When Treasuries Crowd the Debt Market: Treasury Market Inelasticity and the Basis Trade [†]

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Abstract

This paper argues that the Treasury share relative to corporate bonds in the debt market affects Treasury market elasticity—the price impact of new Treasury supply—and its pass-through to corporate bonds. I develop a segmented market model featuring bond investors with duration mandates and balance-sheet constraints. These investors transmit shocks from the Treasury market to the corporate bond market. When the Treasury share is high, investors rely more on Treasuries for duration, their balance-sheet constraints tighten, and transmission weakens, leaving supply shocks concentrated in Treasuries. The model explains elevated Treasury basis-trade activity when Treasuries are abundant relative to corporate bonds and links constraint tightness to the Treasury cash–derivatives spread. Empirically, I identify three novel Treasury supply shocks from the Treasury issuance calendar and estimate Treasury supply effects using intraday data. Consistent with the model, tighter balance-sheet constraints measured by the spread are associated with larger Treasury supply effects and weaker pass-through to corporate bonds. I support the model with unique institution-level data on interest rate derivative positions for global mutual funds and US life insurers. The mechanism implies asymmetric effects of quantitative easing (QE) and quantitative tightening (QT) and informs the optimal timing of QT.

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1 Introduction

When the Federal Reserve began returning its Treasury holdings to the public market through quantitative tightening (QT), officials expected the process to be *"watching paint dry"* that *"runs quietly in the background"* (Yellen, 2017). By design, QT should have limited effects on asset markets: maturing Treasuries passively run off the Fed's balance sheet without reinvestment. In practice, the recent QT episode has been anything but quiet. Three facts stand out. First, long-term Treasury auctions have repeatedly cleared at higher-than-expected yields, indicating a less elastic Treasury market (Figure 2). Second, asset managers have absorbed Treasuries primarily via derivatives rather than cash bonds (Figure 3). The associated highly levered hedge-fund basis trades and episodes of Treasury market dysfunction have raised financial stability concerns (for example, Liang, 2025).[1] Third, corporate bond credit spreads across the ratings spectrum have fallen to historical lows despite the Fed's policy tightening, which has historically raised credit spreads (Figure 4). Why has QT not proceeded quietly—and why have credit spreads compressed?

This paper provides a unified answer, motivated by the sharp rise in the share of Treasury bonds relative to corporate bonds during QT, particularly at the long end (Figure 1). I argue that a higher Treasury share endogenously increases market segmentation between Treasuries and corporate bonds. As a result, Treasury supply shocks have larger effects on Treasury yields and smaller effects on corporate yields, compressing credit spreads. The mechanism features bond allocators—mutual funds, pension funds, and insurance companies—that link Treasury and corporate bond markets but face duration mandates and balance sheet constraints. When the Treasury share rises, allocators' balance sheet constraints bind more tightly, reducing the transmission of Treasury supply shocks to corporate bond markets. The bond market becomes more segmented: Treasury supply shocks remain concentrated in Treasuries, and constrained allocators turn to interest rate derivatives for leverage, elevating Treasury basis trade activity.

The paper proceeds in four parts. First, I develop a theoretical model that formalizes the mechanism and delivers testable predictions for asset prices and allocators' portfolio choices. Second, I provide evidence on asset prices: leveraging institutional features of the Treasury issuance calendar since 1991, I construct three novel shock series to new Treasury supply and estimate high-frequency market responses using intraday Treasury prices. I document larger price impacts

[1] Instead of buying cash Treasuries, asset managers obtain duration exposure by going long Treasury futures or receiving fixed in interest rate swaps. This allows them to take leverage and get duration exposure off the balance sheet. Hedge funds (and dealers) take the opposite side via basis trade: holding cash Treasuries while shorting futures or paying fixed in swaps to capture the cash–derivatives basis. Section 2 and Appendix A.1 details the basis trade.

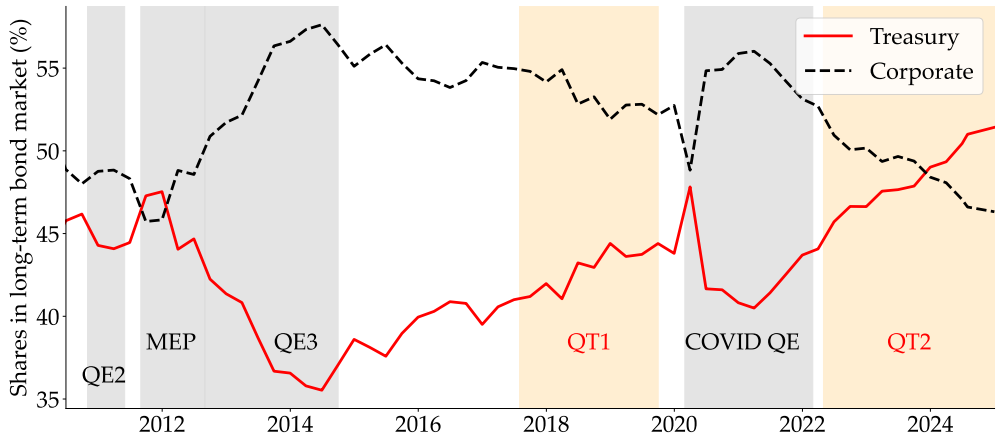


Figure 1: Treasuries vs. corporate bonds in the long-duration bond market

Notes: This figure plots the shares of Treasuries and corporate bonds within the Vanguard Long-Term Bond ETF (BLV), which tracks the Bloomberg US Long Government/Credit Float-Adjusted Index, a proxy for the US long-duration bond market. The index includes investment-grade Treasuries, corporate bonds, agencies, and municipals with remaining maturity > 10 years; MBS are excluded given their lower duration; holdings by the Federal Reserve are excluded from the index. Gray shading denotes QE periods; orange shading denotes QT periods.

when Treasuries are abundant and allocators' balance sheets are constrained. I also show that the Treasury market is more segmented from the corporate market in such states. Third, I show that allocator portfolios are broadly consistent with model predictions using a unique dataset of institution-level interest rate derivative positions from global bond mutual funds and US life insurance companies. Fourth, I draw implications for unconventional monetary policy.

I begin with a tractable model of a partially segmented bond market building on Vayanos and Vila (2021) and Greenwood et al. (2018). The economy features three asset markets: long-term Treasuries, long-term corporate bonds, and short-term corporate bonds. Each market is populated by specialized investors, whereas cross-market allocators trade in all three markets. Allocators face balance sheet constraints and must hold a fixed amount of long-term bonds to satisfy a duration mandate.[2] Through their portfolio choices, these allocators transmit shocks across markets, reduce bond market segmentation, and determine the relative prices of the three assets. The key insight of this model is that the debt market composition endogenously changes the degree of market segmentation through cross-market allocators.

The degree of market segmentation depends on how effectively allocators transmit shocks across markets. Consider an unexpected Treasury supply shock that increases the amount of long-term Treasuries. Treasury specialists must absorb more Treasuries and hence push up Treasury

[2]Life insurers and pension funds match liability duration to immunize equity from interest rate risk (e.g., Domanski et al., 2017); bond mutual funds have mandates to match the duration of their benchmark index (e.g., Barth et al., 2024).

yields. As Treasuries then become relatively attractive for bearing duration risk, allocators rebalance in two steps: (i) buy Treasuries and sell long-term corporate bonds, and (ii) add short-term corporate bonds to restore the credit exposure lost from selling long-term corporate bonds. This two-step rebalancing transmits shocks to both segments of the corporate bond market.

The model then shows that the transmission channel is affected by the debt market composition through allocators' balance sheet constraints. When the Treasury share rises, allocators meet duration mandates by relying more on Treasuries relative to corporate bonds. To absorb credit risk and earn its associated risk premium, they must add short-term corporate bonds. The combination of treasuries and short-term corporate bonds uses more balance sheet space than long-term corporate bonds alone, which makes their balance sheet constraints closer to binding. Once the constraints bind, the shock transmission channel is impaired: allocators can no longer add short-term corporate bonds in the second step and hence become reluctant to sell long-term corporate bonds in the first step. As a result, the market becomes more segmented; Treasury supply shocks remain concentrated in the Treasury market and spillover less to other markets.

In practice, allocators actively employ interest rate derivatives to mitigate balance sheet constraints. To capture this behavior, I extend the model to include hedge funds and dealers that intermediate these derivatives. Hedge funds and dealers hold cash Treasuries on balance sheets and short interest rate derivatives. They are subject to the balance sheet costs of holding cash bonds (Jermann, 2020; Boyarchenko et al., 2018; Du et al., 2023) and therefore charge a derivative spread as compensation. When the balance sheet constraint binds, allocators take leverage via derivatives, effectively renting hedge funds and dealers' balance sheets and paying the derivative spread as rents (Fleckenstein and Longstaff, 2020). Interest rate derivatives ease allocators' balance sheet constraints and restore links across markets. However, the restoration is incomplete because derivative leverage is costly due to the derivative spread. Consequently, bond markets are less segmented relative to the binding case without derivatives but do not return to the slack constraint case.[3]

The model delivers several predictions that guide empirical tests. (i) When the Treasury share of the debt market is high, allocators' balance sheet constraints are more likely to bind, so they take on larger interest rate derivative positions. When allocators' balance sheets bind, (ii) the interest

[3]In theory, allocators can purchase cash Treasuries and finance them in the Repo market to avoid the derivative spread. In practice, several capital regulations and accounting rules discourage allocators from doing so (see Appendix A.1). Another interpretation for derivative leverage is that allocators synthesize long-term corporate bond exposure using short-term credit products plus interest rate derivatives (Kashyap et al., 2025).

rate derivative spread is lower (more negative), (iii) Treasury supply shocks have larger effects on Treasury yields, and (iv) movements in Treasury yields pass through less to corporate bond yields.

During QT episodes, the Treasury share rose sharply (Figure 1) and allocators increased their interest rate derivative usage (Figure 3), consistent with Prediction (i). I also validate that interest rate swap spreads capture the tightness of allocators' balance sheet constraints (Fleckenstein and Longstaff, 2020), consistent with Prediction (ii). Lower (more negative) swap spreads are strongly correlated with larger allocator interest rate derivative positions and greater dealer intermediation volumes.[4]

To test Prediction (iii), I construct three novel shock series from the Treasury issuance calendar and estimate their high-frequency price effects using intraday Treasury data. These shocks arise from the US Treasury Department's quarterly refunding announcements, security-level auction announcements, and security-level auction result releases. I compile a complete timeline of these operations starting in 1990 and identify shocks at both the aggregate and security levels. I then estimate Treasury market responses to these shocks within a 10-minute window to isolate other confounding factors. Consistent with Prediction (iii), I find that all three shocks have quantitatively large effects when the swap spreads are lower (i.e., when constraints are tighter). Treasury supply effects decline substantially as the market moves from the most- to the least-constrained region. Quantitatively, in the most-constrained region the Treasury market's response to auction-result news is about 1.9 times as large as in the least-constrained region. Consistent with Prediction (iv), Treasury yield changes pass through less to corporate bond yields when allocators are more balance sheet constrained. Specifically, in the most-constrained periods, a 10 bp increase in Treasury yields on auction days compresses AAA credit spreads by 0.71 bp—about 10.4 times the effect in the least-constrained periods.

I further support these findings with institutional-level evidence. I assemble a novel dataset of interest-rate derivative positions for global bond mutual funds and US life insurers, covering approximately $175 billion in net positions by mutual funds and $250 billion by life insurers by 2024. On the mutual fund side, actively managed funds track the duration of their benchmark index but seek higher yields by overweighting non-Treasury bonds. When corporate bonds are scarce, this leaves them with a duration shortfall, so they expand Treasury futures positions, consistent with

[4]Allocators use two types of interest rate derivatives: interest rate swaps and Treasury futures. I measure the tightness of their balance sheet constraints with the swap spread, defined as the fixed swap rate minus the yield on a Treasury of the same maturity. A negative spread means end users accept a fixed rate below the cash bond yield, and lower spreads indicate tighter constraints.

Prediction (i). Life insurers hold long-duration liabilities whose duration increases when interest rates fall. Their interest-rate derivative positions respond to rate levels as expected: lower rates lengthen liability duration and raise required asset duration targets. However, consistent with Prediction (i), derivative positions also increase with the debt market's Treasury share. The sharp rise in positions since 2022—despite elevated long-term rates—illustrates the importance of debt composition: as the Treasury share rose, balance sheet constraints tightened, driving insurers to derivatives even in a high-rate environment.

This mechanism has two implications for monetary policy. First, QE and QT have asymmetric effects on the Treasury and corporate bond markets. QE typically occurs at the zero lower bound alongside abundant corporate issuance, whereas past QT episodes coincided with rate hikes when corporate issuance retrenches and the Treasury share relative to corporate bonds rose sharply.[5] Empirically, all three Treasury supply shock series have larger effects on Treasury yields during QT than QE. In corporate bonds, Treasury supply shocks compress daily credit spreads across the credit spectrum during QT, with statistically insignificant effects in QE. Fed offloading in QT tends to raise term premium and heightens financial stability concerns due to highly levered hedge-fund basis trades. These patterns point to a potential "QE ratchet": it becomes harder to reverse past purchases, and QT may need to be slowed or paused earlier than planned.

Second, the mechanism informs the sequencing of rate hikes and balance sheet runoff. In both QT1 and QT2, policy rates were lifted before balance sheet normalization began, so Treasury offloading occurred when corporate issuance was weak. The model suggests that, when feasible, initiating QT ahead of hiking cycles or concentrating QT in periods of rich corporate bond shares can help mitigate basis trade activities and reduce financial stability risks.

Literature. This study builds on market segmentation theory dating back to Tobin (1958, 1969) and formalized in modern preferred-habitat theory by Vayanos and Vila (2021). The central idea is that assets are imperfect substitutes because preferred-habitat investors value non-pecuniary attributes, which segment asset markets. Arbitrageurs then absorb demand and supply shocks across markets and determine relative asset prices. The framework originated in the context of

[5] An established literature documents firms' market timing in bond financing. CFO surveys indicate a preference for short maturities when short rates are low relative to long rates and a shift to longer maturities when long rates are expected to fall (Graham and Harvey, 2001). Empirically, the long-term share of corporate bond issuances is negatively related to inflation, real short rates, and the term spread (Baker et al., 2003). The "gap-filling" view further predicts more long-term corporate issuance when long-maturity Treasuries are scarce (Greenwood et al., 2010; Badoer and James, 2016). Consistent with this view, QE withdrawals of Treasuries are associated with greater corporate bond issuance (Selgrad, 2023; Eren et al., 2025).

term structure and has been extended to corporate bonds (Greenwood et al., 2018), foreign exchange (Gourinchas et al., 2022; Greenwood et al., 2023), and the swap market (Khetan et al., 2024). Recent studies emphasize the role of arbitrageurs' balance sheet frictions and wealth effects in price determination (He et al., 2022; Hanson et al., 2024; Kekre et al., 2024). I build on Greenwood et al. (2018) and microfound how the composition of asset supply shapes the degree of market segmentation through arbitrages' (allocators') balance sheets.[6]

This study also contributes to the extensive literature on how unconventional monetary policy or excess Treasury supply affects asset prices. This paper makes two contributions. First, prior work has primarily examined the QE effects on the Treasury market (e.g., Gagnon et al., 2011; Joyce et al., 2011; Vissing-Jorgensen and Krishnamurthy, 2011; Swanson, 2011; Christensen and Rudebusch, 2012; D'Amico and King, 2013; Bauer and Neely, 2014; Vissing-Jorgensen, 2021; Du et al., 2024; D'Amico and Seida, 2024). A growing body of research studies the effects on corporate yields and credit risk (e.g., Gilchrist and Zakrajšek, 2013; Gilchrist et al., 2015; D'Amico and Kaminska, 2019; Acharya et al., 2025; Selgrad, 2023; Haddad et al., 2024; Eren et al., 2025). This paper shows that the effects on the two markets are intertwined and depend on the strength of shock transmission through cross-market allocators, which in turn hinges on whether these allocators are constrained. Second, the paper makes a methodological contribution by identifying three novel series of shocks to Treasury supply. I trace the full Treasury issuance calendar from the early 1990s and measure high-frequency yield responses within narrow event windows using intraday data. To my knowledge, this is the first study to provide a comprehensive account of the Treasury issuance process—from aggregate borrowing estimates to security-level auction announcements and auction outcomes—and to estimate market responses over a long sample.[7]

Moreover, this study joins the recent discussion on the state dependence of QE and QT and evaluates the full policy cycle. Haddad et al. (2024) view QE and QT as state-contingent policy, with QE announcements in bad states revealing a policy rule and lowering Treasury yields through an insurance channel. Several papers highlight the challenges for central bank balance

[6]This paper also speaks to recent diminishing Treasury convenience yield (e.g., Duffie, 2020; He et al., 2022; Jiang et al., 2025a,b). Since 2024, AAA credit spreads, the proxy for Treasury convenience, have fallen to around 30 bps, near historical lows. This paper offers an explanation: as the Treasury share rises, the relative advantage of corporate bonds—which bundle duration with credit and help allocators meet duration mandates more efficiently under balance sheet constraints—becomes more valuable, thereby eroding Treasuries' convenience premium.

[7]Some prior studies focus on individual stages of the issuance calendar. For example, Greenwood et al. (2014); Wang and Zhao (2024); Haddad et al. (2024) examine Treasury yield moves on quarterly refunding announcement dates but do not quantify shocks or study high-frequency responses. Other papers focus on auction results (e.g., Lou et al., 2013; Fleming and Liu, 2016; Ray et al., 2024; Phillot, 2025). This paper is distinct in encompassing the entire process, covering a sample back to 1990, and studying high-frequency yield responses.

sheet unwinding. From the banking-liquidity perspective, Acharya and Rajan (2024) show that bank reserves accumulated under QE are funded by uninsured deposits and committed credit lines that do not contract when QT drains reserves, increasing banks' vulnerability to liquidity shocks. In the bond market, Jiang and Sun (2024) argue that QT can overshoot bond risk premium because slow-moving bond holders adjust gradually, while risk-averse liquidity traders absorb Fed offloading in the short run. I emphasize that QE and QT have heterogeneous effects because they operate in distinct debt market environments. The Fed directly alters the net supply of Treasuries to the market, while firms time their long-term bond issuance to the interest rate cycle (Graham and Harvey, 2001; Baker et al., 2003; Greenwood et al., 2010). Both forces raise the share of Treasury bonds relative to corporate bonds. I show that this higher Treasury share results in low Treasury-market elasticity and elevated basis trade activity.

Finally, this paper speaks to the growing academic and policy interest in interest rate derivative basis trades. Many studies document hedge funds' basis trades and highlight their unwinds as a key driver of the March 2020 Treasury market dysfunction (Schrimpf et al., 2020; Barth and Kahn, 2025; Vissing-Jorgensen, 2021; Kruttli et al., 2021; Kashyap et al., 2025). Recent work highlights the role of banking regulation and central bank balance sheet policy in shaping the Treasury cash–futures basis trade (Fleckenstein and Longstaff, 2020; d'Avernas et al., 2025). Regarding end-user derivative demand, prior work shows that mutual funds typically use Treasury futures to align with benchmark index duration (Barth et al., 2024), whereas liability-driven investors primarily use interest rate swaps to match liability duration (Klingler and Sundaresan, 2019; Khetan et al., 2024). However, the cyclicality of basis trades remains poorly understood. I offer an explanation: both recent waves occurred during QT, when the Treasury share rose sharply and allocators shifted duration off balance sheet using derivatives to relieve balance-sheet constraints. This mechanism echoes the scarcity of long-maturity corporate bonds suggested by Kashyap et al. (2025). Moreover, I assess the role of basis trades in the Treasury ecosystem. By relaxing allocators' balance-sheet constraints, basis trades can partially restore Treasury market elasticity and lower government borrowing costs, albeit with attendant stability risks. Finally, I contribute new evidence by assembling derivative exposures for mutual funds and life insurers since the Global Financial Crisis; to my knowledge, this is the first study to provide a unified view of Treasury futures and swap usage across these two sectors.

Roadmap. Section 2 starts with three recent facts and institutional details on bond allocators. Section 3 develops the model. Section 4 describes the data. Sections 5 and 6 test its predictions

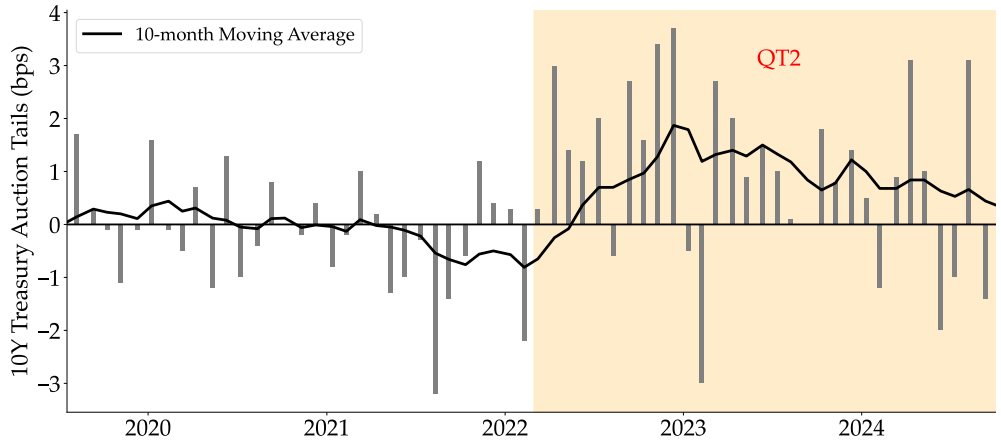
in asset prices and allocators' derivative positions. Section 7 discusses the policy implications. Section 8 concludes.

2 Motivating Facts

2.1 Three Recent Facts

Fact 1: Treasury Auctions Clearing at Unexpectedly High Yield in QT2. Figure 2 plots the 10-year Treasury auction tails, defined as the difference between the auction stop-out yield (the yield at which the auction clears) and the market's expectation, measured by the contemporaneous when-issued yield on the auctioned CUSIP at the auction deadline. A positive tail indicates a weak auction with low bid demand: Treasuries are sold at higher yields (lower prices) than expected. Since QT2, such poor auction outcomes, reflected in larger positive tails, have become frequent.

Figure 2: New Treasury Supply Clears at Unexpectedly High Yields in Auctions



Note: Treasury auction tail is the difference between the auction stop-out yield (the yield at which the auction clears) and the market expectation, measured by the contemporaneous when-issued yield from Treasury futures at the auction deadline. A positive tail indicates a weak auction with low bid demand; Data: Bloomberg USN10YTL Index. The orange region stands for the QT2 periods.

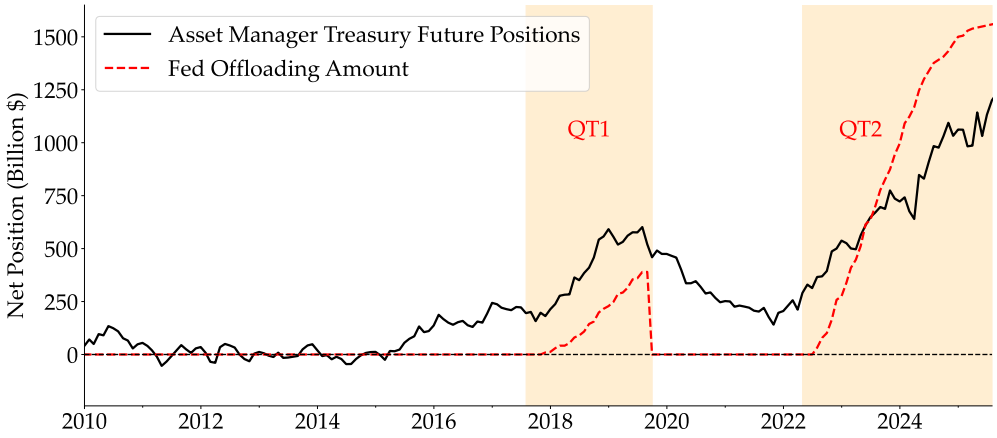
Fact 2: Elevated Hedge Funds Treasury Basis Trade in QTs. Figure 3 shows that asset managers' (mutual funds, pension funds, and insurers) Treasury futures positions rise sharply in the two QT episodes and roughly mirror the Federal Reserve's Treasury offloading. Beyond Treasury futures, asset managers also use interest rate swaps by receiving a fixed rate, and available evidence indicates that swap usage likewise increases during both QT episodes.[8]

Hedge funds (and dealers) are the main trading counterparties to asset managers in Treasury

[8]The swap market is over-the-counter, so aggregate positions across participants are unknown. However, interest rate swap positions of the main end-users—life insurance companies—rise sharply during QT. See Section 6 for details.

derivatives. They conduct basis trades: holding cash Treasuries while shorting futures or paying fixed in swaps to capture the cash–derivatives price difference. These basis trades are highly levered through repo financing.[9] Sushko and Todorov (2025) estimate that hedge funds held about $1.7 trillion in Treasury future or swap basis positions by mid-2025 (8.5% of notes and bonds outstanding). Such concentration among a handful of hedge funds creates systemic risk: abrupt unwinds can trigger a "margin spiral" (Brunnermeier and Pedersen, 2009). Basis trades are widely viewed as a key factor behind the Treasury market disruptions in March 2020 and April 2025.

Figure 3: Elevated Treasury Derivative Basis Trade



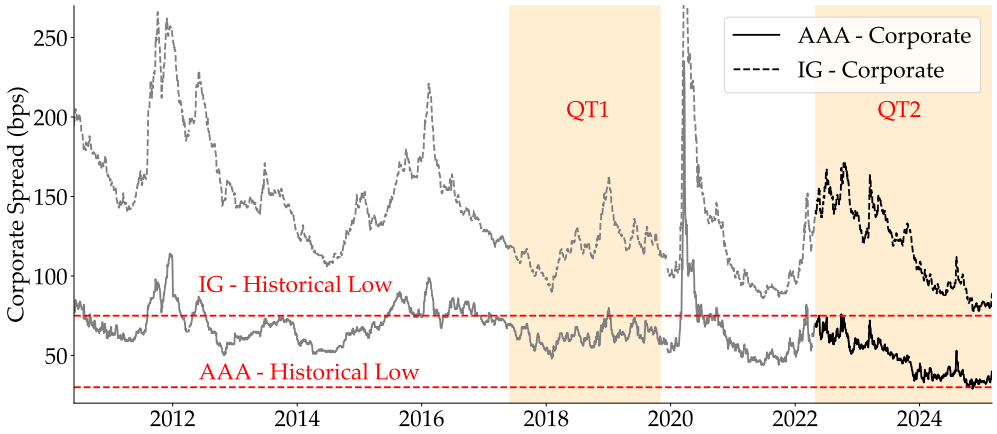
Notes: Asset managers include mutual funds, pension funds, and insurance companies. Orange shading denotes QT periods. Data source: Commodity Futures Trading Commission (CFTC) Traders in Financial Futures (TFF) report.

Fact 3: Compressed Credit Spread in QT2. Figure 4 shows the compressed credit spreads during QT2. Conventional wisdom holds that Fed tightening, including rate hikes and quantitative tightening, should raise investors' risk aversion (e.g. Drechsler et al., 2018; Kekre and Lenel, 2022; Pflueger and Rinaldi, 2022) and widen credit spreads (e.g. Gertler and Karadi, 2015). Yet beginning in late 2024, investment-grade credit spreads across ratings fell to their lowest levels since 2000. Moreover, even during QT1, credit spreads remained relatively low rather than widening.

These three facts—weak Treasury auction demand, elevated basis trade activity, and compressed corporate spreads—emerged during the period when the Treasury share of the debt market rose sharply (Figure 1). In the next section, I develop a model to explain how debt market composition shapes Treasury market elasticity and the transmission of Treasury supply shocks to corporate bonds.

[9] Avalos and Sushko (2023) estimate that leverage ratios in Treasury futures basis trades averaged roughly 175× for the 5-year and 120× for the 10-year Treasury in late 2019. Dealers and hedge funds play different roles in these trades, but for expositional simplicity I treat them jointly as the net suppliers of Treasury derivatives in this paper. Appendix A.1 provides further institutional background on the Treasury basis trade.

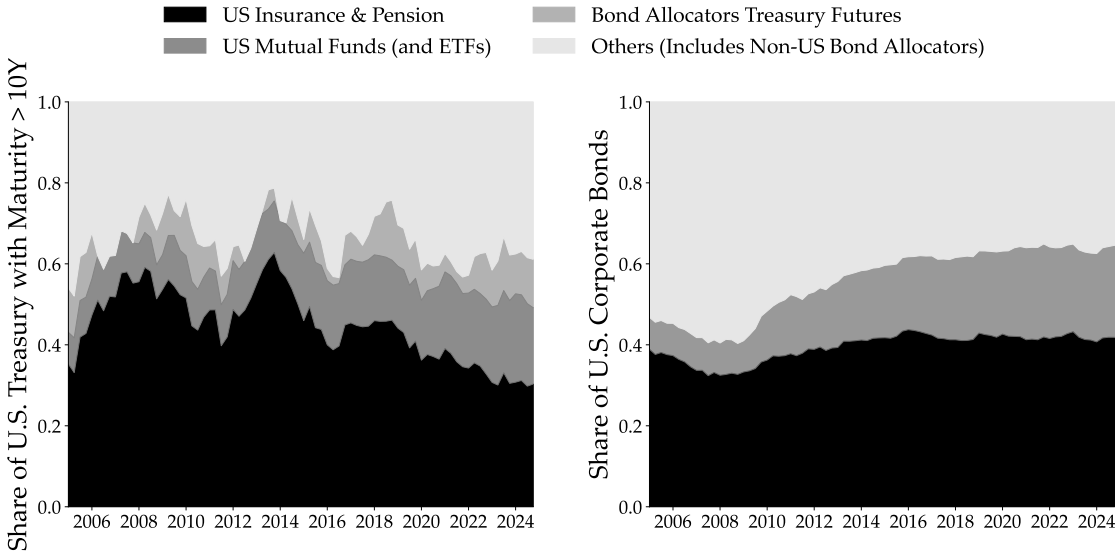
Figure 4: Corporate Bond Credit Spreads Hit Historical Lowest Level



Note: This figure shows the option adjusted spreads of US corporate Bond indices. The corporate indices are taken from the ICE BofA US Corporate Index. Orange shading denotes QT periods.

