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# Testing the Liquidity Support Effects of the U.S. Treasury Buyback Program

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**Prepared by Jing Zhou***

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**ABSTRACT:** The U.S. Treasury's recently introduced liquidity support buyback program offers a natural setting to evaluate whether providing a regular mechanism for selling less liquid off-the-run Treasury securities can enhance market liquidity. In this paper, I present a direct test of this mechanism and quantify the liquidity support effects at both the individual security level and the aggregate balance sheet level of primary dealers. I utilize operational considerations related to the Treasury's selection of buyback securities that are independent of the securities' liquidity conditions—notably, whether a security matures in a month characterized by significant cash inflows to the Treasury—to construct an instrumental variable for the Treasury's buyback selection decisions. I find that buybacks moderately narrow bid-ask and off-the-run spreads and raise prices for securities listed by buyback, further boost prices for those purchased, and reduce primary dealers' net holdings of Treasury bills and coupons. The liquidity support effects are particularly pronounced when dealers hold large Treasury inventories. I rationalize these findings using a model in which buybacks serve as predictable demand for dealers facing inventory constraints and holding costs, thereby mitigating illiquidity risks.



| | |
|---|---|
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WORKING PAPERS

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Prepared by Jing Zhou[1]

[1] I am very grateful for the comments from Philip Barrett, Katharina Bergant, Nigel Chalk, Mai Chi Dao, Wenxin Du, Carlos Goncalves, Sanjay Hazarika, and the colleagues from the U.S. team at the IMF. The views expressed in the paper are those of the author and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

# 1 Introduction

The unprecedented stress experienced in the Treasury market in March 2020, triggered by the surge in liquidity demand ("dash for cash") overwhelming primary dealers capacity, has propelled the discussion surrounding the enhancement of Treasury market resilience to the forefront of policy discourse.[1] As pivotal intermediaries for large amount of transactions in Treasury securities, primary dealers' intermediation capacity—already constrained relative to the rapidly expanding Treasury debt stock[2]—has become a central focus of reform efforts.

In response, the U.S. Treasury introduced the liquidity support buyback program in May 2024, as part of a broader set of initiatives[3] to strengthen market functioning. This program provides a regular and predictable opportunity for primary dealers 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.

The urgency of such a mechanism was highlighted in April 2025, when heightened uncertainty over sweeping tariff proposals triggered renewed volatility and a sharp sell-off in Treasuries. The 10-year Treasury yield jumped by 50 basis points—its largest weekly increase since 2001—to just under 4.5%, defying typical flight-to-safety dynamics and intensifying concerns over market liquidity. Treasury Secretary Scott Bessent responded by signaling the Department's readiness to scale up buyback operations to stabilize conditions if needed.[4] Bessent's remarks emphasized the strategic importance of the buyback program and renewed attention to the role of liquidity support.

As the buyback program approaches its one-year anniversary, this paper presents the first systematic investigation into the liquidity support effects of buybacks. Specifically, I address two key questions: First, do buybacks enhance liquidity in the off-the-run Treasury market, both at the disaggregate security level and for the aggregate primary dealers? Second, if such improvements do occur, what factors influence the efficacy of the liquidity support from buybacks, and under which circumstances is it most pronounced?

To address these questions, I first evaluate the liquidity impacts of buybacks at the security level, distinguishing between two phases of the operation: the announcement of eligible securities for buyback and the actual purchase. This distinction allows for separate identification of a "listing effect" (i.e., differences between listed and non-listed securities within the buyback's targeted bucket) and a "purchasing effect" (i.e., differences between purchased and non-purchased listed securities).

A difference-in-differences (DID) framework with fixed effects is used to estimate these effects. The

[1] See, for instance, Brainard (2021), Duffie (2023).

[2] There are multiple reasons behind the shrinking relative size of primary dealers balance sheet, e.g., regulation tightening, such as the introduction of supplementary leverage ratio, GSIB surcharges. See, for instance, Duffie et al. (2023), for more detailed discussion.

[3] The other policy initiatives include expanding central clearance, improving data collection of non-centrally cleared bilateral Repo. See, for instance, Remarks by Assistant Secretary for Financial Markets Joshua Frost, for more detailed discussion.

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

DID regressions provide baseline estimates of buyback effects; equally important is benchmarking these estimates against a counterfactual of "random" purchase by the Treasury, to see if any additional effects from buybacks. A key challenge here is addressing selection bias to construct the "random" purchase: the Treasury may disproportionately select less liquid securities that are heavily discounted, and such securities may be more price- or spread-sensitive to buybacks. To overcome this, I construct an instrumental variable (IV) for listing or acceptance based on pre-buyback characteristics, following methodologies from D'Amico and King (2013) and Connolly and Struby (2024).

The key to constructing the IV is to select pre-buyback characteristics that are relevant to the Treasury's selection process but uncorrelated with security-level liquidity, thereby satisfying the exclusion restriction. To achieve this, I leverage operational considerations that guide the Treasury buyback decisions yet are plausibly orthogonal to liquidity conditions. One such consideration is SOMA concentration: the Treasury avoids repurchasing securities if doing so would cause SOMA ownership to exceed 70%, a constraint motivated by operational considerations rather than security's liquidity conditions.

A novel pre-buyback characteristic used for IV construction in this paper is the maturity month of a Treasury security. In addition to liquidity support buybacks, the Treasury also conducts "cash management buybacks" to smooth Treasury General Account flows. I use these as a complementary sample because they are less prone to liquidity-based selection bias. Operationally, securities maturing in peak inflow months—such as during tax season—are excluded in cash management buybacks to avoid intensifying TGA inflows. Since maturity month is determined by cash management needs rather than liquidity considerations, it serves as a valid instrument for identifying whether a security is listed or accepted in a buyback.

I find that the listing effect of buybacks is more pronounced than the purchasing effect. Following the release of the list of eligible securities for buyback, the bid-ask spreads spreads for the listed securities narrow by 0.2 basis point, in comparison to those not listed within the same buyback targeted bucket. This effect primarily occurs on the listing day. IV estimates are larger than baseline estimates, suggesting the Treasury tends to list securities with relatively lower sensitivity to added demand (e.g., the securities with decent liquidity conditions). Interestingly, no significant evidence is found regarding the purchasing effect.

I identify two cases in which the listing effect of buybacks is more pronounced. The first is when buybacks target buckets with shorter remaining maturities (i.e., front-end buckets). In the buybacks targeting the shortest remaining maturity bucket, the bid-to-cover ratio reaches eight, compared to an average of three across other buybacks, indicating a significant volume of Treasuries that primary dealers are eager to liquidate. The second is when primary dealers hold substantial Treasury positions of the securities in buybacks' targeted bucket. Both cases are related to a potential excess position of Treasury securities, thereby could suggest a higher propensity to offload the positions.

Additionally, I find that both listing and purchasing raise prices. Bid and ask prices rise by approximately 10 and 4 cents following listing and purchase, respectively. These price effects persist well beyond the buyback date, unlike the spread effects. Again, IV estimates exceed baseline ones, reinforcing the notion that Treasury may select securities with relatively lower sensitivity to added demand.

Next, I investigate the liquidity support effects of buybacks at the primary dealers level. To accomplish this, I employ a standard inventory management model for Treasury securities (e.g., Naik and Yadav (2003), Schultz (2017), Fleming, Nguyen and Rosenberg (2024)) to assess whether buybacks alleviate the net Treasury security positions of primary dealers on their balance sheets. I find that buybacks generally exert a larger impact on the Treasury security positions of primary dealers compared to typical redemptions. This is intuitive, as buybacks essentially "redeem" securities that primary dealers are inclined to offload and are less likely to replenish. Specifically, buybacks lessen primary dealers Treasury bill and coupon positions by \$1.5 billion over a sustained period of six weeks and \$0.2 billion over two weeks, respectively.

Beyond the empirical analysis, I develop a theoretical framework to rationalize the observed effects of buybacks on liquidity. Building on the dealer pricing model of Duffie (2023), the model captures how primary dealers set bid and ask prices, given convex inventory costs and stochastic investor flows. Buybacks are modeled as predictable demand injections triggered by high dealer inventories. The model yields three key predictions: First, listing securities for buyback eligibility reduces bid-ask spreads by lowering the dealers' perceived risks of inventory accumulation, effectively flattening the marginal cost curve. Second, the impact on spreads is stronger when dealers' inventories are large, as the marginal value of liquidity support is higher near capacity constraints. Third, actual purchases by the Treasury raise security prices by directly reducing dealer inventories but exert minimal further effects on spreads, as they represent shifts along a U-shape spread curve. The model offers a unified interpretation of how regular buybacks can support market liquidity even outside of crisis conditions.

Overall, the evidence indicates that buybacks enhance the liquidity of off-the-run Treasuries. While the effects are modest—e.g., a 0.2 basis point spread decline and 10 cent price rise represent less than one-tenth of a standard deviation—this is consistent with the relatively small size of the program. Nonetheless, the findings affirm that buybacks are functioning as intended and could be scaled up to address future market disruptions, as highlighted in Secretary Bessent's remarks mentioned previously.

**Contributions to the literature.** This paper contributes to the existing body of literature examining the liquidity support effects resulting from market-function asset purchases. For example, Boneva, Kastl and Zikes (2024) analyze detailed bidding data from dealers and demonstrate that the Bank of England's QE purchases acted as a backstop in the secondary market for gilts, thereby alleviating market dysfunction and reducing price volatility. Similarly, Krishnamurthy, Vissing-Jorgensen et al. (2013) find that the Federal Reserve's purchases of long-term U.S. Treasury bonds significantly elevated Treasury bond prices, though the spillover effects on private sector bond yields were limited. Rather than reducing term premiums, Bauer and Rudebusch (2018) highlight the important signaling effects of QE that lead to lower expected future short-term interest rates. For a recent survey on the impact of market-function asset purchases, see Duffie and Keane (2023). While much of the literature has focused on QE or large asset purchase programs conducted by central banks during periods of acute market distress or weak growth, this paper contributes by providing evidence that moderate-scale asset purchase programs conducted by fiscal agencies can also enhance market liquidity.

Additionally, this paper extends a small strand of literature examining the buyback programs of the U.S. Treasury. For instance, Han, Longstaff and Merrill (2007) utilize high-frequency intraday data and demonstrate that the buyback program from 2000 to 2002 was highly effective in retiring less-liquid debt with minimal market impact costs. Connolly and Struby (2024) find that the reduction in bond supply resulting from the 2000 to 2002 buyback program contributed, on average, 95 basis points to the yields of both the bonds purchased and those of similar maturity. This paper provides a first analysis of the newly introduced liquidity support buybacks in 2024, which differ in purpose and macroeconomic context from the buybacks conducted in 2000-2002.

Furthermore, this paper relates to the literature addressing primary dealers balance sheet constraints and the associated risks present in the financial market. For example, Fleckenstein and Longstaff (2020) investigate the persistent basis in the interest rate futures market and establish that this basis is strongly correlated with measures of intermediary balance sheet utilization and cost. Duffie et al. (2023) estimate a range of illiquidity metrics, and find that while yield volatility accounts for the majority of variation in Treasury market liquidity under normal conditions, liquidity deteriorates significantly when dealer balance sheets are strained, far exceeding predictions based solely on yield volatility. He, Kelly and Manela (2017) construct intermediary capital ratios and find that exposure to shocks in intermediary capital ratios possesses a robust and consistent ability to explain cross-sectional differences in average asset returns. For a recent survey, see He and Krishnamurthy (2018). This paper offers new empirical evidence suggesting that alleviating pressure on primary dealers' balance sheets can enhance market liquidity conditions.

The remainder of this paper is organized as follows: Section 2 outlines the design of the buyback program (including results obtained thus far) and the datasets utilized in the analysis. Section 3 discusses the empirical strategies employed to identify the liquidity support effects of buybacks, on both security-level and aggregate-level data. Section 4 presents the empirical results. Section 5 introduces a theoretical model to rationalize the empirical findings. Section 6 concludes.

# 2 Data

## 2.1 Background of the Buyback Program

In May 2024, the Treasury launched the liquidity support buyback program, "aim to support liquidity in off-the-runs by providing a regular, predictable opportunity to sell them back to the Treasury."[5] 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.[6] 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

| | |
|---|---|
| Quarterly Refunding | announce buyback plans of the quarter (operation day, maximum envelope, targeted bucket on the yield curve) |
| t−1(list day) | release eligible CUSIPs list (prelimiary) |
| t(operation day) | morning: release eligible CUSIPs list (final)<br>afternoon: dealers submit offers, Treasury announce which to accept |
| t+1 | settlement |

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),[7] and total buyback envelope. Second, on the day before buyback operation, the Treasury announces a preliminary list of CUSIPs that are eligible for buybacks. Third, on the operation day, the Treasury announces the final list of eligible CUSIPs (so far, identical as the preliminary list) in the morning, and primary dealers submit bids in the afternoon. Usually at 2pm, the Treasury announces the

[5] 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.

