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

William Cassidy† and Shreye Mirani‡

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Abstract

We show that the debt ceiling significantly impacts the duration of government liabilities through an unintended interaction between Treasury issuance rules and the debt ceiling constraint. During debt ceiling episodes, the Treasury 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. We exploit this to construct an instrument for bill supply and show that the debt ceiling distorts convenience premia and the pricing of investment-grade corporate credit. We attribute the Treasury's implicit decision to lengthen the duration of its liabilities to an intermediation constraint.

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†Olin School of Business, Washington University in St. Louis. Email: cassidyw@wustl.edu

‡Olin School of Business, Washington University in St Louis. Email: shreye.mirani@wustl.edu

1 Introduction

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

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

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

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

[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. The statutory limit on federal debt can be referred to as the debt ceiling or debt limit; we use both terms interchangeably.

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 debt ceiling would be breached. We exploit this feature of Treasury issuance to construct an instrument called DCIV for total bill supply. Mechanically, our instrument takes the value that the Treasury is forced to run off in bills to keep the debt ceiling inviolate, given scheduled bond and note issuance.

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

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

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

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

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

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

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

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

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

Behind our results lies a fundamental irony. In the 1970s and 1980s, the Treasury adopted its regular and predictable issuance policy to stabilize Treasury and corporate bond markets (Garbade (2007)). In an era of debt ceiling brinkmanship, regular and predictable issuance has become an unintended amplifier of politically induced distortions in financial markets. A policy designed to promote stability has, paradoxically, eroded it.

2 Literature Review

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

Stein and Wallen (2023) examine the impact of the debt ceiling on money market funds and the spread between T-bill rates and rates at the reverse repo facility. Our analysis differs from theirs by focusing primarily on how the debt ceiling affects the duration of Treasury liabilities rather than the effect of technical default risk on MMF demand for Treasuries. Distinct from this strand of the literature, we show that the debt ceiling affects Treasury markets even in the absence of credible concerns about default.

Some Treasury market participants are aware of and discuss the impact of the debt ceiling on bill supply (Wrightson ICAP (2014, 2015)). The Treasury itself has been aware that, in principle, debt ceiling-induced fluctuations could affect asset prices since at least the November 2016 meeting of the Treasury Borrowing Advisory Committee, when an unnamed TBAC member raised the possibility that debt ceiling-induced fluctuations in bill supply could affect short-term funding markets (U.S. Department of the Treasury (2016)).

Our paper also relates to the extensive literature on the impact of political uncertainty on financial markets. Pástor and Veronesi (2012) and Pástor and Veronesi (2013) provide theoretical analyses of how political uncertainty affects stock prices, sparking a large body of subsequent work too extensive to list here. Methodologically, the closest paper to ours is Kelly et al. (2016), which leverages the exogenous timing of elections to identify the effects of political uncertainty on asset markets. Similarly, our paper exploits the implicit and explicit rules governing Treasury issuance to generate exogenous variation in the duration of the government's debt portfolio.

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

Since we posit that the adoption of regular and predictable issuance stems from dealer constraints, our study aligns with research examining primary dealer behavior at auctions and the price impact of limited dealer capacity (Fleming et al. (2024); Lou et al. (2013); Albuquerque et al. (2024)). Correa et al. (2022) discusses the role of the TGA cash balance and its impact on intermediaries and financial markets. Our instrument construction shares similarities with Andreolli (2021), who exploits a historical episode in which Congress imposed an explicit cap on long-term debt issuance to generate exogenous variation in the maturity structure of government debt. Hubert de Fraisse (2024) employs a narrative approach to isolate historical episodes with plausibly exogenous variation in long-term government debt.

Our work also relates to research on how Treasury supply impacts asset prices. Krishnamurthy and Vissing-Jorgensen (2012) provide indicative evidence that Treasury debt supply influences both sovereign and corporate debt pricing, while Greenwood et al. (2010) examine the effects of bill supply on corporate debt pricing. In other closely related work, d'Avernas and Vendeweyer (2024) investigate how Treasury supply affects the pricing of close substitutes.

Our study closely aligns with Greenwood et al. (2015), who construct an instrument for bill supply based on Treasury cash needs around tax deadlines. Our instrument differs from the one studied by these authors because we examine variation in which the total value of publicly-held marketable government debt is held constant while the maturity structure varies. This feature distinguishes us from other work that constructs instruments for government debt supply, such as Selgrad (2023).

A central question raised in Greenwood et al. (2015) and elsewhere is why predictable shocks to bill supply affect the pricing of Treasury securities on impact. Our empirical setting is well-suited to address this question as we examine quantitatively large fluctuations in bill supply that are, by construction, perfectly forecastable. In addition to studying the contemporaneous effect of these shocks on asset prices, we also analyze how dealer bank holdings evolve in anticipation of the shocks. We find that dealers actively accumulate securities in advance and that larger dealer inventories are associated with a smaller pass-through from quantities to convenience premia at issuance.

However, these anticipatory purchases are modest in relation to the size of the supply shocks and insufficient to absorb the effects of predictable flows fully. In this respect, our analysis helps clarify the limits of dealer intermediation in smoothing the price impact of forecastable supply changes. More broadly, our setting allows us to study a class of events that accounts for a substantial share of the variation in total bill supply in recent years, and that plays a quantitatively important role in shaping the maturity structure of public debt over time.

3 Data

Our analysis draws on several distinct datasets that capture Treasury and corporate bond prices, auction outcomes, and a variety of fiscal operations reported in Treasury statements. Each dataset serves a different role in our empirical strategy. In the subsections that follow, we describe each source in detail and explain how we construct our variables of interest.

3.1 Bond Data

We use data from the TRACE and Mergent/FISD datasets to analyze bond market dynamics. Corporate bond transaction data are sourced from the WRDS Clean TRACE Enhanced file, which provides trade-level detail over our sample period. Because multiple trades can occur for a given CUSIP on the same day, we aggregate intraday transactions to the trade-date level by computing the quantity-weighted average yield for each CUSIP. We merge this with bond characteristics from Mergent/FISD, specifically maturity dates and credit ratings, using CUSIP identifiers and assigning each bond the most recent rating available prior to the trade date. Transactions missing yield or maturity information are excluded.

To mitigate the influence of outliers, we winsorize yields within each rating category (investment grade, high yield, and unrated) at the 2nd and 98th percentiles by year-quarter. We then partition the sample by credit quality, defining highly rated bonds as those rated AA- (or Aa3 on the Moody's scale) or higher and A-rated bonds as those rated A- (or A3 on the Moody's scale) or higher.

3.2 Treasury Data

First, we collect historical data on Treasury auctions. We collect this data for bills and longer-term instruments such as bonds and notes. Our empirical analysis focuses on changes in the supply of bills caused by the interaction of regularly scheduled bond and note issuance. For this, we use data on bond and note auctions and the offerings at the Treasury's regularly scheduled weekly bill auctions.

Finally, we pull some additional ancillary data from the Treasury. This includes data about the Treasury's receipts and outlays. We use this data to investigate the timing and nature of flows into and out of the Treasury's cash account at the Fed. We also use the CRSP U.S. Treasury database for some of our analyses. This dataset is widely used and contains information about outstanding U.S. Treasuries. We use this dataset to study the evolution of the bill supply of various maturities.

3.2.1 Auction Schedules

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

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

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

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

As is visually apparent, the Treasury almost always issues the amount it announces. That is, the dots almost always overlap with the line. Between 2015 and mid-2023, there were only two periods during which the Treasury deviated from its forecast. The first is during October and November of 2015. Due to concerns about violating the debt ceiling, the Treasury moved a two-year note auction scheduled for late October to early November[2] (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

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

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.

3.3 Convenience Premia

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

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

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

The risk-free discounting curve required to calculate $R(c-s, \lambda, T)$ is constructed from the term structure of repo OIS: fixed-for-floating interest rate swaps in which the floating rate is the overnight repo rate. From 2018 onwards, SOFR OIS rate data is used, and from 2014 to 2018, the repo OIS rates are inferred by adjusting the fed funds OIS rates down by a spread of 4.50 bps[3]. We estimate convenience premium for individual Treasury bills, notes and bonds, traded over the sample period 2014 – 2023. Pricing data for Treasuries, SOFR OIS, and fed funds OIS is retrieved from Bloomberg. We use CDS spreads reported by Datastream.

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

In Section B.3 of the appendix, we discuss the choice of using Datastream-reported spreads and demonstrate that our results are robust to using spreads from MarkIt.

In robustness checks, we also measure short-term convenience premium using the CP-Tbill spread, defined as the difference between the 3-month commercial paper rate and the 3-month T-bill rate, following Cieslak et al. (2024).

3.4 Commercial Paper

We collect data on rates and issuance of commercial paper through the Federal Reserve Board of Governors' website (FRB). In turn, the FRB derives this data from The Depository Trust & Clearing Corporation (DTCC). We use the data series for AA nonfinancial commercial paper rate from the FRB, ranging from overnight (RIFSPPNAAD01_N.B) to 90-day (RIFSPPNAAD90_N.B). We utilize the FRB data on the total dollar value of issuance of commercial paper with maturity ranging from $1-4$ days (NONFIN.1_4.AA.AMT) to 81+ days (NONFIN.GT80.AA.AMT). To construct the CP-Tbill spread, we use the 90-day AA nonfinancial commercial paper rate (RIFSPPNAAD90_N.B).

3.5 Dealer Holdings

We use weekly data on primary dealer positions from the Federal Reserve Bank of New York's *Primary Dealer Statistics*. Our analysis focuses on net Treasury holdings, which are reported at a weekly frequency and reflect aggregate positions across all primary dealers. The data do not include information on gross long or short exposures and cannot be disaggregated at the dealer level. Treasury holdings are broken out into bills and coupon securities with remaining maturities of less than two years, between two and less than three years, greater than three and less than six years, greater than six and less than seven years, and greater than seven and less than eleven years. These categories, along with total net positions, provide a granular view of dealer inventories across the Treasury yield curve. We use these data to track changes in intermediation activity over time.

4 Empirical Analysis

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

4.1 Debt Ceiling Dynamics

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

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

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

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

In Figure 1, we plot the evolution of the TGA cash balance since 2011. In light red, we shade areas during which the debt ceiling bound.[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.

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

Besides periods during which the debt ceiling binds, two other periods are shaded in Figure 1. We shade the periods immediately following a debt ceiling suspension or raise in light yellow. These periods are associated with pronounced increases in the cash balance at

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

the TGA, as the Treasury seeks to increase its cash balance following declines caused by the debt ceiling. In blue, we shade periods in the quarter before a debt ceiling suspension ends. These periods are associated with declines in the TGA cash balance.

4.1.1 Bill Supply

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

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

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

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

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

4.1.2 Debt Ceiling Instrument (DCIV)

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

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

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

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

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

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

Thus, we can rewrite Equation 4.2 as

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

This expression is the heart of our instrument for the change in bill supply, which we call DCIV. However, for DCIV to be a valid instrument, net scheduled issuance *cannot* endogenously adjust to Treasury demand at the frequency of debt ceiling episodes. In the following paragraphs, we explain why instrument exogeneity is likely satisfied.[5]

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

This policy rule interacts with the debt ceiling, a constraint on the total face value of debt outstanding. If the Treasury designs to keep bond and note issuance constant, it must

[5] In actuality, the summand $\sum_{i \notin \{Bills\}}$ includes intergovernmental debt, not just bonds and notes. We discuss the role of so-called "extraordinary measures" below, which involve changes to how intergovernmental debt is counted against the statutory debt limit, and explain how we account for this in our analysis.

allow more bills to mature than it issues when the debt ceiling constraint binds. Otherwise, the total face value of outstanding Treasury debt would rise, and the debt ceiling would be violated. This force gives rise to the persistent declines in the supply of bills observed in the red-shaded areas of Figure 2.

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

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

The last step in the construction of DCIV is to account for the fact that bill auctions and bond and note auctions are not necessarily held on the same day. Therefore, total bill supply will adjust on days different from days on 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 quarter and multiply by a bill auction day indicator. The indicator counts how many auctions have occurred from the first date the debt ceiling bound.

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

A graphical representation of our instrument is given in Figure 5. The figure displays the hypothetical evolution of our instrument over the course of a month. In this illustration, total quarterly scheduled bond and note issuance is \$288 billion and there are 24 total bill auctions across the quarter. Consequently, DCIV increases by \$96 billion across the eight bill auctions within the month. At the start of the month DCIV = \$24, indicating that two auctions have passed since t_0, the date at which the debt ceiling constraint began to bind. At each of the eight bill auctions, the value of DCIV increments by \$12 billion. This reflects that the Treasury must reduce bill supply by \$96 billion over the month. These reductions will occur by offering fewer bills on auction days. If the Treasury cut each auction amount by the same amount within a month, the offering amount at each bill auction would decrease by \$12 billion.

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

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

As is clear graphically, in all but 2021, the declaration of extraordinary measures was followed by an immediate increase in bill supply for the reasons we have described. We define periods during which the debt ceiling is binding as the time from the first instance of a decline in bill supply following 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 and the same controls used in the second stage of our IV specifications.

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

The estimates from this regression are displayed in the first column of Table 2. We find that one dollar of scheduled bond and note issuance is associated with an eighty-two-cent decline in the supply of bills. That the coefficient estimate is close to one is consistent with the economic intuition for our instrument. The regression provides strong evidence that our instrument is relevant: the t-stat is larger than twelve in magnitude, and the within-R^2 from this regression is over fifty 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. Consistent with the high R^2, the f-stat is considerably larger than ten, indicating a strong first stage.

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

4.1.3 Impact of End-of-Suspension Cash Regulations

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

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

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

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

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

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

In Figure 1, the blue periods are associated with large declines in the Treasury's cash balance. This is precisely due to end-of-suspension cash regulations. We observe that the Treasury tends to cut bill offerings in the quarter before the end of a suspension, which we call end-of-suspension periods. These are the shaded blue periods in Figure 2. This classification is not subject to a look-ahead bias critique, as the date at which a suspension expires is set by legal statute.

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

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

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

4.1.4 Post-Raise/Suspension TGA Buildup

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

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

TGA Cash Buildup Instrument," or TGAIV.

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

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

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

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

The second is the opening of the cash balance upon the initiation of extraordinary measures. This measure is also not bulletproof, as end-of-suspension cash regulations could affect the cash balance on the imposition of extraordinary measures. Our third measure is the cash balance assumptions for the quarter just *before* the initiation of extraordinary measures. 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 monthly outlays. We take this data from FRED. The rolling average is the orange line in Figure 1. As can be seen, the rolling orange line reasonably closely tracks the stated cash balance targets.

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

We re-estimate Equation 4.6 for TGAIV using each of the four possible measures. The results are contained in Table A.13. Again, we find strong evidence for relevance; the t-stats are all large and the within-R^2 is consistently very high. The smallest within-R^2 across all four models is larger than sixty-eight percent, and the largest is nearly eighty percent. The magnitudes are typically not as close to one as in the first instrument; we attribute this to measurement error in the actual cash balance target.

In our analysis, we use the first instrument, which relies on the actual cash balance assumptions to construct the cash target. Our results are not sensitive to this choice.

4.1.5 Unintended Consequences of Increasing the TGA Cash Balance

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

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

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

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

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

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

4.2 Economic Interpretation of Treasury Issuance Rules

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

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

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

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

Modern statements by Treasury officials have reiterated that the Treasury perceives that there is a close connection between regular and predictable and intermediation: "The key point is that when we introduce a new product, Treasury wants to be sure that it can commit to that product for the long term because we recognize that market participants, particularly intermediaries, will need to commit resources to supporting that product in both the primary and secondary markets... To garner sustained support from investors and intermediaries, we remain regular and predictable" (U.S. Department of the Treasury (2024)).

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

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

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

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

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

4.3 Convenience Premia

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

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

Our maturity buckets stretch from a few months to maturity until 30 years to maturity. In all regressions, we use Newey-West standard errors to account for potential serial correlation.

