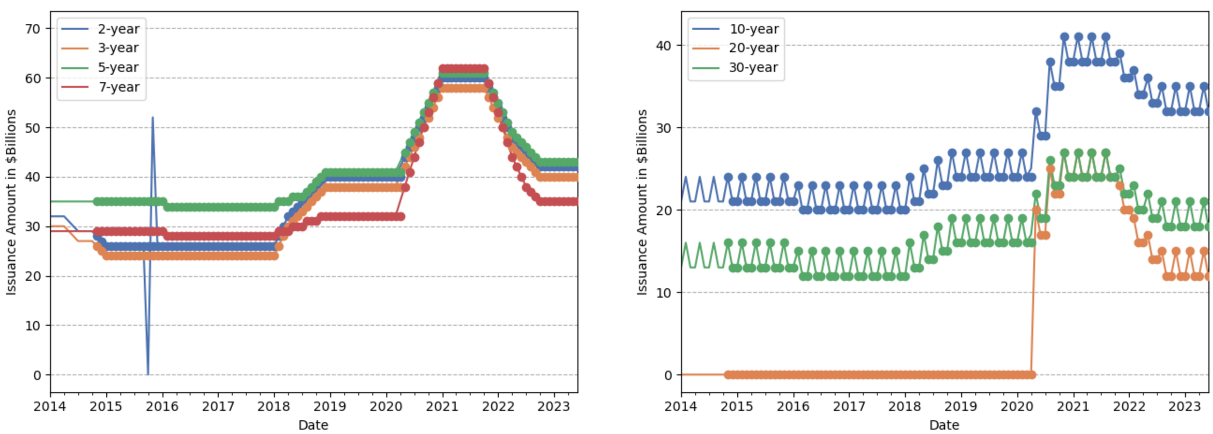


Figure 5
DCIV

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.

Hypothetical Auction Schedule

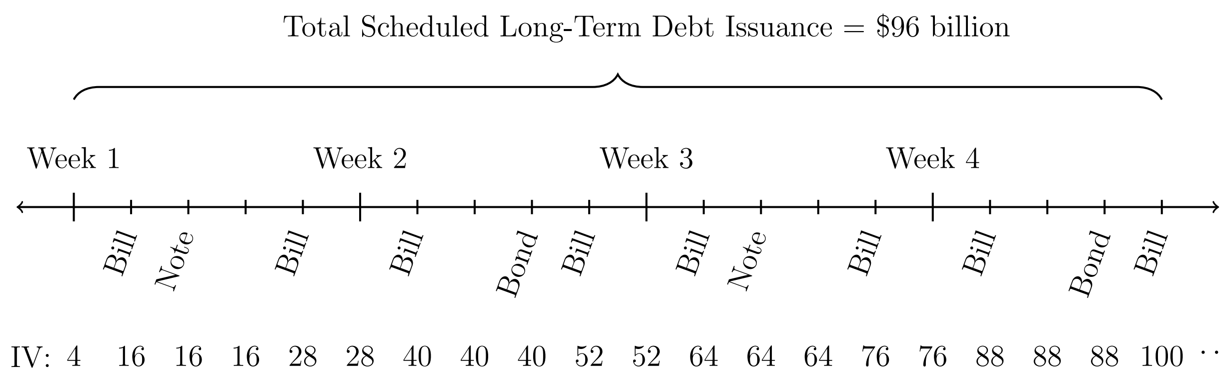


Figure 6
AA and Above Short-Term Corporate Debt

This figure displays the median spread between the yield and the effective funds rate for agency and corporate debt that expires in the second-half of 2023. We show the median yield for all IG corporate bonds rated AA and agency debt transacted between April 1, 2023 and July 1, 2023. The vertical, dashed red line records the date that the debt ceiling raise passed the Senate. It was passed in the House of Representatives on May 31 and signed into law on June 3.

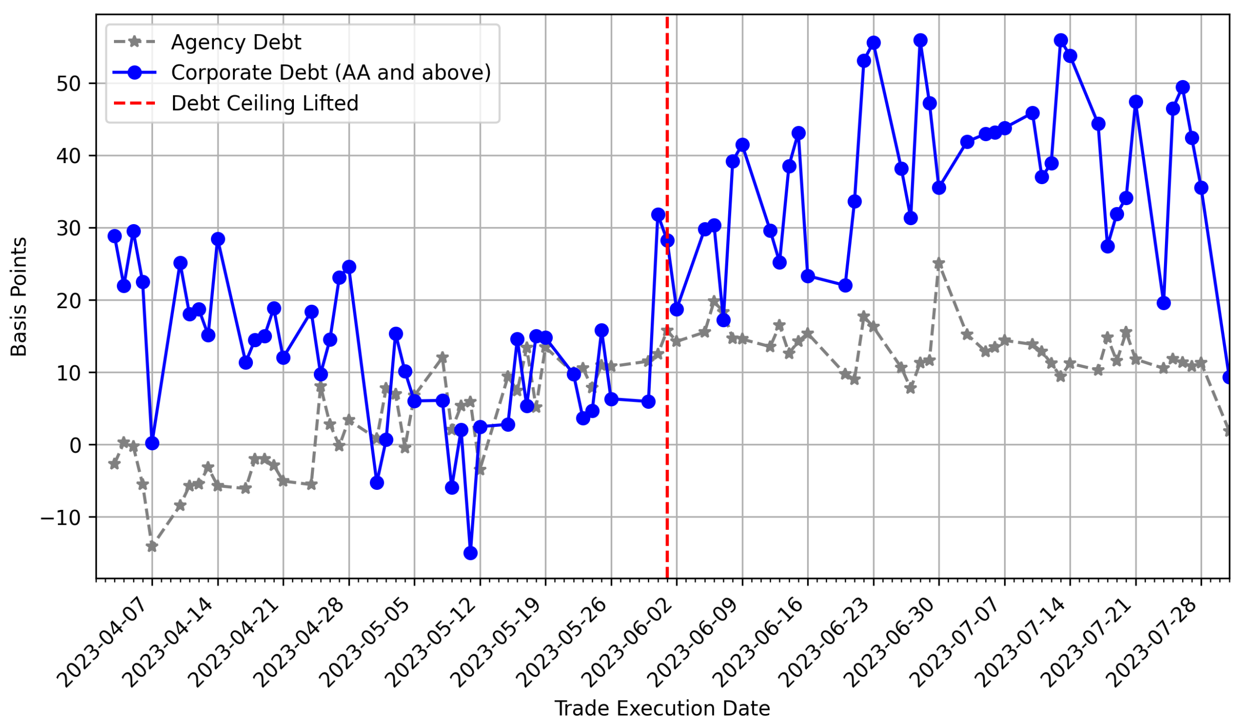


Figure 7
Median Yield Spread versus End-of-Suspension Instrument

This figure is a graphical illustration of the "reduced form" of our instrument episode-by-episode. For each of the four periods preceding an end of suspension, we plot the corporate spreads for the quarter prior on the y-axis and our instrument on the x-axis.

