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

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Abstract

We uncover the significant impact of the debt ceiling on financial markets, caused by the combination of two forces. We show that the debt ceiling induces fluctuations in T-bill supply through the interaction of the treasury's policy rule for bond and note issuance and the debt ceiling constraint. Exploiting this, we devise an instrument for the supply of bills, showing that a $100 billion decrease in bill supply causes an 8.61 basis point decline in yields for short-term investment-grade corporate bonds. Additionally, the debt ceiling separately triggers a shift in the portfolio composition of money market mutual funds. These funds reduce their exposure to treasuries vulnerable to delayed payment and increase their holdings of repurchase agreements collateralized by treasuries. Investigating borrower-by-lender data reveals a 1.5 basis point decrease in the repo rate for bilateral transactions where the lender is a government fund, with no such decrease observed for prime funds.

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1 Introduction

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

We show that the debt ceiling does have large impacts on the pricing of a variety of financial assets outside of CDS and treasury markets and instead affects money and bond markets, broadly. Further, we show that these effects are long-lived and can be traced to the months before and after the debt ceiling is raised or breached.[1]

We emphasize two distinct channels through which the debt ceiling is affects asset prices. The first is the *bill supply channel*. We show that the debt ceiling causes bill supply to decline in the months prior to the X-date through an unintended consequence of treasury policy. The debt ceiling is a constraint on the sum of the face values of all outstanding treasury debt. Once the debt limit is reached, the treasury cannot issue additional debt without redeeming or running off existing debt of equal value (USC 31 Section 3101).

Separate from the debt ceiling, the treasury pursues a policy of "regular and predictable" bond and note issuance. The content of this policy is that four times a year the treasury schedules its bond and note issuance for the following quarter. Importantly, the treasury very rarely deviates from these announcements. In addition, the treasury keeps scheduled note and bond issuance extremely stable from month-to-month and quarter-to-quarter (Garbade (2007)).

We show that the debt ceiling constraint and regular and predictable long-term debt issuance interact to generate a negative bill supply shock. Once the debt ceiling constraint binds, if the treasury designs to keep bond and note issuance stable, it *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 bill offering amounts at treasury auctions. Intuitively, our instrument takes the value that

[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 treasury is forced to run off in bills to keep the debt ceiling inviolate, given scheduled bond and note issuance. We use this as an instrument for the change in bill supply during the period for which the debt ceiling was binding. We show that the R-squared from the first stage of our IV specification is nearly 98%, reflecting that our instrument captures a nearly mechanical relationship between long-term debt issuance and bill supply when the debt ceiling binds.

We use our instrument to characterize the effect of a change in bill supply on the yields of short-term, investment grade corporate bonds. Our IV results imply that the yields of short-term investment grade corporate bonds decline by 8 basis points, for a one hundred billion dollar decline in bill supply.

In addition, we show that for a subset of debt ceiling episodes there has been a second negative bill supply shock. 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, the Congress has mandated that the treasury's cash balance be no larger when the suspension expires than when the suspension was implemented. This is motivated by a desire to prevent the treasury from issuing a larger amount of debt than necessary during the suspension period and indefinitely delaying when the debt limit must be again raised or suspended (H.R. 601).

For much the same logic as DCIV, we show that this rule also systematically generates a negative bill supply shock. To fulfill its legal obligations while keeping bond and note issuance stable, the treasury systematically cuts bill offerings over the quarter prior to the end of a debt ceiling suspension.

To close this part of our analysis, we show that the dynamics we describe have become more pronounced since 2015, when the treasury greatly increased its cash balance at the Treasury General Account (TGA). This change was motivated by the treasury's fear that it was vulnerable to losing access to capital markets due to natural disasters or cyberattacks (Carpenter (2015)). Ironically, it has greatly lengthened the period during which the treasury is able to operate at the debt ceiling constraint and systematically lengthen the duration of its liabilities.

Finally, we show that the debt ceiling has systematically affected short-term investment grade corporate bond markets in every debt ceiling episode since 2011. In an ironic twist, the treasury first adopted its policy of regular and predictable issuance, in part, due to concerns that treasury auctions were disrupting corporate bond markets (Garbade (2007)). We show that in an era of debt ceiling brinkmanship, regular and predictable issuance is now itself having large and, arguably, undesirable effects on corporate bond markets again.

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

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

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

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

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

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

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

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

2 Literature Review

There are few extant papers that have studied the impact of the debt ceiling. The three papers closest to our study are Gallagher and Collins (2016), Zivney and Marcus (1989), Allen et al. (2023) and Benzoni et al. (2023). Gallagher and Collins (2016) studies the impact of the debt ceiling on flows into money market funds. They also argue that there were fluctuations in repo rates around the 2011 debt ceiling due to a decline in collateral quality. These authors, however, does not study the equilibrium effect of changes in the portfolio composition of MMFs on asset prices of fluctuations in bill supply.

In contemporaneous work, Stein and Wallen (2023) studies the impact of the debt ceiling on money market funds and the spread between T-bill rates and rates available at the reverse repo facility. Our analysis differs from Stein and Wallen (2023) primarily by studying the bond market and emphasizing that the interaction of the debt ceiling and the treasury's policy of regular and predictable issuance has induced fluctuations in bill supply and affected the pricing of corporate bonds.

Allen et al. (2023) studies the impact of government shutdowns on money market mutual funds and finds small effects. Benzoni et al. (2023) studies the impact of the 2023 debt ceiling crisis on credit default swaps. Finally, Zivney and Marcus (1989) studies the impact of the brief technical default on U.S. treasuries occurring in 1979, when a computer error delayed payments to bond holders.

Our paper is also related to a large literature of papers studying the impact of political uncertainty on financial markets. Pástor and Veronesi (2012) and Pástor and Veronesi (2013) study theoretically the impact of political uncertainty on stock prices. These papers have spurred an enormous body of follow up work, too large to list here. Closest in methodology to our paper are Kelly et al. (2016) and He et al. (2024). Both of these papers exploit the staggered of maturity of financial assets to cleanly identify the pricing effects of political uncertainty. Kelly et al. (2016) does this within the context of the options market and He et al. (2024) in the real estate market.

In addition, our work relates to work on the asset demand of financial intermediaries and the equilibrium effects on asset prices. He and Krishnamurthy (2013) was an early paper in the literature investigating the impact of intermediary constraints on asset prices. Another notable paper, Koijen and Yogo (2019) has generated much subsequent work in demand system estimation. Vayanos and Vila (2021) is an important theoretical paper analyzing the impact of the asset demand of preferred habit investors on bond prices.

Finally, our work is also related to studies of the impact of the supply of treasuries on the pricing of financial assets. Krishnamurthy and Vissing-Jorgensen (2012) provides descriptive evidence that the the supply of treasury debt affects both the pricing of sovereign and corporate debt. Greenwood et al. (2010) and Greenwood et al. (2015) also study the impact of bill supply on the pricing of corporate debt. Our study is particularly close to Greenwood et al. (2015) in that they construct an instrument for bill supply based on fluctuations in the cash needs of the treasury before tax filing deadlines.

Two additional papers close in spirit to this paper are d'Avernas and Vendeweyer (2024) and Selgrad (2023). d'Avernas and Vendeweyer (2024) studies how the supply of treasury asset can affect the pricing of close substitutes, while Selgrad (2023) studies how changes in the supply of treasuries through quantitative easing can affect the pricing of corporate bonds through a portfolio substitution channel. Our work is also related to papers investigating the market structure of the market for repurchase agreements, notably Huber (2023) and Eisenschmidt et al. (2024).

3 Data

In our analysis, we make use of four distinct datasets. These datasets record treasury and bond prices, auction data from the treasury and holdings data of money market mutual funds themselves. We describe them each in detail in the sections below.

3.1 Holdings

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

When MMFs submit these filings, they provide detailed information both about the overall state of their business and their portfolios. The topline information includes both the overall size of the assets under management and the fund's cash position. In Table 1 we provide summary statistics for fund holdings as of January 2023.

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

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

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

3.2 Bond Data

To study the effects on bond markets, we use data from the WRDS TRACE Standard, and Mergent/ FISD datasets. We obtain transaction-level data on corporate and agency bonds, from the trace and trace agency libraries respectively, for the period January 1, 2023, to December 31, 2023. We drop duplicate transactions – determined by transactions that have the same cusip, trade execution date, reported price and volume. We consider only those transactions where the TRACE-reported sub-product type is CORP or AGCY, and ignore equity linked notes (ELN), and Church Bonds (CHRC). We then combine these with the data on maturity date, and rating, from Mergent/FISD, merging on cusip, and using the latest credit rating issued prior to the trade execution date. We drop transactions for which reported yield, or maturity is not available. We also drop transactions for weekends and trade holidays.[2]

We winsorize TRACE-reported yields at the first and ninety-ninth percentile. Since we are also interested in examining the movement in the spread of the reported yield over the implied effective fund rate, we calculate the implied EFFR yield to maturity for every cusip, using the daily prices of Fed Fund Futures from Bloomberg. We split the corporate bond dataset into different subsamples based on credit ratings. Highly rated corporate bonds are those rated AA- (Aa3 on the Moody's scale) or higher. A-rated include those rated A- (A3 on the Moody's scale) or higher. For Agency debt, we include all ratings, which for our sample period comprises AA+, Aaa and Not Rated. The summary statistics are reported in Table 2. In May, prior to the deadline, the compression of spreads of highly rated corporate bonds relative to agency is most apparent.

In our difference-in-differences regression specifications, we restrict our analysis to a narrower window around June 1, considering trade dates between May 1, 2023, and June 30, 2023, with maturities between July 1, 2023 and January 1, 2024. We also examine the results on expanding the trade window to April 1, 2023 – July 31, 2023. Since there may be multiple transactions for a cusip on a particular transaction date, for each cusip, we aggregate intraday transactions on a trade date to the median yield for all transactions on that date.

3.3 Treasury Data

We combine our data on holdings with data from the treasury. First, we use daily data from treasury direct to construct the yield curve. For this exercise, we use data on the yields of bills.

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

Finally, we pull some additional ancillary data from the treasury. This includes data about the treasury's receipts and outlays. We use this data to investigate the timing and nature of flows into and out of the treasury's cash account at the Fed. The precise timing of these flows is important for justifying our claims that specific treasury maturities are more

[2] There is no set holiday calendar for the OTC bond market. We rely on the NYSE stock market calendar, retaining transactions on Good Friday. While the OTC market would not be closed, there are few transactions on the holidays excluded.

or less exposed to the risk of delayed payment.

For parts of our analysis, we also use the CRSP U.S. treasury database. This dataset is widely used and contains information about outstanding U.S. Treasuries. We use this dataset to study the evolution of the bill supply of various maturities.

3.4 Commercial Paper

We collect data on the 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 collect data on the total number and value of issuances from January 1, 2010 until end February 2024. While the FRB also provides rate indices for commercial paper, there are substantial gaps in the data. The FRB rates data is restricted to commercial paper of maturities up to 90 days, and is not available for many trade dates, where, to quote the website, "trade data was insufficient to support calculation of the particular rate". For instance, data from FRB rates indices for the 60-day AA non-financial commercial paper segment is available for only 98 days for the full calendar year 2023. Such gaps render FRB rates indices unsuitable for our empirical analysis of commercial paper yields. Therefore, we look to another source, viz. Bloomberg indices for commercial paper yields, These indices, ranging from DCPB001Y for 1 day commercial paper, to DCPB270Y for 270 days, are composites of offered levels for dealer-placed commercial paper programs rated A1/P1/F1 for the respective maturities issued by US firms, and do not include asset-backed commercial paper.

3.5 Rates and Futures

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

4 Empirical Analysis

Our empirical analysis proceeds in five steps. First, we provide the institutional details of the debt ceiling and relate this narratively to changes in the yield curve around the X-date.

In the subsequent section, we corroborate these narrative results using holdings data of money market mutual funds and show that the evolution of MMF holdings is not contained to our existing narrative evidence. Using holdings data, we then turn to the asset pricing implications of this compositional shift in holdings, where we show that there are large changes in the terms of repurchase agreements, comparing within the same borrower-issuer pair. Finally, we turn to the dynamics of bill supply around the debt ceiling and the pricing of corporate bonds.

4.1 Evidence from the Yield Curve

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

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

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

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

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

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

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

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

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

The first part of our analysis turns to the evolution of the yield curve around these dates. Figure 1 plots the short end of the yield curve over May 2023. The first line is the blue line, indicating the yield curve the day before Secretary Yellen's letter. Yields in June and later are elevated relative to May, but the difference between June and later months is insubstantial. In contrast, for all yield curves corresponding to weeks after May 1, we document a substantial increase in the yields for all securities maturing in June specifically.[3]

This increase in yields is not surprising. However, what is more surprising is the pronounced *decline* in yields for securities maturing in the first week of July and the last week of May. This figure suggests to the authors that certain kinds of financial institutions strongly desire to hold extremely short-dated maturities of treasury bills. However, these same funds do not want to hold June bills specifically, perhaps due to the potential risks of delayed

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

payment that would occur in the event of technical default.

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

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

4.2 Evidence from MMF Holdings

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

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

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

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

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

$$\begin{aligned}\text{Dollar Value}_{imt} = &\sum_{t'} \beta_{t'} \left(\mathbb{I}\left\{\text{Report Date May}\right\}_t \times \mathbb{I}\left\{\text{Maturity Week}\right\}_{t'}\right) \\ &+ \gamma \text{Total Portfolio Value}_{mt} + \eta \text{Weeks to Maturity}_{it} + \nu_{im}\end{aligned} \tag{4.1}$$

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

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

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

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

We corroborate this analysis in Table 16. In this table, we estimate the regression:

$$\text{Portfolio Share X Months Ahead}_{it} = \sum_t \beta_t \mathbb{I}\left\{\text{Month}\right\}_t + \gamma' \text{Controls}_{it} + \nu_i \tag{4.2}$$

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

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

4.3 Impact on Market for Repurchase Agreements

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

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

$$\text{Portfolio Share Category}_{it} = \sum_t \beta_t \mathbb{I}\left\{\text{Month}\right\}_t + \nu_i \tag{4.3}$$

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

The results in Table 4 are consistent with the visual evidence presented in Figure 5.

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

We do not see a strong pattern of substitution for "other instrument." In Figure 18 in the appendix, we show that there is visual evidence that MMFs increased the dollar amount of their holdings in "other instrument" in May, specifically. However, this pattern is not driven by corporate bonds, and instead by forward settling repurchase agreements.

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

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

$$\text{spread}_{ijt} = \sum_t \left(\beta_t \text{Month} + \gamma_t \text{Month} \times \mathbb{I}\left\{\text{Prime Fund}\right\}\right) + \nu_{ij} \tag{4.4}$$

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

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

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

Once the debt ceiling was raised, there was a substantial increase in bill supply. The treasury issued a substantial amount of additional bills, apparently to raise the cash balance in the TGA to approximately $800 billion. The dynamics of the cash balance can be seen in Figure 15 in the appendix. After the debt ceiling was raised, the dynamics are reversed. MMFs absorb large amounts of new issuance, which crowds out the portfolio share dedicated to repurchase agreements. These dynamics can be seen in Figure 5. This then took the form of a negative lending supply shock in the repo market. The rate to borrow in the repo market increased uniformly for both prime and government MMFs. It is interesting to note that when there was downward pressure on the repo rate, prime MMFs appear not to have lowered the repo rate to the same extent as other funds. However, when there is upward pressure on the repo rate they raise the repo rate symmetrically.