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

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

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

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

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

The results from this regression are given in Table 3. We observe heterogeneous effects across the term structure of convenience premia. The largest effects are for bills that are very close to maturity. A one percentage point increase in the bill-to-GDP ratio depresses the convenience premium of Treasuries with between one and three months to maturity by 5.6 basis points. These effects taper off monotonically across the maturity structure of Treasury debt. The average effect over all T-bills is a decline of 5.3 basis points. Bills with three to six months to maturity decline by 5.2 basis points, while bills with between six- and twelve-months experience only a 4.5 basis point decline in convenience premia.

There is a pronounced shift when crossing the threshold from bills to notes. The estimated effect drops from -4.5 to -0.06 basis points and is no longer significant. Further along the term structure, we find a statistically significant effect on the convenience premia of notes with maturities between two and three years, as well as between three and five years.

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

We then examine the performance of DCIV. Despite the loss of observations, DCIV alone is more strongly correlated with movement in the term structure of convenience premia than the combined instrument, with estimated effects almost uniformly larger in magnitude. Bills with between one and three months to maturity experience a nearly nine basis point decline in convenience premia. Unlike our baseline specification, we also observe stronger differences between the effects on bills and notes. A one percentage point increase in the bill-to-GDP ratio leads to a 3.6 basis point decline in the premia of bills with six to twelve months to maturity but is associated with a 3.1 basis point *increase* in the convenience premia of notes. Over the long end of the yield curve, we observe a consistent increase of approximately six basis points in bonds and notes.[7]

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

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

The results from these tests, presented in Table A.12, are inconclusive. Our results differ slightly across on- and off-the-run Treasuries when using the combined instrument. However, when using DCIV alone, there are no apparent differences.

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

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

[7] We study the performance of TGAIV and SEIV separately in Section B.1 of the appendix.

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

4.3.1 Magnitudes

We caution the reader against interpreting the results in Table 3 as evidence that demand for bills is more inelastic than demand for bonds or notes. Changes in bond and note supply do not exactly offset changes in bill supply, so the estimated coefficients are not comparable one-for-one across instruments.[8]

In Table A.7, we directly instrument the supply of long-term debt using our instruments. The estimated effect of supply on convenience premia is substantially larger for long-term debt than for short-term instruments, exceeding twelve basis points for the longest-maturity bonds, compared to roughly five to eight basis points for bills, depending on the specification used to instrument the bill-to-GDP ratio. This likely reflects more inelastic demand for long-term Treasury securities relative to bills. One contributing factor may be that a smaller share of investors hold significant quantities of long-term debt.

We find that our estimates of the effect of supply on bill convenience premia are consistent in magnitude with other studies that seek to identify the causal impact of supply on bill pricing. The most closely related work, Greenwood et al. (2015), exploits seasonal variation in bill supply induced by the tax calendar to generate exogenous variation in the z-spread, a measure of (negative) convenience premia. In their IV specifications, a one percentage point increase in the bill-to-GDP ratio is associated with a five to fifteen basis point increase in the z-spread. Our estimate falls within this range and is toward the lower end.

To benchmark our results at the long end of the yield curve, we compare our estimates to those reported in Gagnon et al. (2011), who study asset price responses to announcements of large-scale asset purchases (LSAPs). Their estimates imply that a one percentage point decline in the bond-to-GDP ratio is associated with an approximately twenty-one basis point increase in the convenience yield of the ten-year Treasury note, roughly twice the magnitude of our estimate reported in A.7.[9] This comparison is less direct than our comparison to Greenwood et al. (2015), as LSAPs may affect yields and convenience premia through

[8]See Section B.2 for a discussion of how to appropriately scale the coefficients corresponding to the convenience premia of bonds and notes.

[9]See Section B.2.2 for the details of this calculation.

multiple channels beyond changes in the quantity of outstanding Treasuries. Nevertheless, our estimate is of the same order of magnitude.

4.3.2 Measurement of Convenience Premia

As noted by Augustin et al. (2021), it is important to account for time-varying default risk. This risk directly affects the calculation of convenience premia, as it enters into the fair value of a Treasury security. Critically for our analysis, we observe investors' willingness to pay for insurance against sovereign default risk through the spread on a CDS contract. This spread closely reflects the perceived probability of technical default (Benzoni et al. (2023)). We emphasize that this concern is distinct from the effect of time-varying default risk on the demand for safe assets, which we address in Section 4.4. Based on this logic, it is essential to examine changes in the maturity-matched U.S. sovereign CDS spread, since the measurement of the convenience premium depends on the cost of insuring against default over the life of the Treasury security.

Building on this point, changes in the term structure of CDS spreads are important for our analysis. Around debt ceiling episodes, increases in CDS spreads tend to be more pronounced at shorter tenors. To verify this, Table A.8 in the appendix reports regressions of CDS spreads across different maturities. This empirical feature provides additional motivation to use the measure of convenience proposed by Fleckenstein and Longstaff (2024). By construction, their approach defines convenience premia as the deviation of Treasury prices from fundamental value—including the value of default insurance. We study this measure, in part, because it mechanically accounts for shifts in the term structure of CDS spreads. In contrast, alternative measures that ignore these shifts may understate or overstate the effect of supply on premia.

To illustrate this point, Table A.18 in the appendix reports regressions of an alternative measure of convenience premia, the commercial paper to T-bill spread, on the instrumented bill-to-GDP ratio. We find that the estimated effect of a one percentage point increase in the bill-to-GDP ratio nearly doubles when we include controls for the six-month CDS spread. This suggests that, in general, controlling for the appropriate maturity-matched CDS spread is important when studying the evolution of convenience premia around these episodes.

Some research suggests that derivatives-based measures of convenience premia may reflect intermediary balance sheet constraints (Du et al. (2023)). If our results are primarily driven by dealer balance sheet frictions rather than demand from end investors, this would alter the interpretation of the supply shocks we study. While post-crisis regulations, such as the Supplementary Leverage Ratio (SLR), likely influence certain measures of convenience premia, our analysis focuses on within-episode variation during debt ceiling events. The implementation of the SLR is therefore unlikely to bias our results, as its effects should be absorbed by our episode fixed effects.

4.4 Additional Discussion of Exclusion Restriction

The debt ceiling is linked to elevated and time-varying sovereign default risk, which could confound our estimates. We do not assert that the exclusion restriction holds unconditionally, but instead that exclusion holds after properly accounting for the role of default risk. Conceptually, default risk can affect the measurement of convenience premia in two ways. First, by directly affecting the fair value calculation of the Treasury security as discussed in Section 4.3.2. Second, it may affect the demand for safe assets. Paradoxically, investor demand for safe assets in these periods may increase the convenience premia on Treasuries.

Motivated by these considerations, we separately include the five-year U.S. sovereign CDS spread as a control. The motivation is to control for the overall *level* of CDS spreads, because the level is highly correlated with demand for safe assets in these periods. The debt ceiling is also linked to heightened uncertainty, motivating us to include the level of the VIX as a control for the same reasons. Thus, we claim that exclusion holds for convenience premia calculated using the Fleckenstein and Longstaff (2024) measure after including controls for the level of default concerns and proxies for economic uncertainty.

Beyond the controls in our empirical specifications, other aspects of our setting help mitigate the threat that our results are confounded. First, the variation we exploit is low frequency: the effects we document are identified through gradual changes in bill supply, sometimes occurring several quarters before a conceivable government default. For example, Treasury debt managers typically reduce bill supply to comply with end-of-suspension cash regulations well before the actual X-date, conveying no direct information about default probability.

Furthermore, our third instrument, TGAIV, captures variation only after the debt ceiling has been raised or suspended, a period without elevated sovereign default risk. We observe that the variation from TGAIV appears concordant with that from DCIV alone. This is evident in Figure 6, where short-term IG corporate bond yields gradually increase, unlike those of longer-duration corporate bonds, which are shown in Figure A.5, in the appendix. This disproportionate effect on short-term IG corporate bonds, along with its gradual nature, supports the interpretation that fluctuations in bill supply drive our results rather than default risk or political uncertainty.

Additionally, the magnitude of declines in bill supply varies across episodes and is not systematically related to sovereign default risk. Instead, it is driven by scheduled issuance relative to the quantity of maturing notes and bonds. In some episodes, this quantity is large, while in others, such as in 2023, it is relatively small. There is no mechanical link between the relative salience of default risk and the magnitude of the variation we use to identify our estimates.

To provide quantitative backing for these arguments, we conduct an additional validation exercise. As documented in Stein and Wallen (2023), the risk of delayed payment to the holders of Treasuries significantly affects the composition of money market mutual fund portfolios as they substitute away from Treasuries that expire near the date at which the debt ceiling could be breached (the so-called "X-date"). The prior literature studying the debt ceiling suggests that the primary way through which the risk of technical default affects asset prices, besides bill supply, is through money market mutual fund substitution.

Post-crisis regulation of money market mutual funds has, in practice, greatly restricted the set of assets that money market mutual funds hold. For example, MMFs hold very small quantities of corporate debt. Results from Stein and Wallen (2023) indicate that during the 2023 debt ceiling episode, MMFs primarily substituted away from Treasuries at the risk of delayed payment and towards other Treasuries, the Fed's ONRRP facility and repurchase agreements. This means that perturbed MMF demand is more likely to affect the convenience premia of Treasuries rather than the other outcome variables we consider. This pattern of substitution disproportionately affects the yields of Treasuries very close to the X-date itself. MMFs sell Treasuries expiring just after the X-date and purchase those expiring just before.

We use the circumstances surrounding the 2023 debt ceiling episode as a first check as to whether this pattern of substitution affects our measure of convenience premia. In early May 2023, uncertainty about Treasury cash flows was resolved as the April tax season ended. Secretary Yellen wrote to Congress stating that a June 1 X-date was highly likely (Yellen (2023b)). This led to pronounced differences in yields of Treasuries expiring immediately before and after June 1 in the first week of May, but not before.[10] We observe that our measure does not discontinuously jump during this week. Apparently, MMF substitution affects the cross-sectional dispersion of Treasury yields within our maturity buckets, but not the average level.

As a second validation that our empirical results are driven by changes in bill supply and not shifts in MMF demand, we re-estimate the results from Table 3, but leave out bills that expire one month before or after the X-date. If our results are truly driven by changes in bill supply and not perturbations in MMF demand, then we expect our estimated coefficients to be stable after dropping after dropping these bills. The results from this exercise are

[10]The impact of this announcement on Treasury yields is shown in Figure A.6 in the appendix.

reported in Table A.17. We find that our estimates are minimally affected by dropping these bills, bolstering our claim that our results are not driven by perturbed MMF demand.

4.4.1 IV vs. OLS Estimates

A natural question is why we use the instrumented bill-to-GDP ratio rather than simply reporting OLS estimates. Economically, the Treasury uses bills to manage its cash needs, which implies that both cash balances and bill issuance may respond endogenously to economic conditions. Evidence of this endogeneity is visible in Figures 1 and 2. For example, during the COVID-19 pandemic, the Treasury accumulated large cash balances to meet its obligations, financing this accumulation through substantial bill issuance. This resulted in a marked increase in bill supply.

Table A.11 examines the statistical relationship between bill supply and convenience premia over our sample period starting in 2015. We find that the relationship is substantially attenuated over the full sample. Strikingly, outside of debt ceiling episodes—including the pre-suspension, post-suspension, and debt ceiling raise periods—there is no statistically significant relationship between bill supply and T-Bill convenience premia. This underscores that both variables may be jointly driven by latent economic factors, highlighting the importance of isolating exogenous variation in bill supply.

4.5 Effects on the Pricing of Corporate Debt

Prior work suggests that changes in the supply of Treasury bills should affect the pricing of substitutes, particularly highly rated corporate debt (Greenwood et al. (2010)). Motivated by this evidence, we investigate the degree to which fluctuations in bill supply associated with debt ceiling dynamics affect the pricing of corporate credit.

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

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

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

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

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

In Figure A.5, in the appendix, we plot the evolution of high-yield corporate bond yields. Since these bonds carry substantial credit risk and are less substitutable with Treasuries, we expect their yields to show less interpretable variation, if any, around the end of debt ceiling episodes. This expectation is borne out. Yields exhibit little interpretable fluctuation and do not display the clear pattern of increases observed for investment-grade credit.

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

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

m indexes maturity to denote that we estimate these regressions over different maturity buckets. In the first stage, we instrument the bill-to-GDP ratio with our combined instrument. Yields are expressed in basis points. The average is weighted by transaction volume. We estimate this regression over all years 2015 and following.

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

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

Likewise, we find that the turmoil surrounding the failure of Silicon Valley Bank (SVB) significantly affects credit spreads in 2023. We include an indicator for the period after the failure of SVB to purge these effects. We find that seasonal variation in bill supply around this date specifically affects our estimates. We find that illiquidity in the corporate bond market can affect daily averages of yields. To address this concern, we remove outliers—specifically, observations on dates when the one-month to one-year yield exceeds three standard deviations from its conditional mean. This criterion results in the exclusion of five observations from our full sample.

The regression results in Table 4 confirm our visual evidence, showing a pronounced increase in yields for short-term investment-grade corporate bonds. Specifically, yields rise by approximately 2.7 basis points for bonds with up to one year to maturity. Surprisingly, we observe pronounced effects for longer-term corporate bonds. The effect on bonds with maturities of seven to ten years is even larger in magnitude than for those with one to two years. As with our results for convenience premia, we hypothesize that this reflects the different types of variation exploited across instruments. TGAIV specifically is associated with simultaneous increases in both short- and long-term Treasury debt supply. The estimates on the long end appear to be driven specifically by the variation in the post-period.

To better understand this, we conduct two additional tests. First, we construct a panel of corporate bond yields. This allows us to estimate panel regressions instead of regressions with univariate time series. We estimate the same specification as before in the last column of Table 4, except that we use episode-by-maturity fixed effects. We find that this change alone makes our results substantially more interpretable. An instrumented increase in the bill-to-GDP ratio is now associated with an increase in the yields of short-duration corporate bonds. The t-statistic for the interaction term capturing the impact on short-term corporate bonds is nearly three. The coefficient on the uninteracted bill-to-GDP term is negative, corresponding to the impact on long-term corporate debt, although insignificant.

As a second test, we also investigate DCIV specifically in the second panel. We find that DCIV is associated with increases in the yields of short-term corporate credit and declines in the yields of long-term corporate bonds, even when estimating regressions with the univariate time series. The magnitude of the increase in short-term IG corporate bond yields is slightly greater than three percent, consistent with the results from the first panel. The effect on long-term corporate credit is around ten basis points, which is somewhat larger. These magnitudes are close to those observed for convenience yields of similar maturity in Table 3. Both convenience premia and yields of longer-dated instruments appear to be more sensitive to changes in supply.

Despite the consistency of magnitudes, we observe that the coefficients from our univariate regressions displayed in Panel B are not uniformly significant, even for the shortest-maturity bonds. This is likely due do the loss of roughly fifty percent of our sample when using DCIV alone. This loss in power is more pronounced than when investigating convenience premia, possibly due to a difference in the relative importance or number of factors that impact credit spreads. Motivated by this, we also display the panel regression in the final column, where we see a strongly statistically significant relationship between supply and the yields of short-dated corporate bonds. In this specification, the t-statistic for the interaction term is greater than three. The estimated impact on the yields long-term corporate is strongly negative, approximately ten basis points, but insignificant.

As with our convenience premia regressions, we use Newey-West standard errors with lags up to one week for our univariate regressions. For our panel regressions, we use Driscoll-Kraay standard errors with the same number of lags to account for the potential cross-sectional correlation in all the series we use to construct our panel.

4.6 Primary Market for Corporate Credit

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

We study this by estimating the following regression:

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

In the first stage, we instrument the bill-to-GDP ratio using the combined instrument. We include the same set of controls as when studying secondary market yields. These include controls for sovereign default risk, uncertainty and concurrent events that might affect our estimates. We use relatively coarse maturity bins and do not test DCIV alone because there are relatively few investment-grade corporate issuers that issue ultra-short corporate bonds. Because we do not have a true time series, we cluster by week instead of using Newey-West standard errors.