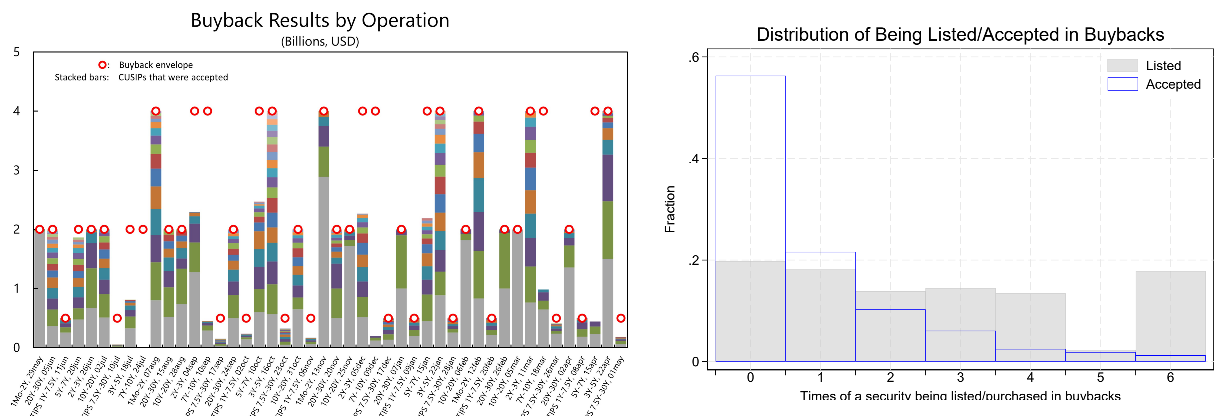
[6] Interview of SEC's Ghamami.

[7] 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.

accepted bids, and the settlement happens the next day.

The buyback procedure involves potential selection bias. The initial stage—the announcement of the buyback schedule—does not involve selection from the Treasury, as the timing of the actual buybacks is predetermined and the targeted bucket rotates on schedule. However, the subsequent stages, namely the selection of eligible securities and the final bid evaluation, do involve selection processes. The Treasury does not disclose the criteria or methodology used to determine which securities become eligible for buybacks in the second stage. For the third stage, the Treasury states only that "offers are evaluated based on their proximity to prevailing market prices at the close of the operation, as well as measures of relative value."[8] This issue will be further examined in section 3, which details the empirical methodology to address selection bias.

Figure 2: Buyback Results




Source: The U.S. Treasury.
Note: This figure plots the results 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 CUSIPs 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 outcome of buybacks vary across time. As shown in the left panel Figure 2, 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 80% of CUSIPs within the targeted category in the eligible list for buybacks (Table 1), assessed in terms of both the number of CUSIPs and their outstanding amounts as a share of the buyback's targeted category. On average, bids from around half of the eligible CUSIPs were accepted by the Treasury, which constituted approximately one-quarter of the total bid amount received. About 10 to 20 percent of all the securities have been listed in buybacks for one to six times,[9] while the buyback purchases are more

[8] FAQs for Treasury Securities Buybacks.
[9] So far, each bucket has had three to seven buybacks.

concentrated, with more than half of the securities have not been bought back (right panel Figure 2).

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 market. Nevertheless, the buyback amount accounts for approximately 10 percent of the average total daily off-the-run transactions, as reported by FINRA, for the same category five days prior to buyback. From the primary dealers perspective, the buyback amount is about 8 and 4 percent of their daily transaction and holdings position on the nearest Wednesday prior to buyback.

Table 1: Buyback Results Summary

| | No. of CUSIPs | Amount outstanding | Total off-the-run transaction | Primary dealer transaction | Primary dealer position |
|---|---|---|---|---|---|
| buyback listed | 81.2% | 83.8% | | | |
| buyback accepted | 35.9% | 0.1% | 10.2% | 7.5% | 4.1% |
| acceptance rate | 44.1% | 22.5% | | | |

Note: This table reports the eligible and accepted CUSIPs as share—in terms of number of CUSIPs and amount outstanding—of all the CUSIPs 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.

Historically, both the Treasury and the Federal Reserve have engaged in buyback activities; 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 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."[10] 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 was to lower long-term interest rates and stimulate borrowing and investment.

## 2.2 Liquidity Measures at Security Level

To assess liquidity conditions at the security level, I primarily utilize the bid-ask spread obtained from LSEG Datastream. This measure is calculated as the difference between the ask and bid

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

prices, divided by the average of the bid and ask prices, a metrics 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 as the principal liquidity measure 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, the differential between them may effectively neutralize potential measurement errors arising from data processing procedures.

In addition to the bid-ask spread, I incorporate the off-the-run spread for nominal coupons as a complementary measure. This spread is calculated as the difference between the yield of an off-the-run security and the corresponding on-the-run yield of the same maturity. On-the-run yield curve is based on Treasury daily yield curve rates, and the whole yield curve is interpolated using spline interpolation.[11] The final sample period extends from May 1st, 2024, to May 1st, 2025, at a daily frequency, with the top and bottom 1 percent of bid-ask spreads being truncated.

As expected, liquidity condition is challenging at the far-end of the off-the-runs (Table 2). Nominal coupons with a remaining maturity exceeding 10 years exhibit a median bid-ask spread of over 15 basis points, which triples that of those maturing within 2 years. The pattern is also present for the TIPS.

Table 2: Summary Statistics of Spreads and Primary Dealers Balance Sheet

| | **Trading Volume** | | | | | **Primary Dealer Treasury Holdings** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | SD | N | | Mean | Median | SD | N |
| coupon, 1m to 2yr | 6.2 | 4.7 | 8.7 | 25779 | bill | 78.1 | 76.9 | 21.2 | 56 |
| coupon, 2 to 3yr | 7.9 | 4.7 | 13.0 | 8738 | coupon, 1m to 2yr | 34.0 | 26.7 | 19.2 | 56 |
| coupon, 3 to 5yr | 8.1 | 4.4 | 11.9 | 13324 | coupon, 2 to 3yr | 15.1 | 14.7 | 4.7 | 56 |
| coupon, 5 to 7yr | 8.4 | 4.0 | 12.7 | 6974 | coupon, 3 to 5yr | 70.8 | 70.2 | 10.2 | 56 |
| coupon, 7 to 10yr | 4.2 | 3.9 | 1.4 | 2478 | coupon, 5 to 7yr | 24.2 | 23.4 | 6.1 | 56 |
| coupon, 10 to 20yr | 18.9 | 18.8 | 7.6 | 11110 | coupon, 7 to 10yr | 27.6 | 29.6 | 7.5 | 56 |
| coupon, 20 to 30yr | 14.9 | 15.1 | 6.0 | 9515 | coupon, 10 to 30yr | 59.5 | 60.6 | 10.8 | 56 |
| total coupon | 9.7 | 5.5 | 10.8 | 77918 | | | | | |
| TIPS, 1 to 7.5yr | 8.4 | 7.7 | 3.3 | 6512 | TIPS, 1 to 7.5yr | 18.5 | 18.3 | 2.3 | 56 |
| TIPS, 7.5 to 30yr | 29.8 | 33.0 | 15.8 | 4739 | TIPS, 7.5 to 30yr | 3.6 | 3.7 | 0.8 | 56 |

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) and primary dealers Treasury holdings on each Wednesday (in billions of USD).

### 2.3 Liquidity Measures at Aggregate Level

Beyond the security level, it is also important to evaluate if any meaningful liquidity condition changes at aggregate level. To achieve this, I use the dataset consists of weekly balance sheet data of primary dealers, obtained from the New York Fed. As part of the objectives of buybacks, dealers may utilize these operations to free up balance sheet capacity allocated to less-liquid positions at

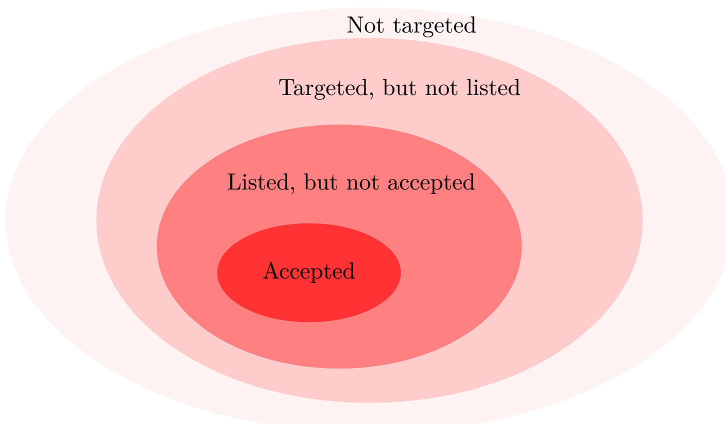
[11] Given that the Treasury only calculate five data points—5, 7, 10, 20, and 30 years—for TIPS, the interpolation doesn't have enough inputs to ensure robustness. As a result, off-the-run spread is not calculated for TIPS.

fair prices. Given that primary dealers Treasury positions are at historically elevated levels, changes in these positions may provide information regarding the liquidity supporting effects of buybacks.

As reported in Table 2, trading volumes are higher for the front-end and far-end securities on the yield curve, compared with those with medium maturities. Primary dealers hold about $80 billion of Treasury bill, which is a shy of one-third of their position of Treasury coupon. Within coupons, primary dealers have larger holdings in the 3 to 5 years of maturity and in the longer maturities with 10 to 30 years.

## 3 Empirical Methodology

The design of the buyback procedure, as discussed in subsection 2.1, 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.




### 3.1 Difference-in-Difference Settings

Across the four groups, I focus one two sets of comparisons: conditional on being targeted, the securities being listed for buyback vs. those not listed; conditional on being listed, the securities being accepted vs. those not accepted.[12] I format the comparisons in DID empirical framework, to assess whether buybacks influence liquidity conditions. The baseline DID regression specification is as follows:

$$y_{isjt} = \beta_1 \mathbb{1}_{i\in\mathcal{I}_j} \times \mathbb{1}_{t\geq t_j} + \beta_2 \mathbb{1}_{t\geq t_j} + \beta_3 \mathbb{1}_{i\in\mathcal{I}_j} + \delta r_{it} + \alpha_i + \alpha_j + \alpha_{st} + \epsilon_{isjt} \tag{1}$$

[12] 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 main analysis. That said, additional results on this DID can be found in the Appendix subsection A.1.

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 $j$." $\mathbb{1}_{t\geq t_j}$ is another dummy variable indicating the date is after the treatment day, which could be the buyback operation day or the day prior to that when the preliminary eligible CUSIP list is released. $\beta_1$ is the coefficient of interest, which estimates the impact of buybacks. The CUSIP fixed effects $\alpha_i$ 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 $\alpha_j$ absorb time-invariant buyback characteristics, such as its targeted bucket. Bucket-specific time fixed effects $\alpha_{st}$ 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 CUSIP $i$, which proxies demand and supply conditions relevant for CUSIP $i$. For each CUSIP in every buyback, I include 30 days before and after the buyback operation day.

A variation of the baseline specification Equation 1 is also used to explore the dynamic impact. Instead of using a single dummy to indicate all days following the treatment, I use a set of dummies to denote each day before or after the treatment.

$$\begin{aligned} y_{isjt} = & \sum_{d=-30,\ldots,-2,0,1,\ldots 30} \beta_{1d}\mathbb{1}_{i\in\mathcal{I}_j} \times \mathbb{1}_{t=t_j+d} \\ & + \sum_{d=-30,\ldots,-2,0,1,\ldots 30} \beta_{2d}\mathbb{1}_{t=t_j+d} \\ & + \beta_3\mathbb{1}_{i\in\mathcal{I}_j} + \delta r_{it} + \alpha_i + \alpha_j + \alpha_{st} + \epsilon_{isjt} \end{aligned} \tag{2}$$

In this specification, a dummy variable is assigned for each day within the range of $[-30, 30]$ around the treatment day. The dummy variable $\mathbb{1}_{t=t_j-1}$ is omitted, allowing $\beta_{1d}$ to measure the deviation as of day $t_j + d$ relative to the day preceding treatment day $t_j$.

### 3.2 Strategies to Address Selection Bias in Buybacks

The first DID analysis compares Treasury securities that are listed for buybacks with those that are not listed within the same buyback's targeted bucket, thereby measuring the "*listing effect*" of buybacks. This DID may be subject to selection bias regarding which securities are included in the eligible list, and Treasury does not disclose information about its decision-making process. For example, Treasury might opt to buy back relatively illiquid securities, whose liquidity conditions may be more responsive to additional demand from buybacks, potentially leading to an overestimation of the liquidity supporting effects of buybacks. In an effort to address this issue, I employ an instrumental variable strategy, akin to the approaches of D'Amico and King (2013) and Connolly and Struby (2024), for instance. This involves using the conditions for each security prior to (average across previous fifteen days) the announcement of the eligible list ($\mathbf{X_{ij}}$) to predict the probability of inclusion in the treatment group, with the predicted probability ($\widehat{\mathbb{1}}_{i\in\mathcal{I}_j}$) serving as an instrument for $\mathbb{1}_{i\in\mathcal{I}_j}$. The idea is specified as below:

$$\mathbb{1}_{i\in\mathcal{I}_j} = \mathbf{\Gamma} \times \mathbf{X_{ij}} + \alpha_j + \epsilon_{ij}, \quad \Longrightarrow \widehat{\mathbb{1}}_{i\in\mathcal{I}_j} \tag{3}$$

$$y_{isjt} = \beta_1 \mathbb{1}_{i\in\mathcal{I}_j} \times \mathbb{1}_{t\geq t_j} + \beta_2 \mathbb{1}_{i\in\mathcal{I}_j} + \beta_3 \mathbb{1}_{t\geq t_j} + \delta r_{it} + \alpha_i + \alpha_j + \alpha_{st} + \epsilon_{isjt}, \tag{4}$$
$$\text{with } \mathbb{1}_{i\in\mathcal{I}_j} \text{ instrumented by } \widehat{\mathbb{1}}_{i\in\mathcal{I}_j}$$

