Liquidity Support Effects of the U.S. Treasury Buyback Program*

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Abstract

This paper studies whether routine, moderate-scale asset purchases by a fiscal agency can improve secondary-market liquidity. Using the U.S. Treasury's liquidity support buyback program that allows primary dealers to sell less liquid off-the-run securities back to the Treasury, I decompose the program's effects into a listing channel, triggered by the announcement of eligible securities, and a purchasing channel, activated by actual buyback execution. The key finding is that listing alone drives the liquidity improvement: bid-ask spreads of eligible securities narrow significantly on the announcement day, but actual purchase confers no additional benefit. This effect is amplified when pre-buyback liquidity conditions are tight or volatility is high. A novel instrumental variable based on the maturity-month exclusion rule in cash management buybacks confirms that selection attenuates the baseline estimates. At the aggregate level, buybacks temporarily relieve dealer inventory pressure and boost trading. A dealer pricing model rationalizes these findings: Treasury buyback demand—more price-elastic than market and rising with dealer inventory—compresses spreads, while portfolio-level inventory management shares the liquidity benefit across securities. The results demonstrate that even small-scale demand interventions can enhance market liquidity—not primarily through realized transactions, but through the option value they provide to constrained intermediaries.

JEL Codes: C65; G12; G14; G28

Key Words: Liquidity support; Primary dealers; Treasury buybacks; Treasury market

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1 Introduction

Can a fiscal agency improve secondary-market liquidity through moderate-scale, routine asset purchases? This paper studies the U.S. Treasury's liquidity support buyback program (launched in May 2024) to answer this question. The program provides primary dealers with a regular, predictable opportunity to sell less liquid off-the-run Treasury securities back to the Treasury, with the aim of relieving balance-sheet pressures and promoting liquidity in the secondary market.[1] The program was introduced against the backdrop of growing concerns about Treasury market resilience, particularly after the March 2020 "dash for cash" episode exposed the fragility of dealer intermediation capacity.[2] Its strategic importance was underscored in April 2025, when heightened uncertainty over tariff policy triggered a sharp sell-off in Treasuries—the 10-year yield rose 50 basis points in a single week, its largest weekly increase since 2001—and Treasury Secretary Scott Bessent signaled readiness to scale up buyback operations if needed.[3]

With the program now in its second year of operation, this paper provides the first comprehensive analysis of its liquidity support effects. I address two questions. First, do buybacks enhance liquidity in the off-the-run Treasury market, both at the individual security level and for primary dealers in aggregate? Second, what factors govern the efficacy of the liquidity support, and under which conditions is it most pronounced?

To address these questions, I exploit the multi-stage structure of buyback operations, which naturally distinguishes between the announcement of eligible securities and the execution of purchases. This distinction allows for separate identification of a *listing effect*—comparing bid-ask spreads of securities listed as eligible for buyback against those not listed within the same targeted maturity bucket—and a *purchasing effect*—comparing securities actually bought back against those listed but not purchased. I implement both comparisons in a difference-in-differences (DID) framework with security, operation, and bucket-specific time fixed effects.

[1] The buyback program is part of a broader set of initiatives to strengthen market functioning, including expanding central clearing and improving data collection on non-centrally cleared bilateral repo. See Remarks by Assistant Secretary for Financial Markets Joshua Frost for further details.

[2] See, for instance, Brainard (2021), Duffie (2023). Primary dealers' balance-sheet capacity has been shrinking relative to the rapidly expanding Treasury debt stock, owing in part to regulatory tightening such as the supplementary leverage ratio and G-SIB surcharges. See Duffie et al. (2023) for detailed discussion.

[3] Bloomberg interview of Secretary Bessent, April 14, 2025.

I find a significant listing effect: on the announcement day, bid-ask spreads for listed securities narrow by 0.3 basis points relative to the prior day, compared with unlisted securities in the same targeted bucket. The effect is transitory, concentrated on the listing day and dissipating once the auction executes. For the purchasing effect, the estimates are statistically insignificant, and the confidence intervals are too wide to rule out effects comparable in magnitude to the listing effect.

Tight liquidity and elevated volatility amplify the listing effect. The listing effect more than doubles when buybacks list securities with wide pre-buyback spreads, target buckets with dealer inventory surpluses or undergoing sharp volatility. Across maturity buckets, the listing effect is largest where buyback demand is high (as measured by bid-to-cover ratios) or where buyback supply is large relative to dealers' trading activity, both indicators of segments where the additional demand from buyback is most valuable.

Because the Treasury selects which securities to list, the baseline estimates reflect the program's impact under its actual operating rules rather than under random assignment. To assess whether this selection materially biases the results, I exploit a natural experiment embedded in a related program—cash management buybacks—where the Treasury excludes securities maturing in peak tax-inflow months (April, June, September, December) for fiscal reasons (to smooth cash inflow spikes) unrelated to liquidity. This maturity-month exclusion rule provides a novel instrumental variable for buyback eligibility. IV estimates are larger than the baseline—reflecting Treasury's tendency to avoid listing the least liquid securities, and the main results are therefore conservative.

At the aggregate level, I assess whether buybacks alleviate primary dealers' inventory pressures and stimulate trading activity, using a standard inventory-adjustment framework (e.g., Naik and Yadav (2003), Schultz (2017), Fleming, Nguyen and Rosenberg (2024)). A one-billion-dollar buyback reduces primary dealers' coupon positions by approximately $550 million in the execution week and increases dealer-to-dealer trading by a comparable amount on the operation day. The inventory effect is an order of magnitude larger than that of regular redemptions, reflecting the fact that buybacks retire less liquid securities that dealers hold involuntarily, whereas redemptions retire securities approaching maturity for which replacement inventory is readily available.

To rationalize these findings, I develop a dealer pricing model that jointly delivers the listing effect, the absence of a purchasing effect, and the dependence on pre-buyback liquidity conditions. Building on Duffie (2023), the model features a dealer setting bid and ask prices for two securities in the same maturity bucket, subject to convex inventory holding costs and stochastic market flows.

The model departs from Duffie (2023) in two ways that are motivated by the institutional design of Treasury buybacks. First, whereas Duffie (2023) models official-sector purchases at the mid-price—a natural assumption for a central bank acting as buyer of last resort—Treasury buybacks operate through competitive reverse auctions in which dealers submit ask prices and Treasury selects from the bids. This price-elastic Treasury demand enters the ask price first-order condition, steepening the effective demand curve and compressing the optimal ask markup (Effect I, the elasticity channel). Second, Treasury demand is modeled as increasing in dealer inventory, reflecting the program's stated objective of relieving balance-sheet congestion; this provides an "backstop" option whose value rises near the capacity constraint (Effect II, the inventory-relief channel).

The absence of a purchasing effect follows from dealers managing inventory risk at the bucket level rather than the individual-security level. Because the value function depends on total bucket inventory, the inventory relief from selling any security to the Treasury relaxes the shared balance-sheet constraint for all securities in the bucket, leaving no differential between purchased and non-purchased securities after execution.

Overall, the evidence indicates that buybacks enhance the liquidity of off-the-run Treasuries. While the effects are modest—a 0.3 basis point spread decline—this is consistent with the relatively limited scale of the program. The findings affirm that the program is functioning as intended and provide a basis for assessing the potential benefits of scaling up buyback operations during periods of market stress.

Contributions to the literature. This paper makes three contributions. First, it provides evidence that moderate-scale asset purchases by a fiscal agency—as distinct from the large-scale programs typically conducted by central banks—can meaningfully improve secondary-market liquidity. The existing literature on market-function purchases has focused primarily on central bank QE during periods of acute distress or weak growth (Krishnamurthy, Vissing-Jorgensen et al. (2013), Bauer and Rudebusch (2018), Boneva, Kastl and Zikes (2024); for a survey, see Duffie and Keane

(2023)). By documenting liquidity effects from a routine, small-envelope program, this paper extends the scope of that literature to a qualitatively different policy instrument.

Second, the paper introduces a decomposition of buyback effects into listing and purchasing channels, and develops a novel instrumental variable strategy based on the maturity-month exclusion rule in cash management buybacks. This approach may be applicable to other settings where government purchase programs operate through multi-stage selection processes. The paper also contributes to the small literature on U.S. Treasury buybacks, which has previously studied the 2000–2002 program (Han, Longstaff and Merrill (2007), Connolly and Struby (2024)), by providing the first analysis of the current liquidity support program, which differs in both purpose and macroeconomic context.

Third, the theoretical model extends Duffie (2023) by incorporating price-elastic Treasury demand through reverse auctions, generating a direct elasticity channel (Effect I) that is absent from frameworks where official-sector purchases occur at the mid-price. This distinction is relevant beyond the buyback context, as it applies to any government purchase program that operates through competitive bidding rather than administratively set prices. The model also relates to the intermediary asset pricing literature on dealer balance-sheet constraints (Fleckenstein and Longstaff (2020), Duffie et al. (2023), He, Kelly and Manela (2017); for a survey, see He and Krishnamurthy (2018)), providing a microfoundation for how targeted demand interventions can relax these constraints and improve market liquidity.

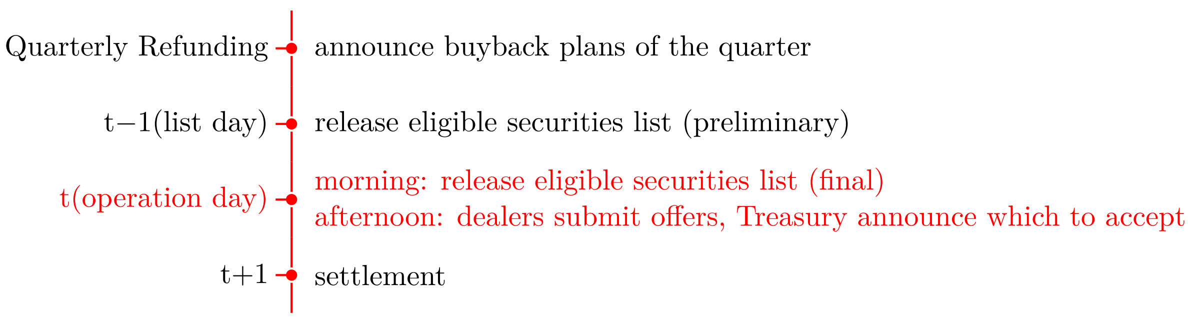
The remainder of the paper is organized as follows. Section 2 describes the buyback program and the data. Section 3 presents security-level results on listing and purchasing effects. Section 4 examines aggregate effects on primary dealer balance sheets and trading activity. Section 5 develops the theoretical model. Section 6 concludes.

2 Data

2.1 Background of the Buyback Program

In May 2024, the Treasury launched the liquidity support buyback program, "aiming to support liquidity in off-the-runs by providing a regular, predictable opportunity to sell them back to the Treasury."[4] The Treasury expects the buybacks to improve dealers' confidence in making markets in off-the-run securities and provide opportunities for dealers to free up balance sheet allocated to less-liquid positions at a fair price.[5] The liquidity support buybacks are generally conducted once per week. Initially, each operation had a total envelope of up to $2 billion for nominal coupon securities and up to $500 million for TIPS. Since August 2024, the maximum envelope for nominal coupons has increased to $4 billion per operation, as Treasury expands its technical capacity.

Figure 1: Timeline of Buyback Operations



The buyback program is conducted in three stages (Figure 1). First, in its quarterly refunding announcement, the Treasury announces its buyback schedules for the incoming quarter, including the buyback operation dates, targeted bucket of the yield curve (Treasury usually rotates the targeted bucket and anticipates purchasing within each maturity bucket at least one time per quarter),[6] and

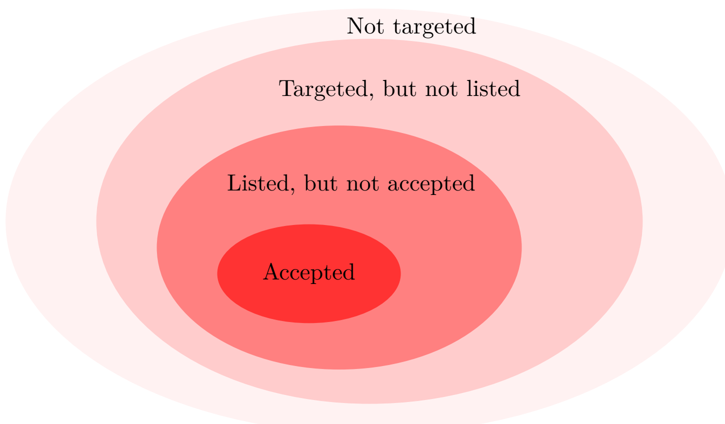
[4] Remarks by Assistant Secretary for Financial Markets Joshua Frost on recent progress by the inter-agency working group on Treasury market surveillance at the Federal Reserve Bank of New York's Annual Primary Dealer Meeting. Along with the liquidity support buybacks, the Treasury also launched cash management buybacks, which are intended to reduce volatility in the Treasury's cash balance and Treasury bill issuance, minimize bill supply disruptions, and/or reduce borrowing costs over time. Cash management buybacks will generally take place seasonally, predominantly during the weeks immediately surrounding major tax payment dates (e.g., mid-April, mid-June, mid-September, and mid-December), when cash balances tend to increase rapidly.

[5] Interview of SEC's Ghamami.

[6] The buybacks target one of the nine buckets of the yield curve each time: nominal coupons with remaining maturity 1 month to 2 years, 2 to 3 years, 3 to 5 years, 5 to 7 years, 7 to 10 years, 10 to 20 years, and 20 to 30 years; TIPS with remaining maturity 1 to 7.5 years and 7.5 to 30 years.

total buyback envelope. Second, on the day before buyback operation, the Treasury announces a preliminary list of securities that are eligible for buybacks. Third, on the operation day, the Treasury announces the final list of eligible securities (so far, identical to the preliminary list) in the morning, and primary dealers submit bids in the afternoon. Usually at 2pm, the Treasury announces the accepted bids, and the settlement happens the next day.

The design of the buyback procedure naturally categorizes all Treasury securities into four non-overlapping groups for each operation: i) securities not targeted by a buyback operation, ii) those targeted but not listed for buyback, iii) those listed but whose bids were not accepted, and iv) those accepted and eventually bought back. Across the four groups, this paper focuses on two sets of comparisons: conditional on being targeted, the securities being listed for buyback vs. those not listed (*listing effect*); conditional on being listed, the securities being accepted vs. those not accepted (*purchasing effect*).[7]

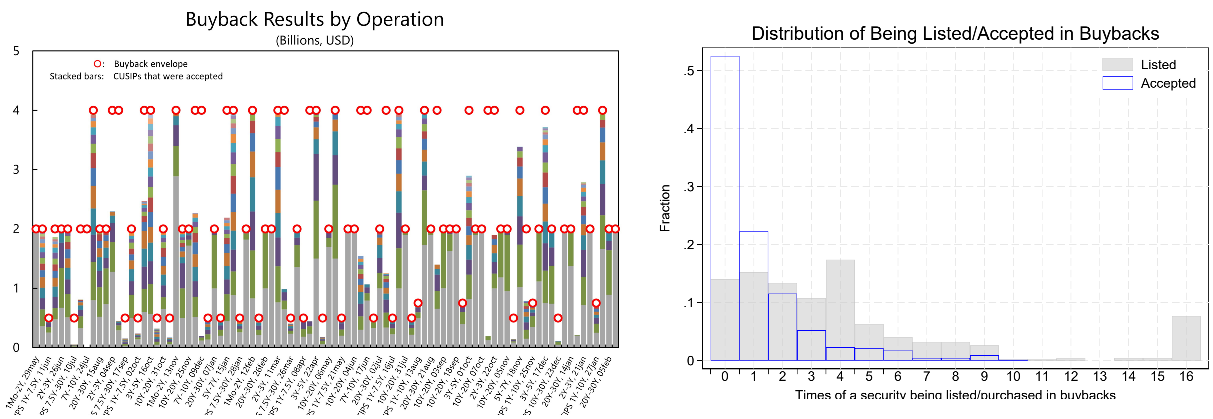


The outcomes of buybacks vary across time. As shown in Figure 2 (left), many of the operations maxed out the total envelope of buyback amount, yet there are instances where the Treasury accepted significantly fewer bids; notably, on July 24th, no bids were accepted during the buyback operation. Typically, the Treasury includes approximately 87% of securities within the targeted category in the eligible list for buybacks (Table 1), assessed in terms of both the number of securities and their outstanding amounts as a share of the buyback's targeted category. On average, bids from around one third of the eligible securities were accepted by the Treasury, which constituted

[7]A third comparison would be between the securities being targeted vs. those not targeted. However, securities with different maturities might not be able to serve as a good control group, hence, I exclude it from the analysis.

approximately one quarter of the total bid amount received. More than 80 percent of all the securities have been listed in buybacks,[8] while the buyback purchases are more concentrated, with more than half of the securities not having been bought back (Figure 2, right).