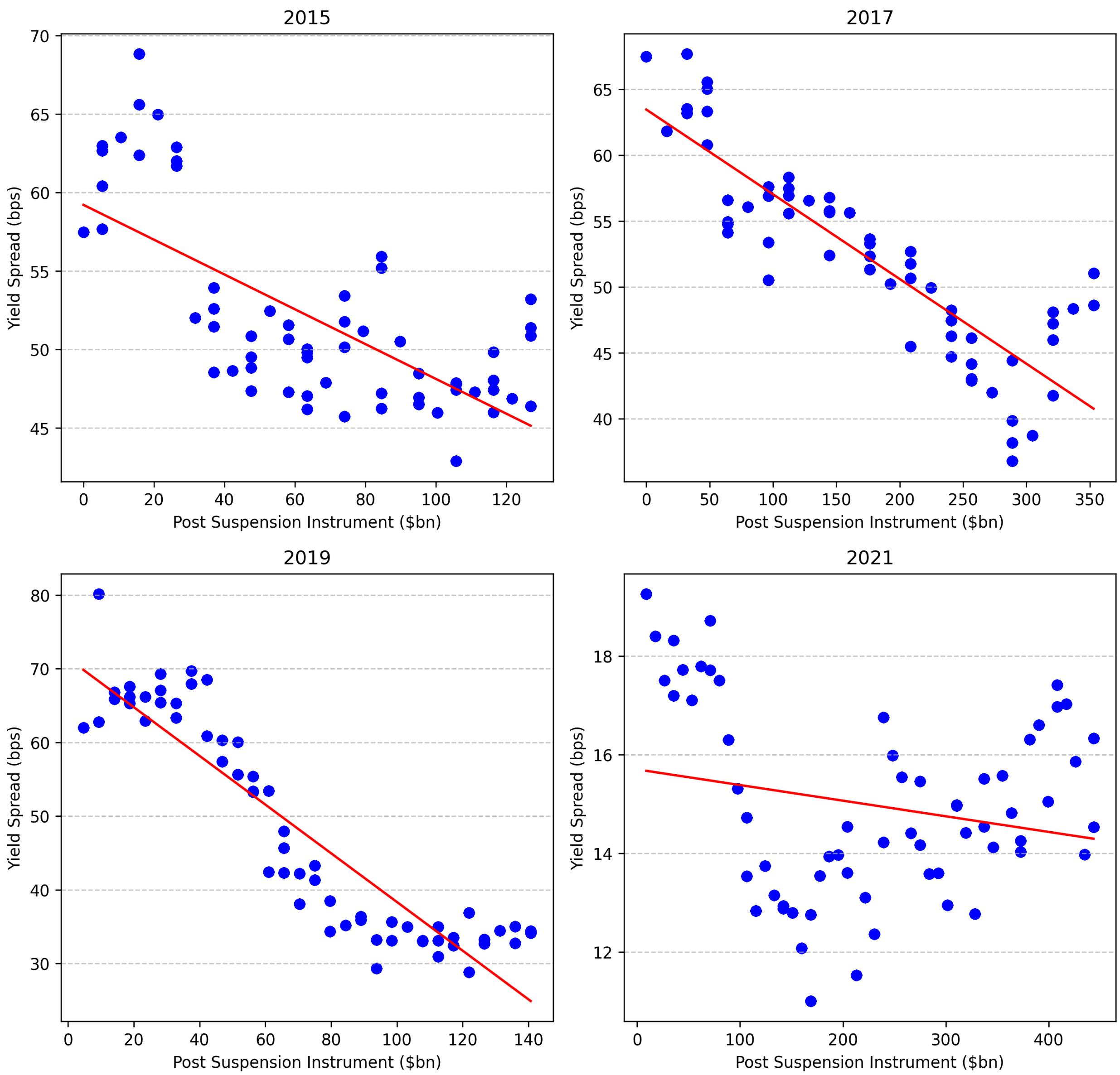
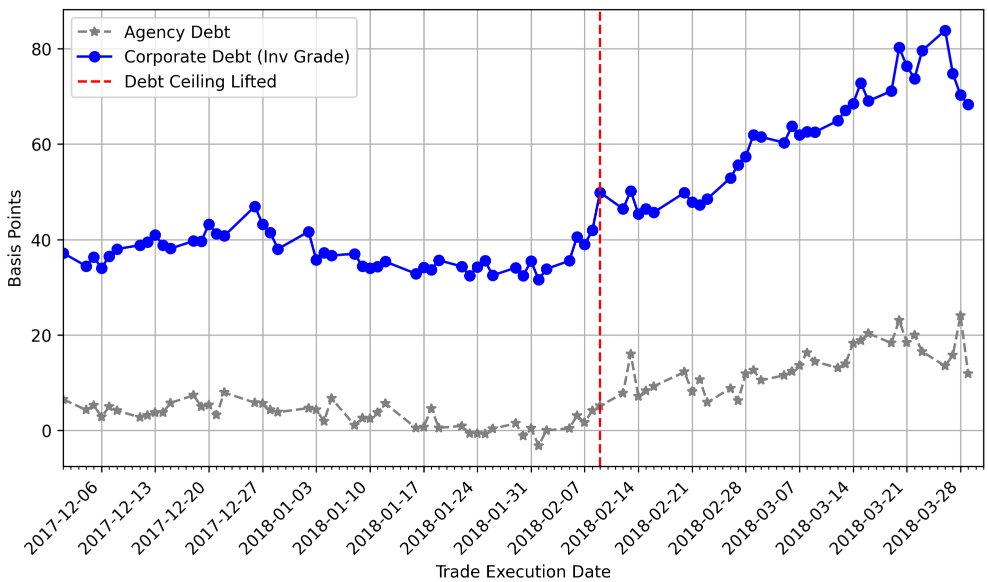


Figure 8
Changes in Spreads Around The Twin 2017 Episodes

We plot the evolution of spreads of agency and IG corporate debt over a version of the effective federal funds rate, taken from fed funds futures. We use the 2017 debt ceiling episode as an ideal experiment for our proposed mechanism. The debt ceiling was suspended in August 2017 as part of an aid package in response to Hurricane Harvey. During this suspension, the treasury was expressly forbidden from increasing its cash balances in the Treasury General Account (TGA). This constrained the Treasury's ability to issue additional bills. For this suspension, we see no movements in spreads. After the debt ceiling was raised in 2018 and there were no such limits on the treasury's ability to issue bills, we see large movements in the yields of corporate and agency debt.