4.4 Futures Market

As a final note, these dynamics of negative and then positive bill supply shocks affecting the repo rate appear to have been anticipated by investors in the futures market. This can be seen visually in Figure 11. In the top-right panel, we plot the forward curve constructed from both fed funds futures and SOFR futures. Notice that from January to September, the forward rate implied by SOFR futures is less than the forward rate implied by fed funds futures. In September, the relationship flips and the futures-implied SOFR rate becomes greater than that of the implied federal funds rate.[4]

In the second panel, we reconstruct the SOFR and Fed Funds forward curve five months later, on May 8. The month at which the SOFR and Fed Funds switch their ordinal ranking is now one month earlier (this can also be seen in the third panel, which plots the difference).

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

These patterns are consistent with futures investors recognizing that before the X-date, the repo rate would be depressed and that after the X-date the repo rate would rise relative to the federal funds rate. In fact, the realized difference between SOFR and the effective funds rate did reflect these dynamics. In the early part of the year the difference is negative and then positive, on average, by the last quarter.

4.5 Effects on the Pricing of Agency and Corporate Debt

In Figure 5, we observe a pronounced increase in the share of agency debt in MMF portfolios during April and May 2023 and a subsequent decline in the following months. In Figure 18 we show a similar, although much smaller in magnitude, pattern for the corporate bond holdings of MMFs. These patterns motivate us to investigate whether the pricing of corporate bonds and agency debt evolved in a way similar to repo rates.

To study this, we start by plotting the evolution investment grade corporate debt rated AA and above and agency debt yields over time in Figure 7. In this figure, we plot the spread over the effective federal funds rate for both kinds of bonds. For bonds that expire in month t', we calculate the implied federal funds rate from t to t' by using the forward rates taken from federal fund futures. There is an extremely striking visual pattern. The spread between agency and corporate debt significantly narrows over the course of April. The spread between agency and corporate debt is essentially zero over the course of May. Once the debt ceiling is lifted in June, the spread between agency debt and corporate debt rapidly increases to levels consistent with early April. We find the extremely rapid increase after the debt ceiling is raised compelling evidence that the debt ceiling itself is causing this pattern.

We formalize this analysis in Table 18, where we estimate regressions of the form:

$$\text{Yield}_{it} = \beta \mathbb{I}\left\{\text{Post}\right\}_t \times \mathbb{I}\left\{\text{Treated}\right\}_i + \nu_t + \eta_i \tag{4.5}$$

In these regressions the treated group are IG corporate bonds and the control is agency debt. The outcome variable, yield, is expressed in basis points. In all regressions we include date fixed effects (ν_t) and bond fixed effects (η_i). Consistent with the visual pattern from Figure 7 each coefficient β from regressions comparing corporate bonds and agency debt is large and positive. These regressions imply that in the post-period highly rated investment grade corporate debt had yields approximately thirty points higher than agency debt, relative to the pre-period. These magnitudes are highly consistent with the visual evidence from Figure 7. These effects are, in fact, slightly smaller than what we observe for AA and above IG corporate debt alone, likely due to the most highly rated corporate debt being more highly substitutable with T-Bills.

To confirm that we are not detecting a spurious statistical correlation, we estimate the same difference-in-differences regression for every debt ceiling episode prior to 2023, starting in 2011. We find extraordinarily consistent results. In every single case, there is a significant increase in the difference between the yields of agency and corporate debt after the debt ceiling is either raised or suspended. Our results are a robust and long-standing feature of corporate bond markets and not statistical noise.

In the appendix, we estimate a bevy of additional regressions with different samples and groups for treated and control. We find that our results are robust to alternative specifications. Further, we find that post-2015 there are no statistically significant differences for the effects on AA and above IG corporate debt versus all other IG corporate debt. This is evidence that our effects cannot be driven by MMFs alone, as MMFs only hold extremely highly rated IG corporate debt. This motivates us to investigate the role of bill supply.

4.6 Bill Supply

In the final part of our analysis, we investigate the impact of the debt ceiling on bill supply. The debt ceiling is a constraint on the sum of the face values of all outstanding treasury debt. Once the debt ceiling binds, all else equal, every dollar of newly issued treasury debt must be matched by another dollar redeemed or run-off.

By itself, the debt ceiling constraint only limits bill supply from increasing, and does not result in increases or decreases in the total amount of bills outstanding. However, the debt ceiling interacts with the treasury's long-standing policy called "regular and predictable" issuance (Garbade (2007)).

The treasury issues a mix of long- and short-duration debt. Unlike the issuance of bills, the treasury announces its anticipated schedule of offering amounts of notes and bonds at a quarterly frequency in "quarterly refunding statements." The anticipated offering amounts of bonds and notes of various maturities can be seen in Table 6. Importantly, the treasury rarely deviates from the total amounts it announces in these quarterly funding statements.

There is a second important quality of the quarterly refunding statements. They are extremely stable over time. From month to month the variation in the announced offerings is minimal and, frequently, unchanged. In contrast, bill issuance from month to month is highly variable. This makes sense from the perspective of the treasury, if the treasury's objective is to issue large quantities of debt. The treasury knows that its ability to issue large amounts of long-duration debt without price impact is much less than its ability to issue short-duration debt. When approaching the debt ceiling, an optimal course is to continue to issue long-term debt while allowing short-term bills to run off. Once the debt ceiling is raised, the treasury can ramp up its short-term bond issuance quickly, without moving prices against itself.

We exploit this intuition to construct an instrument for bill supply. Our instrument is the value that bill supply would have decreased mechanically when the debt ceiling binds, given the scheduled bond and note offering amounts. We encode this variable (DCIV) using the following expression:

$$\text{DCIV}_t = \sum_{t_0 \leq t' \leq t} \left(\frac{\text{Net Schd. LT Issuance Month}\,(t')}{\text{Number Bill Auctions Month}\,(t')} \times \mathbb{I}\left\{\text{Bill Auction Day}\right\}_{t'} \right) \tag{4.6}$$

The first term in the summation divides the net bond and note issuance in a month by the total number of bill auctions in that month. If the treasury spread the total amount that it has to draw down over each bill auction equally over each auction, this would be the mechanical value that it would be draw down. The second term is an indicator for whether a bill auction has occurred on date t'. The DCIV instrument cumulates the amount that the treasury would be expected to drawn down with the number of bill auctions that have occurred up to time t.

The variation that we exploit in the construction of our instrument can be seen in the top panel of Figure 9. This figure compares the offering amounts for bills in the indicated week versus the offering amounts at prior auctions. We construct this by subtracting the two quantities. For example, if all bills were one-week bills, we would subtract the offering amounts at auctions this week from the sum of all offering amounts in the prior week. A positive value indicates that the offering amount is greater than prior auctions and a negative value less.

In all panels, we highlight periods in which "extraordinary measures" were imposed. As can be seen in the first panel, soon after the imposition of extraordinary measures the treasury begins offering fewer bills than it did at previous auctions. This is a period of negative net bill issuance. As can be seen, negative net bill issuance in 2023 begins with a lag from the declaration of "extraordinary measures." This is due to the imposition of extraordinary measures immediately freeing up additional borrowing authority for the treasury, which they promptly used to issue additional bills[5] (Yellen (2023b)). Once the treasury has exhausted the new borrowing authority that the imposition of extraordinary measures generates, they

[5] This additional borrowing authority is generated by redeeming existing and or suspending new investments in the Civil Service Retirement and Disability Fund (CSRDF), Postal Service Retiree Health Benefits Fund (Postal Fund) and Government Securities Investment Fund (G Fund). See Yellen (2023b) for additional details.

begin to cut the offering amounts at bill auctions.

This pattern of lagged, but consistent negative net issuance after the imposition of extraordinary measures is extremely robust and can be seen in every episode after 2015.

The effect of this period of negative net issuance can be seen in Figure 10. In this figure, we display the change in bill supply around the X-date for the six debt ceiling episodes in which the treasury invoked extraordinary measures that have occurred since 2015.[6] For our primary empirical tests, we investigate the 2023 debt ceiling. As can be seen in the shaded region, there is a pronounced decline in the supply of T-bills during this period. The magnitude of the decline is largest for the shortest maturity T-bills with maturity of seventeen weeks or less. Since these ultra-short maturity T-bills constitute a small share of all outstanding T-bills, the relative decline, expressed in percent, is even larger.

This pattern of declines in bill supply around the X-date appears not only in 2023, but almost every instance since 2015. The one exception to this is 2017, during which the debt ceiling was suspended between August and December 2017 and then eventually raised in early 2018. We explain the special circumstances of this event and why it provides a particularly clean test of our mechanism in later sections.

There is an additional complication. Once the debt ceiling constraint binds, the treasury is prevented from issuing additional debt on a net basis. This means that the length of time that the treasury can operate at the debt ceiling constraint crucially depends on the cash balance in the Treasury General Account (TGA) at the Federal Reserve Bank of New York. If the cash balances are low, the treasury can operate for only a short period at the debt ceiling constraint. If the cash balances are high, the treasury has room to operate for some time.

This is a critical consideration because the treasury decided to greatly increase its cash balances at the TGA on May 6, 2015. This was due to past events that had disrupted the treasury's ability to access capital markets, like Superstorm Sandy and the September 11 terrorist attacks (Carpenter (2015)). This sharp break can be seen in Figure 15 in the appendix. After the dashed line corresponding to May 6, 2015, the treasury greatly increased its cash balances.

However, this policy change has had a large, unintended effect. The treasury is now able to operate much longer exactly where the debt ceiling constraint binds. They do so by drawing down the large cash balances at the TGA when extraordinary measures are invoked, which can be seen highlighted in Figure 15. During these instances the treasury systematically increased the duration of its liabilities. Only post-2015, because of this change can the debt ceiling take the form of a bill supply shock.

[6] The same figures for pre-2015 episodes are provided in Figure 16 in the appendix.

Returning to our results in Table 5 there is evidence that this policy change has increased the magnitude of the effect of the debt ceiling on corporate bond markets. The average effect post-2015 is significantly larger than the effects in 2013 and 2014. The effects in 2013 and 2015 are 13 and 16 basis points respectively, whereas the effects in 2022 are nearly 60 basis points.[7] We view this pattern as strong evidence that the change in the treasury's cash balance policy has greatly amplified the effects of the debt ceiling on corporate bond markets. As the treasury has been able to operate at the debt ceiling constraint for a longer period, the disruption in bond and money markets has increased.

To test the relevance of DCIV to actual bill supply, we regress the difference in offering amounts on DCIV over the period the debt ceiling constraint bound, from March 20, 2023 to May 31, 2023:

$$\Delta \text{Bill Supply}_t = \beta_0 + \beta_1 \text{DCIV}_t \tag{4.7}$$

The estimates from this regression are displayed in Table 7. These estimates strongly support the case that our instrument is relevant. Despite having only fifty-eight days of data, the t-stat is -67 and the R-squared is nearly one. The strong level of statistical significance and high R-squared emphasizes that our instrument is based on a mechanical relationship that must nearly hold when the debt ceiling is binding. We say "nearly" because the treasury has some accounting tricks (called "extraordinary measures") that allow it to issue more debt than it otherwise would be able to when the debt ceiling binds. The extent of the utility of these accounting tricks is encoded in the estimated coefficient, which indicates that for every dollar $DCIV$ predicts that bill supply should fall, it actually falls by sixty-three cents.

In Table 8 we display estimated coefficients from the regression specification

$$\text{Yield}_{it} = \Delta \text{Bill Supply}_{t,t_0} + \nu_i \tag{4.8}$$

The left-hand side of the equation is expressed in basis points versus the spread over the effective federal funds rate. The right-hand side is the cumulative net change in offering amounts expressed in hundreds of billions of dollars.

The first two specifications display coefficients from the OLS version of this regression. The second two specifications from IV specifications where we instrument cumulative net issuance with the $DCIV$ instrument. The two sets of coefficients are extremely similar in magnitude, reflecting that changes in bill supply in this period are highly mechanical, even without an instrument.

Our preferred interpretation is from column three, where we find that a decline in bill

[7] The results from 2011 are largest of all, but this appears to reflect the specialness of the first instance of a debt ceiling crisis rather than a general pattern.

supply of one hundred billion dollars causes an approximate eight basis point decline in yields for short-term corporate bonds. We estimate this regression on investment grade corporate bonds expiring between July 2023 and July 2024.

Although our instrument is clearly relevant, one threat to exclusion is that $DCIV$ is negatively correlated with time. Given that we've also shown that there are shifts in the asset demand of MMFs over time, this may violate exclusion. To address this, we exploit that MMFs not only restrict the corporate bonds in their portfolio to investment grade, but also almost exclusively to the highest tier of investment grade bonds: AAA, Aaa and AA+ rated bonds. Bonds with lower ratings than this are frequently never held and, when held, only in trace amounts.

We re-estimate Equation 4.8, but instead on the sample of investment grade bonds, excluding bonds rated AAA, Aaa or AA+. The results from this regression are given in Table 15 in the appendix. These results are extremely similar to our baseline results and, in fact, slightly stronger with both larger magnitudes and higher statistical significance. To rule out additional concerns with our instrument, and to emphasize that our results are driven by changes in bill supply, we use the 2017 debt ceiling episode as an experiment.

4.6.1 2017 Experiment

We find the cleanest evidence for our proposed mechanism in 2017, during which there were two debt ceiling events. During March 2017, the treasury first invoked extraordinary measures. However, after the destruction of Hurricane Harvey, Congress passed a law appropriating money for disaster relief and temporarily suspending the debt ceiling. However, as part of this law, in a section entitled "Restoring Congressional Authority Over the National Debt", Congress expressly forbade the Treasury from increasing its cash balances at the Treasury General Account. This was intended to ensure that the treasury could not use the period of the debt ceiling suspension to evade Congressional action on the debt ceiling by issuing a huge amount of additional debt, greatly increasing the cash available to it and forestalling the need for Congress to lift the debt ceiling. We quote the exact bill language below:

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

As can be seen in Figures 9 and 10 respectively, offering amounts and bill supply do not dramatically increase after the suspension in August 2017. However, after the debt ceiling was lifted in February 2018, there was an increase in bill supply and a sharp increase in offering amounts, which can be seen in the aforementioned figures.

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

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

4.6.2 Impact of End-of-Suspension Cash Regulations

There is a second bill supply shock associated with debt ceiling suspensions, but not debt ceiling raises. Since 2011, the Congress has frequently elected to suspend the debt ceiling instead of raising it. 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, when implementing debt ceiling suspensions, Congress has been careful to rule out a tactic that the treasury could have used to indefinitely delay the need for further debt ceilings raises or suspensions. While the debt ceiling was suspended, the treasury could have issued debt purely in order to build up its cash position in the TGA. Once the debt ceiling was increased, these bonds would have been counted towards the new level that "accomodates federal spending." However, the treasury could have had a huge cash position at the TGA with which to finance new expenditures indefinitely without the need to issue new net debt.

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

$$\text{Suspension End Instrument}_t = \sum_{t_0 \le t' \le t} \left(\frac{\text{Cash}\,(t_0) - \text{Cash Last Suspension}\,(t_0)}{\text{Number Bill Auctions Quarter}\,(t_0)} \times \mathbb{I}\left\{\text{Bill Auction Day}_{t'}\right\} \right) \tag{4.9}$$

The intuition is very similar to DCIV. The suspension end instrument captures the change in offering amounts the treasury needs to make if it adjusts its cash balance by offering fewer bills at auction. In Table 9 we regress the cumulative change in bill supply over the periods in which the suspension has ended on the suspension end instrument. We find that a dollar of cash over the cash as of last suspension translates into a ninety-five cents decline in bill supply.

5 Effects on the Cost of Capital

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

We now turn to this, first by using data from the market for commercial paper, described in Subsection 3.4. We study the issuance and pricing of commercial paper issued by non-financial institutions. To start, we study the dynamics of issuance around the X-date by estimating the following regression:

$$\text{Value Issuances Maturity} > 40 \text{ Days}_t = \sum_{-8 \le k \le 8} \beta_k \mathbb{I}\left\{t_x + 7k \le t < t_x + 7\,(k+1)\right\} + \gamma_x \tag{5.1}$$

This specification is a stacked single-difference specification. We examine the change of relatively longer-dated commercial paper in the weeks before and after the debt ceiling was raised. Our sample includes the week of each debt ceiling event as well as the trailing and preceding eight weeks.