2.2 US Debt Market, Bond Allocators and Their Constraints

Figure 5: Share of Bond Allocators in Treasuries and Corporate Bonds



Note: (1) The left panel reports the share of US bond allocators in the US long-term Treasury market. Mutual fund holdings come from the Morningstar fund holdings dataset. US insurance company holdings come from NAIC statutory filings. US pension fund holdings come from the Federal Reserve Z.1 tables; their weights to long-term Treasuries is approximated with life insurers' weights, following Jansen et al. (2024b). Allocators' future positions come from Traders in Financial Futures report. Federal Reserve Treasury holdings are excluded from the market holdings of long-term Treasuries. (2) The right panel reports US-domiciled bond allocators' share in the US corporate bond market, based on Federal Reserve Z.1 tables. Non-US bond allocators are included in "Others".

The long-duration segment of the bond market consists primarily of Treasuries and corporate bonds. Bond allocators—including mutual funds, insurance companies, and pension funds—are the primary investors in both markets. As shown in Figure 5, US bond allocators alone hold roughly 60% of the long-term Treasury and corporate bond markets. Because many bond alloca-

tors actively hold Treasuries via interest rate swaps and many non-US-domiciled bond allocators hold substantial US bonds, the allocators' effective share is even larger. These allocators connect the two markets through their portfolio allocation decisions.[10]

These bond allocators face two key constraints. The first is a balance-sheet (leverage) constraint: allocators operate with limited balance sheet capacity.[11] Second, they are subject to duration mandates. For life insurers and pension funds, these mandates reflect incentives to match the duration of liabilities and immunize their equity from interest-rate risk (Domanski et al., 2017; Ozdagli and Wang, 2019; Li, 2025). For bond mutual funds, mandates arise from the requirement to match the duration of a benchmark index (Choi et al., 2023; Barth et al., 2024). At the same time, allocators seek sufficient credit exposure to generate enough yield to cover costs. Thus, the ideal asset for meeting duration mandates is long-term corporate bonds, which bundle duration and credit risk (Kashyap et al., 2025). When corporate bonds are scarce, bond allocators must rely more heavily on Treasuries to satisfy their duration mandates.[12]

These institutional features generate the central mechanism of the paper: debt-market composition affects how tightly balance sheet constraints bind through the duration mandate, and thereby determines the degree of segmentation between the Treasury and corporate bond markets. I formalize the mechanism in the next section.

3 Model

This section presents a tractable model with three objectives: (i) to provide microfoundations for Treasury market elasticity and how Treasury supply shocks are transmitted to corporate bonds; (ii) to show how debt market composition shapes this elasticity through allocator balance sheet constraints; and (iii) to derive testable predictions to guide the empirical analysis.

[10] The U.S. bond market is dominated by three asset classes: Treasuries, corporate bonds, and MBS. MBS have the shortest effective duration among the three (typically under five years) because principal is amortized each month and can be prepaid ahead of schedule. Appendix A.2 details the composition of the U.S. debt market by duration.

[11] Mutual funds are regulated under the Investment Company Act of 1940. They are prohibited from issuing senior securities and may borrow only subject to Section 18's 300% asset-coverage requirement. Pension funds face even stricter constraints: ERISA (Employee Retirement Income Security Act of 1974) permits only fully collateralized, temporary loans for narrowly defined purposes (ERISA §§406(a), 408(b)(3)), effectively ruling out balance-sheet leverage. Life insurers are subject to risk-based capital requirements and tight statutory limits on borrowing. Because their liabilities—policy contracts, annuities, and benefit obligations—adjust slowly, bond allocators have very limited scope to expand balance-sheet capacity on short notice. In practice, bond allocators rarely employ leverage through borrowing (e.g., debt, loans, or repos) and instead rely primarily on derivatives to obtain synthetic leverage (Financial Stability Board, 2023). Appendix A.3 details the leverage constrains faced by bond allocators.

[12] Appendix B.2 plots the balance sheets for the two types of allocators and provides detailed discussions.

The model has two parts. The baseline model features bond allocators who connect the Treasury and corporate bond markets but face duration mandates and balance sheet constraints. When these constraints bind, the Treasury market becomes less elastic, and Treasury supply shocks pass through weakly to corporate bonds. I derive the threshold when constraints bind and show that this is more likely when the Treasury share is high.

The extended model introduces interest rate derivatives and basis trades. Constrained allocators can purchase interest rate derivatives to meet duration targets without tying up balance sheet capacity. Hedge funds and dealers intermediate by buying cash Treasuries and shorting derivatives, earning the derivative spread. When allocator constraints bind, derivative demand increases and basis trade activity rises, partially restoring market elasticity.

3.1 Model Setup

The economy lasts for three periods: $t \in \{0, 1, 2\}$. Both the government and corporate sectors issue zero coupon short-term bonds and long-term bonds in period 0. Short-term bonds last for one period and long-term bonds last for two periods. Long-term government and corporate bonds are subject to interest rate risk in period 1. The representative firm may default in period 1, hence both corporate bonds carry credit risk. Cross-market allocators and other specialized investors clear the market in period 0 and pin down bond yields.

3.1.1 Supply Side: Government Bonds and Corporate Bonds

Central bank. The central bank sets the interest rate i_0 in period 0. The interest rate at $t = 1$ follows an AR(1) process

$$i_1 = i_0 + \epsilon_1^i, \quad \text{with } \epsilon_1^i \sim N(0, \sigma_i^2) \tag{1}$$

where ϵ_1^i denotes an interest rate shock. Since ϵ_1^i is stochastic, long-term bonds carry interest rate (duration) risk that will be priced at $t = 0$.

Government. The government issues long-term Treasury bonds (denoted T) in period 0 in an exogenous quantity S_T. It also issues short-term government bills in periods 0 and 1, with bill supply being perfectly elastic to meet market demand. For simplicity, both Treasury bonds and bills are zero coupon bonds with a face value of one.

Firms. A representative firm has financing needs in period 0, which it meets by issuing short-term corporate bonds, S_S, and long-term corporate bonds, S_L.

The firm may default in period 1.[13] Like Treasury bonds, both corporate bonds are zero coupon bonds with a face value of one. Their one period realized returns are

$$1 + R_1^L = \frac{(1 - Z_1)P_1^L}{P_0^L}, \quad 1 + R_1^S = \frac{1 - Z_1}{P_0^S} \tag{2}$$

where P_0^g for $g \in \{S, L\}$ are prices in period 0, P_1^L is the period 1 price of the long-term corporate bond conditional on no default, and $Z_1 \in [0, 1)$ is the random loss fraction realized in period 1. Appendix B.1 micro founds credit risk Z_1 with the standard "recovery of market value" assumption in the credit risk literature (Duffie and Singleton, 1999; Greenwood et al., 2018, for example).

Financial assets and risk factors. In summary, there is one risk-free asset, the Treasury bill (yield-to-maturity i_t), and three risky assets in period 0: a long-term Treasury (yield-to-maturity y_0^T), a short-term corporate bond (yield-to-maturity y_0^S), and a long-term corporate bond (yield-to-maturity y_0^L). All bonds are zero coupons with unit face value at maturity. Unless otherwise noted, "Treasury" refers to the long-term Treasury bond and "Treasury bill" refers to the short-term bill.

There are two sources of risk in the economy: duration and credit risk. First, both the long-term Treasury and the long-term corporate bond are exposed to the interest rate shock ϵ_1^i. Thus, both long-term bonds will suffer a capital loss if short-term rates rise unexpectedly at $t = 1$. Second, both short- and long-term corporate bonds are exposed to credit risk Z_1: the default realization at $t = 1$ is unknown and evolves randomly. The one-period log return of long-term Treasury, long-term corporate bond, and short-term corporate bond follows:

$$\begin{aligned} r_1^T &= 2y_0^T - i_1 \\ r_1^L &= 2y_0^L - i_1 - z_1 \\ r_1^S &= y_0^S - z_1 \end{aligned} \tag{3}$$

where $z_1 \equiv -\log(1 - Z_1)$ is the log default loss at $t = 1$. We assume $z_1 \sim N(\bar{z}, \sigma_z^2)$ with $\bar{z} > 0$.

[13] For tractability, default can occur only at period $t = 1$. Therefore, short- and long-term corporate bonds carry the same credit risk, which allows us to compare their risk premia directly. Allowing the long-term bond to default at $t = 2$ does not affect the result qualitatively.

3.1.2 Demand Side: Bond Investors.

Our model features two investor types: a cross-market allocator (A), who can invest across all bond markets, and specialized investors, who operate within a single asset market.

Allocator (A). The cross-market allocator (A) represents institutional investors—bond mutual funds, insurance companies, and pension funds—that allocate across bond markets to maximize expected returns. These investors face two constraints: (i) duration mandate and (ii) limited balance sheet capacity. The representative allocator has a unit mass and an initial balance sheet normalized to one. He allocates $\{w_T, w_L, w_S\}$ of the balance sheet to the long-term Treasury, long-term corporate bond, and short-term corporate bond, respectively, and solves the following portfolio choice problem:

$$\begin{aligned} \max_{w_T, w_L, w_S} \ & \mathbb{E}_0[ex_1^{\text{portfolio}}] - \frac{\gamma}{2} Var_0[ex_1^{\text{portfolio}}] \\ \text{s.t.} \quad & ex_1^{\text{portfolio}} = w_L ex_1^L + w_T ex_1^T + w_S ex_1^S \\ & w_L + w_T = \bar{D} \\ & w_S + w_L + w_T \leq 1 \end{aligned} \tag{4}$$

where $ex_1^g \equiv r_1^g - i_0$ denotes the one-period excess return relative to the risk-free rate for $g \in \{T, L, S\}$. The condition $w_L + w_T = \bar{D}$ captures the duration mandate: allocators must invest a share $\bar{D}$ of the balance sheet in long-term bonds. Appendix B.2 discusses the balance sheets of mutual funds and liability-driven investors and provides the micro foundations for the duration mandate. The constraint $w_S + w_L + w_T \leq 1$ captures a leverage limit: allocators may hold cash in the form of Treasury bills but cannot borrow to expand the balance sheet.

Specialized investors. The second class of investors specializes in distinct segments of the bond market, a pattern that is pervasive in the bond market. Foreign reserve managers, such as Japan's Ministry of Finance and the Swiss National Bank, invest almost exclusively in sovereign bonds for liquidity and credit reasons.[14] In the credit market, mandate-driven vehicles such as the Vanguard Long-Term Corporate Bond Index Fund and the PIMCO Long-Term Credit Bond Fund hold only long-term corporate bonds, whereas money-market funds are restricted to short-dated paper. Beyond real-money investors, arbitrageurs such as hedge funds and dealers also exhibit market-specific expertise and tend to specialize (Bryzgalova et al., 2025; Siriwardane et al., 2025).

[14] For example, as of 2025 Q2, the Swiss National Bank held roughly 85% of its foreign-currency bond portfolio in government securities. Swiss National Bank, "Investment of the Currency Reserves," 2025 Q2: https://www.snb.ch/en/the-snb/mandates-goals/investment-assets/reserves-bonds.

Specialized investors in asset market g have mean–variance preferences with risk-aversion parameter γ^g, where $g \in \{T, L, S\}$. They allocate wealth between their specialized assets and the risk-free bill. Specialized investors in each market have a unit mass. Their demand curves are

$$D_g = \frac{\mathbb{E}_0[ex_1^g]}{\gamma^g Var_0[ex_1^g]}, \quad \forall g \in \{T, L, S\} \tag{5}$$

Given constant return variances $Var_0[ex_1^g] \equiv \sigma_g^2$, each specialized investor has a constant price elasticity of demand for the corresponding asset:

$$\varepsilon_g \equiv \frac{1}{\gamma^g \sigma_g^2}, \quad \forall g \in \{T, L, S\} \tag{6}$$

where γ^g denotes specialist g's risk-aversion coefficient and σ_g^2 is the return variance for asset g.

3.1.3 Equilibrium

Equilibrium description. Fix the short rate i_0, its law of motion (1), and the exogenous supplies of long-term Treasury S_T and corporate bonds $\{S_L, S_S\}$. An equilibrium is a collection of asset allocations $\{w_T, w_L, w_S, D_T, D_L, D_S\}$, and bond yields $\{y_0^T, y_0^L, y_0^S\}$ such as

(1) cross-market allocators maximize (4), and specialised investors' demands satisfy (5);

(2) each asset market clears:

$$\begin{aligned} \text{Long-term Treasury:} \quad & w_T + D_T = S_T \\ \text{Long-term corporate bond:} \quad & w_L + D_L = S_L \\ \text{Short-term corporate bond:} \quad & w_S + D_S = S_S \end{aligned} \tag{7}$$

The remainder of this section is organized as follows. Section 3.2 introduces a simplified environment that characterizes the boundary for a binding balance-sheet constraint and provide intuition for how such a constraint impairs transmission. Section 3.3 then solves the full model and highlights the parameters that govern the magnitude of Treasury market elasticity. Section 3.4 extends the model to include interest-rate derivatives and examines the role of basis trades.

3.2 A Simplified Model

Throughout this subsection, I impose Assumption 1, under which the short-term corporate market is perfectly elastic and the short-term credit spread is fixed. This simplification is for exposition only and provides clear intuition with simple algebra; the qualitative results are the same as in the full model in Section 3.3. I first characterize the threshold separating the slack and binding regimes and the determinants of this threshold condition. I then derive the equilibrium and obtain closed-form expressions for prices and elasticities, isolating how the balance-sheet constraint dampens transmission from the Treasury market to the corporate bond market.

Assumption 1 (Perfectly elastic short-term corporate bond market)**.** *Short-term corporate bond specialists have perfectly elastic demand, which determines the short-term credit spread at sp_S. Formally,*

$$D_S \;=\; \varepsilon_S\Big(\mathbb{E}_0[ex_1^S] - sp_S\Big)\,, \qquad \textit{with } \varepsilon_S \to \infty. \tag{8}$$

3.2.1 Threshold Condition for the Two Equilibrium Regimes

I solve for the equilibrium in Appendix B.3. The equilibrium features two regimes: a *slack* regime in which the allocator's balance sheet does not bind and a *binding* regime in which it does. The following proposition summarizes the threshold condition for the two equilibrium regimes and the factors that shift the threshold condition.

Proposition 1 (Threshold condition for slack and binding regimes)**.** *The threshold separating the two regimes is*

$$g(S_L, S_T, \bar{D}) \begin{cases} \leq 0 & \textit{(slack regime)}, \\ > 0 & \textit{(binding regime)}, \end{cases} \tag{9}$$
$$\textit{with } g(S_L, S_T, \bar{D}) \equiv \varepsilon_L S_T - \varepsilon_T S_L + \varepsilon_T \bar{D} + \textit{const.}$$

Fixing the total supply of long-term bonds, $S_T + S_L \equiv \bar{S}_{Long}$, and the total supply of corporate bonds, $S_L + S_S \equiv \bar{S}_{Credit}$, the economy is more likely to be in the binding regime when (i) Treasuries comprise a higher share of the long-term bond market and (ii) the allocator faces a higher duration mandate $\bar{D}$.

Here, $g(S_L, S_T, \bar{D})$ is a proxy of the allocator's balance-sheet constraint.[15] As suggested by Equation (3), the long-term corporate bond gives the same duration risks exposure as Treasuries

[15] As shown in Appendix B.3, $g(S_L, S_T, \bar{D})$ has the same functional form as the Lagrange multiplier λ in the binding regime, reflecting that the shadow cost of the balance-sheet constraint rises as the constraint tightens. The intuition is even clearer in Section 3.4, where the allocator can leverage via interest-rate derivatives: when the Treasury share is higher, the allocator is more constrained and therefore uses more derivatives.

and same credit risk exposure as short-term corporate bonds. Fixing the total supply of long-term bonds S_{Long} and corporate bonds $\bar{S}_{Credit}$, the aggregate quantities of duration risk and credit risk that must be absorbed by the market are fixed; what varies is the composition of the instruments that carry these risks. The threshold function then reduces to

$$g(\bar{S}_{Long} - S_T, S_T, \bar{D}) \equiv \underbrace{(\varepsilon_L + \varepsilon_T)S_T}_{\text{Treasury share}} + \underbrace{\varepsilon_T(\bar{D} - \bar{S}_{Long})}_{\text{Duration demand - supply}} + \text{const.} \tag{10}$$

We find it is driven by two forces: (i) the *source* of duration risk, reflected in the Treasury share of the long-term bond market; and (ii) the *quantity* of duration demand (relative to duration supply).

The key intuition for the first force is clear: long-term corporate bonds bundle duration and credit risk and therefore use less balance-sheet space than replicating the same exposure with Treasuries and short-term corporate bonds. When the Treasury share of long-term bonds is low, the allocator naturally holds more long-term corporate bonds and the balance-sheet constraint is slack. As the Treasury share gradually increases, the total supply of duration and credit risk that the market must absorb is unchanged, so equilibrium prices initially do not move: the allocator simply substitutes away from long-term corporate bonds into portfolios of Treasuries and short-term corporate bonds, but in doing so uses more balance sheet space and moves closer to the constraint. Once the constraint binds, further substitution becomes costly, so the allocator demands higher Treasury yields as the Treasury share continues to rise. At the same time, constrained allocators favor corporate bonds as bundled goods, so corporate spreads narrow. Figure 6 illustrates the shifts: below the threshold, equilibrium yields are flat in the Treasury share; above the threshold, Treasury yields increase with the Treasury share as allocators become increasingly constrained.

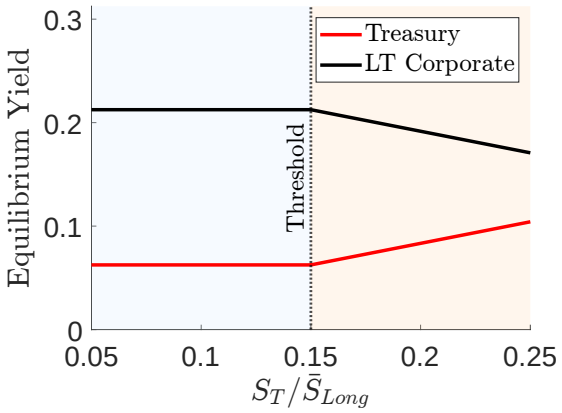
On the other hand, higher duration demand (a longer duration mandate $\bar{D}$) relative to the total duration supply $\bar{S}_{Long}$ increases the likelihood that the balance-sheet constraint binds. Intuitively, high demands for duration risks drive up the price of duration risk; hence, the allocator must use more balance sheet space for duration exposure, leaving less room for credit-risk positions.

3.2.2 Treasury Supply Effects and Shock Spillovers

Proposition 2 formalizes the Treasury supply effects and spillover effects.

Proposition 2 (Supply shocks concentrate in the Treasury Market in the binding regime)**.** *Consider*

(a) Equilibrium Treasury and Corporate Bond Yields



(b) Equilibrium Treasury Demands

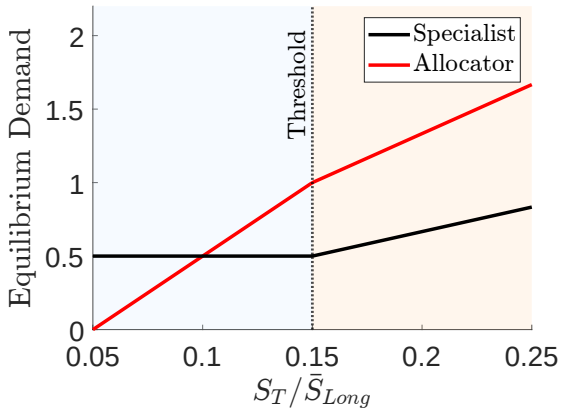


Figure 6: The Comparative Static Analysis

Notes: Those figures plot the equilibrium Treasury yield and demand for in the comparative static analysis. The total long-term bond supply and corporate bond supply are fixed at $\bar{S}_{Credit} = \bar{S}_{Long} = 10$. Parameters: $i_0 = sp_S = 0, \bar{D} = 9, \varepsilon_T = \varepsilon_L = \varepsilon_A = 4, \bar{z} = .3$.

an economy with a perfectly elastic short-term corporate bond market, as in Assumption 1. Comparing with the slack regime*, a marginal Treasury supply shock has*

i) a stronger *price impact on Treasury yield under the* binding regime*:*

$$\frac{\partial y_0^T}{\partial S_T} = \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T + \varepsilon_L}}_{\substack{\text{slack regime,} \\ \text{simplified model}}} < \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T + \varepsilon_L \frac{\varepsilon_A}{\varepsilon_A + \varepsilon_L}}}_{\substack{\text{binding regime,} \\ \text{simplified model}}}, \quad \text{with } \varepsilon_A \equiv \frac{1}{\gamma \sigma_z^2} \tag{11}$$

ii) a weaker *price impact on long-term corporate bond yield under the* binding regime*:*

$$\frac{\partial y_0^L}{\partial S_T} = \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T + \varepsilon_L}}_{\substack{\text{slack regime,} \\ \text{simplified model}}} > \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T \frac{\varepsilon_A + \varepsilon_L}{\varepsilon_A} + \varepsilon_L}}_{\substack{\text{binding regime,} \\ \text{simplified model}}}, \quad \text{with } \varepsilon_A \equiv \frac{1}{\gamma \sigma_z^2} \tag{12}$$

Intuition via no-arbitrage condition. Why are Treasury supply effects larger and spillovers weaker in the binding regime? The key is portfolio rebalancing by allocators. We can understand this channel by focusing on the allocator's portfolio-choice problem. Let λ denote the multiplier

on the balance-sheet constraint in (4). The allocator's Lagrangian is

$$\mathcal{L} = \underbrace{(\bar{D} - w_L)\mathbb{E}_0[ex_1^T] + w_L\mathbb{E}_0[ex_1^L] + w_S\mathbb{E}_0[ex_1^S]}_{\text{expected return}} - \underbrace{\left(\frac{\gamma}{2}\left(w_L + w_S\right)^2\sigma_z^2 + \frac{\gamma}{2}\bar{D}^2\sigma_i^2\right)}_{\text{return variance}} + \underbrace{\lambda(1 - \bar{D} - w_s)}_{\text{balance sheet constraint}} \tag{13}$$

with $\lambda \geq 0$ and $\lambda\left(1 - \bar{D} - w_S\right) = 0$. The first-order conditions imply the no-arbitrage condition:

$$\underbrace{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}_{\text{long-term credit spread}} = \underbrace{\mathbb{E}_0[ex_1^S]}_{\text{short-term credit spread}} - \underbrace{\lambda}_{\substack{\text{shadow cost of} \\ \text{balance sheet constraint}}} \tag{14}$$

where $\mathbb{E}_0[ex_1^T]$ is the term premium on the long-term Treasury, and $\mathbb{E}_0[ex_1^S]$ and $\mathbb{E}_0[ex_1^L - ex_1^T]$ are the short- and long-term credit spreads, respectively.

The no-arbitrage condition (14) captures that bond allocators determine the relative prices across assets via portfolio rebalancing. When the balance sheet constraint is slack ($\lambda = 0$), the allocator can freely substitute for long- and short-term credit risks, ensuring that the two credit spreads are the same. When the constraint binds ($\lambda > 0$), the allocator incurs shadow cost λ when replacing credit risk from long-term corporate bonds with short-term corporate bonds and expanding the balance sheet. This cost creates a wedge in which the short-term spread exceeds the long-term spread. The wedge reflects the allocator's preference for long-term corporate bonds as a bundle of duration risk and credit risk: the allocator is willing to accept a lower expected return on credit risks carried by long-term corporate bonds than by short-term corporate bonds.

Furthermore, relationship in equation (14) clarifies how Treasury supply shocks transmit to other asset markets. When a positive Treasury-supply shock hits the economy, Treasury specialists are forced to absorb more duration risk, and hence charge for a higher Treasury term premium $\mathbb{E}_0[ex_1^T]$. This compresses the long-term credit spread on the left-hand side of equation (14), making long-term corporate bonds less attractive to the allocator. The allocator responds by selling long-term corporate bonds and buying Treasuries, while offsetting lost credit exposure with short-term corporate bonds. This rebalancing raises long-term corporate yields in line with Treasury yields. If the balance-sheet constraint binds, allocators have limited capacity to expand their positions in short-term corporate bonds; consequently, they are reluctant to replace long-term corporate bonds with a combination of Treasuries and short-term corporate bonds. This reluctance weakens the shock's transmission to the credit market, so the price impact is concentrated in the Treasury market.

3.3 The Full Model

I now relax Assumption 1 and solve for the equilibrium of the full model. This allows me to identify the factors that drive Treasury market elasticity. The other conclusions remain the same as in the simplified model. The full equilibrium characterization is provided in Appendix B.4.

Treasury market elasticity and spillover effects. A stronger price impact on Treasury yields is equivalent to a less elastic treasury market. We define Treasury market elasticity ε_{TT} as the inverse of the supply effect on bond yield.[16]

$$\varepsilon_{TT} \equiv \left(\frac{\partial y_0^T}{\partial S_T}\right)^{-1} \tag{15}$$

Proposition 3 gives the equilibrium Treasury market elasticity and spillover effects.

Proposition 3 (Treasury market elasticity and spillover effects in the full model.)**.** *The economy of the setup in Section 3.1 features:*

i) less *elastic Treasury market under the* binding regime*:*

$$\varepsilon_{TT}: \quad \underbrace{2\left(\varepsilon_T + \varepsilon_L \frac{\varepsilon_A + \varepsilon_S}{\varepsilon_A + \varepsilon_L + \varepsilon_S}\right)}_{\substack{\textit{slack regime,}\\ \textit{full model}}} > \underbrace{2\left(\varepsilon_T + \varepsilon_L \frac{\varepsilon_A}{\varepsilon_A + \varepsilon_L}\right)}_{\substack{\textit{binding regime,}\\ \textit{full model}}} \tag{16}$$

ii) weaker *price impact on long-term corporate bond yields under the* binding regime*:*

$$\frac{\partial y_0^L}{\partial S_T} = \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T \frac{\varepsilon_A+\varepsilon_L+\varepsilon_S}{\varepsilon_A+\varepsilon_S} + \varepsilon_L}}_{\substack{\textit{slack regime,}\\ \textit{full model}}} > \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T \frac{\varepsilon_A+\varepsilon_L}{\varepsilon_A} + \varepsilon_L}}_{\substack{\textit{binding regime,}\\ \textit{full model}}} \tag{17}$$

The market-level elasticity ε_{TT} has two components, corresponding to the two players in the Treasury market: the allocator and the Treasury specialist. The factor 2 reflects the two-period duration of long-term Treasury bonds.[17] The contribution of Treasury specialists is ε_T by model assumption, and it is invariant across the slack and binding regimes.

[16] The cross asset elasticity is defined as $\varepsilon_{LT} = \left(\frac{\partial y_0^L}{\partial S_T}\right)^{-1}$. Textbook demand elasticity is defined as $\varepsilon = \frac{dQ/Q}{dP/P}$ and is negative for downward-sloping demand; a larger $|\varepsilon|$ indicates greater elasticity. For tractability, I work with (log) bond yields rather than prices and summarize elasticity by the inverse of the supply effect on yield. With downward-sloping demand, $\partial y_0^T/\partial S_T > 0$, so $\varepsilon_{TT} > 0$; here a larger ε_{TT} corresponds to a more elastic market.

[17] In the model, the interest-rate shock arrives in period 1 while the bond matures in period 2. The relationship between yield to maturity and term premium follows $y_0^T = i_0 + \frac{1}{2}\mathbb{E}_0[ex_1^T]$. Thus, $\varepsilon_{TT} \equiv \left(\frac{\partial y_0^T}{\partial S_T}\right)^{-1} = 2\left(\frac{\partial \mathbb{E}_0[ex_1^T]}{\partial S_T}\right)^{-1}$.

Observe that the allocator's contribution to Treasury market elasticity can be written as

$$\underbrace{\varepsilon_L \frac{\varepsilon_A + \varepsilon_S}{\varepsilon_A + \varepsilon_L + \varepsilon_S}}_{\text{allocator's contribution}} = \frac{1}{\frac{1}{\varepsilon_A + \varepsilon_S} + \frac{1}{\varepsilon_L}} \tag{18}$$

which is the harmonic mean of ε_L and $\varepsilon_A + \varepsilon_S$. The intuition is as follows: the allocator contributes to the Treasury market elasticity through portfolio rebalancing, which operates via (1) a *duration leg*—replacing long-term corporate bonds with Treasury for duration; and (2) a *credit leg*—replacing the credit risk embedded in long-term corporate bonds with short-term corporate bonds. A deeper long-term corporate market (higher ε_L) allows the allocator to unwind long-term corporate bonds with smaller price moves, so more duration can be shifted out of the Treasury market. A deeper short-term corporate market (higher ε_S) and greater willingness to bear credit risk (higher $\varepsilon_A \equiv 1/(\gamma\sigma_z^2)$) make the credit leg easier to execute, so more of the shock can be passed on.

Specifically, the simplified model presented earlier is the extreme case $\varepsilon_S \to \infty$, where the short-term credit spread is fixed and rebalancing has no price impact on credit risk; transmission then depends entirely on duration leg ε_L. Furthermore, note that the elasticity in (16) under the slack region converges to that in the binding region when $\varepsilon_S \to 0$. This corresponds to the case where the short-term corporate bond market is perfectly inelastic and Treasury supply shocks cannot pass through to the short-term corporate bond market, which is effectively the binding case.

3.4 An Extended Model with Interest Rate Derivatives

I now extend the model to allow hedge funds and dealers to supply interest-rate derivatives (futures or swaps) via basis trades. These contracts enable the allocator to use leverage and shift duration off the balance sheet. This sections shows how basis trade activities mitigate Treasury market inelasticity and market segementation. The setup also delivers testable predictions for allocators' derivative usage, which guide the empirical analysis in the next section.