Debt Ceiling Lifted in 2018



Debt Ceiling Suspension Due to Hurricane Harvey

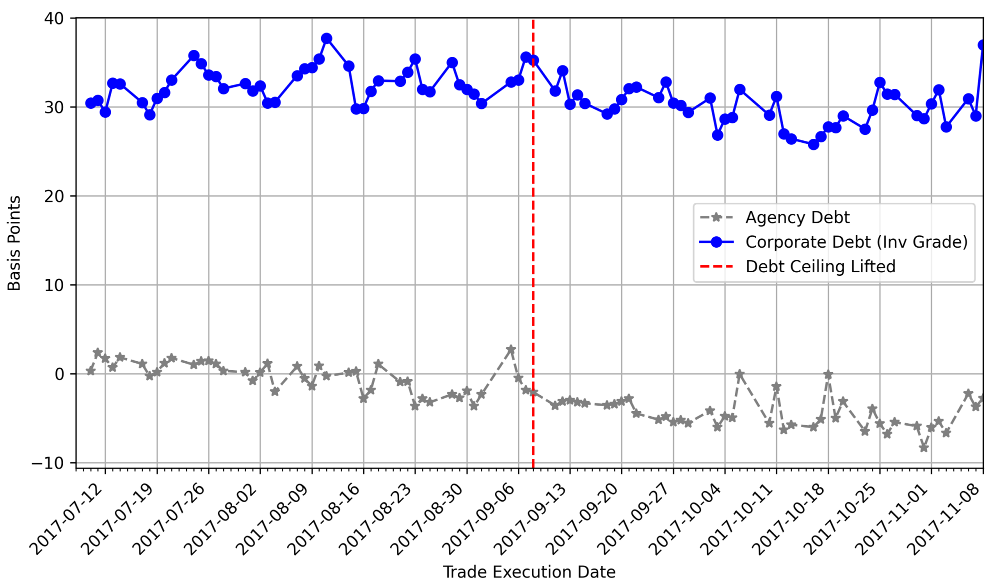


Figure 9
Yield Curve around Kevin McCarthy Speaker Vote

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.

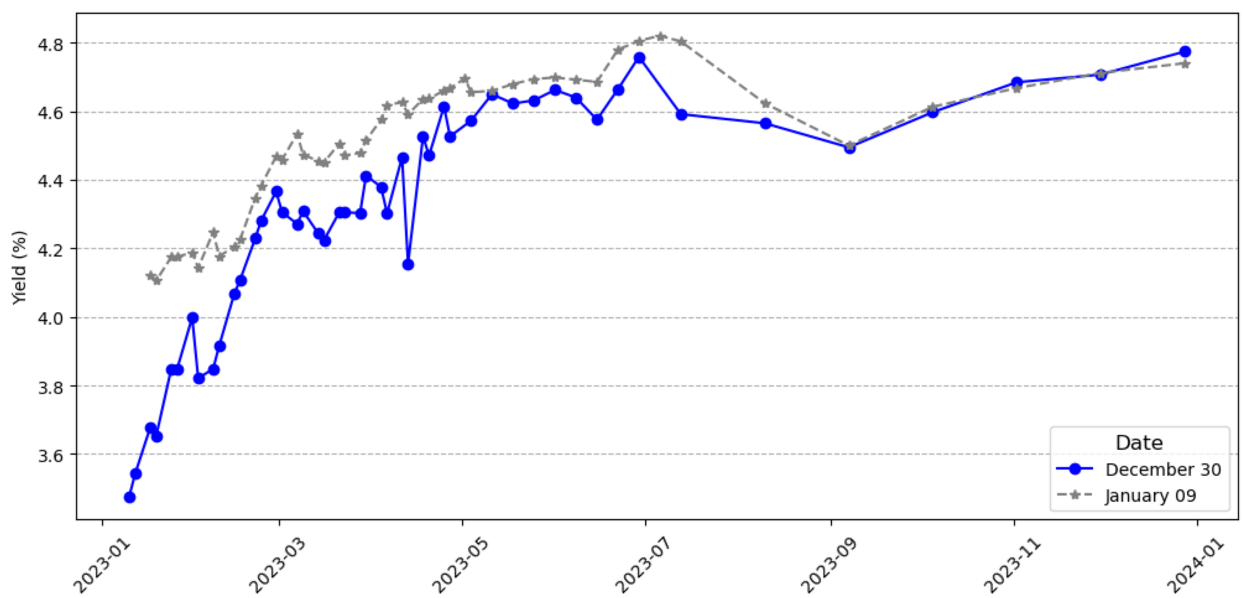


Table 1
Bond Transaction Summary Statistics

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		
	≤ 1 year	1-2 years	2-3 years	≤ 1 year	1-2 years	2-3 years	≤ 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 2
Endogenous Regressor on Instrument

This table reports a regression of the endogenous regessor on our instrument, for each of our instruments. We regress cumulative net issuance of bills since the start of each period on our instrument. The first column corresponds to DCIV and the second to the end-of-suspension instrument. Our four post-period instrument correspond to alternative measures using (i) Cash balance assumptions as per the Quarterly Marketable Borrowing Estimates released by the Treasury, for the quarter following the raise/ suspension (ii) Opening cash balance on initiation of Extraordinary Measures (iii) Cash balance assumptions for the quarter just *before* the raise/ suspension (iv) 6-month rolling average of outlays as per the Monthly Treasury Statements released by the Bureau of the Fiscal Service. T-stats are reported in parantheses calculated using robust standard errors.

Dependent Variable:	Cumulative Net Bill Issuance ($100s billions)					
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
DCIV	-1.001***					
	(-12.04)					
End-of-Suspension Instrument		-0.5836***				
		(-8.222)				
Post-Period Instrument (V1)			-0.6684***			
			(-10.76)			
Post-Period Instrument (V2)				-0.5204***		
				(-9.264)		
Post-Period Instrument (V3)					-0.5703***	
					(-11.55)	
Post-Period Instrument (V4)						-0.8153***
						(-12.60)
Fixed-Effects						
Episode	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics						
Observations	710	244	231	231	231	231
R^2	0.99799	0.99875	0.99801	0.99745	0.99788	0.99823
Within R^2	0.65858	0.67304	0.63664	0.53342	0.61188	0.67675

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

Table 3
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 4
Effect of Bill Supply Shocks on the Pricing of Corporates

This table reports instrumental variable regressions of the spread of corporate bonds maturing in one year or less over the effective federal funds rate in basis points on (instrumented) cumulative net issuance of treasury bills. T-stats are calculated in parantheses using robust standard errors.

