The On-the-Run Discount*

Zhuolu Gao Sven Klingler

October 28, 2026

Job Market Paper

Abstract

The on-the-run premium is one of the most widely studied phenomena in fixed-income markets. Contrary to this phenomenon, we document that the most recently issued (on-the-run) Treasury bills trade at a *discount* relative to older bills of comparable maturities. We link this *on-the-run discount* to short sellers' preference for seasoned bills, driven by the regular and predictable reopening auctions of Treasury bills. Borrowing demand for Treasury bills increases as they age and explains up to 71% of the variation in the on-the-run discount. The on-the-run discount affects the measurement of Treasury convenience premiums and the portfolio allocations of money market funds.

Keywords: Convenience premiums, Government debt, Liquidity, Primary dealers, Treasury auctions, Treasuries

JEL: E43, G12, G18, G29

*Gao and Klingler are at Frankfurt School of Finance and Management (e-mails: z.gao@fs.de and s.klingler@fs.de). We are grateful to Martin Andreasen, Darrell Duffie, Peter Feldhütter, Matthias Fleckenstein, Jean-Sébastien Fontaine, Refet Gürkaynak, David Hirshleifer, Kristy Jansen, David Lando, Wenhao Li, Weiling Liu, Francis Longstaff, Emanuel Moench, Win Monroe, Aaron Pancost, Suresh Sundaresan, Miklos Vari, Dimitri Vayanos, and seminar participants at Aarhus Finance Forum, Armenian Economic Association Conference, Bundesbank, Copenhagen Business School, FMA, FMA European Conference, Frankfurt School, and NFA for helpful comments and suggestions. Both authors gratefully acknowledge support from the European Research Council (ERC grant no. 101040188).

Introduction

Traditionally, the most recently issued (on-the-run) US Treasury security of a given maturity trades at a premium relative to other Treasuries of comparable maturity. This *on-the-run premium* is one of the most widely studied phenomena in fixed-income markets (e.g., Krishnamurthy, 2002, Goldreich et al., 2005, Vayanos and Weill, 2008, Pasquariello and Vega, 2009, Banerjee and Graveline, 2013, Fleckenstein and Longstaff, 2024). Trading the price difference between on-the-run and more seasoned Treasuries is also a famous hedge fund strategy (e.g., *The Economist*, October 17, 1998; Lowenstein, 2001) and a "textbook" arbitrage opportunity (e.g., Sundaresan, 2009, Veronesi, 2016, Pedersen, 2019).

In contrast to this established pattern, we show that the most recently issued Treasury bills generally trade at higher yields (i.e., lower prices) than more seasoned bills. Illustrating this *on-the-run discount*, the blue line in Figure 1 plots the yield spread between the first off-the-run 52-week bill and the on-the-run 52-week bill. In addition, the grey line plots the yield spread between the seasoned 52-week bill with 26 to 30 weeks left to maturity and the newly issued 26-week bill. Because all Treasury bills are widely considered highly liquid and money-like assets (e.g., Duffee, 1996; Krishnamurthy and Vissing-Jorgensen, 2012; Greenwood et al., 2015; Nagel, 2016), a persistent spread between two nearly identical securities is puzzling. Even more puzzling is the sign of the spread, which runs opposite to the established on-the-run premium for coupon-bearing Treasuries.

Examining the apparent puzzle, we first document that the borrowing demand for Treasury bills increases as they age, even though their market liquidity decreases. We then argue that the regular and predictable reopenings of 52-week bills increase the borrowing demand for seasoned bills as primary dealers and other auction participants manage their expected allocations. Consistent with this argument, short-selling demand for a bill rises in the run-

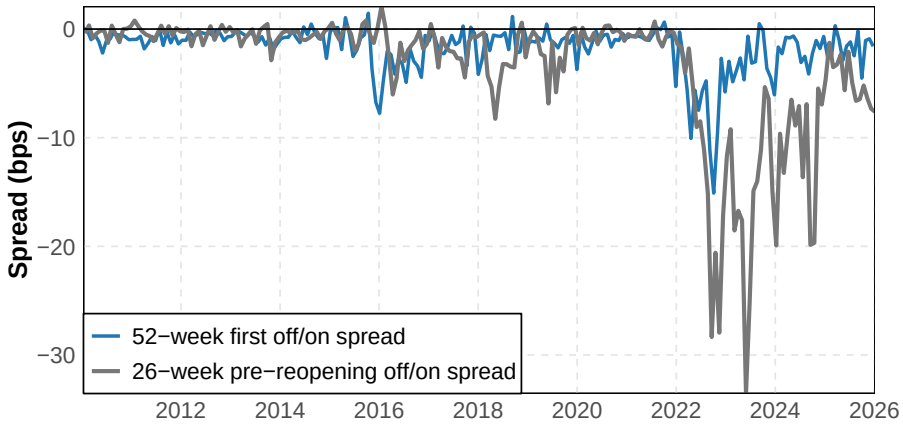


Figure 1: On-the-run discounts for 52-week and 26-week Treasury bills. The blue line shows the spread between the yield of the first off-the-run bill with an initial maturity of 52 weeks and the current on-the-run 52-week bill, averaged within each four-week cycle from the settlement of one 52-week bill to the day before the next. The grey line shows the spread between the yield of the 52-week bill approaching its 26-week reopening (with 26 to 30 weeks to maturity) and the yield of the on-the-run 26-week bill, the most recently settled 26-week security, averaged within each four-week window between consecutive reopening settlements. Both spreads are adjusted for the maturity mismatch between the two securities by subtracting the spread between the OIS rates matching the maturity of each security. Negative values occur when the on-the-run bill is cheaper than the off-the-run bill. Daily CRSP data from January 2010 to December 2025, 209 observations per series.

up to its reopening and falls sharply afterward. Moreover, differences in dealers' borrowing demand explain up to 71% of the variation in the on-the-run discount. The on-the-run discount affects the measurement of Treasury convenience premiums, which are significantly lower for on-the-run bills. In addition, money market mutual funds (MMFs) respond to the on-the-run discount and reduce their holdings of seasoned bills as these become more expensive.

We conduct our analysis in three parts. In the first part of the paper, we construct the on-the-run discount and explore its basic properties. Comparing off- and on-the-run

Treasury bills is particularly straightforward because bills pay no coupons. As a result, their yields are unaffected by accrued interest or coupon differences, making any two bills highly comparable. The main difference between on- and off-the-run bills is the remaining time to maturity, which we adjust for by using liquid overnight index swaps (OIS) with matching maturities. In addition, the regular reopenings allow us to compare on-the-run bills with seasoned bills that have longer remaining maturities. A similar discount in this comparison helps rule out the possibility that the on-the-run discount merely reflects a convenience premium in Treasury bills with shorter maturities.

Examining the resulting spreads, we document three stylized facts about the on-the-run discount. First, the spread between off- and on-the-run bills is unrelated to the same spread for Treasury notes.[1] Second, off-the-run bills are substantially more "special" in the repurchase agreement (repo) market, meaning that borrowing cash against them costs significantly less than borrowing against on-the-run bills. Third, transaction costs are *higher* for the more expensive off-the-run bills than for the cheaper on-the-run bills. Thus, off-the-run bills are cheap to finance but expensive to trade. This combination deepens the puzzle because it goes against the theoretical prediction that short sellers prefer more liquid securities (e.g., Duffie et al., 2002; Vayanos and Weill, 2008; Banerjee and Graveline, 2013).

In the second part of the paper, we therefore reconcile the on-the-run discount with existing theories. Vayanos and Weill (2008) argue that short sellers concentrate in the more liquid on-the-run securities, and Banerjee and Graveline (2013) show that short sellers account for a substantial fraction of the on-the-run premium in Treasury notes. Similarly, we argue that short sellers' preference for off-the-run bills explains the on-the-run discount. Even

[1] We calculate the spread between off-the-run and on-the-run securities in the same way for bills and for notes and bonds. Because the spread is predominantly negative for bills, we refer to it as the "on-the-run discount." This term contrasts it with the "on-the-run premium" documented in previous studies.

though off-the-run bills are less liquid, borrowing demand arises because of the regular and predictable reopenings of 52-week bills. Once a 52-week bill reaches 26 weeks to maturity, the Treasury auctions additional bills with the same CUSIP. Primary dealers and other auction participants manage their expected auction allocations with short positions in the security that is to be reopened.

To test this explanation, we construct three proxies of short-selling demand for individual bills. First, we use repo specialness, defined as the spread between the general collateral repo rate and the security-specific repo rate. Second, we measure borrowing demand in the Federal Reserve's (Fed's) securities-lending operations. The Fed lends Treasury securities from the System Open Market Account (SOMA) to primary dealers, who bid a lending fee for a given security. We define borrowing demand as the ratio of the quantity bid to the lendable supply. Third, we obtain securities-lending data from Markit and define the ratio of short loans to actively lendable supply as a demand proxy.

We use these three measures to examine how short-selling demand evolves as a bill ages. Consistent with seasoned bills being more attractive to short sellers, borrowing demand increases with bill age. However, borrowing demand drops sharply once the reopened bills settle, creating a discontinuity. These patterns suggest that short sellers especially value the ability to close their positions with newly issued bills. Our finding is reminiscent of the established auction cycle, in which primary dealers short close substitutes of the newly auctioned security to hedge expected auction allocations (e.g., Lou et al., 2013). While this pattern is known as the "auction tent," with short-selling demand rising and falling gradually around the auction, the pattern for Treasury bills is qualitatively different. Because dealers can short the very security that the Treasury reopens, we observe a "reopening cliff" with short-selling demand surging in the run-up to the auction and collapsing once the new bills

settle.

Next, we connect short-selling demand to the on-the-run discount. In levels, the borrowing demand differential at the Federal Reserve's securities-lending facility explains 27% of the variation in the yield spread between 52-week off-the-run and on-the-run bills and 71% of the variation in the yield spread between pre-reopening bills and 26-week bills. The association between the two variables remains intact after taking first differences and controlling for security-level differences in their available supply and market-based controls such as the ratio of outstanding bills to GDP.

In the final part of the paper, we examine the broader implications of the on-the-run discount. First, our results matter for measuring the convenience premium of Treasury bills. Investors value the convenience of holding money-like assets and therefore accept lower yields for holding these securities (e.g., Nagel, 2016). Previous studies show that this convenience premium increases as the security approaches its maturity date (e.g., Greenwood et al., 2015; Fleckenstein and Longstaff, 2024). We show that this link between convenience premium and time to maturity is interrupted by a sharp discontinuity around the reopening of the 52-week Treasury bill. Estimates of the convenience premium of Treasury bills thus depend on when in a bill's lifecycle the premium is measured and can increase by about six basis points if measured using off-the-run bills.

Second, the on-the-run discount affects the investment decisions of MMFs. MMFs are typically viewed as hold-to-maturity investors (e.g., Baklanova et al., 2022). Moreover, regulatory caps on weighted average maturity favor shorter-term securities, suggesting that seasoned bills should become more attractive to MMFs as they age. Yet we find that MMFs systematically reduce their holdings of 52-week bills as these bills age. Although MMFs cannot take short positions, they can reduce their holdings of relatively expensive seasoned bills

and increase their holdings of cheaper newly issued bills. Consistent with MMFs competing for small differences in returns (e.g., Kacperczyk and Schnabl, 2013; La Spada, 2018), this reduction is more pronounced when the on-the-run discount is larger.

1 Related Literature

This paper contributes to an extensive empirical literature on the relative pricing of US Treasury securities with similar maturities. Important examples include Gürkaynak et al. (2007), Fontaine and Garcia (2012), Hu et al. (2013), Musto et al. (2018), and Fleckenstein and Longstaff (2024). Two important subsets of this literature focus on the relative pricing of Treasury bills (e.g., Park and Reinganum, 1986; Ogden, 1987; Kamara, 1988; Amihud and Mendelson, 1991; Simon, 1991; Kamara, 1994; Duffee, 1996; Fleming, 2002; Strebulaev, 2002; Seligman, 2006) and on comparing the pricing of the most recently issued (on-the-run) security with that of slightly more seasoned (off-the-run) securities (e.g., Warga, 1992; Krishnamurthy, 2002; Fleming, 2003; Goldreich et al., 2005; Pasquariello and Vega, 2009; Graveline and McBrady, 2011). Closely related to our work, Fleming (2003) finds an on-the-run discount for Treasury bills but attributes it to the slope of the money market yield curve. This paper extends the literature on the relative pricing of Treasuries by showing that, for Treasury bills, the premium associated with the most recently issued Treasury security flips into a discount that cannot be explained by the slope of the yield curve.

Closely related to the relative pricing of Treasury securities is the concept of repo specialness. Studies examining repo specialness explain why particular securities become expensive to borrow and how this cost is capitalized into prices. Key examples include Keane (1995), Duffie (1996), Jordan and Jordan (1997), Buraschi and Menini (2002), Krishna-

murthy (2002), Graveline and McBrady (2011), D'Amico et al. (2018), Corradin and Maddaloni (2020), Dufour et al. (2020), and D'Amico and Pancost (2022). These studies focus on coupon-bearing securities and find that the on-the-run security is special. In theory, short sellers should prefer more liquid securities (e.g., Duffie et al., 2002; Vayanos and Weill, 2008; Banerjee and Graveline, 2013). Our paper extends the literature to Treasury bills and highlights a case where less liquid securities exhibit more repo specialness.

Our paper also relates to the vast literature on the convenience premium of US Treasuries. Investors value the safety and liquidity of Treasuries and accept yields below other benchmark rates for the convenience of holding them. For Treasury bills, this premium is typically measured on the on-the-run bill, using either the constant-maturity Treasury (CMT) yield or the secondary-market rate from the Federal Reserve's H.15 release, both of which capture the on-the-run yield.The benchmark rates used in this literature include commercial paper (Krishnamurthy and Vissing-Jorgensen, 2012; Krishnamurthy and Li, 2023), bankers' acceptance and repo rates (Nagel, 2016; Krishnamurthy and Li, 2023; Ross, 2020), overnight index swap rates (Sunderam, 2015; Augustin et al., 2021; Klingler and Sundaresan, 2023; Infante and Saravay, 2025), Federal Home Loan Bank discount note yields (Klingler and Sundaresan, 2023), and the interest rate on reserves (d'Avernas and Vandeweyer, 2024). Our paper adds to this literature by showing that the measured convenience premium of a Treasury bill depends on when in its lifecycle the bill is priced. Because the standard measures rely on on-the-run bills, they can substantially underestimate the convenience premium of Treasury bills.

2 Background and Data

In this section, we present the institutional background and describe the data underlying our analysis. Table 8 defines all variables and lists their sources. First, we give an overview of the Treasury bill market. Second, we explain how we construct the on-the-run discount. Third and finally, we introduce three proxies for capturing short-selling demand for individual Treasury bills.

2.1 The Treasury Bill Market

Treasury bills are zero-coupon securities with original maturities of up to 52 weeks. They are typically considered safe and liquid assets with money-like features (e.g., Greenwood et al., 2015; Nagel, 2016). One difference between Treasury bills and coupon-bearing Treasuries (which have initial maturities ranging from 2 to 30 years) is that the market liquidity of coupon-bearing securities drops sharply as the security ages (e.g., Fleming, 2003; Barclay et al., 2006; Pasquariello and Vega, 2009; Goyenko et al., 2011; Musto et al., 2018; Brain et al., 2018), while the trading volume of Treasury bills does not drop as sharply as the bill ages (Brain et al., 2018; see Internet Appendix Table IA.1), and reopened bills trade with narrower bid-ask spreads than newly issued bills of the same tenor (Fleming, 2002). Two potential reasons for this continued market liquidity of seasoned Treasury bills are (i) the Treasury auction mechanism, which often involves reopening existing Treasury bills, and (ii) their relatively short time to maturity and increased money-likeness as bills age.[2]

To elaborate on the first point, consider the 52-week Treasury bill, which has been issued every four weeks since its reintroduction in June 2008. When the original 52-week bill reaches

[2]The shorter the time to maturity of a Treasury bill, the lower its sensitivity to changes in interest rates and hence its price volatility. This lower volatility translates into lower bid-ask spreads (e.g., Ho and Stoll, 1981; Amihud and Mendelson, 1991).

a remaining maturity of 26 weeks, the Treasury reopens the same security through a 26-week bill auction.[3] Trading activity for a given security typically peaks around its auction (e.g., Lou et al., 2013; Fleming et al., 2024), which can boost the market liquidity of the Treasury bill (Pasquariello and Vega, 2009). Therefore, the reopening of seasoned bills helps maintain their high market liquidity. Nevertheless, Section 3 shows that seasoned bills still trade at wider bid-ask spreads than on-the-run bills. Coupon-bearing Treasuries are also reopened, often shortly after original issuance. However, these reopenings typically add supply to the current on-the-run issue, whereas bill reopenings reintroduce an aging security as the on-the-run issue in a shorter bill tenor.[4]

In our analysis, we focus on this reopening cycle for 52-week Treasury bills because their four-week auction cycle closely resembles the issuance pattern of coupon-bearing securities. We first compare the newly issued 52-week bill with the first off-the-run bill, issued four weeks earlier. In addition, we compare the 52-week bill in the weeks before its reopening with the on-the-run 26-week bill.