3.4.1 Model Extension with Interest Rate Derivatives

Hedge funds (and dealers). Hedge funds long cash Treasury and short interest rate derivative to earn the cash–derivative basis.[18] They represent a subset of leveraged funds (and dealers) engaged

[18] In the model, the derivative (basis) spread is defined as $\mathbb{E}_0[ex_1^T - ex_1^D] = 2(y^T - y^D)$, the excess yield on cash Treasury over interest rate derivative.

in relative-value arbitrage in the Treasury market. Following standard formulations of arbitrage activity in the literature (e.g. Klingler and Sundaresan, 2019; Greenwood et al., 2023; Hanson et al., 2024), hedge funds choose the derivative supply S_D by solving a optimization problem

$$\max_{S_D} \quad S_D \mathbb{E}_0[ex_1^T - ex_1^D] - \frac{\kappa}{2}(S_D\sigma)^2 \tag{19}$$

where $\frac{\kappa}{2}(S_D\sigma)^2$ captures the balance sheet costs incurred by hedge funds. In this setup, the balance sheet usage of a new derivative position is proportional to the variance in the derivative's mark-to-market value. Coefficient κ can be interpreted as the tightness of the hedge funds' balance sheet constraint. When $\kappa = 0$, hedge funds are unconstrained and would supply derivatives on a cash–derivative basis $\mathbb{E}_0[ex_1^G - ex_1^D] = 0$. The variance $(S_D\sigma)^2$ represents the underlying risk of the basis trade, including counterparty and repo rollover risks, as summarized in Market Risk Advisory Committee (2024).[19]

I define the hedge-fund supply elasticity by $\varepsilon_D \equiv 1/(\kappa\sigma^2)$. The first-order condition then yields hedge funds' supply curve

$$S_D = \frac{\mathbb{E}_0[ex_1^T - ex_1^D]}{\kappa\sigma^2} \equiv \varepsilon_D \mathbb{E}_0[ex_1^T - ex_1^D] \tag{20}$$

Allocator's problem. The allocator can use interest rate derivatives or cash Treasury to obtain the same exposure duration, with the key difference that interest rate derivatives do not use balance sheet space. He faces the problem

$$\begin{aligned} \max_{w_L, w_T, w_D, w_S} \quad & \mathbb{E}_0[ex_1^{\text{portfolio}}] - \frac{\gamma}{2} Var_0[ex_1^{\text{portfolio}}] \\ \text{s.t.} \quad & ex_1^{\text{portfolio}} = w_L ex_1^L + w_T ex_1^T + w_S ex_1^S + w_D ex_1^D \\ & w_L + w_T + w_D = \bar{D} \\ & w_S + w_L + w_T \leq 1 \end{aligned} \tag{21}$$

[19] Hedge funds and dealers are treated as a single intermediary in the model for tractability. In practice, they differ in the balance sheet constraints. Dealers (typically bank-affiliated broker-dealers) face limited balance sheet capacity and capital ratio regulations in holding cash Treasuries on balance sheets. Hedge funds execute the basis trade via repo financing and face counterparty and repo-rollover risks; they also face equity requirements to meet initial margins and repo haircuts (See Figure A.2 for the illustration of basis trade). Kashyap et al. (2025) explicitly distinguishes these sectors with different balance-sheet constraints to captures their distinct roles during Treasury market disruptions. My goal is to highlight the role of derivative intermediation in shaping Treasury market elasticity, so I adopt a reduced-form balance sheet costs proportional to the quantity intermediated.

where $w_L + w_T + w_D = \bar{D}$ and $w_S + w_L + w_T \leq 1$ capture that the allocator can take duration risks w_D off the balance sheet and have more balance sheet space for the short-term bonds.[20]

Equilibrium description. The equilibrium definition is the same as in Section 3.1.3, with three additions: (i) the allocator now maximizes (21), (ii) hedge funds supply interest rate derivatives according to (20), and (iii) the interest rate derivative market clears: $w_D = S_D$.

Equilibrium analysis. Lemma 1 shows that derivatives are used only when the balance sheet constraint binds.

Lemma 1. *The allocator will only use interest rate derivatives to free the balance sheet space for short-term bonds if he is constrained. That is, the optimal allocation* $\{w_L, w_T, w_S, w_D\}$ *satisfies*

$$w_D = 0 \iff w_S \leq 1 - \bar{D}; \tag{22}$$

$$w_D > 0 \iff w_S = 1 - \bar{D} + w_D. \tag{23}$$

When the allocator's balance sheet is slack, he does not use interest rate derivatives, and the equilibrium derivative supply is $S_D = 0$. When the balance sheet constraint binds, he begins to use interest rate derivatives to meet the duration mandate. In particular, the no-arbitrage relation in (14) for credit spreads becomes

$$\text{non-arbitrage relation:} \quad \underbrace{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}_{\text{long-term credit spread}} = \underbrace{\mathbb{E}_0[ex_1^S]}_{\text{short-term credit spread}} - \underbrace{\mathbb{E}_0[ex_1^T] - \mathbb{E}_0[ex_1^D]}_{\text{derivative spread}} \tag{24}$$

Relative to (14), the non-arbitrage condition (24) replaces the shadow cost of the balance sheet constraint with an explicit *wedge*; the allocator pays the cash–derivative spread to hedge funds for intermediation. Interest rate derivatives thereby only *partially* restore Treasury market elasticity, as shown in Proposition 4 below.

[20] Under US GAAP (FAS 133), swaps, futures, forwards and option contracts are derivatives whose notional values are carried off balance sheet and only fair values recorded on the balance sheet. In practice, investors take duration exposure through interest rate derivatives with minimal balance sheet space. For Treasury futures, contract maturity is typically three months; investors post a small initial margin to gain exposure to the notional amount and roll the contract as it approaches the delivery date. For interest rate swaps, investors pay a floating rate and receive a fixed rate, exchanging cash flows periodically.

3.4.2 Treasury Market Elasticity and Spillover Effects

Proposition 4 (Basis trade partially restores Treasury market elasticity and spillover effects)**.** *When the allocators hit the binding regime, the existence of the basis trade*

i) partially restores the Treasury market elasticity:

$$\varepsilon_{TT}: \underbrace{2\left(\varepsilon_T+\varepsilon_L\frac{\varepsilon_A+\varepsilon_S}{\varepsilon_A+\varepsilon_L+\varepsilon_S}\right)}_{\substack{\text{slack regime,}\\ \text{full model}}} > \underbrace{2\left(\varepsilon_T+\varepsilon_L\frac{\varepsilon_A\left(1+\frac{\varepsilon_S}{\varepsilon_D}\right)+\varepsilon_S}{(\varepsilon_A+\varepsilon_L)\left(1+\frac{\varepsilon_S}{\varepsilon_D}\right)+\varepsilon_S}\right)}_{\text{binding regime + basis trade}} > \underbrace{2\left(\varepsilon_T+\varepsilon_L\frac{\varepsilon_A}{\varepsilon_A+\varepsilon_L}\right)}_{\substack{\text{binding regime,}\\ \text{full model}}} \tag{25}$$

ii) partially restores the spillover of Treasury supply shocks to corporate bond market:

$$\frac{\partial y_0^L}{\partial S_T}: \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T\frac{\varepsilon_A+\varepsilon_L+\varepsilon_S}{\varepsilon_A+\varepsilon_S}+\varepsilon_L}}_{\substack{\text{slack regime,}\\ \text{full model}}} > \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T\frac{(\varepsilon_A+\varepsilon_L)\left(1+\frac{\varepsilon_S}{\varepsilon_D}\right)+\varepsilon_S}{\varepsilon_A\left(1+\frac{\varepsilon_S}{\varepsilon_D}\right)+\varepsilon_S}+\varepsilon_L}}_{\text{binding regime + basis trade}} > \underbrace{\frac{1}{2}\frac{1}{\varepsilon_T\frac{\varepsilon_A+\varepsilon_L}{\varepsilon_A}+\varepsilon_L}}_{\substack{\text{binding regime,}\\ \text{full model}}} \tag{26}$$

Specifically, observe that

$$\lim_{\varepsilon_D\to\infty}\varepsilon_{TT}^{\text{BasisTrade}}=\varepsilon_{TT}^{\text{Slack}},\quad \lim_{\varepsilon_D\to\infty}\left(\frac{\partial y_0^L}{\partial S_T}\right)^{\text{BasisTrade}}=\left(\frac{\partial y_0^L}{\partial S_T}\right)^{\text{Slack}}; \tag{27}$$

$$\lim_{\varepsilon_D\to 0}\varepsilon_{TT}^{\text{BasisTrade}}=\varepsilon_{TT}^{\text{Binding}},\quad \lim_{\varepsilon_D\to 0}\left(\frac{\partial y_0^L}{\partial S_T}\right)^{\text{BasisTrade}}=\left(\frac{\partial y_0^L}{\partial S_T}\right)^{\text{Binding}}. \tag{28}$$

When hedge funds have perfectly elastic derivative supply, that is, $\varepsilon_D \to \infty$, they charge zero derivative spread for the basis trade, which is equivalent to removing the balance sheet constraint so the allocator can borrow freely. As a result, the Treasury market elasticity converges to the *slack* regime. In contrast, when derivative supply is perfectly inelastic, that is, $\varepsilon_D \to 0$, they charge an infinite derivative spread for the basis trade, so the allocator cannot expand the balance sheet; Treasury market elasticity converges to the *binding* regime.

3.4.3 Basis Trade Activities

Equation (20) implies that the equilibrium derivative spread charged by hedge funds is proportional to the derivative supply S_D, consistent with other models on arbitrageurs (for example, Klingler and Sundaresan, 2019; Hanson et al., 2024; Du et al., 2023). I conduct comparative statics

analysis analogous to Section 3.2.1, holding the total supply of risk fixed. The following proposition characterizes the determinants of the equilibrium derivative supply and derivative spread.

Proposition 5 (Basis-Trade Activities)**.** *Assume that the total risk supply to the economy is fixed,*

i). Allocators' Treasury-derivative positions (w_D^*) are increasing in the Treasury share of the debt market and duration mandate $\bar{D}$.

$$\frac{\partial w_D^*}{\partial S_T} \geq 0, \quad \frac{\partial w_D^*}{\partial \bar{D}} \geq 0. \tag{29}$$

ii). The derivative spread widens in proportion to allcators' derivative usage

$$\underbrace{\mathbb{E}_0[ex_1^T] - \mathbb{E}_0[ex_1^D]}_{\textit{derivative spread}} = \frac{w_D^*}{\varepsilon_D} \tag{30}$$

The intuition is straightforward: in the binding region, the allocator's balance sheet becomes more constrained when the Treasury share in the debt market is high or when allocators face longer-duration mandates. As a result, they rely more heavily on interest rate derivatives for leverage. In turn, hedge funds and dealers charge wider (more negative) derivative spreads to compensate for the higher volume of intermediation.

Remark (the role of duration mandate). Although the main purpose of the model is to show how the *source* of duration risk matters for Treasury supply effects, it also clarifies the impact of the *level* of duration. In the model, the level of duration demand is captured by the mandate $\bar{D}$ and the level of duration supply by $S_T + S_L$. Duration demand plays two roles: (i) higher duration demand lowers equilibrium Treasury yields, that is, $\frac{\partial y_0^T}{\partial \bar{D}} < 0$. This reflects that a higher duration mandate forces investors to take more long-term bonds, thereby reducing treasury yields. (ii) Higher duration demand $\bar{D}$ relative to total duration supply $S_T + S_L$ makes the allocator more likely to be in the binding regime (see Equation (10)), thereby making the Treasury market less elastic.[21] These two forces are more relevant for liability-driven investors (pensions and life insurers) whose liability durations vary over time. A large literature emphasizes force (i), documenting that liability-driven investors increase long-term bond holdings when long rates decline, further pushing down yields (Domanski et al., 2017; Ozdagli and Wang, 2019). In Section 6, I highlight

[21] Formally, this concerns the cross-partial $\frac{\partial}{\partial \bar{D}}\left(\frac{\partial y_0^T}{\partial S_T}\right)$. In this model, y_0^T is a step function across slack vs. binding regimes, so $\frac{\partial}{\partial \bar{D}}\left(\frac{\partial y_0^T}{\partial S_T}\right)$ collapses to a Dirac delta mass at the threshold.

force (ii) and document that life insurers increase interest-rate derivative usage when interest rates decline, reflecting that a higher duration mandate raises the likelihood of binding constraints.

3.5 Summary of Model Predictions

The model guides empirical analysis with four predictions.

Prediction 1. Allocators' balance-sheet constraints are more likely to bind when the Treasury share of the debt market is high and duration mandates are longer. When more constrained, allocators rely more heavily on interest rate derivatives.

Prediction 2. Allocators' heavier use of derivatives increases the volume intermediated by hedge funds and dealers, thereby widening derivative spreads.

Prediction 3. Where allocators' balance sheet binds, Treasury supply shocks have larger price impacts on Treasuries.

Prediction 4. Where allocators' balance sheets bind, movements in the Treasury yield pass-through less to the corporate bond market.

4 Dataset

I compile data from several sources to identify Treasury supply shocks, estimate Treasury market responses, trace spillovers to the corporate bond market, and analyze allocators' portfolio holdings. Detailed data descriptions and filters are provided in Appendix C.

Treasury prices. I use intraday security-level US Treasury transaction data from GovPX, covering 1991 to 2024. The data provide millisecond timestamps and include both bid and ask quotes. I focus on on-the-run notes and bonds, the most liquid instruments at each maturity (Krishnamurthy, 2002). As trade yields are not consistently available, I proxy yields using the midpoint of the bid and ask yields at each timestamp (Fleming, 2001; Fleming and Liu, 2016). Appendix C.2 details the security-level cleaning procedures.

Mutual fund cash-bond and derivatives positions. I obtain the holdings of global bond mutual funds and ETFs from Morningstar (Maggiori et al., 2020; Coppola, 2025). The Morningstar dataset offers broad coverage of fixed-income funds; as of 2024, covered bond funds account for about $12 trillion in AUM, broadly consistent with the Investment Company Institute's estimate

of $13.8 trillion. A large subset of fund families report contract-level derivative positions, allowing the identification of Treasury futures exposures. The sample spans from 2005Q1 to 2024Q4 at a quarterly frequency. Appendix C.3 details the cleaning procedure.[22]

Insurance company cash-bond and derivatives positions. I obtain US insurers' cash bond and interest rate derivative holdings from the National Association of Insurance Commissioners (NAIC). Life insurers report cash-asset holdings in Schedule D (Coppola, 2025; Li and Wenning, 2025) and derivatives in Schedule DB (Sen, 2023). The sample spans 2008Q1–2024Q4 at a quarterly frequency. Appendix C.4 details the cleaning procedure.[23]

Other data. I complement the above with security-level corporate bond and Treasury issuance data, Federal Reserve operation records, and macro-financial time series from the LSEG Debt New Issue Deals, US Department of the Treasury, Federal Reserve official releases, Bloomberg, and LSEG Refinitiv. Appendix C.5 provides further details on these sources.

5 Evidence from Asset Prices

During QT, the sharp rise in the Treasury share (Figure 1) and elevated allocators' interest rate derivative usage (Figure 3) are consistent to Prediction 1. This Section focuses on other predictions and proceeds as follows. In Section 5.1, I exploit the institutional features of the Treasury issuance process to construct three novel series of shocks to new Treasury supply, and I estimate high-frequency Treasury market responses around announcements. In Section 5.2, I test Prediction 2 and show that lower (more negative) swap spreads are strongly correlated with larger allocator interest rate derivative positions and greater dealer intermediation volumes. In Section 5.3, I show lower swap spreads are associated with larger Treasury supply effects and weaker transmissions to corporate bonds, consistent with Prediction 3 and Prediction 4.

[22] Coppola (2025) compares Morningstar's bond mutual fund coverage with ICI aggregates over time and documents high coverage since 2005. Mutual funds primarily use Treasury futures. Barth et al. (2024) construct US mutual fund Treasury future holdings from the SEC's Form N-PORT, which reports comprehensive derivative positions for funds whose parent investment company has net assets of $1 billion or more. The main limitation is time coverage: N-PORT filing began on September 30, 2019. Morningstar provides broader historical coverage starting in 2005, yet some investment companies do not disclose derivatives at the contract-level. Derivative disclosure varies by fund family. Many large fund families report contract-level positions, including BlackRock, PIMCO, and T. Rowe Price, Prudential, PGIM, and DoubleLine; other families typically report only aggregate positions. In my Morningstar data, mutual funds' net Treasury futures positions cover roughly 45–60% of the positions observed in Form N-PORT.

[23] I use the version distributed by S&P Global, via its division formerly known as SNL Financial.

5.1 Treasury Supply Shocks

The Treasury market is exposed to many shocks from multiple sources, making it difficult to disentangle the demand and supply forces that I study. I address these challenges in two ways. First, I identify unanticipated shocks to the new Treasury supply using operational details from the US Department of the Treasury. Since the early 1990s, the Treasury issuance process has followed a transparent, pre-announced calendar. I compile a complete timeline of operations and identify shocks at the aggregate and security levels. Because these events recur in a stable format over many years, they provide repeated observations and allow for fair comparisons of Treasury market elasticities over time.[24] Second, I estimate high-frequency Treasury market responses in narrow event windows to isolate these shocks from other influences.

5.1.1 The Treasury Issuance Process and Treasury Supply Shocks

Within the US Department of Treasury, the Office of Debt Management (ODM) determines borrowing needs and designs issuance strategies. ODM adheres to two principles: (i) issue debt in a regular, predictable pattern, and (ii) provide transparency in the decision-making process.[25] Since the early 1990s, the Treasury supply process has followed a quarterly refunding cycle (Figure 7). The cycle begins with a *quarterly refunding week* at which the ODM announces its borrowing needs and provides tentative auction plans. This is followed by regular security-level *auction announcements* that detail offering amounts and security characteristics for upcoming auctions. *Regular auctions* are then held, with results released immediately. Finally, securities are delivered several days after the auction date. The timing of each release is prescheduled and publicly disclosed to ensure transparency and predictability. I analyze each step of this issuance process to identify potential shocks to the Treasury market.

Step 1: quarterly refunding week and supply shocks at the aggregate level. During the refunding week, the Treasury Department issues two releases: First, the *market borrowing estimates* at 3:00 p.m. ET on Monday, which outlines net borrowing needs for the current and following quarter. I use the revision of the current quarter net borrowing estimate $\widetilde{\text{Borr. Est}}_t$ scaled by the

[24] Specifically, intraday price responses in the Treasury market largely reflect the actions of intraday traders. Typically, these traders do not trade on their own assessment of the ultimate meaning of new information; rather, they trade on their expectations of how other investors will react (Schmidt-Engelbertz and Vasudevan, 2025). These expectations are more stable when the same type of event repeats over many years. See Robert Shiller's discussion in Vissing-Jorgensen and Krishnamurthy (2011).

[25] See the overview of the Office of Debt Management and government debt supply published by the Department of Treasury: https://home.treasury.gov/system/files/276/Debt-Management-Overview.pdf.

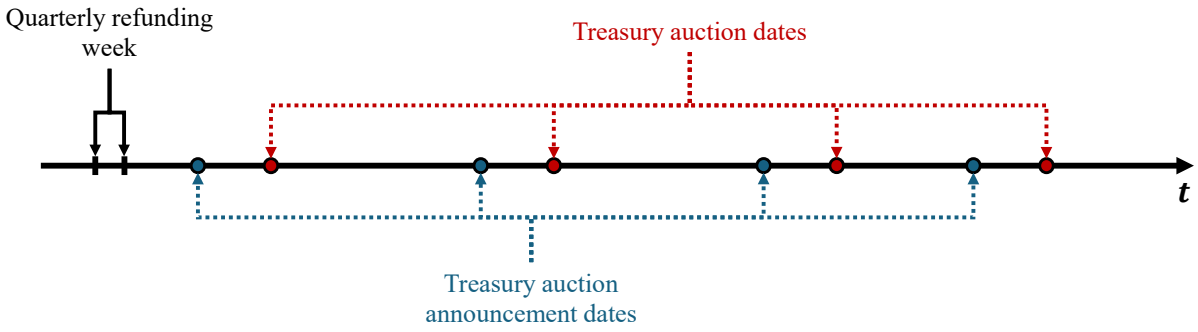


Figure 7: The Timeline of a Quarterly Refunding Cycle

Note: This figure displays the timeline of one quarterly refunding cycle. The blue points denote Treasury auction announcement dates and the red points denote Treasury auction dates within one cycle.

total Treasury outstanding D_t as the Treasury supply shock to the market:

$$\text{Shock } 1_t \equiv \frac{\widetilde{\text{Borr. Est}}_t}{D_t} = \frac{\text{Borr. Est}_t^t - \text{Borr. Est}_{t-1}^t}{D_t} \tag{31}$$

where Borr. Est_t^t is the net borrowing estimate for quarter t released in quarter t, and Borr. Est_{t-1}^t is the estimate for quarter t released in the prior quarter $t-1$. For example, Figure D.1 in the appendix shows the market borrowing estimates released by the Treasury department on February 2, 2004. The format and content of these releases have been largely consistent from 1991Q4 through 2024Q4. In the February 2004 release, Treasury announced that it expected to borrow \$177 billion in 2004Q1 and noted that the prior estimate, which was announced on November 3, 2003, was \$160 billion. In the February 2004 example, the revision is $\widetilde{\text{Borr. Est}}_{2004Q1} = \$177 - \$160 = \$17$ billion.

Figure 8 plots the scaled borrowing estimate revisions from 1991 onward. The shock measure lies between -2.5% and +2.5% of the total treasury outstanding, except for spikes during the 2008 financial crisis and the 2020 pandemic. In my main specification, I exclude quarters of the 2008 global financial crisis and the 2020 pandemic when fiscal expansions were largely anticipated by markets.

Second, at 8:30 a.m. on Wednesdays, the Treasury holds a quarterly refunding conference and releases the *tentative auction schedule* (often referred to as the TBAC recommendation table), which breaks the financing estimate into securities to be auctioned. The plan reports auction announcement dates, auction dates, and tentative offering amounts. Figure D.2 in the Appendix shows the tentative auction plan for 2004Q1 released on February 4, 2004. In that plan, Treasury allocated

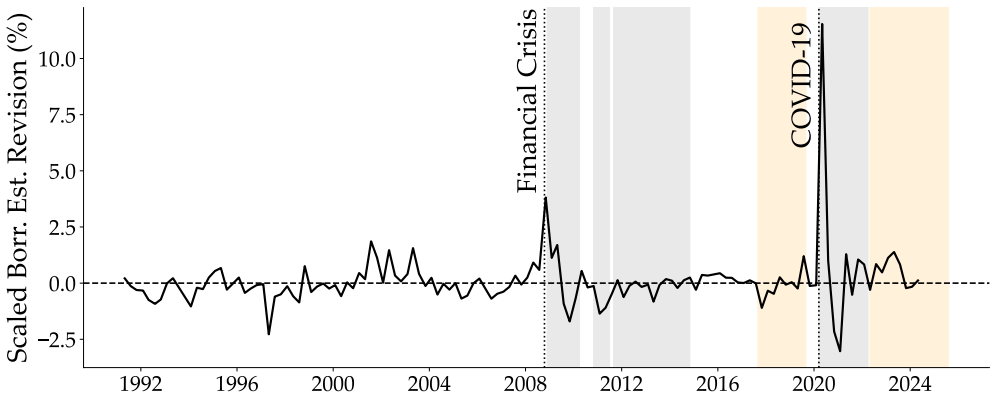


Figure 8: Net Borrowing Estimate Revisions $\widetilde{\text{Borr. Est}}_t$

Note: This figure shows net borrowing estimate revisions scaled by total treasury outstanding during the quarterly refunding process from 1991 to 2024. Gray shading denotes QE periods; orange shading denotes QT periods.

$84 billion of net borrowing to bills and $93.13 billion to notes and bonds, totaling roughly the $177 billion financing need announced on February 2, 2004.

Step 2: Auction announcement and Treasury supply shocks by maturity bucket. A few days before each auction, the Treasury releases a public announcement detailing all relevant information for the auction. This includes the amount offered, security characteristics (e.g., maturity, CUSIP, coupon schedule, auction closing time, and delivery date), and the rules governing the auction. I measure treasury supply shocks as the deviation of the realized offering amount from the tentative plan:

$$\tilde{S}_{m,t} = S_{m,t} - S_{m,t}^{\text{tentative}} \tag{32}$$

where $S_{m,t}$ is the realized offering amount for Treasury security m announced at time t, and $S_{m,t}^{\text{tentative}}$ is the corresponding amount in the *tentative auction plan*. Department of Treasury typically announces two or three securities simultaneously. Figure 9 shows the announcement-day surprises for short-term (maturity $\leq$ 5Y) and long-term Treasuries (maturity $\geq$ 5Y). The magnitude of surprises typically ranges between five billion dollars below zero and five billion dollars above zero, reflecting a relatively stable auction plan. As the figure shows, long-maturity surprises are often the opposite sign of short-maturity surprises, indicating that shocks primarily reflect adjustments to the maturity mix. I aggregate the security-level surprises at announcement time t

into 10-Year equivalent

$$\text{Shock } 2_t = \sum_m \frac{Duration_m}{Duration_{10Y}} \tilde{S}_{m,t} = \sum_m \frac{Duration_m}{Duration_{10Y}} \left(S_{m,t} - S_{m,t}^{\text{tentative}} \right)$$

For example, Figure D.3 in the appendix shows the announcements on March 8, 2004, where a five-year and a ten-year note were announced simultaneously. The realized offering amounts were \$16 billion and \$11 billion, respectively. The *tentative auction plan* in Figure D.2 lists \$16 billion and \$13 billion, respectively. The resulting surprises are Shock $2_t = \tilde{S}_{10Y,t} = -\$2$ billion.

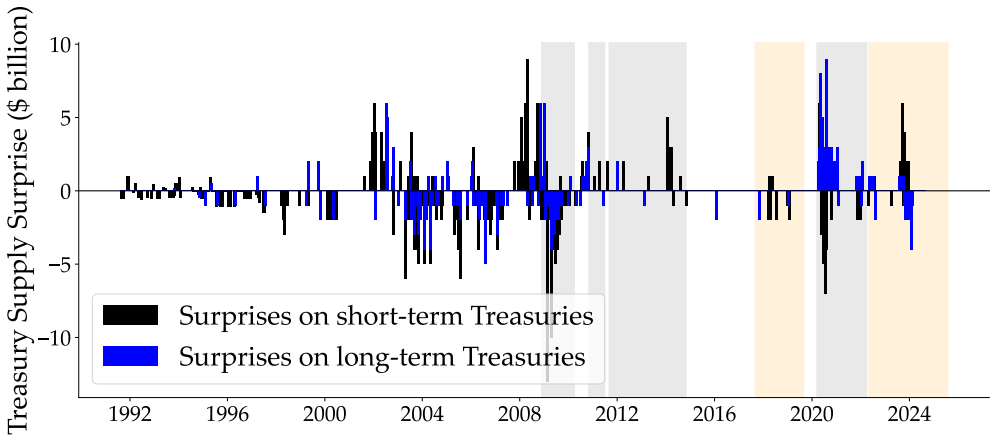


Figure 9: Treasury Supply Shocks on Auction Announcement Dates.

Note: This figure shows treasury supply surprises in the auction announcement dates from 1991 to 2024. Grey shaded areas indicate periods of quantitative easing (QE); orange shaded areas indicate periods of quantitative tightening (QT).

Accordingly, I focus on long-maturity shocks, $\tilde{S}_{\text{long-term},t}$, in my main specification, to which the market is more sensitive.

Step 3: Auction date and auction result news. Starting from auction announcements, Treasury investors can submit bids until the auction closing time stated in the announcement. Shortly after the auction close, competitive bids are accepted in ascending order of yield until the total equals the offering amount net of noncompetitive bids. All winning bidders receive the same yield, which is the highest accepted (stop-out) yield. Once determined, results are released immediately. In addition to the winning yield, one particularly salient piece of information is the bid-to-cover ratio, the ratio of all bids received to all bids accepted (see Figure D.4 for a sample of auction result announcement). A lower bid-to-cover ratio indicates weaker demand in the primary market.

In the following subsection, I estimate high-frequency Treasury yield responses to the bid-

to-cover ratio at primary auctions. Following Ray et al. (2024), bid-to-cover primarily reflect preferred-habitat investors' demand in the primary market. A lower bid-to-cover ratio signals a negative preferred habitat demand shock (i.e., more residual supply must be allocated to other agents), which is equivalent to a positive net supply shock to the rest of the market. Consequently, a stronger price response to bid-to-cover news indicates a less elastic Treasury market.

5.1.2 Narrative Evidence

Treasury supply and auction news are focal for Treasury investors and traders. Major financial news media such as Bloomberg, Reuters, and The Wall Street Journal provide live coverage of the refunding cycle and report auction results in real time. Bloomberg Terminal users also receive headline alerts via the Treasury Auctions channel. Taken together, these streams make refunding announcements, auction notices, and auction result releases key moments for intraday price discovery. Figure 10 shows three examples of intraday price movements. Panel (a) covers the quarterly borrowing estimate announcement on October 30, 2023. The US Treasury announced it expected to borrow $776 billion in Q4, $76 billion less than its July forecast, which Reuters noted "brought some relief to bond markets rattled for months by a glut of new debt."[26] The 30 year Treasury yield fell by approximately 3 basis points within five minutes. Panel (b) shows April 2, 2020, when the Treasury announced auctions for a $40 billion 3 year note, a $25 billion 10 year note, and a $17 billion 30 year bond. Relative to the February 5 tentative plan, the offering sizes increased by $2 billion for the 3 year, $1 billion for the 10 year, and $1 billion for the 30 year. The 30 year yield rose by approximately 3 basis points within five minutes. Panel (c) shows February 9, 2023, when the 30 year bond auction cleared with a bid to cover 2.25, in the bottom quartile of the historical outcomes. 30 year Treasury yield jumped about 5 basis points immediately after the release.[27]

5.1.3 High-frequency Treasury Market Responses to Shocks

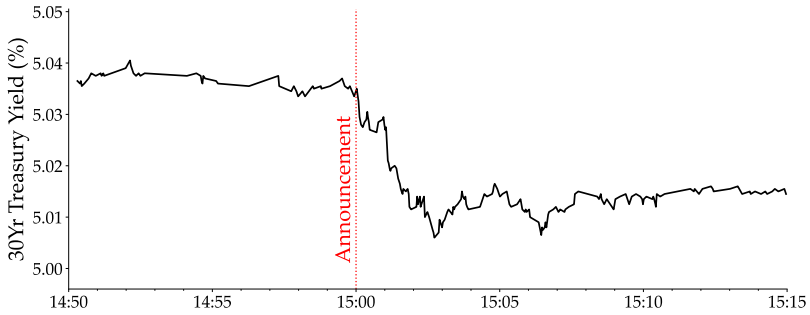
Using Treasury supply shocks and auction news, I estimate the high-frequency Treasury market response using intraday data. Let $y^{(m)}_{t,\text{pre}}, y^{(m)}_{t,\text{post}}$ be the Treasury yields of maturity m before and after

[26] Retuers: *US Treasury cuts Oct-Dec borrowing estimate to $776 bln, yields ease*; https://www.reuters.com/markets/us/us-treasury-borrow-776-billion-q4-2023-10-30/.