Dependent Variable:	Spread vs. EFFR (bps)		
Instrument	Pre-Instrument	DCIV	Post-Instrument
Model:	(1)	(2)	(3)
Variables			
Cumulative Net Bill Issuance ($100s billions)	12.43**	-1.472	9.747**
	(2.384)	(-1.257)	(2.399)
Controls	Yes	Yes	Yes
Fixed Effects			
Episode	Yes	Yes	Yes
Fit Statistics			
Observations	243	496	145
R^2	0.62860	0.69273	0.59953
Within R^2	0.26347	0.30235	0.01009

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

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.

Dependent Variable:	Net Offering Yield (Basis Points)			
Maturity:	2 Years or Less		More than 2 Years	
Rating:	IG	All	IG	All
Model:	(1)	(2)	(3)	(4)
Variables				
Bill-to-GDP Ratio	4.452***	-0.0684	0.0463	-0.0783
	(5.071)	(-0.1276)	(0.5041)	(-0.6773)
Controls	Yes	Yes	Yes	Yes
Fixed-Effects				
Rating	Yes	Yes	Yes	Yes
Episode	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	91	1,283	2,590	3,242
R^2	0.62869	0.32931	0.45698	0.34500
Within R^2	0.14281	0.00265	0.01105	0.00430

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

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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.

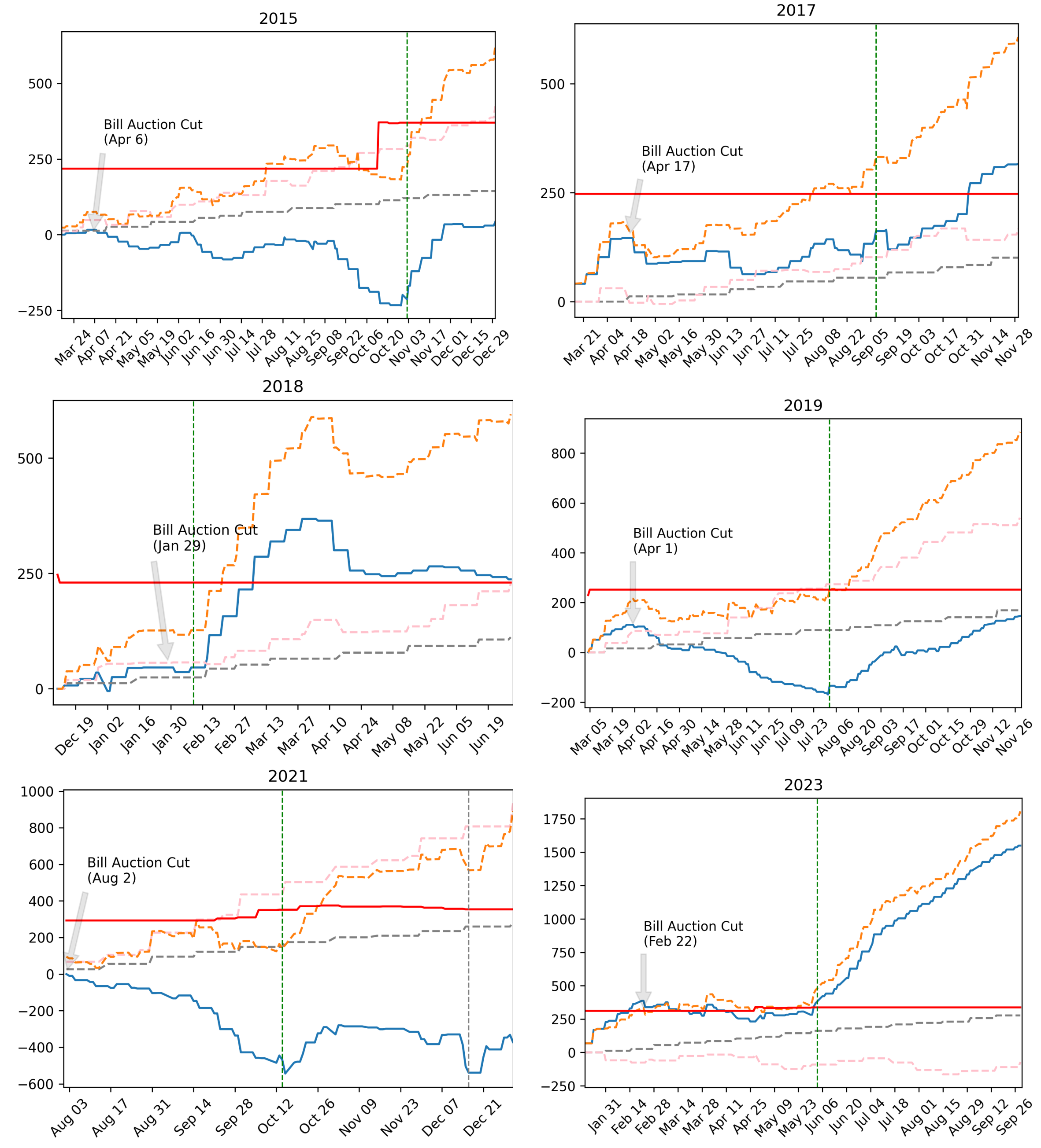
August 2018	"Based on our current forecast, Treasury is announcing additional modest increases to nominal coupon auction sizes and FRNs over the upcoming quarter. Over the next three months, Treasury anticipates increasing the sizes of the 2-, 3-, and 5-year note auctions by $1 billion per month. As 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.



B 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.