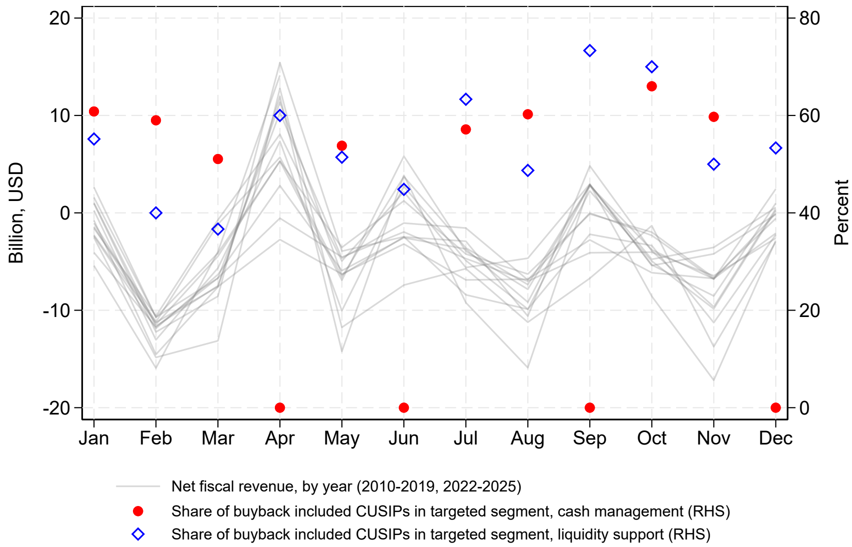
The key of the IV construction is to choose pre-buyback security characteristics that are relevant in Treasury's decision but ideally not correlated with liquidity condition. To this purpose, I mainly use four types of characteristics. The first one is amount outstanding, as Treasury would not want to swing market conditions by conducting a buyback large relative to the market size. In a similar vein, the second characteristic is the share of outstanding amount held by SOMA. 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%.[13] The third one is remaining maturity (and its square), a typical metrics for debt management, and it would make less of difference if Treasury buys back securities maturing soon from letting it matures as scheduled. In general, the "older" the security, the less liquid it may become. However, here I am using the remaining maturity, which is not mechanically linked to maturities forgone, unconditional on total maturity. The last one is coupon rate, as Treasury would consider cost efficiency in buybacks. These characteristics are widely used in the literature, such as Han, Longstaff and Merrill (2007) and Connolly and Struby (2024), and they are tied with operation rules of buybacks or characteristics that likely orthogonal to liquidity condition.

Besides using the pre-buyabck characteristics as IV, a novel approach from this paper is utilizing the results from cash management buybacks, to address the selection bias regarding which CUSIPs Treasury includes in buybacks. 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. By design, liquidity support consideration is not a priority in cash management buybacks. Moreover, 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."[14]

The consideration of maturity month is clearly revealed in the Treasury's selection of eligible

[13] FAQs for Treasury Securities Buybacks.
[14] Treasury's current views on the operational design of a regular buyback program.

Figure 3: Buyback-Included CUSIPs by Maturity Month




Note: This figure plots the share of the CUSIPs that make to 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.

CUSIPs for cash management buybacks. As illustrated in Figure 3, the Treasury excludes all CUSIPs 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 buybacks,[15] which include more than half of the CUSIPs maturing in these four months in their eligible list. This maturity-month-based consideration in the operational design of cash management buybacks—important for buybacks but exogenous to liquidity condition—provides an excellent framework to examine the liquidity support impact of buybacks. I utilize the maturity month, along with other pre-buyback characteristics mentioned above, to construct an instrumental variable for the dummy variable indicating inclusion in buybacks. This IV is pertinent to the selection process but remains reasonably orthogonal of the liquidity conditions of the underlying Treasury security.

The second DID analysis compares the Treasury securities whose bids are accepted in buybacks with those that are eligible but not accepted, thereby measuring the "*purchasing effect*" of buybacks. Similar to the second DID, this DID could also be subject to selection bias. As discussed in subsection 2.1, for this process, the Treasury does outline some general rule for which bids are accepted, "proximity to prevailing market prices" and "relative value" are among the consideration.

[15] 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.

However, relative value or other types of price measures are not ideal to be included for constructing IV, as they tend to correlate with liquidity conditions. For instance, less liquid securities could be heavily discounted in market. Therefore, I apply the same instrument approach as for the second DID to try to account for the selection issue.

Notably, although the Treasury actively makes choices in the whole process, there is a degree of "randomness" from the perspective of market participants, which could partially mitigate selection bias. This is because the exact rules governing the Treasury's decisions on which securities to include or accept in buybacks remain confidential. This confidentiality is justified, as fully predictable decision rules could enable primary dealers to submit higher bids for securities that the Treasury intends to buy back, leading to increased buyback costs for the Treasury. This rationale is similarly argued by Selgrad (2023) concerning the Federal Reserve's quantitative easing operations.

### 3.3 Strategies to Evaluate Buyback Impact on Primary Dealers Balance Sheet

Another method to test whether buybacks support liquidity in Treasury market is to assess the impact on primary dealers Treasury holdings on their balance sheet. To study how buybacks affect primary dealers Treasury holdings, I build on the standard inventory adjustment model in the literature (see Fleming, Nguyen and Rosenberg (2024), for instance) and add the amount of buybacks to the independent variables:

$$\Delta y_t = \alpha + \eta y_{t-1} + \beta_1 \cdot buyback_t + \beta_2 \cdot issuance_t + \beta_3 \cdot redemption_t + \epsilon_t \tag{5}$$

where $\Delta y_t$ denotes the change in net position of Treasury bill, coupon, or total Treasury securities from week $t-1$ to $t$, and $y_{t-1}$ is the net position of the last week $t-1$. The coefficient $\beta_1$ captures the effects of buybacks on the net Treasury positions. I control for the Federal Reserve and Foreign central banks holdings of Treasuries, same as Fleming, Nguyen and Rosenberg (2024).

Similar to the security-level analysis, I also compare the baseline results with a counterfactual of "random" purchase by the Treasury. The key challenge here is that the buyback amount may depend on the extent to which dealers would like to participate in buybacks, which may correlate with factors affecting their Treasury net positions. For instance, if dealers hold a large Treasury position due to unable to offload illiquid ones in the market, then it may bid large amount in buybacks. To address this issue, I use the announced maximum envelope of buybacks as instrument for the actual buyback results. The advantage is that the maximum envelope is pre-announced at each quarterly refinancing announcement, hence exogenous to dealers existing positions and preferences when individual buyback operates. The variations in the maximum envelope depend on buckets of the yield curve, and changes in the technical capacity of Treasury handling buybacks around August 2024.

# 4 Results

## 4.1 Listed vs. Non-Listed: The Listing Effect of Buybacks

As illustrated in subsection 3.2, the choice of which CUSIPs to include in buyback eligible list is unlikely random. To investigate the Treasury's decision-making process, I begin by examining the decision rule employed in this context. Utilizing the specification outlined in Equation 3, I estimate a Logit model where the dependent variable is a binary indicator of whether a CUSIP is listed in the buyback. For the explanatory variables, I include a set of CUSIP level pre-buyback characteristics, averaged over the fifteen days preceding the release of each buyback eligible list. The variables are remaining maturity (and its square), amount outstanding, SOMA holding as share of amount outstanding, and logarithm of price. As illustrated in subsection 3.2, these characteristics are relevant to the Treasury's decision making and arguably not closely linked to liquidity condition. I allow coefficients to vary across different targeted buyback buckets to enhance model fit, and the estimates for buybacks targeting coupons with maturities of less than two years are reported in Table 3.

Table 3: Buyback Eligibility and Pre-buyback Characteristics

| VARIABLES | (1)<br>Buyback listed | (2)<br>Buyback listed |
|---|---|---|
| amount outstanding, billion USD | -0.0255** | |
| | (0.011) | |
| remaining maturity, years | 9.8101*** | |
| | (2.835) | |
| remaining maturity square, years | -3.1002** | |
| | (1.450) | |
| coupon, pps | -0.3081*** | |
| | (0.033) | |
| SOMA share of outstanding if buyback, percent | -0.0481*** | |
| | (0.009) | |
| buyback eligible, predicted | | 1.0083*** |
| | | (0.023) |
| Observations | 1,620 | 1,596 |
| R-squared | 0.608 | 0.657 |
| Operation FE | yes | yes |
| Sample | full+TIPS | full+TIPS |

Note: This table reports the Logit regression to construct IV (Equation 3), 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 is the Logit results, and column 2 regresses the actual listed results on the predicted listed results by column 1. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at operation level.

The results of buyback eligible CUSIPs selection are reported in Table 3. As expected, Treasury tend to include securities with smaller SOMA holdings, in order to minimize the buybacks' footprint on market activity. Regarding maturity, there is a higher likelihood for Treasury to include securities with longer remaining maturities. This is intuitive, because there is less gain for Treasury to buy back a security that matures soon compared with letting it matures as it naturally sets to do. For coupon rate, Treasury tend to restrain from listing high-coupon securities, probably from a cost efficiency perspective. The fit of the predicted likelihood of being listed in buybacks is about 0.7 (column 2).

The results show a significant liquidity supporting effect from buyback listing (Table 4). The baseline (column 1) results suggest that being listed in buyback reduces bid-ask spreads by about 0.2 basis points. However, the IV (column 3) results show a larger impact, doubling the baseline estimates at 0.4 basis point. This suggests that selection bias leads to an underestimation of the liquidity support impact. One possible explanation is that, in contrary to listing less liquid securities, the Treasury tends to include more liquid securities in its buyback list. Given the abundant liquidity already in the market, the extra liquidity supporting effect from buyback demand might be smaller. Similarly, column 6 reports that off-the-run spreads also falls by about 1.9 basis point for the listed securities, following the list announcement.

Table 4: Listing Effect of Buybacks

| VARIABLES | (1) Bid-ask spread | (2) Bid-ask spread | (3) Bid-ask spread IV | (4) Bid-ask spread ask part IV | (5) Bid-ask spread bid part IV | (6) Off-the-run IV |
|---|---|---|---|---|---|---|
| post buyback list release | 0.1496** | 0.1372** | 0.2732*** | 0.2852*** | 0.0120 | 1.3613** |
| | (0.060) | (0.067) | (0.086) | (0.095) | (0.095) | (0.595) |
| buyback listed | 0.0527 | 0.1501 | -0.9666* | -0.6890* | 0.2776 | 0.1676 |
| | (0.142) | (0.137) | (0.518) | (0.369) | (0.295) | (0.971) |
| post buyback list release × buyback listed | -0.1871** | -0.1935** | -0.3617*** | -0.3137*** | 0.0480 | -1.9203** |
| | (0.080) | (0.091) | (0.113) | (0.098) | (0.109) | (0.814) |
| $\Delta$ on-the-run yield, bps | -0.0359*** | -0.0311*** | -0.0360*** | -1.2046*** | -1.1687*** | -0.2996*** |
| | (0.007) | (0.007) | (0.007) | (0.042) | (0.042) | (0.102) |
| Observations | 79,442 | 79,441 | 79,442 | 79,442 | 79,442 | 79,441 |
| R-squared | 0.960 | 0.963 | -0.012 | 0.052 | 0.049 | 0.001 |
| 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 |
| Sample | full | near neighbors as control | full | full | full | near neighbors as control |
| 1st stage F-stat | | | 30.31 | 30.31 | 30.31 | 39.67 |

Note: This table reports the baseline result (Equation 1) in column 1 and 2 and IV result (Equation 4) in column 3 to 6. The treatment group is the Treasury securities listed in the buyback eligible list and the control group is those not listed, conditional on being in the targeted bucket. The treatment day is when the preliminary eligible list is released. Column 2 are the same as column 1, but using near neighbors as control group. Column 4 and 5 are the same as column 3, but using the ask and bid part of the bid-ask spread as dependent variable, respectively. Column 6 is the same as column 3, but using off-the-run spread as dependent variable. Kleibergen-Paap Wald F statistic from the first stage is reported. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at CUSIP level.

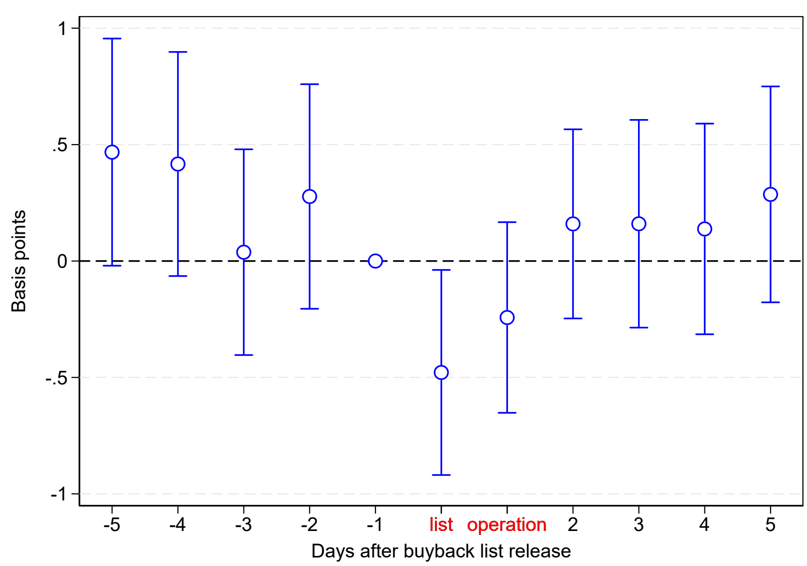
A robustness check is to use the securities with similar remaining maturities to those listed in buybacks as control group. For each CUSIP, I define its "near neighbors" as CUSIPs that mature in the same quarter (for those with remaining maturity less or equal to seven years) or the same year (for those with remaining maturity longer than seven years). The near neighbors, given their same remaining maturity, could serve as a better counterfactual. The estimates (column 2) is almost identical to the baseline (column 1), confirming the robustness of the results.