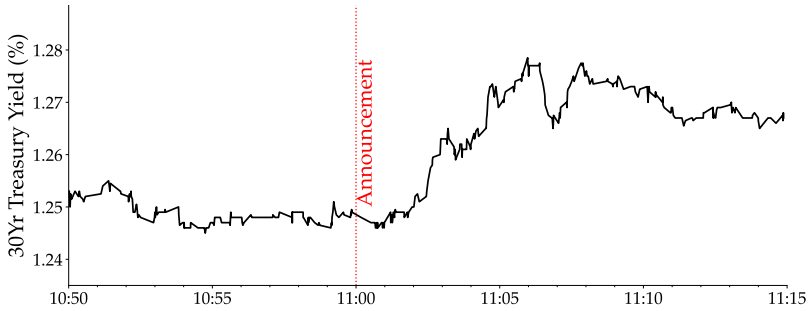
[27] Reuters: *Wall St dips as Treasury yields rise after auction.*; https://www.reuters.com/markets/us/futures-rise-earnings-optimism-disney-climbs-revamp-plan-2023-02-09/.

Figure 10: Intraday Treasury Yield Movements Around Announcements

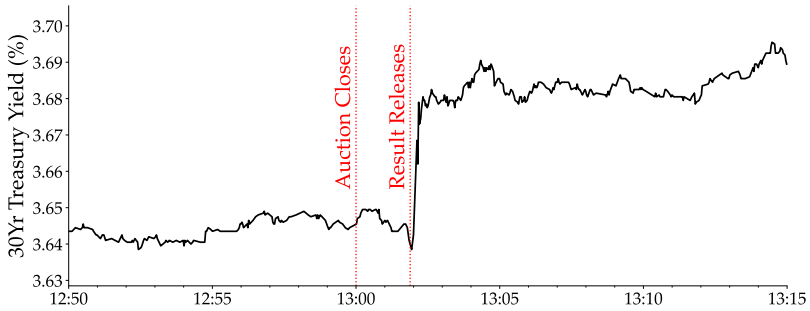
(a) October 30, 2023: Quarterly refunding financing estimates at 3:00 p.m. ET



(b) April 2, 2020: Auction announcements at 11:00 a.m. ET



(c) February 9, 2023: 30-year Treasury auction closes at 1:00 p.m., results released around 1:02 p.m. ET



Note: The panels plot the 30-year Treasury yield around three announcements. Panel (a): Quarterly refunding financing estimates announced on October 30, 2023 (3:00 p.m. ET). Panel (b): Auction announcements for the 3-year note (CUSIP 912828ZH6), 10-year note (CUSIP 912828Z94), and 30-year bond (CUSIP 912810SL3) on April 2, 2020 (11:00 a.m. ET). Panel (c): 30-year bond auction (CUSIP 912810TN8) on February 9, 2023; auction closed at 1:00 p.m. ET and results were released at roughly 1:02 p.m. ET.

the event on date t. I measure the surprise movements in Treasury yield as

$$\Delta y_t^{(m)} = y_{t,\text{post}}^{(m)} - y_{t,\text{pre}}^{(m)} \tag{33}$$

The main specification uses a 10 minute window around each announcement. For each maturity m, I focus on on-the-run Treasury notes and bonds, which are the most liquid instruments in their segments (e.g., Krishnamurthy, 2002). For event timing, the *quarterly borrowing financing estimates* are released at 3:00 p.m. ET on Monday of the refunding week. *Auction announcements*

have varied over time: before 2002 they were typically at 2:30 p.m. ET, and since 2002 they have generally been at 11:00 a.m. ET. *Regular auctions* usually close at 1:00 p.m. ET, and results are published promptly upon the close. The Treasury specifies the exact time of each release in official documents, which allows precise event-time stamping.[28] Specifically, for *auction results*, there can be a gap between auctions close at 1:00 p.m. ET and the public release of results, depending on how quickly the Treasury computes the outcome. Before 2003, release times ranged from approximately 5 min to as long as 60 min. Beginning in 2003, the Treasury began transmitting official results electronically to accredited news services, which sharply reduced delays. From August 2003 onward, the release times were generally less than two minutes. To ensure consistent event timing, my regressions using auction results include only auctions from August 2003 forward.[29]

The above shocks to new Treasury supply and the associated market responses allow me to test how Treasury market elasticity shifts when allocators' balance sheet constraints change. I first test Prediction 2 and validate swap spreads as a measure of balance sheet tightness in Section 5.2. I then compare Treasury market elasticity across periods in Section 5.3.

Validating the Treasury Supply Shocks. Before examining cross-regional heterogeneity, I first establish that the three identified shocks elicit a significant response in the U.S. Treasury market. Figure 11 plots the average high-frequency yield changes around the shock events over the full sample. Two observations emerge. First, all three shocks generate statistically significant yield responses within the 10-minute event window. Long-term Treasury yields are more sensitive to supply shocks and display larger price reactions than shorter maturities. Second, in terms of economic magnitude, a $100 billion (10-year-equivalent) shock from Shock 2 increases the 10-year yield by 7.31 basis points. The price impact for auction-specific demand shocks (Shock 3) is of a similar magnitude: a $100 billion decline in bid submissions raises the 10-year yield by 8.33 basis points. A $100 billion (10-year-equivalent) positive shock to aggregate borrowing needs (Shock 1) raises the 10-year yield by 0.53 basis points. The estimated effect of aggregate shocks is smaller because the Treasury Department adjusts bill issuance to absorb much of the variation in

[28] Original announcement and result documents are available at TreasuryDirect auction archives: https://treasurydirect.gov/auctions/announcements-data-results/announcement-results-press-releases/. I collect the release time for each event from the timestamps in these documents.

[29] The Treasury undertook a program in 2002–2003 to automate and accelerate auction result dissemination, aiming for release within two minutes. On December 18, 2002, Treasury announced that *"...beginning January 13, 2003 it would release official bill and note auction results electronically to accredited news services and the public..."* (see announcement). In late 2002 and early 2003 typical release times were about 4 to 10 minutes (see announcement). From August 2003, release times were consistently under two minutes (see announcement).

borrowing needs (see monthly Treasury auction amounts in Appendix Figure D.5).[30]

5.2 Swap Spread as a Measure of Balance Sheet Constraint

Prediction 1 implies that allocators are more likely to be constrained when the Treasury share in the debt market is high. When constraints are tighter, allocators rely more heavily on derivatives, which in turn leads to more negative derivative spreads. In my main specification, I therefore use derivative spreads rather than the Treasury share as the proxy for balance-sheet tightness. Using the Treasury share as a measure has two drawbacks. First, it is difficult to observe at high frequencies. Second, as shown in the model, balance-sheet tightness depends not only on the Treasury share but also on the level of duration demand relative to duration supply. This dependence makes it hard to compare the absolute level of the Treasury share across periods and to interpret it as a sufficient statistic for the constraint. By contrast, the price-based derivative spreads are available at high frequency and are directly linked to derivative usage, making them a more direct measure of the market-level balance-sheet constraint. In Appendix Table D.1, I proxy the US Treasury share in the long-term bond market using the US bond index composition and show that increases in the Treasury share are strongly associated with lower swap spreads.

In the model, the interest rate swap spread and the Treasury futures spread are equivalent. In practice, they differ because of contract-specific details. Treasury futures spreads are noisy and model-dependent: they hinge on the cheapest-to-deliver choice, conversion factors, delivery-option values, and bond-specific term repo rates—all of which vary over time and across traders. By contrast, the swap spread is stable across contract rolls and available at high frequency. Importantly, hedge funds and dealers engage in both swap and futures basis trades and face balance-sheet costs at the level of their total intermediation volume; therefore, swap spreads also reflect Treasury-futures intermediation activity. Accordingly, I use the 10-year swap spread as my market-level measure of the balance-sheet constraint.[31] In the following section, I first test Predic-

[30] The conversion to a common \$100 billion 10-year-equivalent supply scale proceeds as follows. For Shock 1 (Aggregate Borrowing), the high-frequency estimation implies that a 1% increase in total borrowing raises the 10-year yield by 0.14 bps. To express this in standardized units, note that the average total Treasury debt outstanding from 2008–2024 is approximately \$15 trillion, and the duration-weighted maturity of quarterly supply is about 1.5 years. Consequently, a 1% increase in total debt corresponds to roughly \$26.4 billion in 10-year-equivalent supply. Scaling this relation yields a price impact of $0.14 \times (100/26.4) = 0.53$ bps per \$100 billion shock. This is a conservative, lower-bound estimate, as it assumes a constant issuance maturity mix; in practice, the Treasury absorbs most marginal variation in borrowing needs through adjustments in short-term bill issuance. For Shock 3 (Auction Demand), the estimation shows that a one-unit decrease in the 10-year auction bid-to-cover ratio raises the 10-year yield by 2.0 bps. Given an average 10-year auction offering size of approximately \$24 billion (2008–2024), a \$100 billion decline in total bid submissions corresponds to a yield increase of $2.0 \times (100/24) = 8.33$ bps.

[31] Glicoes et al. (2024) quantify option-adjusted Treasury cash–futures spreads and document that these spreads are higher during periods of elevated Treasury-futures basis trading.

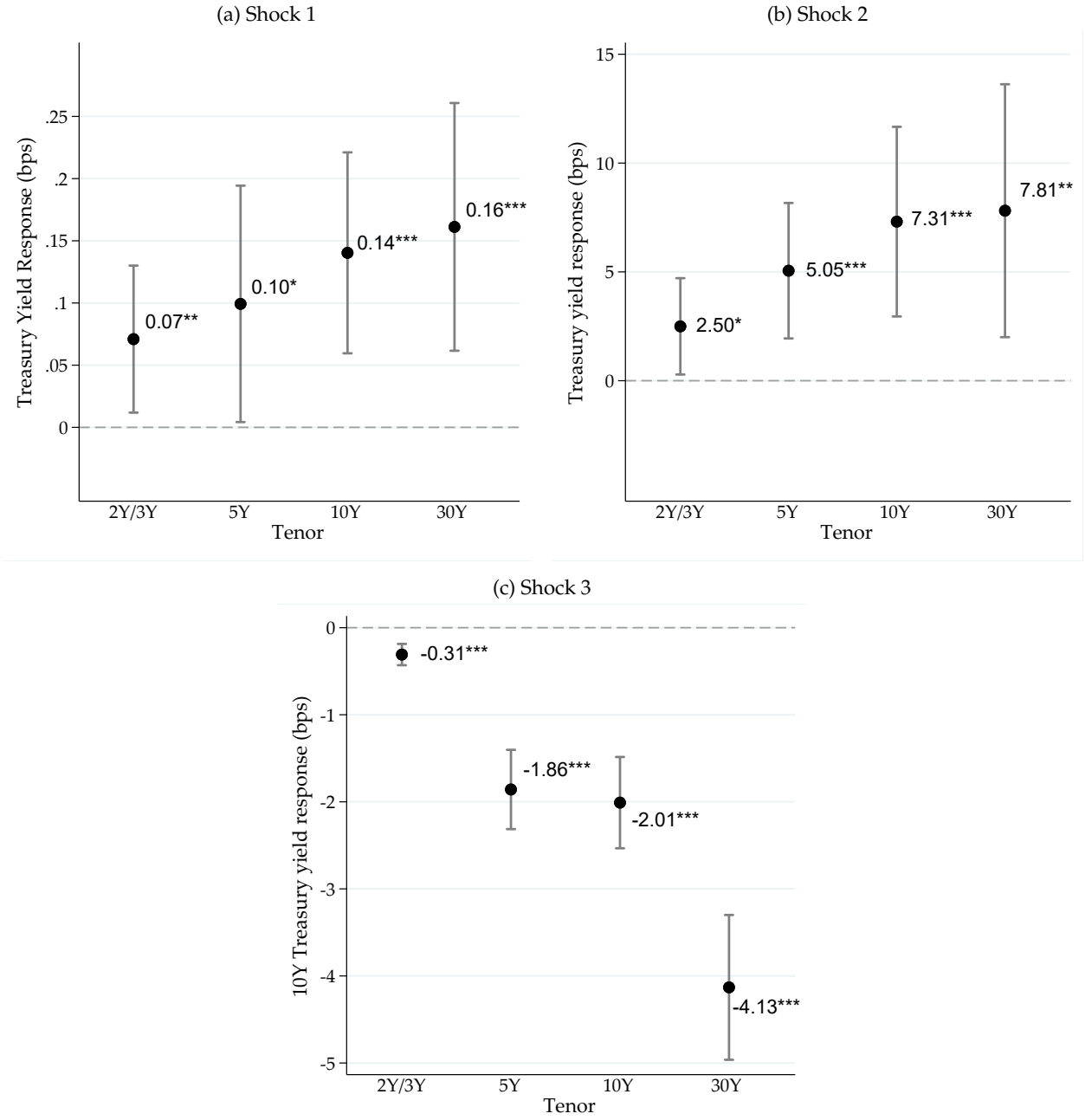


Figure 11: High Frequency Treasury Yield Responses to Supply Shocks

This table reports regressions of Treasury yield changes on three shock measures within a 10-minute window. P-values are based on Newey–West standard errors with nine lags (in parentheses). $p<0.01$, ** $p<0.05$, * $p<0.1$.

tion 2 and further validate swap spreads as a measure of balance-sheet tightness. I then compare Treasury market elasticity and the pass-through from the Treasury market to the corporate bond market across constraint regimes.

Validating Swap Spreads as a Measure of Balance Sheet Constraint Conceptually, a lower swap spread can reflect either stronger swap demand from allocators or higher per-unit intermediation costs for dealers and hedge funds. A large literature documents that swap spreads moved from positive to negative around the GFC, highlighting both demand forces (underfunded pensions' increased swap use (Klingler and Sundaresan, 2019)) and supply forces (higher dealer balance sheet costs of holding cash bonds (Jermann, 2020; Du et al., 2023; Boyarchenko et al., 2018)).[32] The key distinction between demand- and supply-side drivers is that they imply opposite movements in equilibrium derivative quantities. If supply-side costs dominate, lower swap spreads should be associated with lower derivative usage: higher per-unit intermediation costs lead hedge funds and dealers to charge wider (more negative) spreads, making derivatives less attractive to allocators and reducing usage. In contrast, if demand-side forces dominate (as in the model), lower swap spreads should be associated with higher derivative usage and larger intermediation volumes.

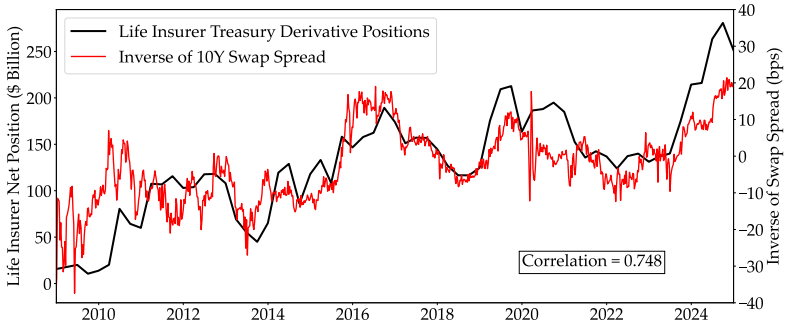
Leveraging NAIC quarterly filings, I obtain US life insurers' derivative positions. Life insurers target long liability durations and use both interest rate swaps and futures for duration management.[33] Figure 12a plots insurers' Treasury-derivative net positions against the 10-year swap spread since 2009: the series move in opposite directions, with lower spreads associated with higher derivative usage, with correlation standing at -0.75. On the intermediation side, Figure 12b shows that primary dealers' net cash Treasury positions—a standard proxy for intermediation activity (Du et al., 2023; Hanson et al., 2024)—also move opposite to the swap spread. Both pieces of evidence provide direct support for Prediction 2.

Quantitatively, I estimate latent demand and supply factors that drive swap spreads using a structural VAR following Hanson et al. (2024). The key identifying assumption is as above: demand and supply shocks that lower swap spreads move end-users' net positions (proxied by

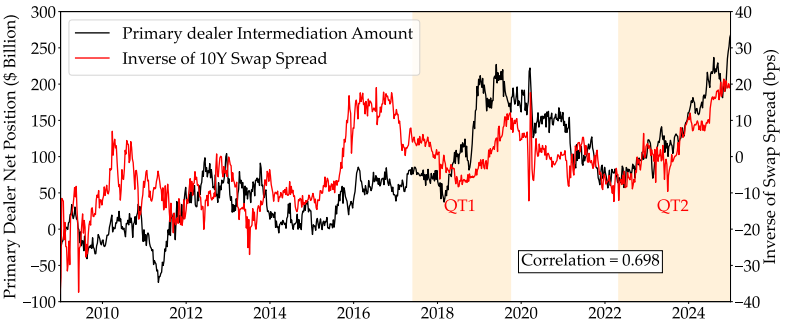
[32] Because the GFC represents a structural break in the swap market, I restrict the main sample to the period since 2009 to avoid confounding pre-GFC dynamics. Whereas prior work emphasizes the pre- versus post-GFC break, I focus on post-GFC swap spread variation and ask whether end-user demand is the primary driver in this period. In Appendix D.3, I use the full sample to compare Treasury market elasticity across different monetary policy regimes.

[33] Life insurers serve as representative allocators with both Treasury futures and swaps positions. Pension funds are another class of liability-driven investors with similar investment behavior (Jansen, 2025; Jansen et al., 2024a).

(a) Life insurer net interest rate derivative positions verse 10Y swap spreads



(b) Intermediation by primary dealers and verse 10Y swap spreads



(c) Decomposition of swap spreads

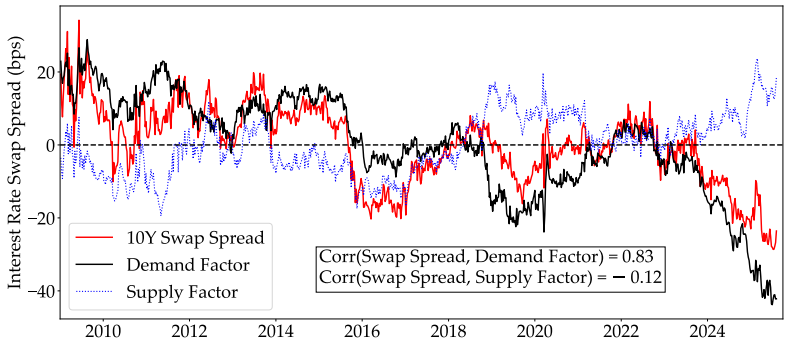


Figure 12: Life Insurer Derivative Usage, Primary Dealer Intermediation, and Swap Spreads.

Notes: The swap spreads was measured by the USD interest rate swap rate (LSEG USDAM3L10Y) minus the Treasury yield of the same maturity. The swap spreads and demand/supply factors in Figure 12c are demeaned.

primary dealers' net Treasury positions) in opposite directions, implying a sign restriction in the VAR (Uhlig, 2005) (see Appendix D.1 for the model and results). Figure 12c shows that, since the GFC, the 10-year swap spread was primarily driven by the demand factor (correlation = 0.83).[34]

[34]Surprisingly, the variance decomposition attributes -12.3% of swap-spread variation to supply factors (versus 112.3% to demand). As Figure 12c indicates, this is driven mainly by 2018–2020 and post-2022 when the supply factor moves opposite to the spread. A potential explanation is cheaper Repo funding costs for dealers and hedge funds enabled by large MMF inflows during hiking cycles (Drechsler et al., 2017; Xiao, 2020). Wallen and Lu (2025) document dealer banks lending at negative haircuts against Treasury collateral in those periods, which is consistent to this hypothesis.

Taken together, these evidence indicate that swap demand from end-users is the dominant driver of post-2009 swap spread variation. They validate the swap spread as a measure of market-level balance sheet constraints.

5.3 Treasury Market Elasticity and Pass-through to Corporate bond market

5.3.1 Treasury Market Elasticity Across Swap-Spread Regimes

Prediction 3 suggests that the Treasury market is less elastic when allocators are more balance sheet constrained. I compare the Treasury supply effects across different swap-spread regimes using three shock series identified in Section 5.1.

First, I estimate the Treasury market's response to the supply shock 1 and 2, across swap-spread regions:

$$\Delta y_t^{m,10min} = \alpha + \beta\ Shock_t + \sum_{i=2}^{4} \mu_i\ (Q_{Swap\ Spread_t^{10Y}} = i) + \sum_{i=2}^{4} \gamma_i\ Shock_t \times (Q_{Swap\ Spread_t^{10Y}} = i) + \lambda_m + \varepsilon_{m,t} \tag{34}$$

where $\Delta y_t^{m,10\text{min}}$ is the yield change for the on-the-run Treasury of maturity m within a 10-minute window around the announcement; $Q_{\text{Swap Spread}_t^{10Y}}$ denotes the quartile indicator of the 10Y swap spread (1 = bottom quartile; 4 = top quartile); and λ_m denotes maturity fixed effects. The results are reported in columns (1) and (2) of Table 1. Consistent with Prediction 3, the supply effect is significantly larger when balance-sheet constraints bind most—that is, when swap spreads are in the bottom quartile—and declines as constraints ease, becoming insignificant in the top quartile.

Second, I provide additional evidence estimating the market responses to auction result releases.

$$\Delta y_t^m = \alpha + \beta\ \text{bid-to-cover}_t^m + \sum_{i=2}^{4} \mu_i\ (Q_{Swap\ Spread_t^{10Y}} = i) + \sum_{i=2}^{4} \gamma_i\ \text{bid-to-cover}_t^m \times (Q_{Swap\ Spread_t^{10Y}} = i) + \lambda_m + \varepsilon_{m,t} \tag{35}$$

Column (3) in Table 1 compares the high-frequency Treasury yield responses to auction news across swap-spread regimes. The Treasury market is significantly more sensitive to auction news when the swap spread is in the bottom quartile. The responses gradually decline as allocators become less constrained. Quantitatively, in the most constrained regime, the Treasury market's response to auction demand news is about 1.68 times that in the least constrained regime.

Alternative measure and robustness check. Prediction 1 suggests that allocators are more likely to be balance-sheet constrained when the Treasury share of the debt market is higher. Using the

Table 1: Treasury Yield Responses to Three Shock Series

	(1) Shock 1	(2) Shock 2	(3) Shock 3
VARIABLES	$\Delta y_{10\text{ min}}$	$\Delta y_{10\text{ min}}$	$\Delta y_{10\text{ min}}$
$Shock_t$	0.677**	30.04**	-2.522**
	(0.266)	(11.98)	(0.518)
$Shock_t \times Q_{Swap\ Spread_t^{10Y}} = 2$	-0.536*	-24.77**	0.730*
	(0.289)	(12.17)	(0.314)
$Shock_t \times Q_{Swap\ Spread_t^{10Y}} = 3$	-0.555**	-25.27*	1.264***
	(0.272)	(13.61)	(0.317)
$Shock_t \times Q_{Swap\ Spread_t^{10Y}} = 4$	-0.859***	-29.74**	1.020**
	(0.292)	(13.45)	(0.314)
$Q_{Swap\ Spread_t^{10Y}} = 2$	0.362	-0.206	-1.742*
	(0.229)	(0.330)	(0.890)
$Q_{Swap\ Spread_t^{10Y}} = 3$	0.428**	-0.178	-2.724**
	(0.178)	(0.340)	(0.924)
$Q_{Swap\ Spread_t^{10Y}} = 4$	0.281	-0.237	-2.107*
	(0.178)	(0.352)	(0.953)
Observations	366	725	1,096
R-squared	0.118	0.112	0.116
Maturity FE	Y	Y	Y

Note: This table reports high-frequency Treasury yield responses to three identified supply shocks across swap-spread quartiles. The sample period covers January 2009 to March 2024. For Shock 1, the COVID quarter (2020Q2) are excluded. Standard errors, reported in parentheses, are clustered at the event-date level for columns (1) and (2), and at the bond-maturity level for column (3). Statistical significance is denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

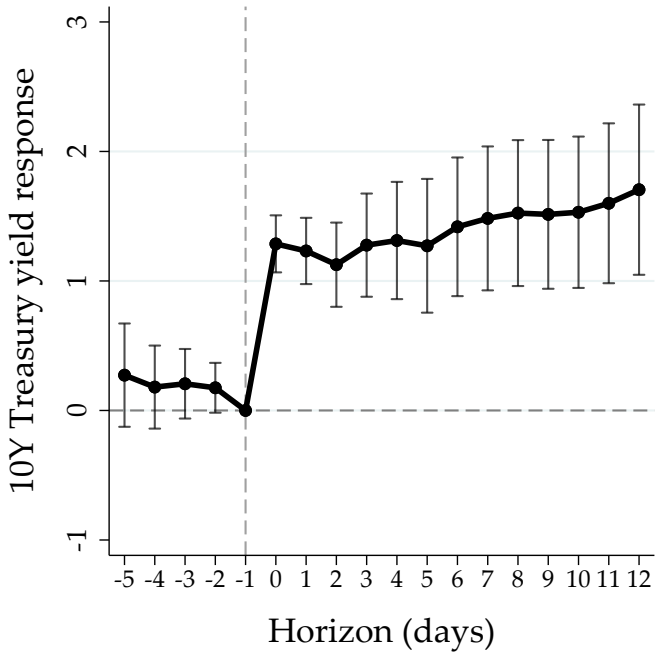
level of the Treasury share in the long-term bond market, I re-estimate the supply effects; Table D.2 shows that the conclusions are unchanged.

5.3.2 Pass-through from Treasury to Corporate Bond Market

Prediction 4 suggests that pass-through from Treasuries to corporate bonds is weaker when allocators' balance-sheet constraints bind. Under full pass-through, a rise in Treasury yields transmits one-for-one to corporate yields, leaving credit spreads unchanged. When pass-through is weaker, corporate yields move less than Treasuries, compressing credit spreads.

To test this prediction, I rely on Treasury shocks on auction days. This shock series has two advantages: (1) frequet observations and (2) persistent price effects. To document this persistence, I estimate how the 10-minute Treasury yield movement around an auction announcement predicts

Figure 13: Persistence of Treasury Market Responses to Auction Demand News



subsequent yield changes:

$$\Delta y^{10Y}_{t-1\to t+h} = \alpha_h + \beta_h \Delta y^{10Y,10\text{min}}_t + \text{Controls}_t + \varepsilon_{t,h}$$

Figure 13 illustrates the persistence of auction news. First, the 10-minute yield response around the auction announcement explains approximately 80% of the same-day yield movement. Second, the effect remains statistically and economically significant for more than two weeks. Given these persistent effects, I estimate the pass-through of Treasury yield movements on auction days to the corporate bond market across swap-spread regimes using the local projections method (Jordà, 2005):

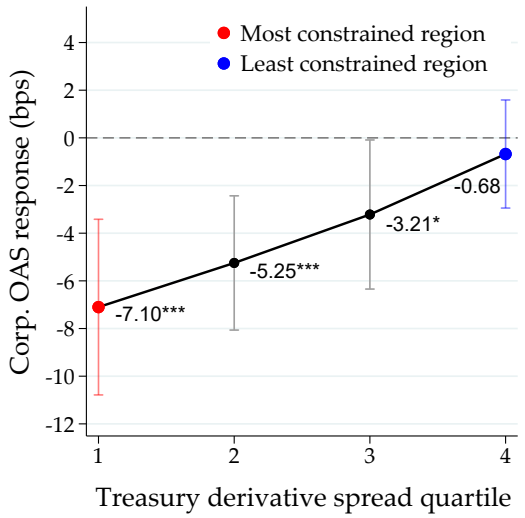
$$\Delta OAS_{t-1\to t+h} = \alpha_h + \beta_h \Delta y^{10Y}_t + \sum_{j=1}^{3} \Delta OAS_{t-j-1\to t-j} + \text{Controls}_t + \varepsilon_{t,h} \tag{36}$$

where $\Delta OAS_{t-1\to t+h}$ is the h-day cumulative change in the option-adjusted credit spread; Δy^{10Y}_t is the change in the 10-year US Treasury yield on auction days; $Q_{\text{Swap Spread}^{10Y}_t}$ is a discrete quartile indicator of the 10-year swap spread. Controls_t capture standard drivers of credit spreads, including the change in the business environment measured by the daily stock-market return $\Delta \log \text{StockIndex}_t$, the change in equity-market volatility ΔVIX_t, and the change in interest-rate

volatility ΔMOVE_t.

Figure 14 illustrates the pass-through from Treasuries to AAA corporate bonds. The left panel shows the immediate pass-through on auction days, and the right panel shows the impulse response functions following auction days. Consistent with Prediction 4, pass-through is weakest when constraints are tightest (bottom swap-spread quartile). Quantitatively, in the most constrained regime, a one percentage point increase in the Treasury yield on an auction day is associated with a 7.1 basis point compression in the AAA credit spread. This effect persists and cumulates to approximately 12 basis points over the following week. By contrast, when constraints are slack, increases in Treasury yields do not significantly compress credit spreads, indicating strong pass-through. This pattern remains qualitatively similar for lower-quality bonds, as shown in Appendix Figure D.6, though the differences across regimes become less statistically pronounced.[35]

(a) Treasury yield response to auction bid-to-cover ratio



(b) Pass-through from Treasuries to AAA corporate bonds

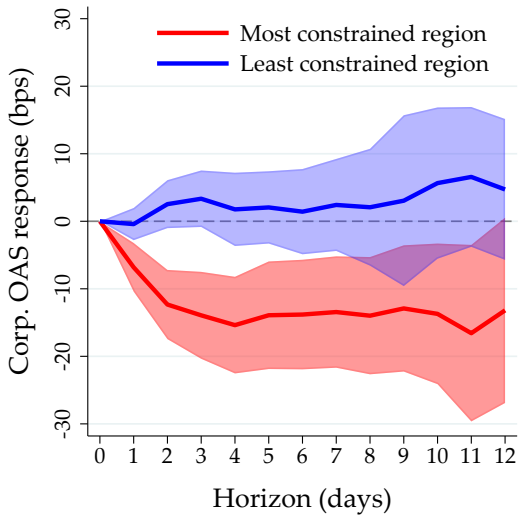


Figure 14: Pass-thorugh from Treasuries to AAA Corporate Bonds

Note: p-values for the left panel are based on Newey–West standard errors with nine lags. The shaded areas in the right panel represent 90% confidence intervals. Statistical significance is denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

One potential concern is that Treasury yield movements around auction days may affect corporate bond credit default probabilities, and this effect could differ across swap-spread regimes,

[35] AAA bonds are especially useful for this test because their default risk is negligible. This paper focuses on a market-segmentation channel: because the Treasury and corporate-bond markets are partially segmented, Treasury shocks need not pass through one-for-one to corporate yields, and pass-through is weaker when segmentation is greater. A distinct mechanism is the default-probability channel (Longstaff and Schwartz, 1995; Collin-Dufresn et al., 2001): higher long-maturity Treasury yields lower the market value of outstanding debt, reduce firms' expected default probabilities, and compress credit spreads. This mechanism works in the same direction as the market-segmentation channel and can mask it. The default-probability channel is far less salient for AAA bonds, making them a cleaner setting to test the market-segmentation channel.