We plot the estimated coefficients from this regression in Figure 12. We show that in the month prior to the debt ceiling raised, there is a statistically significant uptick in the amount of long-term issuance. Our coefficients are interpreted as each day of the week prior to the week of the debt ceiling raise, issuance was, on average, 220 million dollars higher than during the week the debt ceiling was raised.

The four weeks prior to the week the debt ceiling was raised each have higher levels of issuance than the week of the debt ceiling. Further, the week of the debt ceiling raised there is, on impact, lower issuance. Further, this pattern of lower issuance persists.

We count long-term issuance as issuance with maturity greater than forty days, this represents the two highest rungs of maturity available to us. In Figure 21 there is

In both the first two panels, we observe a strong pattern: there is an uptick in both measures of issuance in the three to four weeks before the debt ceiling is raised, including the week the debt ceiling is raised, itself. This pattern manifests for commercial paper with maturity between forty-one and eight days as well as commercial paper with longer maturities. It does not appear for commercial paper of shorter maturities.

We interpret this pattern as indicative of issuers in the commercial paper market increasing issuance just before the X-date would occur, in order to lock-in lower yields than would otherwise be available. Our interpretation is strengthened from evidence from the Government Accountability Office (GAO). GAO interviewed market participants who reported "commercial paper issuers had delayed or otherwise changed issuance plans during the October 2013 debt limit impasse" (GAO (2015)).

Finally, we verify that, like the other money market instruments we have studied, there is systematic variation in yields around the debt ceiling. The rates data we use does not distinguish between primary and secondary market transactions. However, the size of the secondary market for commercial paper is very small, in part driven by the short maturity of commercial paper itself. Thus the results we find for rates are almost certainly driven by issuance in the primary market.

We plot coefficients from the regression

$$\text{Yield}_{i,t} - \text{Implied Fed Funds Rate}_{m(i),t} = \sum_{-8 \leq k \leq 8} \beta_k \mathbb{I}\left\{t_{x-k}\right\} + \nu_w + \gamma_{i,k} \tag{5.2}$$

where the implied fed funds rate is calculated by compounding the forward rate taken from federal funds futures contracts. This regression is effectively a difference-in-differences specification, because we are looking at the spread between the yields on commercial paper and a reference rate, i.e. the differential response of commercial paper versus the effective funds rate.

Consistent with our results from corporate bonds, we find that there is a pronounced increase in the spread between the effective fund rate and the yields on commercial paper in the weeks following a debt ceiling increase. This shift is unlikely to be driven by changes in the spot effective federal funds rate or the expected future federal funds rate, due to our dependent variable being the spread between this object and the yield on commercial paper. Further, these results are comparatively large in magnitude, with the effect measuring as large as fifteen basis points.

6 Conclusion

We show that the debt ceiling causes large fluctuations in the pricing of treasury bills, repurchase agreements and corporate bonds. Different from prior literature, we do not focus on how the debt ceiling introduces credit risk into T-bills and affects T-bill yields. Instead, we study two distinct alternative channels through which the debt ceiling affects asset prices: the *bill supply channel* and *payment delay channel*.

When the debt ceiling binds, the treasury cannot issue more debt without redeeming or allowing to run off debt instruments of equivalent face value. In addition to this, the treasury has a pre-scheduled and nearly constant schedule of bond and note issuance. Taken together, when the debt ceiling binds every dollar of net positive long-term debt issuance implies a dollar of net negative bill issuance. We exploit this to construct an instrument for net bill issuance. Our preferred IV specification implies that one hundred billion dollars of net negative bill issuance lowers yields by eight basis points.

We find large effects in bond markets around the debt ceiling post-2015, which we attribute to an unintended consequence of treasury policy changes. In 2015, the treasury decided to hold much larger cash balances in the treasury general account at the New York Fed (Carpenter (2015)). This has greatly extended the period that the treasury can operate under extraordinary measures without issuing new debt on a net basis. Interacting with the policy of regular and predictable issuance, this has resulted in periods where the treasury has systematically increased the duration of its liabilities by running off bills and issuing bonds and notes.

In our analysis of the *payment delay channel*, we show that MMFs assiduously avoid holding treasuries at the risk of delayed payment and greatly increase their holdings of short-maturity treasuries not exposed to the risk of payment delays. This results in large downward spikes in the yield curve for vintages of treasuries not exposed to the risk of payment delays. However, in aggregate, MMFs are unable to fully compensate for the decline in their holdings of exposed treasuries by substituting across the yield curve. Because of this, they greatly increase the amount of repurchase agreements held in their portfolio. This takes the form of a lending supply shock in the market for repurchase agreements and pushes down the repo rate.

We view our results as evidence that the treasury should review its policy of "regular and predictable" bond and note issuance. In the seventies and early eighties, the treasury adjusted its policy from "tactical" issuance, where it held large and unannounced auctions. At least in part, this change was motivated by the turbulence these auctions induced in corporate bond markets (Garbade (2007)). Now, as was then, the treasury's policy rules are causing large and, arguably, undesirable distortions in capital and money markets. As debt ceiling showdowns promise to be a regular feature of future policy disputes, we hope that our work will prompt a re-evaluation of the treasury's policy framework.

Figure 1
Yield Curves Around the X-date

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

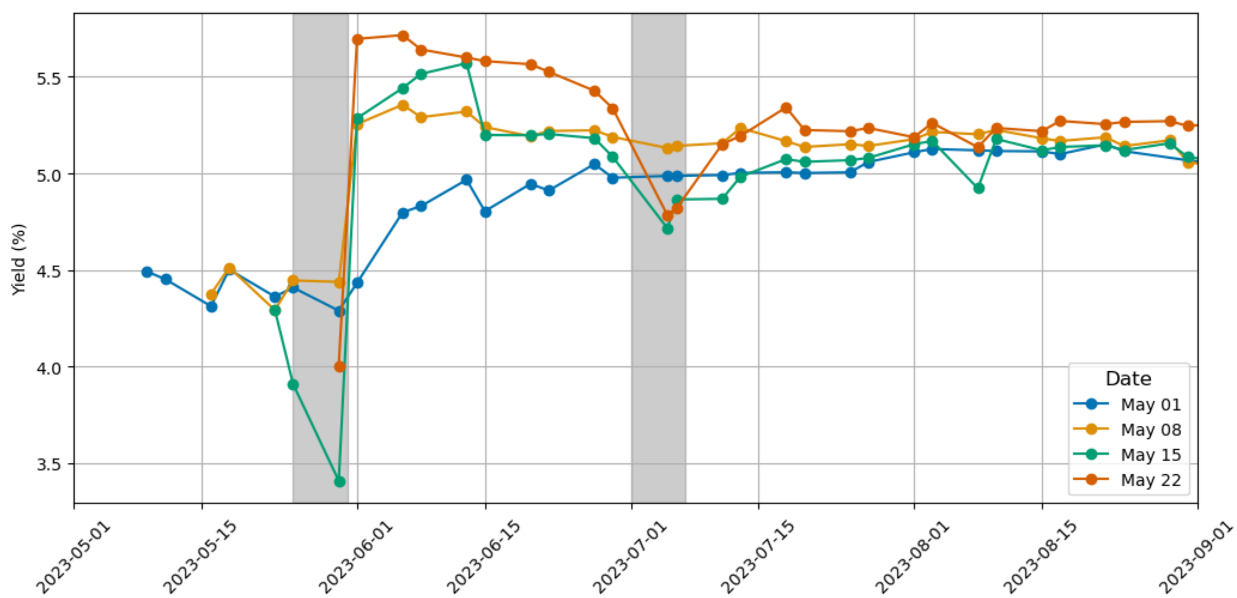


Figure 2
Money Market Mutual Fund Holdings

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

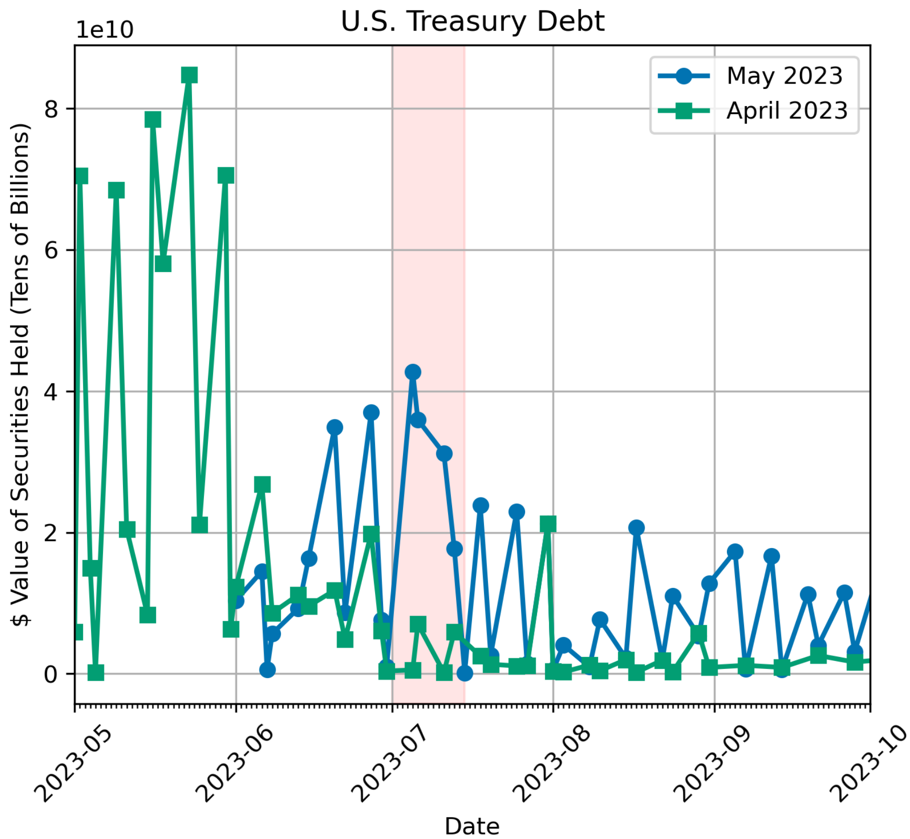


Figure 3
Money Market Mutual Fund Holdings Coefficient Plot

The plot shows coefficients from the following regression:

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

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

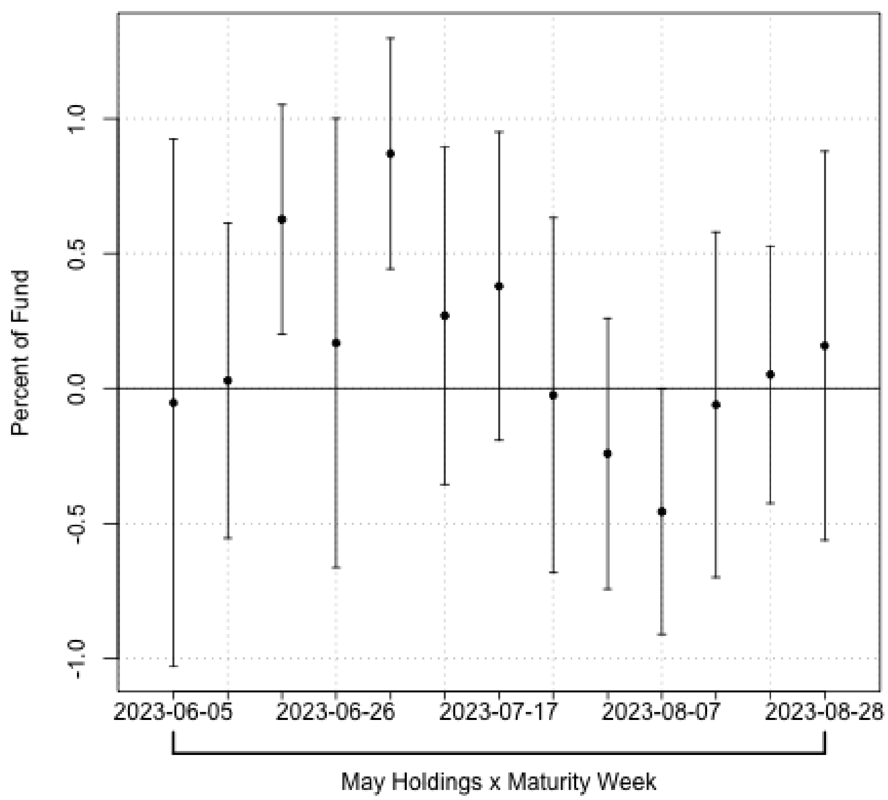


Figure 4
Money Market Mutual Fund Holdings

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

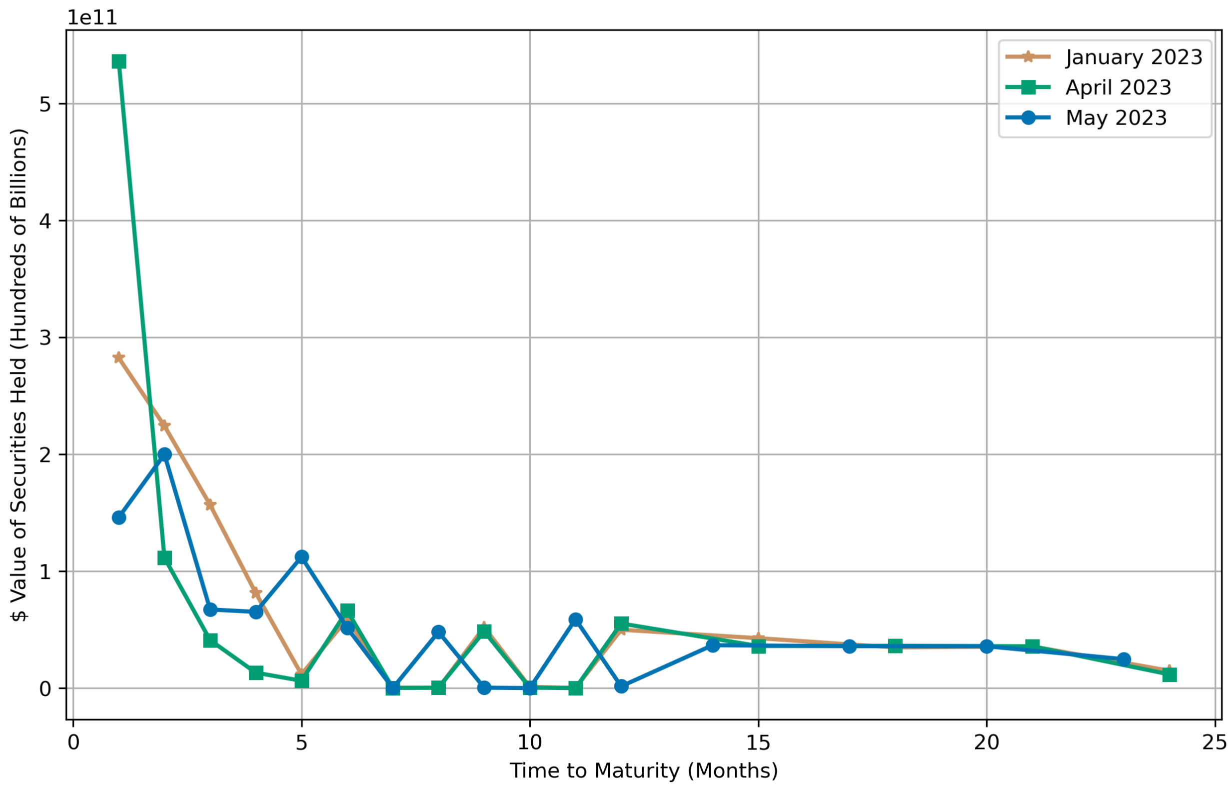


Figure 5
Evolution of Money Market Mutual Fund Holdings

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

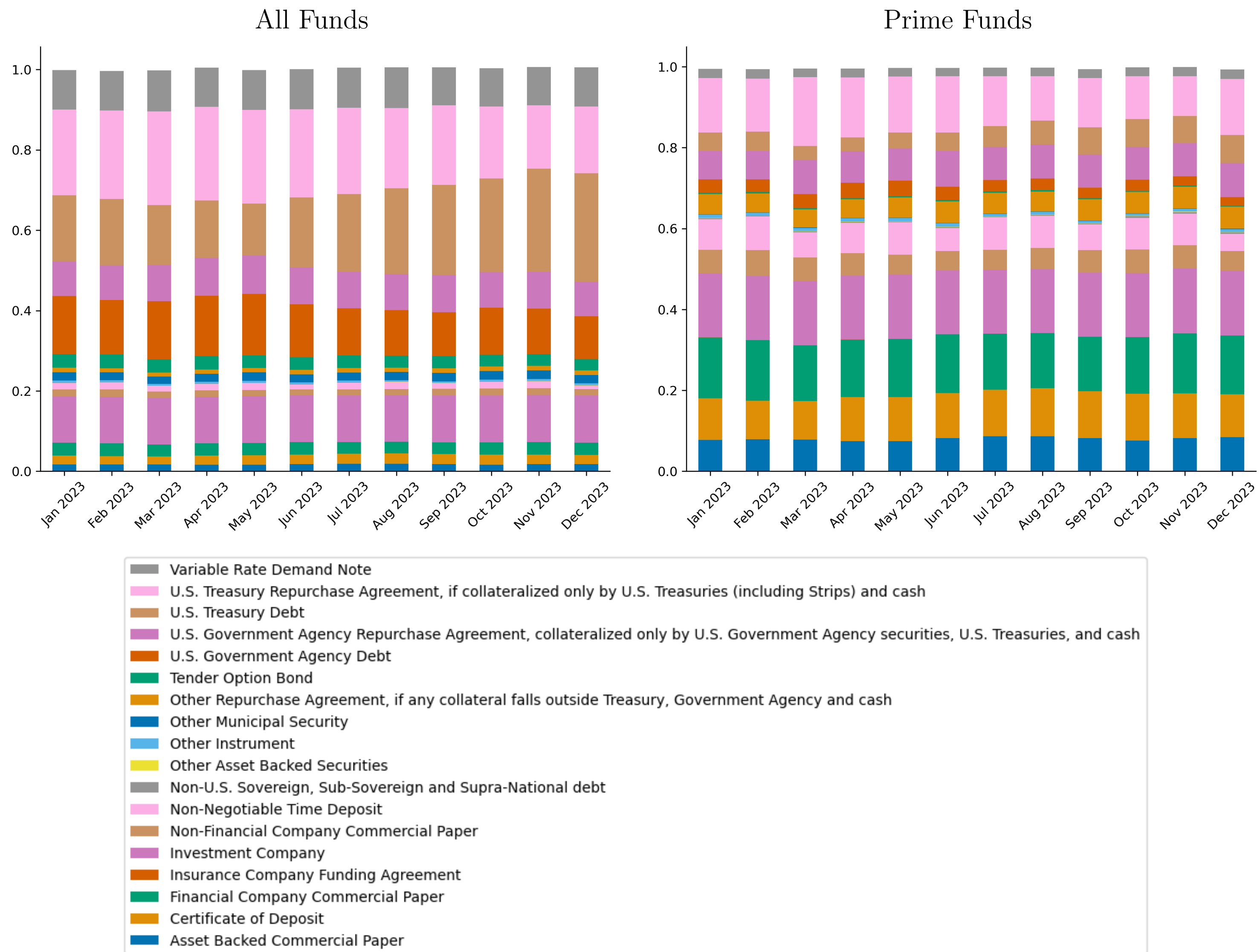


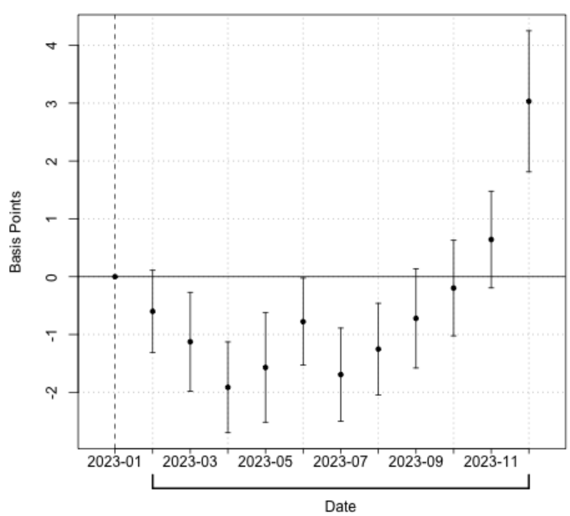
Figure 6
Repo Rates

This table displays coefficients from the regression

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

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

Time Dummies (β_t)



Interaction Terms (γ_t)

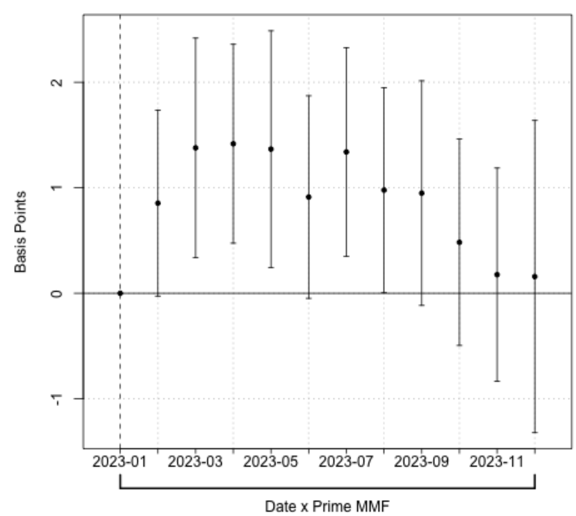


Figure 7
AA and Above Short-Term Corporate Debt

This figure displays the median spread between the yield and the effective funds rate for agency and corporate debt that expires in the second-half of 2023. We show the median yield for all IG corporate bonds rated AA and agency debt transacted between April 1, 2023 and July 1, 2023. The vertical, dashed red line records the date that the debt ceiling was lifted.

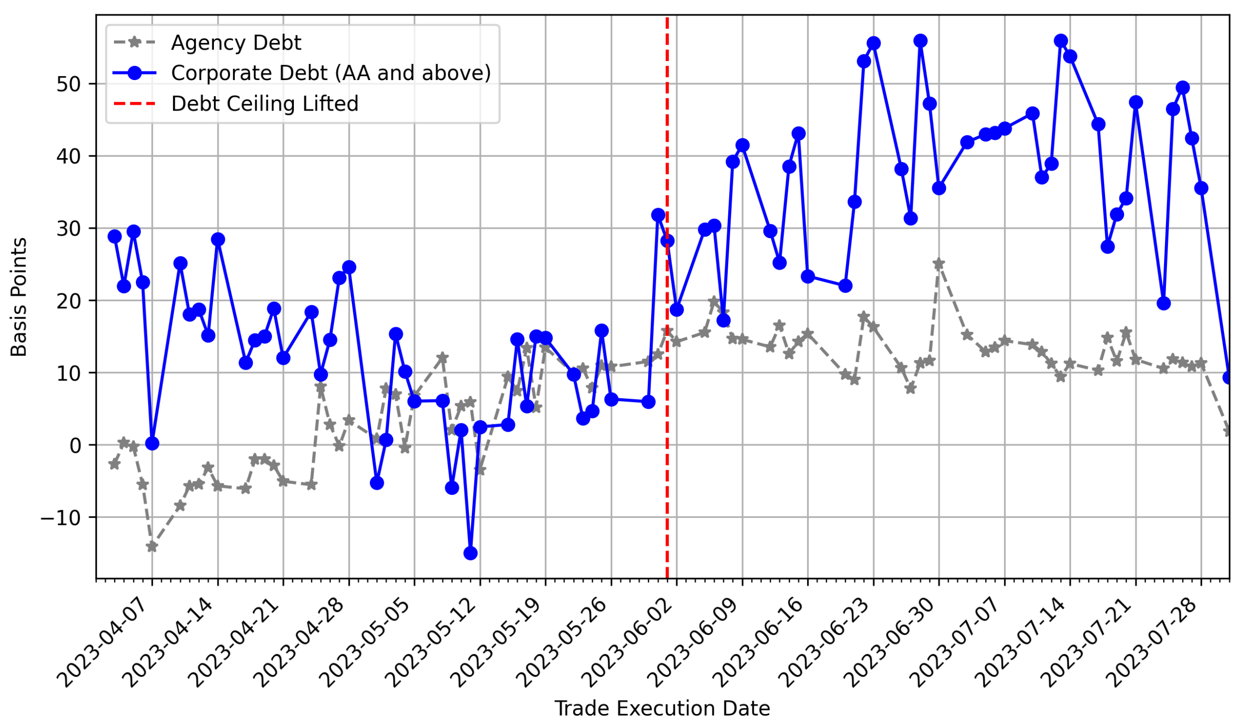
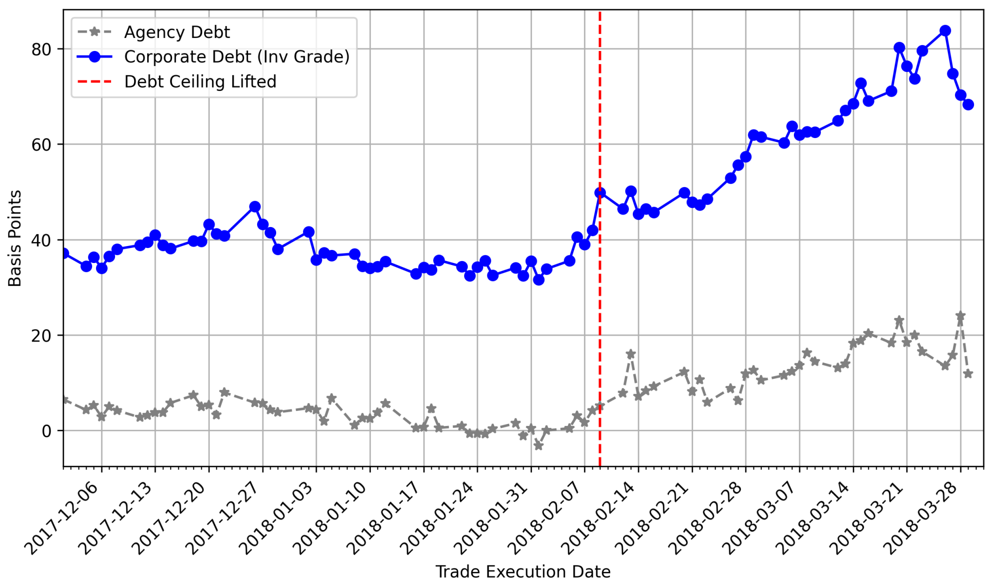


Figure 8
Changes in Spreads Around The Twin 2017 Episodes

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

Debt Ceiling Lifted in 2018



Debt Ceiling Suspension Due to Hurricane Harvey

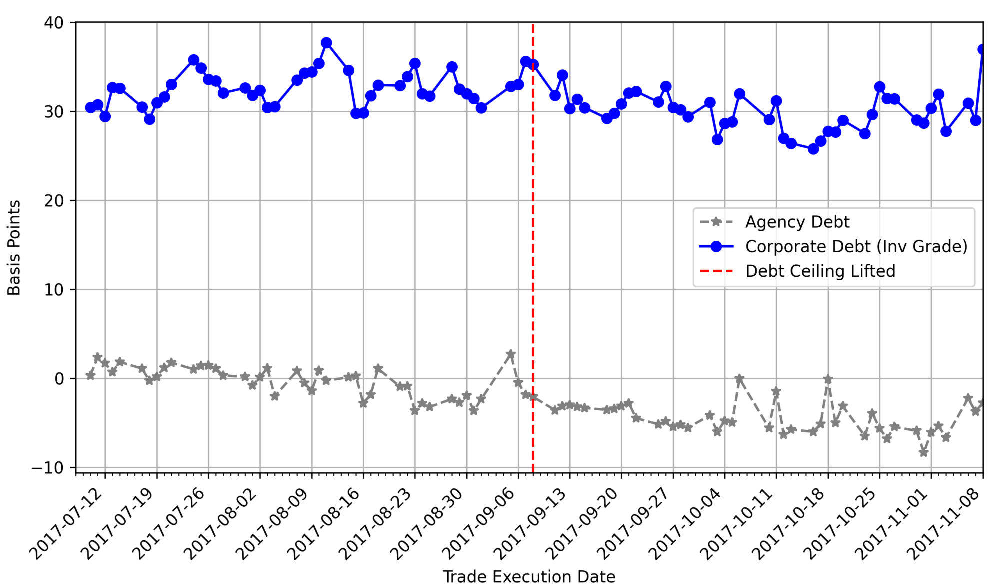


Figure 9
Net Offering Amounts 2023

This figure displays the change in offering amounts for five years. From these figures, is is possible to see a pronounced increase in offering amounts during periods in which the treasury engaged in "extraordinary measures": January 19, 2023 to June 1, 2023; August 2, 2021 to December 16, 2021; March 5, 2019 to August 2, 2019; March 16, 2017 to September 8, 2017; March 15, 2015 to November 2, 2015

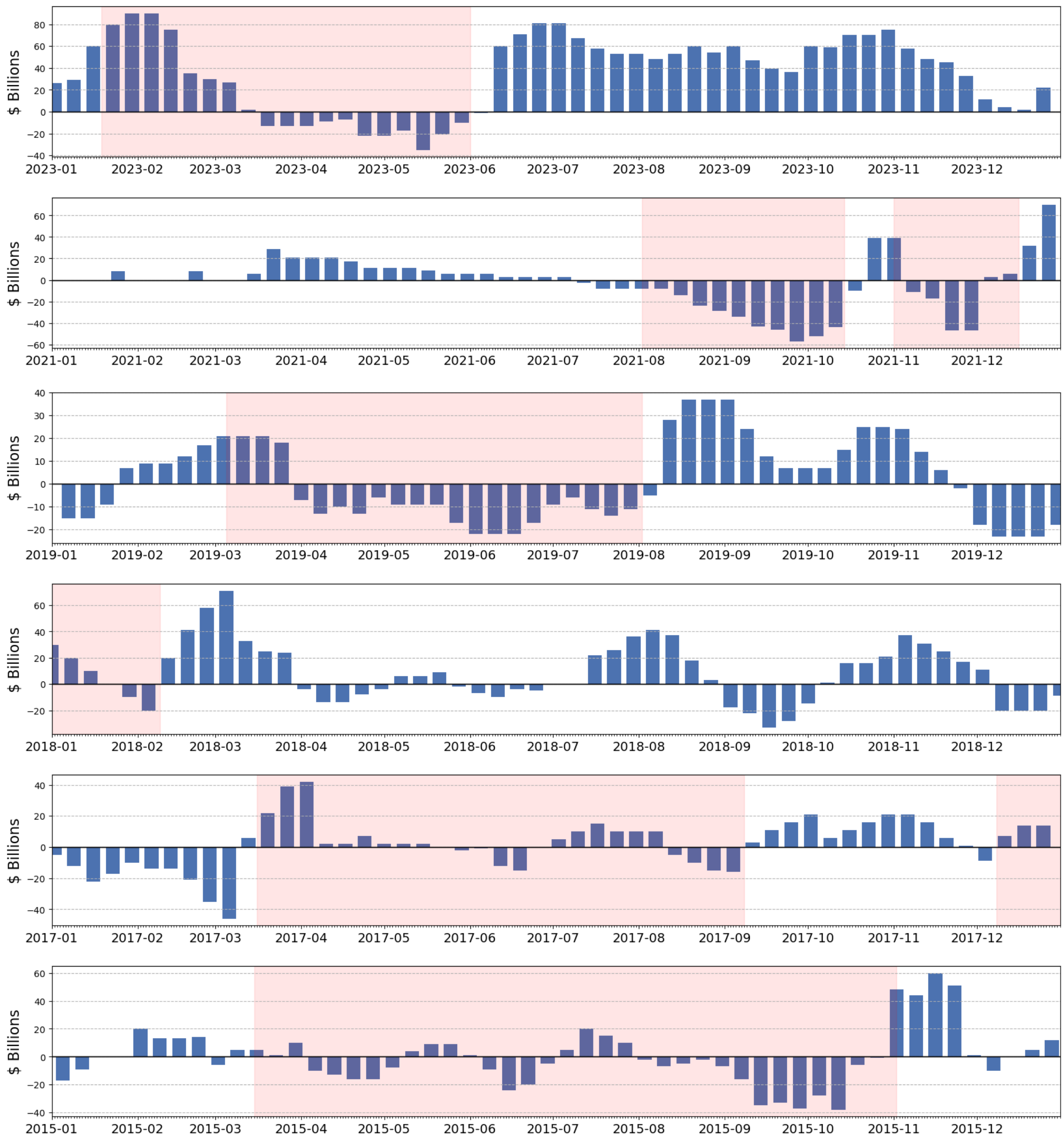


Figure 10
Change in Bill Supply Around X-Dates 2015 and Later

Each panel corresponds to at least one period in which the treasury started implementing "extraordinary measures". We shade the period from which the treasury first invoked extraordinary measures until the debt ceiling was either raised or suspended.