We obtain prices for Treasury bills and notes from CRSP and supplement these data with bid-ask spreads obtained from GovPX. We focus on bid-ask spreads from GovPX because Adrian et al. (2017) show that bid-ask spreads from CRSP are often stale for on-the-run securities. To identify on-the-run and off-the-run securities, we obtain detailed information on Treasury auctions from TreasuryDirect. Panel A of Table 1 provides summary statistics of the Treasury bill yields. The average 52-week on-the-run yield is 1.52% and two basis points higher than the average yield of the first 52-week off-the-run bill. Fleming (2003) observes

[3]Additional reopenings occur later in the bill's lifecycle, for instance, when the security reaches 13 weeks to maturity.

[4]Even though coupon-bearing Treasuries can also be reintroduced as a shorter-tenor issue, the time between issuance and reopening is substantially longer (i.e., years, not months) and less predictable than for Treasury bills.

a similar pattern and attributes it to the upward-sloping term structure of money market yields. However, this explanation cannot account for the lower yield of the pre-reopening off-the-run bill (1.44%) compared to the yield of the on-the-run 26-week bill (1.48%), which has a shorter remaining time to maturity.

2.2 Quantifying the On-the-Run Discount

Comparing on- and off-the-run Treasury bills is straightforward because bills are zero-coupon securities. In contrast to coupon-bearing Treasuries, the yields of Treasury bills are unaffected by differences in coupon rates, accrued interest, or coupon reinvestment. The main difference between two bills is their remaining time to maturity. This maturity gap is about four weeks for 52-week bills and ranges from zero to four weeks for the 26-week pair. Hence, isolating the on-the-run component requires adjusting for the slope of the yield curve. We do so by subtracting the difference in maturity-matched benchmark rates from the yield difference between the off-the-run and on-the-run bills.

Let $y_{p,t}$ denote the yield at time t of the p-th off-the-run security, where $p = 0$ for the on-the-run security and $p < 0$ indicates that the security will be reopened (and turn on-the-run again) after $|p|$ four-week auction cycles. Let $z_{p,t}$ denote the benchmark rate with the same remaining maturity as security p. To calculate the on-the-run spread, we use the benchmark-adjusted yield difference between the p-th off-the-run bill and the on-the-run bill:

$$Spread_{p,t} = y_{p,t} - y_{0,t} - (z_{p,t} - z_{0,t}), \tag{1}$$

which is lower when the on-the-run security is cheaper than the off-the-run security. For the first spread in our analysis, we focus on 52-week on-the-run bills and $p = 1$. For the second

Table 1: Summary statistics. Panel A reports average unadjusted CRSP midpoint yields for the 52-week on-the-run bill, the first 52-week off-the-run bill, the pre-reopening bill with 26 to 30 weeks to maturity, and the on-the-run 26-week bill. Panel B reports the maturity-gap adjustments $z_{1,t} - z_{0,t}$ for the 52-week pair and $z_{-1,t} - z_{0,t}$ for the reopening pair in basis points. The time to maturity for benchmark yield $z_{p,t}$ matches that of bill p. The OIS rows are the adjustments subtracted in the two spreads; the GSW and OIS-plus-CDS rows are alternative adjustments. The OIS-plus-CDS row also controls for the slope of the CDS term structure. The last column reports their correlation with the OIS adjustment. Panel C reports average repo specialness, the benchmark overnight repo rate minus the security-specific repo rate, available from August 2012. The on-the-run and first off-the-run rows average daily observations within each four-week cycle between consecutive 52-week settlements; the pre-reopening and 26-week rows average within each four-week window between consecutive reopening settlements. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel A. Cycle average unadjusted CRSP midpoint yields (%), 2010–2025

	Mean	SD	P25	Median	P75	*N*
On-the-run yield	1.52	1.75	0.16	0.53	2.54	209
First off-the-run yield	1.50	1.75	0.14	0.47	2.53	209
Pre-reopening off-the-run yield	1.44	1.79	0.09	0.38	2.43	209
On-the-run 26-week yield	1.48	1.84	0.10	0.39	2.44	209

Panel B. Cycle average maturity-gap adjustments (bps), 2010–2025

	Mean	SD	P25	Median	P75	*N*	Corr. with OIS
$z_{1,t} - z_{0,t}$ (OIS)	−0.28	2.27	−1.78	−0.38	0.47	209	
$z_{1,t} - z_{0,t}$ (GSW)	−0.25	2.24	−1.59	−0.40	0.38	209	0.96***
$z_{1,t} - z_{0,t}$ (OIS + CDS)	−0.49	2.34	−1.99	−0.61	0.28	209	0.93***
$z_{-1,t} - z_{0,t}$ (OIS)	0.31	1.90	−0.09	0.20	0.93	209	
$z_{-1,t} - z_{0,t}$ (GSW)	−0.08	1.87	−0.76	−0.19	0.74	209	0.86***
$z_{-1,t} - z_{0,t}$ (OIS + CDS)	0.42	1.90	−0.07	0.32	1.04	209	0.97***

Panel C. Cycle average repo specialness (bps), 2012–2025

	Mean	SD	P25	Median	P75	*N*
On-the-run specialness	1.26	9.06	-4.35	-1.02	2.57	169
First off-the-run specialness	7.87	20.66	-2.09	2.00	9.24	169
Pre-reopening off-the-run specialness	60.04	95.32	10.15	20.30	59.01	174
On-the-run 26-week specialness	0.33	4.59	-2.84	-0.47	2.15	174

spread, we focus on 26-week on-the-run bills and $p = -1$. We refer to these spreads as on-the-run *discounts* because they are predominantly negative. For coupon-bearing securities, this spread is typically positive and therefore often referred to as an on-the-run premium.

For our empirical analysis, we average daily spreads within each cycle from one delivery to the next. Specifically, for 52-week bills, we calculate the average spread from the settlement date of the new 52-week bill to the day before the next 52-week bill settles. For 26-week bills, we take four-week averages from the settlement of a reopened 52-week bill to the day before the next one settles. This averaging helps mitigate short-lived fluctuations around auction days (e.g., Lou et al., 2013; Fleming et al., 2026) and allows us to focus on the drivers of the overall spread.

Our preferred proxy for z comes from OIS rates. In an OIS with 18 or fewer months to maturity, two parties exchange a fixed rate against the average overnight rate during the lifetime of the swap.[5] OIS contracts are liquid and trade at granular monthly maturities up to one year. Because we use z only to adjust for the slope of the yield curve, the precise choice of z is less important than in other studies that, for example, examine the (in)convenience premium of Treasuries. As a robustness check, we also construct spreads using the smooth yield curve estimated by Gürkaynak et al. (2007).[6]

An additional concern with comparing Treasury bills with different maturities is differences in credit risk. As noted by Dittmar et al. (2026), political conflict over the debt

[5]The floating leg is based on the compounded overnight rate, and the daily overnight rates therefore enter through a geometric rather than arithmetic average. Traditionally, the predominant floating rate in OIS is the effective federal funds rate (FFR). This changed after the transition from the London Interbank Offered Rate (LIBOR) to the Secured Overnight Financing Rate (SOFR) in the US (e.g., Klingler and Syrstad, 2021). However, to obtain a consistent time series, we use FFR OIS for our main adjustment.

[6]This curve has been used by, among others, Goldreich et al. (2005) and Nagel (2016) to adjust for differences in coupon and maturity structure between on-the-run and off-the-run notes. However, the Gürkaynak et al. (2007) curve is based on coupon-bearing securities and is therefore less suitable for adjusting bill spreads.

limit has led to increased credit risk of Treasuries. Such credit risk could affect the on-the-run discount if the off-the-run bill matured before a debt-limit deadline while the on-the-run bill matured after the deadline. To capture such differences in credit risk, we follow Fleckenstein and Longstaff (2024) and add the interpolated sovereign CDS premium to z.[7]

Panel B of Table 1 shows that the maturity adjustment spreads, $z_{p,t} - z_{0,t}$, are small on average and highly correlated across different benchmark specifications. All relevant correlations are at least 0.86, suggesting that the choice of spread adjustment has, at most, a second-order effect on the on-the-run discount. We therefore focus on the OIS adjustment and control for the differential in CDS premiums in our regressions.[8]

Figure 1 shows the time series of the two spreads. Both are mostly negative throughout the sample period. The 52-week spread averages -1.7 basis points and is negative in 92% of cycles, while the 26-week pre-reopening spread averages -3.5 basis points and is negative in 86% of reopening windows. The discounts are largest in 2022 and 2023, when the 52-week spread and the 26-week pre-reopening spread reach -15 and -34 basis points, respectively.[9] Both series are persistent, with first-order autocorrelations of 0.63 and 0.84. In addition, Augmented Dickey–Fuller tests of both variables do not reject a unit root. Hence, in our empirical analysis, we focus on first differences in the spreads when studying their relationship

[7]While multiple studies emphasize the credit risk of the US Treasury (e.g., Augustin et al., 2021; Dittmar et al., 2026), Klingler and Lando (2018) argue that sovereign CDS are not a clean proxy of credit risk. This is less of a concern for our analysis because we only need the spread between CDS of different maturities for our adjustment.

[8]Because debt-limit risk is concentrated around particular payment dates, Table IA.2 in the Internet Appendix also excludes acute debt-limit periods and bill pairs whose maturity dates straddle projected X-dates. Both on-the-run discounts are robust to these exclusions.

[9]Part of the level increase in the on-the-run discount, especially since 2015, may reflect the fact that the ratio between the original 52-week bill issuance size and the 26-week bill reopening size dropped in this time period. A lower ratio means that the supply of 52-week bills is less able to accommodate short-selling demand in the run-up to the reopening auction. We show in Figures IA.1 and IA.2 in the Internet Appendix that this supply ratio may also explain why the 26-week pre-reopening discount was small from 1987 to 2001, when 52-week auctions were large relative to 26-week auctions.

to other variables.

2.3 Measuring Short-Selling Demand

We now explain our three proxies of short-selling demand. First, we compare the repo specialness of on- and off-the-run bills using granular, security-level special repo data from the Depository Trust & Clearing Corporation (DTCC). The data cover bilateral delivery-versus-payment repos cleared by DTCC's Fixed Income Clearing Corporation and capture interdealer transactions. DTCC reports daily numbers of trades, repo volumes, and volume-weighted repo rates for each security. The data start in January 2011 and the average total daily overnight repo volume captured in the DTCC data is $500 billion during our sample period and represents a substantial fraction of the overall US repo market. To construct a measure of repo specialness, we compute the difference between the market-wide Treasury repo rate for general collateral repos and the repo rate for security i on the same date. Our preferred proxy for market-wide repo rates is SOFR, which captures the cost of overnight borrowing collateralized with US Treasuries (see Klingler and Syrstad, 2021 for more details). Because SOFR is only constructed from 2014 on, we use the weighted average of the tri-party repo rate and the general collateral financing (GCF) rate before then.[10] The tri-party repo rate is available from August 2012, so repo specialness starts only in August 2012.

Panel C of Table 1 contains summary statistics for repo specialness for the four bills. The two on-the-run bills exhibit virtually no specialness, with average specialness of 1.3 basis points for the 52-week bill and 0.3 basis points for the 26-week bill. For off-the-run bills, specialness increases to 7.9 basis points for the first off-the-run bill and 60.0 basis points for the pre-reopening off-the-run bill. This pattern is consistent with Panel A, which shows

[10]This variable captures most transactions that are also included in the calculation of SOFR. Over the overlapping period, this benchmark is nearly perfectly correlated with SOFR, with a correlation of 0.9999.

that the seasoned bills have lower yields than their on-the-run counterparts.

Second, we collect information on the Federal Reserve's securities-lending facility, through which the Federal Reserve lends Treasury securities held in the System Open Market Account (SOMA) to primary dealers. For each security and operation date, the data contain the par amount submitted by dealers and the par amount the Fed can lend out. We define $BD_{i,t}^{Fed}$ as the ratio of the par amount of submitted bids to the par amount available. Because dealers bid at the facility only when a security cannot be obtained more cheaply in the market, the measure captures excess demand for a specific security. Usable coverage of 52-week bills begins in October 2019, when the Federal Reserve resumed its purchases of Treasury bills. The Federal Reserve reports a security only on days with bids, and we count an operation day without bids as zero demand once the bill is available for lending.

Third, we use securities-lending data from S&P Global Securities Finance (formerly IHS Markit), which collects daily records from the custodians and agent lenders that lend securities on behalf of institutional investors. For each security and day, we compute the borrowing demand, $BD_{i,t}^{Mkit}$, as the quantity on loan to short sellers, net of loans made for financing purposes, divided by the quantity that lenders actively make available. The advantage of the Markit data is their broad coverage from 2010 on. Their drawback is that they cover securities lending through participating custodians and agent lenders but do not capture important segments of the repo market, such as dealer-to-dealer repo transactions.[11] In addition, variation in contributor coverage and actively lendable supply introduces measurement error into the short-loan share. Despite these shortcomings, the Markit measure has a correlation of 0.6 with the Fed measure across security-days. We therefore use it as an additional robustness check.

[11] Consistent with the narrower coverage, Table IA.3 in the Internet Appendix shows that the quantity of Treasury bills observed on loan in Markit is relatively small.

3 Properties of the On-the-Run Discount

In this section, we highlight three properties of the on-the-run discount. First, the spread between off- and on-the-run bills is unrelated to the same spread for 2-year and 10-year Treasury notes. Second, seasoned bills are substantially more special in the repo market than on-the-run bills. Third and finally, the bid-ask spreads of the more expensive seasoned bills are higher than the bid-ask spreads of the cheaper on-the-run securities.

3.1 Correlation with Other Measures

To highlight the qualitative differences between bills and coupon-bearing securities, Table 2 shows the correlation between spreads of off- and on-the-run securities of different tenors. In the table, we focus on monthly average spreads and analyze first differences to avoid spurious correlations due to non-stationary time series.

The correlations show that on-the-run spreads for Treasury bills are disconnected from measures of Treasury market frictions focused on coupon-bearing securities. Changes in the 26-week and 52-week bill spreads are positively correlated, suggesting a common component in relative bill pricing. By contrast, bill spreads are not significantly correlated with the on-the-run spreads of 2-year and 10-year notes, while the note spreads are positively correlated with each other. The bill spreads also do not line up with standard Treasury liquidity or stress measures in the same way as note spreads. Their correlations with the note-bill spread (Amihud and Mendelson, 1991), the noise measure (Hu et al., 2013), and the MOVE index are either weak or of the opposite sign to those of coupon-bearing securities. Taken together, these patterns suggest that the on-the-run discount is distinct from the previously documented on-the-run premium.

Table 2: Correlation between on-the-run discounts and other measures. This table reports pairwise correlations of monthly changes among the two bill on-the-run discounts, the on-the-run spreads of 2- and 10-year notes, and other Treasury-market measures. $Spread_{-1,t}$ is the 26-week pre-reopening spread; $Spread_{1,t}$, $Spread^{2y}_{1,t}$, and $Spread^{10y}_{1,t}$ are the OIS-adjusted spreads between off-the-run and on-the-run 52-week bills, 2-year, and 10-year notes, respectively; Note/bill is the note-bill spread constructed following Amihud and Mendelson (1991); Noise is the noise measure of Hu et al. (2013); MOVE is the MOVE index. All series are first differences of monthly averages of daily data for the January 2010 to December 2025 period. p-values in brackets; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	$\Delta Spread_{1,t}$	$\Delta Spread^{2y}_{1,t}$	$\Delta Spread^{10y}_{1,t}$	Δ Note/bill	Δ Noise	Δ MOVE
$\Delta Spread_{-1,t}$	0.17**	0.10	−0.08	−0.12*	−0.09	0.05
	[0.02]	[0.18]	[0.27]	[0.09]	[0.20]	[0.50]
$\Delta Spread_{1,t}$		−0.12	0.03	−0.06	−0.04	−0.05
		[0.11]	[0.64]	[0.42]	[0.55]	[0.49]
$\Delta Spread^{2y}_{1,t}$			0.21***	0.28***	0.30***	0.21***
			[0.00]	[0.00]	[0.00]	[0.00]
$\Delta Spread^{10y}_{1,t}$				0.13*	0.21***	0.27***
				[0.06]	[0.00]	[0.00]

3.2 Special Repo Rates

We next investigate whether differences in repo specialness are related to the on-the-run discount. Repo markets reflect the costs of borrowing a specific Treasury security, and higher repo specialness typically translates into a higher price because the owners of the Treasury security can earn higher rents for lending the security out (e.g., Duffie, 1996, Jordan and Jordan, 1997, D'Amico et al., 2018, D'Amico and Pancost, 2022). We define the repo specialness differential as the on-the-run repo rate minus the off-the-run repo rate. Because a lower repo rate indicates greater specialness, a positive differential indicates that the off-the-run bill is more special than the on-the-run bill. If the on-the-run discount reflects scarcity in the repo market, we expect a positive repo specialness differential. We would also expect a larger differential to coincide with a larger on-the-run discount.

In line with this view, Table 3 shows that the repo specialness differential is positive on average in both pairs. It ranges from 6.8 basis points for the 52-week pair to 52.8 basis points for the 26-week pair. Moreover, changes in the differential are strongly negatively correlated with changes in the spread, with correlations of -0.47 and -0.70, respectively. Hence, when the seasoned bill becomes more special, its yield falls further below that of the on-the-run bill. The on-the-run discount in cash markets therefore moves with the relative cost of borrowing seasoned bills in the repo market. This pattern is the opposite of that for coupon-bearing securities, for which the on-the-run security is the most special (see Table IA.4 for evidence from Treasury notes).