Conceptually, bid-ask spread can be written as the differential between the bid and ask components (Equation 6). As shown in columns 4 and 5 (Table 4), the bid component barely changes following the release of the buyback list, while the ask component experiences a decrease. This phenomenon may imply that, knowing that the Treasury may be an eventual buyer of a security, primary dealers could be more likely to sell securities from the balance sheet, prompting a willingness to lower selling price. Therefore, the ask part represents the changes in primary dealers willingness in market making from a seller's perspectively. While the sell and buy may both respond to additional demand, the improvement in primary dealers willingness in market making from the sell side is more pronounced. More details on the direct impact on bid and ask prices are discussed below in subsection 4.5.

$$\text{bid-ask spread}_t = \frac{p_t^{ask} - p_t^{bid}}{(p_t^{ask} + p_t^{bid})/2} = \underbrace{\frac{p_t^{ask} - (p_t^{ask} + p_t^{bid})/2}{(p_t^{ask} + p_t^{bid})/2}}_{\text{ask part}} - \underbrace{\frac{p_t^{bid} - (p_t^{ask} + p_t^{bid})/2}{(p_t^{ask} + p_t^{bid})/2}}_{\text{bid part}} \tag{6}$$

The effect of buyback listings is relatively short-lived, predominantly observed on the listing day itself. According to estimates based on Equation 2, the bid-ask spread diminishes by 0.5 basis points on the day the eligible list of CUSIPs is released, compared to the preceding day. This effect rapidly halves to 0.2 basis points the following day, when buyback auction operates. The magnitude of the reduction is about one tenth of mean or standard deviation of bid-ask spread. Although the listing effect is transitory, the reverting of the effect could be primary dealers balancing out the gain in liquidity in the listed CUSIPs across different securities among their bid-ask spreads.

Figure 4: The Dynamics of Listing Effect of Buybacks




Note: This figure plots the deviation of bid-ask spread relative to one day before buyback eligible list release, estimated by Equation 2. The dots represent the deviation of bid-ask spreads relative to the day prior to the buyback eligible list release ("$-1$" on the x axis). The intervals represent the 90% confidence interval.

## 4.2 Cash Management Buybacks As A Laboratory to Test Listing Effect

As discussed in subsection 3.2, cash management buybacks, which primarily aim to stabilize Treasury's cash balance, do not necessarily prioritize liquidity support at the forefront of their operations, therefore it is less subjective to selection bias. To illustrate this point, I examine the selection decision of buyback listing of cash management buybacks in the setting of Equation 3. To begin with, I include the same set of pre-buyback characteristics as Table 3 and allow coefficients to vary across buyback operations (average estimates across operations are reported).

Column 1 of Table 5 show that cash management buybacks tend to list CUSIPs with larger amount outstanding, lower SOMA holding, and lower coupon rate, similar to liquidity support buybacks. However, cash management buybacks are more inclined to list CUSIPs with short remaining maturity. In column 2, I add monthly dummies to assess the role of cash flow consideration as demonstrated by Figure 3, i.e., the Treasury refrains from buying back securities maturing in the same month when it experiences substantial cash inflow. The refinement significantly improves the fit—with R-squared increases from 0.3 to 0.7. This observation can be also seen from the fit of the predicted likelihood of being listed by buybacks. The fitted values, predicated on monthly dummies and pre-buyback characteristics, reaching 0.8 for cash management buybacks (column 4), which is substantially higher than the values derived without monthly dummies (column 3).

Table 5: Buyback Eligibility and Pre-buyback Characteristics: Cash Management Buyback

| VARIABLES | (1) Buyback listed | (2) Buyback listed | (3) Buyback listed | (4) Buyback listed |
|---|---|---|---|---|
| amount outstanding, billion USD | 0.002*** | 0.003 | | |
| | (0.000) | (0.003) | | |
| remaining maturity, years | -9.570*** | -29.11*** | | |
| | (0.057) | (7.177) | | |
| remaining maturity square, years | 2.761*** | 8.774*** | | |
| | (0.020) | (2.497) | | |
| coupon, pps | -0.0825*** | -0.2992*** | | |
| | (0.016) | (0.084) | | |
| SOMA share of outstanding if buyback, percent | -0.0092*** | -0.0628*** | | |
| | (0.001) | (0.010) | | |
| buyback listed, predicted | | | 0.9854*** | 0.9932*** |
| | | | (0.094) | (0.012) |
| Observations | 1,370 | 987 | 1,370 | 1,370 |
| R-squared | 0.299 | 0.700 | 0.336 | 0.803 |
| Month FE | no | yes | no | yes |
| Operation FE | yes | yes | yes | yes |
| Sample | cash management | cash management | cash management | cash management |

Note: This table reports the Logit regression to construct IV (Equation 3), averaging across cash management operations, 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. Column 1 is based on the cash management buyback results, and column 2 is based on the same sample but adding the month dummies and dropping insignificant variables. Column 3 to 4 report the fit of the predicted eligibility, based on column 1 and 2, respectively. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at operation level.

The listing effect from cash management buybacks is significant. As shown by column 1 of Table 6, being listed by cash management buybacks reduces the bid-ask spread by about 0.3 basis point following the announcement of the list, compared with those not listed. The IV results in column 2 confirm the estimates, and the minimal difference between the baseline and IV estimates underscores the previous point that cash management buybacks are less susceptible to selection bias associated with liquidity support.

Besides bid-ask spread, the listing effect is also prominent in off-the-run spread. As shown by column 3 and 4 of Table 6, inclusion in cash management buyback listings results in a reduction of the off-the-run spread by approximately 2.5 basis points post-announcement, relative to those not listed. The magnitude of this effect surpasses that of the bid-ask spread, constituting approximately the mean or half of its standard deviation within the target category of cash management buybacks.

Table 6: Listing Effect of Buybacks: Cash Management Buybacks

| VARIABLES | (1)<br>Bid-ask spread | (2)<br>Bid-ask spread IV | (3)<br>Off-the-run spread | (4)<br>Off-the-run spread IV |
|---|---|---|---|---|
| post buyback list release | 0.1315*** | 0.1483*** | 1.2009*** | 1.4181*** |
| | (0.031) | (0.036) | (0.201) | (0.237) |
| buyback listed | -0.0530 | -0.4350*** | 2.9412*** | 5.0082*** |
| | (0.079) | (0.165) | (0.376) | (0.691) |
| post buyback list release × buyback listed | -0.3142*** | -0.3534*** | -2.3687*** | -2.8583*** |
| | (0.062) | (0.071) | (0.314) | (0.372) |
| Δ on-the-run yield, bps | -0.0157*** | -0.0163*** | -0.2778*** | -0.2721*** |
| | (0.005) | (0.005) | (0.014) | (0.014) |
| Observations | 74,428 | 74,428 | 71,813 | 71,813 |
| R-squared | 0.977 | 0.001 | 0.507 | 0.051 |
| CUSIP FE | yes | yes | yes | yes |
| Maturity-specific time FE | yes | yes | yes | yes |
| Operation FE | yes | yes | yes | yes |
| Sample | cash management | cash management | cash management | cash management |
| 1st stage F-stat | | 82.75 | | 82.49 |

Note: This table reports the baseline result (Equation 1) in column 1 & 3 for bid-ask spread and IV result (Equation 4) in column 2 & 4 for off-the-run spread. The treatment group is being listed in buybacks and the control group is those not listed. The treatment day is when the preliminary eligible list is released. Kleibergen-Paap Wald F statistic from the first stage is reported. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at CUSIP level.

### 4.3 Accepted vs. Non-accepted: The Purchasing Effect of Buybacks

Similar to the process in determining which securities to include in buybacks, the Treasury actively selects specific securities for purchase. To investigate the decision-making framework, I utilize a Logit regression specification akin to that presented in Table 3, with the dependent variable being purchased in buybacks, conditional upon being included in the eligible list. Compared with Table 3, many of the variables become insignificant in whether a CUSIP being bought back or not (Table 7). Moreover, despite employing a similar specification, the pre-buyback characteristics exhibit substantially lower predictive power regarding buyback purchase decisions than buyback listing decisions, as evidenced by the low R-squared value of about 0.2. This could be due to that the actual bid prices submitted by primary dealers during buybacks would serve as the most important for the Treasury, when determining which bids to accept. However, it would likely be correlated with the liquidity condition of the security, therefore violates the exclusion condition of IV. Also, the Treasury only discloses the bid prices for CUSIPs that are ultimately purchased, not those bids that are not accepted.

Table 7: Buyback Success and Pre-buyback Characteristics

| VARIABLES | (1) Buyback accepted | (2) Buyback accepted |
|---|---|---|
| amount outstanding, billion USD | 0.0249 | |
| | (0.018) | |
| remaining maturity, years | -4.5267** | |
| | (2.288) | |
| remaining maturity square, years | 1.0146 | |
| | (1.219) | |
| coupon, pps | 0.0043 | |
| | (0.051) | |
| SOMA share of outstanding if buyback, percent | 0.0179 | |
| | (0.013) | |
| buyback accept, predicted | | 0.7682*** |
| | | (0.098) |
| Observations | 975 | 1,237 |
| R-squared | 0.235 | 0.204 |
| Operation FE | yes | yes |
| Sample | full | full |

Note: This table reports the Logit regression to construct IV (Equation 3), where the dependent variable is a dummy variable indicating if a Treasury security is accepted in buyback, conditional on the security is in the eligible list of buyback. Coefficients are allowed to vary across buybacks that target different buckets, and the estimates for the buybacks that target nominal coupons with maturity between one month and two years are shown in column 1. Column 2 is the fit of the projected probability. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at operation level.

The purchasing effect of buybacks appears to be not robust and usually statistically insignificant. First thing to note is that as can be expected from a low fit of the predicted likelihood of being accepted in buybacks, the IV fails weak IV test in almost all of the regressions. The baseline estimates indicate a modest increase in the bid-ask spread for securities purchased in buybacks, compared to those that are listed but not repurchased (column 1, Table 8). However, these results are not corroborated by IV estimates, as the IV fails the weak instrument test (column 2). Similarly, when the purchasing effect is assessed using the off-the-run spread, the results remain insignificant in both baseline and IV regressions (column 3 and 4).

The lack of significant estimates for the purchasing effect can be interpreted in the following ways. First, once the Treasury's buyback is executed, primary dealers no longer face the additional buyback demand until the next operation. In other words, the demand curve—and, by extension, the spread curve—reverts to its pre-buyback state. This mechanism will be explored further in the model section 5. Second, while liquidity, as measured by price indicators (e.g., bid-ask spread and off-the-run spread), does not appear to improve, liquidity as measured by trading volume could still potentially be enhanced for CUSIPs purchased in buybacks. That is the case for the analysis regarding targeting effect in subsection A.1. Last, a key issue in the off-the-run market is the limited transparency of transaction data (Neal (2024)). Given that off-the-run Treasuries are traded less frequently than on-the-run securities, there is less readily available pricing data, making it more difficult for the market to determine feasible trading prices. By making the trades and publishing transaction data, buybacks may provide meaningful pricing information for the relevant off-the-run securities, thereby reducing price dispersion, even if they do not narrow the bid-ask spread.

Table 8: Purchasing Effect of Buybacks

| VARIABLES | (1) Bid-ask spread | (2) Bid-ask spread IV | (3) Off-the-run spread | (4) Off-the-run spread IV |
|---|---|---|---|---|
| post buyback | -0.0304 | -0.1794*** | -0.0036 | -0.0358 |
| | (0.030) | (0.059) | (0.047) | (0.142) |
| buyback accept | -0.0174 | -0.4615 | 0.0674 | 0.2994 |
| | (0.067) | (0.573) | (0.108) | (1.158) |
| post buyback × buyback accept | 0.1941*** | 0.7773*** | 0.0822 | 0.2113 |
| | (0.061) | (0.213) | (0.174) | (0.556) |
| $\Delta$ on-the-run yield, bps | -0.0408*** | -0.0400*** | -0.3432*** | -0.3428*** |
| | (0.012) | (0.012) | (0.034) | (0.034) |
| Observations | 56,511 | 56,511 | 56,511 | 56,511 |
| R-squared | 0.943 | -0.005 | 0.956 | 0.021 |
| CUSIP FE | yes | yes | yes | yes |
| Maturity-specific time FE | yes | yes | yes | yes |
| Operation FE | yes | yes | yes | yes |
| Sample | full | full | full | full |
| 1st stage F-stat | | 6.974 | | 6.974 |

Note: This table reports the baseline result (Equation 1) in column 1 and 3 and IV result (Equation 4) in column 2 and 4. Column 1 to 2 and column 3 to 4 are the results for bid-ask spread and off-the-run spread, respectively. The treatment group is being accepted in buybacks and the control group is those not accepted but listed. The treatment day is the operation day of buyback. Kleibergen-Paap Wald F statistic from the first stage is reported. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at CUSIP level.