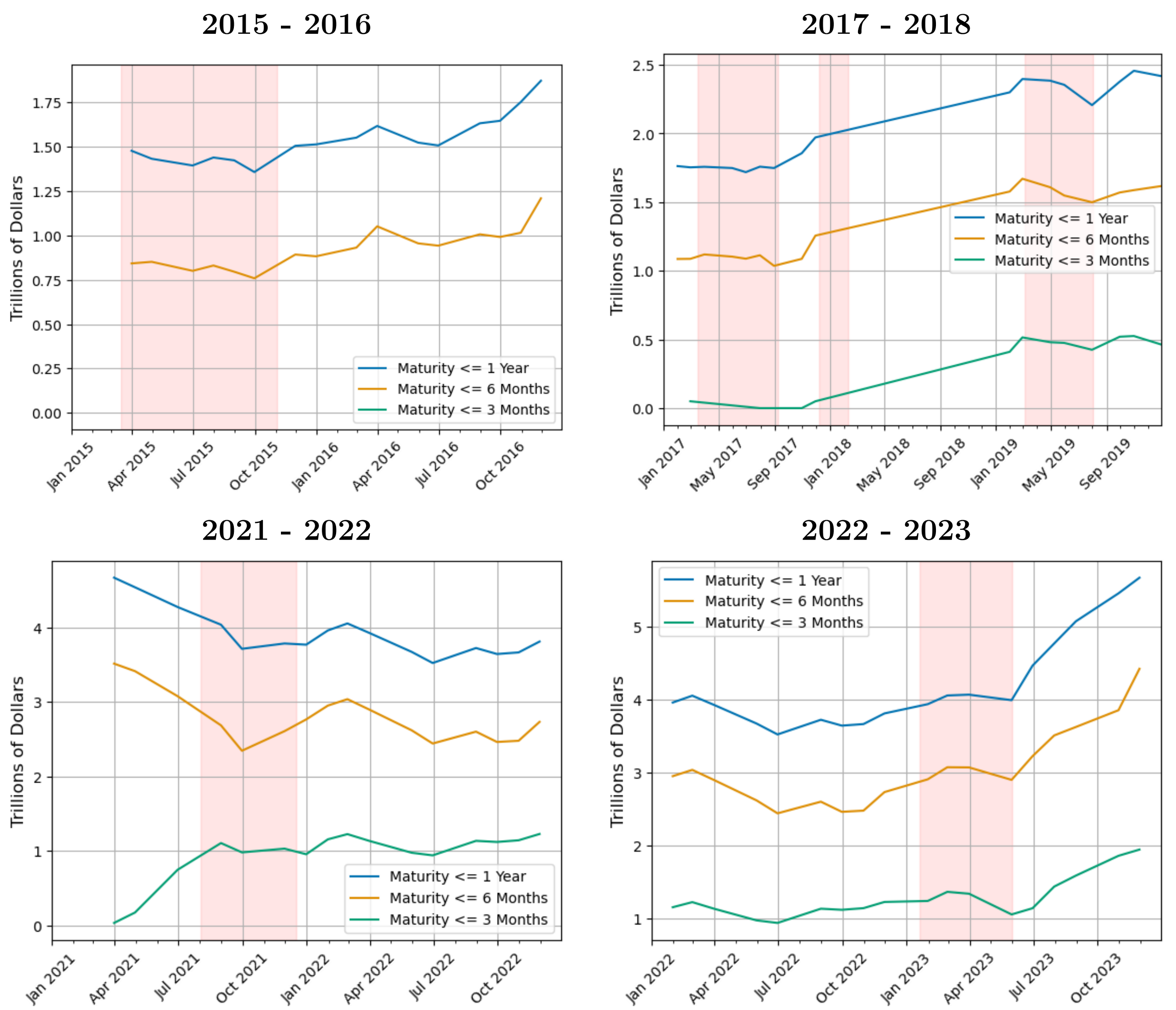


Figure 11
Actual and Futures-Implied Evolution of the Repo Rate

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

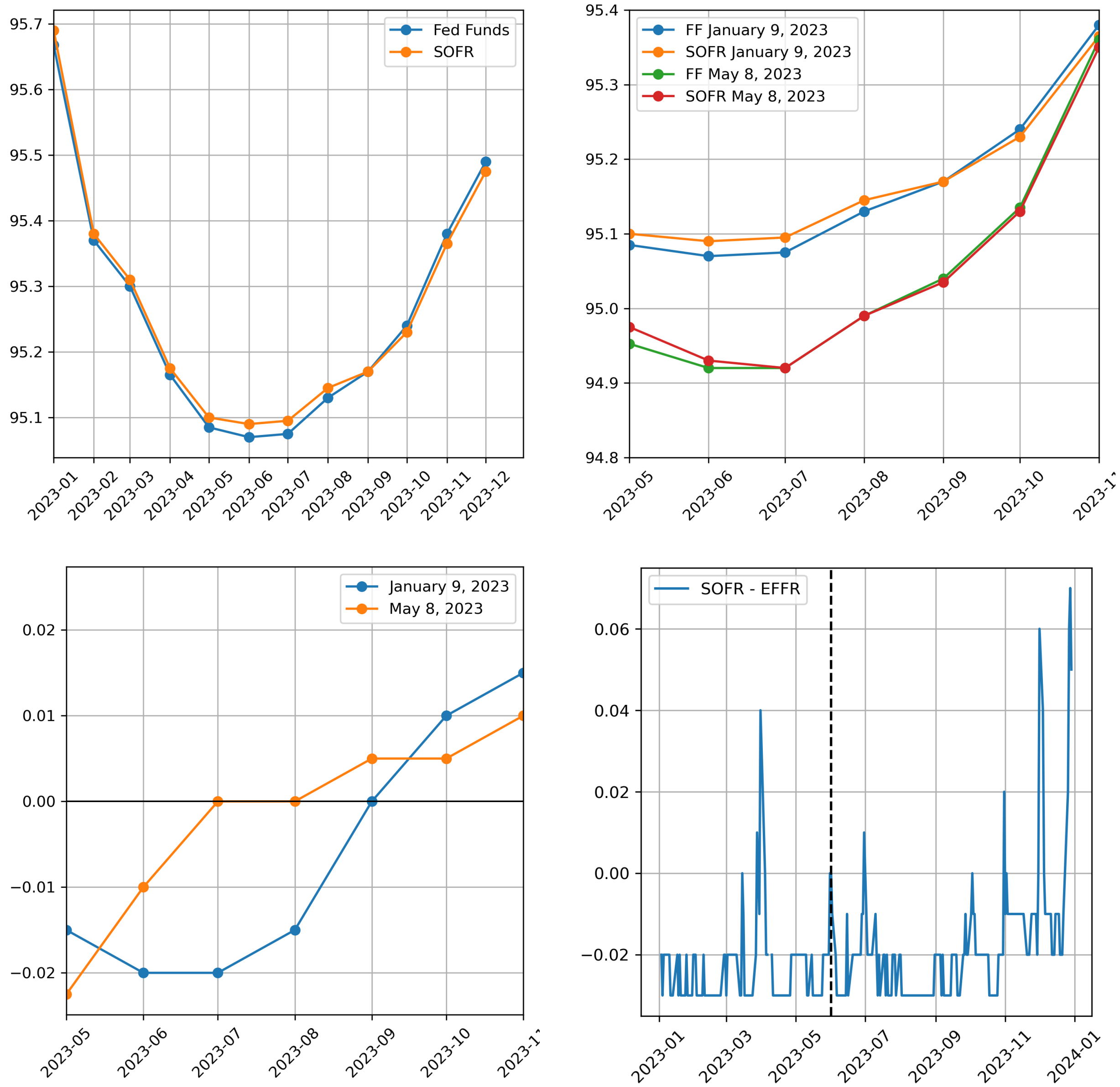


Figure 12
Dynamics of Commercial Paper Issuance

This figure displays regression results from stacked single-difference specifications of the form:

$$\text{Value Issuances Maturity} > 40 \text{ Days}_t = \sum_{-8 \leq k \leq 8} \beta_k \mathbb{I} \left\{ t_x + 7k \leq t < t_x + 7(k+1) \right\} + \gamma_x$$

The dependent variable is the total daily (t) value of issuance of commercial paper with maturity greater than forty days and is measured in millions of dollars. t_x denotes the day of the X-date. γ_x are event fixed effects. We estimate this specification on the leading and trailing eight weeks around each X-date.

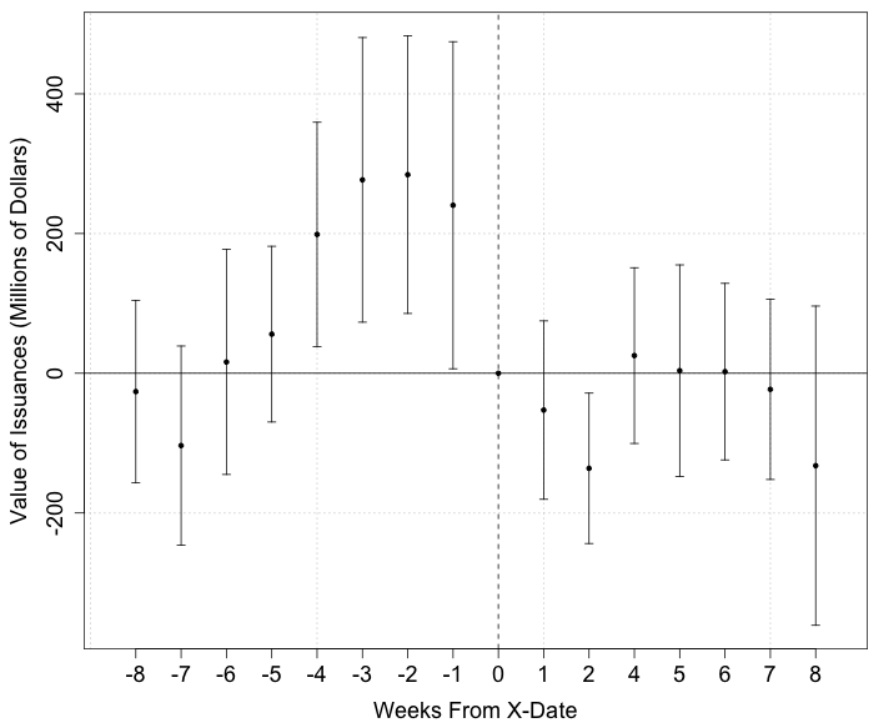


Figure 13
Dynamics of Commercial Paper Yields

This figure displays regression results from stacked single-difference specifications of the form:

$$\text{Commercial Paper Yields Ex. FF Futures-Implied Rate}_t = \sum_{-8 \leq k \leq 8} \beta_k \mathbb{I}\left\{t_x + 7k \leq t < t_x + 7(k+1)\right\} + \gamma_x$$

Each specification is estimated on a time-series of commercial paper of the indicated maturity.

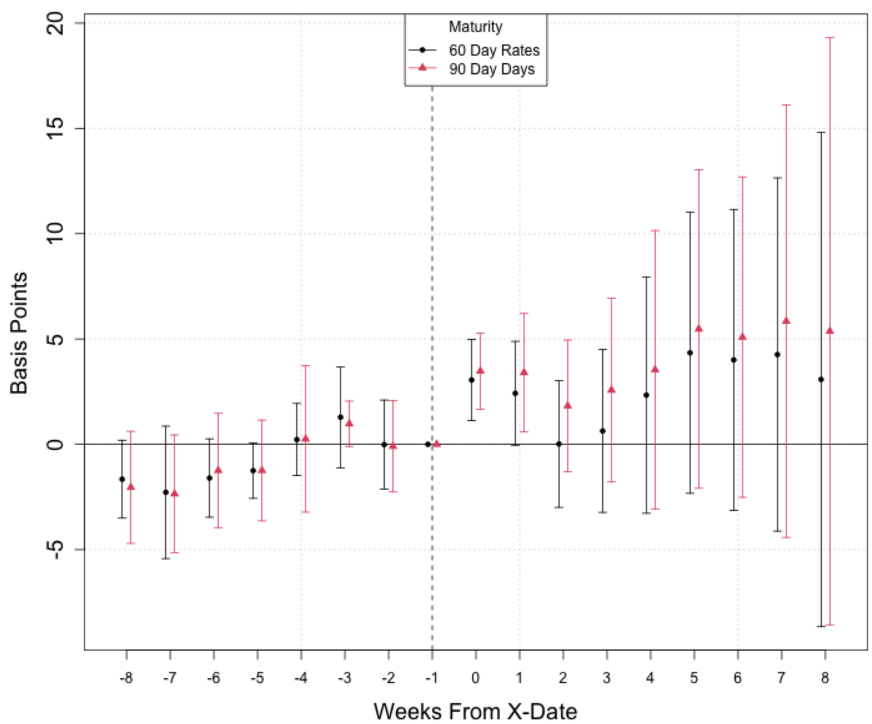


Table 1
Fund Summary Statistics as of January 2023

This table presents summary statistics for the funds in our sample as of January 2023. We list the number of funds as well as summary statistics for the total value of assets in their portfolios expressed in billions of dollars.