3.3 Market Liquidity of Bills

For coupon-bearing securities, the most recently issued security is typically more liquid than older issues and therefore trades at a lower yield (e.g., Barclay et al., 2006; Pasquariello and Vega, 2009). If the on-the-run discount for bills reflected the same market liquidity channel in reverse, we would expect a negative bid-ask differential.

Table 3 shows that the bid-ask differentials are positive, ranging from 0.50 basis points for the 52-week pair to 0.92 basis points for the 26-week pair. Hence, the transaction costs of the more expensive off-the-run security are higher.[12] Moreover, the correlations between changes in bid-ask differentials and changes in the on-the-run discounts are negative, implying that seasoned bills become relatively more expensive when they become relatively less liquid. Table IA.6 in the Internet Appendix provides an overview of other pairwise correlations and highlights that, for the 26-week pair, higher GovPX bid-ask differentials coincide with higher repo specialness differentials. This is in sharp contrast to the on-the-

[12]Figure IA.3 provides a more detailed view of how bid-ask spreads evolve around 26-week reopenings, and Table IA.5 reports bid-ask spreads from both GovPX and CRSP.

Table 3: Market liquidity, repo specialness, and the on-the-run discounts. This table reports summary statistics for benchmark-adjusted bill spreads, repo specialness differentials, and bid-ask differentials, averaged within four-week cycles between consecutive 52-week settlements (Panel A) or windows between consecutive reopening settlements (Panel B). Panel A compares the on-the-run 52-week bill with the first off-the-run bill. Panel B reports the 26-week pre-reopening spread between the 52-week bill approaching its 26-week reopening and the on-the-run 26-week bill. Repo specialness differentials are the difference between the repo rate of the on-the-run and off-the-run security, expressed in basis points. Bid-ask differentials capture the difference between the GovPX bid-ask spread of the off-the-run and on-the-run bill, expressed in basis points of price. The correlation column uses cycle-to-cycle changes of each variable against the change in the spread. p-values from pairwise correlation tests; ***, **, and * indicate significance at the 1%, 5%, and 10% levels. The sample period is 2010–2025, with repo rates from January 2011.

Panel A. The 52-week first off/on spread, 2010–2025

	Mean	Median	N	Corr. with $\Delta Spread$	p-value
$Spread_{1,t}$	−1.69	−1.02	209		
Repo Specialness Differential$_{1,t}$	6.79	2.19	189	−0.47***	0.00
Bid-ask Differential$_{1,t}$	0.50	0.31	207	−0.28***	0.00

Panel B. The 26-week pre-reopening off/on spread, 2010–2025

	Mean	Median	N	Corr. with $\Delta Spread$	p-value
$Spread_{-1,t}$	−3.47	−1.02	209		
Repo Specialness Differential$_{-1,t}$	52.83	17.52	195	−0.70***	0.00
Bid-ask Differential$_{-1,t}$	0.92	0.61	208	−0.46***	0.00

run premium observed for coupon-bearing securities, where lower transaction costs coincide with higher market prices and higher repo specialness. Combined with the repo evidence above, these results show that off-the-run bills are cheap to finance but expensive to trade. This combination deepens the puzzle because it goes against the theoretical prediction that short sellers prefer more liquid securities (e.g., Duffie et al., 2002; Vayanos and Weill, 2008; Banerjee and Graveline, 2013).

4 The Mechanism behind the On-the-Run Discount

In this section, we revisit theories explaining the on-the-run premium and discuss how the Treasury bill market structure can give rise to an on-the-run discount. Afterward, we test whether the Treasury bill reopening cycle generates the borrowing demand that underlies the on-the-run discount.

4.1 Hypothesis

Existing explanations of the on-the-run premium rest on the superior market liquidity of the on-the-run security (Krishnamurthy, 2002, Vayanos and Weill, 2008, Pasquariello and Vega, 2009). Short sellers prefer the most liquid Treasury security (Vayanos and Weill, 2008, Banerjee and Graveline, 2013), and their borrowing demand raises the repo specialness of the on-the-run security, which in turn reinforces its market liquidity. Together, higher liquidity and repo specialness raise the price of the on-the-run security.

Like Vayanos and Weill (2008) and Banerjee and Graveline (2013), we attribute the on-the-run discount to short-selling demand. However, for Treasury bills, this demand arises *despite* the lower market liquidity of the off-the-run bill. Instead, it stems from the regular and predictable reopening schedule of 52-week bills, in which each 52-week bill is eventually reopened as a 26-week bill. The short sellers in this setting are primary dealers and other auction participants who manage their expected auction allocations with short positions in Treasury securities of similar maturity (e.g., Lou et al., 2013, Beetsma et al., 2016, Klingler and Sundaresan, 2023, Fleming et al., 2026). The reopening eases such exposure management because dealers can take short positions in the security that is to be auctioned instead of relying on close substitutes. In addition, the reopening makes any short positions particularly

attractive because it supplies additional amounts of the same CUSIP on a known settlement date, allowing traders to cover their short positions with the newly delivered securities.[13] Borrowing demand for the seasoned bill thus rises ahead of the reopening, even though its cash-market liquidity does not improve. This mechanism is also consistent with the observation that higher specialness coincides with lower market liquidity.

Our hypothesis is therefore that borrowing demand for a Treasury bill rises as the bill approaches its reopening date and drops sharply once the new bills settle. For the on-the-run discount, this implies a wider discount when borrowing demand for the off-the-run bill rises relative to borrowing demand for the on-the-run bill. We test these predictions in the following subsections.

4.2 Short-Selling Demand

To this end, we use the three proxies for security-specific short-selling demand constructed in Section 2.3. We first examine how the three measures evolve as an original 52-week bill approaches its 26-week reopening. Figure 2 presents the three proxies in age bins from the initial auction through the first twelve weeks after the reopening settlement. Panel (a) shows borrowing demand in the Federal Reserve's securities-lending operations, Panel (b) repo specialness, and Panel (c) the Markit short-loan share. All three increase as the reopening approaches, reach their highest values in the final pre-settlement bin, and fall sharply once the reopening supply is delivered and the bill becomes the new on-the-run 26-week bill.[14] While borrowing demand stays well below its pre-reopening peak over the following twelve

[13] Figure IA.4 shows that reopened 26-week bills have lower repo trading volume relative to the amount outstanding than newly issued 26-week bills, consistent with short positions accumulated before the reopening being covered after settlement.

[14] Table IA.7 confirms the existence of this reopening cliff in daily panel regressions with date fixed effects and separate distance trends before and after the settlement, and Columns (4) and (5) show that it survives holding the lendable amount fixed, although the drop in the Markit measure halves.

weeks, it rebuilds as the bill's 13-week reopening approaches.

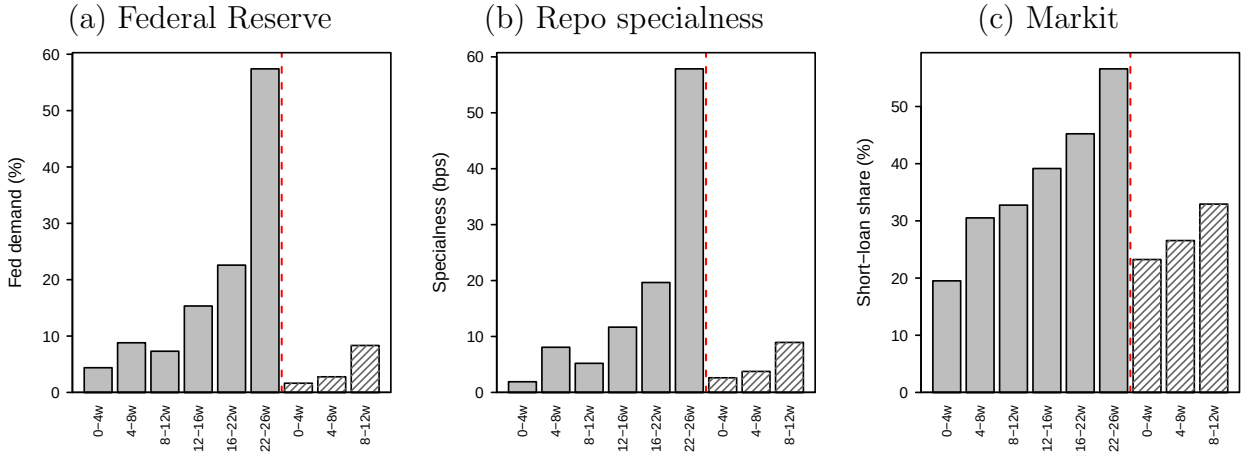


Figure 2: Borrowing demand and repo specialness before and after the 26-week reopening of a 52-week Treasury bill. Each bar shows the average of daily observations within an age bin. Panel (a) plots the borrowing demand estimated from Federal Reserve data, defined as par submitted relative to par available in the Federal Reserve's securities-lending operations. Panel (b) plots repo specialness, measured as the benchmark overnight repo rate minus the security-specific repo rate. Panel (c) plots the borrowing demand estimated from Markit, defined as short-loan quantity relative to actively lendable quantity in the Markit data. Age is measured in weeks from the 52-week auction; every day from week 22 until the settlement of the bill's 26-week reopening belongs to the 22–26 week bin. The three hatched bars cover the first twelve weeks from the settlement, in four-week bins, when the bill trades as a reopened 26-week bill; the red dashed line marks the settlement, and the window ends before the bill's 13-week reopening. Each panel uses the 52-week bills whose whole life lies in its data. The sample period is December 2019 to 2025 for the Federal Reserve measure, 2012 to 2025 for specialness, and 2010 to 2025 for the Markit measure.

We further examine the relationship between bill age and borrowing demand by comparing seasoned bills with newly issued bills. To that end, we use daily borrowing demand measures and regress them on an indicator variable that equals one for the seasoned bill of the pair, controlling for date fixed effects. Table 4 shows that, in the 52-week pair, the seasoned bill carries 3.8 percentage points more borrowing demand in the Federal Reserve data than the on-the-run bill, 6.7 basis points more specialness, and 12.0 percentage points

more borrowing demand in the Markit data. For the 26-week pair, the differences between off- and on-the-run legs widen to 54 percentage points of Federal Reserve borrowing demand, 64 basis points of specialness, and 41 percentage points of Markit borrowing demand.

Table 4: Scarcity of the seasoned bill relative to the newly issued bill. This table reports daily regressions of each scarcity measure on an indicator for the seasoned bill of the pair, with date fixed effects, so the coefficient is the average within-day difference between the seasoned and the newly issued bill. Columns (1) to (3) use the 52-week first off/on pair, the on-the-run 52-week bill and the first off-the-run bill, on the days on which the on-the-run bill has 48 to 52 weeks to maturity. Columns (4) to (6) use the 26-week pre-reopening pair, the 52-week bill in the four weeks before the settlement of its 26-week reopening and the on-the-run 26-week security, the most recently settled one. The dependent variables are $BD_{i,t}^{Fed}$, par submitted relative to par available in the Federal Reserve's securities-lending operations, in percent, with days without bids counted as zero once the bill is available for lending, overnight repo specialness in the DTCC data, in basis points, and $BD_{i,t}^{Mkit}$, the Markit short-loan share, in percent. The sample comprises the days on which both bills of the pair have the measure. The on-the-run leg mean is the average of the dependent variable for the newly issued bill. The numbers in parentheses are t-statistics based on standard errors clustered by date and CUSIP. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	52-week first off/on pair			26-week pre-reopening pair		
	$BD_{i,t}^{Fed}$	Specialness	$BD_{i,t}^{Mkit}$	$BD_{i,t}^{Fed}$	Specialness	$BD_{i,t}^{Mkit}$
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}$(Off-the-run)$_i$	3.83***	6.71***	12.00***	53.70***	64.34***	41.22***
	(3.02)	(6.13)	(10.37)	(15.62)	(11.92)	(22.12)
On-the-run leg mean	4.2	1.0	18.2	2.4	0.1	16.5
Date FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	2019–2025	2012–2025	2010–2025	2019–2025	2012–2025	2010–2025
Bills	83	171	207	325	677	800
Observations	3,102	5,052	7,572	3,106	5,480	7,410
Adjusted R^2	0.02	0.07	0.25	0.26	0.11	0.18

To conclude our examination of short-selling demand, we highlight the qualitative difference between the reopening cliff and the auction tent that is documented for Treasury notes (e.g., Lou et al., 2013). The blue line in Figure 3 shows the repo specialness of the seasoned

52-week bill around its reopening as a 26-week bill. Repo specialness increases sharply in the run-up to the auction, from 36 basis points ten business days before the auction to 110 basis points on the auction day. It keeps rising after the auction and peaks at 156 basis points on the business day before the reopened bills settle. On the settlement day, specialness collapses and stays close to zero thereafter. By contrast, the grey dashed line shows the specialness of the outgoing on-the-run 2-, 5-, and 10-year notes around the auction of the new notes that replace them. Their specialness rises gradually from 7 basis points ten business days before the auction to a peak of 37 basis points on the business day after the auction. It then declines gradually. When the new notes settle, the outgoing notes still carry about 22 basis points of specialness. Hence, the specialness of notes follows a tent centered on the auction, whereas the specialness of bills follows a cliff at settlement.

4.3 The On-the-Run Discount and Short-Selling Demand

Our hypothesis also links relative borrowing demand to the relative cash prices of seasoned and newly issued bills. For each pair p, we define the Federal Reserve and Markit borrowing demand differentials as borrowing demand for the seasoned security minus borrowing demand for the newly issued one, averaging both measures over the same cycle or reopening window used to construct the corresponding yield spread. The repo specialness differential of Section 3 has the same construction. Thus, a positive borrowing demand differential or repo specialness differential means that the seasoned bill is more heavily demanded by borrowers or is more special. Because $Spread_{p,t}$ is the OIS-adjusted yield of the seasoned bill minus that of the newly issued bill, the mechanism predicts a negative relationship between the yield spread and each measure of relative borrowing pressure.

Figure 4 illustrates this relationship in levels using the Federal Reserve borrowing demand

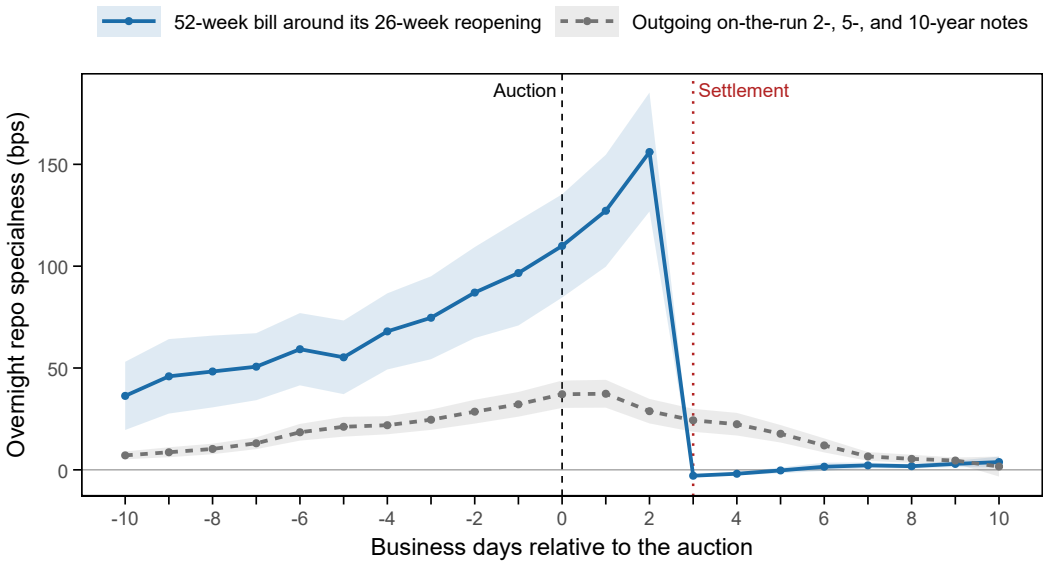
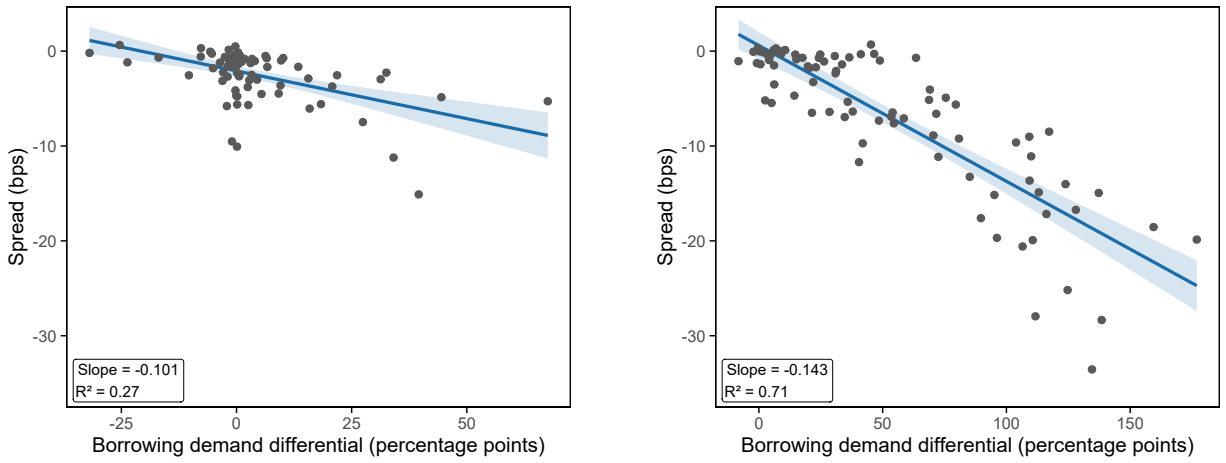


Figure 3: Repo specialness around bill reopenings and note auctions. This figure plots mean overnight repo specialness, measured as the benchmark overnight repo rate minus the security-specific repo rate in the DTCC data, in basis points, against business days relative to an auction. The solid blue line shows original 52-week bills around the auction of their 26-week reopening. The dashed grey line shows the outgoing on-the-run 2-, 5-, and 10-year notes around the auction of the new note that replaces them. Because 10-year notes are reopened while on the run, we use only the auctions of new 10-year notes, so no additional supply of the outgoing note arrives around the auction. Each point averages daily specialness across events; shaded areas show 95% confidence intervals based on the cross-sectional standard error. The black dashed line marks the auction, and the red dotted line marks the settlement of the reopened bills, three business days after the auction. New notes settle a median of four business days after the auction. Business days include all weekdays. The sample period is August 2012 to November 2025.

differential. The borrowing demand differential explains 27% of the variation in the 52-week first off/on spread in Panel (a) and 71% of the variation in the 26-week pre-reopening spread in Panel (b). In both cases, greater borrowing demand for the seasoned bill is associated with a more negative off/on spread, meaning that the seasoned bill trades richer relative to the newly issued bill and the on-the-run discount is larger.[15]



(a) 52-week first off/on spread

(b) 26-week pre-reopening off/on spread

Figure 4: On-the-run discounts and the borrowing demand differential. This figure plots the two on-the-run discounts of Figure 1 against the corresponding borrowing demand differential in the Federal Reserve's securities-lending operations, measured as borrowing demand for the seasoned leg minus borrowing demand for the newly issued leg, in percentage points. Panel (a) shows the 52-week first off/on pair, with one observation per cycle. Panel (b) shows the 26-week pre-reopening off/on pair, with one observation per reopening window. Yield spreads and borrowing demand differentials are averaged over the same days. The lines are OLS fits with 95% confidence bands; the boxes report the slope and the R^2. The sample covers cycles and reopening windows with Federal Reserve lending data, 2019–2025.