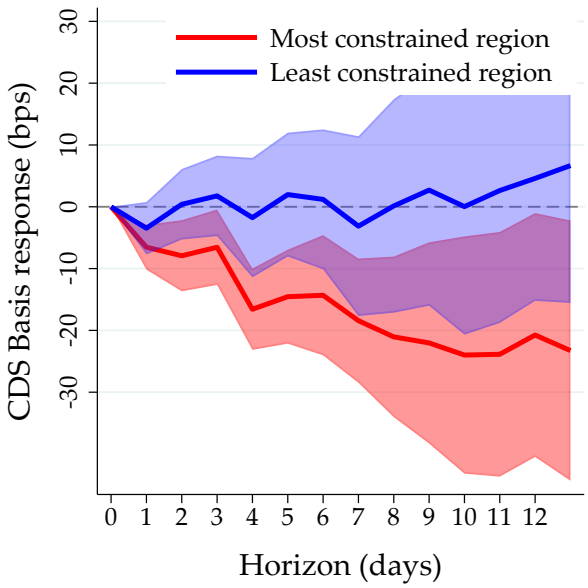


Figure 15: Pass-through from Treasuries to IG Corporate Bond (CDS adjusted)

Note: The shaded areas in the right panel represent 90% confidence intervals. Reported standard errors are based on Newey–West estimation with 9 lags.

thereby driving the observed heterogeneity. To address this, I isolate the non-default component of credit spreads by using the investment-grade (IG) bond CDX spread. Specifically, I calculate the CDS basis as the IG credit spread minus the corresponding IG CDX spread[36], and re-estimate 36. Figure 15 shows that the results are unchanged, indicating that the differential pass-through across swap-spread regimes stems from the degree of market segmentation rather than from heterogeneous changes in credit default risk.

6 Evidence from Allocators' Derivative Positions

In this section, I open cash bond and interest rate derivative holdings for the two types of allocators and provide firm-level support for the model.

6.1 Mutual Fund Sector

Figure 16 summarizes assets under management and Treasury futures positions by bond fund type. It delivers two messages: First, within the bond-fund sector, roughly 69% of funds target the 5-to 10-year segment; these mid-duration funds are primarily Morningstar-classified core or

[36]The IG bond index has a duration of approximately 5–8 years. I use the 5-year IG CDX spread, which is the most liquid tenor.

core-plus vehicles focused on investment-grade bonds (Figure 16a). Second, core and core-plus funds are also the dominant users of Treasury futures (Figure 16b).[37]

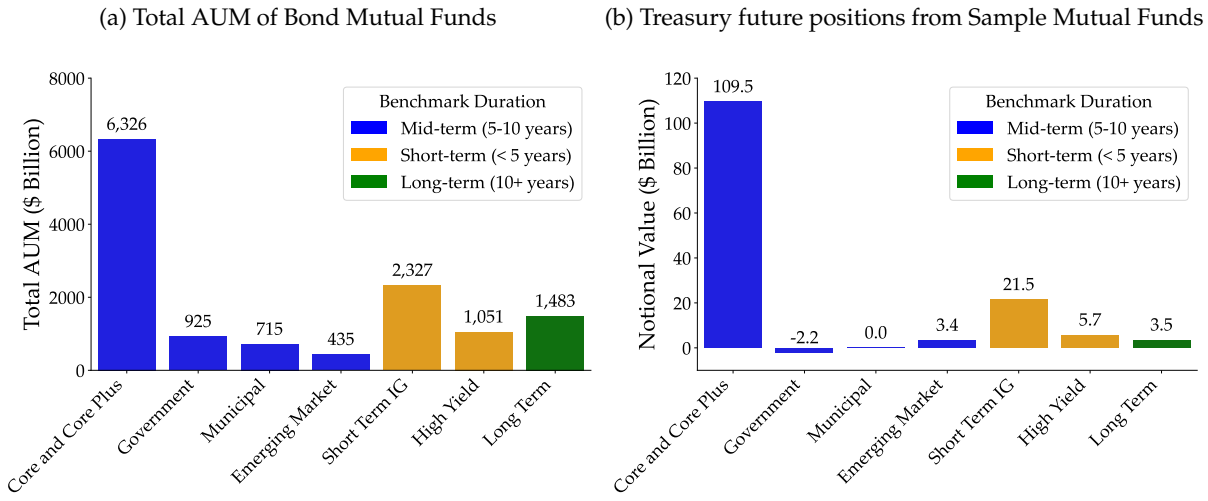


Figure 16: Bond Mutual Funds AUM and Treasury Future Positions

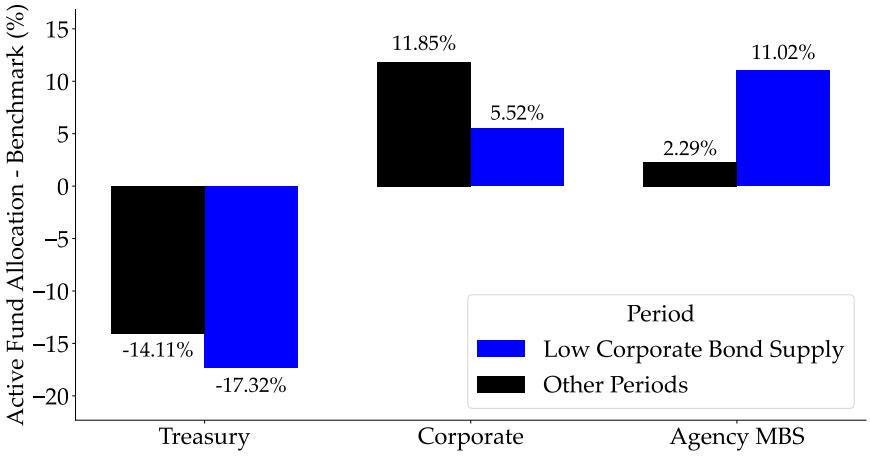
Notes: Figure 16a plots the total assets under management (AUM) of fixed-income mutual funds in the Morningstar dataset, grouped by their Morningstar benchmark index. Benchmark indices are classified as short-term (below five years), medium-term (five to ten years), and long-term (above ten years) based on duration. Figure 16b reports the Treasury futures positions of representative funds within each category that disclose detailed derivative holdings. All data are from the Morningstar holdings reports as of 2024Q2. Funds without an identified Morningstar category are excluded from the sample.

Core and core-plus funds are typically benchmarked to the Bloomberg US Aggregate Bond Index. They pursue two objectives: (i) outperform the benchmark and (ii) keep portfolio duration close to the benchmark—duration mandate in the model (Barth et al., 2024; Treasury Borrowing Advisory Committee, 2024). To generate excess yield, actively managed funds underweight lower-yield Treasuries and overweight higher-yield bonds relative to the benchmark index. Figure 17a compares the asset allocations of all actively managed funds benchmarked to the Bloomberg US Aggregate Bond Index with the index itself. The three main bond assets are Treasuries, corporate bonds, and MBS; in the model, they map to long-term Treasuries, long-term corporate bonds, and short-term corporate bonds.[38] The figure contrasts two regimes: periods of low corporate bond supply (coinciding with quantitative tightening, QT) and all other periods since 2008. In both regimes, active funds systematically underweight Treasuries and overweight corporate bonds and MBS to seek excess yield. When corporate bond supply is ample, they overweight

[37] Appendix Figure D.7 decomposes Treasury-futures positions by maturity bucket. Short-term funds concentrate in short-maturity futures, whereas core and core-plus funds hold comparable positions in short- and mid-maturity futures.

[38] The US bond market consists primarily of Treasuries, corporate bonds, and MBS. Treasuries and corporate bonds make up the long-duration segment, while MBS play the empirical role of the model's short-duration, credit risk–bearing asset. Figure A.5 shows the composition by asset class and duration.

(a) Actively managed funds' bond allocation v.s. Benchmark index



(b) Treasury futures positions

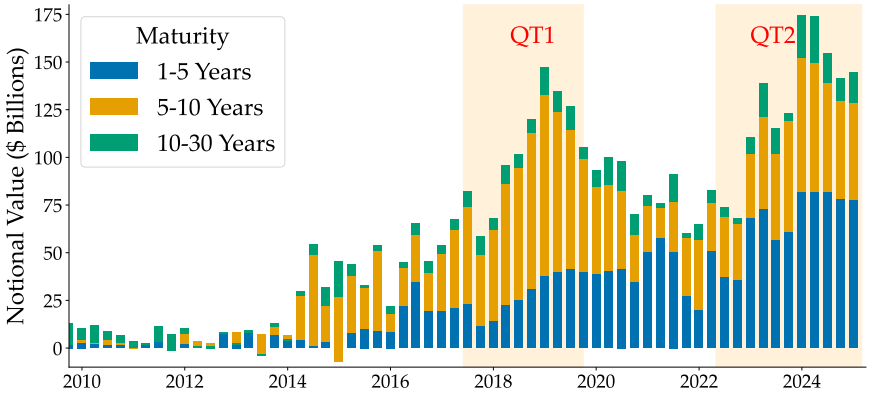


Figure 17: Mutual Fund Cash-bond Allocations and Treasury Future Positions

Note: Figure 17a plots the allocation weights actively managed funds minus the asset weights in the benchmark index. The sample includes all 1,034 actively managed funds in the Morningstar database that benchmark to the Bloomberg US Aggregate Bond Index. Figure 17b plots Treasury futures positions for funds that disclose contract-level derivative holdings. Orange shading denotes quantitative tightening (QT) periods.

corporate bond and maintain a portfolio duration that roughly matches the benchmark. When corporate bond supply is scarce, they face a persistent duration shortfall and bridge it using Treasury futures. As shown in Figure 17b, active funds substantially increase their Treasury futures positions during QT episodes—when Treasury supply is elevated and corporate bond supply is low—which aligns with and supports Prediction 1.

I measure mutual funds' Treasury futures exposure using dollar duration (DV01), defined as the dollar change in the value of their Treasury futures positions for a 1 bp change in interest rates. Columns (1)–(3) of Table 2 estimate the effects of increases in the Treasury share in the long-term bond market and in the duration mandate on mutual funds' Treasury futures exposure. The

Table 2: Regressions of Firm-level Interest Rate Derivative Positions

	Mutual Funds				Life Insurance Companies			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Derivative dollar duration (DV01 in k$)				Derivative dollar duration (DV01 in k$)			
$Swap\ Spread_t^{10Y}$	-1.516***			-0.915**	-26.94**			-22.09***
	(0.413)			(0.454)	(11.56)			(4.726)
Δ *Treasury Share*$_t$		37.75***		20.83*		464.2***		203.8**
		(10.71)		(11.82)		(93.74)		(91.14)
Bond index duration$_t$			36.14***	23.07**				
			(12.93)	(10.14)				
y_t^{10Y}							-274.0***	-307.4***
							(86.71)	(69.57)
Observations	46,197	46,197	46,197	46,197	7,107	7,107	7,107	7,107
R-squared	0.401	0.401	0.401	0.402	0.514	0.514	0.513	0.516
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y

Note: $DV01_{i,t}$ measures firm i's interest-rate exposure from interest-rate derivatives in quarter t (in \$ millions). *Bond index duration*$_t$ is the Bloomberg U.S. Aggregate Bond Index duration, which captures the benchmark duration for Core and Core Plus mutual funds. Δ*Treasury Share*$_t$ denotes the change in the two-year rolling average of the Treasury share in the long-term bond market. y_t^{10Y} is the 10-year Treasury yield. Controls include the MOVE index and the VIX index. p-values are based on robust standard errors (in parentheses) clustered by time and firm. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

duration mandate of mutual funds is approximated by the duration of the Bloomberg U.S. Aggregate Bond Index. Consistent with Prediction 1, a higher Treasury share in the debt market and a higher duration mandate make mutual funds more likely to be balance-sheet constrained and to take larger interest-rate derivatives positions. Quantitatively, a 1 percentage point increase in the Treasury share is associated with an additional \$20.83k of interest-rate exposure via Treasury futures, corresponding to a notional position of approximately \$38 million in 10-year Treasury futures (ZN), an economically significant magnitude. A one-year increase in the duration mandate is associated with an additional \$27.7k of interest-rate exposure via Treasury futures, corresponding to a notional position of approximately \$24.2 million in 10-year Treasury futures.[39]

6.2 Life Insurance Sector

Model prediction 1 suggests that balance-sheet constraints are affected by two forces: (i) the *source* of duration risk available to allocators, captured by the Treasury–corporate bond share; and (ii) the *level* of duration risk required, captured by the duration mandate $\bar{D}$. Constraints are more likely to bind when (i) Treasuries are the principal supplier of duration and (ii) allocators must

[39] See Appendix A.1 for details on the DV01 estimation. A \$1 million notional position in the 10-year Treasury future (contract ZN) has a DV01 of approximately \$860 per basis point.

take more duration risk by mandate (high $\bar{D}$).

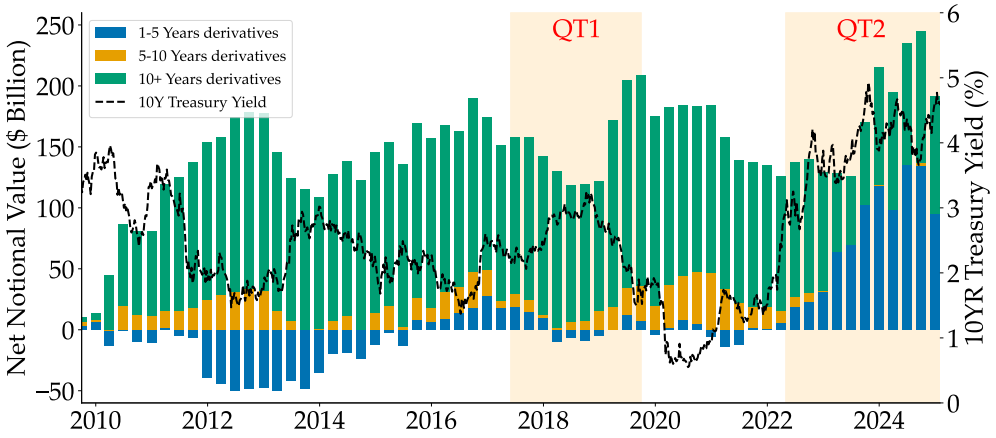


Figure 18: Life Insurer Interest Rate Derivative Positions and Long-term Treasury Yields

Notes: The interest rate derivative positions includes both interest rate swaps and Treasury futures. Data source: NAIC schedule DB.

Life insurers are an ideal setting to test these two forces. They target long liability durations—typically 15–20 years—and the duration of their liabilities declines as long-term interest rates increase (Domanski et al., 2017; Ozdagli and Wang, 2019; Li, 2025). Figure 18 shows life insurers' net Treasury-derivative positions and reveals both forces. On the one hand, derivative usage is sensitive to long-term rates: insurers increase positions when the 10-year Treasury yield declines and scale back when rates rise, reflecting force (ii). On the other hand, the sharp rise in derivative positions since late 2023, despite $\approx$ 5% long-term rates, highlights force (i).

Columns (4)–(6) of Table 2 quantify the sensitivity of U.S. life insurers' interest-rate derivatives exposure to long-term rates and to the Treasury share in the long-term bond market. A 1% increase in the 10-year Treasury yield is associated with a \$201K decline in interest-rate exposure from interest-rate derivatives (DV01), corresponding to a reduction of approximately \$67 million in notional 30-year Treasury futures (WN). A 1 percentage point increase in the Treasury share of the long-term bond market is associated with a \$307k increase in interest-rate exposure from interest-rate derivatives, corresponding to a notional position of approximately \$102 million in 30-year Treasury futures (WN).[40]

[40] A \$1 million notional position in the Ultra 30-Year Treasury future (contract WN) has a DV01 of approximately \$3000 per basis point.

7 Policy Implication

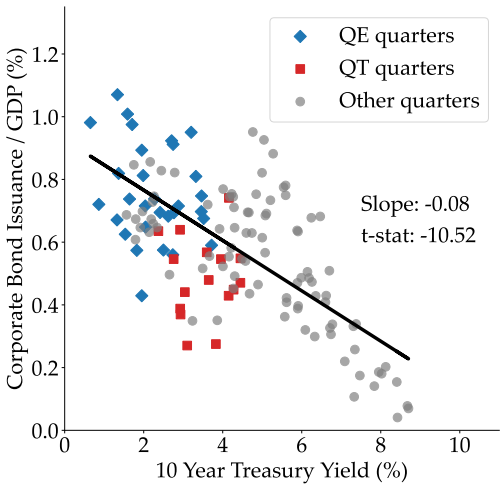
This study argues that debt market composition is a large determinant of Treasury supply effects. The mechanism applies broadly to forces that shift the share of public and private debt. It speaks to both fiscal authorities that issue large quantities of government debt in response to fiscal deficits, and to monetary authorities whose unconventional policies reshape the debt market composition. In this section, I focus on monetary policy implications and draw two conclusions.

QE and QT asymmetry. The mechanism implies the asymmetric effects of QE and QT through the duration-supply channel because they operate in distinct debt market environments. In Appendix D.3, I compare Treasury market elasticity and pass-through from Treasuries to corporate bonds in QT and QE. First, both aggregate and maturity-specific Treasury supply shocks identified in Section 5 significantly move Treasury yields in QT, with no statistically significant effects in QE. Quantitatively, yield responses to primary-market auction news are about 180% larger in QT than in QE. Together, these results indicate a less elastic Treasury market in QT. Second, pass-through from Treasuries to the corporate-bond market is weaker in QT: during QT, Treasury supply shocks compress credit spreads across the credit spectrum, with statistically significant effects absent in QE; in addition, the daily pass-through from Treasury yields to AAA corporate yields is roughly 12.5% weaker in QT than in QE, indicating reduced asset substitutability and weaker transmission.

Federal Reserve operations shape debt market structure from two sides. On the Treasury side, QE removes Treasuries from the market, whereas QT releases them back. On the corporate side, firms time long-term issuance. QE typically occurs when short-term rates are at the zero lower bound and firms tilt toward long-term financing in such low-rate environments (Graham and Harvey, 2001; Baker et al., 2003). In addition, the Fed's Treasury purchases further encourage the corporate sector to "fill the gap" (Greenwood et al., 2010; Badoer and James, 2016; Eren et al., 2025). By contrast, the two most recent QTs took place during rate-hike cycles, when firms reduce long-term bond issuance. Figure 19 shows the deal-level USD-denominated corporate-bond issuance: a 1% increase in the 10-year Treasury yield is associated with an 8% decline in mid-term issuance and a 6% decline in long-term issuance, and QE quarters stand out for elevated corporate issuance.

Distinct debt market structures imply that QE and QT have asymmetric *micro* effects in the Treasury market and *macro* effects in broader asset markets. In terms of *macro* effects, QE generates spillovers to the corporate bond market through allocators' portfolio rebalancing (Selgrad, 2023),

(a) Quarterly corporate bond supply (5Y-10Y)



(b) Quarterly corporate bond supply (≥ 10Y)

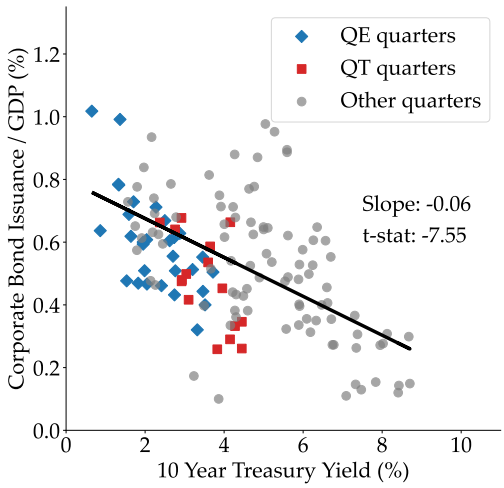


Figure 19: Market Timing of Corporate Bond Issuance

Notes: Those figures plot the quarterly corporate bond supply in 5–10 years and ≥10 years, scaled by GDP. The data covers all corporate bond issuances denominated in USD from 1990Q1 to 2024Q4. Data source: LSEG Debt New Issues Deals Data.

which reduces corporate yields and thus firm borrowing costs. In contrast, during QT, the effects of the Federal Reserve's Treasury offloading are concentrated in the Treasury market, with limited spillover to corporate bonds: credit spreads have remained low throughout QT, and major indices have approached historical lows since 2024 despite the tightening cycle (Figure 4).

These patterns point to a potential "QE ratchet" issue faced by central banks: balance sheet runoff can push the term premium up sharply and raise stability risks from basis trade activities. As a result, central banks may find it harder to reverse past purchases and may need to slow or pause QT earlier than planned. A ratcheting central-bank balance sheet could narrow the future policy space and blur the boundary between monetary and fiscal policies.[41]

Market timing of QT. On the constructive side, the mechanism speaks to policy debates on the optimal timing of QT, particularly the sequencing of rate hikes and balance sheet runoff (for example, Benigno and Benigno, 2022; Alexandrov and Brunnermeier, 2025). When QT was designed in 2017, FOMC members held divergent views on both the pace and timing of balance

[41] See also former Bank of England Governor Mervyn King, *Quantitative Easing Is a Dangerous Addiction*, July 20, 2021: ",[Quantitative easing] tends to be deployed in response to bad news, but isn't reversed when the bad news ends. As a result, the stock of bonds held by central banks ratchets up, expanding their balance sheets into the longer term."

sheet runoff.[42] In both QT1 and QT2, policy rates were raised before balance sheet normalization; as a result, Treasury offloading occurred when corporate issuance was weak, pushing up the Treasury share remarkedly. A cautious reading of the mechanism suggests that, when feasible, initiating QT ahead of hiking cycles—or concentrating QT in periods with rich corporate-bond shares—could help mitigate basis trade pressures.

8 Conclusion

This paper studies how debt market composition affects Treasury market elasticity and pass-through from Treasuries to the corporate bond market. The theory emphasizes fixed-income allocators who link Treasuries to the broader debt market. When the Treasury share of the debt market is high, allocators are forced to meet duration mandates with Treasuries, which tightens balance-sheet constraints and weakens portfolio rebalancing. As a result, marginal Treasury supply has larger impacts on the Treasury market and weaker spillovers to corporate bonds. The theory also explains allocators' elevated positions in interest rate derivatives when the Treasury share increases and identifies swap spreads as a measure of balance-sheet constraints. Using novel supply shocks from the Treasury issuance calendar, I document that lower swap spreads are associated with larger Treasury supply effects and weaker spillovers to corporate bonds. Micro evidence from mutual funds' and life insurers' derivatives positions further supports the theory.

The mechanism implies that QE and QT are not mirror images. QE can effectively compress credit spreads and stimulate corporate borrowing. However, balance-sheet runoff in high-Treasury-share environments can push term premium up and elevate basis-trade activity sharply, raising financial stability concerns. Initiating QT ahead of hiking cycles or concentrating QT in periods with rich corporate bond shares can help mitigate basis trade pressures.

Finally, the mechanism also speaks to persistent US fiscal deficits. The Congressional Budget Office projects that, from 2025 to 2035, federal debt held by the public will rise from about 100% to 118% of GDP as mandatory spending and interest costs outpace revenues. In such an environment, the marginal impact of additional Treasury supply could be even larger, basis trade activity more severe, and the linkage from Treasuries to private credit markets weaker.

[42] See Ben Bernanke's commentary on QT design, *Shrinking the Fed's balance sheet*, which summarizes FOMC discussions. Reserve Bank presidents Robert Kaplan, James Bullard, and Patrick Harker supported earlier QT. President Eric Rosengren also raised the possibility of "active QT", using asset sales to influence the slope of the Treasury yield curve.

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Supplemental Appendix

for "Debt Market Composition and Treasury Supply Effects"

by Daojing Zhai

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A Additional Institutional Background

A.1 Interest Rate Derivatives and the Basis Trade

A.1.1 End Users: Allocators' Duration Mandates and Use of Interest Rate Derivatives

Duration mandate. Duration is a measure of a security's sensitivity to interest rate changes. Asset managers need duration because their liabilities or benchmarks require it. Mutual funds must match the duration of their benchmark index; if the index has long maturity, funds must hold assets with similar interest-rate sensitivity. Life insurers and pension funds face long-duration liabilities: when interest rates fall, the present value of their liabilities increases sharply. To hedge this risk and maintain solvency ratios, they must hold assets with similar duration so that asset values rise when their liability values rise. In both settings, holding too little duration exposes the institution to interest-rate risk and violates regulatory or contractual requirements.

Interest rate derivatives. Asset managers can use interest rate derivatives to obtain duration exposure without purchasing cash bonds. There are two common derivatives: Treasury futures and interest rate swaps. Treasury futures are commonly used by mutual funds targeting intermediate duration (Barth et al., 2024), whereas swaps are prevalent among liability driven investors, such as insurers and pension funds, that hedge long duration (Klingler and Sundaresan, 2019; Khetan et al., 2024). Like cash bonds, changes in the fair value of these derivatives are recorded on the balance sheet and affect equity. The key difference is that holding derivatives does not require showing a large bond asset on the balance sheet. Instead, only small margin balances or derivative receivables/payables appear. As a result, derivatives provide the same interest-rate sensitivity as cash bonds but use only a small fraction of the balance-sheet space.

Treasury futures are standardized contracts on deliverable Treasury securities with a three-month maturity. Going long a Treasury futures contract gives the asset manager the same price sensitivity as holding the deliverable Treasury. In practice, the asset manager deposits only a small amount of margin and can keep the position until expiration, then close it and roll into a new contract. Because no cash Treasury is purchased, the position stays off balance sheet while still delivering full duration exposure.

Interest rate swaps work similarly. A swap is an agreement to exchange interest payments based on a notional amount that is never actually exchanged. By receiving fixed and paying floating, an asset manager replicates the payoff of a long-duration fixed-rate Treasury. The asset

manager only pays or receives periodic net interest payments and deposits a small amount of collateral as needed. No large cash Treasury position appears on the balance sheet, but the swap position generates essentially the same duration as holding a long-duration Treasury.

Regulatory frictions lead to derivative leverage. In theory, asset managers could purchase cash Treasuries and finance them in the repo market to avoid the derivative spread. In practice, asset managers often prefer derivatives to repo-financed cash Treasuries for three reasons (Treasury Borrowing Advisory Committee, 2024). First, regulation on repo financing tilts asset managers toward derivatives. Open-end mutual funds are regulated by the Investment Company Act of 1940 ("40 Act"); repo financing is treated as a borrowing and counts toward Section 18's 300% asset-coverage requirement (i.e., debt $\leq 33\frac{1}{3}\%$ of total assets). By contrast, interest rate derivatives fall under Rule 18f-4 and, when used in compliance with that rule, do not count as borrowings for the Section 18 asset-coverage test.[43] Separate accounts are governed by the client investment management agreement (IMA); in practice, many IMAs permit the use of derivatives (futures and swaps) but restrict or prohibit repo, tilting choices toward derivatives over repo-financed cash Treasuries. Second, from an accounting perspective: funds must report repo interest as a distinct investment expense, whereas derivatives embed financing and avoid a visible interest-expense line. This presentation can make repo financing appear more expensive even when repo rates are more economical. Third, in terms of operational simplicity, futures remove the need for cash/repo trades and simply execution.

Measure the interest rate exposure Interest rate exposure is typically measured by the dollar value of a basis point (DV01), defined as the dollar change in price for a 1 bp change in the yield.

Consider a coupon bond with face value F paying coupons semiannually, with annual coupon rate c, yield to maturity y, and maturity N years. Its Macaulay duration is

$$D_{\text{Mac}} = \frac{1}{P} \sum_{k=1}^{2N} \frac{k}{2} \cdot \frac{CF_k}{(1+y/2)^k}, \tag{A.1}$$

where the cash flows satisfy

$$CF_k = \frac{cF}{2} \quad \text{for } k \leq 2N-1, \quad CF_{2N} = \frac{cF}{2} + F. \tag{A.2}$$

[43] Under Rule 18f-4, derivatives are subject to value-at-risk (VaR) limits (relative VaR $\leq$ 200% of a designated reference portfolio or absolute VaR $\leq$ 20% of NAV) and related risk-management requirements rather than the traditional asset-coverage test for senior securities.

The relation between DV01 and Macaulay duration is

$$DV01 \approx 0.01\% \cdot \frac{P \times D_{\text{Mac}}}{1 + y/2} \tag{A.3}$$

I calculate the DV01 of Treasury futures and interest rate swaps by taking F as the notional value of the derivative position. The coupon rate c and yield to maturity y are taken from the prevailing on-the-run Treasury bond with the same maturity as the corresponding underlying Treasury. For example, an Ultra 10-Year U.S. Treasury futures contract (TN) with a notional value \$1 Million has DV01 of roughly \$850 in 2024. The mapping between Treasury futures and their underlying Treasuries is reported in Table C.1.

A.1.2 The Opposite Side: Hedge Funds, Dealers, and the Basis Trade

Treasury futures. Treasury futures are exchange traded on the Chicago Mercantile Exchange, and the CFTC's Traders in Financial Futures report provides weekly net positions by participant group. Figure A.1 shows asset managers take net long Treasury futures, while leveraged funds (hedge funds) take the opposite side. The asset-manager net long position increased in both QT1 and QT2, reaching about \$500 billion by late 2019 and approaching \$1.2 trillion by April 2025.