### 4.4 When Is the Impact of Buybacks More Pronounced?

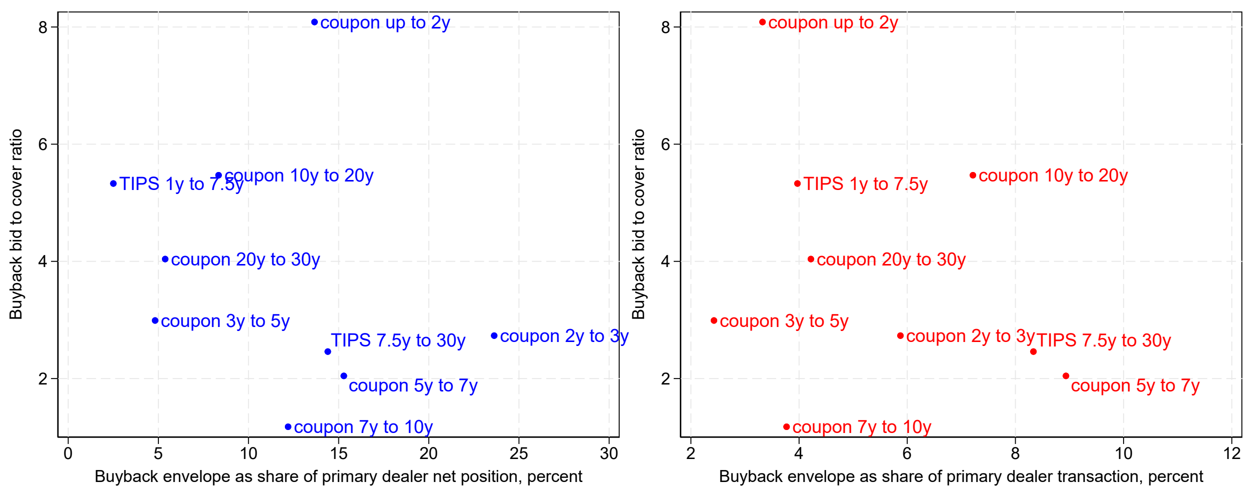
Conceptually, the extent to which buybacks can support liquidity could depend upon the prevailing liquidity conditions of the market and the potential capacity of buybacks in addressing market imbalances. When there is stress in the liquidity condition of the market and buyback size is meaningfully large relative to the scale of the liquidity problem, then buybacks could potentially have significant liquidity support effects. To gauge the existing liquidity condition of the market (i.e., demand for buybacks), I use the demand for buybacks, which is proxied using the bid-to-cover ratio of buyback auctions. To measure the potential liquidity resolution capacity of buybacks (i.e., supply from buybacks), I use the size of the buyback envelope as a proportion of primary dealers net positions or the daily transaction volume within the targeted buyback category.[16] The greater the demand for and supply from buybacks, the higher the likelihood that buybacks will exert a substantial liquidity supporting effect.

As shown by Figure 5, the front-end bucket—nominal coupons with remaining maturity between one month and two years—exhibits the highest demand for buybacks, yet faces low supply from buybacks. The bid-to-cover ratio for buybacks targeting the front-end bucket reaches as high as

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

8, in contrast to a range of 1.5 to 4 for other buckets. Furthermore, the buyback envelope only constitutes approximately 3 percent of the daily transactions of primary dealers prior to the buyback, which is half the average size observed in other buckets. The large net position and transaction of primary dealers at the front end is likely due to short-term Treasuries being more liquid, bearing lower interest rate risks, and involving in high-volume financial transactions such as repo.

Figure 5: Buyback Demand and Supply




Note: This figure plots the buyback demand—proxied by total bids placed as a ratio to the maximum buyback envelope, and buyback supply—proxied by buyback maximal envelope as share of primary dealer net position and daily transaction (on nearest day prior to buyback). All measures are average by targeted bucket of buybacks.

Indeed, the estimates show that the listing impact of buybacks is most pronounced at the front-end buckets. As indicated by Table 9, when buybacks target securities with maturities of less than three years, those included on the buyback eligibility list experience a reduction in the bid-ask spread by a quarter basis point compared to those not included (column 1), and the impact falls to insignificant for those with maturities longer than three years. The differences are more evident in the IV estimates. While the impact for the front-end buckets reach 0.8 basis point, the impact becomes not statistically significant for the buckets with far-end buckets. A substantial oversubscription and the relative limited supply from buybacks suggest a significant motives from the market of liquidate their positions at the front end, which can gain from the liquidity support provided by buybacks, thereby resulting in a more pronounced narrowing of the bid-ask spread.

In addition to its greater magnitude, the listing impact of buybacks demonstrates prolonged persistence for the front-end buckets. As depicted in Figure 6, for Treasury securities with one month to three years maturity, being listed in buybacks reduces bid-ask spread by half basis point compared to those not listed. This effect lasts throughout three days after listing. On the contrary, for the securities with three to thirty years maturity, the impact is only marginally negative on

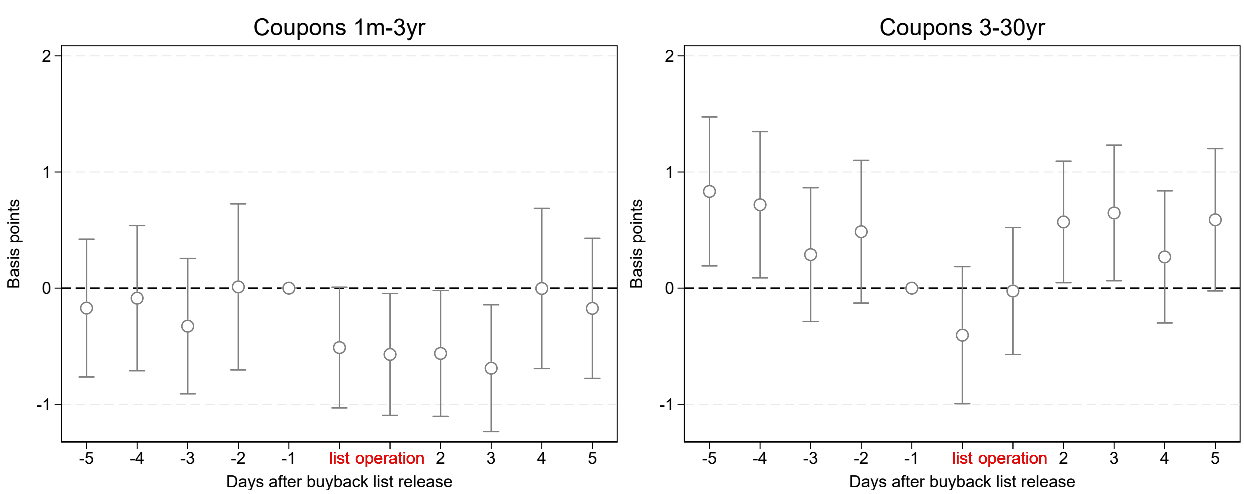
Table 9: Listing Effect of Buybacks: By Targeted Bucket

| VARIABLES | (1) Bid-ask spread 1m-3yr | (2) Bid-ask spread 1m-3yr IV | (3) Bid-ask spread 3-30yr | (4) Bid-ask spread 3-30yr IV |
|---|---|---|---|---|
| post buyback list release | 0.5686** | 0.3491 | 0.1449 | 0.1184 |
| | (0.279) | (0.414) | (0.089) | (0.111) |
| buyback listed | 0.0350 | -2.4519*** | 0.4981** | 0.6256 |
| | (0.120) | (0.680) | (0.241) | (0.808) |
| post buyback list release × buyback listed | -0.2404** | -0.7606*** | -0.1897 | -0.1531 |
| | (0.115) | (0.181) | (0.120) | (0.152) |
| Δ on-the-run yield, bps | -0.0330*** | -0.0393*** | 0.0012 | 0.0010 |
| | (0.008) | (0.008) | (0.027) | (0.027) |
| Observations | 29,620 | 29,620 | 49,820 | 49,820 |
| R-squared | 0.958 | -0.106 | 0.955 | 0.001 |
| CUSIP FE | yes | yes | yes | yes |
| Bucket-specific time FE | yes | yes | yes | yes |
| Operation FE | yes | yes | yes | yes |
| 1st stage F-stat | | 11.12 | | 15.91 |

Note: This table reports the baseline (Equation 1) and IV results (Equation 4) for subsamples with buybacks targeting different buckets. Column 1 and 3 show the baseline results for targeted buckets being Treasury securities with one month to three years maturity and with three to thirty years maturity, respectively. Column 2 and 4 are the IV results. The treatment group is being listed in buybacks and the control group is those not listed. The treatment day is when the preliminary eligible list is released. Kleibergen-Paap Wald F statistic from the first stage is reported. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at CUSIP level.

the listing day, and dissipates thereafter. These different dynamic patterns could be attributed to the sheer size of the front-end off-the-run securities, which necessitates a longer duration for the liquidity impact to permeate.

Figure 6: The Dynamics of Listing Effect of Buybacks: By Targeted Bucket




Note: This figure plots the deviation of bid-ask spread relative to one day before buyback eligible list release, estimated by Equation 2. The left and right panel uses nominal coupons with one month to three years maturity and nominal coupons with three to thirty years maturity, respectively. The dots represent the deviation of bid-ask spreads relative to the day prior to the buyback eligible list release ("−1" on the x axis). The intervals represent the 90% confidence interval.

Another way to test if buybacks have large liquidity supporting impact when there is pressure in the market is to estimate buyback impact by operation and to see if it varies with market condition. Based on their feedback to Treasury shortly following the launch of buyback program, primary dealers perceive buybacks as a tool to exit less-liquid positions, enabling them to redeploy balance sheet for new client activity.[17] By this logic, it is reasonable to expect that when primary dealers are overloaded with Treasury holdings, they are incentivized to liquidate these positions to mitigate risk exposures (e.g., interest rate risks for nominal coupons) and associated costs (e.g., financing cost for warehousing the Treasuries), which in turn increases the likelihood of buybacks exerting a substantial impact.

To empirically investigate this hypothesis, I estimate the listing effect for each cash management buyback operation and correlate these estimates with the excess positions of front-end nominal coupons—maturing in less than two years the designated target category for cash management buybacks—held by primary dealers. Theoretically, the operation-specific impact can be estimated for liquidity support buybacks as well, however, IV estimation—which would be required to address selection bias—sometimes fails weak IV test at operation level. As cash management buybacks are less prone to selection bias, the baseline fixed effects estimation could be used directly.

I use two measures for primary dealers excess position. One is relative primary dealer holdings as total outstanding (following Klingler and Sundaresan (2023)), which is the share of front-end Treasuries held by primary dealers divided by the outstanding Treasuries of the same maturity recently issued (less than 12 weeks ago). The other is relative primary dealer holdings as total asset, which is the share of front-end Treasuries held by primary dealers divided by their total assets. Higher excess position means that there are larger motives to sell and reduce the position.

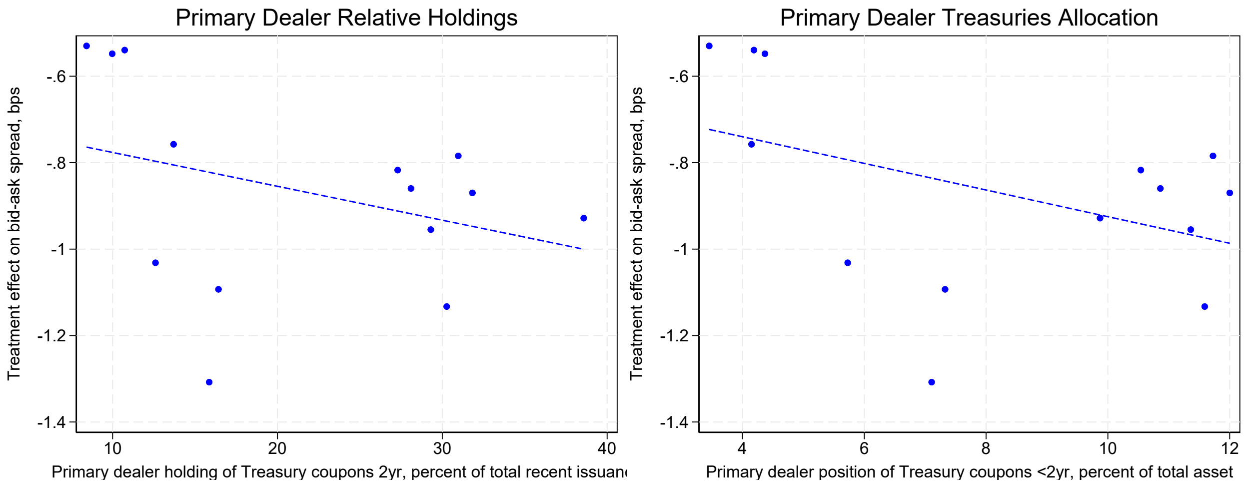
Figure 7 illustrates a strong correlation between the listing effect of buybacks and the primary dealers excess position. This indicates that when primary dealers are over-positioned, the reduction in bid-ask spreads resulting from buyback listings is significantly greater. A one percentage point increase in primary dealers' excess position on front-end nominal coupons as share of total recent issuance and total assets would amplify the listing effect of buybacks by 2 and 0.2 basis points, respectively.

### 4.5 The Listing and Purchasing Effects of Buybacks on Relative Prices

Having established the liquidity-supporting impacts of buybacks in terms of narrowing bid-ask spreads, I now investigate whether buybacks also influence the price levels of off-the-run Treasury securities. Prior sections have primarily focused on spreads, which measure the distance between bid and ask prices; here, by contrast, I analyze absolute price changes resulting from the listing and purchasing phases of buybacks. To properly measure prices excluding changes due to macro conditions, I construct relative prices based on deviations of actual prices from their model-implied

[17] Office of Debt Management, Liquidity Support Buyback Results: 5/29/24 to 7/24/24.