The results from this specification can be seen in Table 5. We find results consistent with the effects we documented in secondary markets. While these regression results align with our previous findings, some important caveats remain. Few investment-grade issuers offer very short-term debt, resulting in a limited number of observations and somewhat underpowered regression estimates. We include them because they are consistent with our prior estimates from the secondary market. Reassuringly, the only significant effects appear for bonds with high credit quality, precisely those that should be substitutable with Treasury bills. The magnitudes are also consistent with our results from the secondary market, a one percentage point increase in the bill-to-GDP ratio is associated with an approximate 2.4 basis point increase in offering yields.

4.7 Commercial Paper

Most investment-grade corporate bond issuers do not issue ultra-short-maturity bonds. Instead, highly creditworthy issuers typically borrow by issuing commercial paper. Given the limited number of observations in our corporate bond primary market analysis, we extend our investigation to commercial paper issuance and rates for highly rated non-financial firms.

We regress commercial paper issuance and rates on the instrumented bill-to-GDP ratio, including episode fixed effects and controls. Consistent with our prior results, we find that greater bill supply affects rates on commercial paper. This is consistent with commercial paper being highly substitutable with T-bills. Both are short-term funding instruments issued by issuers with little credit risk.

Regression estimates from regressing commercial paper rates on the instrumented bill-to-GDP ratio are reported in Table 6. As always, we include episode fixed effects and controls for the VIX, spread on a five-year U.S. Sovereign CDS, and the effective federal funds rate. We report regressions from both the full sample using all three instruments and the debt ceiling period alone. The first six columns correspond to regressions of the indicated univariate time series on the instrumented bill-to-GDP ratio.

In Panel A, we find strong statistical evidence that debt ceiling-induced fluctuations in the bill-to-GDP ratio affect commercial paper rates. A one percent increase in the bill-to-GDP ratio is associated with an approximate two basis point increase in yields. We find consistent, but weaker, statistical evidence using only the debt ceiling periods. This is likely due to the dramatically lower number of observations. The smaller sample is compounded by the frequent pattern of missingness in commercial paper data, particularly for the rates on longer-dated commercial paper of two or three months. Nevertheless, we still observe coefficients consistent with those estimated over the full sample, despite the loss of power.

Motivated by considerations of statistical power, we report estimates from a panel in the last column, in addition to the univariate time series estimates in the prior columns. To account for potential cross-sectional correlation, we use Driscoll-Kraay standard errors with one-week lags. We find that the increase in observations greatly increases the statistical power of our estimates. Using the combined instrument, our results imply that a one percentage point increase in the bill-to-GDP ratio increases commercial paper yields by approximately two basis points. Our estimates using DCIV imply an approximate one-and-a-half basis point increase. The t-statistics are greater than six and two and a half, respectively.

In the second panel, we study the extent to which these changes in yields affect commercial paper issuance by investigating the value of issues, in millions of dollars, on a given day. Notice that the pattern of missingness is much less pronounced for commercial paper issuance as opposed to rates. In contrast to the first panel, we observe a much stronger and statistically significant relationship between the instrumented bill-to-GDP ratio and issuance during the debt ceiling episodes specifically.

We observe that the effects are most pronounced for relatively long-dated commercial paper, with a maturity of between forty-one and eighty days. This maturity bucket has, by far, the highest level of statistical significance. Our results imply that commercial paper issuance falls in debt ceiling episodes by 316 million dollars, for a one percentage point increase in the bill-to-GDP ratio. This pattern is consistent with commercial paper issuers issuing relatively long-term commercial paper before the end of a debt ceiling, when bill supply is low but is expected to rebound after the debt ceiling is raised or suspended quickly.

In Table A.14, we regress the number of distinct commercial paper issuances during debt ceiling episodes, as opposed to the value, on the instrumented bill-to-GDP ratio. We again find that there is a strong pass-through of variation in the bill-to-GDP ratio to issuance metrics during these periods. A one percentage point increase in the bill-to-GDP ratio is associated with eleven fewer issuances by commercial paper issuers on a given day.

Given these apparently large magnitudes within debt ceiling periods, but attenuated results using the combined appendix, we investigate plots of the time series of commercial paper issuance in the appendix, displayed in Figure A.7. We find that there is visual support for the effects documented in Table 6 in the sense that commercial paper issuance, particularly long-term paper issuance, increases over the life of an individual debt ceiling issuance. We also find that there is some visual evidence for gap-filling behavior overall, in that the level of commercial paper issuance tends to be higher during debt ceiling episodes than other periods.

4.8 Dealer Holdings

Lastly, we study the impact of debt ceiling–induced fluctuations in bill supply by examining the holdings of primary dealers. In principle, a variety of financial intermediaries could be affected by changes in bill supply. However, the variation we study occurs at relatively high frequency, with bill supply often changing within a week. Our empirical strategy compares changes in prices and quantities within individual debt ceiling episodes, which typically span a quarter or less. Many asset managers, such as mutual funds, report holdings at most monthly, and many only report quarterly. These reporting constraints lead us to focus on primary dealer holdings, which are available at a weekly frequency. Moreover, primary dealers actively trade across the entire Treasury yield curve, making them a natural group to study when assessing how changes in the maturity structure of public debt affect intermediary inventories.

A further appeal of studying dealer holdings is the traditional view of dealers as arbitrageurs in the Treasury market. As suggested by Greenwood et al. (2015), Lou et al. (2013), and the results in our paper, large and fully predictable flows in the Treasury market can affect prices on impact due to the limited balance sheet capacity of dealers. We view our analysis of dealer holdings both as validation that large flows influence the behavior of a key set of intermediaries and as a means of shedding light on how dealers prepare for and intermediate large, predictable shocks.

As a first test, we examine how dealer inventories evolve during debt ceiling episodes. We regress dealer holdings (in billions of dollars), by maturity bucket, on the instrumented bill-to-GDP ratio. The regression is estimated at the weekly frequency, and the results are reported in Table 7.

We find that changes in the maturity structure of the public debt pass through to dealer inventories. As the supply of bills increases, dealer holdings of bills increase. For a one percentage point increase in the bill-to-GDP ratio, dealer inventories of bills increase by approximately eleven billion dollars. Increases in the supply of bills are also associated with pronounced declines in the quantities of dealer holdings of bonds and notes. This effect is most pronounced for notes with one to two years left to maturity, for which there is a seven-and-a-half billion dollar decline in holdings. There are smaller declines on the order of two billion dollars farther along the yield curve, although not always statistically significant. There is no statistically significant association between the instrument and the overall quantity of holdings, consistent with aggregate Treasury supply being held constant during these periods.

Given the apparent connection between changes in bill supply and dealer inventories, as well as the traditional view of dealers as arbitrageurs in these markets, we examine whether dealer holdings are linked to the impact of supply shocks on convenience premia. In the appendix, we plot a seasonally adjusted moving average of dealer bill holdings. Consistent with the estimates in Table 7, we observe a pronounced decline in dealer bill inventories during periods when the debt ceiling is binding. More surprisingly, there is also visual evidence of increases in dealer bill holdings in the weeks leading up to debt ceiling episodes.

Increases in bill holdings prior to debt ceiling episodes are consistent with the view of dealers as arbitrageurs in Treasury markets. Large purchases of short-term Treasury securities ahead of sharp declines in bill supply suggest that dealers may build inventories in anticipation of a richening in short-term securities. While the number of episodes is too small to support formal statistical testing, we observe that, on average, dealer holdings increase by $5.8 billion over the four weeks leading up to a binding debt ceiling. This pattern appears to have grown more pronounced over time. For example, in the run-up to the 2023 debt ceiling episode, dealer holdings increased by more than $26 billion. A summary of average and episode-specific increases is reported in Table A.10.

Motivated by this suggestive evidence, we examine whether there is a statistical relationship between dealer holdings and the pass-through of changes in Treasury supply to convenience premia. To do so, we estimate the following regression equation.

$$\begin{aligned}\text{Convenience Premia}_{t,m} = &\ \beta_1 \text{Bill / GDP}_t \\ &+ \beta_2 \text{Bill / GDP}_t \times \text{Dealer Bill Inventory / GDP}_{e(t)} \\ &+ \boldsymbol{\gamma}' \boldsymbol{X}_t + \nu_{e(t)} + u_{t,m}\end{aligned} \tag{4.13}$$

As in our primary regression specification, we include the instrumented bill-to-GDP ratio as an independent variable. In contrast to the baseline, we interact this variable with dealer bill holdings, also normalized by GDP, measured on the last reporting date prior to the debt ceiling becoming binding. A higher value of this interaction term corresponds to larger dealer inventories ahead of a binding debt ceiling, which are typically followed by sharp declines in bill supply. The bill-to-GDP ratio is expressed in percent, and dealer holdings relative to GDP are expressed in basis points. Coefficient estimates are reported in Table 8.

We find that the magnitude of dealer holdings has a statistically significant effect on the pass-through of predictable shocks to bill supply. As in the baseline regression, the coefficient on the bill-to-GDP ratio is negative, indicating that a decline in bill supply is associated with an increase in convenience premia. The coefficient on the interaction term is consistently positive and statistically significant in some specifications. This suggests that when dealer inventories are larger prior to the onset of a debt ceiling episode, the resulting increase in convenience premia from a decline in bill supply is attenuated.

One salient feature of our results is that relatively small fluctuations in dealer inventories appear to have comparatively large effects on the impact of bill supply shocks on convenience premia. A one basis point increase in dealer holdings (as a share of GDP) reduces the pass-through from a one percentage point increase in the bill-to-GDP ratio to convenience premia by approximately one basis point. We interpret this in two ways. First, it is possible that other investors also accumulate Treasury securities in advance of debt ceiling episodes in a similar manner. If so, our estimates may overestimate the true role of dealer inventories in driving the response of convenience premia. Second, dealers are often viewed as marginal participants in Treasury markets, so even modest changes in their holdings may have outsized effects on prices.

5 Conclusion

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

When the debt ceiling binds, the Treasury cannot issue more debt without redeeming or allowing to run off debt instruments of equivalent face value. Additionally, the Treasury has a pre-scheduled and highly autocorrelated issuance policy for long-term debt. Taken together, when the debt ceiling binds, every dollar of scheduled net positive long-term debt issuance implies a dollar of net negative bill issuance. We exploit this to construct an instrument for bill supply. Our preferred IV specification implies that a one percentage point increase in the bill-to-GDP ratio results in short-term investment-grade corporate bond yields increasing by approximately three basis points and has quantitatively similar effects on the convenience premia of Treasuries.

We demonstrate that these dynamics have been significantly amplified since 2015, which we attribute to an unintended consequence of changes in Treasury policy. In 2015, the Treasury decided to hold much larger cash balances in the Treasury General Account at the New York Fed (U.S. Department of the Treasury (2015b)). This has 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.

The large and predictable changes in the maturity structure of the public debt make the debt ceiling a critical feature of the Treasury market's life cycle. Our results show that the distortions induced by the debt ceiling have a material impact on asset prices and exert sizable quantitative effects on both financial intermediaries and corporate issuers whose securities compete with Treasury bills.

Beyond highlighting the debt ceiling as an economically important institutional constraint, our analysis exploits a source of statistical variation that is conceptually distinct from studies examining the impact of fiscal surprises. By construction, the total value of

Treasury liabilities must remain constant when the debt ceiling binds, even as the composition of those liabilities shifts. This contrasts with studies of fiscal shocks, which examine variation that changes both the maturity structure of public debt and the quantity of publicly held marketable debt outstanding.

We hope our study encourages further research on the role of Treasury rules in shaping the maturity structure of the public debt and the economic forces behind them. We posit that the Treasury adopted its policy of regular and predictable issuance in response to intermediation constraints, consistent with historical and practitioner accounts. Our findings suggest that rules designed to support dealers can have a significant impact on the maturity structure of public debt, and more broadly, that even well-intentioned rules can have unintended consequences.

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 monthly outlays. The remaining line corresponds to the Treasury's stated cash balance assumptions.

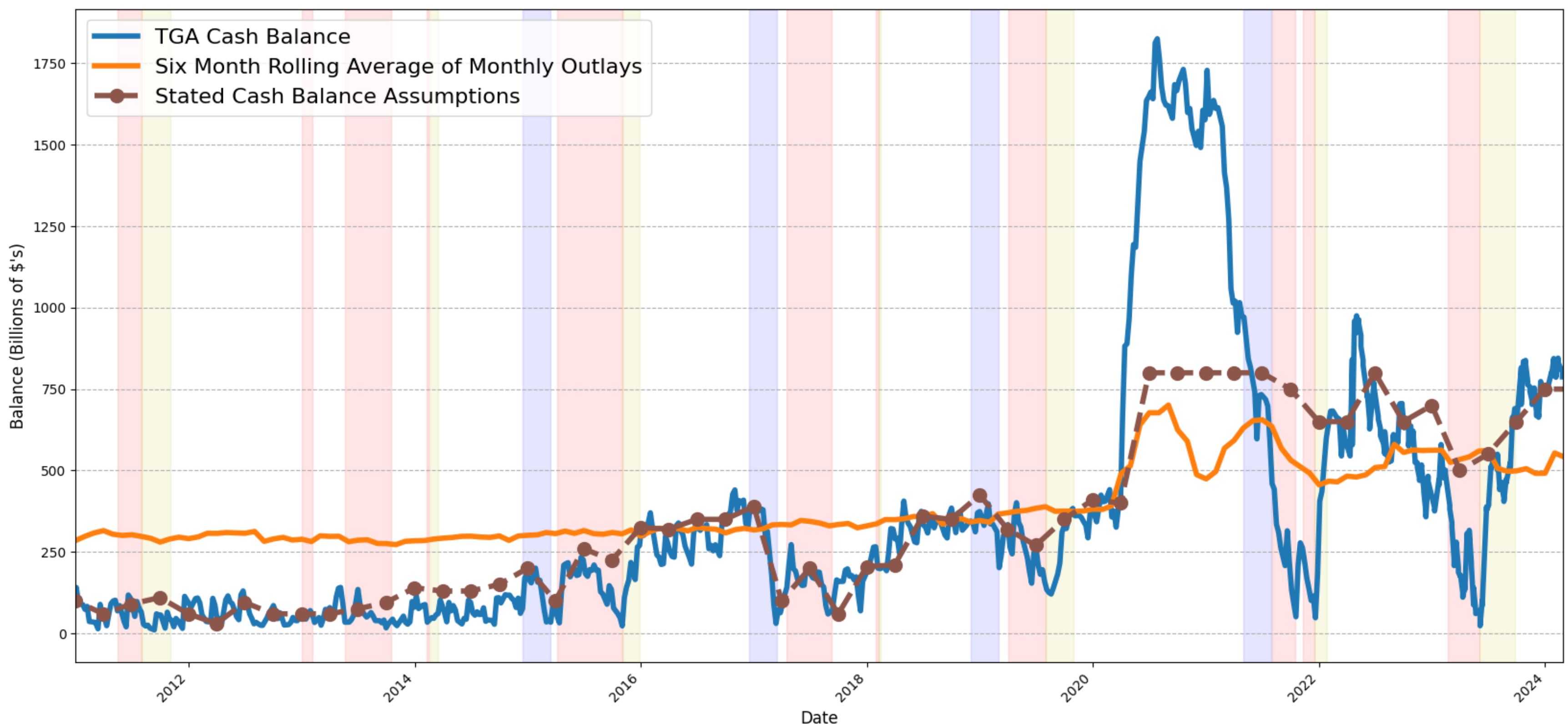


Figure 2
Evolution of Bills / GDP

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.