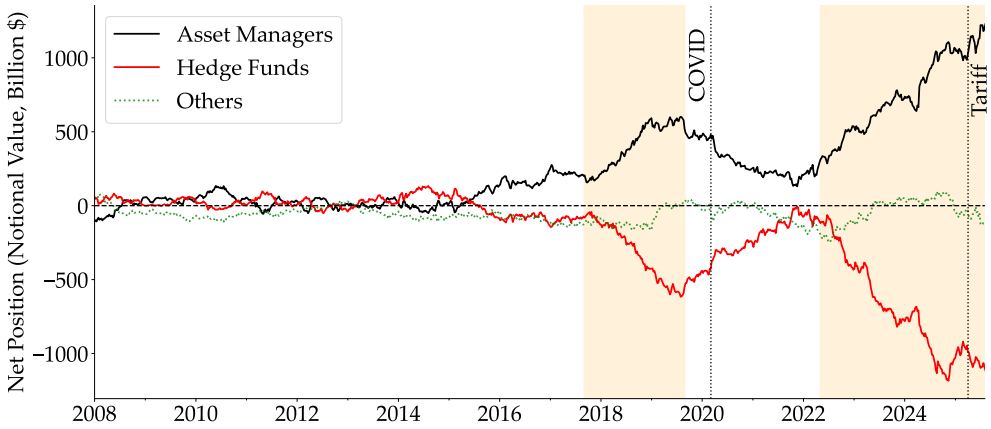


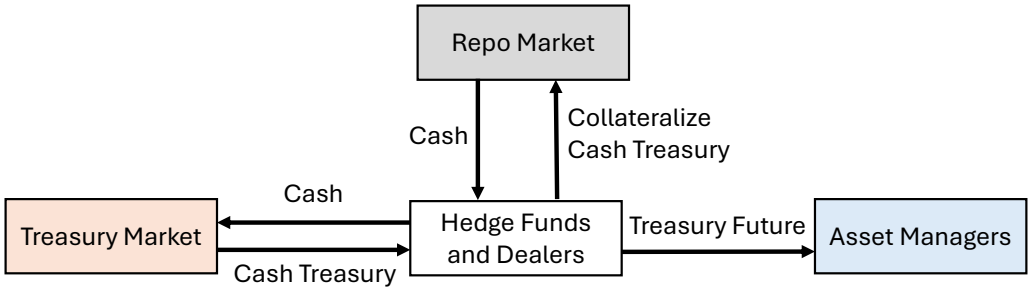
Figure A.1: Net Position of US Treasury Futures by Market Participants

Note: This figure plots net positions in US Treasury futures by participant group. "Asset managers" include mutual funds, pension funds, and insurance companies; "Leveraged funds" are primarily hedge funds; "Others" include dealers and intermediaries. The orange shaded areas indicate periods of quantitative tightening (QT). The "COVID" marker denotes the March 2020 Treasury market turmoil, and "Tariff" denotes the April 2, 2025 tariff shock. The data is retrived from Traders in Financial Futures (TFF) reports published by the Commodity Futures Trading Commission (CFTC). TFF dataset doesn't include 20 Yr treasury future and 3 yr treasury future, which was introduced by CME in 2020 and 2022. So it underestimate the size of treasury market and basis trade.

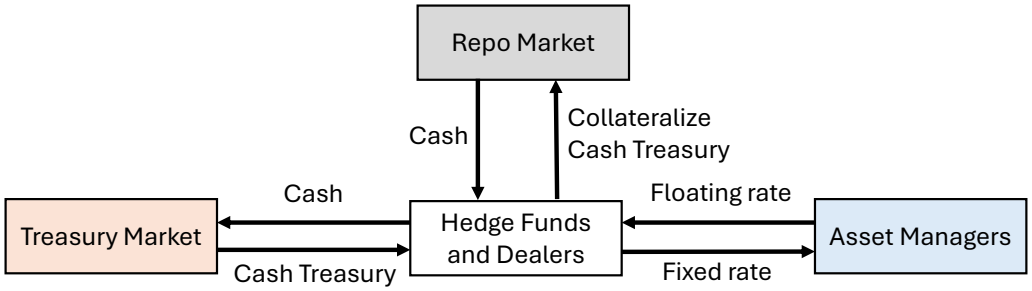
Hedge funds supply Treasury futures via Basis Trade as illustraed in the panel (a) of Figure A.2a. The hedge fund purchases a cash Treasury, finances it in the repo market with the bond

Figure A.2: The Illustrations of Treasury Future and Interest Rate Swap Basis Trade

(a) Treasury future basis trade



(b) Interest rate swap basis trade



Note: This figure illustrates the Treasury future and interest rate swap basis trade. Panel A.2a displays the Treasury future basis trade and is based on Barth and Kahn (2020); Panel A.2b displays the interest rate swap basis trade and is based on Boyarchenko et al. (2018).

as collateral, and sells a Treasury futures contract to the asset manager; the profit is the difference between the cash bond yield and the yield implied by the futures price. Because cash-future basis are small, hedge funds typically employ substantial leverage through repo financing to achieve economically meaningful returns. In late 2019, leverage ratios in futures basis trades averaged roughly 175× for the 5-year and 120× for the 10-year Treasury (Avalos and Sushko, 2023).

Dealers intermediate almost every leg of the hedge-fund basis trade. First, on the financing side, hedge funds obtain leverage by borrowing cash in the repo market, with dealers acting as their main repo counterparties and, in turn, sourcing cash from money market funds. Second, on the derivatives side, dealers facilitate hedge funds' short futures positions by providing margin accounts and clearing services through their futures commission merchant affiliates. Third, in uncleared derivatives and structured basis trades, dealers may also act as the direct counterparty to asset managers, effectively supplying Treasury futures. For expositional simplicity, I abstract from the details of dealer intermediation and treat hedge funds and dealers jointly as the net

suppliers of Treasury derivatives in this paper.[44]

Interest Rate Swaps Interest rate swaps trade over the counter, so data on positions by participant type are limited. A large literature documents strong net demand for receiving fixed in swaps since 2009 and highlights the central role of liability-driven investors (pension funds and life insurance companies)(e.g. Klingler and Sundaresan, 2019; Jermann, 2020; Du et al., 2023; Hanson et al., 2024). This literature also shows that dealers play an important role in supplying swaps (paying fixed), and the intermediation volume is typically approximated using primary dealers' cash-Treasury holdings. Hedge funds also play an important role in supplying swaps.(Kashyap et al., 2025; Perli, 2025) However, their intermediation volume is not directly observed.

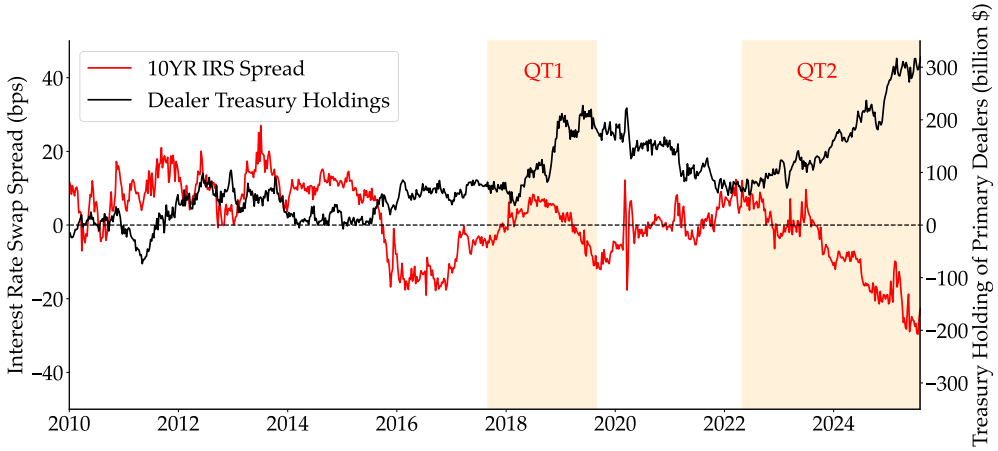


Figure A.3: Interest Rate Swap Spread and Primary Dealer Treasury Positions

Note: This figure plots 10 year interest rate swap spreads together with primary dealers' Treasury holdings. A swap spread is the USD interest rate swap rate (LSEG USDAM3L10Y) minus the Treasury yield of the same maturity. The orange shaded areas indicate periods of quantitative tightening (QT). Sources: LSEG Refinitiv Workspace; Federal Reserve Bank of New York, Weekly Primary Dealer Statistics.

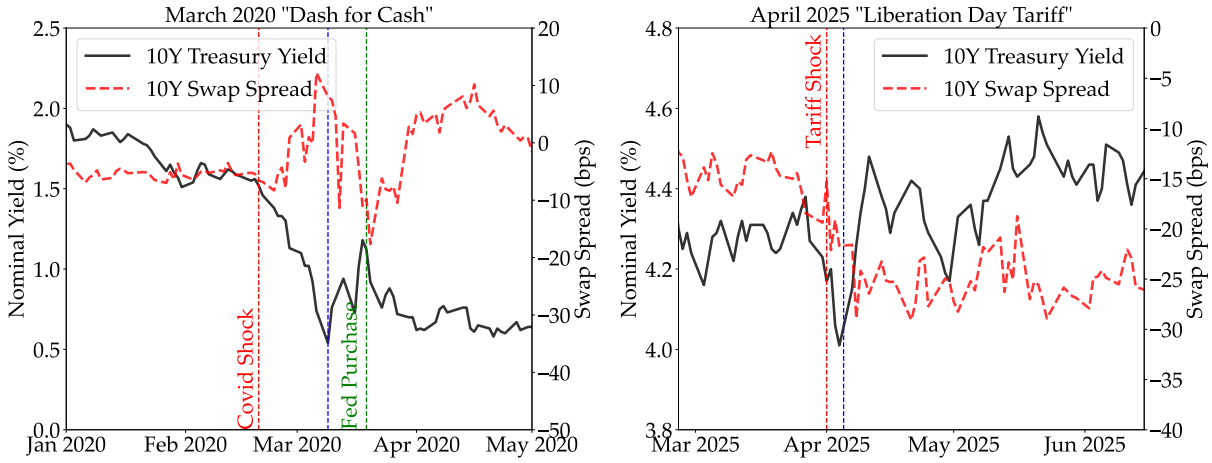
Dealer and hedge-fund swap supply is conceptually similar to Treasury-futures basis trades. Panel (b) of Figure A.2b illustrates the Treasury–swap basis trade (see also Exhibit 1 of Boyarchenko et al. (2018)). Just as Treasury-futures basis trades rise sharply during QT, swap market intermediation also increases. Figure 12b shows that the 10-year swap spread becomes more negative and dealers' intermediation volumes rise markedly during QT, indicating stronger demand for receiving-fixed swaps from asset managers.

[44]See detailed discussion of dealers' role in Barth and Kahn (2025); Kashyap et al. (2025).

A.1.3 Concern on the Basis Trade: US Treasury Market Turmoil in March 2020 and April 2025

What are the consequences of elevated Treasury basis trade? The activity has been criticized for amplifying Treasury market strains when exogenous shocks hit the economy (Schrimpf et al., 2020; Barth and Kahn, 2020; Vissing-Jorgensen, 2021; Kashyap et al., 2025). When funding costs or margin requirements jump, leveraged funds can be forced to unwind cash and derivative positions, triggering the classic "margin spiral" of Brunnermeier and Pedersen (2009), with selling that begets more selling and wider treasury price drops. Basis trades are widely viewed as a key factor behind the Treasury market disruptions in March 2020 and April 2025, as discussed below.

Figure A.4: US Treasury Market Turmoil in March 2020 and April 2025



Note: This figure plots 10 year and 30 year Treasury yields together with the corresponding interest rate swap spreads. A swap spread is the USD interest rate swap rate (LSEG USDAM3L10Y) minus the Treasury yield of the same maturity. The left panel shows the March 2020 "dash for cash" episode, and the right panel shows the April 2025 Treasury market turmoil following tariff headlines. Sources: LSEG Refinitiv Workspace; Federal Reserve Bank of New York, Weekly Primary Dealer Statistics.

The "Dash for Cash" Episode in March 2020 In March 2020, at the onset of the COVID-19 pandemic, heightened uncertainty led investors to shift into safe government bonds, and Treasury yields fell quickly. As the shock intensified in the second week of March, however, the flight to quality turned into a dash for cash as some investors—especially hedge funds and open-end bond mutual funds—raised cash to meet margin calls or satisfy investor redemptions. They sold Treasuries in large amounts (Schrimpf et al., 2020; Vissing-Jorgensen, 2021; Ma et al., 2022). As shown in the left panel of Figure A.4, the 10 year Treasury yield rose by more than 60 basis points within several days, while the swap rate fell by about 30 basis points. This pattern contrasts with typical flight-to-safety episodes in which investors flock to Treasuries and drive down treasury yield.

Market functioning was restored only after the Federal Reserve began purchasing large amounts

of Treasury securities to provide liquidity. The Fed first expanded overnight and term repo operations, then announced capped asset purchases, and on March 23, 2020 committed to "purchase Treasury securities and agency mortgage-backed securities in the amounts needed to support smooth market functioning and the effective transmission of monetary policy to broader financial conditions." Market functioning improved after these steps.

The "Liberation Day Tariffs" Episode in April 2025 Financial markets reacted strongly to the April 2 announcement of significantly higher than expected tariffs. Risk assets sold off as investors reassessed the US outlook. Initially, Treasury yields fell in a classic flight to safety. After a few days, however, longer term Treasury yields rose sharply. One factor that appears to have contributed to this pattern is the unwinding of the swap spread trade. Reportedly, many leveraged investors were positioned to benefit from a decrease in Treasury yields of longer maturity relative to interest rate swaps, partially due to the expectation for an easing of banking regulation that would bolster bank demand for Treasuries. In effect, they were making a directional bet that swap spreads would increase and thus increasing treasury position. Following the tariff news, swap spreads declined, making the trade unprofitable. Because this trade is usually highly leveraged, margin calls forced a rapid unwind. The unwind involved selling longer term Treasuries, which likely amplified the rise in yields. As shown in the right panel of Figure A.4, by April 11 the ten year Treasury yield was about 30 basis points above its April 2 level, while the ten year swap spread had declined by about 15 basis points.

On April 9, the Administration announced a ninety day pause on country specific reciprocal tariffs for most countries. Policy uncertainty eased following that announcement, market conditions stabilized, and the Treasury market gradually recovered.[45]

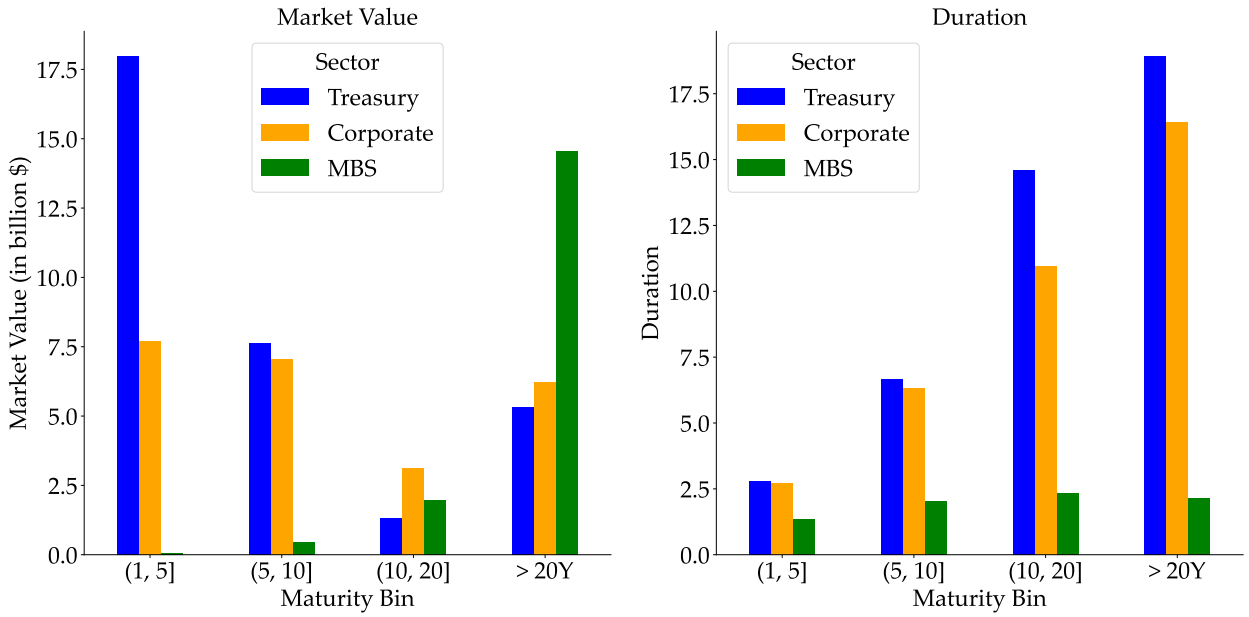
A.2 US Debt Market: Composition, Duration Supply and Demand

U.S. Debt Market Composition. Figure A.5 uses the iShares Core U.S. Aggregate Bond ETF (AGG) as a benchmark to illustrate market composition and to distinguish duration from stated maturity. MBS often have long stated maturities but low effective duration for two reasons: first, scheduled amortization, because mortgage payments include principal so investors receive principal back each month; second, prepayment risk, because when interest rates fall many borrowers

[45] For concise official discussions of these two episodes, see Nellie Liang's April 2025 testimony for the House Committee on Financial Services (Liang, 2025), and Roberto Perli's speech at the Federal Reserve Bank of New York (Perli, 2025).

refinance or prepay and return additional principal before maturity. Consequently, Treasuries and corporate bonds comprise the long duration segment of the debt market. The shares of Treasuries and corporate bonds are comparable across segments, except in the 1 to 5 year segment.

Figure A.5: US Bond Market Composition



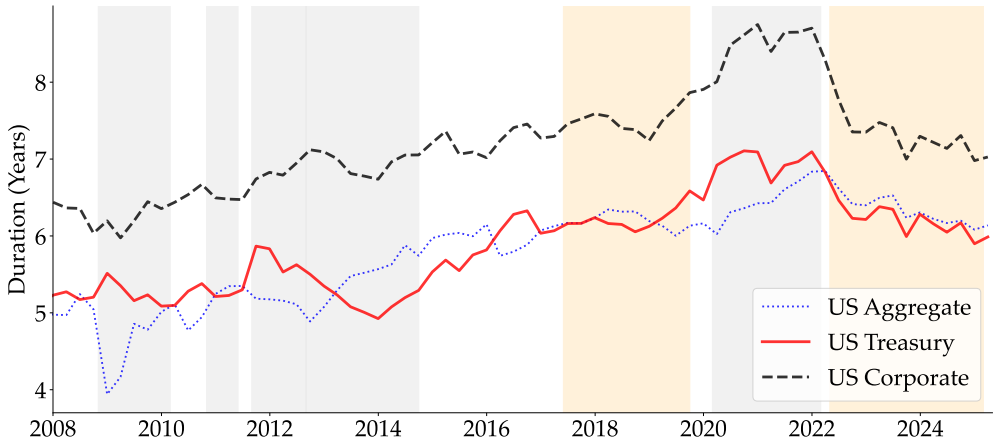
Note: The figure summarizes the composition of the iShares Core US Aggregate Bond ETF (ticker: AGG), which tracks the Bloomberg US Aggregate Bond Index and provides a representative view of the US aggregate bond market. The left panel shows the shares of three bond categories across maturity buckets; the right panel reports the corresponding effective durations. The reporting date is January 29, 2021.

Figure A.6a compares the durations of U.S. corporate and Treasury bond indexes. On average, the corporate index has a longer duration than the Treasury index, reflecting the larger Treasury weight in the 1–5 year segment. As shown in Figure A.6b, the duration gap widens during QE—when the Federal Reserve removes long-duration Treasuries from the market and firms tilt issuance toward long-duration corporate bonds (e.g. Selgrad, 2023; Eren et al., 2025)—and narrows during QT, as the Fed returns Treasuries to the market and corporate issuance declines in a high-rate environment.

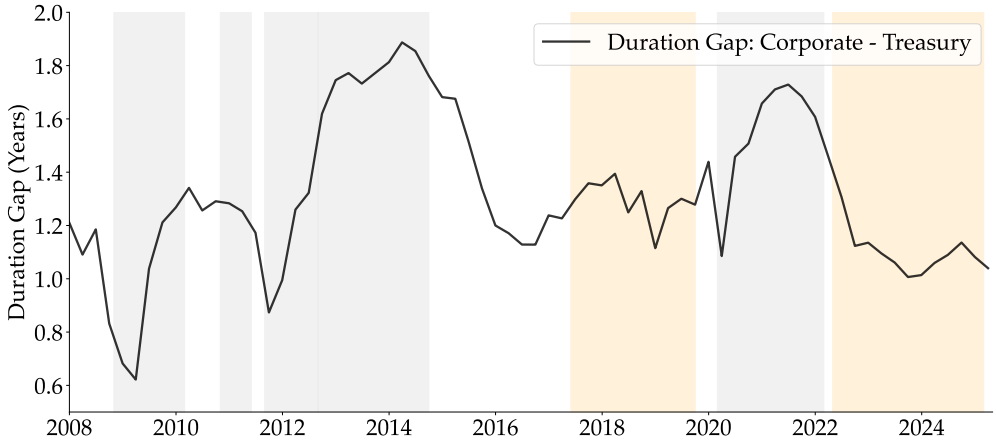
Duration Demand and Supply from Treasuries and Corporate bonds. Figure A.7 reports the quantity of duration risk from U.S. Treasuries and corporate bonds scaled by GDP. Panel A.7a shows total duration supply; Panel A.7b focuses on long-duration bonds. In the post-GFC low-rate environment, both the Treasury and corporate sectors extended maturity, so duration supply grew faster than GDP. As Panel A.7b shows, the gap in duration supply (long-term corporate

Figure A.6: Duration of US Bond Indices: Treasuries, Corporate Bonds, and the Aggregate Market

(a) Duration of US Bond Indices



(b) Duration Gap between Corporate Bond Index and Treasury Index



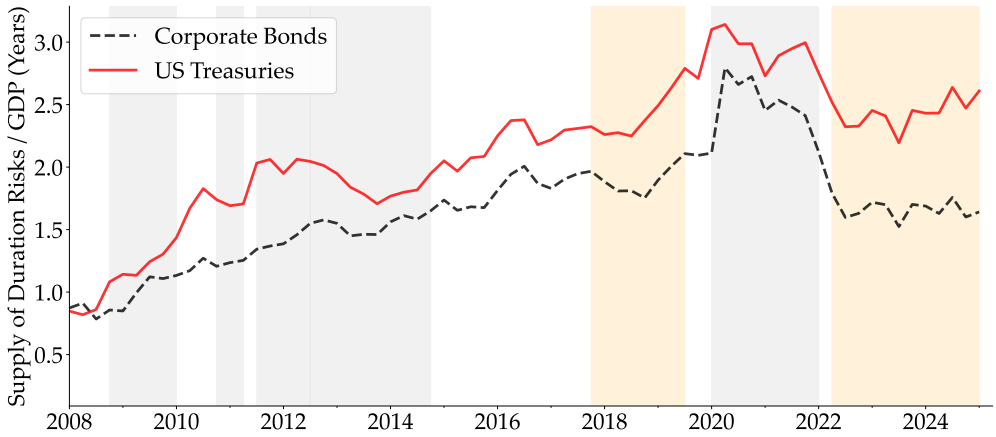
Note: The panel A.6a plots modified duration for the Bloomberg US Treasury Index, Bloomberg US Corporate Index, and Bloomberg US Aggregate Bond Index in years. The panel A.6b plots the duration gap between corporate bond index and treasury index. Gray shaded areas denote periods of quantitative easing (QE); orange shaded areas denote periods of quantitative tightening (QT).

bonds - Treasuries) widens during QE—when the Fed removes long-term Treasuries from the market while firms increase long-term corporate bond issuance—and narrows during QT as the Fed returns Treasuries to the market and corporate issuance slows in a high-rate environment. Since 2022, long-term Treasury duration supply has surpassed that of corporate bonds.

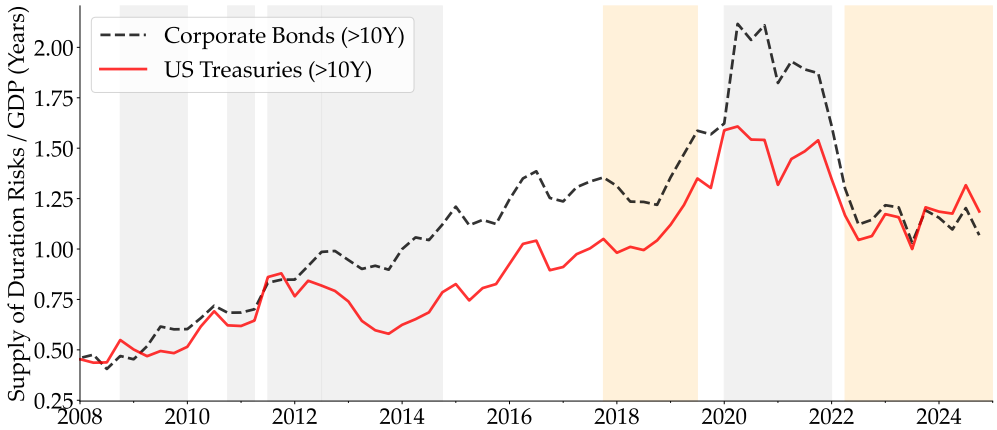
On the demand side, the expansion in duration supply is associated with the post-GFC rise of non-bank financial institutions (NBFIs). Figure A.8 plots financial assets of U.S. banks and NBFIs (mutual funds, life insurers, and pension funds). Postcrisis tightening of bank regulation encouraged a shift toward market based intermediation, increasing the role of NBFIs (Financial Stability Board, 2024; IMF, 2025). These investors often face explicit or implicit duration mandates, and their demand growth roughly matches the increase in duration supply in Figure A.7.

Figure A.7: Quantity of Duration Risks from US Corporate Bonds and Treasuries

(a) Duration Supply from US Corporate Bonds and Treasuries



(b) Duration Supply from US Long-term Corporate Bonds and Treasuries (>10 year)



Note: Panel A.7a plots the supply of duration from US corporate bonds and US Treasuries. Duration supply is computed as modified duration times bonds outstanding for the corresponding index, scaled by real GDP. The corporate series is constructed from the Bloomberg US Corporate Bond Index; the Treasury series from the Bloomberg US Treasury Index. Since 2008, Treasuries have supplied more duration than corporates in the aggregate. The gap narrows during QE periods (especially MEP, QE3, and the COVID QE) and widens during QT episodes. Panel A.7b plots the duration supply of long-term corporate bonds and Treasuries based on the Bloomberg US Long Government/Credit Float Adjusted Index, which includes Treasuries, agencies, and corporate bonds with remaining maturity greater than 10 years. I split the index's duration supply into Treasury and corporate components using the observed shares in the Vanguard Long-Term Bond ETF (BLV), which closely tracks this benchmark. Since 2008, long-term corporate bonds have supplied more duration than Treasuries at the long end of the yield curve. The gap widens during QE periods (especially MEP, QE3, and the COVID QE) and narrows during QT episodes. Gray shading denotes QE periods; orange shading denotes QT periods.

This demand–supply backdrop motivates the paper's key state variable: the share of long-term Treasuries versus corporate bonds. In the model of Section 3, the total quantity of duration risks is fixed and what matters is the source of duration risks. Further more, because demand has grown markedly, the Treasury share of new issuance (flow) is especially informative. Consequently, the level of the Treasury share in the outstanding stock is not an ideal state measure. In Section 5, I use swap spreads as the state variable measure to capture the evolving balance between demand and supply.

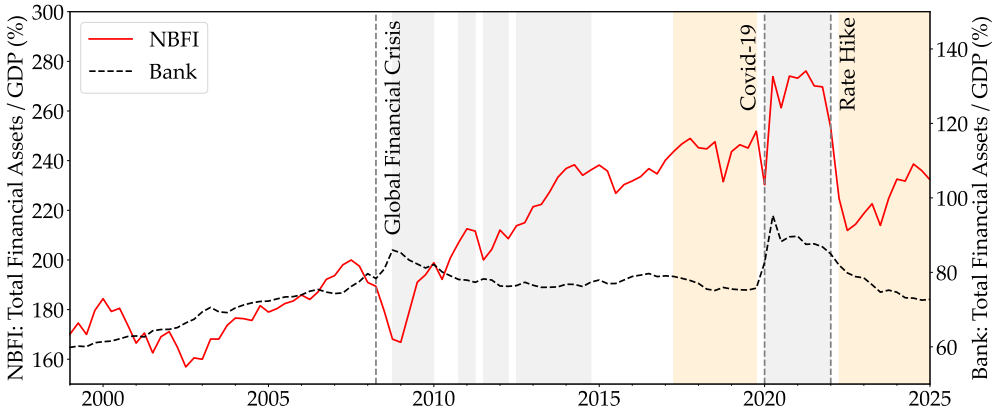


Figure A.8: Financial Assets of US Bank and Non-bank Financial Intermediary

A.3 Leverage Constraint on US Bond Investors

Leverage can take the form of financial leverage or synthetic leverage. Financial leverage typically involves on-balance-sheet borrowing through debt, loans, or repurchase agreements, whereas synthetic leverage is taken off the balance sheet through derivative positions. As reported by Financial Stability Board (2023), synthetic leverage is substantially more prevalent among mutual funds, pension funds, and insurance companies, while direct financial leverage through borrowing remains limited, with the aggregate debt-to-asset ratio around 1.5% as of 2022.

In the US, bond investors are subject to the following regulations governing financial and synthetic leverage.

Mutual funds Mutual funds are regulated under the Investment Company Act of 1940. With respect to financial leverage, they are prohibited from issuing senior securities and may borrow only subject to Section 18's 300% asset-coverage requirement, which implies that debt may not exceed $33\frac{1}{3}\%$ of total assets.

Synthetic leverage through derivatives is therefore a more effective channel for taking duration exposure than direct borrowing. Consider a mutual fund with $1 billion in assets under management (AUM) that seeks to increase its exposure to 10-year U.S. Treasury duration. Under Section 18, the fund may borrow at most one-third of assets, allowing it to raise $333 million of debt to purchase Treasuries. If the borrowed funds are fully allocated to 10-year Treasuries, this strategy increases the fund's DV01 by approximately $283K per basis point. In contrast, derivative positions are governed by Rule 18f-4, which limits leverage through a portfolio-level value-at-risk (VaR) constraint. Under the relative VaR framework, a fund's 99% VaR over a 20-trading-day

horizon may not exceed 200% of the VaR of a designated Treasury-heavy reference index. This constraint allows the fund to sustain portfolio VaR of approximately 12% of net asset value, permitting on the order of $1.36 billion of 10-year Treasury exposure.[46] The resulting incremental DV01—approximately $1.2 million per basis point—substantially exceeds the duration that can be obtained through direct borrowing under Section 18, while avoiding balance-sheet expansion.