Because both the yield spreads and the measures of relative borrowing pressure are

[15]Examining the borrowing demand through the lens of repo specialness gives a qualitatively similar picture. Duffie (1996) and D'Amico and Pancost (2022) argue that the price of a special security includes the present value of the specialness it earns until it stops being special. We compare this premium with the 26-week pre-reopening spread, and Figure IA.5 in the Internet Appendix shows that the two track each other closely.

persistent, we use first differences in our regression analysis and estimate:

$$\Delta Spread_{p,t} = \alpha_p + \beta^{BD}\ \Delta BD\ Differential_{p,t} + \gamma' \Delta Controls_{p,t} + \varepsilon_{p,t}, \tag{2}$$

where the dependent variable is the change in the OIS-adjusted yield spread with $p = 1$ for the 52-week bill pair and $p = -1$ for the 26-week pre-reopening pair. As the main independent variable, we use the Federal Reserve borrowing demand differential. The controls include the difference in available supply between the off- and on-the-run securities, proxied by the par amount awarded to primary dealers at the bill's initial auction; the pair's CDS differential; the bill-to-GDP ratio; the MOVE index; the slope of the money market yield curve, measured as one-year-minus-one-month OIS; and the level of the one-month OIS rate.[16]

Table 5 shows the regression results. For the 52-week spread in Columns (1) and (2), a unit increase in the borrowing demand differential lowers the yield spread by 7.01 basis points without controls and 6.43 basis points with controls. For the 26-week pre-reopening spread in Columns (3) and (4), the coefficients are -7.31 and -7.57. The borrowing demand differential alone yields adjusted R^2 values of 0.31 and 0.36 for the two spread changes, and the coefficients remain statistically significant after adding the controls.

Table IA.8 in the Internet Appendix repeats the regressions using the repo specialness differential in Panel A and the Markit short-loan share in Panel B. Both measures yield qualitatively similar results. Because Markit measures the stock of outstanding loans whereas the Federal Reserve measure records bids at a backstop facility, the coefficient magnitudes

[16] An alternative to controlling for the CDS differential would be to measure Treasury richness as in Fleckenstein and Longstaff (2024) by directly adjusting for differences in CDS premiums. Because the OIS and OIS-plus-CDS adjustments are highly correlated, and we control for the CDS differential directly, we use the OIS adjustment in the main specification.

Table 5: Changes in the on-the-run discounts and the borrowing demand differential. This table reports window-to-window regressions of Equation (2) for the two on-the-run discounts of Figure 1. The dependent variable is the change in the OIS-adjusted 52-week first off/on spread, $\Delta Spread_{1,t}$, one observation per cycle, in Columns (1) and (2), and the change in the 26-week pre-reopening off/on spread, $\Delta Spread_{-1,t}$, one observation per reopening window, in Columns (3) and (4), both in basis points. Each relative measure is constructed as the value for the seasoned leg minus the value for the newly issued leg, averaged over the corresponding window. ΔBD^{Fed} *Differential*$_{p,t}$ uses par submitted relative to par available in the Federal Reserve's securities-lending operations, on the cycles and windows with Federal Reserve lending data, and is expressed as a ratio rather than a percentage. Δ*AS Differential*$_{p,t}$ is the change in the log available supply of the seasoned leg minus that of the newly issued leg, where available supply is the par amount awarded to primary dealers at the bill's initial auction. The even columns add this control, the pair's CDS differential, and the market controls listed in Section 4.3; the market controls are not reported. The numbers in parentheses are t-statistics based on heteroskedasticity-robust standard errors. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	$\Delta Spread_{1,t}$		$\Delta Spread_{-1,t}$	
	(1)	(2)	(3)	(4)
ΔBD^{Fed} *Differential*$_{p,t}$	-7.01^{***}	-6.43^{***}	-7.31^{***}	-7.57^{***}
	(-6.53)	(-6.70)	(-6.44)	(-6.40)
Δ*AS Differential*$_{p,t}$		1.10^{***}		1.77
		(3.09)		(1.48)
Δ*CDS Differential*$_{p,t}$		-0.16		1.55^{**}
		(-0.97)		(2.50)
Market controls	No	Yes	No	Yes
Sample	2019–2025	2019–2025	2019–2025	2019–2025
Observations	81	81	81	81
Adjusted R^2	0.31	0.36	0.36	0.40

are not directly comparable.[17]

5 Implications of the On-the-Run Discount

In this section, we draw out two implications of the on-the-run discount. Each concerns an established regularity in money markets that is interrupted by the reopening cycle. First, the convenience premium of US Treasuries increases as short-term Treasuries approach their maturity date. We document a sharp discontinuity in this pattern when the 52-week bill is reopened as a 26-week bill. Second, MMFs prefer Treasury bills with short maturities and are widely regarded as hold-to-maturity investors. MMF holdings are consistent with both descriptions for bills with less than six months to maturity. However, for 52-week bills, MMFs tilt toward longer maturities and reduce their positions as the reopening approaches.

5.1 Convenience Premiums of Near-Money Assets

The literature measures Treasury convenience premiums by comparing the yield of a Treasury security with a "risk-free" reference rate that carries no convenience benefits. Examples of reference rates include OIS rates referencing the effective federal funds rate (e.g., Klingler and Sundaresan, 2023; He et al., 2020), OIS rates referencing SOFR combined with a CDS contract on the US Treasury (Fleckenstein and Longstaff, 2024), and yields from a Treasury curve fitted on longer maturities (e.g., Greenwood et al., 2015).[18] While reference rates

[17]The results remain qualitatively similar when we restrict the sample to the cycles and reopening windows with Federal Reserve lending data (Internet Appendix Table IA.9).

[18]Other reference rates include the risk-free rate implied by put-call parity in index options (e.g., van Binsbergen et al., 2022), term repo rates (e.g., Nagel, 2016; Krishnamurthy and Li, 2023; Ross, 2020), the yield of highly rated commercial paper (e.g., Krishnamurthy and Vissing-Jorgensen, 2012), and the yield of Federal Home Loan Bank discount notes (e.g., Nagel, 2016; Klingler and Sundaresan, 2023). We focus on OIS rates and extrapolated Treasury yields because we require a reference rate available in granular maturity buckets between 22 and 52 weeks.

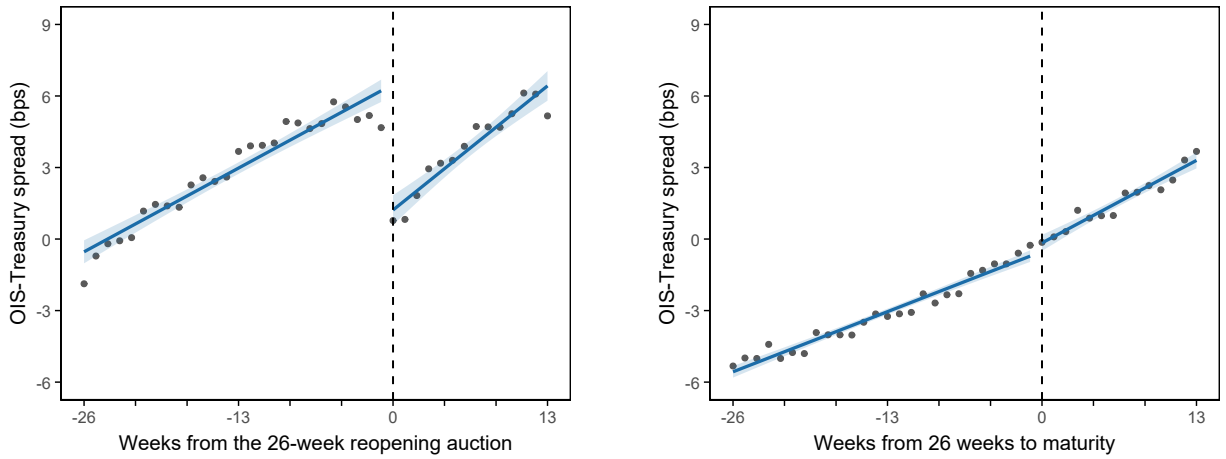
vary across studies, it is common to measure the convenience premium using on-the-run Treasuries.

A common view is that convenience premiums rise as maturity shortens, because shorter-term bills are closer substitutes for money (Krishnamurthy and Vissing-Jorgensen, 2012, Greenwood et al., 2015, Nagel, 2016, Fleckenstein and Longstaff, 2024). Reexamining this view, Figure 5 plots the term structure of the convenience premium, measured by OIS–Treasury spreads. Panel (a) shows the premium for original 52-week bills against the time to the 26-week reopening auction. In line with the previous literature, the premium increases as the bill ages and approaches its 26-week reopening. However, it drops sharply at the reopening and starts rebuilding afterward as the 26-week bill ages. Panel (b) repeats the exercise for 2-, 5-, and 10-year notes with less than one year to maturity. The richness of these securities also rises as maturity shortens. However, they are not reopened when they cross 26 weeks to maturity, and therefore their richness does not drop at 26 weeks.

To test for this reopening cliff in convenience premiums more formally, we examine the convenience premium $CY_{i,t}$ of bill i, measured either relative to the OIS rate, the CDS-adjusted SOFR OIS rate of Fleckenstein and Longstaff (2024), or the extrapolated Gürkaynak et al. (2007) yield. For each measure, we estimate the following regression:

$$CY_{i,t} = \beta_1 \mathbb{1}(\text{Reopened})_{i,t} + \beta_2 Distance_{i,t} + \beta_3 Distance_{i,t} \times \mathbb{1}(\text{Reopened})_{i,t} + FE_t + \epsilon_{i,t}, \tag{3}$$

where $CY_{i,t}$ is the convenience premium of bill i on date t, $\mathbb{1}(\text{Reopened})_{i,t}$ is an indicator variable that equals one from the day of the bill's 26-week reopening auction, $Distance_{i,t}$ is the number of days between date t and the reopening auction (negative before the auction), and FE_t are date fixed effects that absorb all market-wide variation, such as rate levels and



(a) Original 52-week bills

(b) Seasoned 2-, 5-, and 10-year notes

Figure 5: Average OIS–Treasury spread around the 26-week reopening: bills versus notes. Each dot shows the average OIS–Treasury spread, measured as the maturity-matched OIS rate minus the security's yield, in basis points; higher values indicate that the security is richer relative to OIS. Panel (a) plots original 52-week bills by the number of weeks between the observation date and the bill's 26-week reopening auction; the vertical dashed line marks the auction. Panel (b) plots seasoned 2-, 5-, and 10-year notes in the last year of their life, pooled across the three tenors and aligned at 26 weeks to maturity, the point at which a 52-week bill is reopened; these securities face no reopening. Both panels share the same vertical scale. The solid lines show separate weighted linear fits on each side of the dashed line, with shaded 95% confidence intervals. The sample period is 2010–2025.

seasonal effects.

As shown in Table 6, all three measures drop sharply at the reopening auction. This drop ranges from 5.9 to 6.3 basis points. Given that the average OIS–Treasury spread in the regression sample is 2.75 basis points, this discontinuity highlights that the magnitude of the convenience premium is strongly affected by when in a bill's lifecycle the premium is measured. In addition, the table confirms that convenience premiums increase with shorter

times to maturity.[19] Moreover, we find that the decline at the 26-week reopening is larger for bills that were more special beforehand and for larger primary-dealer allocations at the reopening (Table IA.11).

5.2 Money Market Funds Prefer On-the-Run Bills

In this subsection, we examine whether MMFs internalize the on-the-run discount. Most investors are not sensitive to small yield differentials between off- and on-the-run bills, holding Treasury bills for their safety and liquidity and accepting small yield spreads for the convenience of holding safe assets. By contrast, MMFs compete aggressively for small yield differentials (Kacperczyk and Schnabl, 2013; La Spada, 2018). They are large investors in the market for Treasury bills (e.g., Doerr et al., 2023). Although MMFs cannot take short positions, they can reduce their positions in expensive off-the-run bills and hold more of the cheaper on-the-run bills.

To investigate this possibility, we obtain MMF holdings of Treasury bills from Crane Data. We focus on Government and Treasury MMFs because other fund types hold virtually no Treasury bills. Panel (a) of Figure 6 shows aggregate average MMF holdings of 52-week bills by remaining maturity, measured as a fraction of the amount outstanding.[20] We examine the short end (six or fewer months to maturity) separately from the longer end (7 to 12 months to maturity). For the longer end, MMF holdings decrease as the bill ages. MMFs thus hold a larger share of the cheaper on-the-run bills and reduce their positions as the bill approaches its reopening. This tilt toward bills with longer maturities is especially surprising given that

[19] Given that the short-selling demand gradually rebuilds toward the 13-week reopening (Figure 2), we also repeat this analysis for 26-week bills around the 13-week reopening. Table IA.10 in the Internet Appendix shows a similar but smaller discontinuity in the convenience premium of around -1.4 basis points when the bill is reopened as a 13-week bill.

[20] Figure IA.6 in the Internet Appendix shows that this pattern is virtually identical when we include all Treasury bills.

Table 6: Convenience premiums over the bill's life. This table reports daily panel regressions of three convenience-premium measures for original 52-week Treasury bills on the bill's distance to its 26-week reopening auction, an indicator that equals one from the auction day, and their interaction. Each measure is a reference rate at the bill's remaining maturity minus the bill's yield, in basis points, so higher values mean that the bill is richer relative to the reference rate. Column (1) uses the maturity-matched OIS rate referencing the effective federal funds rate. Column (2) uses the synthetic risk-free rate of Fleckenstein and Longstaff (2024) (FL), SOFR OIS rates combined with the US sovereign CDS premium, from a replication of their measure. Column (3) uses the fitted Treasury curve of Gürkaynak et al. (2007) evaluated at the bill's remaining maturity. $Distance_{i,t}$ is the number of days between date t and bill i's 26-week reopening auction, negative before it, and $\mathbb{1}(\text{Reopened})_{i,t}$ equals one from the auction day, so its coefficient is the jump when the reopening supply is priced; an additional indicator for the settlement, three business days later, yields no further jump (untabulated). The window runs from each bill's 52-week auction to four weeks after its reopening settlement, and the sample period is 2010–2025. Average spread is the mean of the dependent variable in the regression sample, in basis points. All specifications include date fixed effects. The numbers in parentheses are t-statistics based on standard errors clustered by date and CUSIP. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	OIS-T	FL	GSW
	(1)	(2)	(3)
$\mathbb{1}(\text{Reopened})_{i,t}$	-6.299^{***}	-6.227^{***}	-5.868^{***}
	(-10.500)	(-10.321)	(-9.812)
$Distance_{i,t}$ (days)	0.039^{***}	0.030^{***}	0.050^{***}
	(17.626)	(13.207)	(14.658)
$Distance_{i,t} \times \mathbb{1}(\text{Reopened})_{i,t}$	0.069^{***}	0.072^{***}	0.087^{***}
	(9.957)	(7.322)	(6.925)
Average spread	2.75	16.99	6.99
Date FE	Yes	Yes	Yes
Bills	203	203	203
Observations	29,771	29,289	29,777
R^2	0.850	0.948	0.625
Adjusted R^2	0.827	0.940	0.567

regulatory rules generally push MMFs toward shorter-maturity instruments. By contrast, for bills with six or fewer months to maturity, holdings increase as maturity shortens.