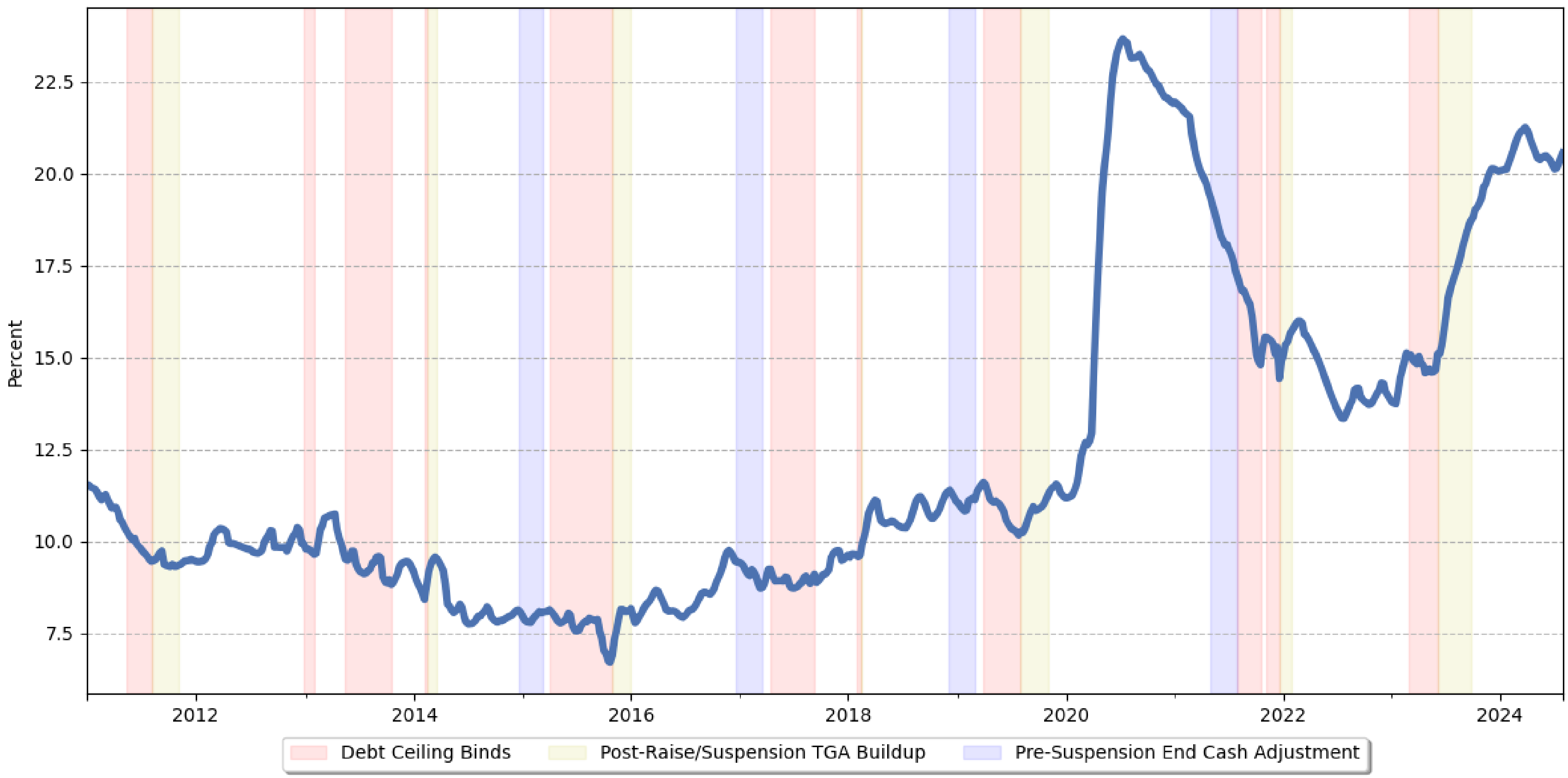


Figure 3
Headroom

This figure displays the evolution of bill supply in dollar amounts around each of 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.

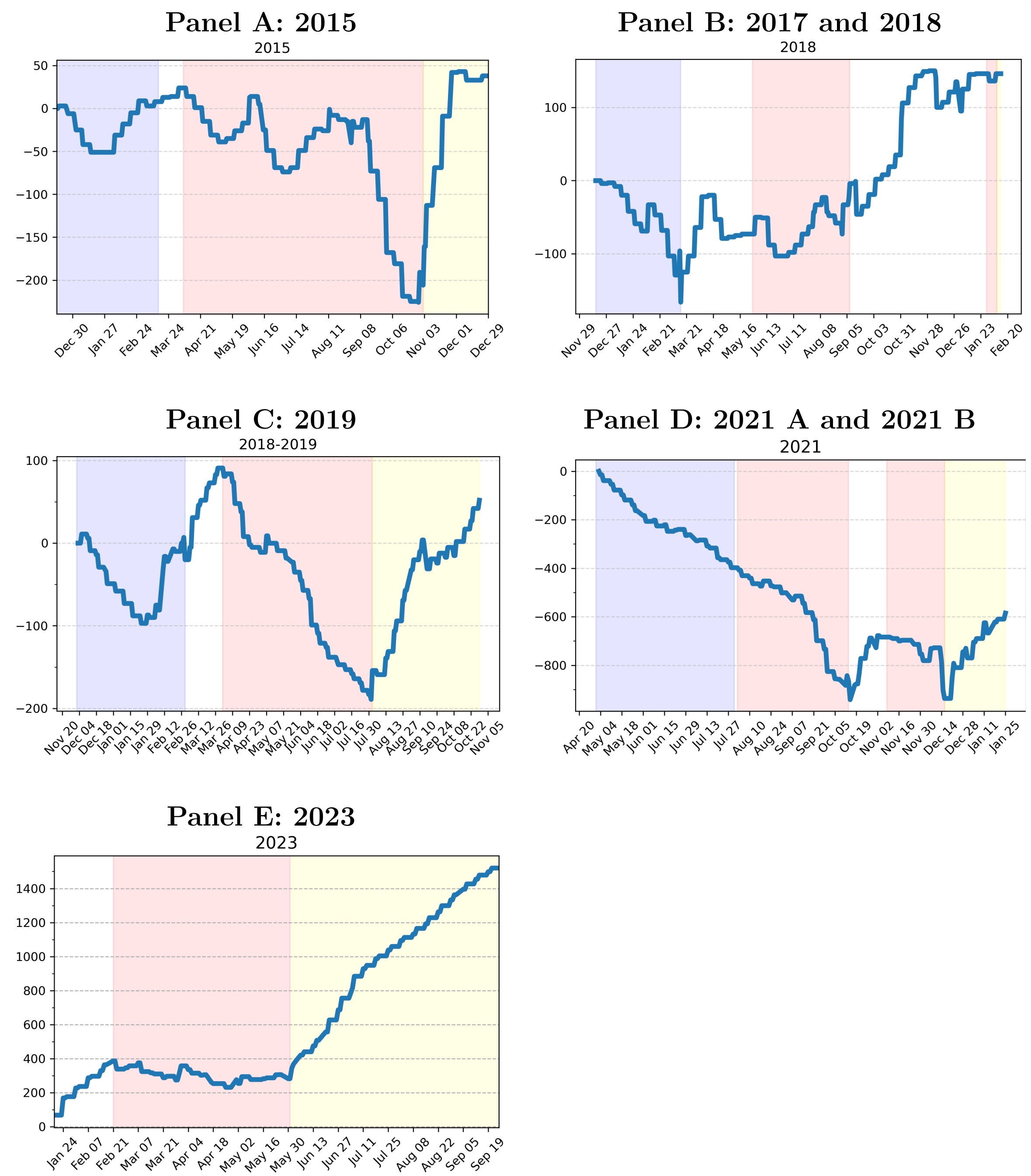
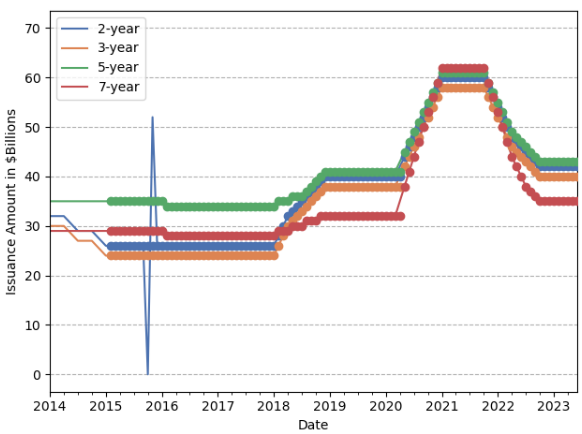


Figure 4
Auction Offering Actual and Scheduled Amounts

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.



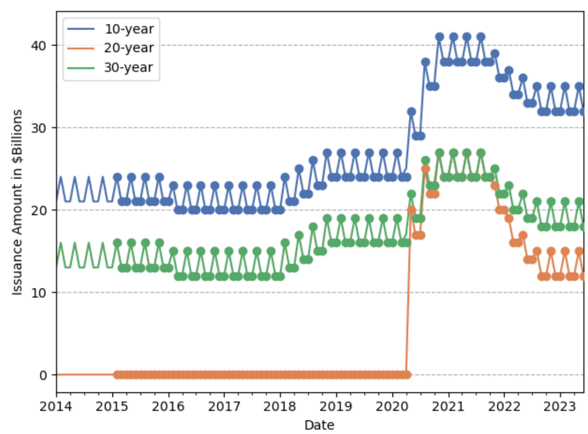


Figure 5
DCIV

This figure illustrates the construction of DCIV, given a hypothetical auction schedule. In this quarter, there is $288 billion dollars total of scheduled bond and note issuance. There are twenty-four total bill auctions, eight of which occur this month. The initial value of the instrument is $24, indicating that two bill auctions have passed since the debt ceiling constraint began to bind. Every day that there is a scheduled bill auction, the value of the instrument increases by $288 / 24 = 12. At the start of the next month, assuming the debt ceiling constraint is still in effect, the value of the instrument would start at $120.

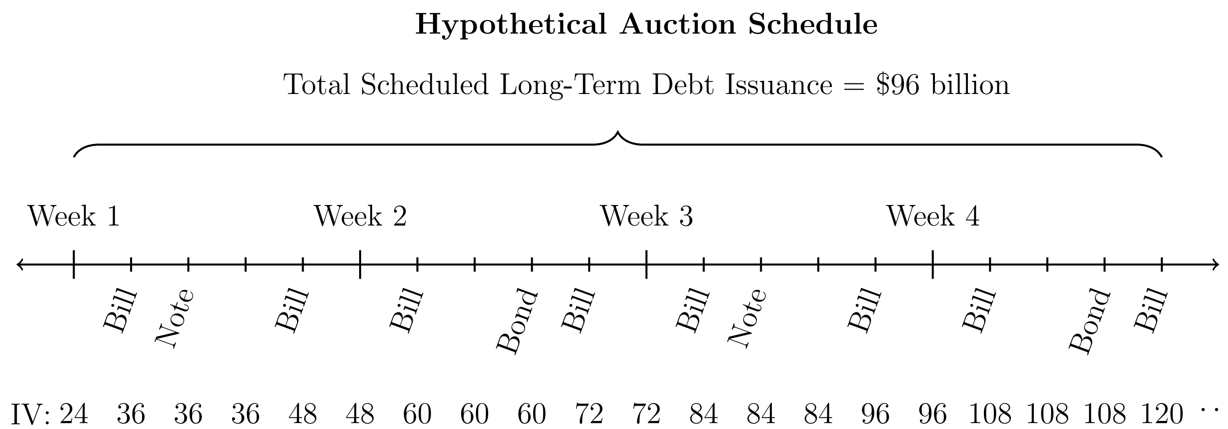


Figure 6
2017 Episode and Effect on Corporate Yields

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

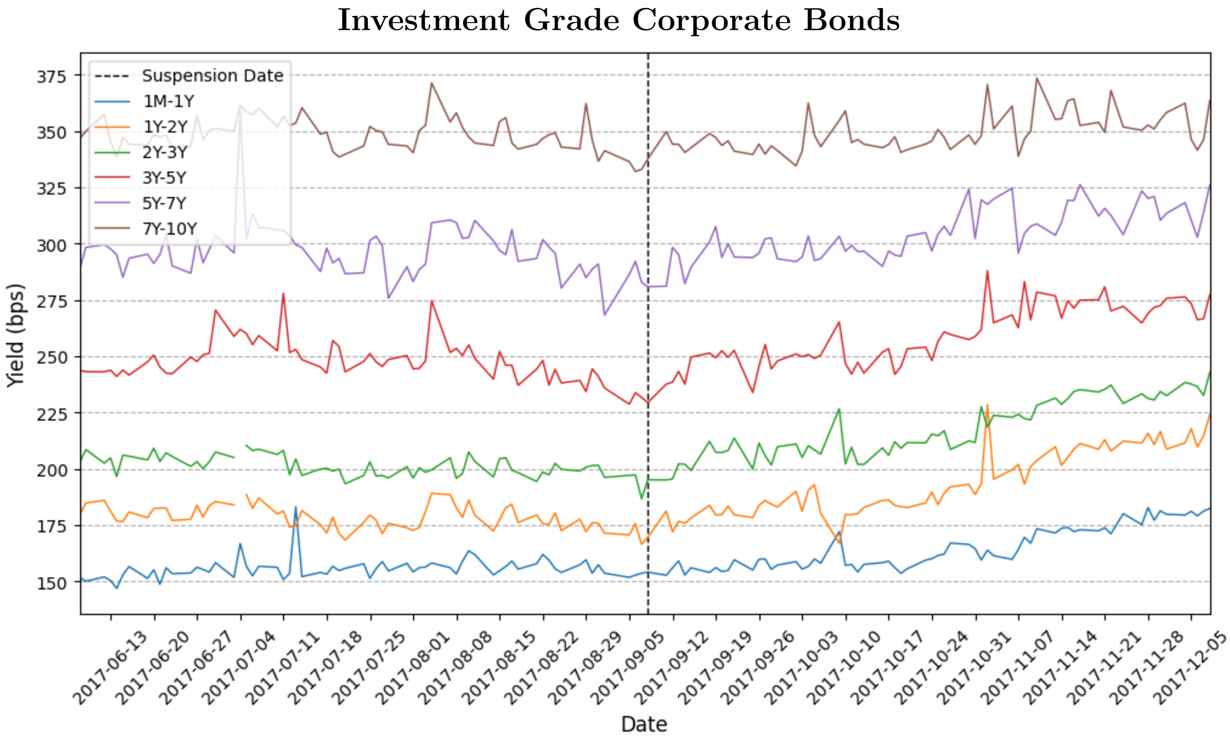


Table 1
Debt Ceiling Episode Summary Statistics

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

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

Table 2
First Stage

This table presents regressions of the first stage for each of our instruments: DCIV, SEIV, and TGAIV. In the first three specifications, the dependent variable is the dollar amount of bill supply. In the next three, the dependent variable is the bill-to-GDP ratio. In all specifications, we include controls for the CDS spread, VIX and effective federal funds rate.

Dependent Variables:	Bill Supply ($Billions)			Bill-to-GDP Ratio (%)		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Debt Ceiling Instrument	-0.8246***			-0.0042***		
	(-12.36)			(-14.23)		
End-of-Suspension Instrument		-0.6283***			-0.0035***	
		(-6.145)			(-7.944)	
Post-Raise/Suspension Instrument			-1.348***			-0.0048***
			(-9.595)			(-12.29)
Fixed-Effects						
Episode	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics						
Observations	512	258	214	512	258	214
R^2	0.99571	0.99670	0.99469	0.99163	0.99456	0.99161
Within R^2	0.51889	0.41747	0.83340	0.55483	0.47165	0.80474
F-test	11,855.1	11,096.3	4,985.3	6,050.9	6,716.4	3,145.0

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

Table 3
Convenience Premia

This table presents regression results of convenience premia on the instrumented bill-to-GDP ratio. Each of the two panels uses a different instrument for the bill-to-GDP ratio, indicated in bold. Columns represent the averages within the specified maturity range. In all specifications, we control for the effective federal funds rate, five-year U.S. sovereign CDS spread and the VIX.