Figure 7: Listing Effect of Cash Management Buybacks and Primary Dealers Excess Treasury Position




Note: This figure plots the treatment effect based on column 1 of Table 6—estimated individually based on each cash management buyback—and the primary dealers position on Treasury coupons with maturity less than 2 years, measured as percent of the outstanding Treasuries of the same maturity recently issued (less than 12 weeks ago) on the left panel, and as percent of primary dealers total assets on the right panel.

counterparts, which are calculated as the present discounted value of future cash flows following Selgrad (2023).[18]

Table 10 presents the results for the impact of both listing and purchasing events on relative prices. The listing effect is clearly evident: inclusion in the buyback eligible list significantly raises relative bid and ask prices by approximately 9 cents (columns 1 and 3). The IV estimates suggest an even larger impact of about 19 cents, indicating that the price elasticity for securities listed in buybacks might be lower than average. This statistically significant price increase reflects dealers' revised valuation following the announcement of the buyback eligibility list. When their securities are included in the buyback eligible list, dealers perceive increased demand, which reduces their perceived risks of holding inventory. The resulted upward price adjustment aligns with reduced holding risks and enhanced dealer confidence in managing their positions.

Turning to the purchasing effect, the evidence presented in Table 10 indicates that Treasury's actual acceptance and purchase of securities further elevate relative bid and ask prices. The baseline estimates show that bid and ask prices for those bought back by the Treasury increase by 4 cents, relative to those not bought back. The IV estimates robustly confirm that the buyback purchase raises bid and ask prices by approximately 28 cents. This purchasing effect, in addition to the listing effect, underscores that actual Treasury transactions have an incremental impact on dealer price revisions. Importantly, one potential channel could be that the purchasing stage alleviates pressure

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

Table 10: Listing and Purchasing Effects of Buybacks on Relative Prices

| VARIABLES | (1) Bid price | (2) Bid price IV | (3) Ask price | (4) Ask price IV | (5) Bid price | (6) Bid price IV | (7) Ask price | (8) Ask price IV |
|---|---|---|---|---|---|---|---|---|
| post buyback list release | -0.0756*** | -0.1444*** | -0.0741*** | -0.1416*** | | | | |
| | (0.014) | (0.020) | (0.014) | (0.020) | | | | |
| buyback_include | -0.0162 | -0.0388 | -0.0158 | -0.0455 | | | | |
| | (0.058) | (0.243) | (0.058) | (0.244) | | | | |
| post buyback list release × buyback listed | 0.0937*** | 0.1892*** | 0.0918*** | 0.1854*** | | | | |
| | (0.017) | (0.023) | (0.017) | (0.023) | | | | |
| post buyback | | | | | -0.0185** | -0.0847*** | -0.0185** | -0.0858*** |
| | | | | | (0.008) | (0.014) | (0.008) | (0.015) |
| buyback accept | | | | | -0.0377 | -0.8819*** | -0.0379 | -0.8830*** |
| | | | | | (0.036) | (0.229) | (0.036) | (0.229) |
| post buyback × buyback accept | | | | | 0.0397** | 0.2761*** | 0.0412** | 0.2820*** |
| | | | | | (0.016) | (0.037) | (0.016) | (0.037) |
| Δ on-the-run yield, bps | 0.0005 | 0.0006 | 0.0001 | 0.0002 | -0.0019* | -0.0014 | -0.0023** | -0.0018 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Observations | 78,969 | 78,969 | 78,969 | 78,969 | 56,057 | 56,057 | 56,057 | 56,057 |
| R-squared | 0.928 | - | 0.927 | - | 0.952 | - | 0.952 | - |
| CUSIP FE | yes | yes | yes | yes | yes | yes | yes | yes |
| Bucket-specific time FE | yes | yes | yes | yes | yes | yes | yes | yes |
| Operation FE | yes | yes | yes | yes | yes | yes | yes | yes |
| Sample | full | full | full | full | full | full | full | full |
| 1st stage F-stat | | 30.26 | | 30.26 | | 18.70 | | 18.70 |

Note: This table reports the baseline (Equation 1) in columns with odd numbers and IV results (Equation 4) in columns with even numbers, for the impact of listing and purchasing on bid and ask prices (relative to model-based price). Columns 1 to 4 and columns 5 to 8 show the results for listing and purchasing effects, respectively. Kleibergen-Paap Wald F statistic from the first stage is reported. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at CUSIP level.

on dealer balance sheets, thus prompting a repricing of the securities.

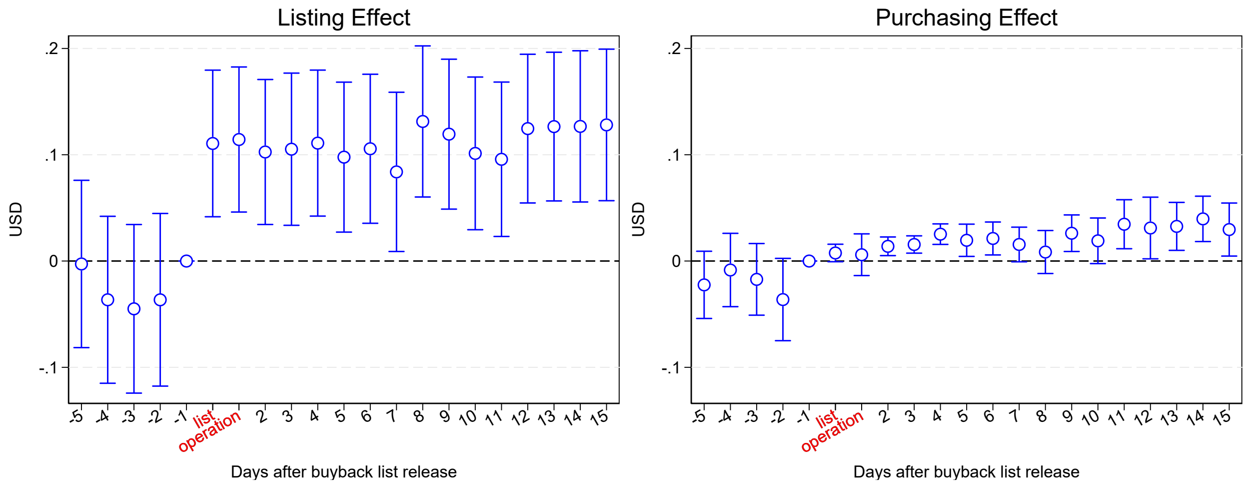
Figure 8 provides additional insights into the dynamic patterns of these price impacts, illustrating the evolution of relative prices around both the listing and purchasing days. Relative prices immediately rise upon the announcement of the buyback eligible list, with a clear and statistically significant jump. Following the buyback operation, the purchasing effect reinforces and modestly expands this initial rise in relative prices. Notably, the price impacts from both listing and purchasing effects are persistent, maintaining elevated price levels weeks after the transaction. This persistent pattern suggests that buybacks have a more durable impact on absolute prices than on spreads.

### 4.6 Have Buybacks Alleviated Primary Dealers Treasury Security Positions?

So far, the analysis has concentrated on the liquidity support impact of buybacks on individual security, and this subsection shifts the focus to the aggregate effects on primary dealers balance sheet. The objective is to evaluate whether buybacks facilitate the alleviation of Treasury positions held by primary dealers by providing them with the opportunity to liquidate positions that are difficult to sell at fair prices. To establish a baseline for comparison with the buyback estimates, I begin by estimating the standard balance sheet management model as specified in Equation 5.

The estimates presented in Table 11 (column 1 to 3) align closely with the magnitudes found in the literature (e.g., Fleming, Nguyen and Rosenberg (2024)). Primary dealers exhibit a tendency to "mean revert" to a certain level of Treasury positions, as evidenced by the negative coefficients

Figure 8: Listing Effect and Purchasing Effect on Relative Prices




Note: This figure plots the deviation of relative bid price in comparison to one day before buyback eligible list release, estimated by Equation 2. The left and right panel presents the listing and purchasing effect, respectively. The dots represent the deviation ofrelative bid price in comparison to the day prior to the buyback eligible list release ("$-1$" on the x axis). The intervals represent the 90% confidence interval.

associated with the beginning position, with a more pronounced mean reversion observed for bill positions. Issuance and redemption concurrently increase and decrease these positions, respectively. Specifically, an issuance of one billion dollar is estimated to augment the position by approximately \$100 million, while a redemption of one billion dollar would reduce the position by between \$50 million and \$100 million.

With the inclusion of buybacks in the regression, the results don't indicate a significant response in the Treasury positions during the buyback week (column 4 to 5 Table 11). Note that, when restricting the sample to buyback periods (i.e., post May 2024), the impact of redemptions already becomes insignificant even without including buyback in the regression. This may reflect the rising role of hedge fund in Treasury market (see Kruttli et al. (2025), for instance).

Similar to the bill position, the coupon position experiences negligible changes during the buyback week (column 5 Table 11). To investigate the underlying reasons for this observation, I analyze the Treasury positions and buyback results at the bucket level, estimating the direct impact of buybacks on the targeted bucket. As demonstrated in column 7, in response to a one billion dollar buyback, the position in the targeted coupon bucket does decline by \$180 million. Although the magnitude is moderate compared with primary dealers average positions in Treasury coupons (primary dealers Treasury coupon positions have averaged around \$230 billion since the first buyback in May 2024, with a standard deviation of \$45 billion (Table 2)), it is larger than that of redemptions. In general, the insignificant impact on the overall coupon position could be due to the direct effect on the targeted bucket being offset by spillover into the untargeted buckets, or that the increase in one bucket is not large enough to move the position in the aggregate coupon holdings. The IV results in panel B of Table 11 confirms the baseline results that buyback reduces primary dealers holdings of the buyback targeted bucket but no significant impacts on the rest Treasury holdings.

Table 11: Primary Dealers Treasury Position Management

| **Panel A** | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| VARIABLES | Δ Bill | Δ Coupon | Δ Total | Δ Bill | Δ Coupon | Δ Total | Δ Coupon |
| beginning position, billion USD | -0.2225*** | -0.0143*** | -0.0236*** | -0.2357 | -0.0105 | -0.0664 | -0.0804** |
| | (0.022) | (0.004) | (0.005) | (0.157) | (0.021) | (0.047) | (0.022) |
| issuance, billion USD | 0.1085*** | 0.1049*** | 0.1134*** | 0.1048*** | 0.0658*** | 0.1286*** | 0.0123 |
| | (0.010) | (0.011) | (0.008) | (0.022) | (0.019) | (0.017) | (0.012) |
| redemption, billion USD | -0.0742*** | -0.0485*** | -0.1000*** | -0.0264 | 0.0374 | -0.0132 | 0.0259 |
| | (0.012) | (0.011) | (0.009) | (0.035) | (0.050) | (0.041) | (0.031) |
| buyback, billion USD | | | | 0.1527 | -0.2644 | 0.2859 | -0.1840* |
| | | | | (0.568) | (0.245) | (0.577) | (0.077) |
| R2 | 0.254 | 0.222 | 0.243 | 0.407 | 0.161 | 0.422 | 0.0666 |
| **Panel B, IV results** | | | | | | | |
| beginning position, billion USD | | | | -0.2344 | -0.0102 | -0.0709 | -0.0798** |
| | | | | (0.156) | (0.020) | (0.048) | (0.022) |
| issuance, billion USD | | | | 0.1055*** | 0.0658*** | 0.1290*** | 0.0123 |
| | | | | (0.023) | (0.019) | (0.017) | (0.012) |
| redemption, billion USD | | | | -0.0280 | 0.0374 | -0.0137 | 0.0258 |
| | | | | (0.037) | (0.050) | (0.042) | (0.031) |
| buyback, billion USD | | | | 0.2850 | -0.2723 | 0.4775 | -0.1995* |
| | | | | (0.657) | (0.214) | (0.704) | (0.094) |
| R-squared | | | | 0.406 | 0.160 | 0.421 | 0.064 |
| 1st stage F-stat | | | | 258.9 | 446.9 | 389.4 | 129.8 |
| Observations | 1,242 | 1,242 | 1,242 | 52 | 52 | 52 | 312 |
| Bucket FE | no | no | no | no | no | no | yes |
| Sample | 11jul2001 | 11jul2001 | 11jul2001 | 01may2024 | 01may2024 | 01may2024 | 01may2024 |
| | 23apr2025 | 23apr2025 | 23apr2025 | 23apr2025 | 23apr2025 | 23apr2025 | 23apr2025 |

Note: This table reports the baseline and IV results of Equation 5 for the relationship between primary dealers Treasury positions and buybacks. In Panel A, column 1 to 3 shows the results as in the literature without including buybacks, for bill, coupon, and total Treasuries, respectively. Column 4 to 6 are the results with buybacks, and column 7 is the panel regression for various buckets of coupons. Panel B is the same specification, but using maximum buyback envelope as the IV for buyback amounts. Kleibergen-Paap Wald F statistic from the first stage is reported. ***, **, * represent significance of 1%, 5% and 10%, respectively. Newey-west standard errors with 12 lags are used in column 1 to 6, and standard errors are clustered at bucket level for column 7.

To investigate the dynamics of the impact on primary dealers balance sheet in the subsequent weeks following a buyback, I estimate the Treasury bill, coupon, and total holdings in Table 11 panel A (column 4, 7, and 6, respectively) with a local projection framework. As shown in Figure 9, primary dealers position in the buyback targeted coupon bucket shrinks by about $200 million after a one billion buyback operation, and the decrease persists for the buyback week and the following week.