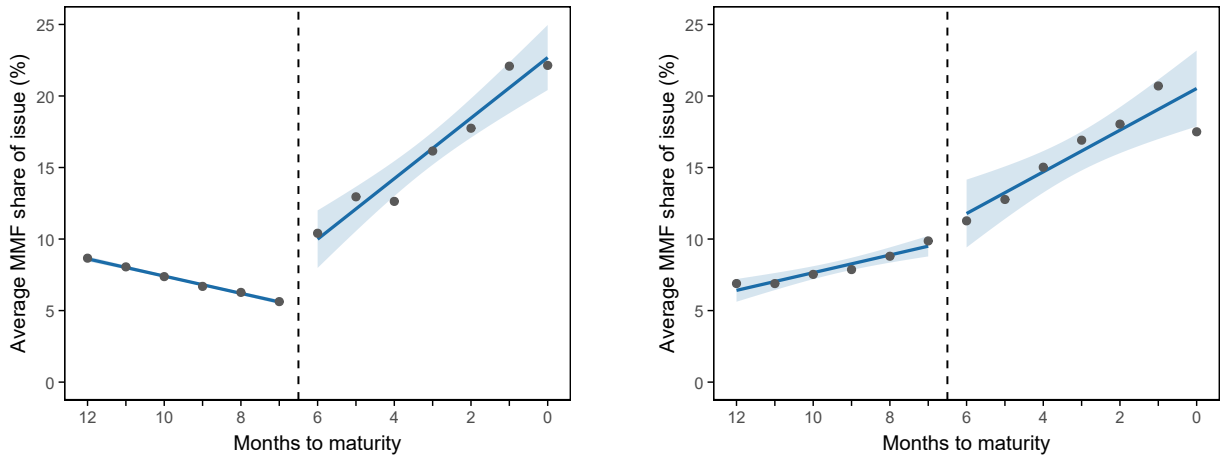
Panel (b) shows that MMF holdings of Treasury notes in their final year display no such reversal. The MMF share rises as maturity shortens. Hence, MMFs' tilt toward longer-term bills is specific to securities that are about to be reopened. Figure 6 thus suggests that MMFs are aware of the on-the-run discount and respond by holding more of the cheaper on-the-run securities. However, given that MMFs are relatively small investors in Treasury bills with longer maturities, it is plausible that their investment behavior is not enough to correct the on-the-run discount.

While Figure 6 provides suggestive evidence that MMFs are aware of the on-the-run discount, we next examine the association between their Treasury holdings and the on-the-run discount more closely. Because MMF holdings are only available monthly, we focus on their longer-term Treasury bill holdings and construct the principal-weighted aggregate duration of MMF holdings of Treasury bills with more than 36 weeks to maturity ($Duration_t$). We then construct the on-the-run discount as the difference between the OIS-adjusted yields of the fourth off-the-run bill (with about 36 weeks to maturity) and the on-the-run 52-week bill and run linear regressions of the following form:

$$Duration_t = \alpha + \beta Spread_{4,t} + \gamma' Controls_t + \epsilon_t. \tag{4}$$

We run the regressions in both levels and first differences. We pair the holdings at the end of each month with the average daily spread over the previous calendar month, so that the spread is measured before the portfolio it explains. Controls include aggregate MMF weighted average life and flows. In addition, for the level specification, controls include year fixed effects.

Table 7 shows the results of our analysis. The coefficient on $Spread_{4,t}$ is negative and sta-



(a) 52-week bills **(b)** Treasury notes

Figure 6: Money market fund holdings by remaining maturity: bills versus notes. This figure plots the average fraction of each issue held by money market funds, in percent of the amount outstanding, by remaining maturity in months, using month-end Crane holdings matched to Treasury issuance data. Panel (a) covers securities issued as 52-week Treasury bills, followed through their reopenings (178 bills, October 2011 to July 2025). Panel (b) covers Treasury notes in the last year of their life (758 securities, same period). Each dot is the average across issue-month observations in that months-to-maturity bin, and both panels share the same vertical scale. The solid lines show separate weighted linear fits for the 7-to-12-month and 0-to-6-month segments, with shaded 95% confidence intervals, and the vertical dashed line marks 26 weeks to maturity, the point at which a 52-week bill is reopened. For bills, the share falls as the security ages toward its reopening and rises afterward; for notes, the share rises monotonically as maturity shortens.

tistically significant across specifications. Since more negative values of $Spread_{4,t}$ correspond to a deeper on-the-run discount, the estimates imply that deeper discounts are associated with longer MMF bill portfolios and a larger tilt toward bills with a longer time to maturity. This evidence is consistent with MMFs responding to cheap on-the-run bills by buying longer-maturity bills and reducing their holdings of more expensive shorter-maturity bills.

Table 7: On-the-run discounts and money market fund portfolio maturity. This table reports monthly regressions of the maturity profile of money market fund Treasury bill portfolios on the 52-week bill on-the-run discount. The dependent variable, Duration, is the principal-weighted remaining maturity, in months, of MMF Treasury bill holdings with more than 252 days remaining to maturity. The key explanatory variable, $Spread_{4,t}$, is the OIS-adjusted spread between the fourth off-the-run 52-week bill and the current on-the-run bill; more negative values indicate a deeper on-the-run discount. It is the average daily spread over the calendar month before the holdings date. Columns (1)–(2) use levels and include year fixed effects, while Columns (3)–(4) use first differences. Columns (2) and (4) include aggregate MMF weighted average life and flows as controls. The sample is monthly and determined by the overlap of Crane holdings and 52-week spread data. The numbers in parentheses are t-statistics based on Newey–West standard errors with 12 lags in Columns (1) and (2) and on heteroskedasticity-robust standard errors in Columns (3) and (4). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Levels		Changes	
	(1)	(2)	(3)	(4)
$Spread_{4,t}$	-0.03^{**}	-0.03^{***}	-0.04^{***}	-0.04^{***}
	(-2.10)	(-2.63)	(-2.89)	(-2.65)
WAL		0.003		0.04
		(0.25)		(1.45)
Flow		0.59		-1.09
		(0.76)		(-0.90)
Constant			-0.01	-0.01
			(-0.16)	(-0.18)
Year FE	Yes	Yes	No	No
Observations	163	160	160	157
Adjusted R^2	-0.01	-0.03	0.04	0.05

6 Conclusion

We show that the most recently issued US Treasury bill trades at a discount relative to older Treasury bills of comparable maturity. This on-the-run discount for Treasury bills contrasts with coupon-bearing on-the-run Treasuries, which trade at a premium relative to comparable seasoned securities. The higher price of the seasoned Treasury bills coincides with higher repo specialness but also higher transaction costs. To explain this puzzling on-

the-run discount, we link it to the Treasury bill reopening cycle and short-selling activity. As a bill approaches its reopening, its relative price increases as short-selling demand and repo specialness increase. We refer to this pattern as the "reopening cliff" because the relative price drops at the reopening auction and short-selling demand collapses once the reopening delivers additional securities of the same CUSIP. Viewed from the other side of the trade, the discount reflects a reopening premium, with seasoned bills commanding higher prices.

The reopening cycle has two broader implications. First, it interrupts the term structure of convenience premiums. The convenience premium of a 52-week bill rises as the bill ages, drops by roughly 6 basis points at the reopening auction, and then builds anew. Hence, the measured convenience premium of a near-money asset depends on where in the reopening cycle the security sits. Second, MMFs appear to respond to the discount by holding more of the cheaper on-the-run bills and reducing their positions in seasoned bills as the reopening approaches.

References

Adrian, T., M. J. Fleming, and E. Vogt (2017). An index of Treasury market liquidity: 1991-2017. Working paper, Federal Reserve Bank of New York.

Amihud, Y. and H. Mendelson (1991). Liquidity, maturity, and the yields on us treasury securities. *The Journal of Finance 46*(4), 1411–1425.

Augustin, P., M. Chernov, L. Schmid, and D. Song (2021). Benchmark interest rates when the government is risky. *Journal of Financial Economics 140*(1), 74–100.

Baklanova, V., I. Kuznits, and T. Tatum (2022). Money market funds in the Treasury

market. U.S. Securities and Exchange Commission, Division of Investment Management, Analytics Office.

Banerjee, S. and J. J. Graveline (2013). The cost of short-selling liquid securities. *Journal of Finance 68*(2), 637–664.

Barclay, M. J., T. Hendershott, and K. Kotz (2006). Automation versus intermediation: Evidence from treasuries going off the run. *The Journal of Finance 61*(5), 2395–2414.

Beetsma, R., M. Giuliodori, F. De Jong, and D. Widijanto (2016). Price effects of sovereign debt auctions in the euro-zone: The role of the crisis. *Journal of Financial Intermediation 25*, 30–53.

Brain, D., M. De Pooter, D. Dobrev, M. Fleming, P. Johansson, F. Keane, M. Puglia, T. Rodrigues, and O. Shachar (2018). Breaking down TRACE volumes further. *Liberty Street Economics Blog*.

Buraschi, A. and D. Menini (2002). Liquidity risk and specialness. *Journal of Financial Economics 64*(2), 243–284.

Corradin, S. and A. Maddaloni (2020). The importance of being special: Repo markets during the crisis. *Journal of Financial Economics 137*(2), 392–429.

D'Amico, S., R. Fan, and Y. Kitsul (2018). The scarcity value of treasury collateral: Repo-market effects of security-specific supply and demand factors. *Journal of Financial and Quantitative Analysis 53*(5), 2103–2129.

D'Amico, S. and N. A. Pancost (2022). Special repo rates and the cross-section of bond prices: The role of the special collateral risk premium. *Review of Finance 26*(1), 117–162.

d'Avernas, A. and Q. Vandeweyer (2024). Treasury bill shortages and the pricing of short-term assets. *Journal of Finance 79*(6), 4083–4141.

Dittmar, R. F., A. Hsu, G. Roussellet, and P. Simasek (2026). Default risk and the pricing of us sovereign bonds. *The Journal of Finance 81*(2), 829–869.

Doerr, S., E. Eren, and S. Malamud (2023). Money market funds and the pricing of near-money assets. Working paper, Swiss Finance Institute.

Duffee, G. R. (1996). Idiosyncratic variation of treasury bill yields. *The Journal of Finance 51*(2), 527–551.

Duffie, D. (1996). Special repo rates. *The Journal of Finance 51*(2), 493–526.

Duffie, D., N. Garleanu, and L. H. Pedersen (2002). Securities lending, shorting, and pricing. *Journal of Financial Economics 66*(2-3), 307–339.

Dufour, A., M. Marra, I. Sangiorgi, and F. S. Skinner (2020). Explaining repo specialness. *International Journal of Finance and Economics 25*(2), 172–196.

Fleckenstein, M. and F. A. Longstaff (2024). Treasury richness. *The Journal of Finance 79*(4), 2797–2844.

Fleming, M., G. Nguyen, and J. Rosenberg (2024). How do treasury dealers manage their positions? *Journal of Financial Economics 158*, 103885.

Fleming, M. J. (2002). Are larger treasury issues more liquid? evidence from bill reopenings. *Journal of Money, Credit and Banking 34*(3), 707–735.

Fleming, M. J. (2003). Measuring treasury market liquidity. *Federal Reserve Bank of New York Economic Policy Review 9*(3), 83–108.

Fleming, M. J., W. Liu, and G. Nguyen (2026). Intraday price pressure and order flow around us treasury auctions. *Federal Reserve Bank of New York Staff Report* (1188).

Fontaine, J. S. and R. Garcia (2012). Bond liquidity premia. *The Review of Financial Studies 25*(4), 1207–1254.

Goldreich, D., B. Hanke, and P. Nath (2005). The price of future liquidity: Time-varying liquidity in the us treasury market. *Review of Finance 9*(1), 1–32.

Goyenko, R., A. Subrahmanyam, and A. Ukhov (2011). The term structure of bond market liquidity and its implications for expected bond returns. *Journal of Financial and Quantitative Analysis 46*(1), 111–139.

Graveline, J. J. and M. R. McBrady (2011). Who makes on-the-run Treasuries special? *Journal of Financial Intermediation 20*(4), 620–632.

Greenwood, R., S. G. Hanson, and J. C. Stein (2015). A comparative-advantage approach to government debt maturity. *The Journal of Finance 70*(4), 1683–1722.

Gürkaynak, R. S., B. Sack, and J. H. Wright (2007). The US Treasury yield curve: 1961 to the present. *Journal of Monetary Economics 54*(8), 2291–2304.

He, Z., S. Nagel, and Z. Song (2020). Treasury inconvenience yields during the covid-19 crisis. Working paper, National Bureau of Economic Research.

Ho, T. and H. R. Stoll (1981). Optimal dealer pricing under transactions and return uncertainty. *Journal of Financial Economics 9*(1), 47–73.

Hu, G. X., J. Pan, and J. Wang (2013). Noise as information for illiquidity. *The Journal of Finance 68*(6), 2341–2382.

Infante, S. and Z. Saravay (2025). Treasury Reuse and the Demand for Safe Assets. *Review of Financial Studies*. Forthcoming.

Jordan, B. D. and S. D. Jordan (1997). Special repo rates: An empirical analysis. *The Journal of Finance 52*(5), 2051–2072.

Kacperczyk, M. and P. Schnabl (2013). How safe are money market funds? *Quarterly Journal of Economics 128*(3), 1073–1122.

Kamara, A. (1988). Market trading structures and asset pricing: Evidence from the Treasury-bill markets. *Review of Financial Studies 1*(4), 357–375.

Kamara, A. (1994). Liquidity, taxes, and short-term treasury yields. *Journal of Financial and Quantitative Analysis 29*(3), 403–417.

Keane, F. (1995). Expected repo specialness costs and the Treasury auction cycle. Research Paper 9504, Federal Reserve Bank of New York.

Klingler, S. and D. Lando (2018). Safe haven CDS premiums. *The Review of Financial Studies 31*(5), 1855–1895.

Klingler, S. and S. Sundaresan (2023). Diminishing treasury convenience premiums: Effects of dealers' excess demand and balance sheet constraints. *Journal of Monetary Economics 135*, 55–69.

Klingler, S. and O. Syrstad (2021). Life after LIBOR. *Journal of Financial Economics 141*(2), 783–801.

Krishnamurthy, A. (2002). The bond/old-bond spread. *Journal of Financial Economics 66*(2-3), 463–506.

Krishnamurthy, A. and W. Li (2023). The Demand for Money, Near-Money, and Treasury Bonds. *Review of Financial Studies 36*(5), 2091–2130.

Krishnamurthy, A. and A. Vissing-Jorgensen (2012). The aggregate demand for Treasury debt. *Journal of Political Economy 120*(2), 233–267.

La Spada, G. (2018). Competition, reach for yield, and money market funds. *Journal of Financial Economics 129*(1), 87–110.

Lou, D., H. Yan, and J. Zhang (2013). Anticipated and repeated shocks in liquid markets. *The Review of Financial Studies 26*(8), 1891–1912.

Lowenstein, R. (2001). *When genius failed: The rise and fall of Long-Term Capital Management*. Random House trade paperbacks.

Musto, D., G. Nini, and K. Schwarz (2018). Notes on bonds: Illiquidity feedback during the financial crisis. *The Review of Financial Studies 31*(8), 2983–3018.

Nagel, S. (2016). The Liquidity Premium of Near-Money Assets. *Quarterly Journal of Economics 131*(4), 1927–1971.

Ogden, J. P. (1987). The end of the month as a preferred habitat: A test of operational efficiency in the money market. *Journal of Financial and Quantitative Analysis 22*(3), 329–343.

Park, S. Y. and M. R. Reinganum (1986). The puzzling price behavior of Treasury bills that mature at the turn of calendar months. *Journal of Financial Economics 16*(2), 267–283.

Pasquariello, P. and C. Vega (2009). The on-the-run liquidity phenomenon. *Journal of Financial Economics 92*(1), 1–24.

Pedersen, L. H. (2019). *Efficiently inefficient: How smart money invests and market prices are determined*. Princeton University Press.

Ross, C. P. (2020). Safe Asset Migration. Working paper, Yale School of Management.

Seligman, J. (2006). Does urgency affect price at market? An analysis of U.S. Treasury short-term finance. *Journal of Money, Credit and Banking 38*(4), 989–1012.

Simon, D. P. (1991). Segmentation in the Treasury bill market: Evidence from cash management bills. *Journal of Financial and Quantitative Analysis 26*(1), 97–108.

Strebulaev, I. A. (2002). Many faces of liquidity and asset pricing: Evidence from the US Treasury securities market. Working paper, UCLA.

Sundaresan, S. (2009). *Fixed income markets and their derivatives*. Academic Press.

Sunderam, A. (2015). Money creation and the shadow banking system. *The Review of Financial Studies 28*(4), 939–977.

van Binsbergen, J. H., W. F. Diamond, and M. Grotteria (2022). Risk-free interest rates. *Journal of Financial Economics 143*(1), 1–29.