Figure 2: Buyback Results



Source: The U.S. Treasury.
Note: This figure plots the outcomes of liquidity support buyback. The left panel shows the results of each liquidity support buyback, with the stacked bars representing the amount of accepted bids by different securities and red circle representing the buyback envelope. The x axis indicates the targeted buckets (with remaining maturity) and the operation date. The right panel plots the distribution of how many times a Treasury security has been listed or accepted in buybacks.

The total buyback envelope, capped at $4 billion so far, is relatively small compared to the overall size of the off-the-run market, with the resultant buyback sizes representing about 0.1 percent of the targeted category of the off-the-run total amount outstanding. However, some of the outstanding securities may not be actively traded, e.g., pension funds and retail investors tend to hold to maturity. Therefore, if focusing on the portion of Treasuries that are being actively traded, the buyback amount accounts for approximately 10 percent of the average total daily off-the-run transactions, for the same bucket average across five days prior to buyback. From the primary dealers' perspective, the buyback amount is about 7 and 5 percent of their daily transaction and holdings on the nearest Wednesday prior to buyback, respectively.

Historically, both the Treasury and the Federal Reserve have engaged in the purchase of off-the-run Treasuries; however, the current buyback program is unique in its focus on enhancing liquidity conditions for off-the-run securities. The last instance of the Treasury buybacks occurred

[8]Up till mid February 2026, each bucket has had 7 to 11 buybacks.

between 2000 and 2002, during which the Treasury repurchased $67.5 billion of its securities across 45 operations ($1.5 billion per operation, on average). This initiative was conducted in a context different from today, characterized by a fiscal surplus and declining refinancing needs, which led to an increasing maturity profile of the Treasury debt as short- and intermediate-term obligations were retired upon maturity. The aim at that time was to "smooth out increases in the cash balance, allow the Treasury to maintain the issue sizes of new securities, and conceivably reduce the government's cost of borrowing."[9] Another form of buyback activity is the quantitative easing programs implemented by the Federal Reserve. Between 2010 and 2021, the Federal Reserve purchased $5.34 trillion of Treasury securities over approximately 1200 operations (around $4.5 billion per operation, on average). The primary aim of these purchases following the global financial crisis was to lower long-term interest rates and stimulate borrowing and investment, and unlike buybacks, the Fed's purchases did not retire the securities.

Table 1: Buyback Results Summary

	No. of securities	Amount outstanding	Total off-the-run transaction	Primary dealer transaction	Primary dealer position
buyback listed	87.1%	89.0%			
buyback accepted	30.9%	27.3%	11.0%	6.8%	4.5%
acceptance rate	35.4%	20.4%			

Note: This table reports the eligible and accepted securities as shares—both in terms of the number of securities and the amount outstanding—of all the securities in the bucket targeted by buyback. The accepted rate in terms of amount outstanding is calculated as the ratio between bids accepted and total bids submitted. It also reports the accepted amount as share of daily off-the-run transactions for the buyback targeted buckets reported in FINRA or conducted by primary dealers, and as share of primary dealers' position for the targeted bucket.

2.2 Liquidity Measures

Security level. I utilize the bid-ask spread obtained from LSEG Datastream. This measure is calculated as the difference between the ask and bid prices, divided by the average of the bid and ask prices, a metric widely used in the literature (see, for instance, Adrian, Fleming and Vogt (2017) and Duffie et al. (2023)). I rely on the bid-ask spread for two main reasons: firstly, it is available at relatively high frequency compared to other liquidity measures such as trading volumes or trading frequency; secondly, because bid and ask spreads are derived from the same data source,

[9] Minutes of the Meeting of the Treasury Borrowing Advisory Committee, February 3, 1998. Garbade and Rutherford (2007)

the differential between them may effectively neutralize potential measurement errors arising from data processing procedures. The final sample period extends from May 1st, 2024, to Feb 12th, 2026 with a $[-10, 10]$ days window centered around the day before buyback list announcement, at a daily frequency. The top and bottom 2 percent of bid-ask spreads are truncated to mitigate the influence of outliers.

Primary dealer aggregates. I use the weekly balance sheet data of primary dealers, obtained from the New York Fed, for total primary dealer holdings for each coupon bucket. I utilize trading volume data for off-the-run and on-the-run Treasury securities from FINRA (dealer-to-customer trading volume, dealer-to-dealer trading volume including alternative trading systems)[10] to assess if buybacks alleviate primary dealer inventory pressures and stimulate increased trading.

As reported in Table A1, bid-ask spreads are higher for the long-end buckets, compared with those with shorter remaining maturity. Primary dealers' holdings and trading volumes are both high for front-end and long-end buckets. Trading volumes are higher for dealer-to-customer trades than dealer-to-dealer trades across the curve.

3 Security-Level Results

3.1 The Selection of Buyback Listing and Purchasing

The choice of which securities to include in the buyback eligible list and to purchase is unlikely to be random. To investigate the Treasury's decision-making process, I begin by examining the decision rule based on security characteristics. Shown in the specification below, I estimate a Logit model where the dependent variable is a dummy indicator of whether a security i is listed or purchased in the buyback operation j ($\mathbb{1}_{i\in\mathcal{I}_j}$).

$$\mathbb{1}_{i\in\mathcal{I}_j} = \mathbf{\Gamma} \times \mathbf{X_{ij}} + \alpha_j + \epsilon_{ij} \tag{1}$$

For the explanatory variables ($\mathbf{X_{ij}}$), I use five types of characteristics valued pre-buyback. The

[10] According to FINRA FAQ 3.5.34, buyback trades are reported under "Dealer to customer" category.

first one is the share of outstanding amount held by SOMA if bought back by the Treasury. As indicated on the buyback page, Treasury does not intend to buy back a security if doing so would result in the SOMA ownership of that security exceeding 70%.[11] The second one is remaining maturity (and its square), a typical metric for debt management for duration targeting. The third one is coupon rate, as Treasury would consider cost efficiency in buybacks. The fourth one is relative value, given that the Treasury mentions that "proximity to prevailing market prices" and "relative value" are among the consideration for which bids are accepted. The relative price is constructed as deviations of actual prices from their model-implied counterparts, which are calculated as the present discounted value of future cash flows following Selgrad (2023).[12] The last one is bid-ask spread. For relative value and bid-ask spread, the 15-day average prior to buyback list announcement is used. I also include being listed or purchased in last buyback to see if the Treasury intentionally rotate in its purchases as well as bid-ask spread. These characteristics are widely used in the literature, such as Han, Longstaff and Merrill (2007), D'Amico and King (2013), and Connolly and Struby (2024).

The results of buyback listing selection are reported in Table 2 (column 1). As expected, the Treasury tends to list underpriced securities (i.e., those with lower relative value), consistent with cost-efficient purchasing. It also tends to list securities with smaller SOMA holdings, in order to minimize the buybacks' footprint on market activity. Regarding maturity, the Treasury is more likely to include securities with longer remaining maturities. This is intuitive, because there is less benefit for the Treasury to buy back a security that matures soon compared with allowing it to mature on schedule. For coupon rate, the Treasury tends to exclude high-coupon securities, likely reflecting cost-efficiency considerations. Interestingly, the Treasury tends to exclude securities with wide bid-ask spreads from the eligible list. These observed characteristics explain a substantial share of the Treasury's listing decision, with the R^2 between 0.5 and 0.7.

Notably, the negative coefficient on bid-ask spreads in the listing regression reveals an interesting tension: Treasury systematically avoids listing the least liquid securities, yet as shown later in subsection 3.3, the listing effect is largest precisely for high-spread securities. This implies that the program's liquidity support impact could be amplified if Treasury were to include a broader set of

[11] FAQs for Treasury Securities Buybacks.

[12] The discount function is based on Fed Yield Curve Models and Data from the Federal Reserve.

Table 2: Buyback Selections and Pre-buyback Characteristics

VARIABLES	(1) Listed	(2) Listed	(3) Listed	(4) Purchased	(5) Purchased	(6) Purchased
bid-ask spread, basis points	-0.0256*	-0.0468**	-0.0467**	0.0575**	0.0304	0.0296
	(0.015)	(0.020)	(0.020)	(0.028)	(0.028)	(0.028)
relative value, as percent of price	-0.6578***	0.3306*	0.2865	-0.3562*	-0.2224	-0.2175
	(0.200)	(0.194)	(0.207)	(0.200)	(0.216)	(0.216)
SOMA share of outstanding if buyback, percent	-0.0581***	-0.0379***	-0.0385***	-0.0022	-0.0018	-0.0017
	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
coupon, pps	-0.5658***	-0.4071***	-0.4068***	-0.1855***	-0.1772***	-0.1761***
	(0.112)	(0.092)	(0.095)	(0.053)	(0.056)	(0.055)
remaining maturity, years	2.8810***	2.8448***	2.7902***	-1.0011***	-1.1854***	-1.1958***
	(0.307)	(0.278)	(0.274)	(0.256)	(0.265)	(0.263)
remaining maturity square, years	-0.0621***	-0.0645***	-0.0641***	0.0186***	0.0220***	0.0222***
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
listed in the last buyback		3.6734***	4.1307***			0.1204
		(0.650)	(0.572)			(0.299)
purchased in the last buyback			-1.1715***		1.1084***	1.0889***
			(0.422)		(0.185)	(0.194)
Observations	2,982	2,606	2,606	2,224	2,045	2,045
Operation FE	yes	yes	yes	yes	yes	yes
Targeted bucket FE	yes	yes	yes	yes	yes	yes
R2	0.554	0.696	0.700	0.162	0.190	0.190

Note: This table reports the Logit regression Equation 1, where the dependent variable is a dummy variable indicating if a Treasury security is listed in the eligible list of buyback, conditional on the security is in the targeted segment by the buyback (column 1 to 3); if a Treasury security is purchased in the buyback, conditional on the security is listed (column 4 to 6). ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at operation level.

illiquid securities in the eligible list, though this would need to be weighed against the Treasury's other objectives such as cost efficiency and minimizing market footprint.

The purchasing decision is less well explained, with an R^2 below 0.2. Coupon and remaining maturity still play a role (Table 2, column 4), but relative value and spread have no robust predictive power. The reason could be that the relative price implied by the *actual* bids submitted by primary dealers is what matters for the purchasing decision; however, this information is not disclosed publicly. The low explanatory power from observed characteristics also suggests that, from the perspective of market participants, there is a degree of unpredictability in the Treasury's acceptance decisions, as the exact rules governing the Treasury's decisions remain confidential. This confidentiality is deliberate: fully predictable selection rules would enable dealers to submit higher bids for securities the Treasury intends to purchase, raising buyback costs. This rationale echoes arguments by Selgrad (2023) concerning the Federal Reserve's quantitative easing operations.

Prior buyback status is a strong predictor of subsequent selection. Being listed or purchased in the previous operation is significantly positively correlated with current listing or purchase, respectively. When the lagged listing indicator is included, relative value loses its predictive power for the decision making, suggesting that the Treasury persistently lists the same undervalued securities across operations.

3.2 Listing and Purchasing Effects

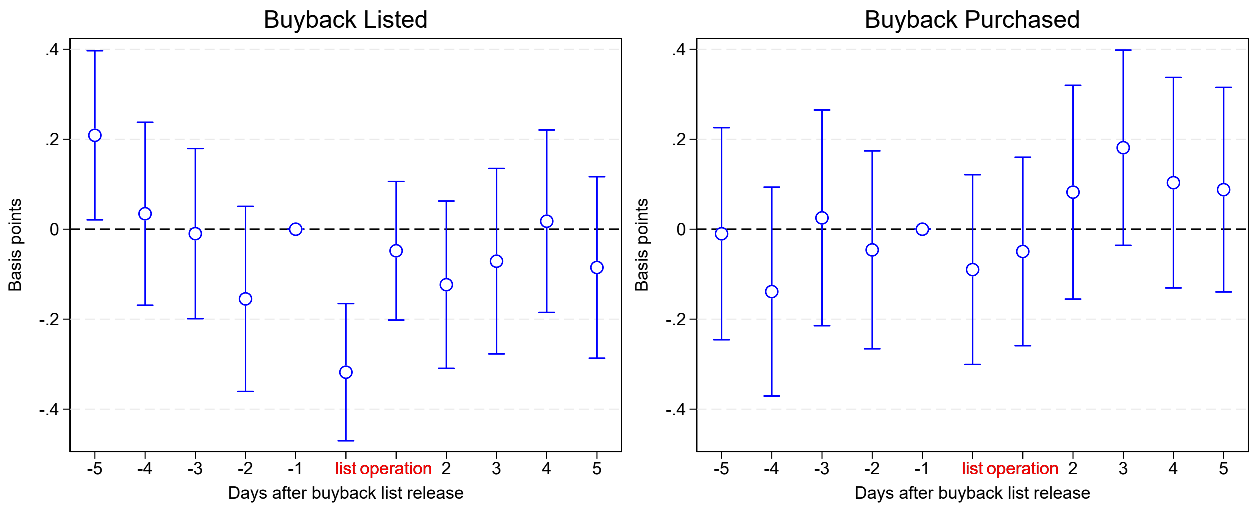
To explore the listing and purchasing effects of buyback on Treasury market liquidity conditions, I focus on two sets of comparisons: conditional on being targeted, the securities being listed for buyback vs. those not listed (*listing effect*); conditional on being listed, the securities being accepted vs. those not accepted (*purchasing effect*). I format the comparisons in DID framework as follows:

$$
\begin{aligned}
y_{isjt} = & \sum_{d=-10,\ldots,-2,0,1,\ldots 10} \beta_{1d} \mathbb{1}_{i \in \mathcal{I}_j} \times \mathbb{1}_{t=t_j+d} \\
& + \sum_{d=-10,\ldots,-2,0,1,\ldots 10} \beta_{2d} \mathbb{1}_{t=t_j+d} \\
& + \beta_3 \mathbb{1}_{i \in \mathcal{I}_j} + \delta r_{it} + \alpha_i + \alpha_j + \alpha_{st} + \epsilon_{isjt}
\end{aligned} \tag{2}
$$

where y_{isjt} is the outcome variable for security i on bucket s (one of the nine buckets targeted by buybacks) in buyback operation j at day t. $\mathbb{1}_{i \in \mathcal{I}_j}$ is the dummy variable indicating if security i is in the treated group $\mathcal{I}_j$, which could be "listed by operation j" or "bought back in operation j." $\mathbb{1}_{t=t_j+d}$ is another dummy variable indicating the date is d days (up to 10 days) before or after the day when the preliminary eligible buyback list is released (t_j). β_{1d} is the coefficient of interest, which estimates the impact of buybacks. The dummy variable $\mathbb{1}_{t=t_j-1}$ is omitted, allowing β_{1d} to measure the deviation as of day $t_j + d$ relative to the day preceding announcement day t_j. The security fixed effects α_i absorb the time-invariant (and to a large extent slow moving) security characteristics, such as coupon rate, initial maturity, and amount outstanding. The buyback operation fixed effects α_j absorb time-invariant buyback characteristics, such as its targeted bucket. Bucket-specific time fixed effects α_{st} are included to account for potential different movements in various buckets on the Treasury yield curve across time. I further include the on-the-run yield r_{it} (in first difference) corresponding to the maturity of security i, which proxies demand and supply conditions relevant for security i.