More intriguingly, primary dealers' holdings of Treasury bills begin to decline a couple of weeks after the buyback program starts—falling by as much as $2 billion over six weeks. While the buyback targets only coupon securities, the reduction in bill holdings may stem from several indirect effects. First, when the Treasury buys back coupons, dealers receive proceeds as reserves. Instead of using that proceeds to expand positions, they may reduce bill holdings to shrink overall exposure. Second, bills often serve as short-term liquidity vehicles. If dealers initially held bills to meet liquidity needs (e.g., margin calls or repo collateral), the reserve injection from buybacks may reduce that need, leading to bill sales. Third, dealers frequently fund coupon positions with repos collateralized by bills. As they unwind those coupon holdings post-buyback, they may also exit the associated repos, resulting in a decline in bill holdings despite bills not being the buyback target.

The dynamic impacts of buybacks on primary dealers Treasury security positions diverge from those of redemptions in two significant ways. First, the magnitude of the impact is considerably greater for buybacks than for redemptions, by an order of magnitude of ten. The impact of a buyback on bill holdings typically fluctuates around $2 billion in response to a one billion dollar buyback, whereas the impact of redemption is typically less than $100 million. This stark contrast can be attributed to the fact that buybacks redeem less liquid Treasuries that primary dealers are likely keen to offload without replenishing. However, since primary dealers are mandated to participate in Treasury auctions with firm commitment underwriting for initial Treasury offerings and to maintain a market presence in the secondary market for Treasuries, they are likely to roll into new issuances or recent off-the-runs following a regular redemption.

The second distinction is that the impact of redemption on primary dealers Treasury positions is notably short-lived. For example, a one billion dollar redemption may reduce bill positions by approximately $75 million during the redemption week if using longer sample (local projection based on column 1 Table 11, not shown in the chart), but this effect does not persist beyond that time frame. In fact, the impact on Treasury positions lasts a maximum of two weeks for redemptions. In contrast, the effects of buybacks on reducing bill positions can endure for as long as six weeks. Although neither a permanent nor substantially large in the scale of total position, the impact from buybacks on primary dealers bill position has been in the right direction and fairly sustained.

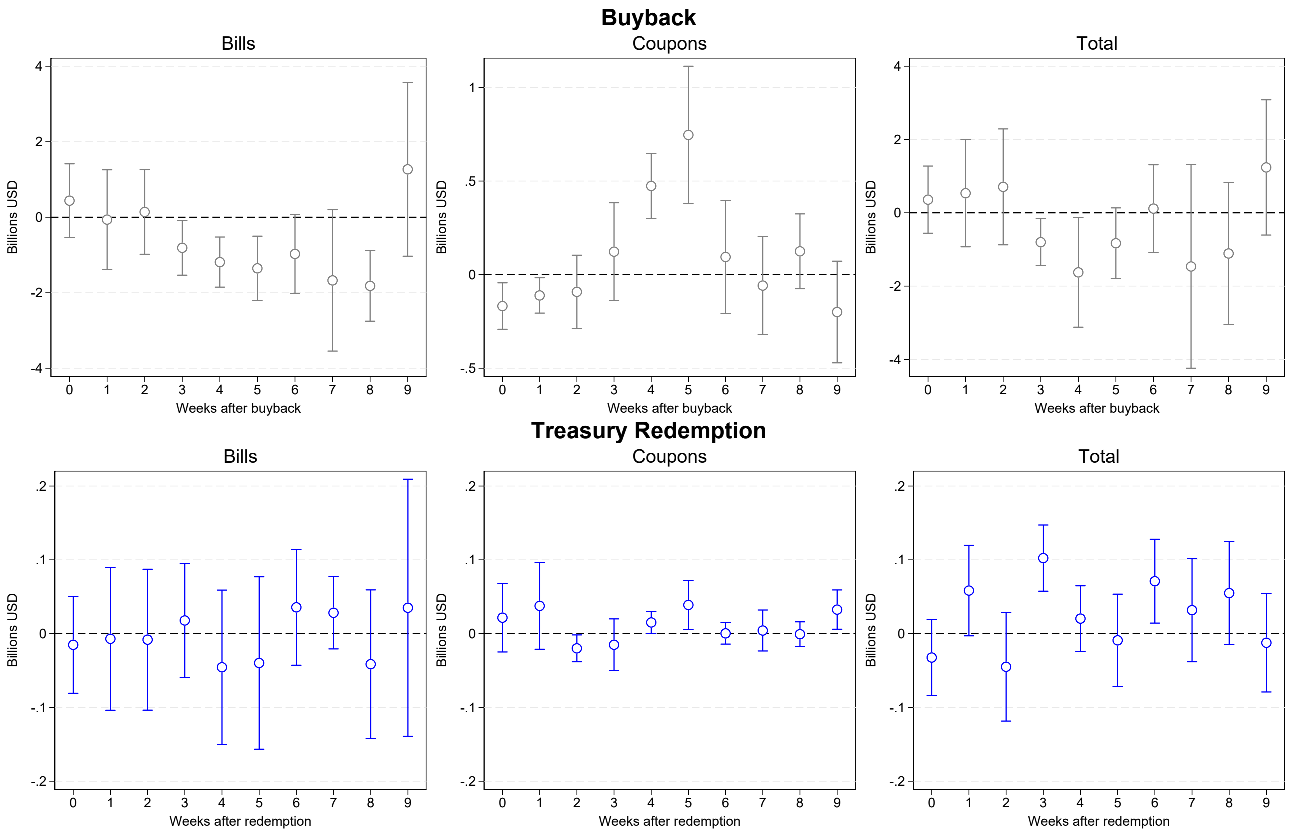
# 5 Theory

This section builds on the dealer capacity and pricing framework of Duffie (2023) to rationalize empirical findings. Specifically, the model is able to explain: i) why the listing effect significantly reduces the bid-ask spread, whereas the purchasing effect does not further narrow spreads meaningfully, ii) why the listing effect is more pronounced when primary dealers hold larger inventories, and iii) why both listing and purchasing increase bid and ask prices.

## 5.1 Bid and Ask Price Setting

Suppose a dealer quotes a bid price $b_x$ and an ask price $a_x$ while holding an inventory $x \in [0, \bar{x}]$ of Treasury securities. The dealer receives a dividend $d(x)$ and incurs inventory holding costs $g(x)$. 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, the dealer buys quantity $B(b)$ from and sells quantity $A(a)$ to investors.

Figure 9: The Dynamic Effect of Buybacks On Primary Dealers Treasury Position




Note: This figure plots the changes in primary dealers Treasury positions relative to the week prior to buyback, in response to one billion buyback or redemption, from the operation week to eight weeks after. From the left to the right, the estimates are based on column 4, 7, and 6 in Panel A of Table 11 in a local projection setting, respectively. The intervals represent the 90% confidence interval.

The dealer's problem is to maximize the expected present value of future discounted cash flows, defined as:

$$V(x) = \sup_{a,b} \mathbb{E}\Big[\int_0^\infty e^{rt}\big[a_t A(a_t) - b_t B(b_t) + d(x_t^{(a_t,b_t)}) - g(x_t^{(a_t,b_t)})\big]\mathrm{d}t\Big] \tag{7}$$

$$s.t. \quad x_t^{(a_t,b_t)} = x + B(b_t) - A(a_t), \qquad x_t^{(a_t,b_t)} \in [0, \bar{x}], \forall t$$

The Hamilton-Jacobi-Bellman (HJB) conditions capturing optimal pricing conditions are given by:

$$\max_{a,b}\Big[-rV(x)+d(x)-g(x)+A(a)\big[a+V(x-1)-V(x)\big]+B(b)\big[V(x+1)-V(x)-b\big]\Big]=0,\quad x\in(0,\bar{x}) \tag{8}$$

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

$$\max_{b}\Big[-rV(0)+d(0)-g(0)+B(b)\big[V(1)-V(0)-b\big]\Big]=0$$

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 dividend payments $d(x)$, expected gains from selling securities $A(a)\big[a+V(x-1)-V(x)\big]$, expected gains from buying securities $B(b)\big[V(x+1)-V(x)-b\big]$, and subtracting inventory holding costs $g(x)$. The associated first-order conditions are:

$$\begin{aligned} A'(a)\big[V(x-1)-V(x)+a\big]+A(a)=0,&\quad x\in(0,\bar{x}] \\ B'(b)\big[V(x+1)-V(x)-b\big]-B(b)=0,&\quad x\in[0,\bar{x}) \end{aligned} \tag{9}$$

For the numerical analysis, I assume exponential demand $A(a)=ce^{-\alpha a}$ and supply $B(b)=\kappa e^{\beta b}$ where $c=e^{40}$, $k=e^{-20}$, $\alpha=\beta=3$, dividend as $d(x)=x$, and inventory cost function as $g(x)=0.01x^2$. The inventory has an upper limit of $\bar{x}=50$.[19] Thus, the optimal bid and ask prices are:

$$a=V(x)-V(x-1)+\frac{1}{\alpha},\qquad b=V(x+1)-V(x)-\frac{1}{\beta} \tag{10}$$

The bid-ask spread is given by:

$$s=\frac{1}{\alpha}+\frac{1}{\beta}+2V(x)-V(x-1)-V(x+1) \tag{11}$$

## 5.2 Buyback Program

The buyback program introduces additional demand $K(a)=\lambda A(a)$ at mid-price $\frac{a+b}{2}$ when inventory exceeds threshold $\widetilde{x}$. The modified HJB equation, except for boundary points, becomes:

$$\begin{aligned}\max_{a,b}\Big[&-rV(x)+d(x)-g(x)+A(a)\big[a+V(x-1)-V(x)\big]+B(b)\big[V(x+1)-V(x)-b\big] \\ &+\mathbb{1}_{x\geq\widetilde{x}}\cdot K(a)\big[\tfrac{a+b}{2}+V(x-1)-V(x)\big]\Big]=0\end{aligned} \tag{12}$$

A key point of interest is how being listed in the buyback program and being purchased by

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

the buyback program alters the dealer's pricing strategy. After the securities are included in the buyback eligible list, the dealer faces additional expected demand from buybacks and optimizes pricing according to Equation 12 instead of Equation 8. However, once the securities are purchased, the buyback demand is realized, and the dealer reverts to solving Equation 8 with a lower inventory due to the buyback. Essentially, this indicates that the listing effect shifts the entire pricing curve, while the purchasing effect relocates the pricing to a different inventory point along the same curve.

For parameterization, I set $\widetilde{x} = 25$, meaning that buyback becomes active when inventory is half of dealer's maximum capacity. $K(a)$ is assumed to be equal to $0.05A(a)$, given that the buyback size is about 10% of dealer transaction volume and the probability of eventually bought back conditional on being listed is about 50% (see Table 1).

Figure 10: Listing Effect of Buybacks: Pricing and Bid-Ask Spread


Note: This figure plots the simulations with exponential demand and supply function, quadratic holding cost function, and buyback as specified in section 5. The left two panels plot the policy function of prices, and the right panel plots the difference between bid-ask spreads with and without buyback program.

## 5.3 Model Prediction of Listing Effect

The simulations illustrate that bid and ask prices decrease as inventory increases (Figure 10, left two panels). Given that $V(x)$ is concave,[20] marginal value of inventory diminishes as inventory builds up, causing dealers to value each additional unit less. Therefore, when inventory is high, the amount that dealer is willing to pay to gain one extra unit is low, and the amount that dealer is willing to accept to offload one extra unit is low (as shown mathematically in Equation 10).

This pattern is accentuated near the boundaries—the pricing curves exhibit sharp convexity as inventory nears its lower and upper limits. At very low inventory, it means losing the last unit of security is most painful, therefore $\Delta V(1) \equiv V(1) - V(0)$ is much larger than $\Delta V(2)$, resulting in a

[20]The next payoff from extra unit of security ($d(x) - g(x) = x - 0.01x^2$) is concave.

steep increase in price as $x$ approaches to lower bound. At very high inventory, the last unit means very little in value, therefore $\Delta V(\bar{x})$ is much smaller than $\Delta V(\bar{x}-1)$, resulting in a steep decrease in price as dealer's capacity depletes.

This valuation behavior also generates a distinct U-shape bid-ask spread (Figure 11, right panel). With relative large $\Delta V(1)$ and small $\Delta V(\bar{x})$, the bid-ask spreads at the edges ($\Delta V(1)-\Delta V(0)+\frac{1}{\alpha}+\frac{1}{\beta}$ and $\Delta V(\bar{x}-1)-\Delta V(\bar{x})+\frac{1}{\alpha}+\frac{1}{\beta}$, see Equation 11) turn out to be large.

As expected, the listing effect elevates both bid and ask prices (Figure 10, left two panels). Intuitively, the buyback functions as an "insurance policy" for the dealer's inventory; whenever inventory exceeds the threshold, the dealer can regularly unload some positions at the mid-price. Therefore, an additional unit of security is perceived as less risky, as the buyback mitigates tail risks (i.e., it reduces the curvature of $V(x)$), making the dealer more inclined to pay for it (resulting in a higher bid price) and more hesitant to relinquish it (leading to a higher ask price).