	Convenience Premia (Basis Points)										
Maturity:	All TBill	1-3M	3-6M	6-12M	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y
	Panel A: Combined Instrument										
Bill / GDP	-5.265**	-5.649**	-5.207*	-4.503**	0.0619	1.058	1.752***	1.746***	1.461**	1.284	2.177**
	(-2.072)	(-2.217)	(-1.877)	(-2.211)	(0.0691)	(1.533)	(2.743)	(2.842)	(2.141)	(1.616)	(2.038)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects											
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics											
Observations	948	948	948	948	948	948	948	948	948	948	948
R^2	0.90703	0.89526	0.89214	0.94093	0.96145	0.96143	0.95242	0.94126	0.93833	0.87439	0.85200
Within R^2	0.67545	0.62564	0.68587	0.69958	0.71877	0.74934	0.78238	0.77044	0.69666	0.48517	0.31515
	Panel B: Debt Ceiling Instrument (DCIV)										
Bill / GDP	-7.888***	-9.520***	-8.185***	-3.677**	3.068***	5.282***	6.199***	6.628***	6.275***	4.697**	6.911**
	(-3.386)	(-3.740)	(-3.236)	(-2.114)	(3.739)	(4.235)	(4.648)	(4.911)	(3.796)	(2.310)	(2.530)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects											
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics											
Observations	499	499	499	499	499	499	499	499	499	499	499
R^2	0.95654	0.94049	0.95362	0.97563	0.97612	0.96634	0.94853	0.91599	0.89586	0.79684	0.72996
Within R^2	0.85740	0.79839	0.87383	0.88484	0.83967	0.80167	0.80857	0.77607	0.66636	0.42307	0.25390

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

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

This table reports estimates from instrumental variable regressions of the yield of investment-grade corporate bonds. In the first panel, we use the combined instrument; in the bottom panel, we use only DCIV. In all specifications, we control for the effective federal funds rate, five-year U.S. sovereign CDS spread, level of the VIX, cumulative SMCCF sales, and a Silicon Valley Bank crisis indicator.

	Corporate Bond Yields						
	1M-1Y	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	Panel
	Panel A: Combined Instrument						
Bill / GDP	2.711*	1.836	3.073	4.596*	8.082***	10.91***	-5.436
	(1.856)	(0.8793)	(1.335)	(1.883)	(2.886)	(4.506)	(-1.021)
Bill / GDP (%) x 1YR							8.907***
							(2.832)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects							
Episode	Yes	Yes	Yes	Yes	Yes	Yes	
Episode x Maturity							Yes
Fit Statistics							
Observations	965	963	962	965	965	965	5,785
R^2	0.99624	0.98350	0.98955	0.97612	0.96824	0.97049	0.98576
Within R^2	0.12515	0.08123	0.17661	0.11505	0.17893	0.18604	0.04040
	Panel B: Debt Ceiling Instrument (DCIV)						
Bill / GDP	3.137	-6.413	-12.41*	-7.864	-12.20	-5.392	-8.490
	(0.6661)	(-0.8831)	(-1.822)	(-1.200)	(-1.376)	(-0.7146)	(-1.259)
Bill / GDP (%) x 1YR							9.816***
							(3.133)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects							
Episode	Yes	Yes	Yes	Yes	Yes	Yes	
Episode x Maturity							Yes
Fit Statistics							
Observations	504	503	501	504	504	504	3,020
R^2	0.99566	0.98695	0.98368	0.97782	0.95651	0.95463	0.98569
Within R^2	0.11068	0.08751	0.11066	0.15202	0.10685	0.09690	0.07037

Newey-West (L=5) co-variance matrix, t-stats in parentheses
Driscoll-Kraay standard errors for Panel
*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. In all specifications, we control for the effective federal funds rate, U.S. sovereign CDS spread, level of the VIX, cumulative SMCCF sales, and a Silicon Valley Bank crisis indicator.

Dependent Variable:	Offering Yield (Basis Points)			
Maturity:	2 Years or Less		More than 2 Years	
Rating:	IG	Ex. IG	IG	Ex. IG
Model:	(1)	(2)	(3)	(4)
Variables				
Bill-to-GDP Ratio	2.420*	-0.2330	0.0826	-0.0932
	(1.948)	(-1.121)	(1.626)	(-0.5423)
Controls	Yes	Yes	Yes	Yes
Fixed-Effects				
Rating	Yes	Yes	Yes	Yes
Episode	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	89	1,155	3,268	1,689
R^2	0.47462	0.18106	0.55874	0.38185
Within R^2	0.09645	0.00648	0.01151	0.00817

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

Table 6
Commercial Paper Yields and Issuance

This table presents regressions of commercial paper rates and issuance on the instrumented bill-to-GDP ratio. Each column corresponds to commerical paper of the indicated maturity. In all specifications, we include controls for the five-year U.S. Sovereign CDS spread, VIX and effective federal funds rate. All specifications also include an episode fixed effect.

Panel A: AA Non-Financial Rates (Basis Points)							
Maturity	Overnight	7 Day	15 Day	30 Day	60 Day	90 Day	Panel
	Panel A.1: Combined Instrument						
Bill-to-GDP Ratio	1.751***	2.233***	1.977***	1.913**	1.782*	2.225*	1.955***
	(2.901)	(3.084)	(3.026)	(2.126)	(1.739)	(1.713)	(3.364)
Observations	932	788	810	846	704	642	4,722
R^2	0.99737	0.99889	0.99910	0.99857	0.99904	0.99879	0.99791
Within R^2	0.44164	0.65747	0.65452	0.51079	0.61174	0.56483	0.46783
	Panel A.2: Debt Ceiling Instrument						
Bill-to-GDP Ratio	-0.3721	1.283	1.710*	2.421	2.465	2.077	1.482
	(-0.9773)	(1.522)	(1.653)	(1.538)	(1.263)	(0.9697)	(1.297)
Observations	488	421	439	450	397	373	2,568
R^2	0.99923	0.99911	0.99910	0.99910	0.99866	0.99860	0.99844
Within R^2	0.79742	0.77900	0.73953	0.71533	0.65084	0.60439	0.62998
Panel B: Value of AA Non-Financial Issues (Millions of Dollars)							
Maturity:	1-4 Days	5-9 Days	10-20 Days	21-40 Days	41-80 Days	80+ Days	Panel
	Panel B.1: Combined Instrument						
Bill-to-GDP Ratio	337.2	-11.66	-7.094	-14.87	-65.45	-4.722	38.90
	(1.424)	(-0.2025)	(-0.2786)	(-0.4060)	(-1.558)	(-0.2170)	(0.9099)
Observations	947	947	947	947	947	947	5,682
R^2	0.14204	0.28565	0.15831	0.16730	0.13315	0.17349	0.03377
Within R^2	0.00637	0.00132	0.00643	0.00639	0.01012	0.01571	0.00134
	Panel B.2: Debt Ceiling Instrument						
Bill-to-GDP Ratio	-613.8	-175.7	-93.50*	-57.87	-316.0***	-58.23	-219.2**
	(-1.249)	(-1.456)	(-1.862)	(-0.8813)	(-3.523)	(-1.299)	(-2.583)
Observations	498	498	498	498	498	498	2,988
R^2	0.23068	0.26406	0.14456	0.17733	0.10149	0.11615	0.04593
Within R^2	0.06062	0.00931	-0.01369	0.00156	-0.00673	0.03122	0.00581

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

Table 7
Dealer Inventories

This table displays regression results from regressions of dealer Treasury inventories on our debt ceiling instrument. Data on dealer holdings is observed at a weekly frequency. We include controls for the five-year U.S. Sovereign CDS spread, VIX and effective federal funds rate. The dependent variable in all regressions is the quantity of dealer holdings, expressed in billions of dollars. The first column corresponds to holdings of the total quantity of all Treasury securities, the second to bills and the remaining to coupon-bearing Treasury securities by time-to-maturity.

Security Type	All	Bills	Coupons				
Dependent Variables:	Total	$Y \leq 1$	$1 < Y \leq 2$	$2 < Y \leq 3$	$3 < Y \leq 6$	$6 < Y \leq 7$	$7 < Y \leq 11$
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bill/ GDP	-9.045	11.52***	-7.484***	-2.028	-2.637	-2.715***	-1.624
	(-1.596)	(3.320)	(-3.311)	(-1.530)	(-1.562)	(-3.403)	(-1.490)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects							
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics							
Observations	103	103	103	103	103	103	103
R^2	0.94920	0.80691	0.93524	0.81182	0.86978	0.81915	0.77718
Within R^2	0.11638	0.33629	0.29676	0.09271	0.09837	0.26066	0.04062

IID co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 8
Convenience Premia and Dealer Holdings

This table reports coefficients from a regression of convenience premia on dealer bill holdings normalized by GDP (in basis points) and the bill-to-GDP ratio (in percent). Dealer bill holdings are calculated as of the last reporting date prior to the onset of a debt ceiling episode. The dependent variable is convenience premia, expressed in basis points. In all specifications, we include episode fixed effects and control for the effective federal funds rate, VIX and the five-year U.S. Sovereign CDS spread. We estimate these regressions using daily data over periods during which the debt ceiling bound.

Dependent Variable:	Convenience Premia (bps)			
Model:	(1)	(2)	(3)	(4)
Bill / GDP	-17.18**	-13.15	-21.41***	-17.23**
	(-2.067)	(-1.434)	(-2.602)	(-2.442)
Bills / GDP (%) x Dealer-Owned Bills / GDP (Bps)	0.7155	0.2797	1.019*	1.044**
	(1.139)	(0.3936)	(1.667)	(1.998)
Controls	Yes	Yes	Yes	Yes
Fixed Effects				
Episode	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	499	499	499	499
R^2	0.95018	0.93769	0.94482	0.96921
Within R^2	0.83652	0.78890	0.84991	0.85452

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

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INTERNET APPENDIX

Table of Contents

A Instrument Construction

A.1 2021 Justice Department Legal Ruling

The Bipartisan Budget Act of 2019, which 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. Furthermore, in 2015, the Treasury revised its cash management policy to maintain a higher prudential balance. Before 2015, as shown in Figure 1, the cash balance at the TGA was significantly lower. Hence, neither the suspension end instrument nor the post-suspension raise instrument is meaningful before 2015. Our instrumental variables regression focuses on the post-2015 episodes.

The suspensions in 2017 and 2018 can be viewed as a single, extended 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, the 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]	Extraordinary 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]	Extraordinary 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.

Table A.3
Schedule Text

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 represents all marketable securities, including bonds, notes, and bills. The grey line corresponds to bonds, and the dotted pink line to notes. The solid red line corresponds to estimates of the headroom as released by the Treasury, which may differ from the actual headroom from day to day.

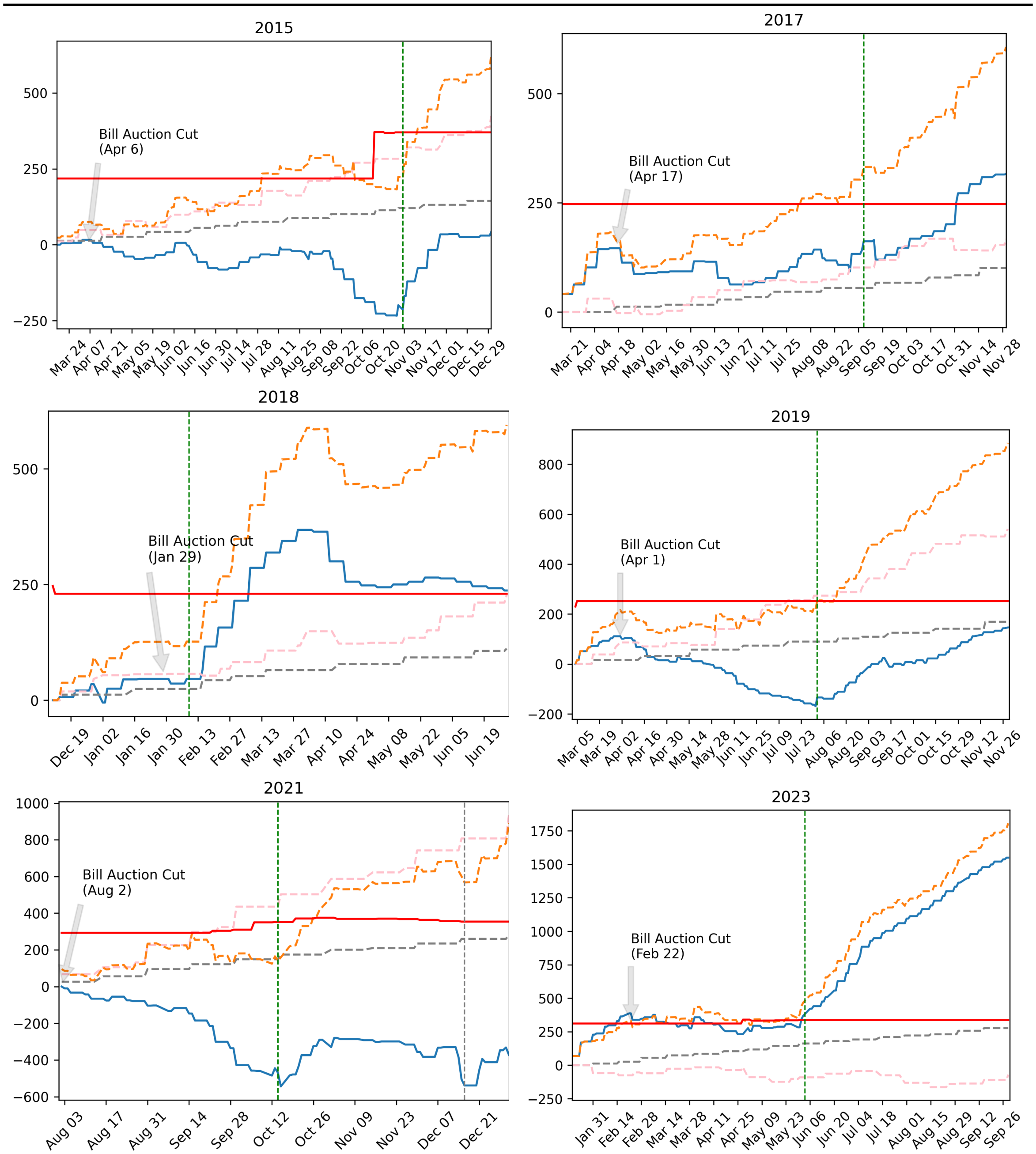
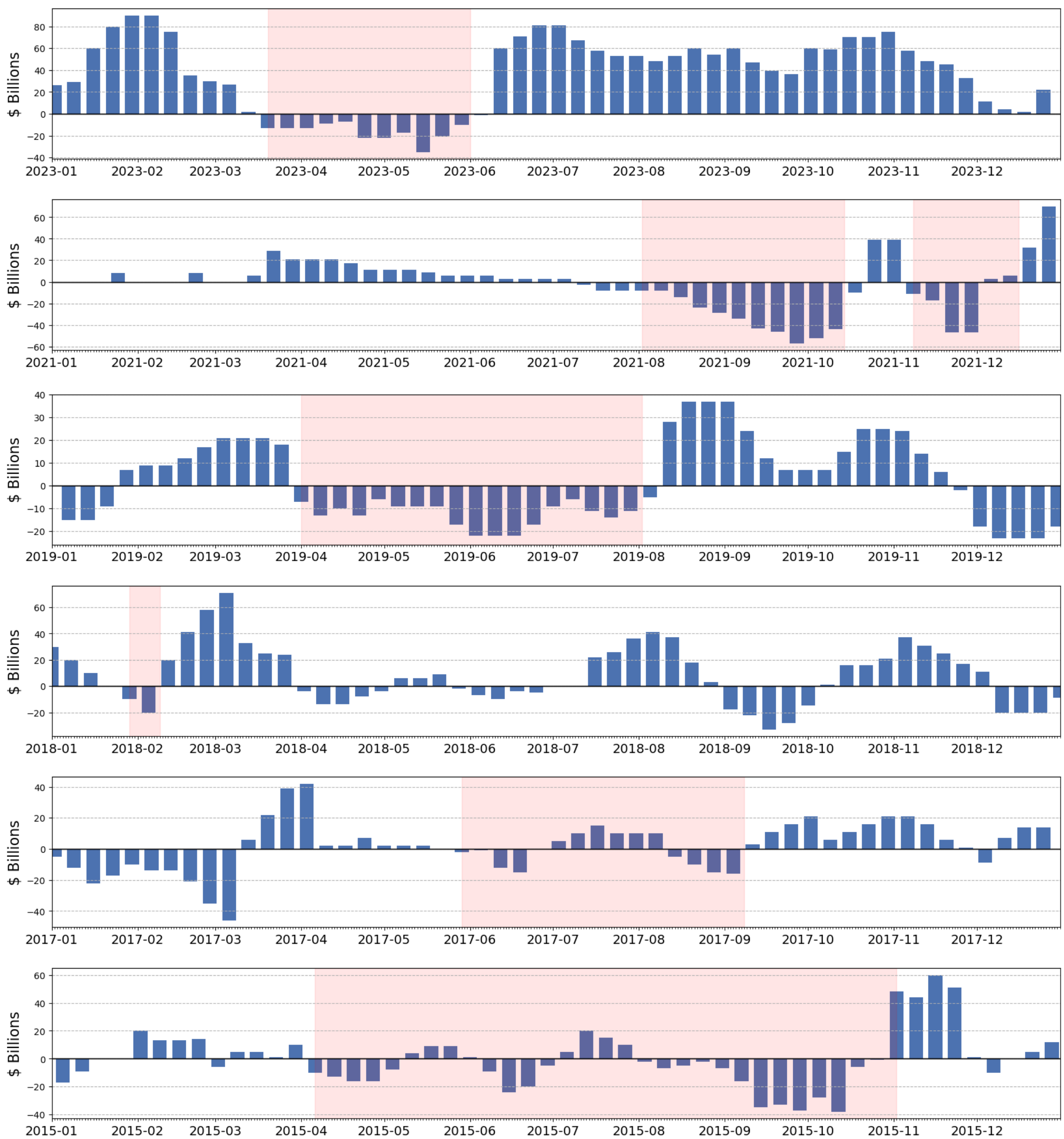


Figure A.2
Net Offering Amounts

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



B Additional Results

B.1 Results using TGAIV or SEIV Alone

As an additional check, we also examine the estimated effect of a change in bill supply using only SEIV and TGAIV, i.e., instruments that exploit the pre-end-of-suspension and post-suspension/raise periods. When performing this exercise, we are confronted with a significant reduction in the number of observations. There are approximately two-fifths of the number of observations in the post-suspension raise period as in the debt ceiling periods themselves and even fewer in the pre-end-of-suspension periods. This smaller sample has a significant impact on the statistical precision of our estimates.