Vayanos, D. and P.-O. Weill (2008). A search-based theory of the on-the-run phenomenon. *The Journal of Finance 63*(3), 1361–1398.

Veronesi, P. (2016). *Handbook of fixed-income securities*. John Wiley & Sons.

Warga, A. (1992). Bond returns, liquidity, and missing data. *Journal of Financial and Quantitative Analysis 27*(4), 605–617.

Table 8: Variable description. This table defines the variables used in our empirical analysis and shows the data sources.

Variable	Description	Source
OIS rates	Overnight index swap rates with maturities of 1 to 11 months and 1, 2, 3, 5, 7, 10, 15, 20, and 30 years, linearly interpolated to each security's remaining maturity.	Bloomberg
GSW yields	Continuously compounded zero-coupon yields from a fitted Svensson curve, evaluated at each security's remaining maturity. The curve is fitted to off-the-run Treasury notes and bonds and excludes bills.	Gürkaynak et al. (2007)
CDS adjustment	US sovereign CDS spreads are interpolated across maturities and added to OIS-based benchmark adjustments as robustness checks. The CDS differential between the two securities of a pair is also a control in the regressions.	Markit
On-the-run spreads	Yield difference between an off-the-run security and the most recently settled security of the same original tenor, adjusted for differences in maturity using interpolated OIS rates, as in Equation (1). On-the-run status is determined at settlement. Daily spreads are averaged over issuance cycles, from one settlement date to the day before the next.	Author calculations
Pre-reopening off/on spreads	Yield difference between the 52-week bill approaching its 26-week reopening and the current on-the-run 26-week bill, adjusted for differences in maturity using interpolated OIS rates, as in Equation (1). Daily spreads are averaged over four-week windows from one reopening settlement to the day before the next.	Author calculations
SOFR rates	The overnight repo benchmark is SOFR from August 2014. We construct synthetic SOFR as the volume-weighted average of the general-collateral (GC) repo rate and the BNY Tri-Party Repo Index between August 2012 and August 2014.	Fed, DTCC and BNY Tri-Party Repo Index
Repo rates and specialness	Security-level overnight repo rates are volume-weighted repo rates. Repo specialness is SOFR minus security-specific repo rate.	DTCC
Fed borrowing demand	Borrowing demand is calculated as the total par amount bid by primary dealers for a security divided by the par amount available for lending. Since the Federal Reserve reports securities only when bids are received, we assign zero borrowing demand on operation dates for which no bids are received but the security is available for lending.	Federal Reserve Bank of New York
Markit borrowing demand	Borrowing demand is calculated as the quantity of securities on loan to short sellers divided by the actively lendable quantity. We assign zero borrowing demand on days without short loans if the security has lendable inventory.	Markit
Bid–ask spreads	Ask price minus bid price relative to the mid price, in bps.	CRSP, GovPX
Auction results	For each Treasury auction, we obtain auction and settlement dates, maturity dates, offering and accepted amounts, bid-to-cover ratios, auction yields, reopening information, and cash-management-bill indicators.	TreasuryDirect
Auction allocations	For each Treasury auction, we obtain the par amount allotted to each investor class.	TreasuryDirect
Available supply	Log of the par amount awarded to primary dealers at the auction that issued the security. The AS differential is the available supply of the seasoned security minus that of the newly issued security.	TreasuryDirect
Reopening event time	Event time is measured in calendar days relative to the 26-week reopening settlement, with negative values before settlement. The reopened indicator equals one from the settlement date. For convenience-premium regressions, both variables are instead defined relative to the reopening auction date.	TreasuryDirect
Bill/GDP	Ratio of outstanding Treasury bills to quarterly GDP.	Klingler and Sundaresan (2023)
MOVE index	Market-wide Treasury volatility, measured by the MOVE index.	Bloomberg
Noise	Root mean squared deviation of Treasury note and bond yields from a fitted zero-coupon curve.	Hu et al. (2013)
One-month OIS rate	The level of short-term interest rates.	Bloomberg
Money-market slope	The one-year minus the one-month OIS rate.	Bloomberg
Money market fund holdings	Monthly Treasury holdings by money market funds are aggregated to the CUSIP level and scaled by the issue's outstanding amount to measure the share held by MMFs.	Crane Data

Internet Appendix for:

The On-the-Run Discount

Zhuolu Gao, Sven Klingler

October 28, 2026

This document contains additional descriptions, figures, tables, and robustness checks that supplement the paper titled "The On-the-Run Discount."

IA.1 Additional Information on Data Construction **2**

IA.1.1 Treasury Bill Yield Calculation 2

IA.1.2 Note-Bill Spread 3

IA.2 Additional Descriptive Statistics **3**

IA.3 Additional Evidence on Mechanisms **4**

Gao and Klingler are at Frankfurt School of Finance and Management. E-mails: z.gao@fs.de and s.klingler@fs.de.

IA.1 Additional Information on Data Construction

This section provides additional details on the construction of variables in the paper.

IA.1.1 Treasury Bill Yield Calculation

Treasury bills are quoted on a bank-discount basis. We convert bill discount rates into prices and coupon-equivalent yields following the US Treasury's calculation methodology. Let d denote the discount rate, r the number of days remaining to maturity, $y = 365$ the number of days in the year, and P the price per \$100 of face value. The price implied by a discount-rate quote is

$$P = 100\left(1 - \frac{dr}{360}\right).$$

For bills with $r \leq y/2$ days remaining to maturity, the coupon-equivalent yield is calculated as

$$i = \left(\frac{100 - P}{P}\right)\left(\frac{y}{r}\right).$$

For bills with $r > y/2$ days remaining to maturity, the coupon-equivalent yield is determined using the Treasury's semiannual-compounding equation,

$$P\left[1 + \left(r - \frac{y}{2}\right)\frac{i}{y}\right]\left(1 + \frac{i}{2}\right) = 100,$$

which can be rearranged into the quadratic equation

$$\left(\frac{r}{2y} - 0.25\right)i^2 + \frac{r}{y}i + \frac{P - 100}{P} = 0,$$

and we select the root with the positive square-root term in the quadratic formula, which

yields a positive rate for bills priced below par.

IA.1.2 Note-Bill Spread

We construct the note-bill spread from CRSP Treasury prices in the spirit of Amihud and Mendelson (1991). For each date, we compute dirty midpoint prices as the midpoint of the bid and ask prices plus accrued interest. For bills, we convert the dirty price into an annualized yield, $100[(100/P)^{365/r} - 1]$, where P is the dirty price per \$100 face value and r is remaining maturity in days. For coupon notes, we select the note closest to the target remaining maturity and compute a comparable standardized yield from the dirty price and the semiannual coupon component. We then linearly interpolate bill yields to the exact remaining maturity of the selected note using the two bracketing bills on the same date. The note-bill spread is the note yield minus this interpolated bill yield, expressed in basis points. In Table 2, we use the note with 120 to 180 days to maturity whose maturity is closest to 150 days.

IA.2 Additional Descriptive Statistics

This section reports additional descriptive statistics that support the main sample construction and comparisons. Table IA.1 reports trading volume for on-the-run and off-the-run Treasury securities. Table IA.2 shows that both on-the-run discounts are robust to excluding debt-limit episodes and bill pairs whose maturity dates straddle projected X-dates. Figure IA.1 plots the two bill on-the-run discounts since 1987 together with the size of 52-week auctions relative to 26-week auctions, and Figure IA.2 relates both discounts to the supply of the reopened bill. Table IA.3 documents the two borrowing demand measures, with their

numerators and denominators, for original 52-week bills before their 26-week reopening. It also reports the borrowing demand differential of the two bill pairs, whose window-to-window changes are the key regressors in Section 4.3, and of the 2-year and 10-year note pairs. Table IA.4 reports additional summary statistics for coupon securities and their relation to adjacent-issue spreads. Table IA.5 reports the bid-ask spreads of the four bills that form the two pairs, from GovPX in Panel A and from CRSP in Panel B, and the CRSP bid-ask differentials of the two pairs together with the on-the-run spreads in Panel C, complementing the GovPX differentials of Table 3. Figure IA.3 reports bid-ask spreads over the lifecycle of 52-week Treasury bills. Table IA.6 reports the pairwise correlations of cycle-to-cycle changes in the on-the-run discounts, the repo specialness differentials, and the GovPX and CRSP bid-ask differentials.

IA.3 Additional Evidence on Mechanisms

This section provides additional evidence on the reopening mechanism, together with robustness checks for the main results.

We sharpen the test of our hypothesis in Section 4 by exploiting the timing of the reopening settlement. Because the newly auctioned securities cannot be used to cover short positions until they are delivered, borrowing pressure should fall discontinuously when the additional supply becomes available. We test this prediction using daily observations around each bill's reopening settlement.

For each original 52-week bill, we use observations from its initial issue date through four weeks after its 26-week reopening auction and estimate

$$Y_{i,t} = \beta_1 \, Distance_{i,t} + \beta_2 \, Distance_{i,t} \times \mathbb{1}(\text{Reopened})_{i,t} + \beta_3 \, \mathbb{1}(\text{Reopened})_{i,t} + \lambda_t + \epsilon_{i,t}, \quad \text{(IA.1)}$$

where $Y_{i,t}$ is repo specialness, $BD^{Fed}_{i,t}$, or $BD^{Mkit}_{i,t}$. $Distance_{i,t}$ is the number of days relative to the settlement of bill i's reopening and is negative before settlement. The indicator $\mathbb{1}(\text{Reopened})_{i,t}$ equals one beginning on the settlement date, and λ_t denotes date fixed effects. Unlike in Equation (3) of the paper, both variables are timed from the settlement of the reopening rather than from its auction. The two distance terms allow separate linear trends before and after settlement, while β_3 measures the discontinuity when the reopening supply becomes deliverable.

Table IA.7 shows a large and statistically significant decline in all three outcomes at the reopening settlement. Relative to the fitted pre-settlement trend, repo specialness falls by 43 basis points, Federal Reserve borrowing demand by 39 percentage points, and the Markit short-loan share by 39 percentage points. The estimated declines are robust to quadratic trends and to holding the lendable amounts at their last pre-settlement values (Panel B and Columns (4) and (5) of Table IA.7), although holding the denominator fixed removes more than half of the drop in the Markit measure and less than a tenth of the drop in the Federal Reserve measure. Together with Figure 5, these estimates link the lifecycle of borrowing pressure, repo specialness, and cash-market richness to the reopening cycle rather than to a smooth function of remaining maturity.

The window-to-window regressions of Table 5 are also robust to the measure of borrowing pressure. Table IA.8 repeats them with the pair's repo specialness differential (Panel A) and the Markit borrowing demand differential (Panel B) in place of the Federal Reserve borrowing demand differential, and Table IA.9 repeats the same two specifications on the cycles and windows with Federal Reserve lending data, so that all three measures are estimated on one sample.

Repo specialness also accounts for the level of the 26-week pre-reopening discount. Fol-

lowing Duffie (1996) and D'Amico and Pancost (2022), the cash premium of a special security is the present value of the specialness it earns while it stays special. For each day in a reopening window, we take the realized overnight specialness of the 52-week bill from the next night until the settlement of its 26-week reopening, net of the specialness of the on-the-run 26-week bill over the same nights. We discount each night at the overnight general collateral rate and convert the price premium into a yield premium. Because the measure uses realized rather than expected specialness, it is an ex post benchmark. Figure IA.5 shows that this specialness premium closely tracks the 26-week pre-reopening spread. Across 173 reopening windows from August 2012 to November 2025, it averages -4.8 basis points, against -4.0 basis points for the spread. A regression of the spread on the specialness premium has a slope of 0.71 and an R^2 of 0.80 in levels, and a slope of 0.41 and an R^2 of 0.38 in window-to-window changes.

If short sellers cover their positions with the newly delivered bills, part of the reopening supply flows to them instead of into dealer inventory that has to be financed in the repo market. Figure IA.4 compares the DTCC repo volume of 52-week bills reopened as 26-week bills with that of newly issued 26-week bills over the four weeks after the settlement, relative to the amount outstanding. The two types of auctions are of similar size, about \$43 billion on average. After the settlement, however, the reopened bill has about \$73 billion outstanding, because the reopening adds to the original 52-week issue. Nevertheless, it trades only slightly more in the repo market than a newly issued bill, \$1.18 billion per day compared with \$1.04 billion. Relative to the amount outstanding, its repo volume is therefore about one third lower, 1.63 percent per day compared with 2.55 percent (t-statistic of -10.18). Hence, the repo activity of the reopened bill rises much less than its amount outstanding, consistent with short sellers covering their positions with the delivered bills.

Figure 2 shows that borrowing pressure also rebuilds ahead of the bill's 13-week reopening. The convenience premium drops by 1.3 to 1.4 basis points at the 13-week reopening auction (Table IA.10). Table IA.11 relates the drop in the convenience premium at the 26-week reopening auction to the bill's specialness before the auction and to the primary-dealer allocation at the reopening: for all three measures of Table 6, the drop is larger for bills that are more special before the auction, by 3.2 basis points per 100 basis points of specialness in the OIS–Treasury spread (t-statistic of 9.04), and larger for larger primary-dealer allocations at the reopening.

Finally, Figure IA.6 repeats the bill panel of Figure 6 for all Treasury bills.

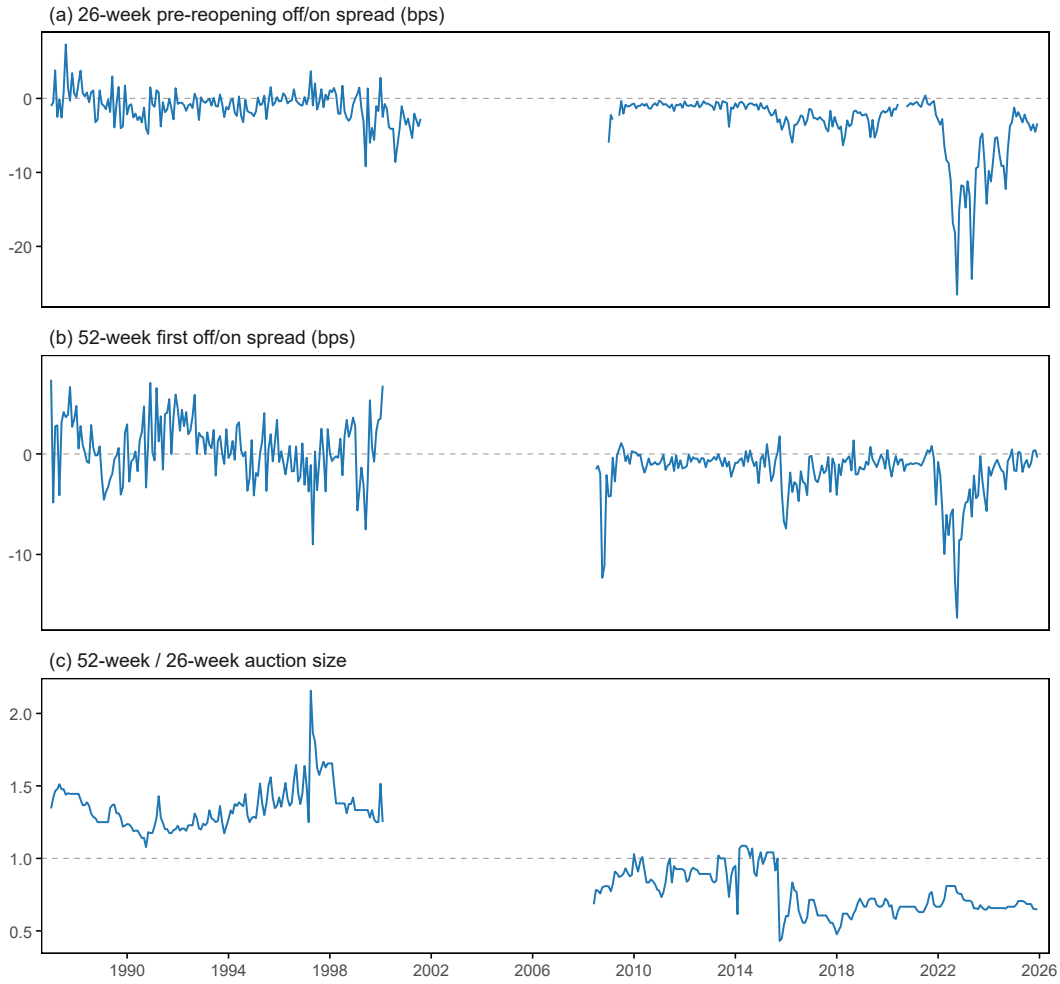
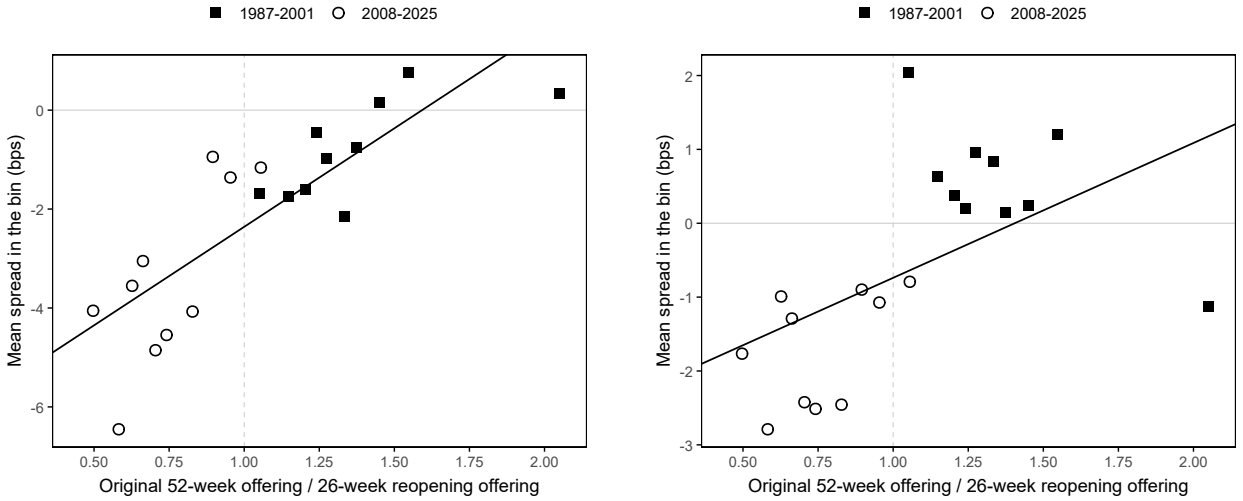


Figure IA.1: The bill on-the-run discounts and the relative size of 52-week auctions since 1987. This figure plots monthly averages of three series. Panel (a) shows the maturity-matched 26-week pre-reopening off/on spread in basis points, the yield of seasoned 52-week bills interpolated at the maturity of the on-the-run 26-week bill minus the on-the-run yield. Panel (b) shows the 52-week first off/on spread in basis points, adjusted with the zero-coupon curve of Gürkaynak et al. (2007), which goes back to 1987, and averaged first within auction cycles and then within months. Panel (c) shows the mean offering amount of the original 52-week auctions in a month divided by the mean offering amount of the 26-week auctions in that month (TreasuryDirect). The dashed lines mark zero in Panels (a) and (b) and one in Panel (c). No 52-week bills were issued from February 2001 to May 2008, so all three series have a gap. The sample covers January 1987 to December 2025.