		Total Value of Portfolio Securities				
Fund Category	N	Mean	Std Dev	25%	Median	75%
Exempt Government, Treasury	57	24.21	24.59	3.37	15.04	36.8
Government/Agency	2	15.9	22.11	8.09	15.9	23.72
Government/Agency, Exempt Gov.	141	20.3	48.7	0.49	1.56	9.51
Other Tax Exempt	35	2.5	3.9	0.38	1.0	2.92
Prime	70	17.72	33.03	1.43	4.44	14.63
Single State	18	1.79	2.18	0.24	0.77	2.53
Treasury	3	2.42	3.21	0.59	1.16	3.61

Table 2
Bond Transaction Summary Statistics

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

	Agency Debt				IG Corporate Debt				A-Rated Corporate Debt			
	Count	Mean	SD	Median	Count	Mean	SD	Median	Count	Mean	SD	Median
Month												
January	21,046	8.11	28.21	5.90	201,070	34.58	70.08	27.32	111,636	21.37	67.16	15.20
February	17,201	3.52	28.77	1.47	192,355	28.43	72.56	22.24	107,588	18.91	78.98	12.37
March	19,388	14.88	38.25	9.38	209,838	107.35	198.25	61.14	124,329	105.43	223.54	48.00
April	12,016	14.62	41.62	9.25	158,346	76.95	105.22	61.33	89,671	62.01	104.41	49.10
May	12,888	25.85	39.76	21.80	172,624	108.82	201.46	66.51	95,781	63.71	99.46	51.39
June	13,647	23.49	32.34	20.75	162,752	76.64	84.07	66.39	89,576	57.65	70.59	52.83
July	12,813	16.91	30.92	16.74	141,238	65.23	81.55	56.71	77,709	49.21	70.82	44.20
August	11,971	13.63	33.20	12.97	157,119	63.66	77.81	57.11	88,282	49.26	73.25	45.39
September	10,119	16.45	30.01	15.38	125,411	69.27	83.62	61.86	71,907	55.28	65.24	51.17
October	10,597	22.40	34.32	20.99	146,111	80.63	75.06	73.39	84,789	66.88	69.04	62.56
November	9,966	17.46	43.03	19.14	138,498	79.33	84.51	72.36	77,408	64.39	73.20	59.36
December	9,506	16.36	44.83	19.17	123,556	73.82	69.89	68.47	67,642	57.90	68.23	53.60

Table 3
Evolution of Bill Holdings First-Half 2023

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

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

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

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

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

Table 4
Evolution of Holdings by Category 2023

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

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

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

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

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

Table 5
Difference-in-Differences Results Around the Debt Ceiling

In this table we report results from difference-in-differences regressions of the form

$$\text{Yield}_{it} = \beta \mathbb{I}\left\{\text{Post}\right\}_t \times \mathbb{I}\left\{\text{Treated}\right\}_i + \nu_t + \eta_i$$

where $\mathbb{I}\left\{\text{Post}\right\}_t$ is the period immediately following the debt ceiling increase or suspension, indicated by the row "Treated Date". The treated and control groups are as indicated in the table. In all regressions we include both date and bond fixed effects. The dependent variable is expressed in basis points.

Dependent Variable:	Yield (bps)								
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables									
Post x Treated	139.0***	16.12***	13.83*	27.37***	30.92***	45.16***	12.78***	56.43***	25.43***
	(11.60)	(4.029)	(1.816)	(6.174)	(7.556)	(9.149)	(7.544)	(12.99)	(4.100)
Sample Description									
Treated Group	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp
Control Group	Agency	Agency	Agency	Agency	Agency	Agency	Agency	Agency	Agency
Sample Period	Jun-Oct 11	Aug-Dec 13	Dec-Apr 14	Sep-Jan 16	Jul-Nov 17	Dec-Apr 18	Jun-Sep 19	Oct-Feb 22	Apr-Jul 23
Treated Date	08/02/11	10/16/13	02/07/14	11/02/15	09/08/17	02/09/18	08/02/19	12/16/21	06/01/23
Fixed-Effects									
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cusip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics									
Observations	12,031	14,239	12,723	15,219	20,301	20,417	18,639	15,092	5,067
R^2	0.91950	0.98040	0.11902	0.77709	0.93766	0.97835	0.94166	0.77382	0.41740
Within R^2	0.01012	0.00059	0.00016	0.00103	0.00091	0.00188	0.00079	0.00278	0.01071

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

Table 6
Projected Bond Issuance from May Refunding Statement

This table is taken from the treasury's May 2023 refunding statement. The first three rows are issuances for each month for the quarter before the refunding statement was published. The last three columns are the projected issuances for the second quarter. The horizontal axis refers to the duration of the debt instrument in question, except for the final column which stands for "Floating Rate Notes."

	2-Year	3-Year	5-Year	7-Year	10-Year	20-Year	30-Year	FRN
Feburary	42	40	43	35	35	15	21	22
March	42	40	43	35	32	12	18	22
April	42	40	43	35	32	12	18	24
May	42	40	43	35	35	15	21	22
June	42	40	43	35	32	12	18	22
July	42	40	43	35	32	12	18	24

Table 7
First Stage of IV Regression

This table reports the first stage of our instrumental variables regression. Here we regress cumulative net issuance on our instrument, which is a function of the cumulative scheduled issuance of bonds and notes (DCIV).

Dependent Variable:	Cumulative Δ Supply (\$100s billions)
Model:	(1)
Variables	
Constant	0.1351***
	(6.272)
DCIV	-0.6262***
	(-63.75)
Fit Statistics	
Observations	51
R^2	0.98809
Adjusted R^2	0.98784

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

Table 8
Effect of Bill Supply Shocks on the Pricing of Corporates

This table reports regression of the spread of corporate bonds over the effective federal funds rate in basis points on cumulative net issuance of treasury bills. We report both the OLS specifications in the first two rows and the IV specifications in the second. For the IV specifications, we instrument cumulative net issuance with DCIV. The first and third column use the sample of all investment grade bonds maturing between July 1, 2023 and July 1, 2024. The second and fourth columns use the sample of all A-rated bonds maturing over the same time horizon.

Dependent Variable:	Spread vs. Effective Funds Rate (bps)			
Model:	(1)	(2)	(3)	(4)
Variables				
Cumulative Δ Supply ($100s billions)	7.148***	8.734***	8.605***	10.49***
	(3.805)	(2.952)	(4.489)	(3.499)
Fixed-Effects				
CUSIP	Yes	Yes	Yes	Yes
Fit Statistics				
Observations	15,149	7,658	15,149	7,658
R^2	0.93855	0.59713	0.93853	0.59701
Within R^2	0.00480	0.00697	0.00460	0.00669

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

Table 9
Effect of End-of-Suspension Cash Rules on Bill Supply

This table shows the regression of the cumulative change in net bill issuance on the "debt suspension instrument," the instrumented constructed from rules governing how much cash the treasury can hold when a debt ceiling suspension ends.

Dependent Variable:	Cumulative Net Bill Issuance ($billions)
Model:	(1)
Variables	
Constant	-8.592*
	(-1.682)
End-of-Suspension Instrument	-0.9559***
	(-17.83)
Fit Statistics	
Observations	121
R^2	0.72760
Adjusted R^2	0.72531

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

Table 10
Effect of Debt Ceiling on Pricing of Commercial Paper

This table presents estimates from a stacked single-difference estimator. The dependent variable is the yield on commercial paper of the indicated maturity net of the implied federal funds rate of the same maturity, constructed from federal funds futures. Each specification includes fixed-effects corresponding to each individual X-date. The sample includes each X-date since 2011 as well as the leading and trailing eight weeks.

Dependent Variable:	Yield Ex Futures-Implied Federal Funds Rate													
Maturity (Days)	Overnight	7	15	21	30	45	60	90	120	150	180	210	240	270
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Variables														
X-Date Post	-0.8412	0.0964	0.5724*	1.219***	1.614***	2.112***	3.262***	4.651***	10.65***	11.08***	11.42***	16.23***	17.03***	16.41***
	(-1.431)	(0.2371)	(1.787)	(3.789)	(4.854)	(5.514)	(8.060)	(10.32)	(17.96)	(19.69)	(21.52)	(18.52)	(19.14)	(19.12)
Fixed-Effects														
X-Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics														
Observations	1,588	1,605	1,605	1,605	1,605	1,594	1,605	1,605	1,605	1,605	1,605	1,605	1,605	1,605
R^2	0.38765	0.50922	0.63331	0.65290	0.69117	0.69191	0.70591	0.74780	0.89127	0.89028	0.88795	0.90985	0.88994	0.87550
Within R^2	0.00551	0.00014	0.00725	0.03240	0.05225	0.06711	0.12733	0.19521	0.44225	0.48621	0.51562	0.47155	0.49174	0.48798

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

Table 11
Commercial Paper Difference-in-Differences Specification

This table presents results from stacked difference-in-differences specifications. In both cases, the dependent variable is the total daily value of highly rated non-financial commercial paper issuance with maturities greater than forty days, expressed in millions of dollars. In the first specification the control group is the issuance of highly rated commercial paper by financial issues of the same maturity, the second specification uses lower-rated nonfinancial commercial paper issuance of the same maturity as a control.

Dependent Variable:	Daily Value of Issuances ($ Millions)	
Model:	(1)	(2)
Variables		
X-Date Post × Long-Term AA Nonfinancial	-110.1***	-63.71**
	(-4.368)	(-2.342)
Fixed-Effects		
Date	Yes	Yes
Episode by Rating and Maturity	Yes	Yes
Control	LT AA Fin	LT A2/P2 Nonfin
Fit Statistics		
Observations	5,616	5,616
R^2	0.47207	0.40234
Within R^2	0.01255	0.00373

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

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INTERNET APPENDIX

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A Debt Ceiling Events since 2011

Table 12
Debt Limit Suspensions Since 2011

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

Year	Reset Date	Debt on reset ($ tn)	Cash on reset ($ bn) [1]	Extra-ordinary Measures Initiated [2]	Headroom created ($bn) [3]	Act	Date bill signed into law	Cash on suspension ($bn) [4]	Suspended till	Other events
2012-2013	Dec 31	16.4	92.7	Dec 31	200	No Budget No Pay Act, 2013	Feb 4	60.1	May 18, 2013	Tax filings delayed by 8 days in Jan
2013	May 19	16.7	34.2	May 20	NA	Continuing Appropriations Act, 2014	Oct 17	46.3	Feb 7, 2014	Low deficit compared to previous years; special dividends of $ 66bn from Fannie Mae & Freddie Mac in June
2014	Feb 8	17.2	34.1	Feb 10	NA	Temporary Debt Limit Extension Act	Feb 15	33.2	Mar 15, 2015	Tax refund season implied a shorter period to X date
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

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
2018	Dec 9	20.5	69.1	Dec 11	243	Bipartisan Budget Act of 2018	Feb 9	202.6	Mar 1, 2019	
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 13
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.

B Additional Figures

Figure 14
Yield Curves for May 1 and 2

This figure displays the yield curve for the first two days in May. These yield curves are calculated using data on bills from treasury direct. The x-axis denotes the date that the bill matures. The y-axis denotes the yield in percent. Each line corresponds to a specific data that the yield curve was constructed as of. For example, the blue line shows the yield curve as of May 1, 2023.

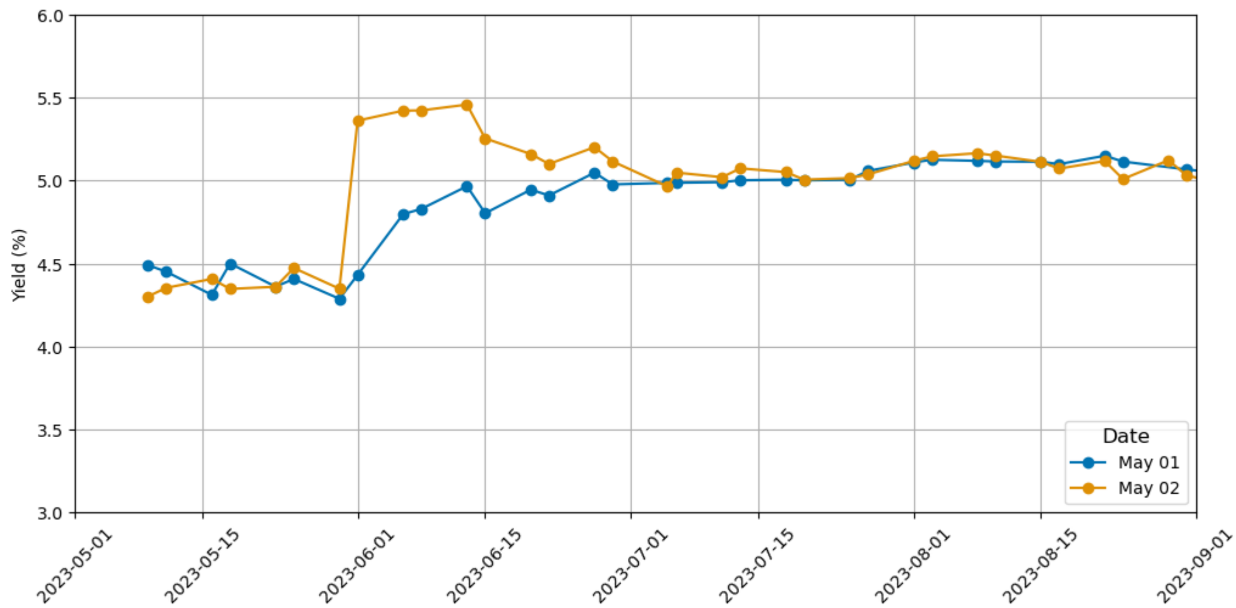


Figure 15
TGA Cash Balance

This figure displays the evolution of TGA cash balances from 2010 onwards. The shaded periods are from the start of each instance of the start of "extraordinary measures" to the day at which the debt ceiling was either suspended or raised. The dashed vertical line corresponds to May 6, 2015 when the treasury announced its policy of increasing

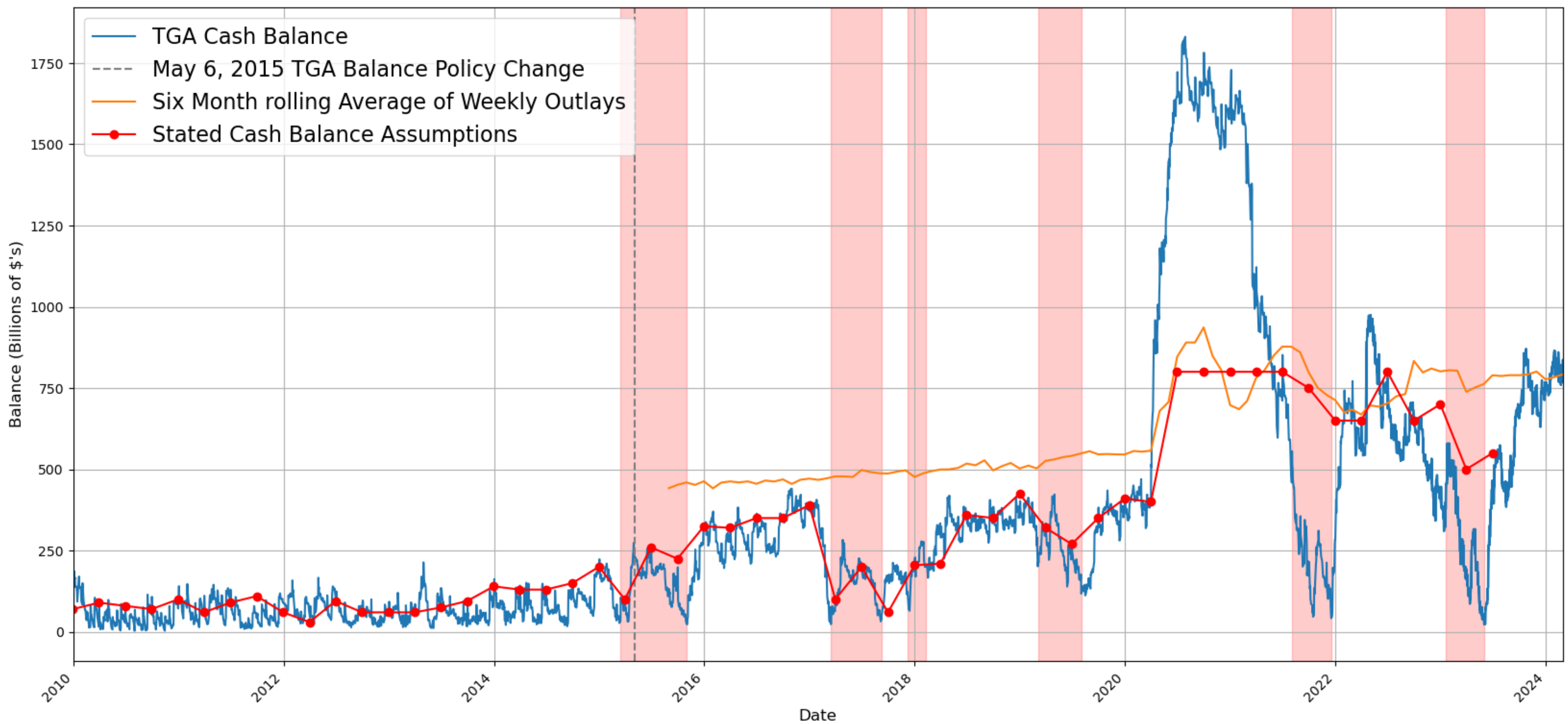


Figure 16
Change in Bill Supply Around X-Dates Pre-2015

This figure displays the change in bill supply around X-dates prior to 2015. Notice that these earlier dates do not display the same pattern of decreases in bill supply as the prior figure.