The identifying assumption underlying Equation 2 is that, absent the buyback, the bid-ask spreads of listed and unlisted securities (or purchased and non-purchased securities) would have followed parallel paths. The event-study coefficients for $d < 0$ provide a direct test: if the pre-announcement coefficients β_{1d} are jointly indistinguishable from zero, the parallel trends assumption is supported. As shown in Figure 3, the pre-announcement coefficients are generally small and statistically insignificant for both the listing and purchasing specifications.[13]

Figure 3: The Dynamics of Listing and Purchasing Effects of Buyback



Note: This figure plots the deviation of bid-ask spread relative to one day before buyback list announcement day, as estimated by Equation 2. The dots represent the change of bid-ask spreads relative to the day prior to the buyback eligible list release ("−1" on the x axis) of securities listed in buyback (or bought back), compared to those not listed (or not bought back). The intervals represent the 90% confidence interval. Full regression results are in Table A2.

Listed by buyback significantly narrows spreads on the listing day. Relative to unlisted securities, the bid-ask spread of listed securities tightens by 0.3 basis points on the announcement day relative to the preceding day (Figure 3, left). The effect dissipates by the following day, when

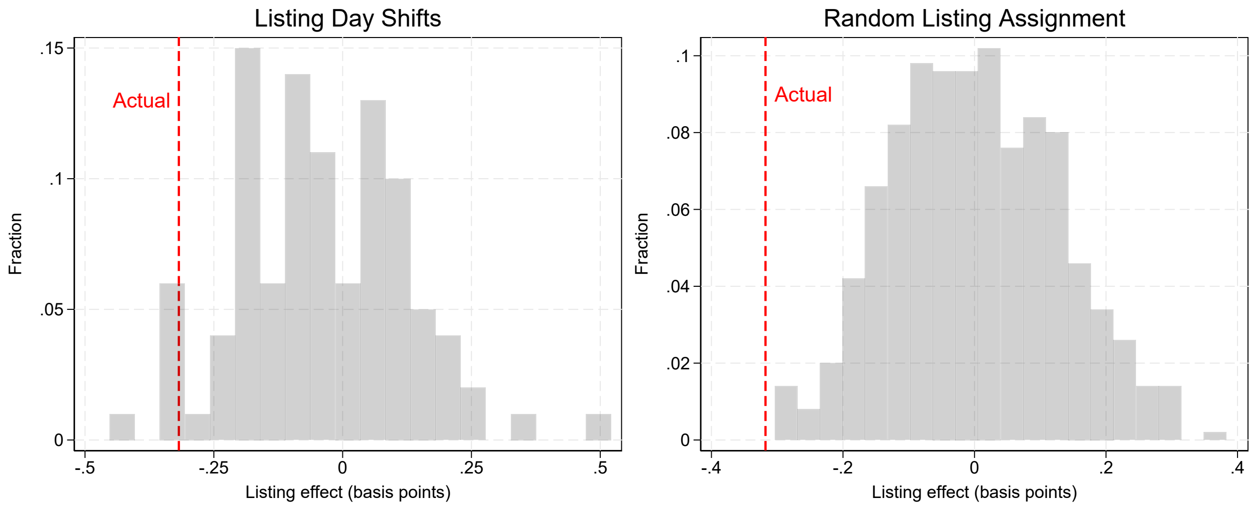
[13] One pre-period coefficient ($d = -5$) in Table A2 is statistically significant in the listing specification. This isolated significance is consistent with chance at conventional levels and does not indicate a systematic pre-trend. As a robustness check, the condensed specification in Table 4 pools all pre-period coefficients into a single indicator, which is insignificant.

the buyback auction executes. This transitory pattern is consistent with the model developed later in section 5: on the listing day, the dealer pricing incorporates the expected Treasury demand, which offers option value to reduce tail risks of high inventory. Once the buyback concludes, the option is exercised and the dealer reverts to the no-buyback pricing, and spreads difference between the listed and non-listed returns to pre-announcement levels. Moreover, I find no evidence of intensive-margin effects that the listing effect depends on the purchase amount (Table A2, column 3), consistent with the mechanism that the listing effect operates through the option value of potential purchase rather than through realized purchase amount.

To confirm that the listing effect reflects the actual buyback announcement rather than spurious correlation, I conduct two placebo exercises. First, I shift the announcement date by $t, t \in [-60, -11] \cup [+11, +60]$ trading days while retaining the true listing assignment (in total 100 placebo estimates). The actual listing-day estimate of -0.3 basis points falls in the far left tail of the placebo coefficients ($p = 0.04$, Figure 4). Second, I retain the true announcement date but randomly reassign listing status within each operation, preserving the operation-specific listing share. Across 500 random assignments, none produces a coefficient as negative as the actual estimate (permutation $p < 0.01$). Together, these tests confirm that the listing effect requires both the correct timing and the correct securities, ruling out explanations based on calendar regularities or mechanical correlations between listing-predictive characteristics and spread dynamics.

No robust evidence of a purchasing effect on spreads. As shown in Figure 3 (right), the bid-ask spreads of securities bought back by the Treasury do not differ significantly from those listed but not purchased. The point estimate on the listing day is -0.09 basis points with a standard error of 0.13, yielding a confidence interval that spans from -0.34 to $+0.15$ basis points. The data therefore cannot distinguish the purchasing effect from zero. This means that, conditional on being listed, actual purchase does not generate *additional* spread compression beyond what listing already provides. This pattern is consistent with dealers managing inventory risk at the portfolio level: because the value function depends on total bucket inventory rather than individual positions, the inventory relief from any buyback purchase benefits all securities in the bucket symmetrically, leaving no differential between purchased and non-purchased securities. This portfolio rebalancing

Figure 4: Placebo Distribution of Listing Effect



Note: This figure plots the baseline listing effect from Equation 2 against placebo distributions. The left distribution is based on 100 re-estimated listing effect by shifting the announcement date by $t, t \in [-60, -11] \cup [+11, +60]$ trading days while retaining the true listing assignment. The right distribution is based on 500 re-estimated listing effect by reassigning listing status within each operation, preserving the operation-specific listing share.

mechanism is formally developed in section 5.

Listed by buyback raises both bid and ask prices, but more for bids. To shed light on the mechanism behind the spread compression, I estimate Equation 2 separately using the ask and bid prices (in cents) as the dependent variable. As shown in Table 3, on the listing day both the ask and bid prices of listed securities increase significantly relative to unlisted securities, by 3.4 and 3.7 cents, respectively. The difference of approximately 0.3 cents corresponds to the spread narrowing documented above. This pattern maps directly onto the two channels in the model developed in section 5. The buyback option raises the value of holding inventory, which pushes both prices upward. However, the ask rises *less* because the price-elastic Treasury demand compresses the ask markup (Effect I), partially offsetting the upward shift. The bid, which is unaffected by Treasury demand, reflects the full value-function increase (Effect II). The net result—both prices rise, but the bid rises more—narrows the spread from the bid side rather than through an ask decline.

Neither component shows a significant purchasing effect, consistent with purchased and non-purchased securities receiving symmetric inventory relief through the shared value within portfolio.

Table 3: Listing and Purchasing Effects on Bid and Ask Prices

	(1)	(2)	(3)	(4)
	treatment: listed		**treatment: purchased**	
VARIABLES	Ask price	Bid price	Ask price	Bid price
listing day × buyback treatment	3.4458***	3.7470***	0.3347	0.4136
	(1.309)	(1.312)	(0.510)	(0.503)
operation day × buyback treatment	1.4724	1.5368	-0.7838	-0.7302
	(1.297)	(1.303)	(0.585)	(0.588)
Observations	60,353	60,353	45,502	45,502
R-squared	0.998	0.998	0.999	0.999
CUSIP FE	yes	yes	yes	yes
Bucket-specific time FE	yes	yes	yes	yes
Operation FE	yes	yes	yes	yes

Note: This table reports Equation 2, where ask price in cents (column 1 and 3) or bid price in cents (column 2 and 4) is the dependent variable. Column 1 and 2 estimate listing effect, column 3 and 4 estimate purchasing effect. Full table is in Table A3. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at security level.

3.3 When Are the Effects of Buyback More Pronounced?

Conceptually, the extent to which buybacks support liquidity may depend on prevailing market conditions. When liquidity is already strained, the additional demand from buyback could be particularly valuable. To measure pre-buyback liquidity conditions, I construct two dummy variables. The first measure is at security level: for each operation, I sort securities in the buyback targeted bucket by their pre-buyback bid-ask spreads (average across 25 days before buyback eligible list announcement) and label the top quartile as high spread (i.e., tight liquidity condition). The second measure is at operation level: for each coupon bucket, I sort operations by primary dealers' pre-buyback excess holdings[14] (average across 4 weeks before buyback eligible list announcement) and label the top quartile as high excess holdings.

To test whether pre-buyback liquidity conditions affect the magnitude of buyback effects, I extend Equation 2 to a triple DID setting by interacting the tight liquidity dummy with the existing DID variables. To reduce the number of regressors, I condense the full day-by-day dynamic specification to prior listing, listing day, operation day, and post operation (or listing) days.

[14] I use the dealer inventory management regression (more in subsection 4.1) based on Fleming, Nguyen and Rosenberg (2024) to calculate expected dealer position and use the deviation from the expected dealer position as excess holdings.

Listing effect is larger when liquidity is tight. The baseline results continue to hold that buyback listing narrows spreads for those listed relative to pre-announcement day, compared with those not listed. Moreover, the triple interaction term shows that the listing effect for those less liquid securities is twice as large as the more liquid counterparts (Table 4, column 1). This channel, where less price-responsive market demand (hence, less liquid) makes buyback more valuable, is validated in the model in section 5.

The triple interaction term also shows that the listing effect for those times with excessive primary dealer holdings is one third larger than the rest times (Table 4, column 3). This is rationalized by the model's feature that buyback demand scales up with inventory pressure where extra demand is most needed, therefore inventory pressure augments buyback effect.

Table 4: Listing and Purchasing Effects and Pre-buyback Liquidity Condition

	(1)	(2)	(3)	(4)	(5)	(6)
	Large: high bid-ask spread		**Large: high excess holdings**		**Large: on-the-run volatility**	
treatment:	**listed**	**purchased**	**listed**	**purchased**	**listed**	**purchased**
VARIABLES	Bid-ask spread	Bid-ask spread	Bid-ask spread	Bid-ask spread	Bid-ask spread	Bid-ask spread
listing day × buyback treatment	-0.2626***	-0.1065	-0.2859***	-0.1091	0.3555	-0.1000
	(0.090)	(0.119)	(0.094)	(0.140)	(0.232)	(0.271)
Large × listing day × buyback treatment	-0.2430*	0.1394	-0.5756*	0.2245	-17.8756**	0.2772
	(0.132)	(0.306)	(0.309)	(0.197)	(6.934)	(7.831)
operation day × buyback treatment		-0.0050		-0.0452		-0.2270
		(0.113)		(0.139)		(0.269)
Large × operation day × buyback treatment		-0.0406		-0.0473		4.2037
		(0.307)		(0.229)		(7.754)
post listing × buyback treatment	-0.0325		-0.0559		0.1866	
	(0.092)		(0.097)		(0.201)	
post purchasing × buyback treatment		0.0924		0.0869		0.0616
		(0.114)		(0.136)		(0.258)
pre listing × buyback treatment	-0.0925	-0.0834	-0.0310	-0.0651	-0.0357	0.1118
	(0.081)	(0.099)	(0.091)	(0.126)	(0.202)	(0.250)
Large × post listing × buyback treatment	-0.0844		0.1279		-6.3192	
	(0.136)		(0.302)		(6.800)	
Large × post purchasing × buyback treatment		-0.0527		-0.1784		0.2414
		(0.294)		(0.200)		(7.520)
Large × pre listing × buyback treatment	0.1382	0.0396	-0.3456	0.1104	-0.3563	-3.9104
	(0.134)	(0.292)	(0.227)	(0.193)	(6.285)	(7.164)
buyback treatment	-0.0063	0.0671	0.1186	0.1369	-0.3370	0.0915
	(0.119)	(0.119)	(0.121)	(0.146)	(0.310)	(0.286)
Δ on-the-run yield, bps	-0.0437***	-0.0417***	-0.0454***	-0.0455***	-0.0425***	-0.0448***
	(0.009)	(0.016)	(0.010)	(0.016)	(0.009)	(0.016)
Observations	60,353	45,502	60,353	45,502	60,353	45,502
R-squared	0.947	0.938	0.947	0.938	0.947	0.938
CUSIP FE	yes	yes	yes	yes	yes	yes
Bucket-specific time FE	yes	yes	yes	yes	yes	yes
Operation FE	yes	yes	yes	yes	yes	yes

Note: This table reports the triple DID extension of a condensed form of Equation 2, with the third dimension (besides post treatment and buyback treatment) being a dummy variable indicating if a Treasury security is less liquid pre-buyback (column 1 and 2), a dummy variable indicating if an operation happens when primary dealer has large excess holdings pre-buyback for the buyback targeted bucket (column 3 and 4), and a continuous variable of the standard deviation of daily on-the-run (of the targeted bucket) yield changes prior five days before listing. Column 1, 3, and 5 are listing effect, and column 2, 4, and 6 are purchasing effect. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at security level.

Listing effect scales with Treasury market volatility. To test whether the program's efficacy varies with market volatility, I interact the listing treatment with pre-buyback realized volatility of on-the-run yields in the targeted bucket. As shown in column 5 of Table 4, the triple interaction is negative and statistically significant: a one-unit increase in realized volatility amplifies the listing effect by approximately 18 basis points. At the median level of rate volatility, the implied listing effect is about -0.3 basis point, matching the baseline estimate. While at the 95th percentile, it rises to -1.0 basis point, more than three times as large. The purchasing effect continues to show no significant interaction with volatility (column 6). The amplification under high volatility is a natural implication of the option-value interpretation of buyback: when rate uncertainty is elevated, the probability that inventory costs reach levels where the buyback exit becomes valuable increases, raising the expected payoff of the option embedded in listing eligibility. These results suggest that the program functions as a liquidity backstop whose stabilizing benefits would scale meaningfully during periods of market stress, precisely the conditions under which Treasury market resilience is most consequential.

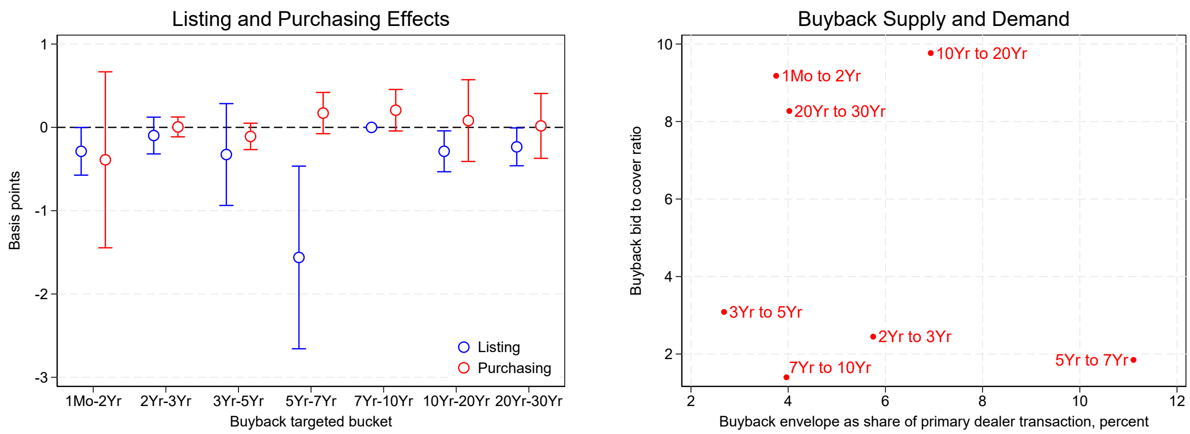
Listing effect is high if sizable buyback demand or supply. The bucket-specific estimates (Figure 5, left) show that the listing effect is more pronounced for the front-end and long-end buckets—coupons with remaining maturity between one month and 10 years or over 10 years—as well as the bucket with 5 to 7 years remaining maturity, narrowing spread by about 0.3 basis point on the listing day. By contrast, most of the belly buckets show no significant listing effect. Similarly to full sample results (Figure 3), the listing effect largely dissipates after listing day, and purchasing effect is not significant across buckets.