Pension Funds Pension funds face tighter constraints on balance-sheet leverage than mutual funds. Under the Employee Retirement Income Security Act of 1974 (ERISA), borrowing is limited to fully collateralized, temporary loans for narrowly defined purposes (ERISA §§406(a), 408(b)(3)), effectively ruling out persistent financial leverage. Pension funds are, however, permitted to use derivatives. In practice, they use derivatives primarily within liability-driven investment strategies and for interest-rate risk management rather than speculative leverage (Klingler and Sundaresan, 2019; Financial Stability Board, 2023).

Insurance companies. Insurers are subject to risk-based capital (RBC) regulation, which limits their ability to expand balance-sheet capacity through borrowing. In particular, interest-rate risk plays a central role in the RBC framework for life insurers via the C-3 capital charge, which is based on stress-test losses in statutory surplus induced by asset–liability duration mismatch. As a result, borrowing to finance long-duration Treasury holdings increases required capital by amplifying surplus sensitivity to interest-rate shocks, even when the Treasuries are default-free.[47]

In addition, borrowing by life insurers is constrained by state-level insurance laws that restrict the use of pledged assets and collateralized financing. For example, under New York Insurance Law § 1411(c), a domestic insurer may not pledge or transfer securities as collateral for loans (including sale-and-repurchase agreements) in excess of 5% of admitted assets without the approval

[46] The maximum Treasury exposure permitted under the relative VaR constraint satisfies

$$X \leq \frac{200\% \times \mathrm{VaR}_{\mathrm{benchmark}} \times \mathrm{NAV}}{z_{0.99}\, D\, \sigma_y \sqrt{20}},$$

where X denotes total 10-year Treasury exposure (notional amount); $\mathrm{VaR}_{\mathrm{benchmark}}$ is the 99% value-at-risk of the designated reference index over a 20-trading-day horizon expressed as a fraction of net asset value; $z_{0.99} = 2.33$ is the 99th percentile of the standard normal distribution; D is the modified duration of the 10-year Treasury; and σ_y is the daily volatility of the 10-year Treasury yield. Empirically, a Treasury benchmark with duration of roughly six to seven years exhibits a 20-day 99% VaR of about 6% of net asset value. The square-root-of-time scaling assumes approximately independent daily yield innovations.

[47] Under the NAIC Risk-Based Capital framework for life insurers, C-3 interest-rate risk is computed as the maximum decline in statutory surplus under prescribed interest-rate stress scenarios that jointly revalue assets and liabilities. For example, if insurers borrow through repurchase agreements to finance long-term Treasury positions, an increase in interest rates reduces the market value of Treasuries while the borrowing amount remains fixed, leading to a decline in statutory surplus.

of the superintendent.[48]

With respect to derivatives, insurers may use derivative instruments only if such use is consistent with prudent risk management and does not create speculative exposure. As shown in Section 6, interest-rate derivative usage by asset managers is widespread.

[48] New York Insurance Law § 1411(c). Available at https://law.justia.com/codes/new-york/isc/article-14/1411/.

B Model and Proofs

B.1 Financial Assets Prices, Yields, and Returns

Micro Found Credit Risk. A representative firm may default at time 1. Suppose that a random fraction h_1 of the corporate bonds default in period 1 and are worth $(1 - L_1)P_1^g$, where $L_1 \in [0, 1)$ is the loss-given-default as a fraction of the market value P_1^g for $g \in \{S, L\}$. The remaining fraction, $(1 - h_1)$ of corporate bonds does not default and is worth P_1^g. Since the short-term corporate bond matures at $t = 1$, its market value $P_1^S = 1$ is conditional on non-default. Thus, the one-period returns of short-term and long-term corporate bonds follow

$$1 + R_1^L = \frac{(1 - Z_1)P_1^L}{P_0^L}, \quad 1 + R_1^S = \frac{1 - Z_1}{P_0^S} \tag{B.1}$$

where $Z_1 = h_1 L_1$, satisfies $0 \leq Z_1 < 1$, and is the random portfolio default realization at time 1. This stylized formulation of default risk follows Duffie and Singleton (1999)'s "recovery of market value" assumption, which has become standard in the credit risk literature.

Asset Prices, Yields, and Returns. At time 0, the prices of the Treasury bill and long-term Treasury bond follow $P_0^{Tbill} = \frac{1}{1+i_0} \approx \exp(-i_0)$ and $P_0^T = \frac{1}{(1+y_0^T)^2} \approx \exp(-2y_0^T)$, where i_0 and y_0^T are the two bonds' yields to maturity, respectively. The one-period log return of long-term government then follow

$$r_1^T \equiv \log\left(\frac{P_1^{Tbill}}{P_0^T}\right) \approx 2y_0^T - i_1 \tag{B.2}$$

The prices of long-term and short-term corporate bonds follow $P_0^L = \frac{1}{(1+y_0^L)^2} \approx \exp(-2y_0^L)$ and $P_0^S = \frac{1}{1+y_0^S} \approx \exp(-y_0^S)$, where y_0^L and y_0^S are the two bonds' yields to maturity, respectively. Since the representative firm can only default in period 1, the non-default long-term corporate bonds have the same price as the Treasury bill in period 1, that is, $P_1^L = P_1^{Tbill}$. According to equation (B.1), the log return of long-term corporate bond and short-term corporate bond then follows

$$\begin{aligned} r_1^L &= \log\left(1 + R_1^L\right) = -\log(P_0^L) + \log(P_1^L) + \log(1 - Z_1) \approx 2y_0^L - i_1 - z_1, \\ r_1^S &= \log\left(1 + R_1^S\right) = \log(P_1^S) + \log(1 - Z_1) \approx y_0^S - z_1 \end{aligned} \tag{B.3}$$

where $z_1 \equiv -\log(1 - Z_1)$ is the log default loss at time 1. We assume a log default loss $z_1 \sim$

$N(\bar{z}, \sigma_z^2)$ with $\bar{z} > 0$.

B.2 Micro Foundation of Duration Mandate

This section discusses the micro foundations and modeling of duration mandates for liability-driven investors (e.g., life insurers and pension funds) and bond mutual funds. For each investor type, I consider the form of the duration mandate under three cases: (a) not leverage, (b) leverage via borrowing, and (c) leverage via taking derivatives.

Liability-driven investors. Liability-driven investors hold long-term bonds of value B to immunize equity from interest rate changes. Figure B.1 shows a representative balance sheet. Assume that the durations of short-term bonds, equity, and cash are zero; let the duration of long-term bonds be D_B and the duration of liabilities be D_L. The left panel shows the unlevered case, the middle panel shows leverage via short-term borrowing, and the right panel shows leverage via derivatives. In the derivatives case, we denote the total long-duration exposure as $B = B_1 + B_2$, where B_1 is cash bonds and B_2 is derivatives.

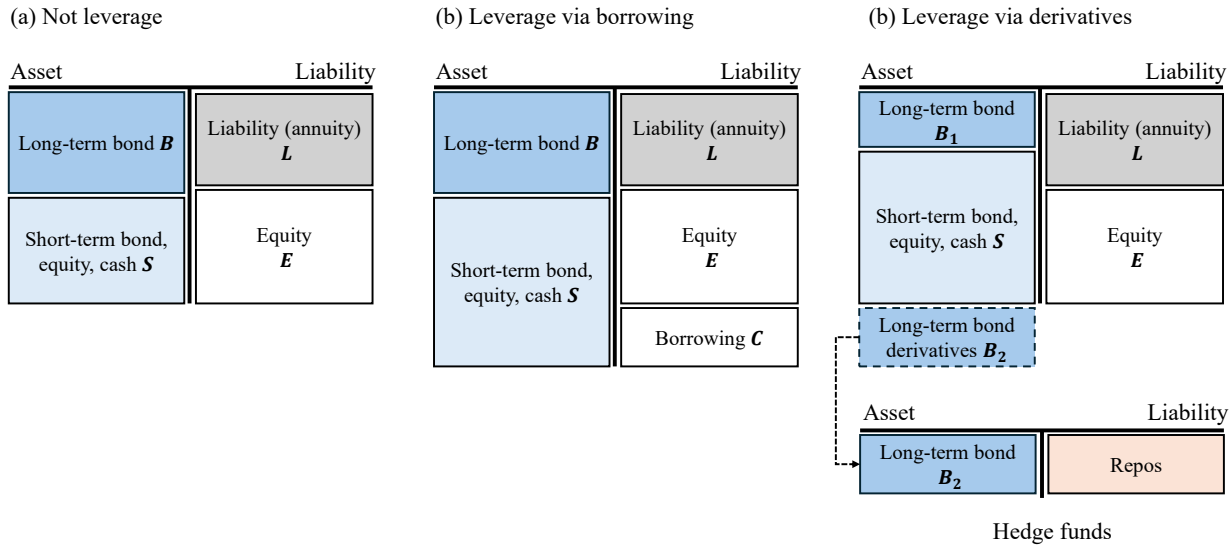


Figure B.1: Balance Sheet of A Typical Liability-driven Investor

The balance sheet identity yields $E = B + S - L$. To immunize equity value E from interest rate changes, life insurance company needs to choose long-term bond B (in terms of cash bond or

derivatives) such that

$$\frac{dE}{di} = \frac{dB}{di} - \frac{dL}{di} = -BD_B + LD_L = 0 \quad \Longrightarrow \quad \frac{B}{L} = \frac{D_L}{D_B} \tag{B.4}$$

Thus, liability-driven investors require a *fixed level of long-duration exposure* to hedge interest rate risk. In the model, I impose the duration mandate $w_L + w_T = \bar{D}$, which maps to (B.4) via

$$\underbrace{w_L + w_T}_{\equiv \frac{B}{L}} = \bar{D} \equiv \frac{D_L}{D_B} \tag{B.5}$$

Mutual funds. Bond mutual funds target the duration of the benchmark index. Figure B.2 shows a representative fund balance sheet. Let the benchmark duration be D_I, the long-term bond duration D_B, and the durations of short-term bonds, equity, and cash be zero. We denote long-term bond exposure by B, short-term, equity, and cash holdings by S, assets under management (AUM) by E, and borrowing (if any) by C. When using derivatives, the total long-duration exposure is again $B = B_1 + B_2$. Taking E as a given, the duration mandate in each case is as follows:

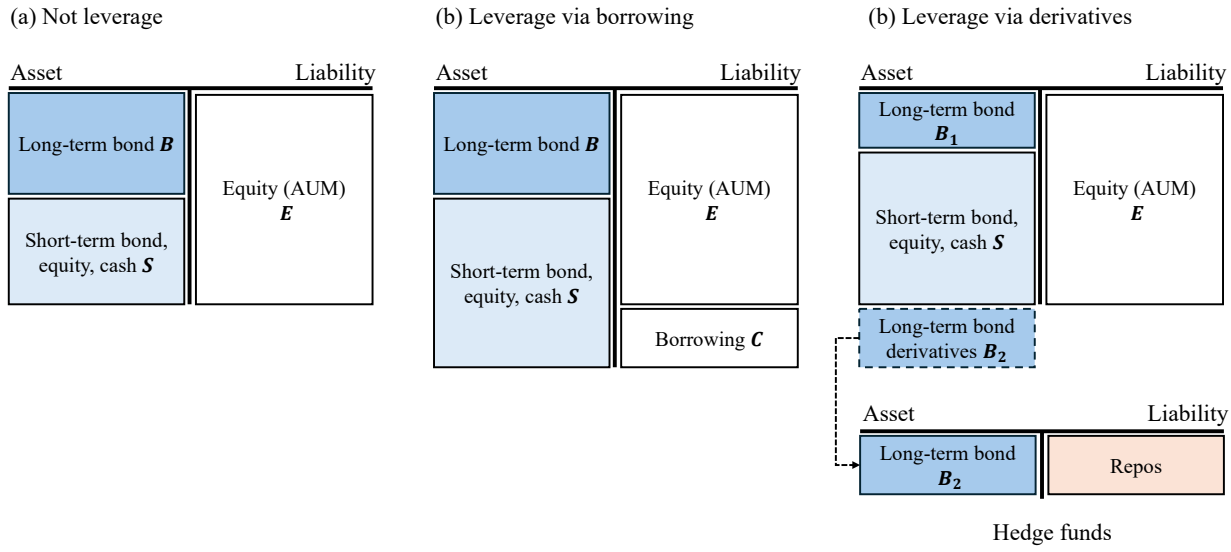


Figure B.2: Balance Sheet of Mutual Funds

(a) *Unlevered.*

$$\frac{B}{B+S} D_B = \underbrace{\frac{B}{E}}_{\equiv w_B} D_B = D_I \quad \Longrightarrow \quad w_B = \frac{D_I}{D_B} \tag{B.6}$$

(b) *Leverage via borrowing.* If the fund borrows C, then total invested assets are $E + C$, so

$$\frac{B}{B+S}D_B = \underbrace{\frac{B}{E}}_{\equiv w_B}\frac{E}{E+C}D_B = D_I \quad \Longrightarrow \quad w_B = \frac{D_I}{D_B}\underbrace{\frac{E+C}{E}}_{\text{leverage ratio}} \tag{B.7}$$

(c) *Leverage via derivatives.* When the fund uses derivatives to obtain duration, the same mandate as in (B.7) applies, with B interpreted as the total duration exposure (cash bond + derivatives).

In summary, mutual funds require a *fixed share of total assets* in long-duration exposure to meet the benchmark duration. If the balance sheet expands through leverage, the required long-duration position increases proportionally. In the example above, this is captured by $\bar{D} = \frac{D_I}{D_B} \times$ (leverage ratio). This amplification strengthens my channel in leveraged states.

B.3 Derivations for the Simplified Model

In the simplified setting, the short-term corporate bond specialist has perfectly elastic demand and pins short-term credit spread at $\mathbb{E}_0[ex_1^S] = sp_S$. I first solve for the slack equilibrium and binding equilibrium individually and then derive the threshold condition that separates the two regimes.

B.3.1 Slack Equilibrium.

Because specialists act in a single market with constant demand elasticity, allocators determine market-level elasticity. Let λ denote the multiplier of the balance sheet constraint in (4). The first-order conditions are

$$\begin{aligned}
[w_L] \quad & \mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T] = \gamma(w_L + w_S)\sigma_z^2 \\
[w_S] \quad & \mathbb{E}_0[ex_1^S] = \gamma(w_L + w_S)\sigma_z^2 + \lambda \\
[\lambda] \quad & w_S = 1 - \bar{D} \text{ if } \lambda > 0, \quad w_S < 1 - \bar{D} \text{ if } \lambda = 0.
\end{aligned} \tag{B.8}$$

Note that $\mathbb{E}_0[ex_1^T]$ is the term premium on the long-term Treasury, and $\mathbb{E}_0[ex_1^S]$ and $\mathbb{E}_0[ex_1^L - ex_1^T]$ are the short- and long-term credit spreads.

When the balance sheet constraint is slack ($\lambda = 0$), the allocator's first-order conditions in (B.8)

imply their demand curve for duration risk and credit risk

$$\begin{aligned} \text{Duration risk:} \quad & w_T + w_L = \bar{D} \\ \text{Credit risk:} \quad & w_L + w_S = \frac{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}{\gamma \sigma_z^2} \end{aligned} \tag{B.9}$$

Moreover, allocators ensures the non-arbitrage condition on the credit spreads

$$\underbrace{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}_{\text{long-term credit spread}} = \underbrace{\mathbb{E}_0[ex_1^S]}_{\text{short-term credit spread}} \tag{B.10}$$

Using (B.9), the asset market-clearing conditions (7) can be expressed as market-clearing conditions for risks:

$$\begin{aligned} \text{Duration risk}: \quad & \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialists}} + \underbrace{\varepsilon_T \mathbb{E}_0[ex_1^T]}_{\text{Treasury specialists}} + \underbrace{\bar{D}}_{\text{allocators}} = S_L + S_T \\ \text{Credit risk}: \quad & \underbrace{D_S}_{\text{short-term corporate specialists}} + \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialist}} + \underbrace{\frac{sp_S}{\gamma \sigma_c^2}}_{\text{allocators}} = S_S + S_L \end{aligned} \tag{B.11}$$

where credit spreads are fixed at $\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T] = \mathbb{E}_0[ex_1^S] = sp_S$.

We solve for the equilibrium risk premium based on (B.10) and (B.11).

$$\begin{aligned} \mathbb{E}_0[ex_1^T] &= \frac{1}{\varepsilon_L + \varepsilon_T} S_T + \frac{1}{\varepsilon_L + \varepsilon_T} S_L - \frac{\varepsilon_L sp_S + \bar{D}}{\varepsilon_L + \varepsilon_T} \\ \mathbb{E}_0[ex_1^L] &= \frac{1}{\varepsilon_L + \varepsilon_T} S_T + \frac{1}{\varepsilon_L + \varepsilon_T} S_L - \frac{\varepsilon_L sp_S + \bar{D}}{\varepsilon_L + \varepsilon_T} + sp_S \\ \mathbb{E}_0[ex_1^S] &= sp_S \end{aligned} \tag{B.12}$$

Based on (3) and $\mathbb{E}_0[ex_1^T] = \mathbb{E}_0[r_1^g - i_0], \forall g \in \{T, L, S\}$, the equilibrium bond yields

$$\begin{aligned} y_0^T &= \frac{\mathbb{E}_0[i_1 + r_1^T]}{2} = i_0 + \frac{1}{2}\mathbb{E}_0[ex_1^T] = i_0 + \frac{1}{2}\left[\frac{1}{\varepsilon_L + \varepsilon_T} S_T + \frac{1}{\varepsilon_L + \varepsilon_T} S_L - \frac{\varepsilon_L sp_S + \bar{D}}{\varepsilon_L + \varepsilon_T}\right] \\ y_0^L &= \frac{\mathbb{E}_0[i_1 + r_1^L + z_1]}{2} = i_0 + \frac{1}{2}\mathbb{E}_0[z_1 + ex_1^L] = i_0 + \frac{1}{2}\left[\bar{z} + sp_S + \frac{1}{\varepsilon_L + \varepsilon_T} S_T + \frac{1}{\varepsilon_L + \varepsilon_T} S_L - \frac{\varepsilon_L sp_S + \bar{D}}{\varepsilon_L + \varepsilon_T}\right] \\ y_0^S &= \mathbb{E}_0[r_1^S + z_1] = i_0 + \mathbb{E}_0[z_1 + ex_1^S] = i_0 + \bar{z} + sp_S \end{aligned} \tag{B.13}$$

B.3.2 Binding equilibrium

When the balance sheet constraint binds $\lambda > 0$, the allocators' optimal portfolio satisfies

$$\begin{aligned} w_S &= 1 - \bar{D}. \\ w_L &= \frac{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}{\gamma \sigma_z^2} - w_S \\ w_T &= \bar{D} - w_L \end{aligned} \tag{B.14}$$

Therefore, the asset market-clearing conditions (7) can be expressed as market-clearing conditions for risks:

$$\begin{aligned} \text{Duration risk}: \quad & \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialists}} + \underbrace{\varepsilon_T \mathbb{E}_0[ex_1^T]}_{\text{Treasury specialists}} + \underbrace{\bar{D}}_{\text{allocators}} = S_L + S_T \\ \text{Long-term Credit risk}: \quad & \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialist}} + \underbrace{\frac{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}{\gamma \sigma_c^2} - (1 - \bar{D})}_{\text{allocators}} = S_L \\ \text{Short-term Credit risk}: \quad & \underbrace{D_S}_{\text{short-term corporate specialists}} + \underbrace{1 - \bar{D}}_{\text{allocators}} = S_S \end{aligned} \tag{B.15}$$

Note that the allocator's exposure to duration risk is fixed at $\bar{D}$, whereas his demand for credit risk is elastic. We define their credit risk demand elasticity as $\varepsilon_A \equiv \frac{1}{\gamma \sigma_c^2}$. Solving the above market-clearing system then yields the equilibrium risk premium:

$$\begin{aligned} \mathbb{E}_0[ex_1^T] &= \frac{\varepsilon_L + \varepsilon_A}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_T + \frac{\varepsilon_A}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_L - \frac{\varepsilon_A \bar{D} + \varepsilon_L}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} \\ \mathbb{E}_0[ex_1^L] &= \frac{\varepsilon_A}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_T + \frac{\varepsilon_A + \varepsilon_T}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_L - \frac{(\varepsilon_A + \varepsilon_T)\bar{D} - \varepsilon_T}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} \\ \mathbb{E}_0[ex_1^S] &= sp_S \end{aligned} \tag{B.16}$$

The equilibrium bond yields the following:

$$\begin{aligned} y_0^T &= i_0 + \frac{1}{2}\mathbb{E}_0[ex_1^T] = i_0 + \frac{1}{2}\left[\frac{\varepsilon_L + \varepsilon_A}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_T + \frac{\varepsilon_A}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_L - \frac{\varepsilon_A \bar{D} + \varepsilon_L}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A}\right] \\ y_0^L &= i_0 + \frac{1}{2}\mathbb{E}_0[z_1 + ex_1^L] = i_0 + \frac{1}{2}\left[\bar{z} + \frac{\varepsilon_A}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_T + \frac{\varepsilon_A + \varepsilon_T}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} S_L - \frac{(\varepsilon_A + \varepsilon_T)\bar{D} - \varepsilon_T}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A}\right] \\ y_0^S &= i_0 + \mathbb{E}_0[z_1 + ex_1^S] = i_0 + \bar{z} + sp_S \end{aligned} \tag{B.17}$$

B.3.3 Threshold for Slack Regime versus Binding Regime

The *threshold* comes when the allocators exactly exhaust their balance sheet capacity but the constraint is still slack, that is

$$w_S = 1 - \bar{D}, \qquad \lambda = 0. \tag{B.18}$$

In this corner, the balance sheet limit is met without generating a positive Lagrangian multiplier, so the economy remains in the slack regime. Therefore, I start from the slack allocation and derive the boundary condition for the two regimes.

Let $(\tilde{w}_G, \tilde{w}_L, \tilde{w}_S)$ denote the equilibrium allocation in the slack regime, which follow

$$\begin{aligned} \tilde{w}_G &= S_T - \varepsilon_T \mathbb{E}_0[ex_1^T] \\ \tilde{w}_L &= \bar{D} - \tilde{w}_G \\ \tilde{w}_S &= \frac{\mathbb{E}_0[ex_1^S]}{\gamma \sigma_c^2} - \tilde{w}_L \end{aligned} \tag{B.19}$$

The condition for slack equilibrium requires

$$\tilde{w}_S \leq 1 - \bar{D} \quad \Longleftrightarrow \quad \underbrace{\frac{\mathbb{E}_0[ex_1^S]}{\gamma \sigma_c^2}}_{\text{allocation to credit markets}} + \underbrace{\tilde{w}_G}_{\text{allocation to Treasury market}} \leq 1 \tag{B.20}$$

Substituting the risk premium into $\tilde{w}_G$ yields the threshold condition

$$g(S_L, S_T, \bar{D}) \begin{cases} \leq 0 & \text{(slack regime)}, \\ > 0 & \text{(binding regime)}, \end{cases} \tag{B.21}$$

$$\text{with } g(S_L, S_T, \bar{D}) \equiv \varepsilon_L S_T - \varepsilon_T S_L + \varepsilon_T \bar{D} - (\varepsilon_L + \varepsilon_T) - (\varepsilon_L \varepsilon_A + \varepsilon_T \varepsilon_A + \varepsilon_T \varepsilon_L) s p_S$$

Hence when $g(S_L, S_T, \bar{D})$ is non-positive, the economy is in the slack regime with prices in (B.13); otherwise the balance sheet constraint binds and prices follow (B.17).

Specifically, the shadow cost of balance sheet constrain λ in the binding region follows

$$\lambda = \frac{\varepsilon_L S_T - \varepsilon_T S_L + \varepsilon_T \bar{D} - \varepsilon_L - \varepsilon_T}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} - s p_S \tag{B.22}$$

$$= \frac{g(S_L, S_T, \bar{D})}{\varepsilon_T(\varepsilon_L + \varepsilon_A) + \varepsilon_L \varepsilon_A} \tag{B.23}$$

Note that λ follows the same function form as the $g(S_L, S_T, \bar{D})$, reflecting that the shadow cost of balance sheet constraint rises as the constraint tightens.

B.4 Derivations for the Full Model

In this subsection, I solve for the equilibrium in the full model. I first solve for the slack and binding equilibria and then derive the threshold condition that separates the two regimes.

B.4.1 Slack Equilibrium.

When the balance sheet constraint is slack ($\lambda = 0$), the allocator's first-order conditions in (B.8) imply his demand curve for duration risk and credit risk, as in (B.9). Moreover, the allocator ensures the non-arbitrage condition on the credit spreads, as in (B.10).

Using the allocator's demand curves (B.9) and specialists' demand curves (5), the asset market-clearing conditions (7) can be expressed as the market-clearing conditions for risks:

$$\begin{aligned}
\text{Duration risk}: \quad & \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialists}} + \underbrace{\varepsilon_T \mathbb{E}_0[ex_1^T]}_{\text{Treasury specialists}} + \underbrace{\bar{D}}_{\text{allocator}} = S_L + S_T \\
\text{Credit risk}: \quad & \underbrace{\varepsilon_S \mathbb{E}_0[ex_1^S]}_{\text{short-term corporate specialists}} + \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialist}} + \underbrace{\frac{\mathbb{E}_0[ex_1^S]}{\gamma \sigma_c^2}}_{\text{allocator}} = S_S + S_L
\end{aligned} \tag{B.24}$$

I then solve for the equilibrium risk premium based on (B.10) and (B.24).

$$\begin{aligned}
\mathbb{E}_0[ex_1^T] &= \frac{-\varepsilon_L S_S + (\varepsilon_S + \varepsilon_A) S_L + (\varepsilon_L + \varepsilon_S + \varepsilon_A)(S_T - \bar{D})}{(\varepsilon_S + \varepsilon_A)(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L} \\
\mathbb{E}_0[ex_1^S] &= \bar{z} + \frac{\varepsilon_T S_S + (\varepsilon_S + \varepsilon_A + \varepsilon_T) S_L + (\varepsilon_S + \varepsilon_A)(S_T - \bar{D})}{(\varepsilon_S + \varepsilon_A)(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L} \\
\mathbb{E}_0[ex_1^L] &= \mathbb{E}_0[ex_1^T + ex_1^S]
\end{aligned} \tag{B.25}$$

The equilibrium bond yields the following:

$$\begin{aligned}
y_0^T &= i_0 + \frac{1}{2}\mathbb{E}_0[ex_1^T] = i_0 + \frac{1}{2}\left[\frac{-\varepsilon_L S_S + (\varepsilon_S + \varepsilon_A) S_L + (\varepsilon_L + \varepsilon_S + \varepsilon_A)(S_T - \bar{D})}{(\varepsilon_S + \varepsilon_A)(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L}\right] \\
y_0^L &= i_0 + \frac{1}{2}\mathbb{E}_0[z_1 + ex_1^L] = i_0 + \frac{1}{2}\left[\bar{z} + \frac{\varepsilon_T S_S + (\varepsilon_S + \varepsilon_A + \varepsilon_T) S_L + (\varepsilon_S + \varepsilon_A)(S_T - \bar{D})}{(\varepsilon_S + \varepsilon_A)(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L}\right] \\
y_0^S &= i_0 + \mathbb{E}_0[z_1 + ex_1^S] = i_0 + \bar{z} + \frac{(\varepsilon_L + \varepsilon_T) S_S + \varepsilon_T S_L - \varepsilon_L (S_T - \bar{D})}{(\varepsilon_S + \varepsilon_A)(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L}
\end{aligned} \tag{B.26}$$

B.4.2 Binding equilibrium

When the balance sheet constraint binds $\lambda > 0$, the allocator's optimal portfolio follows (B.14). The asset market-clearing conditions (7) can be expressed as the market-clearing conditions for risks:

$$\begin{aligned}
\text{Duration risk}: &\quad \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialists}} + \underbrace{\varepsilon_T \mathbb{E}_0[ex_1^T]}_{\text{Treasury specialists}} + \underbrace{\bar{D}}_{\text{allocator}} = S_L + S_T \\
\text{Long-term Credit risk}: &\quad \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate specialist}} + \underbrace{\frac{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}{\gamma \sigma_c^2} - (1 - \bar{D})}_{\text{allocator}} = S_L \\
\text{Short-term Credit risk}: &\quad \underbrace{\varepsilon_S \mathbb{E}_0[ex_1^S]}_{\text{short-term corporate specialists}} + \underbrace{1 - \bar{D}}_{\text{allocator}} = S_S
\end{aligned} \tag{B.27}$$

Solving above market-clearing system then yields the equilibrium risk premium:

$$\begin{aligned}
\mathbb{E}_0[ex_1^T] &= \frac{\varepsilon_A}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon} S_L + \frac{\varepsilon_A + \varepsilon_L}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon_A}(S_T - \bar{D}) \\
\mathbb{E}_0[ex_1^L] &= \frac{\varepsilon_A + \varepsilon_T}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon_A} S_L + \frac{\varepsilon_A}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon_A}(S_T - \bar{D}) \\
\mathbb{E}_0[ex_1^S] &= \frac{1}{\varepsilon_S}\left(S_S - (1 - \bar{D})\right)
\end{aligned} \tag{B.28}$$

The equilibrium bond yields follow:

$$\begin{aligned}
y_0^T &= i_0 + \frac{1}{2}\left[\frac{\varepsilon_A}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon_A} S_L + \frac{\varepsilon_A + \varepsilon_L}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon_A}(S_T - \bar{D})\right] \\
y_0^L &= i_0 + \frac{1}{2}\left[\bar{z} + \frac{\varepsilon_A + \varepsilon_T}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon_A} S_L + \frac{\varepsilon_A}{(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L \varepsilon_A}(S_T - \bar{D})\right] \\
y_0^S &= i_0 + \bar{z} + \frac{1}{\varepsilon_S}\left(S_S - (1 - \bar{D})\right)
\end{aligned} \tag{B.29}$$

B.4.3 Threshold for slack regime versus binding regime

In the corner, the balance sheet limit is met without generating a positive Lagrangian multiplier, and the economy remains in the slack regime. I use the corner case to derive the boundary condition between the slack and binding regimes.