In Table A.4, we estimate our baseline regressions using only the baseline set of controls in the first panel. As we observed, the substantial loss in the number of observations is associated with a general lack of statistical significance. Motivated by this, we include additional controls in order to shrink the residual variance. Estimates from these regressions are given in the second panels. As an additional step to increase the power of these estimates, in the last panel, we report estimates from using both TGAIV and SEIV, which approximately doubles the number of observations.

As we noted in the different estimates of the combined instrument, TGAIV and SEIV have no particularly strong implications for the behavior of the behavior of convenience premia at the long end of the yield curve. Therefore, we investigate the evolution of convenience premia for bills, specifically.

In our specifications, including additional controls, we find estimates mostly consistent with our baseline estimates.

Table A.4
Convenience Premia Instrumenting by TGAIV and SEIV Alone

This table reports results from convenience premia regressed on the instrument bill-to-GDP ratio, the same specification as reported in Table 3. As in Table 3, we include controls for the effective federal funds rate, five-year U.S. sovereign CDS spread and the VIX in both panels. Unlike the analysis in Table 3, we use only TGAIV and SEIV. In panel B, we also control for the ON-RRP increase in 2021, the May 2021 CPI, and an indicator for March. In Panel C, we include an indicator for the September tax date.

	Convenience Premia (bps)							
Maturity:	All TBill	1-3M	3-6M	6-12M	All TBill	1-3M	3-6M	6-12M
	Panel A.1: TGAIV Baseline				Panel A.2: SEIV Baseline			
Bill / GDP	-0.9082	-1.244	0.1513	-2.704***	-0.2080	0.1519	-0.0311	-0.8641
	(-1.416)	(-1.476)	(0.2224)	(-3.793)	(-0.2170)	(0.1850)	(-0.0305)	(-0.7207)
Observations	206	206	206	206	243	243	243	243
R^2	0.62356	0.51957	0.63209	0.88511	0.92616	0.93176	0.92787	0.90498
Within R^2	0.28565	0.21499	0.32618	0.44626	0.01517	0.01263	0.00999	0.11341
	Panel B.1: TGAIV + Controls				Panel B.2: SEIV + Controls			
Bill / GDP	-0.5296	-1.116	0.8401	-1.675	-4.685	-2.515	-4.827	-6.823*
	(-0.3095)	(-0.4513)	(0.5512)	(-1.507)	(-1.601)	(-1.065)	(-1.538)	(-1.920)
Observations	206	206	206	206	243	243	243	243
R^2	0.62212	0.51854	0.63200	0.88814	0.91365	0.93561	0.91322	0.84651
Within R^2	0.28291	0.21331	0.32601	0.46090	-0.15164	0.06825	-0.19110	-0.43219
	Panel C.1: TGAIV + SEIV				Panel C.2: TGAIV + SEIV + Controls			
Bill / GDP	-0.0193	0.4409	0.4844	-1.734	-2.805	-1.141	-2.536	-5.607**
	(-0.0223)	(0.6496)	(0.5039)	(-1.405)	(-1.614)	(-0.7935)	(-1.359)	(-2.446)
Observations	449	449	449	449	449	449	449	449
R^2	0.79240	0.74995	0.81613	0.88514	0.79475	0.76390	0.80741	0.86255
Within R^2	0.21966	0.14509	0.25036	0.33646	0.22850	0.19276	0.21479	0.20601

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

B.2 Bonds and Notes Prices and Quantities

This section records results related to changes in the quantities and pricing of long-term debt securities. Table A.5 reports how bond and note supply vary during debt ceiling episodes. As indicated by our baseline empirical results, the change in bill supply is nearly one-for-one with changes in bond and note supply during periods during which the debt ceiling is bound. Outside of these periods, bill supply and long-term security supply can be positively or negatively correlated. The final three columns directly regress bond and note supply on our instruments. As expected, the coefficient estimate from regressing bond and note supply directly on DCIV is positive and close to one. The fact that it is not exactly one is due to the mixed frequency of our independent and dependent variables.

Table A.7 displays regression results from specifications of instrumented bond and note supply on convenience premia – note that, unlike the results displayed in the main text, we instrument *bond and note supply* rather than *bill supply*.

B.2.1 Comparison of Bills vs. Bonds and Notes Coefficients

The estimates from Table 3 are different from those reported in Table A.7. This is because the supply of bonds does not move one-for-one with the supply of bills, due in part to the impact of extraordinary measures. We also caution that it is inappropriate to scale by the first coefficient estimate in Table 2. This is because it is a regression of bill supply in dollars, whereas our instrumental variable specifications use the bill-to-GDP ratio. The correct scaling factor is reported in Table A.6. A formal argument for why using the coefficient in Table 2 is given below.

Suppose we have the relationship (x= bills, y=bonds + notes). Denote the cumulative change in bills by Δx and in bonds and notes by Δy

$$\Delta y_t = \beta \Delta x_t + \varepsilon_t, \qquad |\beta| < 1 \tag{B.1}$$

Suppose $\beta = -0.8$, due to the impact of extraordinary measures, for instance. For simplicity, we do not include controls or fixed effects. We can rewrite this regression equation in levels:

$$y_t = (y_0 - \beta x_0) + \beta x_t + \varepsilon_t \tag{B.2}$$

This implies that if we look at a unit change in x this will imply a β unit change in y. But suppose that we are instead interested in looking at y_t/z_t, where z_t is the time-series of

GDP, i.e. we are interested in estimating the below equation in ratios:

$$\frac{y_t}{z_t} = \gamma \frac{x_t}{z_t} + \nu_t \tag{B.3}$$

Dividing equation (B.2) by z_t yields

$$\frac{y_t}{z_t} = \frac{(y_0 - \beta x_0)}{z_t} + \beta \frac{x_t}{z_t} + \frac{\varepsilon_t}{z_t} \tag{B.4}$$

The OLS estimate for γ in equation (B.3) is given by

$$\hat{\gamma} = \frac{Cov(x_t/z_t, y_{t/}z_t)}{Var(x_t/z_t)} \tag{B.5}$$

Substituting the expression for y_t/z_t from Equation (B.4) in the above yields

$$\hat{\gamma} = \beta + (y_0 - \beta x_0) \frac{Cov\,(x_t/z_t, 1/z_t)}{Var\,(x_t/z_t)} + Cov\,(x_t/z_t, \epsilon_t/z_t) \tag{B.6}$$

In general, $\hat{\gamma} \neq \beta$ and the exact magnitude will depend on several constants and covariance terms. We report the estimated $\hat{\gamma}$ in Table A.6.

B.2.2 Gagnon et. al (2011) Convenience Premium Calculation

Gagnon et al. (2011) report a 91 basis points cumulative decline in ten-year Treasury yields across eight announcements by the Federal Reserve between November 2008 and November 2009, in which new information about LSAPs was released. Using the methodology outlined in their paper, i.e., calculating the difference in the closing level of yields on the day of the announcement and the previous day, and adding these up for the eight announcement dates, we estimate a cumulative decline of 48 basis points for Moody's Seasoned Aaa Corporate Bond Yield Index. This implies a cumulative increase in the convenience premium of 43 basis points over the same period. The Federal Reserve's announced LSAP for "up to" $300 billion in longer-term Treasury securities translates into a net reduction in Treasury supply of approximately 2.1% of 2009 GDP. Based on these estimates, a one percentage point decline in the ratio of Treasury supply relative to GDP is associated with an approximately 21 basis points increase in Treasury convenience premium.

Table A.5
Instruments and Long-Term Debt Security Issuance

In this table, we regress the sum of bond and note on bill issuance and our instruments over various periods, indicated in the line "sample." The first row of coefficients corresponds to coefficients where we regress bond and note issuance on actual bill issuance. The remaining coefficients are actual bond and note issuance regressed on our three instruments over those periods during which those instruments are defined.

Dependent Variable:	Cumulative Net Bond/Note Issuance ($ billions)						
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Cumulative Net Bill Issuance ($ billions)	-0.2346***	-0.7678***	-1.037***	0.0823***			
	(-2.847)	(-13.49)	(-6.568)	(3.700)			
Debt Ceiling Instrument					1.071***		
					(28.50)		
End-of-Suspension Instrument						1.139***	
						(7.342)	
Post-Period Instrument (V1)							-0.2605***
							(-4.773)
Sample	Full	DC	Pre	Post	DC	Pre	Post
Fixed-Effects							
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics							
Observations	984	512	258	214	512	258	214
R^2	0.99914	0.99950	0.99855	0.99964	0.99984	0.99917	0.99971
Within R^2	0.09516	0.48883	0.45698	0.07448	0.84094	0.68778	0.26142

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

Table A.6
First Stage Bonds and Notes

This table reports regression results of the ratio of long-term debt outstanding to GDP on the ratio of bills to GDP. We estimate this over the sample during which the debt ceiling bound. In all specifications, we include episode fixed effects and control for the effective federal funds rate, five-year U.S. sovereign CDS spread and the VIX.

Dependent Variable:	Bond / GDP
Model:	(1)
Bill / GDP	-0.5634***
	(-6.167)
Fixed Effects	
Episode	Yes
Fit Statistics	
Observations	512
R^2	0.99715
Within R^2	0.28718

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

Table A.7
Bond and Note Convenience Premia on Instrumented Long-Term Debt / GDP

In this table, report regressions of the convenience premia of bonds and notes on the instrumented long-term debt-to-GDP ratio. In all specifications, we include controls for the VIX, five-year U.S. Sovereign CDS spread and effective federal funds rate. In all specifications, we include episode fixed effects. We estimate this over the sample during which the debt ceiling constraint bound.

Dependent Variable:	Convenience Premia (bps)							
Maturity:	Overall	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Bond / GDP	-10.04***	-5.445***	-9.373***	-11.00***	-11.76***	-11.14***	-8.335***	-12.26***
	(-6.419)	(-3.584)	(-6.191)	(-8.367)	(-9.070)	(-6.060)	(-2.671)	(-3.068)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-Effects								
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics								
Observations	499	499	499	499	499	499	499	499
R^2	0.95115	0.97496	0.96862	0.95706	0.92721	0.91407	0.78991	0.72426
Within R^2	0.82187	0.83184	0.81515	0.84029	0.80596	0.72471	0.40339	0.23814

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

B.3 U.S. Sovereign CDS

Below, we present several results related to U.S. Sovereign CDS. Table A.8 regresses U.S. sovereign CDS spreads of various tenors on our instruments. Notice that our instrument is correlated with changes in CDS spreads, and the effect on CDS spreads is heterogeneous across tenors. This result emphasizes that to recover the change in convenience premia, it is essential to account for both the change in the term structure of CDS spreads and the potential for heterogeneous changes in yields across the Treasury yield curve.

In Table A.9, we show that our results are robust to using MarkIt CDS spreads, instead of CDS spreads from Datastream. We find that the only meaningful differences between CDS and MarkIt spreads come in early in the sample, when U.S. Sovereign CDS contracts were less frequently traded. We verify that our results are essentially unchanged if you calculate convenience premia using MarkIt and drop 2014 and 2015.

Figure A.3 shows CDS spreads for three tenors over our entire sample. Consistent with our verbal description above, the single place where the CDS spreads meaningfully deviates across data providers is in 2015 for the six-month contract. For all other tenors and periods we analyze, the two series are highly consistent.

Table A.8
Term Structure of CDS Spreads

This table estimates regressions of a CDS spread of the indicated tenor on each of the three instruments, interacted with dummies. In all specifications, we include controls for the effective federal funds rate and the level of the VIX. All specifications also include episode fixed effects.

	CDS Spread of Indicated Tenor						
Dependent Variables:	6M	1Y	2Y	3Y	5Y	7Y	10Y
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Debt Ceiling Instrument × $\mathbb{I}${Debt Ceiling Period}	3.399**	1.321*	0.8566*	0.5691	0.0963	-0.0710	-0.1296
	(2.279)	(1.918)	(1.812)	(1.483)	(0.2963)	(-0.2453)	(-0.4599)
End-of-Suspension Instrument × $\mathbb{I}${Post-Suspension}	-0.2690***	-0.3000***	-0.2979***	-0.2881***	-0.1491*	-0.1125	-0.1870
	(-3.161)	(-3.336)	(-3.460)	(-3.346)	(-1.725)	(-1.021)	(-1.328)
Post-Raise/Suspension Instrument (V1) × $\mathbb{I}${Post-Raise/Suspension}	-0.5721	-0.2967	-0.5954	-0.7040	-0.7184	-0.7763	-0.8481
	(-1.336)	(-0.5801)	(-0.7882)	(-0.8416)	(-0.8237)	(-0.7534)	(-0.7811)
Controls	No	No	No	No	No	No	No
Fixed Effects							
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics							
Observations	984	984	984	984	984	984	984
R^2	0.59472	0.81376	0.81576	0.81440	0.79379	0.77296	0.77874
Within R^2	0.01059	0.00659	0.00853	0.00969	0.00930	0.01160	0.01548

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

Table A.9
Convenience Premia Regressions using MarkIt Ex. 2015

This table reports results from regressions of convenience premia on the instrumented bill-to-GDP ratio. Unlike our baseline regressions, we compute these convenience premia using CDS spreads from MarkIt, instead of Datastream. We estimate these specifications over the entire example, excluding 2014 and 2015.