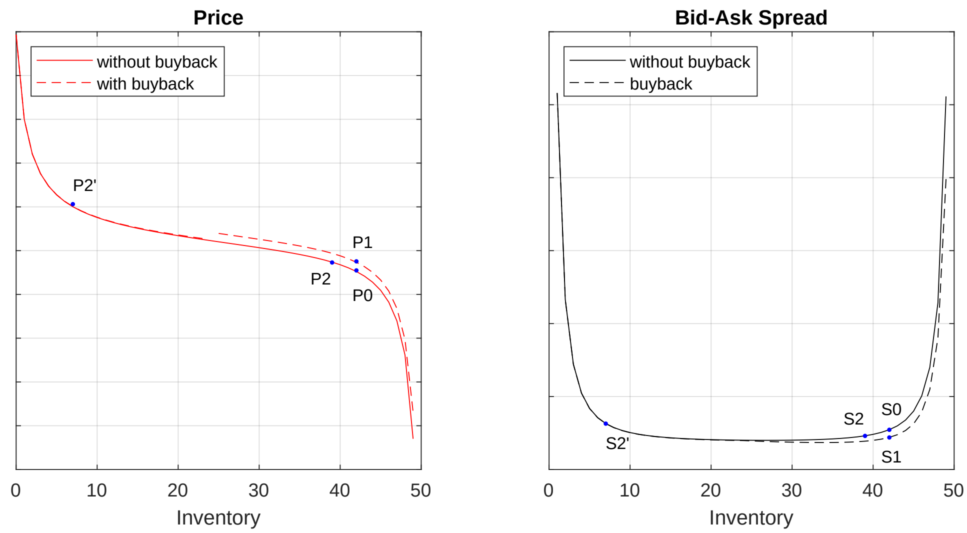
The listing effect narrows the bid-ask spread (Figure 11, right panel), with a more pronounced effect observed when dealers hold larger inventories. Essentially, the bid-ask spread serves as the dealer's compensation for the risk associated with holding inventory. When the Treasury stands ready to buy at the mid-price, the dealer faces reduced risk of being stuck with an inventory position that they cannot exit, thus requiring a smaller cushion between the bid and ask prices for protection. This "insurance" effect is most prominent when additional demand is critical as the dealer approaches inventory capacity, resulting in a significant reduction in spreads at the upper end of the curve.

### 5.4 Model Prediction of Purchasing Effect

As previously discussed, a key distinction between the purchasing effect and the listing effect lies in the fact that buyback purchases shift along the price curves, while buyback listings result in a shift of the price curves. To illustrate, consider Figure 11: let $P0$ represent the price one day prior to the announcement of the listing. On the day of listing, the price jumps to $P1$ on the new price curve at the same inventory level, reflecting the new pricing dynamics given the anticipated additional buyback demand. On the next day, following the implementation of the buyback, the price reverts to the original price curve and moves to a level corresponding to a lower inventory $P2$. A similar movement occurs in the bid-ask spread.

Unlike the impact of listing, the purchasing effect could result in either a narrowing or widening of the spread. The reason is two-fold. On one hand, given the U-shape of the spread curve, depending on the drawdown in inventory due to the buyback, the resulting spread could be higher than the original level (e.g., $S2'$). On the other, the spread curve is close to flat when the inventory is neither too low nor too high, therefore the change in spread might moderate. Nonetheless, it is noteworthy that since price decreases with inventory level, buyback purchases will invariably lead to an increase in prices, regardless of the extent of the inventory drawdown (e.g., both $P2$ and $P2'$ will be higher than $P0$).

Figure 11: Purchasing Effect of Buybacks: Pricing and Bid-Ask Spread




Note: This figure plots the simulations with exponential demand and supply function, quadratic holding cost function, and buyback as specified in section 5. The left panel plots the policy function of price, and the right panel plots the spreads. The solid and dashed lines represent the case without and with buyback program, respectively. $P0, S0$ denote price and spread one day prior to listing, $P1, S1$ denote price and spread on the listing day, and $P2, S2$ and $P2', S2'$ denote two possibilities of price and spread on the purchasing day.

# 6 Conclusion

As part the overall effort to improve resilience in the Treasury market, Treasury introduced the liquidity support buyback program in May 2024, as a regular and predictable opportunity for the sale of less liquid off-the-run securities back to Treasury. My paper is the first as the time of writing to evaluate whether the buyback program has had any liquidity support effects, as it is designed to do. Utilizing security level data encompassing all off-the-run Treasury securities, along with primary dealers' balance sheet data, I assess the liquidity support effects throughout various stages of the buyback operation.

I find that inclusion in the buyback eligibility list narrows bid-ask spreads relative to unlisted securities. This effect is particularly strong when the program targets short-maturity securities or when primary dealers hold sizable Treasury inventories. Additionally, both listing and purchasing in buybacks increase the prices of affected securities. At the aggregate level, I find that buybacks exert a more substantial impact on primary dealers' balance sheets compared to typical redemptions. Specifically, buybacks alleviate holdings of the buyback targeted Treasury coupon bucket for a couple of weeks and holdings of Treasury bill over a period exceeding one month.

These findings can be rationalized by a model where primary dealers face convex inventory costs and stochastic investor flows and buybacks serve as predictable demand injections hence truncating the range of possible illiquidity states of the world.

The magnitude of these effects is moderate. For example, the $2 billion reduction in Treasury bill holdings represents less than one-twentieth of the average dealer holdings. This is consistent with the relatively limited scale of buybacks compared to the broader off-the-run Treasury market. Still, if buybacks provide dealers with confidence that they can later liquidate inventory, they may encourage greater market-making and temporarily increase dealers' holdings.

In sum, the evidence indicates that the buyback program delivers measurable liquidity support. These results highlight the financial stability benefits of targeted market-functioning operations—not only through large-scale asset purchases like quantitative easing but also through more modest, routine interventions (e.g., Duffie and Keane (2023)).

Looking ahead, buyback design could be improved to enhance its impact. Since liquidity effects are more pronounced when dealers hold larger unwanted inventories, Treasury might consider scheduling buybacks around such periods—for instance, shortly after new on-the-run issuances, when dealers often roll older securities into new ones. Additionally, buybacks could be scaled up during periods of emerging stress. If Treasury General Account balances constrain such scaling, swap-format operations—exchanging off-the-runs for on-the-runs—could offer a flexible alternative.

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# A Appendix

## A.1 Targeted vs. Non-Targeted: The Targeting Effect of Buybacks

This DID analysis compares Treasury securities that are targeted by buybacks with those that are not, thereby assessing the the "*targeting effect*" of buybacks. The advantage of this DID is that it is not subject to selection bias. The assignment of treatment and control groups is exogenous to their liquidity conditions at buyback, as the buyback schedule is pre-announced in the quarterly refunding announcements, which occur one week to three months before the actual buyback operations. However, a potential challenge in identification is that the control groups may not serve as ideal counterfactuals for the treated groups, given that different buckets of the yield curve encounter varying market conditions. For instance, far-end of the curve is known to be less liquid. To address this issue, I rely on bucket-specific time fixed effected $\alpha_{st}$ to control for different dynamics across various buckets, and on-the-run yield $r_{it}$ to control for demand and supply conditions affecting CUSIP $i$.

The targeting effect of buybacks appears to be insignificant. As reported in Table A1, the baseline estimates (column 1) show that the bid-ask spreads for CUSIPs within the targeted bucket do not differ statistically from those of other securities following the release of the buyback list. This observation holds true regardless of whether less liquid buckets (column 2) or more liquid ones (column 3) are targeted. If measured by off-the-run spreads, liquidity condition for the targeted bucket does improve, but the magnitude is not significant (column 4). These findings may suggest that, if measured by spreads, the effects of buybacks are localized and concentrated among those securities that are listed or accepted in buybacks, resulting in a relatively small aggregate impact on the entire bucket.

Regarding trading volume, buybacks boost the trading volumes of the targeted bucket, primarily on the operation day. Generally, trading volume data at the CUSIP level is less accessible than spread data. However, since buyback targets are specified at the bucket level, I utilize trading volume data for off-the-run securities from FINRA (i.e., dealer-to-customer trading volume, excluding buyback trades)[21] to assess whether buybacks stimulate increased trading, despite having no substantial impact on spreads. The baseline regression follows Equation 1, with the addition of trading volume (all in first differences to address non-stationarity) for the corresponding on-the-run Treasury securities to control for factors affecting demand and supply within the same bucket. Column 5 of Table A1 indicates that trading volume does not change significantly following buybacks.

Nevertheless, a closer examination of the post-buyback period dynamics, as depicted in the left panel of Figure A.1, reveals an increase in trading volume on the buyback operation day by nearly \$3 billion. However, trading volume drops in the next day, almost offsetting the increase on the day before. There could be two reasons underlying the pattern. On one hand, it could suggest that buyback trades send a price signal to the market—which is important, as off-the-run securities are

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

Table A1: Targeting Effect of Buybacks

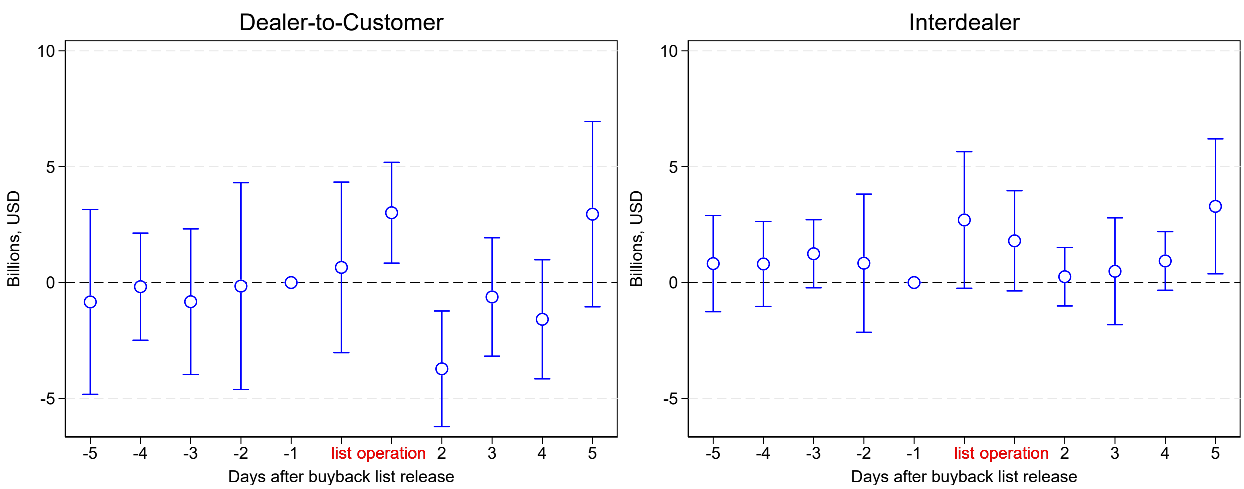
| | (1) Bid-ask spread | (2) Bid-ask spread | (3) Bid-ask spread | (4) Off-the-run spread | (5) $\Delta$ Trading volume |
|---|---|---|---|---|---|
| post buyback list release | -0.0005 | -0.0034 | 0.0002 | 0.0432 | -0.0049 |
| | (0.001) | (0.004) | (0.000) | (0.026) | (0.005) |
| buyback targeted | -0.0077* | -0.0268** | 0.0016 | -0.3345* | -0.0215 |
| | (0.004) | (0.012) | (0.003) | (0.170) | (0.025) |
| post buyback list release $\times$ buyback target | 0.0037 | 0.0170 | -0.0015 | -0.2907 | 0.0423 |
| | (0.006) | (0.018) | (0.004) | (0.182) | (0.050) |
| $\Delta$ on-the-run yield, bps | -0.0536*** | -0.0579*** | -0.0506*** | -0.6265** | |
| | (0.009) | (0.010) | (0.008) | (0.272) | |
| $\Delta$ trading volume of on-the-runs, same maturity | | | | | 0.1344** |
| | | | | | (0.043) |
| Observations | 495,715 | 178,628 | 317,087 | 495,715 | 49,572 |
| R-squared | 0.966 | 0.964 | 0.967 | 0.359 | 0.267 |
| CUSIP FE | yes | yes | yes | yes | |
| Bucket-specific time FE | yes | yes | yes | yes | |
| Operation FE | yes | yes | yes | yes | yes |
| Maturity FE | | | | | yes |
| Time FE | | | | | yes |
| Sample | full | coupons 1m-3yr | coupons 3-30yr | full | full |

Note: This table reports the baseline regression (Equation 1), where the treatment group is the Treasury securities targeted by buyback and the control group is those not targeted. The treatment day starts with Treasury announces the preliminary list of CUSIPs eligible for buyback, i.e., one day prior to the actual operation. Column 1 is based on the full sample. Column 2 and 3 are based on subsamples of coupons with maturity more and less than 3 years, respectively. Column 4 and 5 use off-the-run spread and dealer-to-customer trading volume (in first difference) as dependent variable, respectively. ***, **, * represent significance of 1%, 5% and 10%, respectively. Standard errors are clustered at CUSIP level.

not traded frequently—and facilitate the market to clear potential trades. On the other hand, as FINRA records both sell and buy sides in the dealer-to-customer part of its reporting, the increase could reflect customers sell the off-the-run securities to the dealer and ask the dealers to sell them back to Treasury on their behalf. Without more detailed data, it is difficult to gauge the magnitude of the two channels.

In contrast to dealer-to-customer trades, there are no significant changes in interdealer trades for the buyback targeted bucket (right panel of Figure A.1). This could suggest that the securities that bought back by Treasury are from either primary dealers' own balance sheet (see more in subsection 4.6) or the customers (e.g., hedge funds, mutual funds) from dealer-to-customer trades, but less likely from other dealers from interdealer trades.

Figure A.1: Dynamics of Targeting Effect on Trading Volume




Note: This figure plots the dynamic impact on trading volume of dealer-to-customer (excluding the buyback trades) and interdealer from buybacks on the left and right panel, estimated based on Equation 2, respectively. The dots represent the deviation of trading volume relative to the day prior to the buyback eligible list release ("$-1$" on the x axis). The intervals represent the 90% confidence interval.

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