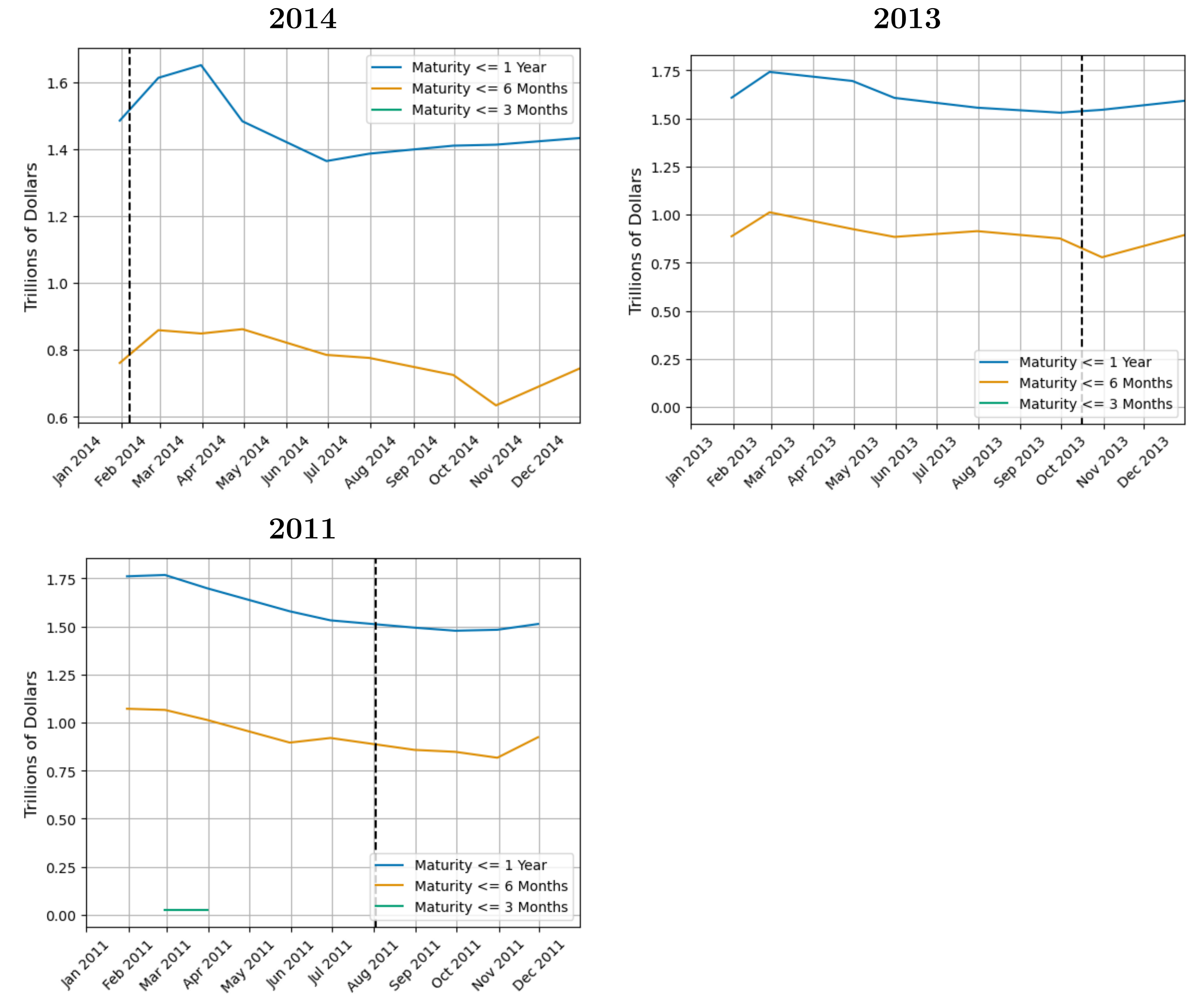


Figure 17
Flow of Funds

This figure displays the aggregate shares of treasury holdings by investor class. Data is taken from the flow of funds.

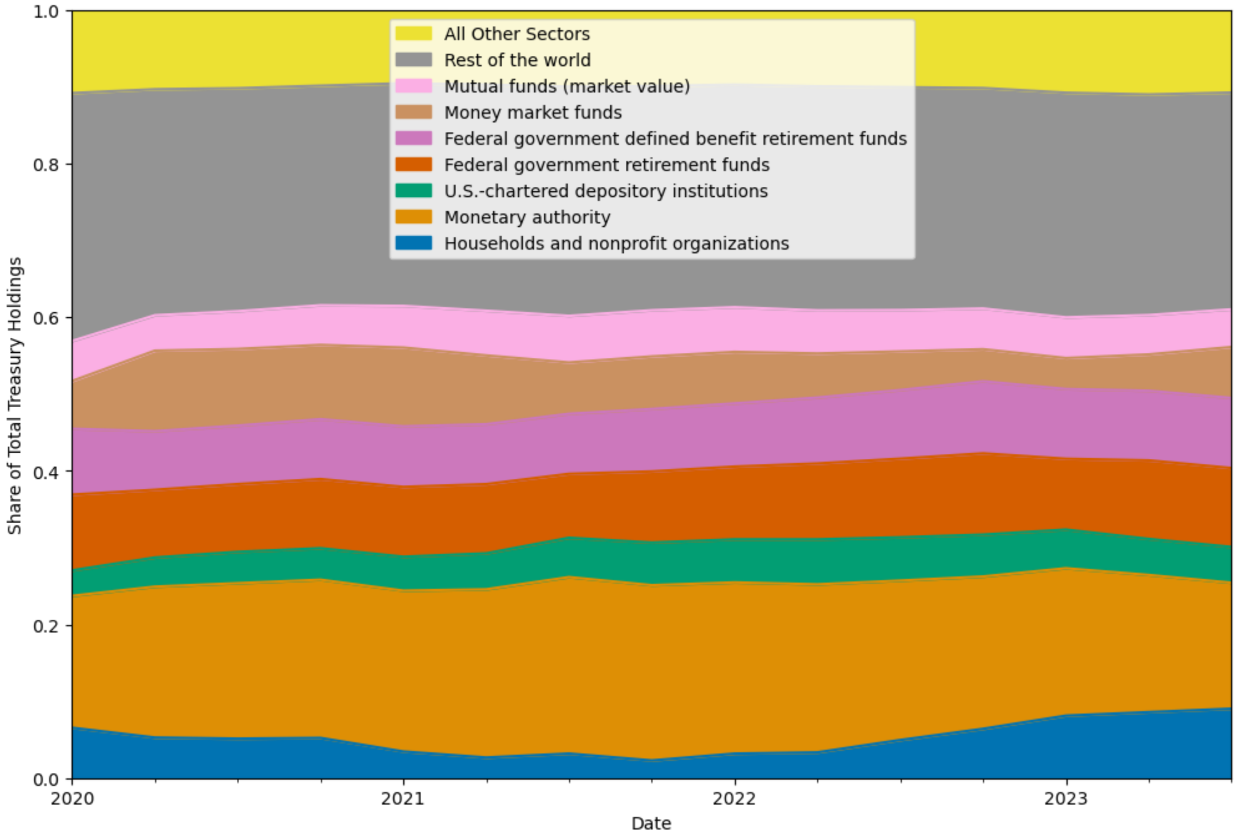


Figure 18
MMF Holdings

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

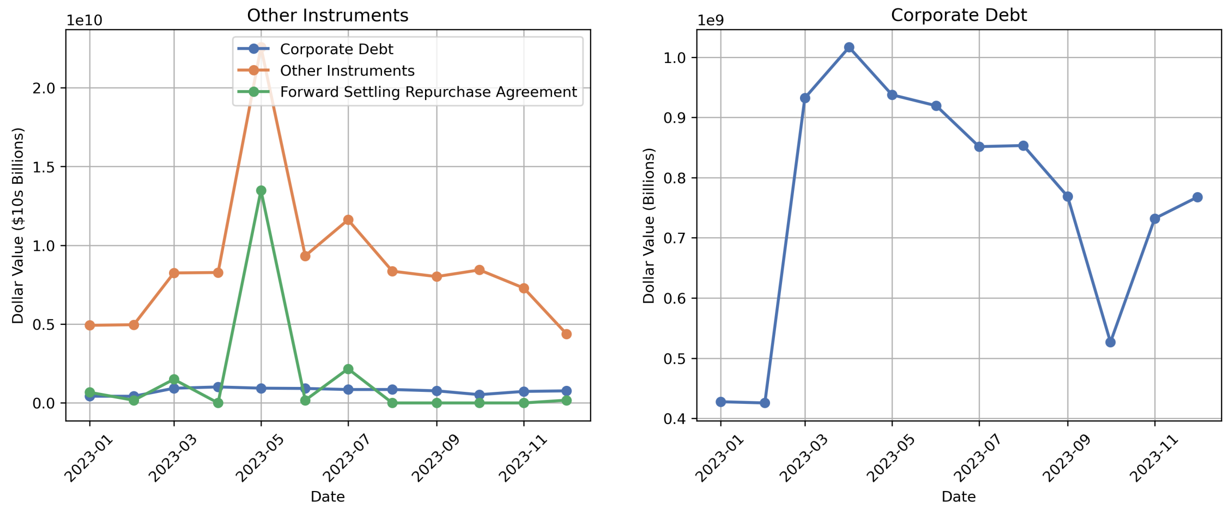


Figure 19
Yield Curve around Kevin McCarthy Speaker Vote

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

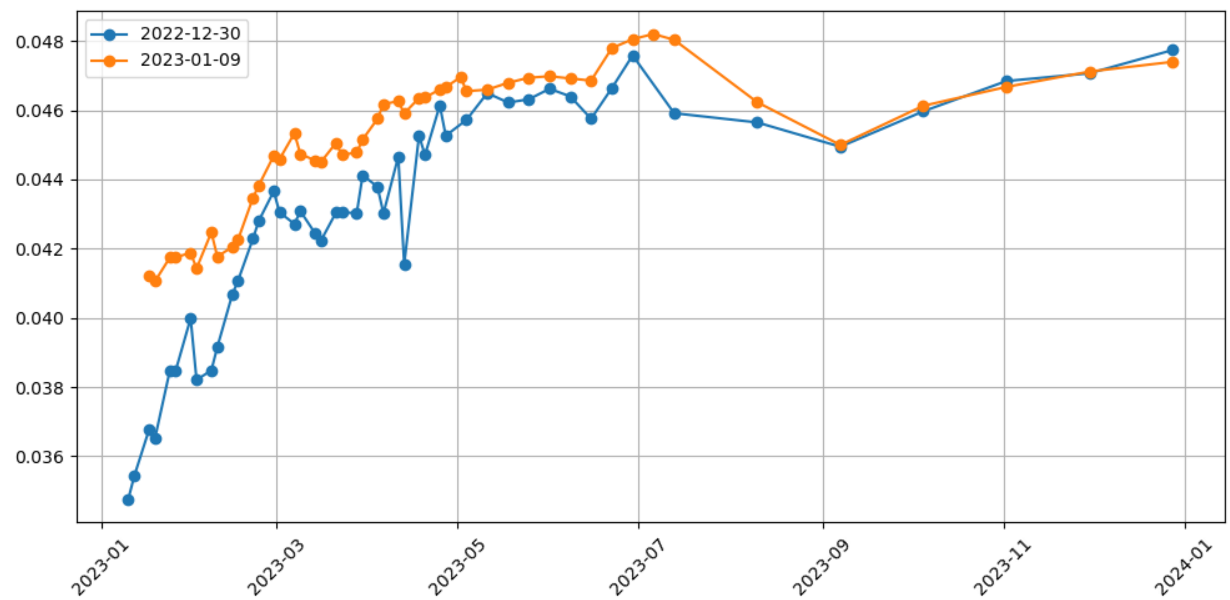


Figure 20
Evolution of CDS Spreads

This figure displays the evolution of the spreads of sovereign CDS over the course of 2023.

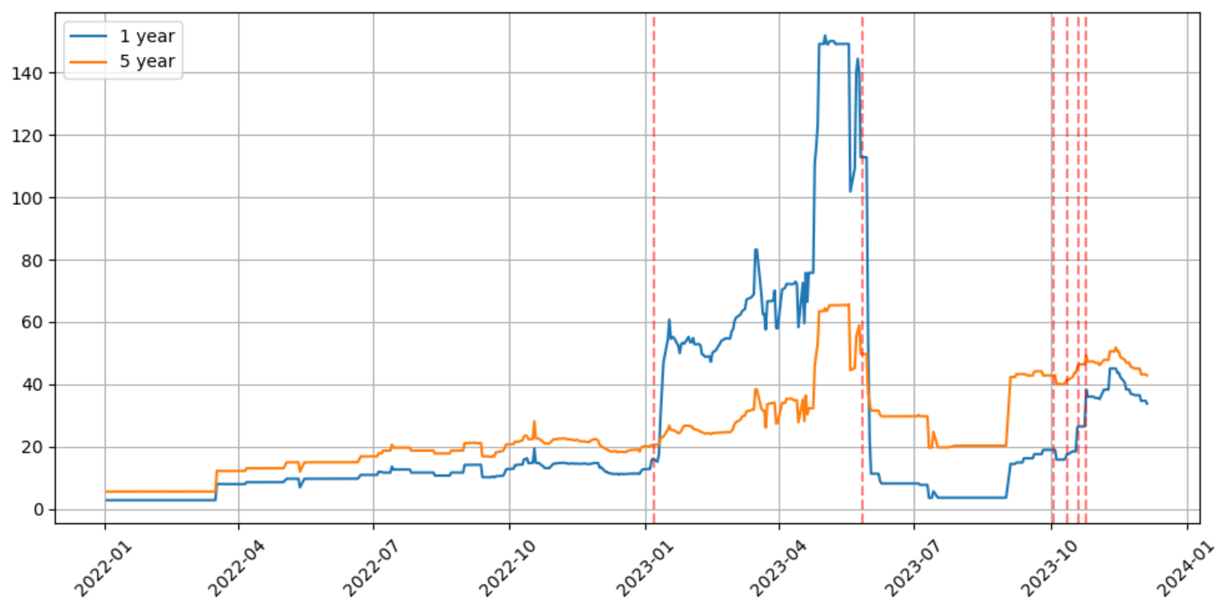


Figure 21
Short-Term High-Grade Non-Financial Commercial Paper Issuance

This figure displays regression results from stacked single-difference specifications of the form:

$$\text{Value Issuances Maturity} \leq 40 \text{ Days}_t = \sum_{-8 \leq k \leq 8} \beta_k \mathbb{I}\left\{t_x + 7k \leq t < t_x + 7(k+1)\right\} + \gamma_x$$

The dependent variable is the total daily (t) value of issuance of commercial paper with maturity greater than forty days and is measured in millions of dollars. t_x denotes the day of the X-date. γ_x are event fixed effects. We estimate this specification on the leading and trailing eight weeks around each X-date.