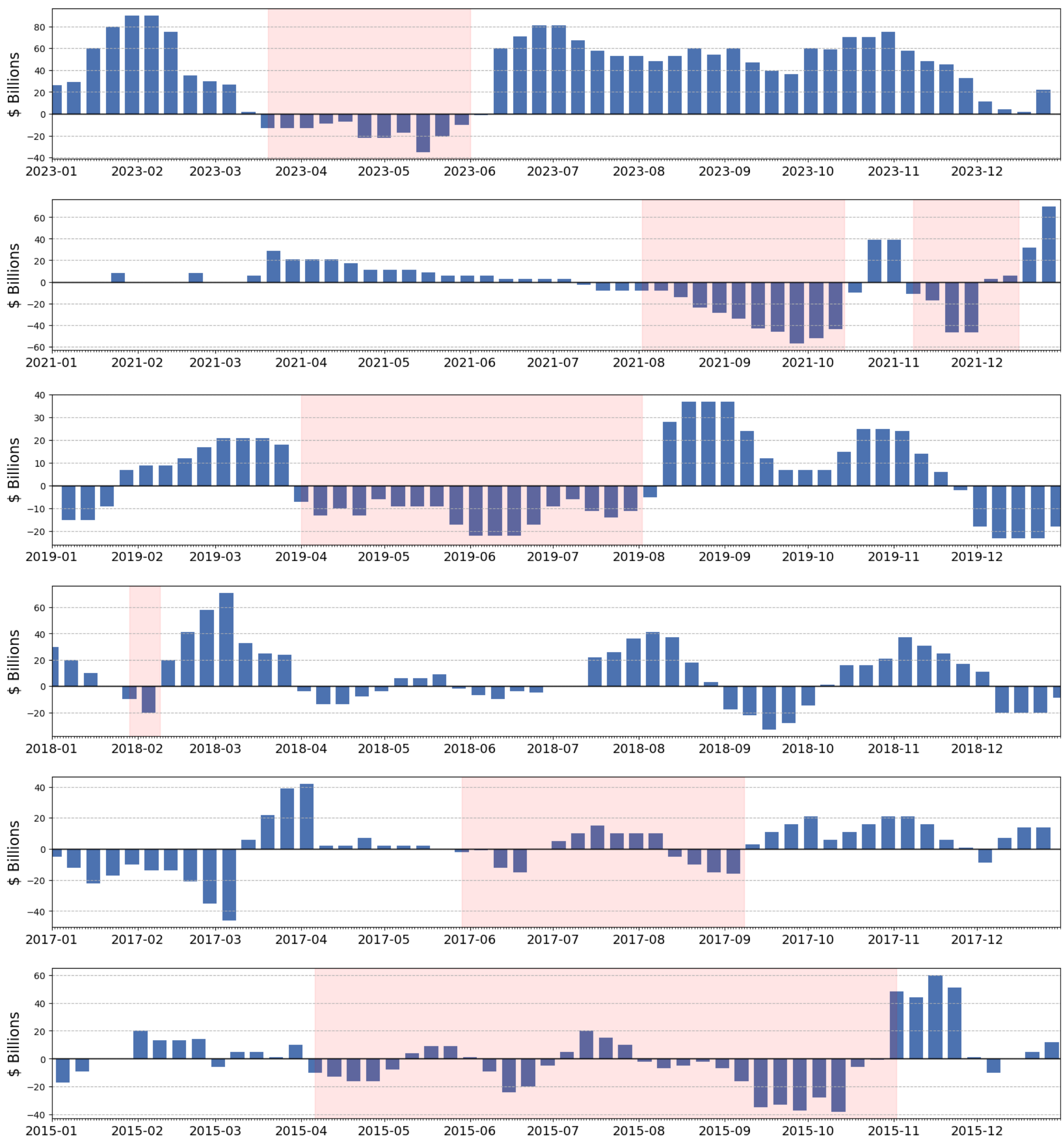
However, substituting across treasury maturities by itself cannot fully compensate for the massive decline in the quantity of T-bills held by MMFs. MMFs are also forced to substitute across asset classes. MMFs typically hold a small number of assets in their portfolio. Besides treasuries, the modal fund's 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

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.



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.

B.1 Data

B.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.

B.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.

B.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)).

B.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:

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

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.2. In this table, we estimate the regression:

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

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.

B.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.3. In this table we estimate the regression

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

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.3 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:

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

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.

B.5 Futures Market

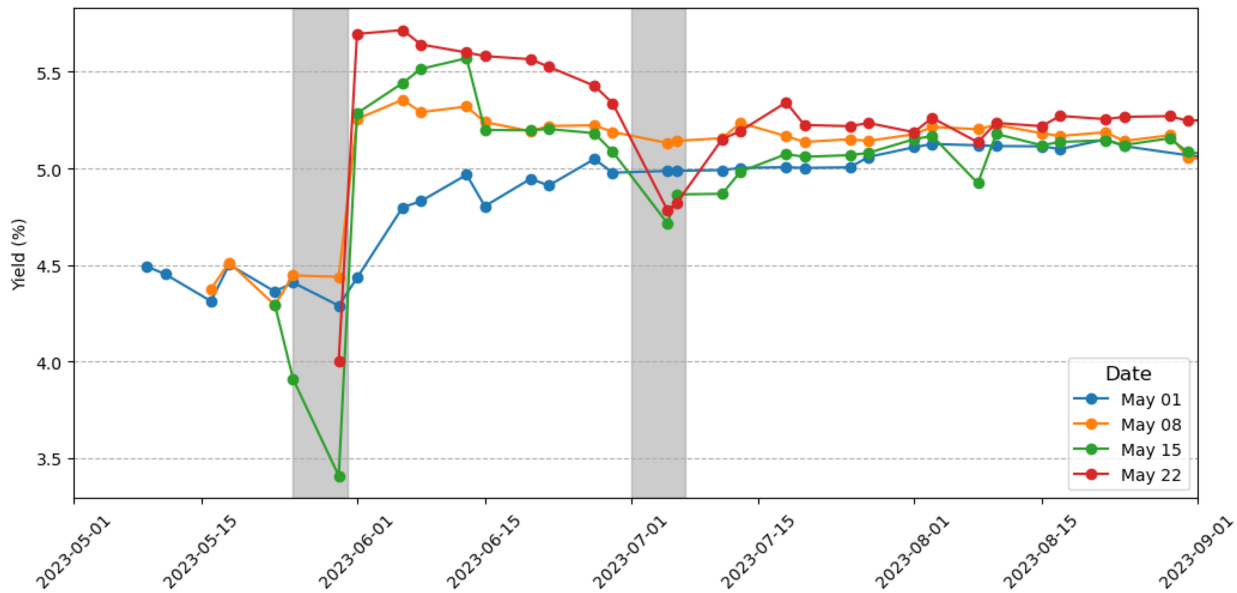
As a final note, these dynamics of negative and then positive bill supply shocks affecting the repo rate appear to have been anticipated by investors in the futures market. This can be seen visually in Figure B.7. In the top-right panel, we plot the forward curve constructed from both fed funds futures 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.

B.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.