To explain the heterogeneity across buckets, I focus on their buyback demand and supply. For the former, I use the bid-to-cover ratio of buyback auctions. For the latter, I use the size of the buyback envelope as a proportion of primary dealers' transactions in the targeted buyback category.[15] As shown by Figure 5 (right), the front-end and long-end buckets exhibit the highest demand for buybacks. The bid-to-cover ratio for buybacks is above 8 for these buckets, in contrast to a range of 1.5 to 4 for the rest. From the perspective of buyback supply, the buyback envelope

[15] Given that the data is weekly, I use the nearest day prior to buyback.

constitutes about 11 percent of the primary dealers transaction prior to the buyback for 5 to 7 years remaining maturity bucket, which is notably higher than the others. Higher buyback demand indicates needs to offload inventories, and higher buyback supply suggests capacity to create extra demand in the market. Both could lead to larger effect of buyback listing.

Figure 5: By Bucket Results



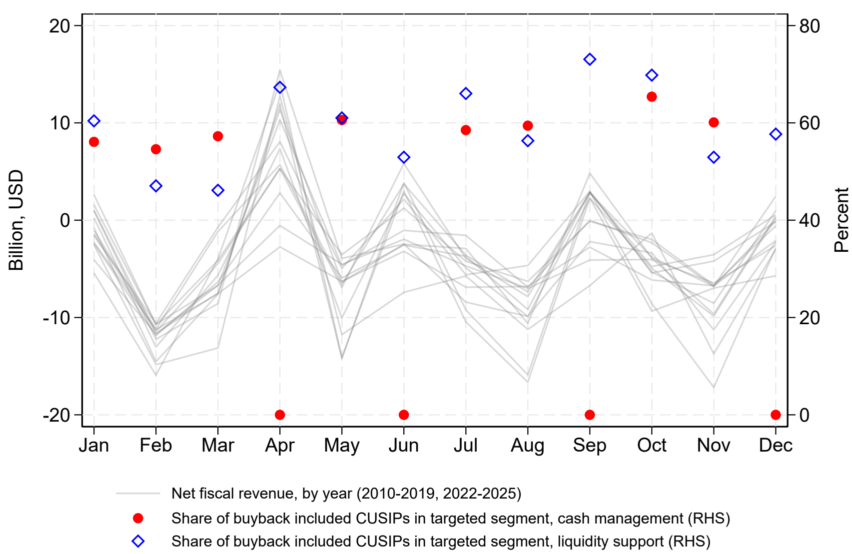
Note: The left figure plots the listing and purchasing effects on the listing day estimated bucket-by-bucket, based on Equation 2. More estimates are shown in Table A4. Bands represent 90% confidence intervals. The right figure plots the average bid-to-cover ratio and buyback envelope as share of primary dealer transaction by bucket. The former is to proxy buyback demand, and the latter is to proxy buyback supply.

3.4 Quantifying Potential Selection Bias:: Evidence from Cash Management Buybacks

The fixed-effects estimates in the preceding sections capture the listing effect of the program as actually implemented, with Treasury's endogenous selection of which securities to list. From a policy perspective, this is a relevant estimate: it measures the liquidity improvement delivered by the program under its actual operating rules. However, because the Treasury systematically avoids listing the least liquid securities (subsection 3.1), these estimates may understate the potential liquidity gains from a less selective listing policy.

To gauge this selection bias, I exploit a distinct feature of cash management buybacks to construct a novel instrumental variable for buyback listing. Unlike liquidity support buybacks, cash management buybacks aim to reduce volatility in Treasury's cash balance and typically occur in the weeks immediately preceding major tax payment dates (e.g., April 15, June 15, September 15, and December 15), when Treasury experiences substantial cash inflows. To this end, Treasury explicitly states that the maturity dates of securities are considered in its buyback decisions: "Securities with maturity dates that would not benefit Treasury from a cash management perspective would also be excluded. For example, if Treasury bought back securities with maturities that occur on dates with high cash inflows (such as major tax payment dates) this would potentially amplify rather than mitigate cash balance and issuance volatility."[16]

Figure 6: Buyback-Included CUSIPs by Maturity Month



Note: This figure plots the share of the CUSIPs that make it into the buyback eligible list by their maturity month. The red dots and blue diamonds represent cash management and liquidity support buyback results, respectively. The gray lines represent the fiscal outlay net of fiscal revenue in each month from 2010 to 2025, excluding COVID years 2020 and 2021.

The consideration of maturity month is clearly revealed in the Treasury's selection of eligible securities for cash management buybacks. As illustrated in Figure 6, the Treasury excludes all securities maturing in the months when there is substantial cash inflow to Treasury General Account—i.e., large positive net fiscal revenue, which is net changes in Treasury General Account aside from debt issuance and redemption, specifically in April, June, September, and December—from the buyback eligible list. This approach contrasts with the pattern observed in liquidity support

[16] Treasury's current views on the operational design of a regular buyback program.

buybacks,[17] which include more than half of the securities maturing in these four months in their eligible list. This maturity-month-based consideration in the operational design of cash management buyback—important for buybacks but exogenous to liquidity condition—provides a compelling framework to examine the liquidity support impact of buybacks resembling a quasi-random purchase.

I utilize the maturity month, along with SOMA holdings and coupon rate (which are well argued to be related with the Treasury's choice but unrelated with spreads, e.g., D'Amico and King (2013)), to construct an instrumental variable for the dummy variable indicating inclusion in buybacks. The Logit regression is specified as Equation 1:

$$\mathbb{1}_{i\in\mathcal{I}_j} = \mathbf{\Gamma} \times \mathbf{X_{ij}} + \alpha_j + \epsilon_{ij}, \quad \Longrightarrow \widehat{\mathbb{1}}_{i\in\mathcal{I}_j}$$

where $\mathbb{1}_{i\in\mathcal{I}_j}$ indicates security i is listed in operation j, $\mathbf{X_{ij}}$ are the three security-level variables (average across 15 days before buyback listing) and an interaction term between SOMA holdings and coupon, and α_j are operation fixed effects. I allow coefficients to vary across operations to improve the fit. The fitted value from the Logit regression is the resulting IV ($\widehat{\mathbb{1}}_{i\in\mathcal{I}_j}$).

To assess the validity of the exclusion restriction of the IV, I test whether maturity month dummies, SOMA holdings, and coupon rate predict bid-ask spread changes (relative to one day before announcement day, the same reference day as in second stage regressions)[18] in the pre-announcement window. As shown in columns 1 and 2 of Table 5, none of the individual coefficients is statistically significant, and the joint F-test on the maturity month dummies yields p-value of 0.9, indicating that these variables have no predictive power for spread movements before buyback eligibility is revealed. As security fixed effects are included second stage regression, they absorb any time-invariant correlation between security characteristics and spread levels. The exclusion restriction therefore requires that the instruments do not predict *within-security* spread variation around the buyback event through channels other than listing. Consistent with this requirement,

[17] Cash management only targets nominal coupons with remaining maturity between 1 month and 2 years, so I only include liquidity support buybacks targeting the same segment in the comparison.

[18] The exclusion restriction test uses bid-ask spread changes rather than levels as the dependent variable. This is the appropriate test because the main specification includes security fixed effects, which absorb any time-invariant correlation between security characteristics and spread levels. The exclusion restriction therefore requires only that the instruments do not predict *within-security* spread variation through channels other than listing.

Table 5: Listing Effect: Cash Management Buyback IV

VARIABLES	(1) Exclusion restriction test Δ Bid-ask spread	(2) Δ Bid-ask spread	(3) IV construction Listed	(4) Bid-ask spread	(5) IV Bid-ask spread
buyback listed				-0.0575	0.2030
				(0.114)	(0.325)
listing day × listed				-0.1163**	-0.1741**
				(0.047)	(0.088)
post listing day × listed				-0.0366	-0.0922
				(0.036)	(0.067)
pre buyback × listed				0.0704	-0.0385
				(0.046)	(0.081)
SOMA share of outstanding if buyback, percent	0.0030	0.0028	0.0526***		
	(0.005)	(0.056)	(0.017)		
coupon, percent	-0.0006		0.8494***		
	(0.041)		(0.186)		
interaction of the above two			-0.0299***		
			(0.006)		
Δ on-the-run yield, bps				0.0020	0.0021
				(0.004)	(0.004)
Observations	19,333	19,333	1,215	34,345	34,345
R2	0.082	0.093	0.268	0.984	–
p-value for maturity month	0.873				
1st stage F-stat					11.45
Security FE		yes		yes	yes
Maturity month FE	yes	yes	yes		
Operation FE	yes	yes	yes	yes	yes
Bucket-specific time FE				yes	yes

Note: Column 1 and 2 test the exclusive restriction for IV. The sample is 10 days window up to two days before buyback listing. Dependent variable is bid-ask spread relative to one day before buyback listing, to be consistent with the second stage where the reference day is also one day before buyback listing. Column 3 reports the Logit regression used to construct IV Equation 1, where the dependent variable is a dummy variable indicating if a Treasury security is listed in buyback, conditional on the security is in the targeted bucket by the buyback. As the regression allows coefficient to vary across operations, the average is reported here. Column 4 and 5 are the condensed version of Equation 2 with baseline fixed effects specification and IV specification, respectively. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at operation level for column 1 to 3 and at security level for column 4 and 5.

the instruments have no predictive power for spread changes in the pre-announcement window.

Column 3 of Table 5 shows that cash management buybacks tend to list securities with lower SOMA holding and lower coupon rate, similar to liquidity support buybacks (Table 2).[19] Including maturity month dummies significantly improves the fit. Without maturity month dummies, the R^2 from regressing buyback listed dummy on the Logit predicted value is less than 0.1, as the more powerful explanatory variables such as relative value and spread are excluded. By including maturity month dummies, the R^2 substantially increases to 0.5.

The listing effect is significant; selection attenuates the baseline estimate. Similar to liquidity support buyback, being listed by cash management buyback reduces the bid-ask spread

[19] Although the coefficients for SOMA holding and coupon rate alone are positive, the combined coefficients with interaction term are mostly negative.

by about 0.1 basis point on announcement day relative to a day prior, compared with those not listed. The IV results in column 5 show that a more random listing would narrow the spread by about 0.2 basis point, higher than the baseline estimates. This could be explained by the findings from subsection 3.1 and subsection 3.3 that the Treasury is less likely to list securities with higher spreads and listing effect is higher if higher-spread securities are listed. The baseline estimates are therefore conservative measures of the program's potential liquidity support effects.

The IV analysis serves a specific diagnostic purpose: it confirms that the baseline fixed effects estimates are attenuated by Treasury's selection toward more liquid securities, and that the true listing effect is, if anything, larger than the baseline. The instrument is not intended to replace the main specification, which exploits within-bucket, within-operation variation across all maturity segments and the full sample period, as cash management IV applies only to the 1Mo–2Yr bucket. Nonetheless, the qualitative conclusion that selection attenuates rather than inflates the estimated listing effect provides important reassurance about the program's efficacy and suggests that expanding the eligible list to include less liquid securities could amplify the program's impact.

4 Aggregate-Level Results

This section complements the security-level analysis by examining the aggregate effects of Treasury buybacks along two dimensions: primary dealer balance sheets (subsection 4.1) and secondary-market trading activity (subsection 4.2). While the security-level results in section 3 quantify effect of buyback listing on individual securities' bid-ask spreads, the aggregate analysis characterizes the broader footprint of the program on dealer intermediation capacity.

4.1 Dealer Balance Sheet

A stated objective of the buyback program is to alleviate balance-sheet pressure on primary dealers when their Treasury holdings become elevated. To quantify this channel, I build on the standard inventory-adjustment framework in the literature (see Fleming, Nguyen and Rosenberg (2024), for instance) and augment the specification with the dollar amount of buybacks:

$$\Delta y_t = \alpha + \eta y_{t-1} + \beta_1 \cdot buyback_t + \beta_2 \cdot issuance_t + \beta_3 \cdot redemption_t + \epsilon_t \tag{3}$$

where Δy_t denotes the weekly change in the net position of Treasury coupons (or total Treasury securities) from week $t-1$ to t, and y_{t-1} is the lagged level. The coefficient β_1 captures the effect of buybacks on net Treasury positions. Following Fleming, Nguyen and Rosenberg (2024), I control for Federal Reserve and foreign central bank holdings of Treasuries. Importantly, buyback timing and amounts are predetermined at the quarterly refunding announcement, making them exogenous to contemporaneous dealer positions—the same identification assumption that applies to issuance and redemption in this framework.

The estimates in Table 6 column 1, which covers the full sample period prior to buybacks, align with magnitudes reported in the literature. Primary dealers exhibit mean reversion in Treasury positions, as reflected in the negative coefficient on lagged holdings. Issuance and redemption increase and decrease positions, respectively: a one-billion-dollar issuance raises coupon positions by approximately \$100 million, while an equivalent redemption reduces them by roughly \$50 million.

Buybacks significantly reduce coupon holdings in the execution week. With buybacks included in the regression, the results indicate a significant decline in coupon positions during buyback weeks. A one-billion-dollar buyback reduces primary dealers' coupon positions by approximately \$550 million (Table 6, column 2)—an elasticity considerably larger than that of redemption. To isolate the direct impact on the targeted maturity segment, I estimate a panel specification at the bucket level with bucket and week fixed effects. Column 3 shows that the position in the targeted coupon bucket declines by \$300 million per billion dollars of buyback. Although moderate relative to primary dealers' average coupon holdings of approximately \$270 billion (with a standard deviation of \$60 billion; see Table A1), the elasticity is economically meaningful and suggests that the balance-sheet impact would scale proportionally with the size of the program. Notably, buybacks do not affect dealers' overall Treasury holdings (Table 6, column 4), which could be due to dealers rebalancing across maturity segments following the sale of off-the-run coupons via buyback.

Table 6: Primary Dealers Treasury Position Management

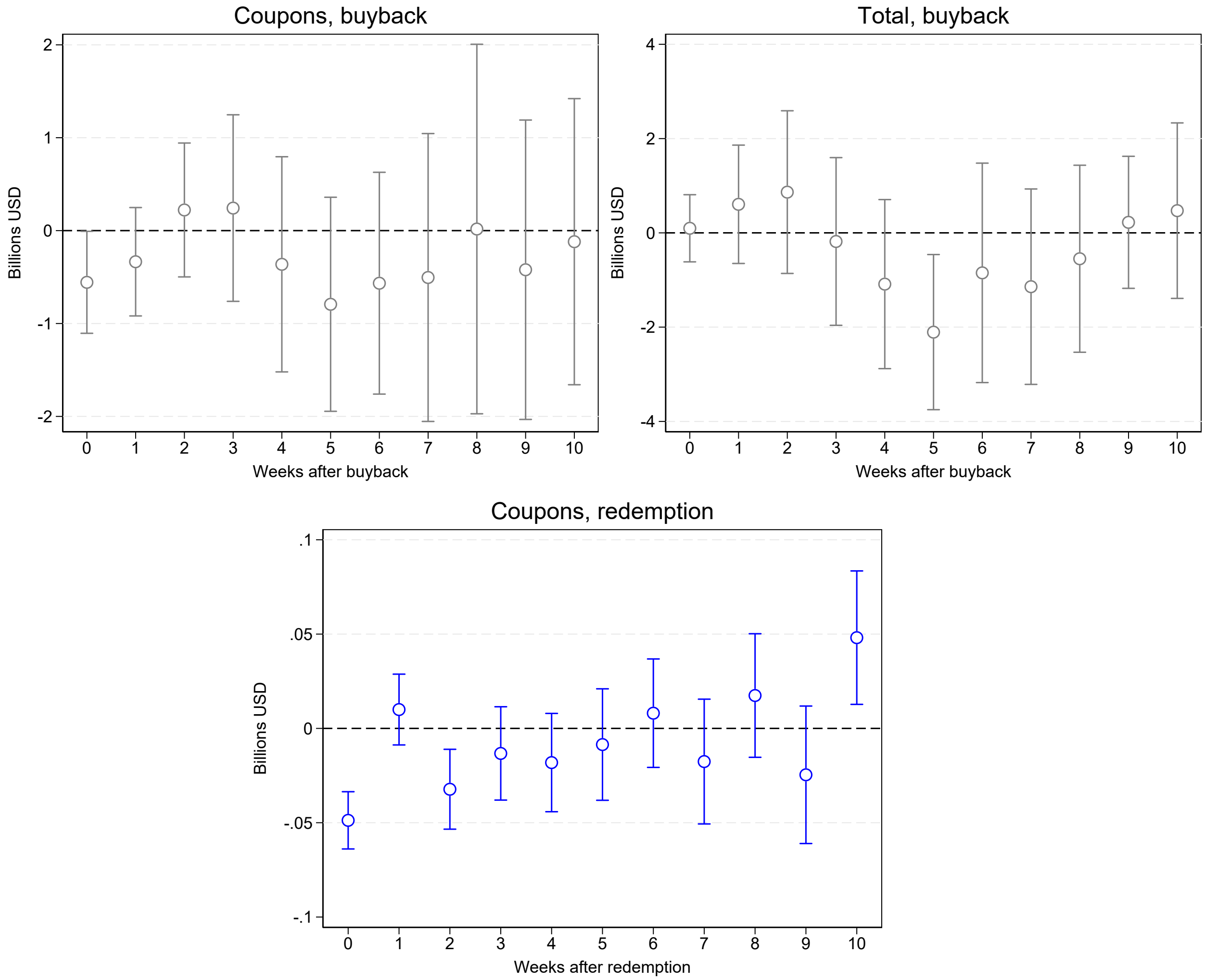
VARIABLES	(1) Δ Coupon	(2) Δ Coupon	(3) Δ Coupon	(4) Δ Total
buyback, $bn		-0.5565*	-0.2758**	0.0971
		(0.334)	(0.087)	(0.433)
lag holdings, $bn	-0.0110***	-0.0219	-0.0764***	-0.0830
	(0.003)	(0.028)	(0.015)	(0.066)
issuance, $bn	0.0998***	0.0581***	0.0116	0.1081***
	(0.009)	(0.021)	(0.012)	(0.016)
redemption, $bn	-0.0487***	0.0054	0.0114	-0.0421
	(0.009)	(0.029)	(0.025)	(0.044)
Observations	1,283	97	582	97
Bucket FE	no	no	yes	no
Week FE	no	no	yes	no
Sample start	11jul2001	03apr2024	03apr2024	03apr2024
Sample end	04feb2026	04feb2026	04feb2026	04feb2026
R2	0.213	0.133	0.248	0.369

Note: This table reports estimates of Equation 3 relating primary dealers' Treasury positions to buybacks. Columns 1–3 report results for coupon positions; column 4 reports results for total Treasury holdings. Columns 1, 2, and 4 are time-series regressions; column 3 is a panel regression across coupon buckets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Newey–West standard errors with 4 lags are used in columns 1, 2, and 4; standard errors in column 3 are clustered at the bucket level.