(a) 26-week pre-reopening spread **(b)** 52-week first off/on spread

Figure IA.2: The bill on-the-run discounts and the supply of the reopened bill. This figure sorts four-week reopening windows into equal-count bins of the supply ratio and plots the mean spread in each bin against the mean ratio. A window runs from the settlement of one 26-week reopening of a 52-week bill to the settlement of the next. Its supply ratio is the original 52-week offering of the bill reopened at the end of the window divided by the offering of its 26-week reopening (TreasuryDirect). The vertical axis shows the window average of the daily maturity-matched 26-week pre-reopening off/on spread in Panel (a) and of the daily 52-week first off/on spread of Figure IA.1 in Panel (b), in basis points. The windows from 1987 to 2001 (black squares, 178 windows) and from 2008 to 2025 (open circles, 216 windows) are sorted separately into ten bins each, with 17 to 22 windows per bin. The solid lines are OLS fits on the 394 windows, and the dashed vertical lines mark a ratio of one. The sample covers January 1987 to December 2025, without February 2001 to May 2008, when no 52-week bills were issued.

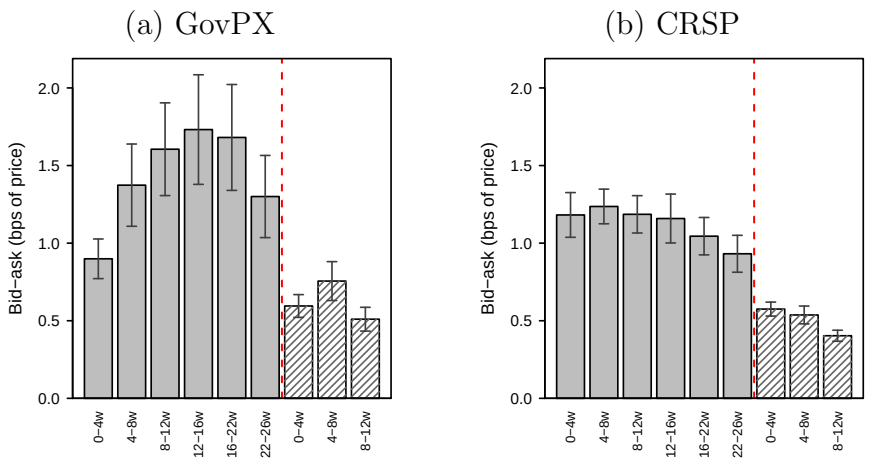


Figure IA.3: Bid-ask spreads before and after the 26-week reopening of a 52-week Treasury bill. This figure reports average bid-ask spreads for original 52-week Treasury bills by age. Panel (a) uses GovPX closing quotes and Panel (b) uses CRSP closing quotes. Bid-ask spreads are measured in basis points of price and are computed as the ask price minus the bid price divided by the midpoint price. For GovPX bill quotes, discount-rate quotes are first converted into prices, and days with a negative quoted spread are dropped. Each bar first averages daily observations within a bill and age bin and then averages across original 52-week bills; error bars show 95% confidence intervals based on Newey–West standard errors. Age is measured in weeks from the 52-week auction; every day from week 22 until the settlement of the bill's 26-week reopening belongs to the 22–26 week bin. The three hatched bars cover the first twelve weeks from the settlement, in four-week bins, when the bill trades as a reopened 26-week bill; the red dashed line marks the settlement. Both panels share the same vertical scale. The samples are bills whose full life from the 52-week auction to maturity lies within the data, 2010–2025: 195 bills with GovPX quotes and 196 bills with CRSP quotes.

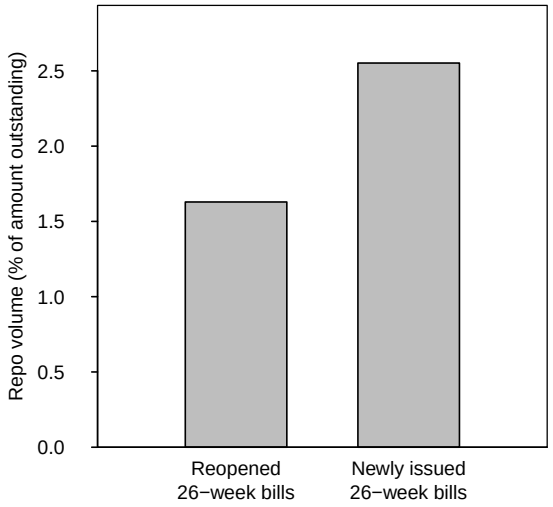


Figure IA.4: Repo volume relative to the amount outstanding after the settlement of reopened and newly issued 26-week bills. This figure plots the average daily DTCC repo volume across all trade terms from the settlement day through four weeks after it, in percent of the amount outstanding, for 194 reopenings of 52-week bills as 26-week bills and for 577 newly issued 26-week bills. Weekdays without trades count as zero. The amount outstanding of a reopened bill comprises its original 52-week issue and the 26-week reopening. Each bar first averages across the weekdays of an auction and then across auctions. The sample covers settlements from January 2011 to October 2025.

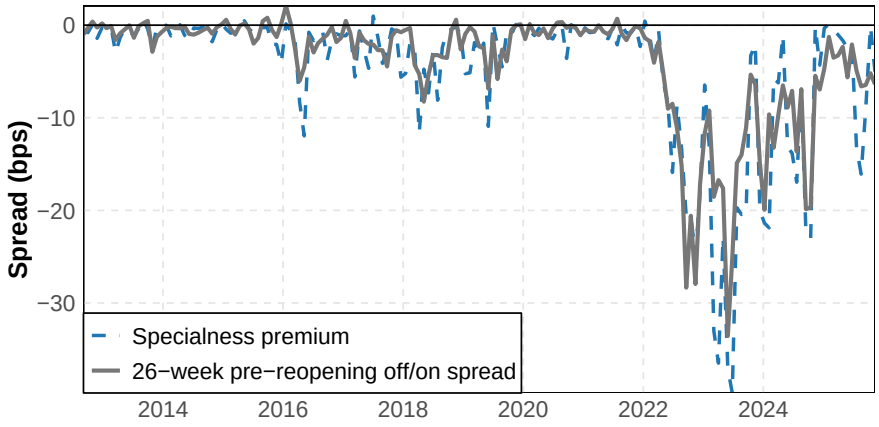


Figure IA.5: The 26-week pre-reopening spread and the specialness premium. This figure plots the 26-week pre-reopening off/on spread of Figure 1 (solid grey line) and the specialness premium (dashed blue line), both in basis points and averaged within each four-week window between consecutive reopening settlements. Following Duffie (1996) and D'Amico and Pancost (2022), the specialness premium is the present value of the realized DTCC overnight specialness that the 52-week bill approaching its 26-week reopening earns and the on-the-run 26-week bill does not, from the next night until the reopening settles. Each night is discounted at the overnight general collateral rate, and the price premium is converted into a bond-equivalent yield. Negative values mean that the pre-reopening bill is rich. The sample covers 173 reopening windows from August 2012 to November 2025.

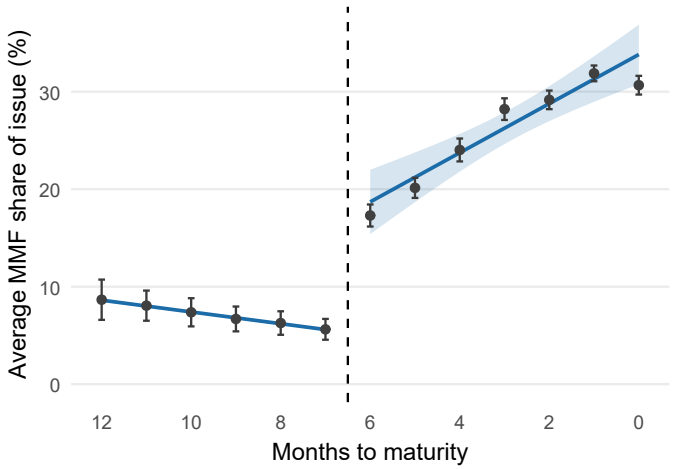


Figure IA.6: Money market fund holdings of all Treasury bills by remaining maturity. This figure repeats Panel (a) of Figure 6 using all Treasury bills instead of only securities issued as 52-week bills. Each dot is the average fraction of each issue held by money market funds, in percent of the amount outstanding, across issue-month observations in that months-to-maturity bin, using month-end Crane holdings matched to Treasury issuance data (1,132 securities, October 2011 to July 2025); whiskers denote 95% confidence intervals. The solid lines show separate weighted linear fits for the 7-to-12-month and 0-to-6-month segments, with shaded 95% confidence intervals, and the vertical dashed line marks 26 weeks to maturity. The bins above six months consist almost entirely of securities issued as 52-week bills, while the shorter bins also contain the shorter bill tenors, which money market funds hold intensively, so the levels in the 0-to-6-month segment are higher. The pattern is unchanged: the share falls as a security ages toward the 26-week mark and rises as maturity shortens thereafter.

Table IA.1: Trading volume by on-the-run status. This table reports average daily trading volume in billions of dollars for on-the-run and off-the-run Treasury securities from August 2017 through July 2018. Source: Brain et al. (2018).

Status	**Coupons**	**Bills**
On-the-Run	362	25
First Off-the-Run	31	8.3
Second Off-the-Run	7.7	7.6

Table IA.2: Robustness to debt-limit episodes and projected X-dates. This table reports cycle-level summary statistics for the two on-the-run discounts of Figure 1 after excluding debt-limit episodes in four ways. $Spread_{1,t}$ is the OIS-adjusted spread between the first off-the-run and the on-the-run 52-week bill, averaged within each four-week cycle between consecutive 52-week settlements; $Spread_{-1,t}$ is the OIS-adjusted spread between the 52-week bill approaching its 26-week reopening and the on-the-run 26-week bill, averaged within each window between consecutive reopening settlements. Acute periods are the periods of acute market concern about the debt limit identified by the Government Accountability Office (GAO-26-107872, Table 2): July 6 to August 2, 2011; September 24 to October 17, 2013; October 14 to November 2, 2015; June 7 to September 8, 2017; January 3 to February 9, 2018; August 16 to December 16, 2021; and April 5 to June 3, 2023. An X-date is the projected date on which the Treasury would exhaust its cash and extraordinary measures under the debt limit and could no longer pay all obligations on time; we use the final projected X-date of each episode between 2011 and 2025 or, where no single date was reached, the representative date reported by the GAO. The baseline row uses all cycles and windows. The second row drops the trading days that fall in an acute period. The third row drops every cycle or window that contains at least one such day. The fourth row drops the days on which a projected X-date lies between the maturity dates of the two bills of a pair, so that one bill would be repaid before and the other after a possible payment delay; the two bills of the 52-week pair mature four weeks apart, those of the 26-week pair up to four weeks apart. The last row applies the third and fourth exclusions together: cycles and windows that touch an acute period are dropped, and in the remaining ones the days with a maturity pair around an X-date are dropped as well. Mean spreads are in basis points, with t-statistics based on variation across cycles in parentheses. Negative (%) is the share of cycle or window averages below zero, and N is the number of cycles or windows. The sample period is 2010–2025.

	$Spread_{1,t}$			$Spread_{-1,t}$		
Specification	Mean (t-stat.)	Negative (%)	N	Mean (t-stat.)	Negative (%)	N
Baseline	−1.69 (−11.5)	91.9	209	−3.47 (−8.6)	85.6	209
Exclude acute trading dates	−1.68 (−11.3)	92.1	202	−3.29 (−8.6)	84.5	200
Exclude overlapping cycles	−1.74 (−11.0)	93.1	188	−3.26 (−8.4)	84.9	186
Exclude X-date-straddling maturity pairs	−1.70 (−11.3)	91.9	197	−3.43 (−8.6)	86.5	207
Exclude overlapping cycles and straddling pairs	−1.75 (−10.8)	93.2	176	−3.22 (−8.4)	85.9	184

Table IA.3: The borrowing demand measures before the reopening. Panels A and B report summary statistics of the two borrowing demand measures for original 52-week Treasury bills on the days from each bill's issue date to the day before the settlement of its 26-week reopening. Observations in these panels are bill-days. Panel A covers the Federal Reserve's securities-lending operations. $BD_{i,t}^{Fed}$ is par submitted by dealers relative to par available for the security, in percent, first on operation days with bids and then on all operation days with days without bids counted as zero, the measure used throughout the paper. Par submitted and par available are in billions of dollars. Panel B covers Markit securities lending on days with lendable inventory. $BD_{i,t}^{Mkit}$ is the short-loan quantity relative to the actively lendable quantity, in percent, with days without loans counted as zero; the two quantities are in billions of dollars. Panel C reports the Federal Reserve borrowing demand differential of the pairs, $BD_{i,t}^{Fed}$ for the seasoned security minus $BD_{i,t}^{Fed}$ for the newly issued security, averaged over the window, in percentage points, with days without bids counted as zero once a security is available for lending: the 52-week first off/on pair and the 26-week pre-reopening pair, one observation per cycle or reopening window, and the 2-year and 10-year first off/on note pairs, one observation per cycle. The bill series start in October 2019, when the Federal Reserve resumed its purchases of Treasury bills; the note series start in 2010.

Panel A. Federal Reserve securities-lending operations, October 2019 to 2025 (82 bills)

	Mean	SD	P25	Median	P75	*N*
$BD_{i,t}^{Fed}$ on days with bids (%)	26.10	42.44	0.88	8.06	31.85	6,896
$BD_{i,t}^{Fed}$, days without bids as zero (%)	19.12	38.28	0.00	1.55	19.44	9,330
Par submitted on days with bids ($ billion)	0.61	0.80	0.02	0.23	0.96	6,896
Par available on days with bids ($ billion)	3.31	1.97	2.16	3.13	4.04	6,896

Panel B. Markit securities lending, 2010–2025 (206 bills)

	Mean	SD	P25	Median	P75	*N*
$BD_{i,t}^{Mkit}$ (%)	38.07	36.74	12.96	30.96	57.39	26,285
Short-loan quantity ($ billion)	0.38	0.42	0.08	0.22	0.52	26,285
Actively lendable quantity ($ billion)	1.08	0.82	0.42	0.87	1.54	26,285

Panel C. Federal Reserve borrowing demand differential of the pairs (percentage points), window averages

	Mean	SD	P25	Median	P75	*N*
52-week first off/on pair, 2019–2025	3.79	14.19	-1.53	0.32	5.17	82
26-week pre-reopening pair, 2019–2025	53.53	45.95	14.82	40.80	88.56	82
2-year first off/on pair, 2010–2025	-10.38	26.43	-22.06	-3.32	0.99	123
10-year first off/on pair, 2010–2025	-24.84	24.33	-35.00	-19.77	-6.67	164

Table IA.4: Market liquidity, repo specialness, and on-the-run note spreads. This table reports the statistics of Table 3 for the first off/on pairs of 2-year (Panel A, $Spread^{2y}_{1,t}$) and 10-year (Panel B, $Spread^{10y}_{1,t}$) Treasury notes: means, medians, and correlations for the OIS-adjusted on-the-run note spread, its repo specialness differential, and its bid-ask differential, averaged within cycles between consecutive settlements. Repo specialness differentials are the on-the-run repo rate minus the off-the-run repo rate, so positive values indicate that the off-the-run note is more special. The bid-ask differential is the difference between the GovPX bid-ask spread of the off-the-run and the on-the-run note, expressed in basis points of price. The correlation column reports correlations between cycle-to-cycle changes in each row variable and changes in the spread. The sample period is 2010–2025.