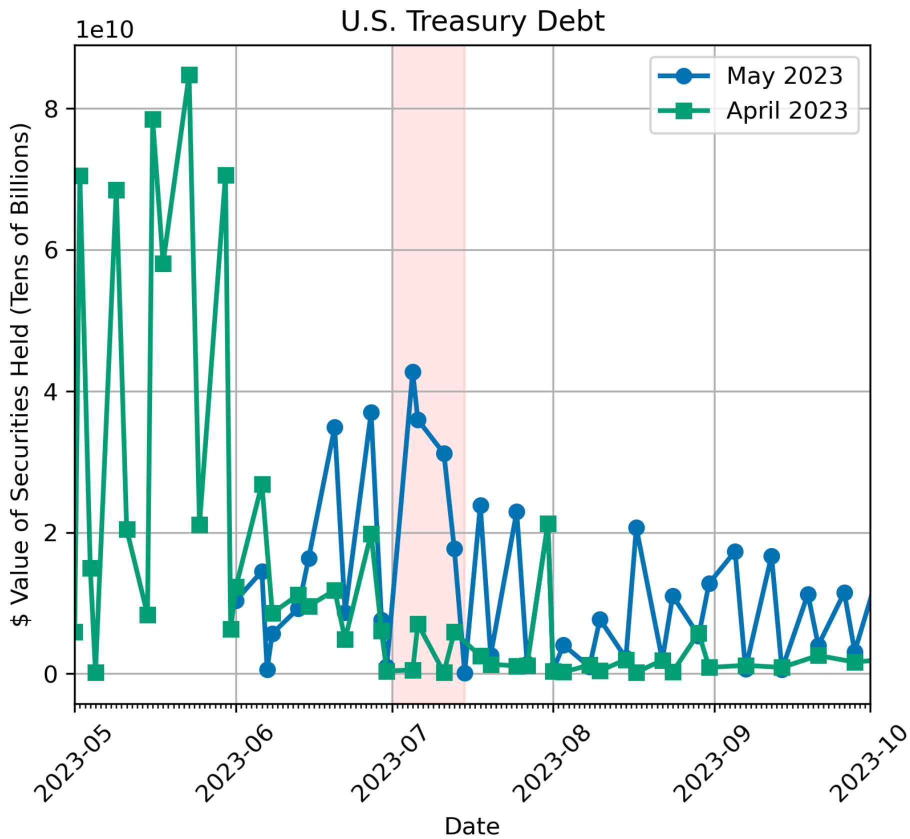


Figure B.3
Money Market Mutual Fund Holdings Coefficient Plot

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.

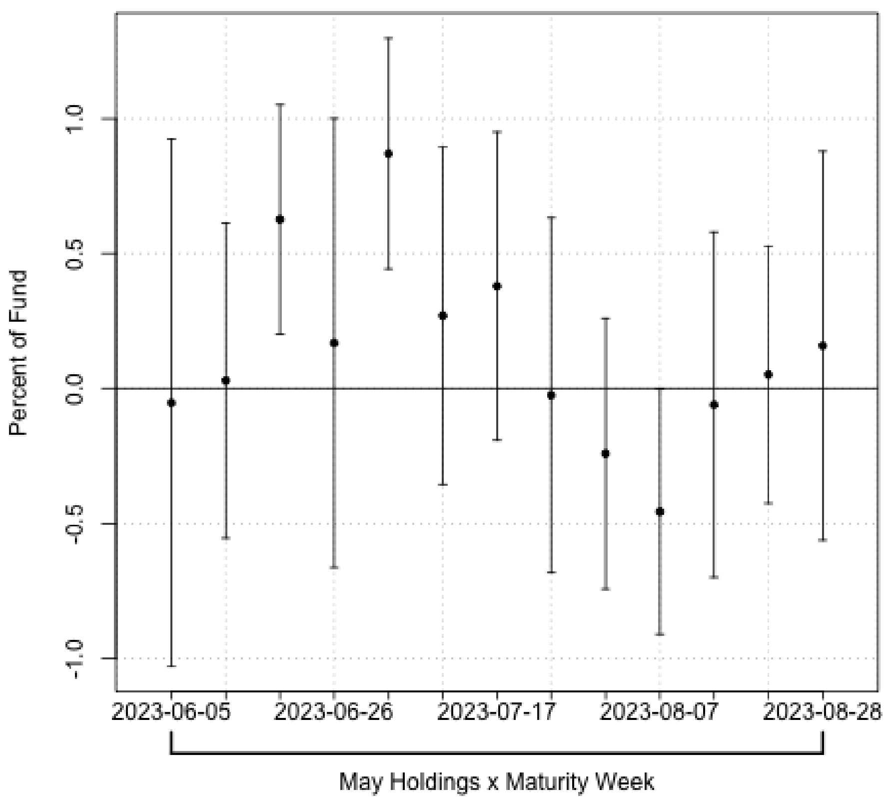


Figure B.4
Money Market Mutual Fund Holdings

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.