The inventory reduction is short-lived. To trace the dynamics of the balance-sheet impact, I estimate Equation 3 in a local projection setting. As shown in Figure 7 (top panel), the coupon position in the targeted bucket contracts by approximately $500 million in the execution week but reverts to pre-buyback levels within one to two weeks. Total Treasury holdings show no discernible response at any horizon. This pattern could indicate that dealers replenishing off-the-run coupon inventory through secondary-market purchases or new issuance shortly after selling to the Treasury.

The buyback effect on inventory is an order of magnitude larger than that of redemption. The dynamic response of dealer coupon holdings to buybacks far exceeds that of redemptions (Figure 7, bottom panel), with the peak impact roughly ten times larger. Both buyback and redemption schedules are predetermined at the quarterly refunding announcement, so this difference does not reflect differential information content. Instead, it reflects the nature of the securities involved: buybacks retire less liquid, deep off-the-run coupons that dealers or market participants hold reluctantly and cannot easily replenish through natural market flow. Redemptions, by contrast,

Figure 7: Dynamic Effect of Buybacks On Primary Dealers Treasury Position

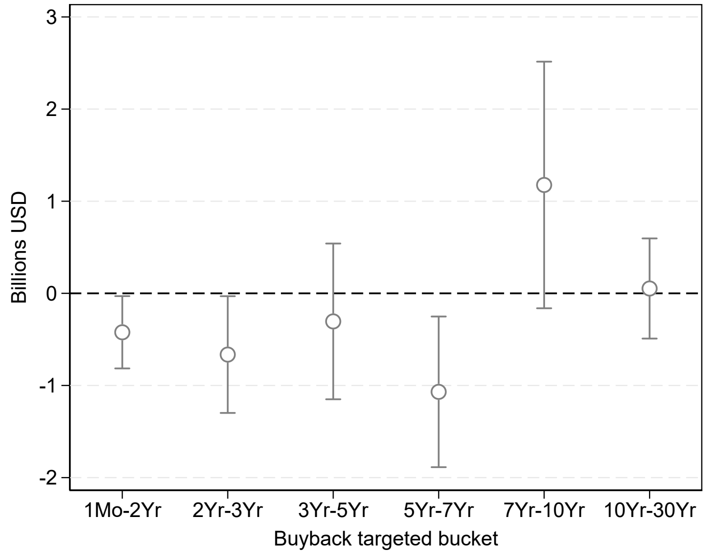


Note: This figure plots impulse responses of primary dealers' Treasury positions to a one-billion-dollar buyback or redemption, estimated via local projections based on Equation 3. Horizon 0 corresponds to the buyback execution week. The top panel reports results for coupon and total Treasury holdings in response to buyback; the bottom panel reports results for coupon holdings in response to redemption. Newey–West standard errors with 4 lags are used. Bands represent 90% confidence intervals.

retire securities approaching maturity—a segment where dealers maintain positions through auction participation and market-making obligations, and where replacement inventory is readily available from new issuance.

The inventory effect is concentrated in shorter-maturity buckets. The magnitude of inventory relief may vary across maturity segments if the composition of buyback supply—dealer

Figure 8: Effect of Buybacks On Primary Dealers Treasury Position: By Targeted Bucket



Note: This figure plots the change in primary dealers' coupon positions by maturity bucket in the buyback execution week, relative to the prior week, in response to a one-billion-dollar buyback. Estimates are based on Equation 3. Newey–West standard errors with 4 lags are used. Bands represent 90% confidence intervals.

inventory versus client intermediation—differs by bucket. To investigate, I estimate Equation 3 separately for each coupon bucket. Figure 8 shows that the point estimates are negative and statistically significant for the front-end buckets: coupon holdings decline by between $300 million and $1 billion for maturities ranging from 1 month to 7 years in response to a one-billion-dollar buyback. The estimates for longer-maturity buckets are imprecise, with wide confidence intervals that do not support economically meaningful effects in either direction.

The extent to which buybacks reduce dealer holdings depends on how much of the supply comes from dealers' own inventory versus client intermediation. As discussed at the 2025 U.S. Treasury Market Conference at the Federal Reserve Bank of New York, a nontrivial share of buyback supply reflects dealers selling on behalf of clients rather than reducing their own positions. I investigate this channel further in subsection 4.2.

4.2 Dealer Transaction Volume

Beyond inventory relief, buybacks may affect secondary-market trading activity in the off-the-run segment. Off-the-run Treasuries trade less frequently than their on-the-run counterparts, and buyback operations—by generating realized transactions in these securities—could stimulate additional trading. To test this, I estimate the following specification using FINRA's daily dealer transaction data:

$$y_t = \alpha + \eta y_{t-1} + \beta_1 \cdot buyback_t + \beta_2 \cdot issuance_t + \beta_3 \cdot redemption_t + \gamma y_t^{\text{on-the-run}} + \epsilon_t \qquad (4)$$

The specification parallels Equation 3, with on-the-run trading volume as a control to absorb broad market-wide trading conditions.

Buybacks increase dealer trading volume on the execution day. As reported in Table 7, a one-billion-dollar buyback is associated with a $560 million increase in dealer-to-dealer trading and a $1.3 billion increase in total dealer-to-customer trading (columns 1 and 3). The panel estimates with bucket and day fixed effects (columns 4–6) are somewhat smaller but qualitatively similar. When buyback volume is excluded from the dealer-to-customer category, the residual volume does not change significantly in response to buyback (columns 2 and 5), indicating that the increase in dealer-to-customer trading largely reflects the buyback transactions themselves rather than incremental private sector activity.

Part of the buyback supply comes from client intermediation. Conceptually, if buyback supply were drawn entirely from dealers' own inventory, one would expect no change in dealer-to-dealer trading and a one-for-one response of dealer-to-customer trading. The significant increase in dealer-to-dealer trading suggests that part of the buyback supply originates from clients—such as principal trading firms and hedge funds—who sell to dealers via interdealer trading systems ahead of the buyback window, with dealers subsequently intermediating these positions to the Treasury. That said, the increase in dealer-to-dealer trading could also reflect post-buyback portfolio rebalancing by dealers. Absent security-level trading data, it is difficult to distinguish between these two channels.

The trading increase is concentrated on the execution day and partially reverses thereafter. The local projection estimates (extending Equation 4) in Figure 9 reveal that the initial increase in trading volume on the execution day is followed by a statistically significant decline

Table 7: Primary Dealers Treasury Trading Volume

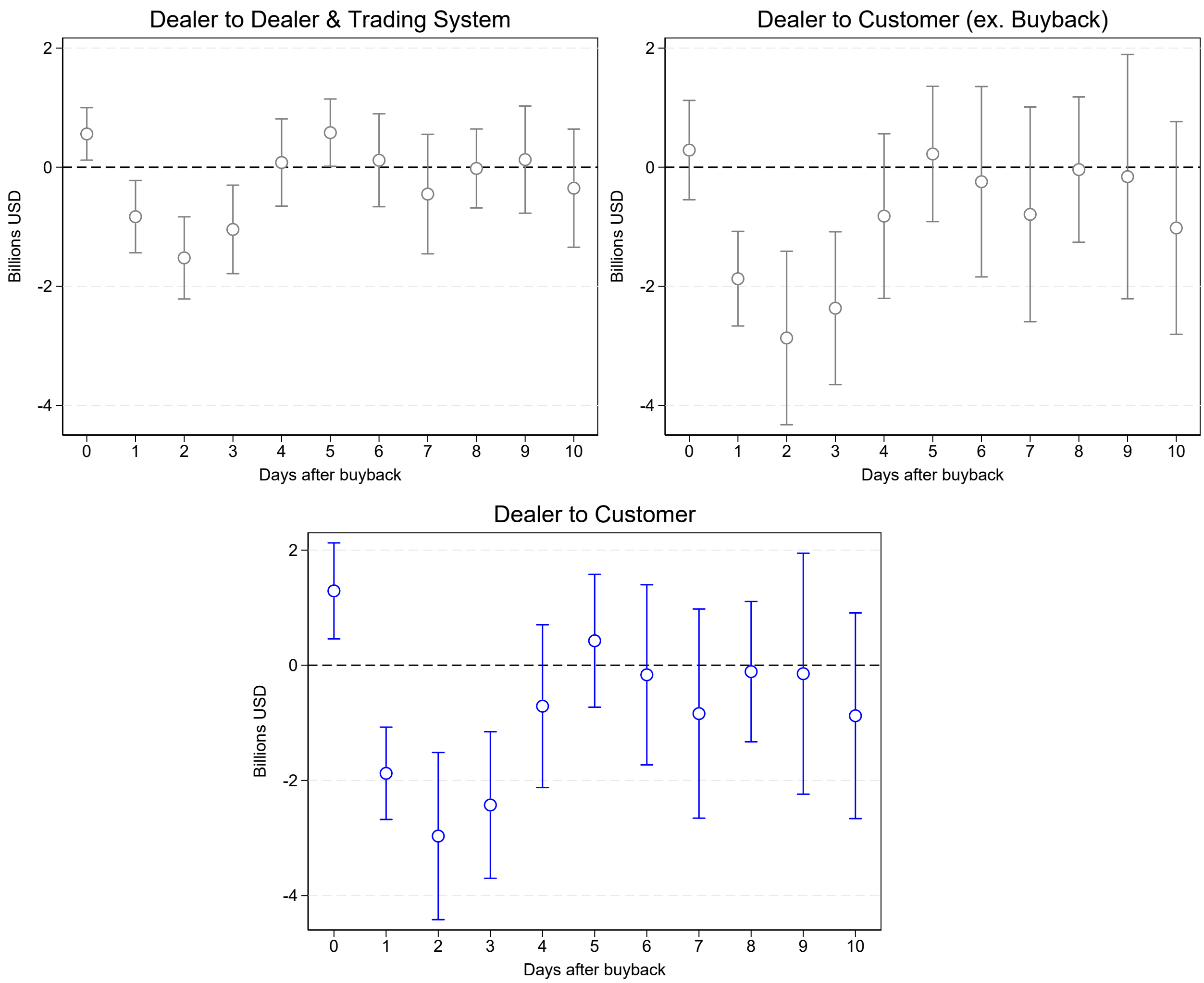
VARIABLES	(1) Dealer to dealer	(2) Dealer to customer ex. buyback	(3) Dealer to customer	(4) Dealer to dealer	(5) Dealer to customer ex. buyback	(6) Dealer to customer
buyback, $bn	0.5592**	0.2874	1.2916**	0.3018***	-0.0952	0.9234***
	(0.268)	(0.507)	(0.507)	(0.048)	(0.143)	(0.143)
y, lagged	0.3701***	0.2570***	0.2526***	0.3095***	0.3272***	0.3216***
	(0.055)	(0.051)	(0.051)	(0.056)	(0.068)	(0.069)
trading volume, $bn	0.0749***	0.3804***	0.3809***	0.1005***	0.4218***	0.4228***
(on-the-run)	(0.018)	(0.068)	(0.068)	(0.022)	(0.057)	(0.057)
issuance, $bn	0.0921***	-0.0573	-0.0572	-0.0892***	-0.2654***	-0.2658***
	(0.029)	(0.068)	(0.068)	(0.013)	(0.034)	(0.034)
redemption, $bn	0.0931***	0.1981***	0.2007***	0.0622	0.1066	0.1080
	(0.023)	(0.055)	(0.055)	(0.039)	(0.090)	(0.091)
Observations	449	449	449	2,694	2,694	2,694
Bucket FE	no	no	no	yes	yes	yes
Day FE	no	no	no	yes	yes	yes
Sample start	01may2024	01may2024	01may2024	01may2024	01may2024	01may2024
Sample end	12feb2026	12feb2026	12feb2026	12feb2026	12feb2026	12feb2026
R2	0.540	0.633	0.635	0.757	0.763	0.765

Note: This table reports estimates of Equation 4 relating primary dealers' Treasury trading volumes to buybacks. Columns 1–3 report time-series results for dealer-to-dealer volume (including trading-system volume), dealer-to-customer volume excluding buyback amounts, and total dealer-to-customer volume, respectively. Columns 4–6 estimate the same specifications as panel regressions across coupon buckets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Newey–West standard errors with 30 lags are used in columns 1–3; standard errors in columns 4–6 are clustered at the bucket level.

over the subsequent three trading days, for both dealer-to-dealer and dealer-to-customer categories. This intertemporal pattern suggests that buyback operations induce participants to bring forward trades they would otherwise have executed later in the week, rather than generating net new trading activity. The finding has implications for the market-quality effects of the program: if buybacks primarily redistribute trading activity across days rather than creating incremental volume, the mechanism through which they improve market functioning is more likely to operate through the standing availability of the buyback option—consistent with the elasticity channel (Effect I) in the model in section 5—rather than through increased realized transaction flow.