Dependent Variable:	Convenience Premia (bps)										
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Bill / GDP	-7.055***	-8.976***	-6.881***	-3.114**	0.4766	0.3911	0.7148	1.476***	0.8683	0.7612	0.9821
	(-4.074)	(-4.249)	(-3.835)	(-2.406)	(0.3517)	(0.3383)	(0.9691)	(2.995)	(1.565)	(1.052)	(1.019)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects											
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics											
Observations	701	701	701	701	701	701	701	701	701	701	701
R^2	0.85557	0.82482	0.82841	0.93265	0.94780	0.95431	0.93825	0.91690	0.93054	0.82459	0.64943
Within R^2	0.38204	0.28723	0.40290	0.53269	0.58255	0.61640	0.62363	0.58200	0.51326	0.04078	0.01594

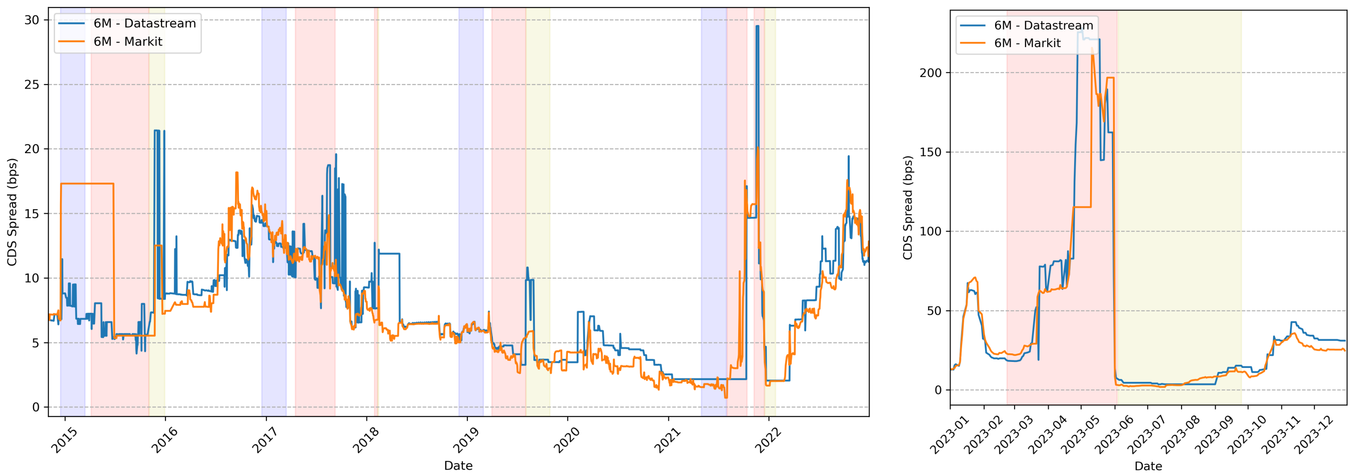
Newey-West (L=5) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Figure A.3
Comparison of MarkIt vs. Datastream CDS Spreads

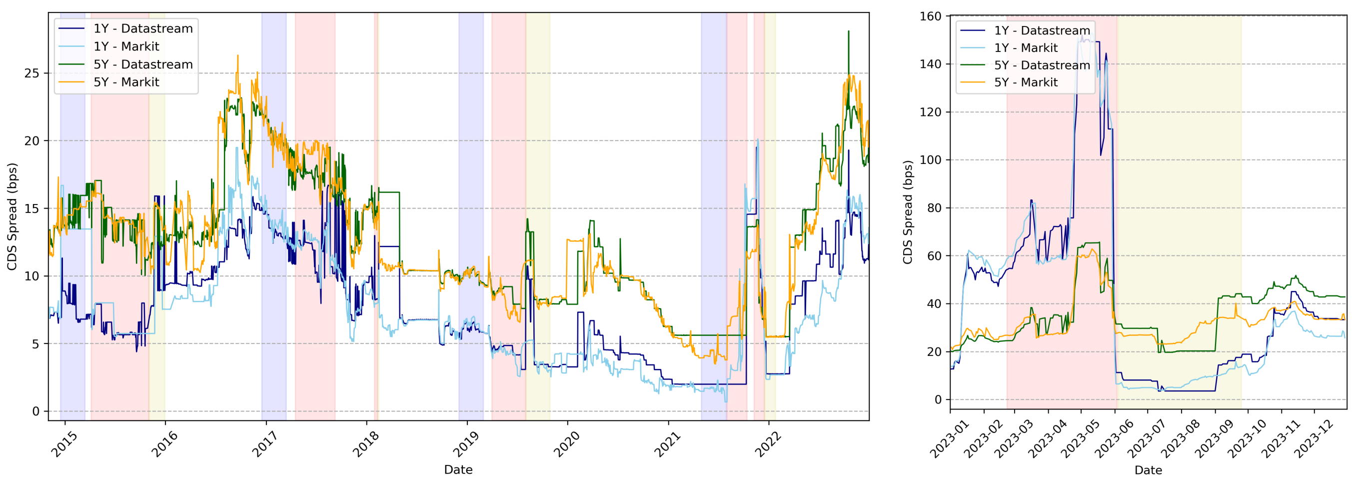
This figure compares CDS spreads from MarkIt and Datastream for various tenors. As is visually apparent, the CDS and MarkIt spreads are highly consistent. During our sample, the only meaningful deviation occurs in late 2014 to early 2015 for the six-month contract, which is the least liquid.

2015-2022	2023

Six Month CDS Contract



One Year and & Five Year CDS Contract



B.4 Dealer Holdings

Table A.10
Change in Dealer Holdings Before Disruption Periods

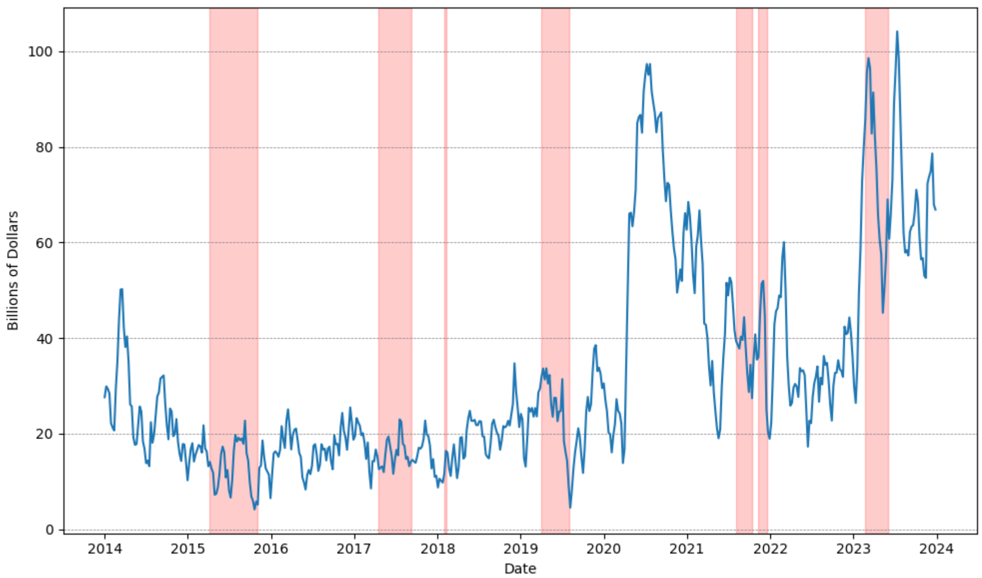
This table reports the four-week change in bill holdings expressed in billions of dollars. To calculate bill holdings, we first account for seasonality by demeaning bill holdings with the full sample average of bill holdings for that week of the year across our entire sample. We then calculate a four-week exponentially weighted moving average of bill holdings and then take the four-week first difference. We report the average across all episodes in the final row.

Episode Start Date	Δ Holdings (Billions)
April 01, 2015	2.0462
April 12, 2017	8.1993
January 24, 2018	1.7234
March 27, 2019	10.9586
July 28, 2021	-9.8849
November 03, 2021	1.199
February 22, 2023	26.4091
Average	5.8072

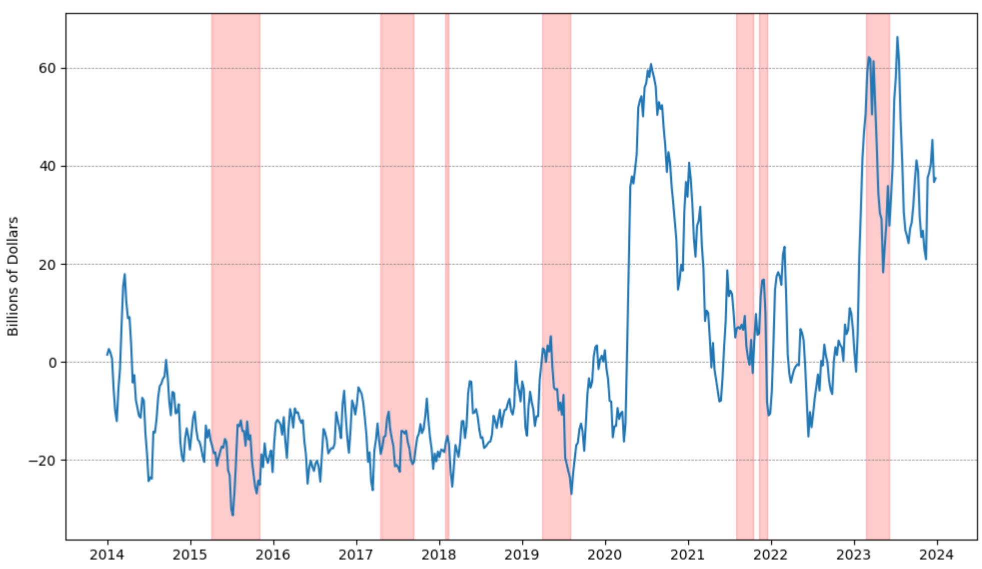
Figure A.4
Time Series of Dealer Bill Holdings

This figure displays the time series of dealer bill holdings. The right-hand side shows the raw series and the left-hand side a seasonally adjusted series. To calculate the seasonally adjusted series, we first regress dealer holdings on week-of-the-year dummies and then subtract the estimated coefficients to remove seasonality. After demeaning, we take a four-week exponentially weighted moving average. In light red, we shade the debt ceiling periods.

Four-Week Moving Average



Four-Week Moving Average (Seasonally Adjusted)



B.5 Miscellaneous

Figure A.5
2017 Episode and Effect on High-Yield Corporate Bonds

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

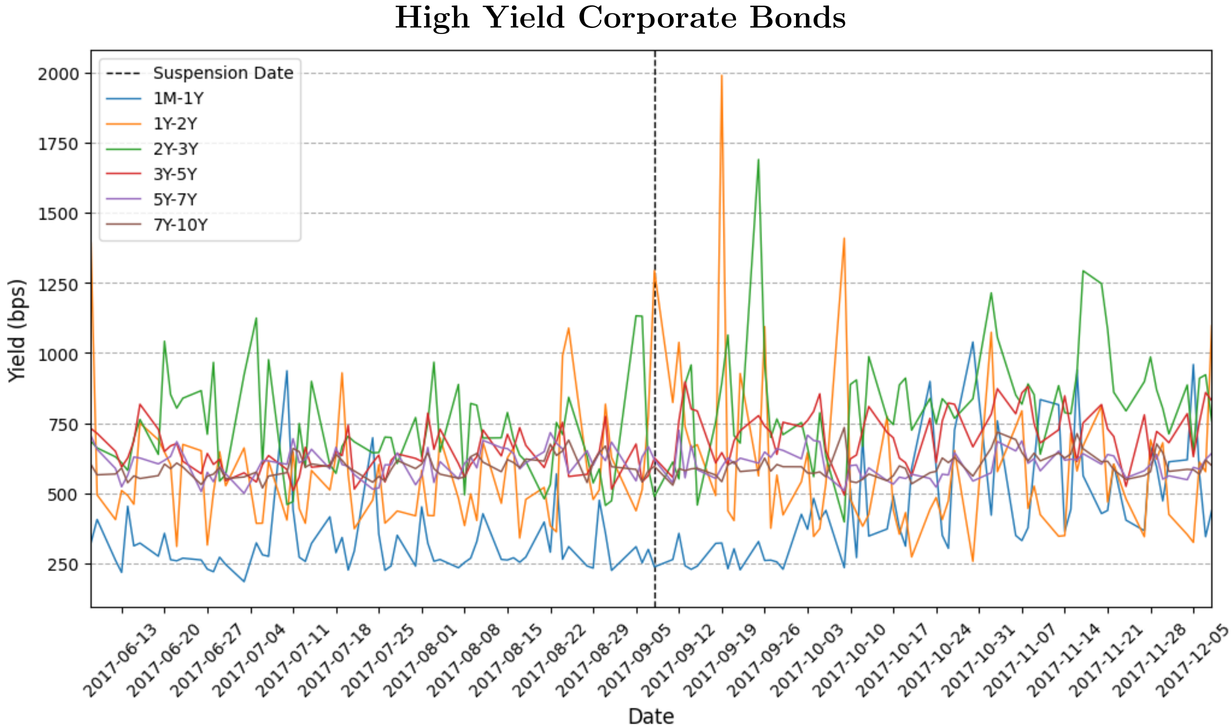


Figure A.6
Yield Curves Around the X-date

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

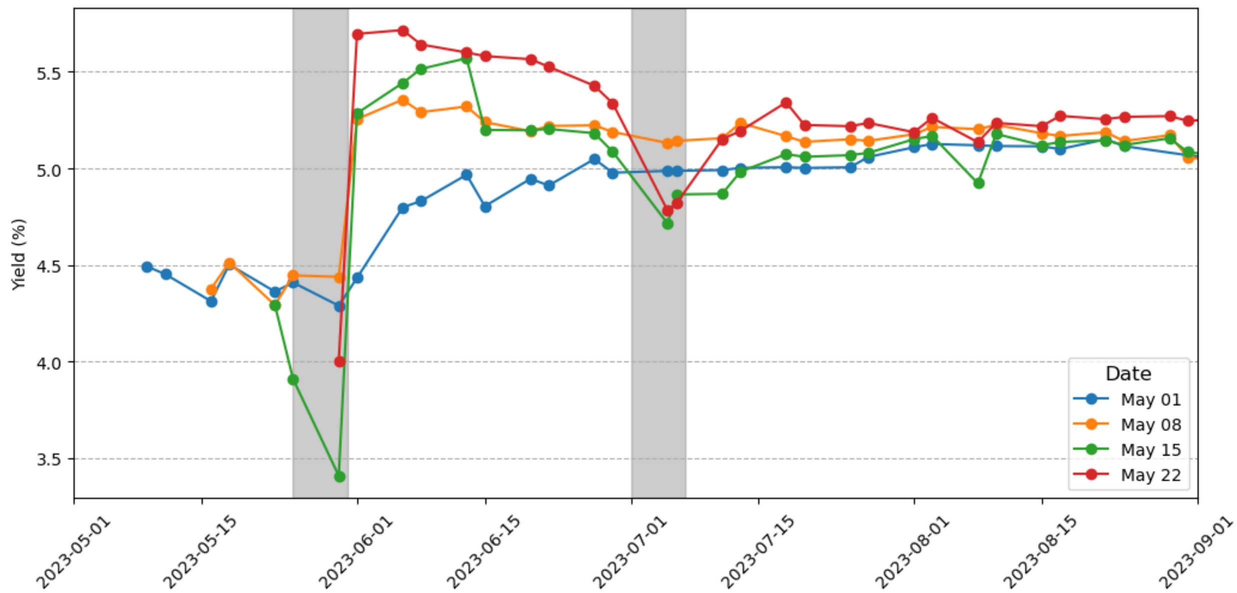


Table A.11
IV versus OLS Comparison

This table reports four OLS regressions of the average convenience yield for T-bills regressed on the bill-to-GDP ratio, estimated over four distinct periods. "Full Sample" corresponds to the full sample between 2015 and mid-2023, "Ex DC, Pre, Post" is the full sample, excepting periods in which the debt ceiling bound, the period before a suspension-end, and the period following a raise or suspension. "Only DC, Pre, Post" corresponds to only these periods. "Only DC" corresponds to only periods during which the debt ceiling bound. All specifications use year-month fixed effects and control for the VIX, effective federal funds rate and five-year U.S. Sovereign CDS spread.