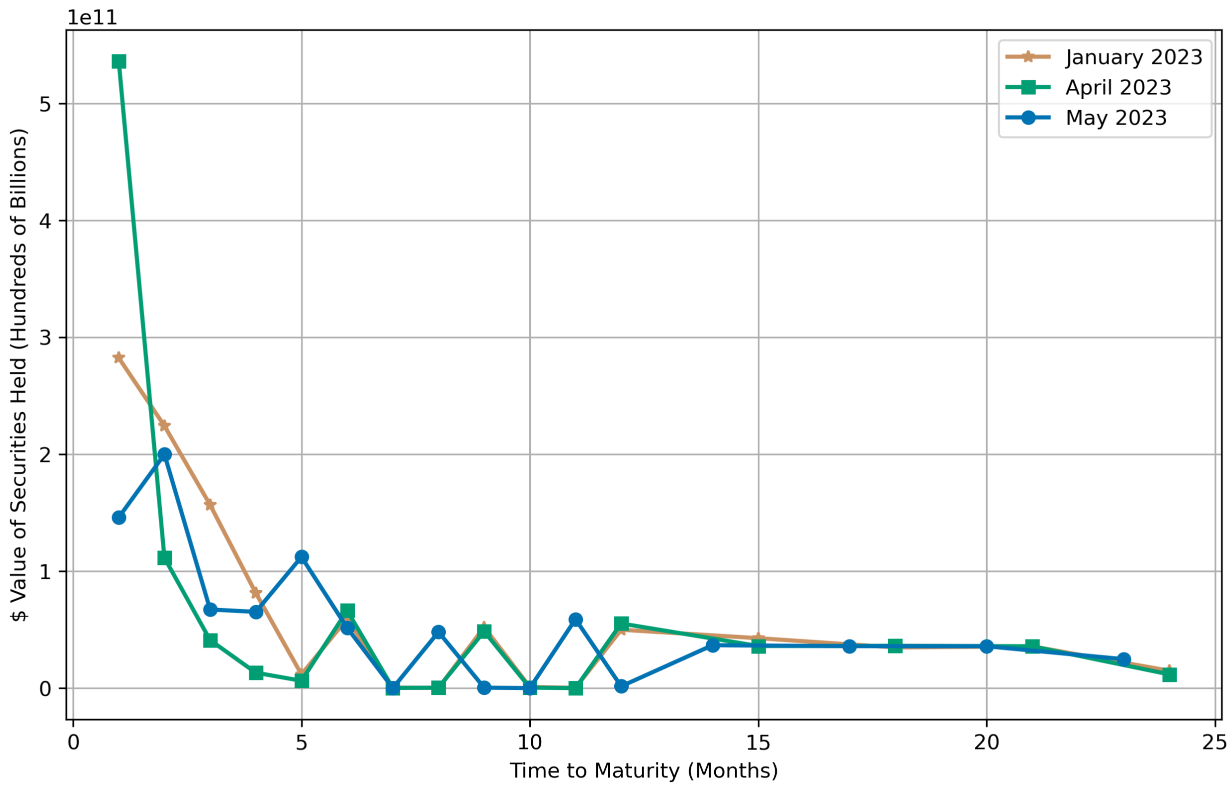


Figure B.5
Evolution of Money Market Mutual Fund Holdings

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.

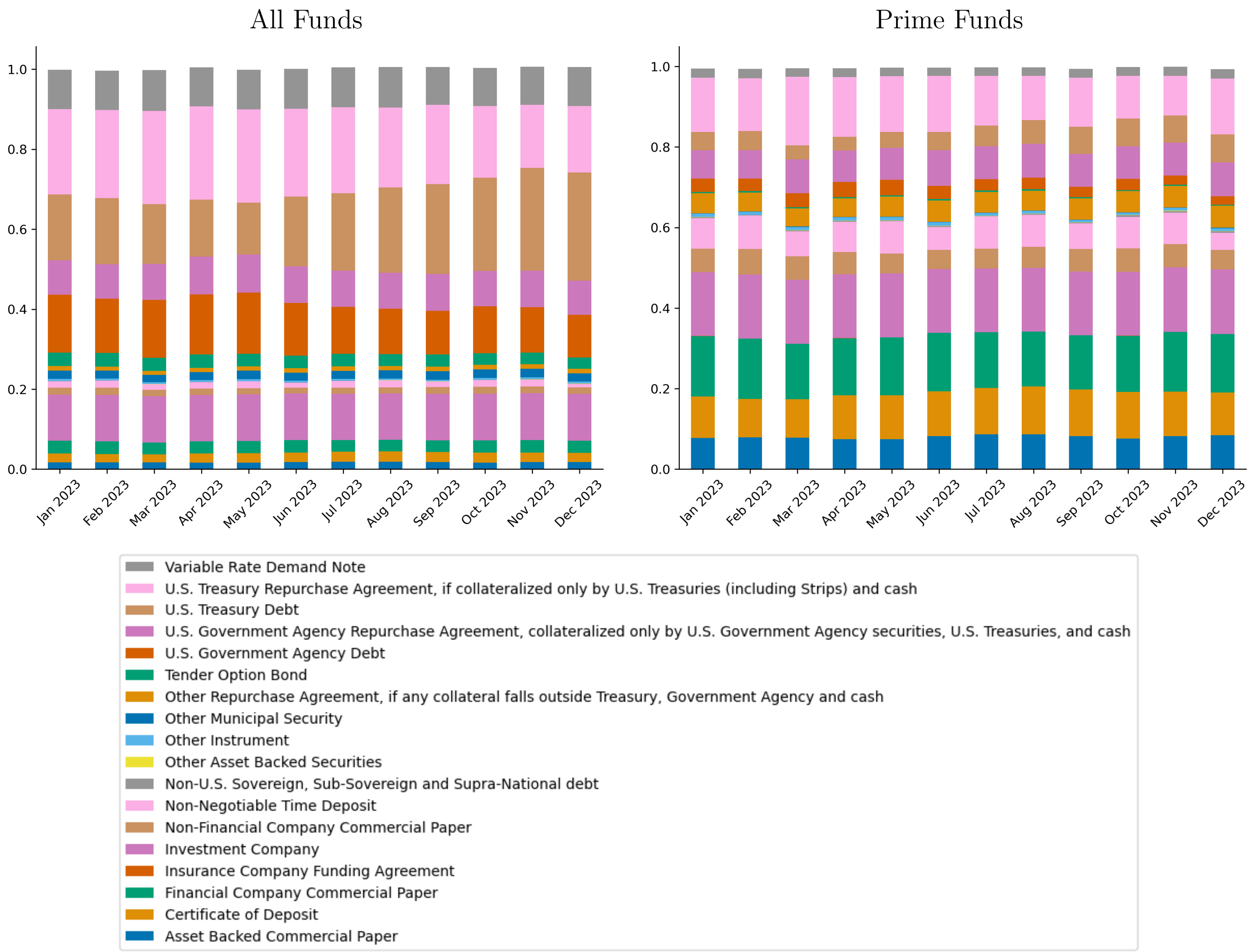


Figure B.6
Repo Rates

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)

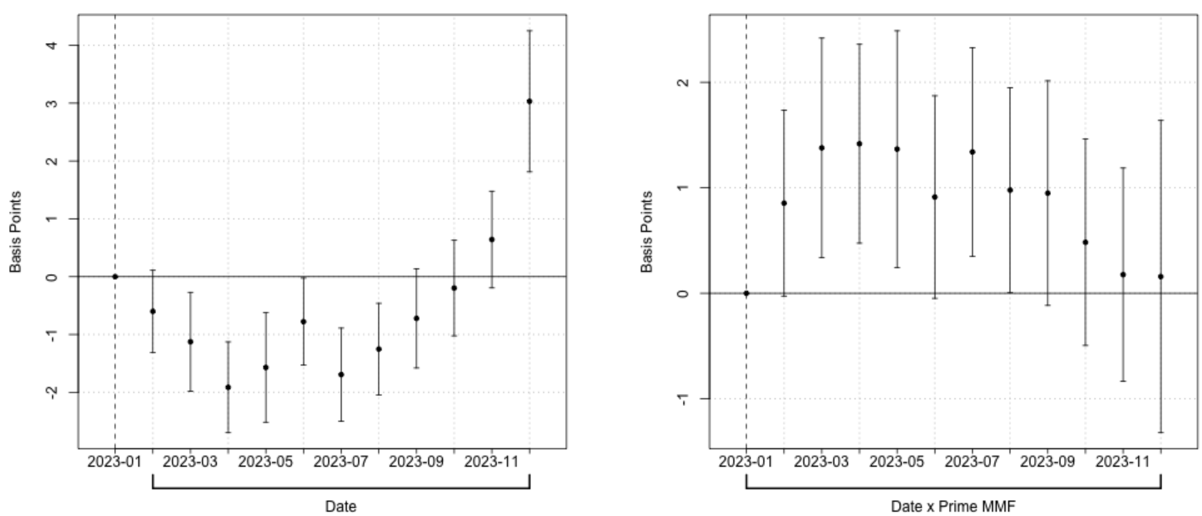


Figure B.7
Actual and Futures-Implied Evolution of the Repo Rate

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.