Client intermediation accounts for a larger share of buyback supply in longer-maturity buckets. The finding in subsection 4.1 that dealer inventory for longer-maturity buckets barely changes after buyback is consistent with the bucket-level trading evidence in Figure 10. For the 10–30 year bucket, both dealer-to-dealer and dealer-to-customer (excluding buyback) volumes increase significantly in response to buyback, suggesting that market participants such as hedge

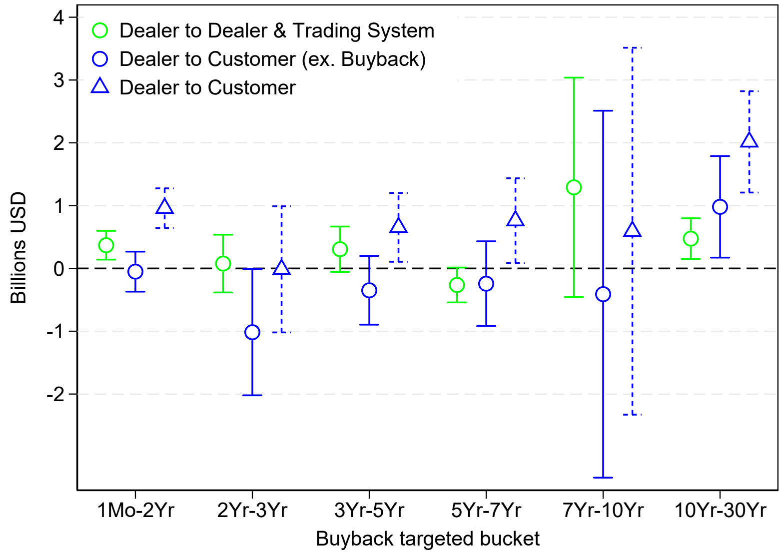
Figure 9: Dynamic Effect of Buybacks On Primary Dealers Treasury Trading Volume



Note: This figure plots impulse responses of primary dealers' Treasury trading volumes to a one-billion-dollar buyback, estimated via local projections based on Equation 4. Horizon 0 corresponds to the buyback execution day. The top panel reports results for dealer-to-dealer (including trading-system) volume and dealer-to-customer volume excluding buyback amounts; the bottom panel reports total dealer-to-customer volume. Newey–West standard errors with 30 lags are used. Bands represent 90% confidence intervals.

funds (counted in dealer to dealer category) and insurance companies (counted in dealer to customer category) route their supply through dealers acting as intermediaries. By contrast, for the 7–10 year bucket, none of the trading categories respond significantly—consistent with relatively low selling interest in this segment, as reflected in the lower bid-to-cover ratios in buyback auctions for this bucket (Figure 5).

Figure 10: Effect of Buybacks On Primary Dealers Treasury Trading Volume: By Targeted Bucket



Note: This figure plots primary dealers' Treasury trading volumes on the buyback execution day in response to a one-billion-dollar buyback. Estimates are based on Equation 4. Green circles, blue circles, and blue triangles denote dealer-to-dealer (including trading-system) volume, dealer-to-customer volume excluding buyback amounts, and total dealer-to-customer volume, respectively. Newey–West standard errors with 30 lags are used. Bands represent 90% confidence intervals.

5 Theory

This section builds on the dealer capacity and pricing framework of Duffie (2023) to rationalize the empirical findings. The model delivers three predictions that map to the evidence: (i) bid-ask spreads narrow for securities on the buyback eligible list (*listing effect*, subsection 3.2); (ii) spreads of purchased and non-purchased securities do not diverge after execution (absence of *purchasing effect*, subsection 3.2); and (iii) the listing effect is larger when less liquid securities are listed or when dealers hold excess inventory (subsection 3.3).

The model compares two stationary environments: one in which the dealer faces only market demand (V), and one in which Treasury buyback demand is also present ($\widetilde{V}$). The empirical listing effect corresponds to the transition from V-pricing to $\widetilde{V}$-pricing upon announcement of the eligible list; once the auction executes and Treasury exits the market, the dealer reverts to V-pricing. The model is therefore best interpreted as characterizing the changes triggered by pricing regime switching, and the spread change $\tilde{s}_i(x) - s_i(x)$ maps directly to the listing-day DID coefficient $\beta_{1,\text{list}}$

in Equation 2.

The key mechanism operates through two channels. First, Treasury's price-elastic demand—reflecting the competitive reverse-auction format—steepens the effective demand curve the dealer faces, compressing the optimal ask markup (Effect I: the elasticity channel). Second, Treasury demand that intensifies with dealer inventory provides a valuable backstop option, raising $\widetilde{V}(x)$ relative to $V(x)$ especially near the capacity constraint and reducing the curvature of the value function (Effect II: the inventory-relief channel). The absence of a purchasing effect follows from dealers managing risk at the portfolio level: because the value function depends on total bucket inventory $x = x_1 + x_2$ rather than individual security positions, the inventory relief from any buyback purchase benefits all securities in the bucket symmetrically.

The assumption of portfolio-level (or bucket-level) management rather than at the idiosyncratic security level is based on a well-established literature on primary dealers. Since securities within the same maturity bucket are close substitutes in terms of duration and basis risk, the marginal cost of providing liquidity is driven by a dealer's aggregate exposure to that risk factor (Logue and Oldfield (1970), Stoll (1978)). Empirically, Fleming, Nguyen and Rosenberg (2024) demonstrate that while dealers absorb massive idiosyncratic supply shocks during Treasury auctions, they prioritize the management of aggregate duration risk over security-specific position rebalancing. This behavior aligns with modern intermediary asset pricing theories where balance sheet capacity is a common, constrained resource shared across all assets within a risk class (He and Krishnamurthy (2013)). Consequently, the dealer's value function and the resulting bid-ask spreads are endogenously determined by the total inventory of the bucket, allowing for liquidity spillovers across substitutes when the aggregate constraint is relaxed (Hendershott and Menkveld (2014) and Pasquariello and Vega (2009)).

5.1 Bid and Ask Price Setting

Suppose a dealer quotes a bid price b_i and an ask price a_i while holding a total inventory $x \in [0, \bar{x}]$ of two Treasury securities ($i = 1, 2$). The inventory holding costs $g(x)$ for the dealer. The function $g(x)$ is convex, indicating sharply rising costs at higher inventory levels (see Duffie et al. (2023), for instance). Let the discount rate be r. Given bid and ask prices (b_i and a_i, respectively), the dealer buys quantity $B^i(b_i)$ from and sells quantity $A^i(a_i)$ to investors.

The dealer's problem is to maximize the expected present value of future discounted cash flows, the Hamilton-Jacobi-Bellman (HJB) conditions capturing optimal pricing conditions are given by:

$$\max_{a_i,b_i} \Big\{-rV(x) - g(x) + \sum_i \Big[A^i(a_i)\big[a_i + V(x-1) - V(x)\big] + B^i(b_i)\big[V(x+1) - V(x) - b_i\big]\Big]\Big\} = 0, \quad x \in (0, \bar{x}) \tag{5}$$

$$\max_{a_i} \Big\{-rV(\bar{x}) - g(\bar{x}) + \sum_i \Big[A^i(a_i)\big[a + V(\bar{x}-1) - V(\bar{x})\big]\Big]\Big\} = 0$$

$$\max_{b_i} \Big\{-rV(0) - g(0) + \sum_i \Big[B^i(b_i)\big[V(1) - V(0) - b_i\big]\Big]\Big\} = 0$$

The intuition is that optimal pricing sets the incremental gain from trading equal to the gain from holding the current inventory, which is $rV(x)$. The incremental trading gain comprises expected gains from selling securities $A^i(a_i)\big[a_i + V(x-1) - V(x)\big]$, expected gains from buying securities $B^i(b_i)\big[V(x+1) - V(x) - b_i\big]$, and subtracting inventory holding costs $g(x)$. The associated first-order conditions are:

$$\begin{aligned} A'^i(a_i)\big[V(x-1) - V(x) + a_i\big] + A^i(a_i) = 0, &\quad x \in (0, \bar{x}] \\ B'^i(b_i)\big[V(x+1) - V(x) - b_i\big] - B^i(b_i) = 0, &\quad x \in [0, \bar{x}) \end{aligned} \tag{6}$$

For the numerical analysis, I assume exponential demand arriving rate $A^i(a_i) = c^i e^{-\alpha^i a_i}$ and supply arriving rate $B^i(b_i) = \kappa^i e^{\beta^i b_i}$ where $c = e^{40}$, $k_i = e^{-20}$ for both $i = 1, 2$. The ask and bid elasticities are set as $\alpha_1 = \beta_1 = 2$ and $\alpha_2 = \beta_2 = 4$, representing that the demand and supply for security 1 is less price responsive than security 2, therefore less liquid.

To capture the nonlinear balance-sheet costs that dealers face near capacity, the holding cost function is set to

$$g(x) \;=\; g_0\, x^2 \;+\; g_1 \cdot \frac{x}{\bar{x} - x} \tag{7}$$

where $g_0 = 0.01$ is the baseline quadratic cost and the second term (with $g_1 = 0.0015$) is negligible for small x but accelerates sharply as x approaches $\bar{x}$. The specification captures the empirically documented nonlinearity of dealer balance-sheet constraints, where repo haircuts spike, Value-at-Risk limits bind, and regulatory capital ratios deteriorate rapidly near capacity (see, e.g., Duffie et al., 2023).[20]

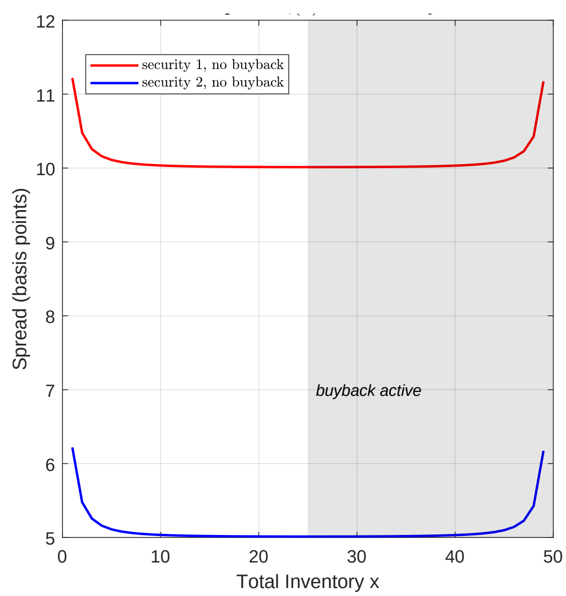
The optimal bid and ask prices are:

$$a_i(x) = V(x) - V(x-1) + \frac{1}{\alpha^i}, \qquad b_i(x) = V(x+1) - V(x) - \frac{1}{\beta^i} \tag{8}$$

The bid-ask spread is given by:

$$s_i(x) = \frac{1}{\alpha^i} + \frac{1}{\beta^i} + 2V(x) - V(x-1) - V(x+1) \tag{9}$$

Figure 11: Bid-Ask Spread Without Buyback



Note: This figure plots the simulation result of bid-ask spread without buyback Equation 9.

U-shaped bid-ask spread. The bid-ask spread $s_i(x)$ in equation Equation 9 exhibits a U-shaped pattern in inventory, as illustrated in Figure 11. This follows directly from the discrete

[20]The parameterization largely follows Duffie (2023), except for $g(x)$.

concavity of the value function $V(x)$. At interior inventory levels, $V(x)$ is approximately linear, so $2V(x) - V(x-1) - V(x+1) \approx 0$ and the spread is close to its minimum $1/\alpha_i + 1/\beta_i$, reflecting only the direct markups taken from buyers and sellers. Near the lower boundary $x = 0$, the dealer cannot replenish inventory by buying from market (the lower boundary condition), so the marginal value of an additional unit $V(1) - V(0)$ is high. The value function is therefore sharply concave near $x = 0$, widening the spread as the dealer raises the ask price to discourage further sales and lowers the bid to reflect the scarcity of balance-sheet capacity. Near the upper boundary $x = \bar{x}$, the nonlinear holding cost $g(x)$ accelerates sharply, compressing the marginal value of inventory and making $V(x)$ steeply concave. The dealer responds by lowering the ask to encourage investor purchases and reduce congestion, but the curvature term $2V(x) - V(x-1) - V(x+1)$ rises and dominates, widening the spread. The U-shape is therefore a direct reflection of the dealer's inventory management problem: spread compression in the interior represents normal market-making conditions, while spread widening at both extremes reflects balance-sheet stress—either from scarcity of inventory near $x = 0$ or from binding capacity constraints near $\bar{x}$.

5.2 Buyback Program

The buyback program introduces additional demand from the Treasury for securities in the targeted bucket. Two features of the actual program design shape the modelling choices here. First, Treasury demand is *price-elastic*: the program operates through competitive reverse auctions in which dealers submit ask prices and Treasury accepts after evaluations. A dealer therefore internalises that a higher ask price reduces the quantity Treasury purchases from it. Second, Treasury demand is concentrated at *high inventory levels*: the program is designed to relieve congested dealer balance sheets, so its effective intensity rises as inventory approaches the balance-sheet capacity constraint $\bar{x}$. This is consistent with Treasury Secretary Scott Bessent indicating that the Treasury can scale up buyback operations if needed. In fact, following TBAC's feedback, Treasury doubled the buyback frequency and increased the buyback envelope from \$30 billion to \$38 billion per quarter for buckets at the long end of the curve in July 2025.[21]

[21] Quarterly Refunding Statement of Deputy Assistant Secretary for Federal Finance Brian Smith, July 2025.

Treasury demand. At ask price a_i, Treasury demand for security i is

$$\widetilde{A}_i(a_i, x) \;=\; \sigma(x)\, \widetilde{c}_i\, e^{-\widetilde{\alpha}_i a_i}, \qquad x \geq \widetilde{x} \tag{10}$$

where the two parameters capture distinct features of the program's design. The scale parameter $\widetilde{c}_i$ is calibrated so that Treasury demand equals 0.3 times market demand at the fundamental price, reflecting the program's limited envelope. The elasticity parameter $\widetilde{\alpha}_i > \alpha_i$ ($\widetilde{\alpha}_1 = 5, \widetilde{\alpha}_2 = 6$) reflects the competitive reverse-auction format: because Treasury collects asks from multiple dealers and selects from the lowest upward—or rejects all bids, as in the July 2024 operation—an individual dealer faces demand that drops off sharply with its quoted price. This is distinct from the level of Treasury purchases $\widetilde{c}_i$, and $\widetilde{\alpha}_i > \alpha_i$ captures the steepness of the demand curve, not its scale. The activation weight $\sigma(x)$ captures the inventory-dependence of buyback intensity:

$$\sigma(x) = \frac{e^{\left(\eta \frac{x - \widetilde{x}}{\bar{x} - \widetilde{x}}\right)} - 1}{e^{\eta} - 1}, \qquad x \geq \widetilde{x} \tag{11}$$

where $\eta > 0$ governs the steepness of the ramp. For η close to zero, $\sigma(x)$ approaches the linear ramp $(x - \widetilde{x})/(\bar{x} - \widetilde{x})$; for large η, it concentrates Treasury demand near $\bar{x}$. The parameterization sets $\widetilde{x} = \bar{x}/2$, $\eta = 8$. The inventory sensitive Treasury demand offers larger demand when inventory approaches limit, where the inventory cost Equation 7 also grows substantially, shielding the dealer from this cost spike. This underpins the inventory-relief channel discussed in Section 5.3 below.

Modified HJB equation. With Treasury demand Equation 10 active for $x \geq \widetilde{x}$, the dealer's HJB equation becomes, for interior points $x \in (0, \bar{x})$:

$$\max_{\widetilde{a}_i, \widetilde{b}_i} \Big\{ -r\widetilde{V} - g(x) + \sum_i \Big[A^i(\widetilde{a}_i)\big[\widetilde{a}_i + \widetilde{V}(x-1) - \widetilde{V}(x)\big] + B^i(\widetilde{b}_i)\big[\widetilde{V}(x+1) - \widetilde{V}(x) - \widetilde{b}_i\big]\Big] \tag{12}$$
$$+ \mathbb{1}_{x \geq \widetilde{x}} \cdot \sum_i \widetilde{A}(\widetilde{a}_i)\big[\widetilde{a}_i + \widetilde{V}(x-1) - \widetilde{V}(x)\big]\Big]\Big\} = 0$$

Because Treasury demand enters only the ask first-order condition, the bid price is unaffected:

$$\tilde{b}_i(x) \;=\; \widetilde{V}(x+1) - \widetilde{V}(x) - \frac{1}{\beta_i} \tag{13}$$

Ask price with buyback. Differentiating Equation 12 with respect to $\tilde{a}_i$ and substituting the exponential specifications $A_i'(a) = -\alpha_i A_i(a)$ and $\widetilde{A}_i'(a) = -\widetilde{\alpha}_i \widetilde{A}_i(a)$ yields

$$\tilde{a}_i(x) \;=\; \frac{A_i(\tilde{a}_i(x)) + \widetilde{A}_i(\tilde{a}_i(x), x)}{\alpha_i A_i(\tilde{a}_i(x)) + \widetilde{\alpha}_i\, \widetilde{A}_i(\tilde{a}_i(x), x)} + \widetilde{V}(x) - \widetilde{V}(x-1) \;\equiv\; \frac{1}{\alpha_i^{\text{eff}}(x)} + \widetilde{V}(x) - \widetilde{V}(x-1) \tag{14}$$

where the *effective ask elasticity* is the arrival-rate-weighted average of α_i and α_i^e:

$$\alpha_i^{\text{eff}}(x) \;\equiv\; \frac{\alpha_i\, A_i(\tilde{a}_i(x)) + \widetilde{\alpha}_i\, \widetilde{A}_i(\tilde{a}_i(x), x)}{A_i(\tilde{a}_i(x)) + \widetilde{A}_i(\tilde{a}_i(x), x)} \tag{15}$$

Bid-ask spread with buyback. Combining Equation 13 and Equation 14:

$$\tilde{s}_i(x) \;=\; \frac{1}{\alpha_i^{\text{eff}}(x)} + \frac{1}{\beta_i} + 2\widetilde{V}(x) - \widetilde{V}(x-1) - \widetilde{V}(x+1), \qquad x \geq \widetilde{x} \tag{16}$$

and $\tilde{s}_i(x) = \frac{1}{\alpha_i} + \frac{1}{\beta_i} + 2\widetilde{V}(x) - \widetilde{V}(x-1) - \widetilde{V}(x+1)$ for $x < \widetilde{x}$ (buyback inactive).