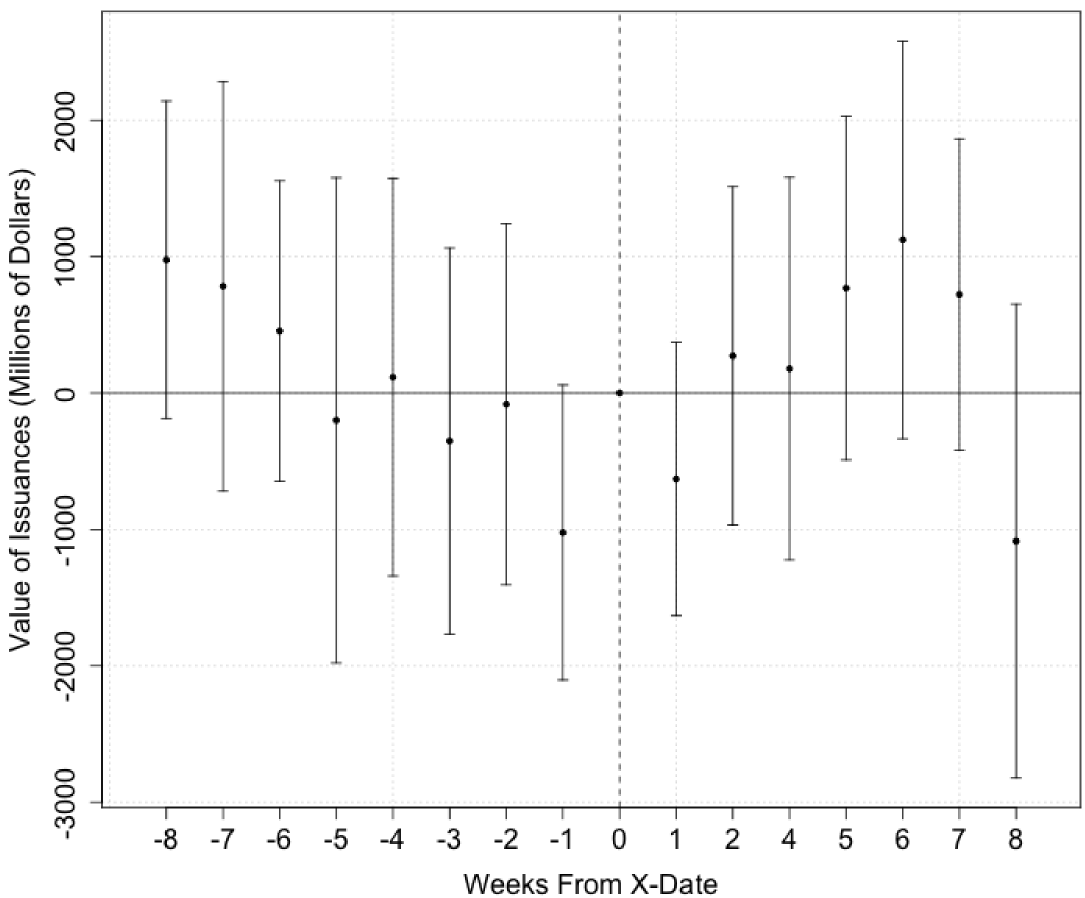
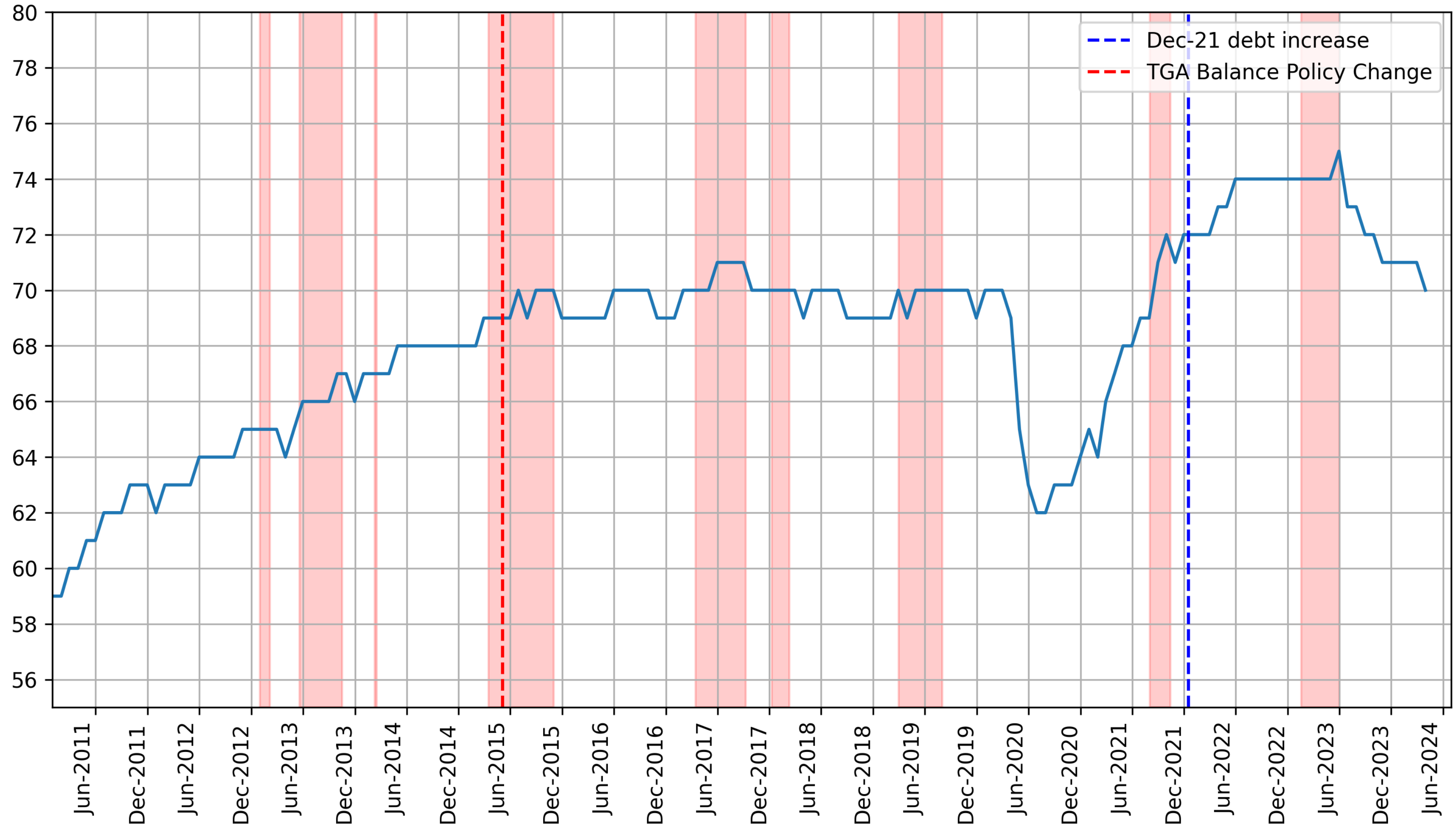


Figure 22
Average Maturity of Treasury Debt (months)

This figure displays the average maturity (in months) of outstanding Treasury Marketable securities, as disclosed in the Treasury's Quarterly Refunding Release Data. The shaded periods are from the start of each instance of the start of "extraordinary measures" to the day at which the debt ceiling was either suspended or raised. The pattern of increasing average maturities leading up to and during each of these episodes is notable, implying a reduction in outstanding bills.



C Additional Tables

Table 14
Summary Statistics – Treasury Repo Market

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

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

Table 15
Effect of Bill Supply Shocks Sample ex. Triple A

This table reports regression of the spread of corporate bonds over the effective federal funds rate in basis points on cumulative net issuance of treasury bills. We instrument cumulative net issuance with DCIV. The sample is all investment grade bonds excluding bonds rated triple A maturing between July 1, 2023 and July 1, 2024.

Dependent Variable:	Spread vs. Effective Funds Rate (bps)	
Model:	(1)	(2)
Variables		
Cumulative Net Issuance ($100s billions)	7.272***	8.770***
	(4.808)	(5.689)
Fixed-Effects		
CUSIP	Yes	Yes
Fit Statistics		
Observations	14,777	14,777
R^2	0.93894	0.93893
Within R^2	0.00491	0.00470

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

Table 16
Evolution of Bill Holdings First-Half 2023 compared to 2022

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

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

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

Dependent Variable:	Portfolio Share X Months Ahead				
Model:	(1)	(2)	(3)	(4)	(5)
Variables					
February 2023	-8.615***	-2.305***	-4.214***	-3.001***	-1.013***
	(-40.94)	(-14.55)	(-44.84)	(-97.98)	(-18.93)
March 2023	-0.6954	-6.575***	-6.290***	-3.742***	-0.0355
	(-1.803)	(-28.22)	(-50.34)	(-104.3)	(-0.5217)
April 2023	1.779***	-9.657***	-6.161***	-0.9139***	-2.044***
	(3.944)	(-28.59)	(-32.48)	(-20.43)	(-37.92)
May 2023	-8.356***	-5.120***	-1.153***	-1.995***	0.6849***
	(-24.19)	(-15.59)	(-4.889)	(-13.49)	(4.275)
Fixed-Effects					
Fund ID	Yes	Yes	Yes	Yes	Yes
Fit Statistics					
Observations	2,046	2,046	2,046	2,046	2,046
R^2	0.75980	0.66553	0.47308	0.29081	0.24397
Within R^2	0.04532	0.07161	0.09539	0.07799	0.07423

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

Table 17
Diff-in-Diff Results Around the Debt Ceiling Narrow Window

In this table we report results from difference-in-differences regressions of the form

$$\text{Yield}_{it} = \beta \mathbb{I}\left\{\text{Post}\right\}_t \times \mathbb{I}\left\{\text{Treated}\right\}_i + \nu_t + \eta_i$$

where $\mathbb{I}\left\{\text{Post}\right\}_t$ is the period immediately following the debt ceiling increase or suspension, indicated by the row "Treated Date". The treated and control groups are as indicated in the table. In all regressions we include both date and bond fixed effects. The dependent variable is expressed in basis points. This reports results from the same specifications as in Table **??**, but with narrower pre- and post-windows.

Dependent Variable:	Yield (bps)								
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables									
Post x Treated	88.80***	12.28**	19.33*	8.959***	23.90***	33.52***	9.552***	40.51***	14.66***
	(6.571)	(2.327)	(1.764)	(3.410)	(4.799)	(6.058)	(5.941)	(7.551)	(3.838)
Sample Description									
Treated Group	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp	IG Corp
Control Group	Agency	Agency	Agency	Agency	Agency	Agency	Agency	Agency	Agency
Sample Period	Jul-Sep 11	Sep-Nov 13	Jan-Mar 14	Oct-Dec 15	Aug-Oct 17	Jan-Mar 18	Jul-Aug 19	Nov-Jan 22	May-Jun 23
Treated Date	08/02/11	10/16/13	02/07/14	11/02/15	09/08/17	02/09/18	08/02/19	12/16/21	06/01/23
Fixed-Effects									
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cusip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics									
Observations	6,332	7,514	6,851	7,726	10,380	11,321	9,938	7,922	10,909
R^2	0.94407	0.98146	0.09812	0.88161	0.93316	0.97985	0.92161	0.79819	0.48304
Within R^2	0.00583	0.00031	0.00018	0.00025	0.00050	0.00100	0.00076	0.00140	0.00071

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

Table 18
Diff-in-Diff Results Around the Debt Ceiling AA and Above

In this table we report results from difference-in-differences regressions of the form

$$\text{Yield}_{it} = \beta \mathbb{I}\left\{\text{Post}\right\}_t \times \mathbb{I}\left\{\text{Treated}\right\}_i + \nu_t + \eta_i$$

where $\mathbb{I}\left\{\text{Post}\right\}_t$ is the period immediately following the debt ceiling increase or suspension, indicated by the row "Treated Date". The treated and control groups are as indicated in the table. In all regressions we include both date and bond fixed effects. The dependent variable is expressed in basis points. This reports results from the same specifications as in Table **??**, but with using only AA and above corporate debt as the treated group.

Dependent Variable:	Yield (bps)								
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables									
Post x Treated	-72.81***	-22.12***	-15.91*	-10.27	1.573	-13.49	-0.9429	21.43	-5.319
	(-4.587)	(-5.162)	(-1.736)	(-1.126)	(0.1745)	(-1.125)	(-0.1891)	(1.617)	(-1.021)
Sample Description									
Treated Group	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp
Control Group	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG
Sample Period	Jun-Oct 11	Aug-Dec 13	Dec-Apr 14	Sep-Jan 16	Jul-Nov 17	Dec-Apr 18	Jun-Sep 19	Oct-Feb 22	Apr-Jul 23
Treated Date	08/02/11	10/16/13	02/07/14	11/02/15	09/08/17	02/09/18	08/02/19	12/16/21	06/01/23
Fixed-Effects									
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cusip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics									
Observations	8,819	11,132	9,934	12,931	17,652	17,694	15,999	13,680	16,848
R^2	0.91899	0.98047	0.10840	0.77529	0.93763	0.97833	0.94222	0.77301	0.38037
Within R^2	0.00241	0.00051	0.00011	0.00011	2.68×10^{-6}	0.00017	5.21×10^{-6}	0.00050	4.75×10^{-5}

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

Table 19
Diff-in-Diff Results Using Spreads Around the Debt Ceiling

In this table we report results from difference-in-differences regressions of the form

$$\text{Yield}_{it} = \beta \mathbb{I}\left\{\text{Post}\right\}_t \times \mathbb{I}\left\{\text{Treated}\right\}_i + \nu_t + \eta_i$$

where $\mathbb{I}\left\{\text{Post}\right\}_t$ is the period immediately following the debt ceiling increase or suspension, indicated by the row "Treated Date". The treated and control groups are as indicated in the table. In all regressions we include both date and bond fixed effects. The dependent variable is expressed in basis points. This reports results from the same specifications as in Table **??**, but using the spread constructed from forward rates taken from federal funds futures.

Dependent Variable:	Yield (bps)								
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables									
Post x Treated	-73.04***	-22.12***	-15.93*	-10.08	1.885	-13.42	-1.917	23.00*	-6.182
	(-4.601)	(-5.160)	(-1.738)	(-1.106)	(0.2092)	(-1.119)	(-0.3831)	(1.730)	(-1.182)
Sample Description									
Treated Group	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp	AA Corp
Control Group	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG	Other IG
Sample Period	Jun-Oct 11	Aug-Dec 13	Dec-Apr 14	Sep-Jan 16	Jul-Nov 17	Dec-Apr 18	Jun-Sep 19	Oct-Feb 22	Apr-Jul 23
Treated Date	08/02/11	10/16/13	02/07/14	11/02/15	09/08/17	02/09/18	08/02/19	12/16/21	06/01/23
Fixed-Effects									
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cusip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit Statistics									
Observations	8,819	11,132	9,934	12,931	17,652	17,694	15,999	13,680	16,848
R^2	0.91904	0.98048	0.10857	0.77450	0.93752	0.97831	0.94194	0.77169	0.35988
Within R^2	0.00242	0.00051	0.00011	0.00010	3.84×10^{-6}	0.00017	2.16×10^{-5}	0.00057	6.33×10^{-5}

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