Panel A. The 2-year first off/on spread, 2010–2025

	Mean	Median	N	Corr. with $\Delta Spread$	p-value
$Spread^{2y}_{1,t}$	0.31	0.26	192		
Repo Specialness Differential$^{2y}_{1,t}$	−7.39	−1.72	176	−0.34***	0.00
Bid-ask Differential$^{2y}_{1,t}$	0.13	0.00	190	0.01	0.86

Panel B. The 10-year first off/on spread, 2010–2025

	Mean	Median	N	Corr. with $\Delta Spread$	p-value
$Spread^{10y}_{1,t}$	1.09	0.81	193		
Repo Specialness Differential$^{10y}_{1,t}$	−19.68	−10.82	181	−0.44***	0.00
Bid-ask Differential$^{10y}_{1,t}$	−0.67	−0.07	192	0.14**	0.05

Table IA.5: Bid-ask spread levels and differentials. This table reports bid-ask spreads for the two on-the-run pairs of Table 1, where a bid-ask spread is the ask price minus the bid price relative to the midpoint price, in basis points of price. Panels A and B report summary statistics for the four bills that form the pairs, from GovPX closing quotes and from CRSP closing quotes; in GovPX, days with a negative quoted spread are dropped. The on-the-run and first off-the-run rows average daily observations within each four-week cycle between consecutive 52-week settlements; the pre-reopening and 26-week rows average within each four-week window between consecutive reopening settlements. Panel C repeats the spread and bid-ask rows of Table 3 with CRSP quotes instead of GovPX quotes: the first two rows are the 52-week pair, the on-the-run 52-week bill against the first off-the-run bill ($Spread_{1,t}$), and the last two the 26-week pair, the 52-week bill approaching its reopening against the on-the-run 26-week bill ($Spread_{-1,t}$). In each pair, the spread row is the OIS-adjusted spread in basis points and the bid-ask row is the CRSP bid-ask differential, the off-leg minus the on-leg bid-ask spread. The correlation column uses cycle-to-cycle changes of the differential against the change in the spread, with p-values from pairwise correlation tests; ***, **, and * indicate significance at the 1%, 5%, and 10% levels. The sample period is 2010–2025.

Panel A. GovPX bid-ask spread levels (bps of price), 2010–2025

	Mean	SD	P25	Median	P75	N
On-the-run bid-ask spread	0.89	0.51	0.56	0.74	1.05	208
First off-the-run bid-ask spread	1.39	1.02	0.68	1.07	1.77	207
Pre-reopening off-the-run bid-ask spread	1.29	0.97	0.62	1.00	1.62	208
On-the-run 26-week bid-ask spread	0.37	0.14	0.29	0.33	0.41	208

Panel B. CRSP bid-ask spread levels (bps of price), 2010–2025

	Mean	SD	P25	Median	P75	N
On-the-run bid-ask spread	1.18	0.61	0.83	1.02	1.26	209
First off-the-run bid-ask spread	1.29	0.52	0.92	1.12	1.53	209
Pre-reopening off-the-run bid-ask spread	0.93	0.46	0.58	0.82	1.06	209
On-the-run 26-week bid-ask spread	0.53	0.17	0.42	0.50	0.58	209

Panel C. CRSP bid-ask differentials, 2010–2025

	Mean	Median	N	Corr. with $\Delta Spread$	p-value
$Spread_{1,t}$	−1.69	−1.02	209		
Bid-ask Differential$_{1,t}$ (CRSP)	0.11	0.09	209	−0.16**	0.02
$Spread_{-1,t}$	−3.47	−1.02	209		
Bid-ask Differential$_{-1,t}$ (CRSP)	0.41	0.27	209	−0.11	0.11

Table IA.6: Correlations of changes in on-the-run discounts, repo specialness differentials, and bid-ask differentials. This table reports pairwise correlations of cycle-to-cycle changes in four variables for the two bill pairs of Table 3: (1) the OIS-adjusted off/on spread in basis points; (2) the repo specialness differential, the on-leg minus the off-leg repo rate in basis points, so that positive values indicate that the seasoned bill is more special; (3) the GovPX bid-ask differential; and (4) the CRSP bid-ask differential, each the off-leg minus the on-leg bid-ask spread in basis points of price. All variables are averaged within four-week settlement-to-settlement cycles (Panel A, the on-the-run 52-week bill against the first off-the-run bill) or reopening windows (Panel B, the 52-week bill approaching its 26-week reopening against the on-the-run 26-week bill) and then first-differenced across consecutive cycles or windows. Repo-rate data start in January 2011. Numbers in brackets are p-values from pairwise correlation tests; ***, **, and * indicate significance at the 1%, 5%, and 10% levels. The sample period is 2010–2025.

Panel A. The 52-week first off/on spread, 2010–2025

	(1)	(2)	(3)	(4)
(1) $\Delta Spread$	1			
(2) Δ Repo specialness differential	-0.47^{***} [0.00]	1		
(3) Δ Bid-ask differential (GovPX)	-0.28^{***} [0.00]	0.07 [0.32]	1	
(4) Δ Bid-ask differential (CRSP)	-0.16^{**} [0.02]	0.08 [0.28]	0.25^{***} [0.00]	1

Panel B. The 26-week pre-reopening off/on spread, 2010–2025

	(1)	(2)	(3)	(4)
(1) $\Delta Spread$	1			
(2) Δ Repo specialness differential	-0.70^{***} [0.00]	1		
(3) Δ Bid-ask differential (GovPX)	-0.46^{***} [0.00]	0.52^{***} [0.00]	1	
(4) Δ Bid-ask differential (CRSP)	-0.11 [0.11]	0.04 [0.60]	0.44^{***} [0.00]	1

Table IA.7: Discontinuity in borrowing pressure at the delivery of the reopening supply. This table reports daily panel regressions for original 52-week Treasury bills from each bill's issue date to four weeks after its 26-week reopening auction, estimated from Equation (IA.1), so that the coefficient on $\mathbb{1}(\text{Reopened})_{i,t}$ is the jump at the delivery of the reopening supply. The dependent variables are repo specialness in basis points (Column (1), 2012–2025), $BD_{i,t}^{Fed}$ in percent (Column (2), October 2019 to December 2025), and $BD_{i,t}^{Mkit}$, the Markit short-loan share, in percent (Column (3), 2010–2025), each as defined in Section 2.3. Columns (4) and (5) repeat Columns (2) and (3) with the denominator of the measure held at its last observation before the settlement, where it rises with the delivered supply. Panel A allows linear and Panel B quadratic trends on each side of the settlement; date fixed effects, samples and observation counts are as reported in Panel A. The numbers in parentheses are t-statistics based on standard errors clustered by date and CUSIP. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Panel A. Linear trends

	Contemporaneous denominator			Fixed denominator	
	Specialness	$BD_{i,t}^{Fed}$	$BD_{i,t}^{Mkit}$	$BD_{i,t}^{Fed}$	$BD_{i,t}^{Mkit}$
	(1)	(2)	(3)	(4)	(5)
$\mathbb{1}(\text{Reopened})_{i,t}$	−42.56***	−38.58***	−38.75***	−34.95***	−17.12***
	(−8.67)	(−9.19)	(−15.89)	(−7.63)	(−5.46)
$Distance_{i,t} \times \mathbb{1}(\text{Reopened})_{i,t}$	−0.65***	−0.55***	−0.01	−0.21	1.29***
	(−4.97)	(−7.97)	(−0.16)	(−1.19)	(2.93)
$Distance_{i,t}$ (days)	0.35***	0.29***	0.24***	0.28***	0.24***
	(8.33)	(9.67)	(12.38)	(9.40)	(11.64)
Date FE	Yes	Yes	Yes	Yes	Yes
Sample	2012–2025	2019–2025	2010–2025	2019–2025	2010–2025
Observations	20,635	11,141	30,010	11,141	29,993
R^2	0.28	0.33	0.33	0.29	0.21

Panel B. Quadratic trends

	(1)	(2)	(3)	(4)	(5)
$\mathbb{1}(\text{Reopened})_{i,t}$	−75.10***	−62.05***	−39.75***	−60.94***	−23.25***
	(−8.47)	(−10.66)	(−16.30)	(−9.96)	(−7.73)
$Distance_{i,t} \times \mathbb{1}(\text{Reopened})_{i,t}$	−0.47	−0.93***	−0.09	0.03	2.53***
	(−1.36)	(−4.86)	(−0.44)	(0.06)	(3.82)
$Distance_{i,t}^2 \times \mathbb{1}(\text{Reopened})_{i,t}$	−0.04***	−0.01	0.002	−0.03*	−0.05**
	(−2.75)	(−1.18)	(0.29)	(−1.89)	(−2.00)
$Distance_{i,t}$ (days)	1.22***	0.97***	0.27***	0.97***	0.27***
	(7.73)	(10.13)	(6.66)	(9.97)	(5.51)
$Distance_{i,t}^2$	0.005***	0.004***	0.0002	0.004***	0.0002
	(7.31)	(9.20)	(1.01)	(9.04)	(0.74)
Observations	20,635	11,141	30,010	11,141	29,993
R^2	0.32	0.39	0.33	0.34	0.21

Table IA.8: Changes in the on-the-run discounts, the repo specialness differential, and the Markit borrowing demand differential. This table repeats Table 5 with the pair's repo specialness differential in Panel A and the pair's Markit borrowing demand differential in Panel B in place of the Federal Reserve borrowing demand differential. $\Delta Specialness\ Differential_{p,t}$ is the change in the on-the-run leg's overnight repo rate minus the off-the-run leg's rate in the DTCC data, averaged over the window, in basis points, so positive values indicate that the seasoned bill became relatively more special. The Panel A sample comprises all cycles and reopening windows with repo data for both legs, 2011–2025. $\Delta BD^{Mkit}\ Differential_{p,t}$ is the change in Markit's short-loan quantity relative to actively lendable quantity for the seasoned leg minus that for the newly issued leg, expressed as a ratio, and the Panel B sample comprises all cycles and reopening windows, 2010–2025. Columns, controls, and standard errors are as in Table 5.

Panel A. Repo specialness, 2011–2025

	$\Delta Spread_{1,t}$		$\Delta Spread_{-1,t}$	
	(1)	(2)	(3)	(4)
$\Delta Specialness\ Differential_{p,t}$	-0.03^{***}	-0.02^{***}	-0.04^{***}	-0.04^{***}
	(-3.44)	(-3.01)	(-8.04)	(-9.88)
$\Delta AS\ Differential_{p,t}$		1.04^{***}		0.17
		(3.36)		(0.28)
$\Delta CDS\ Differential_{p,t}$		-0.04		1.63^{***}
		(-0.25)		(7.00)
Market controls	No	Yes	No	Yes
Observations	186	186	194	194
Adjusted R^2	0.22	0.26	0.49	0.55

Panel B. Markit short-loan share, 2010–2025

	$\Delta Spread_{1,t}$		$\Delta Spread_{-1,t}$	
	(5)	(6)	(7)	(8)
$\Delta BD^{Mkit}\ Differential_{p,t}$	-1.17^{***}	-0.95^{***}	-0.92^{*}	-0.90^{*}
	(-3.87)	(-3.45)	(-1.70)	(-1.73)
$\Delta AS\ Differential_{p,t}$		1.56^{***}		0.80
		(5.82)		(0.94)
$\Delta CDS\ Differential_{p,t}$		-0.01		1.47
		(-0.08)		(1.50)
Market controls	No	Yes	No	Yes
Observations	203	203	203	203
Adjusted R^2	0.06	0.19	0.01	0.05

Table IA.9: Changes in the on-the-run discounts and relative borrowing pressure on the Federal Reserve sample. This table reports the repo specialness and Markit specifications corresponding to Table 5 after restricting the sample to the cycles and reopening windows with Federal Reserve lending data. The Markit observation counts match the corresponding Federal Reserve columns of Table 5; the repo specialness samples are slightly smaller where DTCC observations are unavailable. Panel A uses the pair's repo specialness differential, in basis points, and Panel B the pair's Markit borrowing demand differential, expressed as a ratio. In each panel, the dependent variable is the change in the 52-week first off/on spread in the first two columns and the change in the 26-week pre-reopening spread in the last two. Columns, controls, and reported statistics are as in Table 5.

Panel A. Repo specialness, Federal Reserve sample, 2019–2025

	$\Delta Spread_{1,t}$		$\Delta Spread_{-1,t}$	
	(1)	(2)	(3)	(4)
Δ*Specialness Differential*$_{p,t}$	-0.08^{***}	-0.07^{***}	-0.04^{***}	-0.04^{***}
	(-6.25)	(-4.97)	(-7.38)	(-9.01)
Δ*AS Differential*$_{p,t}$		0.66		0.95
		(1.43)		(0.79)
Δ*CDS Differential*$_{p,t}$		-0.04		1.69^{***}
		(-0.30)		(7.17)
Market controls	No	Yes	No	Yes
Observations	75	75	80	80
Adjusted R^2	0.33	0.31	0.54	0.60

Panel B. Markit short-loan share, Federal Reserve sample, 2019–2025

	$\Delta Spread_{1,t}$		$\Delta Spread_{-1,t}$	
	(5)	(6)	(7)	(8)
ΔBD^{Mkit} *Differential*$_{p,t}$	-2.10	-1.82	-5.89^{**}	-5.73^{**}
	(-1.59)	(-1.54)	(-2.63)	(-2.59)
Δ*AS Differential*$_{p,t}$		1.62^{***}		0.28
		(3.84)		(0.14)
Δ*CDS Differential*$_{p,t}$		0.02		1.52
		(0.12)		(1.54)
Market controls	No	Yes	No	Yes
Observations	81	81	81	81
Adjusted R^2	0.03	0.14	0.08	0.07

Table IA.10: Convenience premiums around the 13-week reopening. This table repeats Table 6 at the bill's 13-week reopening. The sample comprises the bills reopened as 13-week bills: original 26-week bills and former 52-week bills that were already reopened once as 26-week bills. The window runs from the bill's issue date (original 26-week bills) or the settlement of its 26-week reopening (former 52-week bills) to four weeks after the settlement of its 13-week reopening, and the sample period is 2010–2025. $Distance_{i,t}$ is the number of days between date t and bill i's 13-week reopening auction, negative before it, and $\mathbb{1}(\text{Reopened})_{i,t}$ equals one from the auction day, so its coefficient is the jump when the reopening supply is priced. Dependent variables, the average spread, fixed effects, and standard errors are as in Table 6. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	OIS-T	FL	GSW
	(1)	(2)	(3)
$\mathbb{1}(\text{Reopened})_{i,t}$	-1.433^{***}	-1.396^{***}	-1.277^{***}
	(-14.657)	(-13.542)	(-10.389)
$Distance_{i,t}$ (days)	0.066^{***}	0.056^{***}	0.100^{***}
	(32.062)	(25.643)	(28.196)
$Distance_{i,t} \times \mathbb{1}(\text{Reopened})_{i,t}$	0.039^{***}	0.039^{***}	0.055^{***}
	(7.749)	(6.864)	(6.622)
Average spread	4.88	17.98	12.23
Date FE	Yes	Yes	Yes
Bills	837	837	837
Observations	68,333	67,268	68,350
R^2	0.891	0.976	0.830
Adjusted R^2	0.884	0.974	0.819

Table IA.11: The reopening cliff, pre-auction specialness, and available supply. This table reports cross-sectional regressions with one observation per 26-week reopening of an original 52-week Treasury bill. The dependent variable $Cliff_i$ is the average convenience premium of bill i over the five business days before its reopening auction minus the average over the auction day and the following four business days, in basis points. The convenience premium is the OIS–Treasury spread in Column (1), the FL measure in Column (2), and the GSW measure in Column (3), each a reference rate minus the bill's yield as in Table 6, so a positive $Cliff_i$ means that the bill cheapens at the reopening. $Specialness_i^{pre}$ is the bill's average overnight repo specialness in the DTCC data, the benchmark overnight repo rate minus the security-specific repo rate, in basis points, averaged over the five business days before the reopening auction. AS_i^{reo} is the logarithm of the par amount awarded to primary dealers at the reopening auction. The sample comprises the 172 reopenings from August 2012 to November 2025 with repo data, 170 in Column (2). We exclude the reopening auctioned on May 30, 2023, two days before the projected X-date of the 2023 debt-limit episode, whose cliff in the FL measure is 237 basis points. FE_y denotes fixed effects for the year of the reopening auction. Adj. R^2 without FE is the adjusted R^2 of the regression after the year fixed effects are partialed out, and negative values are reported as zero. The numbers in parentheses are t-statistics based on heteroskedasticity-robust standard errors. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The regression equation is

$$Cliff_i = \beta_1 Specialness_i^{pre} + \beta_2 AS_i^{reo} + FE_y + \epsilon_i.$$

	OIS-T	FL	GSW
	(1)	(2)	(3)
$Specialness_i^{pre}$	0.032***	0.035***	0.027***
	(9.04)	(8.60)	(7.31)
AS_i^{reo}	2.353**	4.113***	2.309*
	(2.39)	(3.22)	(1.97)
Year FE	Yes	Yes	Yes
Adj. R^2	0.74	0.65	0.67
Adj. R^2 without FE	0.43	0.39	0.30
N	172	170	172