5.3 Listing Effect: Spread Narrows Upon Announcement

This section analyses why the bid-ask spread narrows for eligible securities once the buyback list is announced. Subtracting Equation 9 from Equation 16 and writing $\Delta(x) \equiv \widetilde{V}(x) - V(x)$ gives

$$\tilde{s}_i(x) - s_i(x) \;=\; \underbrace{\frac{1}{\alpha_i^{\text{eff}}(x)} - \frac{1}{\alpha_i}}_{\text{Effect I}} - \underbrace{\Big[\Delta(x+1) - \Delta(x)\Big] - \Big[\Delta(x) - \Delta(x-1)\Big]}_{\text{Effect II} = -\Delta^2\Delta(x)} \tag{17}$$

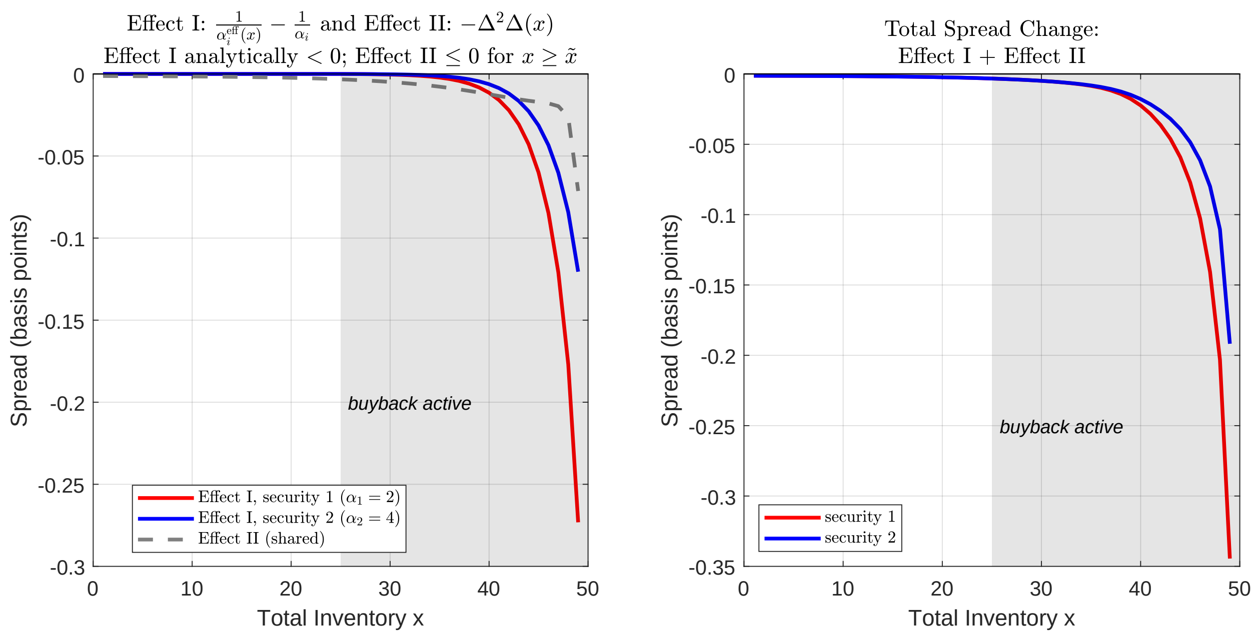
where $\Delta^2\Delta(x) \equiv \Delta(x-1) + \Delta(x+1) - 2\Delta(x)$ denotes the discrete second difference. The two effects have distinct economic interpretations.

Effect I is strictly negative. By construction, $\alpha_i^{\text{eff}}(x)$ is a strict convex combination of α_i and $\widetilde{\alpha}_i$ with positive weights $A_i > 0$ and $\widetilde{A}_i > 0$. Since $\widetilde{\alpha}_i > \alpha_i$, the weighted average strictly exceeds α_i, so

$1/\alpha_i^{\text{eff}}(x) < 1/\alpha_i$ for all $x \geq \tilde{x}$ (Figure 12, left panel). Intuitively, upon the buyback announcement, eligible securities gain an additional source of demand from Treasury. Because Treasury is more price-sensitive than market ($\tilde{\alpha}_i > \alpha_i$), its demand pulls back sharply if the ask price rises. This steepens the effective demand curve the dealer faces, compressing the optimal ask markup from $1/\alpha_i$ to $1/\alpha_i^{\text{eff}}(x) < 1/\alpha_i$. Effect I is therefore the analytically guaranteed channel of the listing effect.

Moreover, Effect I is larger for less liquid securities. For security i, the markup compression is $1/\alpha_i^{\text{eff}} - 1/\alpha_i < 0$. A less price-sensitive security (lower α_i) has a larger initial markup $1/\alpha_i$ and a larger gap $\tilde{\alpha}_i - \alpha_i$, producing a greater proportional reduction. This cross-sectional prediction is consistent with the empirical finding that illiquid securities experience larger spread reductions upon listing (Table 4).

Figure 12: Listing Effect of Buybacks: Change in Bid-Ask Spread



Note: This figure plots the simulation result of the change in bid-ask spread with vs. without buyback Equation 16. The left panel plots Effect I and II separately, and the right panel plots the total effect.

Effect II is negative. The anticipated future demand from Treasury raises the value of inventory, so $\Delta(x) \equiv \widetilde{V}(x) - V(x) > 0$ throughout the buyback region. Intuitively, with buyback the dealer always has the option to revert to no-buyback pricing, so the with-buyback outcome is weakly better:

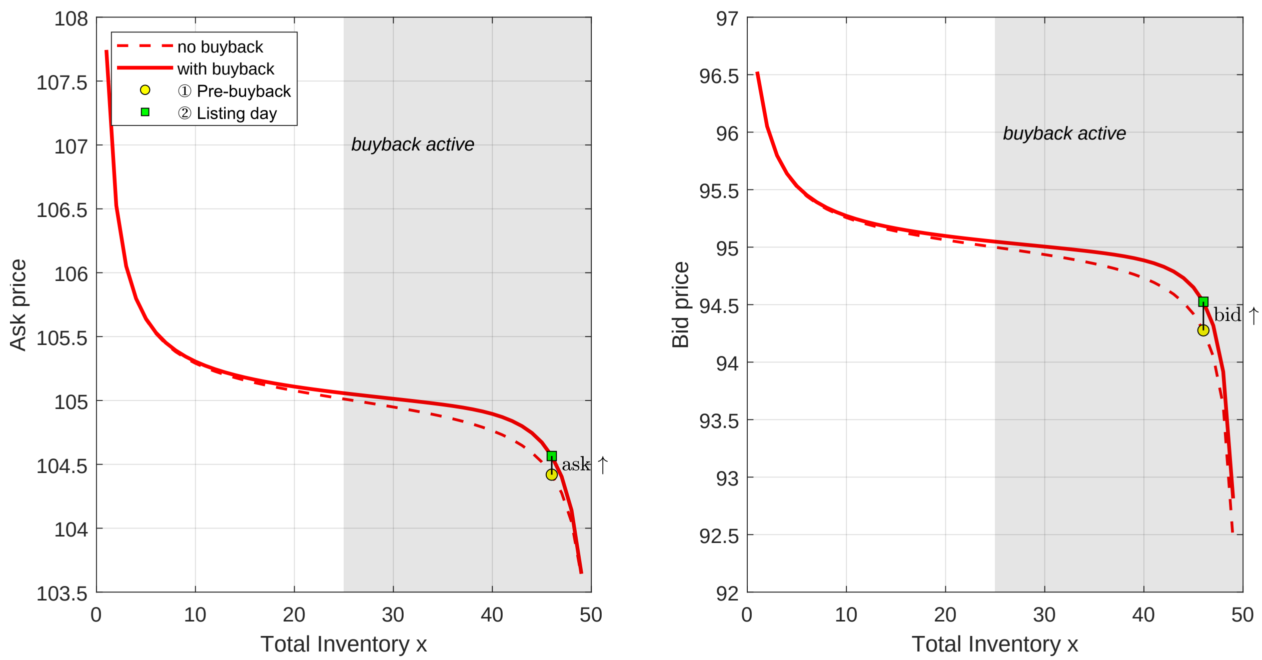
$\widetilde{V}(x) \geq V(x)$. Moreover, $\Delta(x)$ is increasing in x: the buyback option is most valuable precisely when inventory is high and the dealer is close to its balance-sheet capacity, because Treasury demand offloads inventory at the moment it is most costly to hold.

Effect II $= -\Delta^2\Delta(x)$ is non-positive when $\Delta(x)$ is convex in x. The convexity of Δ follows from two reinforcing mechanisms. First, the activation weight $\sigma(x)$ is convex in x for $\eta > 1$—Treasury demand accelerates as inventory grows toward $\bar{x}$—so the marginal value of inventory relief grows at an increasing rate. Second, the nonlinear inventory cost Equation 7 makes $V(x)$ sharply more concave near $\bar{x}$, while $\widetilde{V}(x)$ is partially shielded by Treasury demand. The gap $\Delta(x) = \widetilde{V}(x) - V(x)$ therefore widens at an accelerating rate as x approaches $\bar{x}$.

Taken together, these mechanisms imply that Effect II ≤ 0 with the parameterization, as confirmed numerically in Figure 12 (left panel). One key difference between the current model and Duffie (2023) is that Duffie (2023) models official-sector purchases at the market mid-price $(a+b)/2$ and these are taken as exogenous by the dealer, while here Treasury demand is a function of dealer ask price. The exogenous demand generates an additive forcing term in the value function recursion that guarantees convexity of $\Delta(x)$ throughout the buyback region. Meanwhile, the price-elastic structure of Treasury demand here means that convexity of $\Delta(x)$ is an endogenous equilibrium outcome governed by the convexity of inventory cost and inventory sensitive Treasury demand.

Bid and ask prices increase. The price-level predictions underlying the spread decomposition are illustrated in Figure 13. Both the ask and bid prices shift upward when buyback is announced, reflecting the higher value function $\widetilde{V}(x) > V(x)$ from the inventory reliefing effect. However, the two prices respond asymmetrically. The bid rises by the full amount of the value-function shift, because Treasury demand does not enter the bid first-order condition. The ask rise is partially offset by the markup compression from $1/\alpha_i$ to $1/\alpha_i^{\text{eff}}$, so it increases by less than the bid. Moreover, because $\Delta(x)$ is convex, the value-function shift itself is larger on the bid side than the ask side, reinforcing the asymmetry. This prediction is confirmed empirically in Table 3: on the listing day, both ask and bid prices of listed securities increase significantly, with the bid rising approximately 0.3 cents more than the ask.

Figure 13: Listing Effect of Buybacks: Bid and Ask Prices



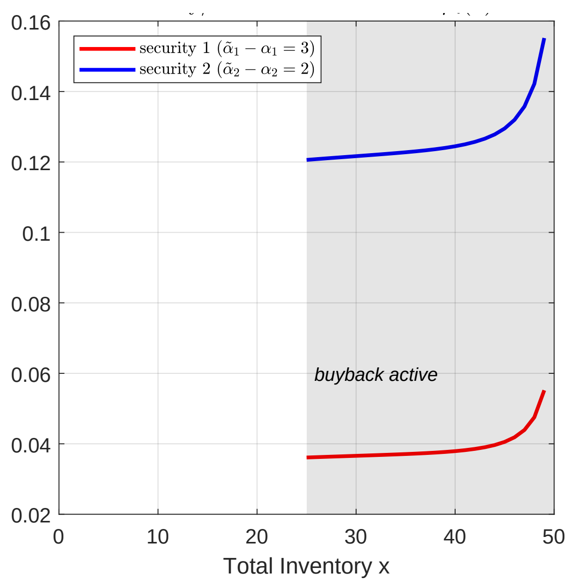
Note: This figure plots the simulation result of the change in bid-ask spread with (Equation 14, Equation 13) vs. without buyback (Equation 8). The left panel plots ask price, and the right panel plots bid price.

Treasury/market demand ratio. A useful summary statistic for the relative importance of the two channels is the Treasury-to-market demand ratio at the equilibrium ask price:

$$\mu_i(x) \equiv \frac{\sigma(x)\, \widetilde{A}_i(\widetilde{a}_i^*(x))}{A_i(\widetilde{a}_i^*(x))} \tag{18}$$

As shown in the lower-right panel of Figure 14, $\mu_i(x)$ is increasing in x: Treasury's share of demand rises as inventory grows. This occurs through two channels—$\sigma(x)$ increasing mechanically, and the dealer lowering the ask price to reduce inventory, which raises Treasury demand faster than market demand because $\widetilde{\alpha}_i > \alpha_i$. The increasing $\mu_i(x)$ confirms that both the elasticity channel (Effect I) and the inventory-relief channel (Effect II) intensify as the dealer approaches its balance sheet limit.

Figure 14: Treasury/Market Demand Ratio



Note: This figure plots the simulation result of Treasury demand to market demand ratio Equation 18.

5.4 Purchasing Effect: No Additional Spread Compression at Execution

This section explains the behavior of spreads around the actual execution of the buyback. From Equation 9, the spreads difference between security 1 and 2 follows

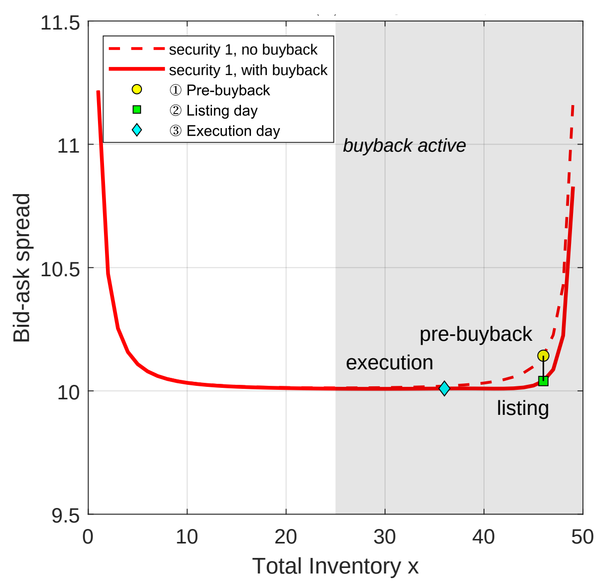
$$s_1 - s_2 = \Big(\frac{1}{\alpha_1} - \frac{1}{\alpha_2}\Big) + \Big(\frac{1}{\beta_1} - \frac{1}{\beta_2}\Big), \qquad x < \widetilde{x} \tag{19}$$

The key insight of Equation 19 is that the spread differential is constant and does not depend on the inventory level, as long as buyback is not in the picture. Intuitively, after execution, the Treasury exits the market: buyback demand is extinguished and the value function returns to V (Figure 15, from yellow circle to cyan diamond). At this point, all securities face the same two forces: (i) market demand A_i and supply B_i governed solely by security-specific elasticities (α_i, β_i), and (ii) a new common inventory level $x - \delta$ that affects all securities through the shared curvature $\Delta^2 V(x - \delta)$. Because both forces are symmetric across purchased and non-purchased securities, the spread difference collapses to the pre-announcement benchmark, which is determined purely by intrinsic liquidity characteristics, not by buyback participation.

$$[s_1(x-\delta) - s_1(x)] - [s_2(x-\delta) - s_2(x)] = [s_1(x-\delta) - s_2(x-\delta)] - [s_1(x) - s_2(x)] = 0$$

Key mechanism: portfolio-level value function. The central assumption in the absence of additional spread narrowing at buyback execution is that $V(x)$ depends on *total* bucket inventory $x = x_1 + x_2$, not on the individual position. This follows from dealers hedging duration exposure at the bucket level, as discussed earlier. Were the value function security-specific then the inventory relief from selling security j to the Treasury would lower V_j but not V_k, generating a positive spread differential in favor of the purchased security. Under bucket-level portfolio management, however, the δ units sold to the Treasury relax the shared balance sheet constraint for all securities in the bucket. The purchased and non-purchased securities benefit symmetrically from the lower aggregate inventory, leaving no differential after buyback execution.