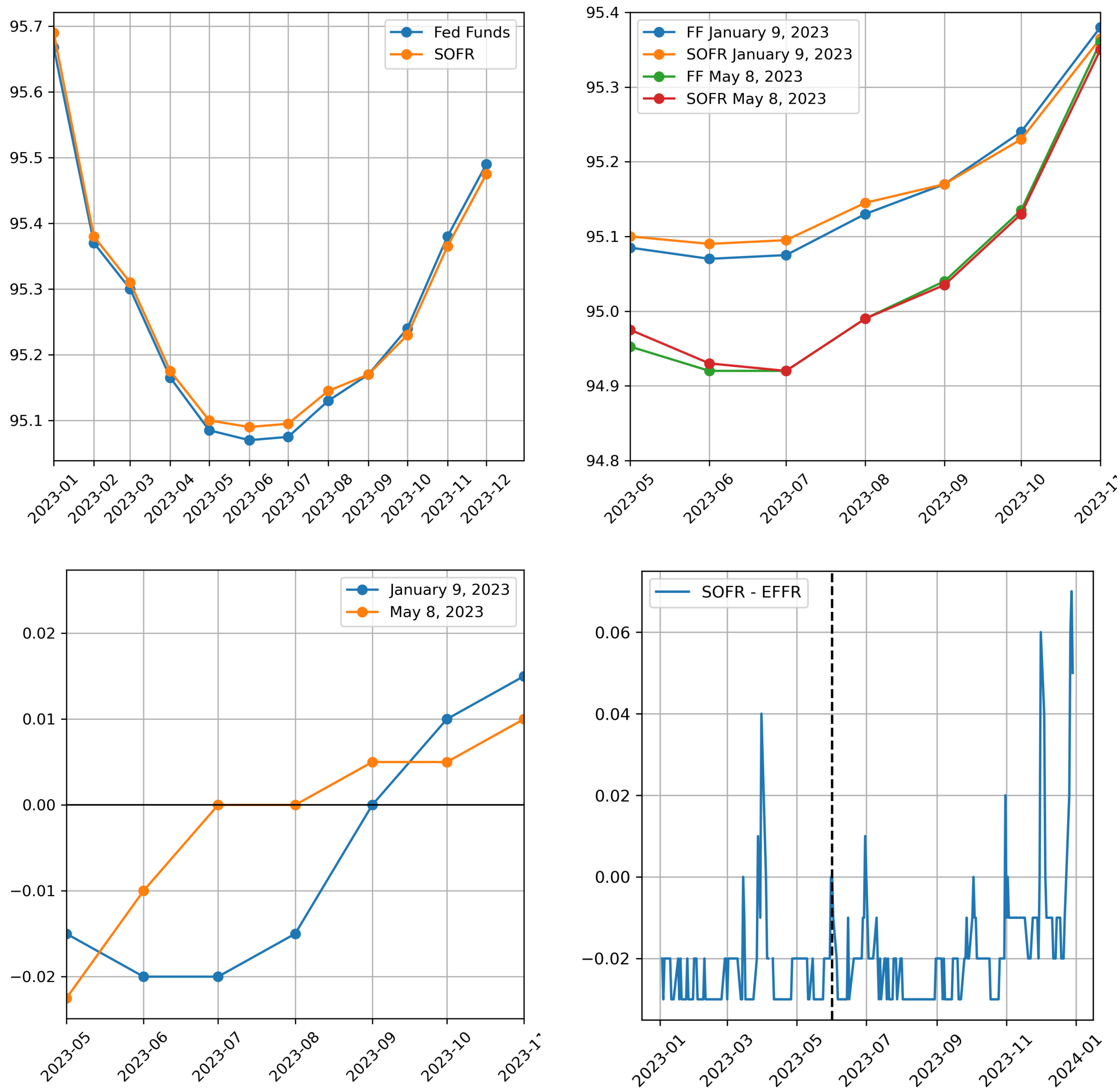
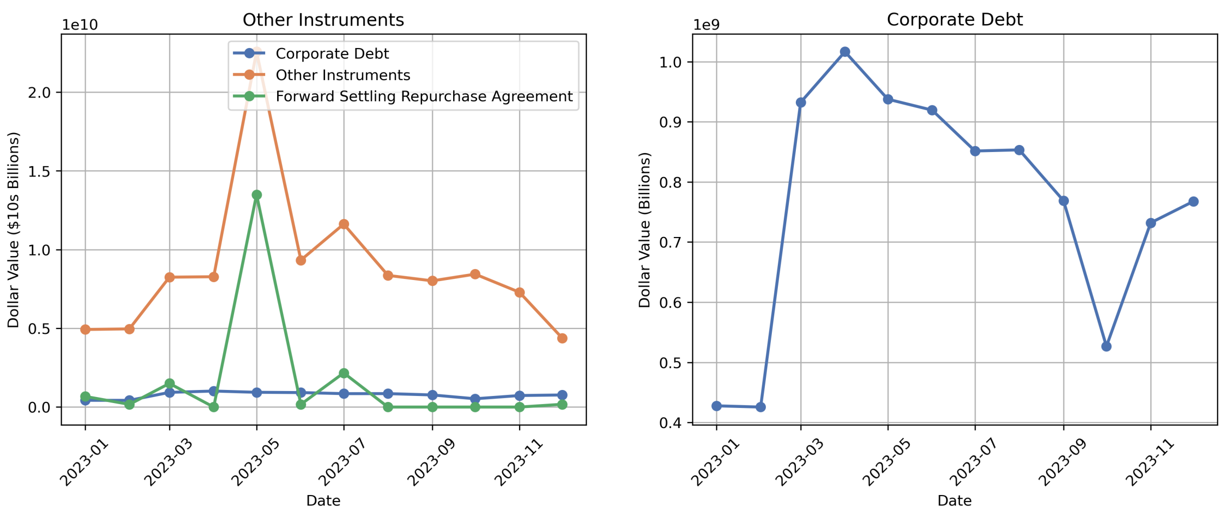


Figure B.8
MMF Holdings

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.



B.7 Tables

Table B.1
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.2
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.3
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*