Dependent Variable:	Convenience Premia (bps)			
Model:	(1)	(2)	(3)	(4)
Sample	Full Sample	Ex DC, Pre, Post	Only DC, Pre, Post	Only DC
Bill / GDP	-0.8807**	-0.3971	-1.946*	-3.386***
	(-2.398)	(-1.394)	(-1.951)	(-3.039)
Controls	Yes	Yes	Yes	Yes
Fixed Effects				
Year-Month	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	2,266	1,318	948	499
R^2	0.95870	0.93587	0.96723	0.97768
Within R^2	0.40764	0.10992	0.53313	0.68782

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

Table A.12
Convenience Premia Notes & Bonds On- versus Off-Run

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

	Convenience Premia (Basis Points)													
Maturity:	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20-30Y
Panel A: Combined Instrument														
	On-Run							Off-Run						
Bill / GDP	0.7248	1.200*	1.714***	1.211**	1.628**	1.456*	3.132***	0.0483	1.055	1.751***	1.758***	1.448**	1.259	2.154**
	(0.9921)	(1.712)	(3.091)	(1.991)	(2.290)	(1.823)	(2.624)	(0.0536)	(1.528)	(2.734)	(2.859)	(2.123)	(1.586)	(2.023)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects														
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics														
Observations	911	904	905	905	933	313	933	948	948	948	948	948	948	948
R^2	0.96542	0.95625	0.95894	0.94512	0.92739	0.82457	0.84773	0.96132	0.96147	0.95223	0.94113	0.93867	0.87261	0.85251
Within R^2	0.73289	0.75013	0.80492	0.76435	0.63677	0.73906	0.32527	0.71805	0.74898	0.78159	0.77029	0.69890	0.48527	0.31473
Panel B: Debt Ceiling Instrument (DCIV)														
	On-Run							Off-Run						
Bill / GDP	5.170***	5.372***	6.055***	5.994***	6.074***	-2.120**	8.503***	3.032***	5.275***	6.200***	6.644***	6.290***	4.705**	6.868**
	(4.631)	(3.918)	(4.995)	(4.376)	(3.581)	(-2.152)	(2.786)	(3.700)	(4.239)	(4.641)	(4.921)	(3.806)	(2.318)	(2.523)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects														
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics														
Observations	480	476	474	474	491	148	491	499	499	499	499	499	499	499
R^2	0.97265	0.95924	0.95076	0.92128	0.88106	0.75306	0.70844	0.97613	0.96642	0.94841	0.91586	0.89643	0.79327	0.73120
Within R^2	0.80468	0.79675	0.81565	0.76647	0.58341	0.69422	0.21651	0.83981	0.80150	0.80810	0.77605	0.67017	0.42434	0.25471

Table A.13
Post-Raise / Suspension Instrument – Alternative Specifications

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

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

Dependent Variables:	Bill Supply ($Billions)				Bill-to-GDP Ratio (%)			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Post-Raise/Suspension Instrument	-1.348***	-1.195***	-1.187***	-1.597***	-0.0048***	-0.0042***	-0.0041***	-0.0056***
	(-9.595)	(-6.597)	(-8.979)	(-11.28)	(-12.29)	(-7.849)	(-11.12)	(-15.13)
vixcls	-12.97***	-17.30***	-13.48**	-9.476**	-0.0424**	-0.0574**	-0.0440**	-0.0301**
	(-2.630)	(-2.703)	(-2.433)	(-2.299)	(-2.454)	(-2.514)	(-2.229)	(-2.163)
cds_spread	-0.3352	0.0399	0.0453	0.8452	-0.0060	-0.0046	-0.0045	-0.0018
	(-0.1705)	(0.0177)	(0.0244)	(0.4694)	(-1.038)	(-0.6732)	(-0.8086)	(-0.3435)
fed_funds	615.0***	712.8***	721.1***	645.6***	1.788***	2.150***	2.184***	1.898***
	(4.659)	(4.107)	(5.205)	(5.843)	(4.348)	(3.834)	(4.994)	(5.708)
Instrument Version	V1	V2	V3	V4	V1	V2	V3	V4
Fixed-Effects								
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics								
Observations	214	214	214	214	214	214	214	214
R^2	0.99469	0.99350	0.99497	0.99518	0.99161	0.98955	0.99145	0.99225
Within R^2	0.83340	0.79617	0.84238	0.84870	0.80474	0.75688	0.80117	0.81968

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

Table A.14
Number of AA Non-Financial Commercial Paper Issuances

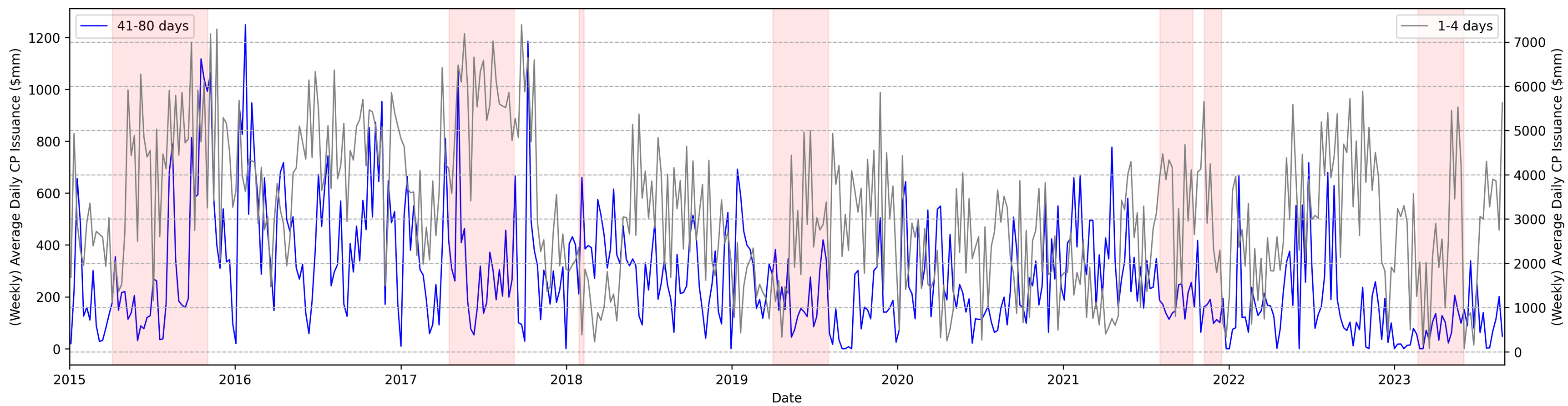
This table displays estimates of the total number of daily AA non-financial commercial issues. We instrument the Bill-to-GDP ratio using DCIV. We also include controls for the level of the VIX, five-year U.S. Sovereign CDS spread and the effective federal funds rate. We use Driscoll-Kraay standard errors for Panel regressions and Newey-West standard errors, both with one-week lags.

Dependent Variable:	Quantity AA Non-Fin. Issuance (Number)						
Maturity:	1-4 Days	5-9 Days	10-20 Days	21-40 Days	41-80 Days	$\geq$ 80 Days	Panel
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Bill-to-GDP Ratio	-17.62	-5.855	-4.744**	-1.546	-11.74***	-1.695	-7.200***
	(-1.199)	(-1.567)	(-2.362)	(-0.5925)	(-3.148)	(-0.9925)	(-2.760)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-Effects							
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics							
Observations	498	498	498	498	498	498	2,988
R^2	0.26901	0.27721	0.16736	0.25267	0.09362	0.24605	0.05682
Within R^2	0.05871	0.00341	-0.01740	0.01366	-0.01768	0.07728	0.00596

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

Figure A.7
Commercial Paper Issuance

This figure displays the weekly average of daily AA non-financial commercial paper issuance, expressed in millions of dollars. Two series are shown. In blue, we plot total issuance for commercial paper with time to maturity of between forty-one and eighty days; the magnitudes for this series correspond to the left-hand side y-axis. In gray, we plot issuance of commercial paper with time to maturity of between one and four days; quantities correspond to those indicated on the right-hand side y-axis. Periods during which we judge the debt ceiling to have bound are shaded in light red.



C Robustness Checks

C.1 Alternative Clustering

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

Table A.15

Convenience Premium Regressions – Combined Instrument with Alternative Newey-West Lags

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

Maturity:	All TBill	1M-3M	3M-6M	6M-12M	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	10Y-20Y	20Y-30Y
Bill / GDP	-5.265**	-5.649**	-5.207*	-4.503**	0.0619	1.058	1.752***	1.746***	1.461**	1.284	2.177**
	(-2.072)	(-2.217)	(-1.877)	(-2.211)	(0.0691)	(1.533)	(2.743)	(2.842)	(2.141)	(1.616)	(2.038)
NW Lag						L=5					
Bill / GDP	-5.265*	-5.649*	-5.207	-4.503*	0.0619	1.058	1.752**	1.746**	1.461*	1.284	2.177
	(-1.693)	(-1.819)	(-1.531)	(-1.802)	(0.0564)	(1.220)	(2.153)	(2.230)	(1.680)	(1.291)	(1.631)
NW Lag						L=10					
Bill / GDP	-5.265	-5.649*	-5.207	-4.503*	0.0619	1.058	1.752*	1.746*	1.461	1.284	2.177
	(-1.555)	(-1.676)	(-1.402)	(-1.655)	(0.0512)	(1.028)	(1.758)	(1.797)	(1.361)	(1.082)	(1.382)
NW Lag						L=20					
Bill / GDP	-5.265*	-5.649*	-5.207	-4.503*	0.0619	1.058	1.752	1.746	1.461	1.284	2.177
	(-1.689)	(-1.820)	(-1.522)	(-1.774)	(0.0531)	(0.9143)	(1.516)	(1.535)	(1.183)	(0.9811)	(1.283)
NW Lag						L=40					
Bill / GDP	-5.265**	-5.649***	-5.207*	-4.503*	0.0619	1.058	1.752**	1.746**	1.461*	1.284	2.177
	(-2.227)	(-3.467)	(-1.877)	(-1.688)	(0.0564)	(1.440)	(2.571)	(2.524)	(1.680)	(1.224)	(1.631)
NW Lag	L=4	L=1	L=5	L=14	L=10	L=6		L=7	L=10	L=12	L=10
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Episode FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	948	948	948	948	948	948	948	948	948	948	948
R^2	0.90703	0.89526	0.89214	0.94093	0.96145	0.96143	0.95242	0.94126	0.93833	0.87439	0.85200
Within R^2	0.67545	0.62564	0.68587	0.69958	0.71877	0.74934	0.78238	0.77044	0.69666	0.48517	0.31515

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

Table A.16
Convenience Premium Regressions – DCIV with Alternative Newey-West Lags

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

Maturity:	All TBill	1M-3M	3M-6M	6M-12M	1Y-2Y	2Y-3Y	3Y-5Y	5Y-7Y	7Y-10Y	10Y-20Y	20Y-30Y
Bill / GDP	-7.888***	-9.520***	-8.185***	-3.677**	3.068***	5.282***	6.199***	6.628***	6.275***	4.697**	6.911**
	(-3.386)	(-3.740)	(-3.236)	(-2.114)	(3.739)	(4.235)	(4.648)	(4.911)	(3.796)	(2.310)	(2.530)
NW Lag						L=5					
Bill / GDP	-7.888***	-9.520***	-8.185***	-3.677*	3.068***	5.282***	6.199***	6.628***	6.275***	4.697*	6.911**
	(-2.839)	(-3.134)	(-2.713)	(-1.762)	(3.158)	(3.422)	(3.714)	(3.909)	(3.021)	(1.876)	(2.093)
NW Lag						L=10					
Bill / GDP	-7.888**	-9.520***	-8.185**	-3.677	3.068***	5.282***	6.199***	6.628***	6.275**	4.697	6.911*
	(-2.443)	(-2.715)	(-2.340)	(-1.499)	(2.854)	(2.918)	(3.080)	(3.213)	(2.489)	(1.598)	(1.848)
NW Lag						L=20					
Bill / GDP	-7.888**	-9.520**	-8.185**	-3.677	3.068***	5.282***	6.199***	6.628***	6.275**	4.697	6.911*
	(-2.237)	(-2.497)	(-2.135)	(-1.371)	(2.899)	(2.601)	(2.634)	(2.728)	(2.139)	(1.449)	(1.740)
NW Lag						L=40					
Bill / GDP	-7.888***	-9.520***	-8.185***	-3.677**	3.068***	5.282***	6.199***	6.628***	6.275***	4.697**	6.911***
	(-2.999)	(-3.309)	(-2.865)	(-2.013)	(3.562)	(4.235)	(9.925)	(5.295)	(4.491)	(2.478)	(2.704)
NW Lag		L=8		L=6		L=5	L=0	L=4	L=3	L=4	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Episode FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	499	499	499	499	499	499	499	499	499	499	499
R^2	0.95654	0.94049	0.95362	0.97563	0.97612	0.96634	0.94853	0.91599	0.89586	0.79684	0.72996
Within R^2	0.85740	0.79839	0.87383	0.88484	0.83967	0.80167	0.80857	0.77607	0.66636	0.42307	0.25390

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

Table A.17
Convenience Premia Regressions ex. Treasuries Expiring Near X-Date

This table reports regressions of convenience premia on the instrumented bill-to-GDP ratio. Unlike our baseline specifications, we drop all Treasuries maturing within one month of the X-date. All specifications include episode fixed effects and controls for the level of the VIX, effective federal funds rate and five-year U.S. Sovereign CDS spread.

	Convenience Premia (Basis Points)										
Maturity	All TBill	1-3M	3-6M	6-12M	1-2Y	2-3Y	3-5Y	5-7Y	7-10Y	10-20Y	20Y-30Y
	Panel A: Combined Instrument										
Bill / GDP	-4.953*	-4.781*	-5.396*	-4.521**	0.0619	1.058	1.752***	1.746***	1.461**	1.284	2.177**
	(-1.910)	(-1.814)	(-1.945)	(-2.220)	(0.0691)	(1.533)	(2.743)	(2.842)	(2.141)	(1.616)	(2.038)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects											
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics											
Observations	948	931	948	948	948	948	948	948	948	948	948
R^2	0.90904	0.88601	0.89024	0.94087	0.96145	0.96143	0.95242	0.94126	0.93833	0.87439	0.85200
Within R^2	0.69455	0.60114	0.68518	0.69924	0.71877	0.74934	0.78238	0.77044	0.69666	0.48517	0.31515
	Panel B: Debt Ceiling Instrument										
Bill / GDP	-7.014***	-7.440***	-8.525***	-3.723**	3.068***	5.282***	6.199***	6.628***	6.275***	4.697**	6.911**
	(-3.077)	(-2.973)	(-3.394)	(-2.124)	(3.739)	(4.235)	(4.648)	(4.911)	(3.796)	(2.310)	(2.530)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects											
Episode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics											
Observations	499	482	499	499	499	499	499	499	499	499	499
R^2	0.96410	0.93613	0.95198	0.97553	0.97612	0.96634	0.94853	0.91599	0.89586	0.79684	0.72996
Within R^2	0.88595	0.78774	0.87101	0.88433	0.83967	0.80167	0.80857	0.77607	0.66636	0.42307	0.25390

Table A.18
Alternative Measures of Convenience Premia

This table shows results using the spread between the 90-day AA non-financial commercial paper rate and the 3-month T-bill rate as a measure of convenience premia. In columns (1) and (3), we control for the effective federal funds rate, VIX, and 5-year U.S. sovereign CDS spread. In columns (2) and (4), we additionally control for the 6-month U.S. sovereign CDS spread.

Dependent Variable:	CP-Tbill Spread (bps)			
Model:	(1)	(2)	(3)	(4)
Instrument:	Combined Baseline	Combined + 6M CDS	DCIV Baseline	DCIV + 6M CDS
Bill / GDP	-0.0814	-0.8266	-2.623**	-4.918***
	(-0.1019)	(-0.8753)	(-2.513)	(-3.074)
Fixed Effects				
Episode	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	642	642	373	373
R^2	0.72399	0.73787	0.62843	0.66688
Within R^2	0.15809	0.20040	0.17235	0.25799

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