Figure 15: Bid-Ask Spreads At Different Stages of Buyback



Note: This figure plots the simulation result of bid-ask spreads of security 1 (as an example) at different stages of buyback, according to Equation 9 and Equation 16.

This prediction extends to the individual price components: after execution, both the ask and bid revert from $\widetilde{V}$-pricing to V-pricing at the new common inventory level $x - \delta$, with no security-specific channel on either side. Consistent with this, Table 3 shows that neither the ask nor the bid price exhibits a significant differential between purchased and non-purchased securities on the operation day.

6 Conclusion

This paper provides the first comprehensive analysis of the U.S. Treasury's liquidity support buyback program, which was introduced in May 2024 to provide primary dealers with a regular opportunity to sell less liquid off-the-run securities back to the Treasury. Combining security-level bid-ask spread data with primary dealer balance-sheet and trading-volume data, I document three main findings.

First, inclusion in the buyback eligible list significantly narrows bid-ask spreads on the announcement day—by approximately 0.3 basis points relative to unlisted securities in the same maturity bucket. The effect is transitory, concentrated on the listing day, and larger for less liquid (i.e., highest-spread) securities and when dealers hold excess inventory. IV estimates using the maturity-month exclusion rule from cash management buybacks suggest that baseline estimates are attenuated by selection, as the Treasury tends to avoid listing the highest-spread securities. Second, actual purchase does not generate additional spread compression beyond what listing provides, consistent with dealers managing inventory at the bucket level rather than the individual-security level. Third, at the aggregate level, buybacks temporarily reduce dealer coupon holdings and boost trading volume on the execution day, with effects an order of magnitude larger than those of regular redemptions.

These findings are rationalized by a model in which Treasury buyback demand—more price sensitive than market and rising in dealer inventory—compresses dealers' optimal ask markup through an elasticity channel (Effect I) and reduces the curvature of the value function through an inventory-relief channel (Effect II). The key theoretical insight is that reverse-auction mechanics generate a direct pricing channel absent from frameworks where official-sector purchases occur at administratively set prices, as in Duffie (2023).

The magnitude of these effects is moderate. For example, the $2 billion reduction in coupon holdings (corresponding to the maximum $4 billion buyback envelope) represents less than one tenth of the standard deviation in dealer holdings. This is consistent with the relatively limited scale of the program. Nonetheless, the standing availability of the buyback option may encourage greater market-making even when the direct effects are small, and the program can be scaled up during periods of stress—as the Treasury has begun to do by expanding the buyback envelope and frequency in July 2025, and by planning to extend participation beyond primary dealers in 2026.

Several limitations warrant discussion. The sample period covers approximately two years of operations and 69 operations in total, which could limit the power to detect purchasing effect. Future work could exploit the anticipated expansion of the program—both in scale and in the set of eligible counterparties—to test whether the liquidity effects scale proportionally. Examining the interaction between buybacks and other market-structure reforms, such as expanded central clearing, would also be valuable for informing the optimal design of Treasury market resilience policies.

In sum, the evidence indicates that the buyback program delivers measurable liquidity support to the off-the-run Treasury market. These results highlight the financial stability benefits of targeted, routine market-functioning operations—a complement to the large-scale asset purchases that have dominated the literature (e.g., Duffie and Keane (2023)). Looking ahead, the program's design could be enhanced by scheduling buybacks to coincide with periods of elevated dealer inventory—such as shortly after new on-the-run issuances—and by considering swap-format operations that exchange off-the-run for on-the-run securities when Treasury General Account constraints limit outright purchases.

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Table A1: Summary Statistics of Spreads and Primary Dealers Balance Sheet

	Bid-ask Spreads					**Primary Dealer Treasury Holdings**			
	Mean	Median	SD	N		Mean	Median	SD	N
coupon, 1m to 2yr	4.6	4.3	3.2	12665	coupon, 1m to 2yr	52.5	61.0	26.9	98
coupon, 2 to 3yr	5.0	4.1	5.5	4834	coupon, 2 to 3yr	15.6	15.5	5.1	98
coupon, 3 to 5yr	6.4	4.2	8.4	7318	coupon, 3 to 5yr	72.1	71.8	9.0	98
coupon, 5 to 7yr	5.8	3.9	6.4	3743	coupon, 5 to 7yr	27.2	27.0	6.2	98
coupon, 7 to 10yr	3.8	3.3	1.0	1349	coupon, 7 to 10yr	32.4	33.1	8.7	98
coupon, 10 to 20yr	17.5	17.8	7.0	17148	coupon, 10 to 30yr	71.2	69.8	18.4	98
coupon, 20 to 30yr	12.9	12.8	5.7	13296	total coupon	270.9	285.2	61.2	98
total coupon	10.4	6.5	8.1	60353	total	369.2	375.5	60.6	98

	Trading volume, dealer to dealer					**Trading volume, dealer to customer**			
	Mean	Median	SD	N		Mean	Median	SD	N
coupon, 1m to 2yr	21.8	20.1	8.5	450	coupon, 1m to 2yr	31.4	27.3	16.3	450
coupon, 2 to 3yr	7.1	6.1	4.5	450	coupon, 2 to 3yr	13.5	11.8	8.0	450
coupon, 3 to 5yr	15.4	14.0	7.4	450	coupon, 3 to 5yr	27.4	24.6	12.6	450
coupon, 5 to 7yr	5.8	4.9	3.2	450	coupon, 5 to 7yr	11.7	9.9	6.4	450
coupon, 7 to 10yr	6.7	5.6	4.3	450	coupon, 7 to 10yr	11.1	9.4	7.0	450
coupon, 10 to 30yr	14.5	14.2	4.4	450	coupon, 10 to 30yr	30.1	28.9	10.8	450
total coupon	71.3	69.0	20.8	450	total coupon	125.2	120.3	41.8	450
total	73.5	72.0	21.5	450	total	131.5	126.6	44.0	450

Note: This table reports the summary statistics (in the order of mean, median, standard deviation, and number of observations) for daily bid-ask spreads (in basis points), primary dealers' Treasury holdings on each Wednesday (in billions of USD), primary dealers' daily off-the-run Treasury trading volumes (in billions of USD).

Table A2: Listing and Purchasing Effect of Buybacks

VARIABLES TREATMENT	(1) Bid-ask spread being listed	(2) Bid-ask spread being purchased	(3) Bid-ask spread buyback amount	(4) Bid-ask spread buyback amount
buyback listed	0.1415			
	(0.124)			
buyback purchased		0.1433		
		(0.135)		
buyback amount, $bn			-0.1685	-0.1491
			(0.148)	(0.164)
listing day × buyback treatment	-0.3179***	-0.0898	-0.1337	-0.0555
	(0.093)	(0.128)	(0.156)	(0.154)
operation day × buyback treatment	-0.0480	-0.0495	-0.1674	-0.1664
	(0.094)	(0.127)	(0.225)	(0.202)
3 days after × buyback treatment	-0.1234	0.0823	0.0702	0.0913
	(0.113)	(0.144)	(0.239)	(0.228)
4 days after × buyback treatment	-0.0711	0.1812	-0.0292	-0.0241
	(0.125)	(0.132)	(0.150)	(0.151)
5 days after × buyback treatment	0.0177	0.1033	0.1417	0.1359
	(0.123)	(0.142)	(0.234)	(0.238)
6 days after × buyback treatment	-0.0851	0.0878	0.2166	0.2396
	(0.123)	(0.138)	(0.207)	(0.222)
7 days after × buyback treatment	-0.0566	0.1266	0.3326*	0.3491*
	(0.124)	(0.143)	(0.197)	(0.197)
8 days after × buyback treatment	-0.0673	0.0297	0.1170	0.1313
	(0.124)	(0.137)	(0.191)	(0.211)
9 days after × buyback treatment	0.0989	-0.0112	-0.0859	-0.1142
	(0.137)	(0.144)	(0.202)	(0.197)
10 days after × buyback treatment	-0.1133	-0.0382	-0.1720	-0.1437
	(0.118)	(0.136)	(0.152)	(0.156)
1 day before × buyback treatment	-0.1417	0.0497	0.0685	0.1079
	(0.102)	(0.099)	(0.180)	(0.177)
2 days before × buyback treatment	0.1276	-0.1093	0.1504	0.1340
	(0.130)	(0.153)	(0.191)	(0.188)
3 days before × buyback treatment	-0.0806	0.0223	0.0039	0.0283
	(0.102)	(0.144)	(0.287)	(0.273)
4 days before × buyback treatment	-0.1192	-0.1198	0.0886	0.1191
	(0.112)	(0.141)	(0.186)	(0.189)
5 days before × buyback treatment	-0.2610**	-0.2002	-0.1592	-0.0996
	(0.121)	(0.132)	(0.180)	(0.170)
6 days before × buyback treatment	-0.1088	-0.0269	0.1429	0.1761
	(0.106)	(0.152)	(0.161)	(0.154)
7 days before × buyback treatment	0.2086*	-0.0102	0.2277*	0.1958
	(0.114)	(0.143)	(0.131)	(0.146)
8 days before × buyback treatment	0.0344	-0.1387	0.0634	0.0669
	(0.124)	(0.141)	(0.198)	(0.192)
9 days before × buyback treatment	-0.0099	0.0251	0.0964	0.0978
	(0.115)	(0.146)	(0.139)	(0.147)
10 days before × buyback treatment	-0.1549	-0.0460	0.1622	0.2029
	(0.125)	(0.134)	(0.188)	(0.181)
Δ on-the-run yield, bps	-0.0462***	-0.0458***	-0.0460***	-0.0446***
	(0.010)	(0.016)	(0.009)	(0.016)
Observations	60,353	45,502	60,353	45,502
R-squared	0.947	0.938	0.947	0.938
CUSIP FE	yes	yes	yes	yes
Bucket-specific time FE	yes	yes	yes	yes
Operation FE	yes	yes	yes	yes

Note: This table reports the baseline regression (Equation 2). Column 1 and 2 estimate listing and purchasing effects where being listed or purchased (dummy indicator variable) is the treatment, respectively. Column 3 and 4 estimate listing and purchasing effects where the amount purchased by buyback (continuous variable) is the treatment. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at security level.

Table A3: Listing and Purchasing Effects on Bid and Ask Prices

	(1)	(2)	(3)	(4)
	treatment: listed		**treatment: purchased**	
VARIABLES	Ask price	Bid price	Ask price	Bid price
buyback listed	-4.3339	-4.5120		
	(7.458)	(7.488)		
buyback purchased			-8.1924**	-8.2961**
			(4.030)	(4.045)
listing day × buyback treatment	3.4458***	3.7470***	0.3347	0.4136
	(1.309)	(1.312)	(0.510)	(0.503)
operation day × buyback treatment	1.4724	1.5368	-0.7838	-0.7302
	(1.297)	(1.303)	(0.585)	(0.588)
3 days after × buyback treatment	-0.0742	0.1395	0.1946	0.1346
	(1.320)	(1.333)	(0.559)	(0.567)
4 days after × buyback treatment	0.3302	0.5229	-0.4079	-0.4982
	(1.504)	(1.512)	(0.611)	(0.638)
5 days after × buyback treatment	0.9607	1.0149	-0.5513	-0.6026
	(1.468)	(1.480)	(0.802)	(0.818)
6 days after × buyback treatment	2.9069*	3.0647**	-0.5154	-0.5749
	(1.525)	(1.545)	(0.805)	(0.823)
7 days after × buyback treatment	2.5418*	2.6588*	-1.5346	-1.5988
	(1.542)	(1.563)	(0.961)	(0.986)
8 days after × buyback treatment	2.6716	2.8130	-0.3976	-0.3895
	(1.774)	(1.794)	(1.364)	(1.382)
9 days after × buyback treatment	3.8187**	3.7699**	-0.4540	-0.4224
	(1.694)	(1.703)	(1.452)	(1.463)
10 days after × buyback treatment	4.1865**	4.3113**	0.1404	0.1498
	(1.758)	(1.778)	(1.430)	(1.443)
1 day before × buyback treatment	-0.1384	0.0329	0.2109	0.1833
	(1.527)	(1.533)	(0.541)	(0.552)
2 days before × buyback treatment	3.8502***	3.8418***	1.2039**	1.3297**
	(1.357)	(1.369)	(0.583)	(0.601)
3 days before × buyback treatment	2.0998	2.2231	0.4565	0.4436
	(1.466)	(1.479)	(0.682)	(0.701)
4 days before × buyback treatment	1.8196	1.9696	0.9708	1.0804
	(1.378)	(1.389)	(0.776)	(0.787)
5 days before × buyback treatment	2.6530*	2.9797**	0.7697	0.9388
	(1.355)	(1.363)	(0.786)	(0.811)
6 days before × buyback treatment	1.9440	2.1092	0.7892	0.8259
	(1.577)	(1.589)	(0.822)	(0.832)
7 days before × buyback treatment	1.7973	1.7008	0.4026	0.4380
	(1.432)	(1.436)	(0.838)	(0.845)
8 days before × buyback treatment	1.7589	1.7953	-0.6242	-0.5008
	(1.474)	(1.484)	(0.909)	(0.918)
9 days before × buyback treatment	1.6580	1.7771	-0.6405	-0.6202
	(1.486)	(1.491)	(0.956)	(0.966)
10 days before × buyback treatment	-0.1132	0.1494	-1.5260	-1.4545
	(1.659)	(1.636)	(1.184)	(1.193)
Δ on-the-run yield, bps	-0.6114***	-0.5630***	-0.2690	-0.2222
	(0.133)	(0.131)	(0.185)	(0.188)
Observations	60,353	60,353	45,502	45,502
R-squared	0.998	0.998	0.999	0.999
CUSIP FE	yes	yes	yes	yes
Bucket-specific time FE	yes	yes	yes	yes
Operation FE	yes	yes	yes	yes

Note: This table reports Equation 2, where ask price in cents (column 1 and 3) or bid price in cents (column 2 and 4) is the dependent variable. Column 1 and 2 estimate listing effect, column 3 and 4 estimate purchasing effect. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at security level.

Table A4: Listing and Purchase Effect of Buybacks by Bucket

Segment	(1) listing day × listed	(2) operation day × listed	(3) listing day × purchased	(4) operation day × purchased
1Mo-2Yr	-0.2876*	-0.4103**	-0.4787	-0.3894
	(0.1739)	(0.1846)	(0.6566)	(0.6421)
2Yr-3Yr	-0.0980	-0.1260	0.0140	0.0054
	(0.1341)	(0.3348)	(0.0777)	(0.0724)
3Yr-5Yr	-0.3259	0.2323	-0.1105	-0.1085
	(0.3716)	(0.3444)	(0.1547)	(0.0964)
5Yr-7Yr	-1.5613**	-0.1333	0.0838	0.1716
	(0.6665)	(0.6234)	(0.1078)	(0.1506)
7Yr-10Yr	0.0000	0.0000	0.0598	0.2060
	(0.0000)	(0.0000)	(0.2246)	(0.1516)
10Yr-20Yr	-0.2872*	0.1511	0.3799	0.0815
	(0.1493)	(0.1540)	(0.2700)	(0.2982)
20Yr-30Yr	-0.2339*	0.0091	-0.2035	0.0177
	(0.1381)	(0.1792)	(0.2244)	(0.2367)

Note: This table reports the estimates based on bucket-by-bucket regression of Equation 2. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at security level.