Let $(\tilde{w}_G, \tilde{w}_L, \tilde{w}_S)$ denote the allocators' equilibrium allocation in the slack regime, which follows (B.19). The condition for the slack equilibrium requires (B.20). Substituting the risk premia $\mathbb{E}_0[ex_1^S]$

and $\mathbb{E}_0[ex_1^T]$ into (B.20) yields the threshold condition

$$g(S_T, S_L, S_S, \bar{D}) \equiv \frac{\varepsilon_L \varepsilon_S}{\Delta} S_T - \frac{\varepsilon_T \varepsilon_S}{\Delta} S_L + \frac{\varepsilon_A(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L}{\Delta} S_S + \frac{\varepsilon_A(\varepsilon_L + \varepsilon_T) + \varepsilon_T(\varepsilon_L + \varepsilon_S)}{\Delta} \bar{D} - 1$$
$$\begin{cases} \leq 0 & \text{(slack regime)}, \\ > 0 & \text{(binding regime)}, \end{cases} \qquad \text{where} \quad \Delta \equiv (\varepsilon_S + \varepsilon_A)(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L \tag{B.30}$$

Hence, when $g(S_T, S_L, S_S, \bar{D})$ is non-positive, the economy is in the slack regime with prices in (B.26); otherwise, the balance sheet constraint binds and prices follow (B.29).

I conduct comparative statics analysis similar to those in Section 3.2.1. That is, we fix the long-term bond supply $S_L + S_T = \bar{S}_{Long}$ and corporate bond supply $S_S + S_L = \bar{S}_{Credit}$. Then find

$$\frac{\partial g(S^{long} - S_L, S_L, S^{Credit} - S_L, \bar{D})}{\partial S_L} = \frac{\varepsilon_T \varepsilon_S}{\Delta} + \frac{\varepsilon_L \varepsilon_S}{\Delta} + \frac{\varepsilon_A(\varepsilon_L + \varepsilon_T) + \varepsilon_T \varepsilon_L}{\Delta} < 0 \tag{B.31}$$

$$\frac{\partial g(S^{long} - S_L, S_L, S^{Credit} - S_L, \bar{D})}{\partial \bar{D}} = -\frac{\varepsilon_A(\varepsilon_L + \varepsilon_T) + \varepsilon_T(\varepsilon_L + \varepsilon_S)}{\Delta} > 0 \tag{B.32}$$

Hence, we obtain the same conclusion as in Proposition 1.

B.5 Derivations for the Extended Model

In this subsection, I solve the extended model with the Treasury derivative.

B.5.1 Proof of Lemma 1

Let $\{w_L, w_T, w_S, w_D\}$ denote the allocator's optimal portfolio solving (21). By construction of the model, the allocator is net absorbers of Treasury derivatives, and the hedge fund is the net supplier, so $w_D \geq 0$ naturally. I prove this lemma in four steps.

Prove $w_D = 0 \Rightarrow w_S \leq 1 - \bar{D}$**.** If $w_D = 0$, the duration mandate implies $w_L + w_T = \bar{D}$. The balance-sheet constraint then gives $w_S + \bar{D} \leq 1$ hence, $w_S \leq 1 - \bar{D}$.

Prove $w_S \leq 1 - \bar{D} \Rightarrow w_D = 0$**.** Proceed by contradiction. Suppose $w_S \leq 1 - \bar{D}$, and at the optimum, $w_D > 0$. Then, the duration mandate yields $w_L + w_T < \bar{D}$. As a result, the allocator has slack balance-sheet capacity, that is, $w_L + w_T + w_S < 1$. Since the cash–derivative basis is positive,

$\mathbb{E}_0[ex_1^T - ex_1^D] > 0$, there exists $\epsilon > 0$ such that the alternative portfolio $\{\tilde{w}_L, \tilde{w}_G, \tilde{w}_S, \tilde{w}_D\}$ with

$$\tilde{w}_L = w_L; \quad \tilde{w}_G = w_T + \epsilon; \quad \tilde{w}_S = w_S; \quad \tilde{w}_D = w_D - \epsilon \tag{B.33}$$

satisfies

$$\begin{aligned} \text{Duration mandate:} \quad & \tilde{w}_L + \tilde{w}_G + \tilde{w}_D = w_L + w_T + w_D = \bar{D}; \\ \text{balance sheet constraint:} \quad & \tilde{w}_L + \tilde{w}_G + \tilde{w}_S = w_L + w_T + w_S + \epsilon = 1; \\ \text{Welfare improvement:} \quad & U(\tilde{ex}_1^{\text{portfolio}}) - U(ex_1^{\text{portfolio}}) = \epsilon \mathbb{E}_0[ex_1^G - ex_1^D] > 0. \end{aligned} \tag{B.34}$$

Therefore, the alternative portfolio $\{\tilde{w}_L, \tilde{w}_G, \tilde{w}_S, \tilde{w}_D\}$ strictly dominates portfolio $\{w_L, w_T, w_S, w_D\}$, which contracts that $\{w_L, w_T, w_S, w_D\}$ is the optimal portfolio. Hence, it must be $w_D = 0$.

Prove $w_D > 0 \Rightarrow w_S = 1 - \bar{D} + w_D$. Consider the case $w_D > 0$. Then, the duration mandate implies $w_L + w_T = \bar{D} - w_D < \bar{D}$. According to the balance sheet constraint,

$$w_L + w_T + w_S = w_S + \bar{D} - w_D \leq 1 \quad \Rightarrow \quad w_S \leq 1 - \bar{D} + w_D \tag{B.35}$$

Now, I show that it cannot be $w_S < 1 - \bar{D} + w_D$ by contradiction. The logic is the same as that in the previous step. If $w_S < 1 - \bar{D} + w_D$ hence the allocator has slack balance sheet, there exist $\epsilon > 0$, such that an alternative portfolio $\{\tilde{w}_L, \tilde{w}_G, \tilde{w}_S, \tilde{w}_D\}$ with

$$\tilde{w}_L = w_L; \quad \tilde{w}_G = w_T + \epsilon; \quad \tilde{w}_S = w_S; \quad \tilde{w}_D = w_D - \epsilon \tag{B.36}$$

satisfies (B.34). Therefore, the alternative portfolio $\{\tilde{w}_L, \tilde{w}_G, \tilde{w}_S, \tilde{w}_D\}$ strictly dominates portfolio $\{w_L, w_T, w_S, w_D\}$, which contracts to that $\{w_L, w_T, w_S, w_D\}$ is the optimal portfolio. Hence, it must be $w_S = 1 - \bar{D} + w_D$.

Prove $w_S = 1 - \bar{D} + w_D \Rightarrow w_D > 0$. If $w_S = 1 - \bar{D} + w_D$, then (excluding the corner $w_S = 1 - \bar{D}$[49]) we have $w_S > 1 - \bar{D}$. The balance sheet constraint $w_L + w_T + w_S \leq 1$ yields $w_L + w_T < \bar{D}$. Therefore, the duration mandate $w_L + w_T + w_D = \bar{D}$ results in $w_D > 0$. □

[49]The corner case $w_S = 1 - \bar{D}$ is considered in the previous scenario $w_S \leq 1 - \bar{D}$, which has been covered by the first two parts in the proof.

B.5.2 Solve for Equilibrium

Slack equilibrium. Based on Lemma 1, if the allocator has a slack balance sheet ($w_S \leq 1 - \bar{D}$), he will not invest in Treasury derivatives, that is, w_D. In this scenario, the allocator's portfolio choice problem (21) degenerates to (4) in the full model, and the equilibrium result is the same as in the full model.

Binding equilibrium. Based on Lemma 1, if the allocator's balance sheet binds, he will free up the balance sheet by taking Treasury derivatives. Plug $w_S = 1 - \bar{D} + w_D$ into problem (21), the portfolio return writes

$$ex_1^{\text{portfolio}} = \bar{D}ex_1^T + w_L(ex_1^L - ex_1^T) + w_D(ex_1^D - ex_1^T) + (1 - \bar{D} + w_D)ex_1^S \tag{B.37}$$

and the Lagrangian can now be written as:

$$\begin{aligned}\mathcal{L} = &\underbrace{\bar{D}\mathbb{E}_0[ex_1^T] + w_L(\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]) + w_D(\mathbb{E}_0[ex_1^D] - \mathbb{E}_0[ex_1^T]) + (1 - \bar{D} + w_D)\mathbb{E}_0[ex_1^S]}_{\text{expected return}} \\ &- \underbrace{\left(\frac{\gamma}{2}\left(w_L + (1 - \bar{D} + w_D)\right)^2\sigma_z^2 + \frac{\gamma}{2}\bar{D}^2\sigma_i^2\right)}_{\text{return variance}}\end{aligned} \tag{B.38}$$

The first-order conditions of the Lagrangian yield

$$\begin{aligned}\text{non-arbitrage relation:} \quad & \mathbb{E}_0[ex_1^L - ex_1^T] = \mathbb{E}_0[ex_1^S] - \mathbb{E}_0[ex_1^T - ex_1^D] \\ \text{credit risk exposure:} \quad & w_S + w_L = \frac{\mathbb{E}_0[ex_1^S] - \mathbb{E}_0[ex_1^T - ex_1^D]}{\gamma\sigma_z^2}\end{aligned} \tag{B.39}$$

Then, I can express corporate bond allocations w_S and w_L in terms of derivative allocation w_D:

$$\begin{aligned}w_S &= 1 - \bar{D} + w_D \\ w_L &= \frac{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}{\gamma\sigma_z^2} - w_S = \frac{\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]}{\gamma\sigma_z^2} - (1 - \bar{D}) - w_D\end{aligned} \tag{B.40}$$

Plug the hedge fund supply curve (20), specialized investors' demand curves (5), and allocator's demand curve (B.40) into the market-clearing conditions. Then, we have a group of linear func-

tions:

$$
\begin{aligned}
\text{Derivative clearing}: \quad & \underbrace{w_D}_{\text{allocator demand}} = \underbrace{\varepsilon_D \times \mathbb{E}_0[ex_1^T - ex_1^D]}_{\text{HF supply}} \\
\text{Duration risk}: \quad & \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate sp}} + \underbrace{\varepsilon_T \mathbb{E}_0[ex_1^T]}_{\text{long-term Gov sp}} + \underbrace{\bar{D}}_{\text{allocator}} = S_L + S_T \\
\text{Short-term Credit risk}: \quad & \underbrace{\varepsilon_S \mathbb{E}_0[ex_1^S]}_{\text{short-term corporate sp}} + \underbrace{1 - \bar{D} + w_D}_{\text{allocator}} = S_S \\
\text{Long-term Credit risk}: \quad & \underbrace{\varepsilon_L \mathbb{E}_0[ex_1^L]}_{\text{long-term corporate sp}} + \underbrace{\varepsilon_A(\mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T]) - (1 - \bar{D}) - w_D}_{\text{allocator}} = S_L \\
\text{non-arbitrage relation}: \quad & \mathbb{E}_0[ex_1^L - ex_1^T] = \mathbb{E}_0[ex_1^S] - \mathbb{E}_0[ex_1^T - ex_1^D]
\end{aligned}
\tag{B.41}
$$

Observe that we have five unknown variables $\{w_D, \mathbb{E}_0[ex_1^L], \mathbb{E}_0[ex_1^T], \mathbb{E}_0[ex_1^S], \mathbb{E}_0[ex_1^D]\}$ and the five independent equations above. Then, we can solve for the equilibrium prices:

$$
\begin{aligned}
\mathbb{E}_0[ex_1^T] &= \frac{\left(1 + \frac{\varepsilon_S}{\varepsilon_D}\right)(\varepsilon_A + \varepsilon_L) + \varepsilon_S}{\Pi} S_T + \frac{\left(1 + \frac{\varepsilon_S}{\varepsilon_D}\right)\varepsilon_A + \varepsilon_S}{\Pi} S_L - \frac{\varepsilon_L}{\Pi} S_S \\
&\quad - \frac{\frac{\varepsilon_S}{\varepsilon_D}\varepsilon_L + \bar{D}\left[\varepsilon_L + \varepsilon_S + \left(1 + \frac{\varepsilon_S}{\varepsilon_D}\right)\varepsilon_A\right]}{\Pi} \\
\mathbb{E}_0[ex_1^L] &= \frac{S_L + S_T - \bar{D} - \varepsilon_T \mathbb{E}_0[ex_1^T]}{\varepsilon_L} \\
\underbrace{\mathbb{E}_0[ex_1^T - ex_1^D]}_{\text{Derivative spread}} &= \frac{1}{\varepsilon_D}\left(-\left[\left(1 + \frac{\varepsilon_T}{\varepsilon_L}\right)\varepsilon_A + \varepsilon_T\right]\mathbb{E}_0[ex_1^T] + \frac{\varepsilon_A}{\varepsilon_L} S_L + \left(1 + \frac{\varepsilon_A}{\varepsilon_L}\right) S_T - \frac{\varepsilon_A}{\varepsilon_L}\bar{D} - 1\right) \\
\mathbb{E}_0[ex_1^S] &= \mathbb{E}_0[ex_1^L] - \mathbb{E}_0[ex_1^T] + \mathbb{E}_0[ex_1^T - ex_1^D]
\end{aligned}
\tag{B.42}
$$

where $\Pi \equiv \varepsilon_S(\varepsilon_T + \varepsilon_L) + \left(1 + \frac{\varepsilon_S}{\varepsilon_D}\right)[(\varepsilon_A + \varepsilon_L)\varepsilon_T + \varepsilon_L\varepsilon_A]$. As the result is lengthy, I express all equilibrium risk premiums in terms of $\mathbb{E}_0[ex_1^T]$.

The price elasticity of the Treasury market is written as

$$
\frac{1}{\partial \mathbb{E}_0[ex_1^T]/\partial S_T} = \varepsilon_T + \frac{\varepsilon_S\varepsilon_L + \varepsilon_A\varepsilon_L(1 + \frac{\varepsilon_S}{\varepsilon_D})}{(\varepsilon_A + \varepsilon_L)(1 + \frac{\varepsilon_S}{\varepsilon_D}) + \varepsilon_S} \tag{B.43}
$$

Specifically, when $\varepsilon_D \to \infty$, hedge funds will be perfectly elastic and do not charge any derivative spread for basis trade, and the Treasury market fully recovers to the slack case. On the contrary, when $\varepsilon_D \to 0$, the hedge funds will not provide derivative service and the Treasury market de-

generate to the binding case.

$$\lim_{\varepsilon_D \to \infty} \varepsilon_T + \frac{\varepsilon_S \varepsilon_L + \varepsilon_A \varepsilon_L (1 + \frac{\varepsilon_S}{\varepsilon_D})}{(\varepsilon_A + \varepsilon_L)(1 + \frac{\varepsilon_S}{\varepsilon_D}) + \varepsilon_S} = \underbrace{\varepsilon_T + \frac{1}{\frac{1}{\varepsilon_A + \varepsilon_S} + \frac{1}{\varepsilon_L}}}_{slack} \tag{B.44}$$

$$\lim_{\varepsilon_D \to 0} \varepsilon_T + \frac{\varepsilon_S \varepsilon_L + \varepsilon_A \varepsilon_L (1 + \frac{\varepsilon_S}{\varepsilon_D})}{(\varepsilon_A + \varepsilon_L)(1 + \frac{\varepsilon_S}{\varepsilon_D}) + \varepsilon_S} = \underbrace{\varepsilon_T + \frac{1}{\frac{1}{\varepsilon_A} + \frac{1}{\varepsilon_L}}}_{binding} \tag{B.45}$$

The price impact of Treasury supply shocks on long-term bond market follows

$$\begin{aligned} \frac{\partial \mathbb{E}_0[ex_1^L]}{\partial S_T} &= 1 - \frac{\varepsilon_T}{\varepsilon_L} \frac{\partial \mathbb{E}_0[ex_1^T]}{\partial S_T} \\ &= \frac{1}{\varepsilon_T \frac{(\varepsilon_A + \varepsilon_L)\left(1 + \frac{\varepsilon_S}{\varepsilon_D}\right) + \varepsilon_S}{\varepsilon_A \left(1 + \frac{\varepsilon_S}{\varepsilon_D}\right) + \varepsilon_S} + \varepsilon_L} \end{aligned} \tag{B.46}$$

Threshold Condition. The same as in the full model, according to Lemma 1.

B.5.3 Size of Basis Trade and Derivative Spread

In equilibrium, the size of basis trade activities S_D follows

$$S_D = \varepsilon_D \times \underbrace{\mathbb{E}_0[ex_1^T - ex_1^D]}_{\equiv ds} \tag{B.47}$$

Observe that the derivative spread is a function of $(S_L, S_T, S_S, \bar{D})$ according to (B.42). I conduct the same comparative statics analysis as in Section 3.2.1 to study the determinants of derivative spread. That is, we fix the long-term bond supply $S_L + S_T = S_{Long}$ and corporate bond supply $S_S + S_L = S_{Credit}$. Then, we study the size of the derivative spread in response to the long-term corporate bond S_L share:

$$\begin{aligned} \frac{\partial ds(S_L, S_{Long} - S_L, S_{Credit} - S_L, \bar{D})}{\partial S_L} &= \frac{1}{\varepsilon_D} \left(- \left[\left(1 + \frac{\varepsilon_T}{\varepsilon_L} \right) \varepsilon_A + \varepsilon_T \right] \frac{\partial \mathbb{E}_0[ex_1^T]}{\partial S_L} + \frac{\varepsilon_A}{\varepsilon_L} - (1 + \frac{\varepsilon_A}{\varepsilon_L}) \right) \\ &= \frac{1}{\varepsilon_D} \left(\left[(\varepsilon_L + \varepsilon_T) \varepsilon_A + \varepsilon_T \varepsilon_L \right] \frac{\varepsilon_S}{\varepsilon_D \Pi} - 1 \right) \\ &= - \frac{(\varepsilon_S + \varepsilon_A)(\varepsilon_T + \varepsilon_L) + \varepsilon_T \varepsilon_L}{\Pi} < 0 \end{aligned} \tag{B.48}$$

And the size of derivative spread in response to duration mandate follows

$$\begin{aligned}\frac{\partial ds(S_L, S_{Long} - S_L, S_{Credit} - S_L, \bar{D})}{\partial \bar{D}} &= \frac{1}{\varepsilon_D}\left(-\left[\left(1+\frac{\varepsilon_T}{\varepsilon_L}\right)\varepsilon_A + \varepsilon_T\right]\frac{\partial \mathbb{E}_0[ex_1^T]}{\partial \bar{D}} - \frac{\varepsilon_A}{\varepsilon_L}\right) \\ &= \frac{1}{\varepsilon_D}\left(\left[\left(1+\frac{\varepsilon_T}{\varepsilon_L}\right)\varepsilon_A + \varepsilon_T\right] \times \frac{\varepsilon_L + \varepsilon_S + \left(1+\frac{\varepsilon_S}{\varepsilon_D}\right)\varepsilon_A}{\Pi} - \frac{\varepsilon_A}{\varepsilon_L}\right) \\ &= \frac{(\varepsilon_L + \varepsilon_T)\,\varepsilon_A + \varepsilon_T(\varepsilon_L + \varepsilon_S)}{\varepsilon_D \Pi} > 0\end{aligned} \tag{B.49}$$

That is, even though the total risk supply is fixed, with fewer corporate bonds providing duration risks or a higher duration mandate $\bar{D}$, the higher the demand from the allocator for Treasury derivatives, the larger the derivative spread.

C Details on Data Construction

C.1 Treasury Issuance Calendar

1. **Quarterly borrowing (financing) estimates.** Retrieved from the US Treasury's archive of quarterly refunding materials from treasury website, which covers 1991 to 2024: https://home.treasury.gov/policy-issues/financing-the-government/quarterly-refunding/quarterly-refunding-archives/quarterly-refunding-financing-estimates-by-calendar-year

2. **Historical TBAC recommended financing tables.** Retrieved from the US Treasury's archive of quarterly refunding materials from treasury website, which covers 2002 to 2024: https://home.treasury.gov/policy-issues/financing-the-government/quarterly-refunding/quarterly-refunding-archives/tbac-recommended-financing-tables-by-calendar-year. For earlier years (1991–2001), retrieved from the National Archives of Treasury press releases published by the Federal Reserve Bank of St. Louis: https://fraser.stlouisfed.org/title/press-releases-united-states-department-treasury-6111.

3. **Historical Treasury auction announcements.** Retrieved from the US Treasury's Treasury Direct website. Which covers all treasury securities auctions starting from 1997 to 2024: https://treasurydirect.gov/auctions/announcements-data-results/announcement-results-press-releases/. For earlier years (1991-1997), retrieved from the National Archives of Treasury press releases published by the Federal Reserve Bank of St. Louis.

4. **Historical Treasury auction results.** Retrieved from US Treasury's *FiscalData* website: https://fiscaldata.treasury.gov/datasets/treasury-securities-auctions-data/treasury-securities-auctions-data, which covers auction results from 11/15/1979. I include only coupon auctions and single-price auctions (Dutch auctions), which started in September 1992. The bid-to-cover ratio in the auction results excludes the Federal Reserve New York's SOMA participation:

$$\text{Bid-to-cover ratio} \equiv \frac{\text{Total Tendered - SOMA Tendered}}{\text{Total Accepted - SOMA Accepted}} \tag{C.1}$$

   The department of Treasury did not report the bid-to-cover ratio of auctions before 1998, but it reported the offering amount (to the market) and total accepted. Because SOMA places non-competitive bidding, all demands will be fulfilled. I calculated the SOMA Tendered

and SOMA Accepeted via Total Accepted–Offerring amount. Then, we use equation (C.1) to calculate the bid-to-cover ratio.

5. **Total Treasury outstanding**: retrieved from FRED (GFDEBTN).

C.2 Intraday Treasury Prices

The data on secondary market treasury yields come from GovPX, which provides comprehensive intraday coverage of all active and off-the-run US Treasuries from June 1991 through March 2024. The sample is restricted to on-the-run treasury securities at each maturity. To identify on-the-run treasuries, I used the dataset's "Active Code" field for 1991–2008 and the "Record" field for 2009–2024.

To proxy the transaction yields, I take the midpoint of the bid and ask yields at each timestamp. The coverage of bid and ask yields varies across subperiods. From 1991 to 1992, GovPX did not report bid and ask yields. For these years, I recover bond coupon and maturity information from the Treasury auction results and convert reported bid and ask prices into yields. During the transition from voice broking to electronic trading, roughly from 1999 to 2008, reported bid and ask yields (and prices) are sparse (Mizrach and Neely, 2006); for that window, I rely on indicative bid and ask yields. For all other years, 1993–1998 and 2009–2024, I use the reported bid and ask yields to proxy the transaction yields.

C.3 MorningStar Mutual Fund Holdings

I obtain US and international mutual fund and ETF holdings from Morningstar. I restrict coverage to fixed-income funds and ETFs over 2005Q1–2024Q4. The dataset covers 20,369 mutual funds and ETFs globally and provides broad coverage of the mutual fund industry (Maggiori et al., 2020; Coppola, 2025).

Benchmark index. Morningstar reports both the "Primary Prospectus Benchmark" and the "Morningstar Index" for each fund. The former is the self-reported benchmark chosen by the fund, and the latter is Morningstar's category-based index. Figure D.8 is based on the Morningstar Index. Figure 17a is based on the Primary Prospectus Benchmark, where I select funds benchmarked to the Bloomberg US Aggregate Bond Index.

Bond positions. I obtain cash-bond positions as follows:

1. **Sample selection.** Following Koijen and Yogo (2019), I retain fixed-income mutual funds and ETFs with assets under management of at least $10 million at any point in the sample.

2. **Bond information cleaning.** Morningstar provides CUSIP and ISIN for the cash-bond positions, along with security characteristics (bond type, market value, face value, maturity, base currency, etc.). I standardize identifiers and clean missing or conflicting fields before aggregating to the fund–date–security level.

Treasury futures positions. A large subset of fund families report contract-level derivatives holdings, which allows identification of Treasury futures via name matching. Derivatives disclosure varies by fund family: many large US fund families (e.g., BlackRock, PIMCO, T. Rowe Price, Prudential/PGIM, DoubleLine) report contract-level details, while others provide only aggregates or do not disclose. I extract Treasury future positions for funds with contract-level disclosure over 2005Q1–2024Q4. I follow the steps below to identify positions:

1. **Identify Treasury futures.** I use the "holding type" reported by Morningstar to classify Treasury futures. I keep positions with Type = "BOND – TREASURY FUTURE." To avoid non-US Treasury contracts, I retain only USD-denominated entries. Some Treasury futures appear as "UNIDENTIFIED HOLDING"; I additionally classify these positions by name matching to contract labels, CME Globex codes, or Bloomberg tickers listed in Table C.1.

2. **Identify the maturity of the underlying Treasury bond.** Morningstar does not provide maturity information for derivatives. However, as shown in Table C.1, there are only eight standard US Treasury futures contracts. I identify Treasury future positions' underlying tenor by name matching to the contract label, CME Globex code, or Bloomberg ticker listed in Table C.1.

3. **Determine position direction.** Morningstar reports "marketValue" and "numberOfShares" for derivatives positions. I treat a positive market value as a long position and a negative market value as a short position.

4. **Compute notional exposure.** When "number of share" is available, notional exposure equals (number of share) $\times$ (contract size from Table C.1). If "number of share" is missing, I proxy notional using the reported face value of the contract.

Following these steps, I identify 625,165 unique Treasury futures positions held by 4,916 funds over 2005Q1–2024Q4.

Table C.1: CME US Treasury Future Contracts

Contract Futures	Other Names	Deliverable Maturities	Intro Date	CME Globex	Bloomberg Ticker	Contract Size
2YR UST Future	-	1YR 9M – 2YR	1990	ZT	TU	$200K
3YR UST Future	-	2YR 9M – 3YR	2020	Z3N	3Y	$200K
5YR UST Future	-	4YR 2M – 5YR 3M	1988	ZF	FV	$100K
10YR UST Future	-	6YR 6M – 8YR	1982	ZN	TY	$100K
Ultra 10YR UST Future	-	9YR 5M – 10YR	2016	TN	UXY	$100K
UST Bond Future	30YR UST Future	15YR – 25YR	1977	ZB	US	$100K
20YR UST Future	-	19YR 2M – 19YR 11M	2022	TWE	TWE	$100K
Ultra 30YR UST Future	Long-term Bond Future	25YR – 30YR	2010	UB	WN	$100K

Note: This table presents the CME US treasury future contracts. CME Globex stands for the futures' CME ticker. Bloomberg Ticker stands for the futures' Bloomberg ticker. Retrieved on April 24, 2025, from https://www.cmegroup.com/trading/interest-rates/basics-of-us-treasury-futures.html.

C.4 NAIC Life Insurance Holdings

The life-insurance asset-holdings data are sourced from US insurers' statutory filings, accessed via S&P Global's SNL Sector Financial platform. All US insurers file with the National Association of Insurance Commissioners (NAIC), which disseminates these data for research. My primary datasets are NAIC Schedule D, Part 1 (Bonds), and NAIC Schedule DB. Schedule D, Part 1 is available at annual and quarterly frequencies: the annual file reports year-end portfolio holdings, and the quarterly files record security-level acquisitions and disposals within each quarter, including the trade date and amount for each transaction. These features allow me to observe portfolio rebalancing at quarterly frequency. Schedule D, Part 1 is widely used in the literature (e.g., Ozdagli and Wang (2019); Coppola (2025); Li and Wenning (2025)).

The NAIC Schedule DB table provides position-level details on insurers' derivatives holdings and is used to study life insurers' hedging behavior (e.g., Sen (2023)). I extract interest-rate swap positions from Part A (Options, Caps, Floors, Collars, Swaps, and Forwards) and Treasury futures positions from Part B (Futures Contracts). Each record reports the instrument type and stated purpose (hedging, income generation, replication, other), notional amount, maturity information (open date, maturity date, termination date), counterparty information, and pricing information (book/adjusted carrying value, fair value, strike price, etc.). Schedule DB is available at both quarterly and annual frequencies: the quarterly filing reports positions open at quarter-end, and the annual filing reports positions open at year-end as well as positions terminated during the

year. I rely on quarterly filings to maintain a consistent panel of open positions.[50]

Bond Positions I extract life-insurer bond holdings from NAIC Schedule D. The coverage spans 2008Q1–2024Q4. I clean the bond positions as follows:

1. **Sample selection.** Following Koijen and Yogo (2019), I retain life insurance companies with assets under management of at least $10 million at any point in the sample.

2. **Bond information cleaning.** Schedule D provides CUSIP and ISIN identifiers for each position, as well as security characteristics (fair value, par value, maturity, coupon rate, etc.). I standardize identifiers and resolve missing or conflicting fields before aggregating to the insurer–date–security level.

Identify Interest Rate Swap Positions I extract life-insurer interest-rate swap positions from Part A of NAIC Schedule DB. The coverage spans 2010Q1–2024Q4. I identify swap positions in four steps:[51]

1. **Identify interest rate swap positions.** I first select interest rate swaps using the "row-number" field. In addition, NAIC reports the contract's "Type(s) of Risk," and interest-rate swaps are labeled as *interest-rate* risk. I retain positions labeled *interest-rate* and exclude those labeled *equity*, *currency*, *credit default*, *inflation*, or *other*. I also drop positions with no descriptive information. The remaining positions are the interest rate swap positions.

2. **Identify remaining maturity of interest rate swaps.** Schedule DB reports the maturity or expiration date for each swap. I compute contract i's remaining maturity at date t as

$$\text{Remaining Maturity}_{i,t} = \frac{\text{Expiration Date}_i - t}{365 \text{ day/year}}, \tag{C.2}$$

3. **Determine swap direction.** I infer *receive-fixed* versus *pay-fixed* from the field "Strike Price, Rate or Index Received (Paid)." When this field is missing, I use the position description, which typically states the contract direction (e.g., *"Interest rate swap—Rec fixed; Pay float-*

[50] An alternative is to use the annual filing and back out quarter-end status from termination dates. However, this approach has two limitations: (i) when the termination date is missing, it is impossible to determine the contract's status in a specific quarter; and (ii) for terminated positions, only the fair value at termination is recorded, whereas quarter-end fair values during the life of the position are not reported.

[51] NAIC redesigned Schedule DB in 2010. Before 2010, swaps were recorded in Part C (Collars, Swaps, and Forwards) and were then moved to a unified Part A (with options, caps/floors, collars, and forwards). Pre-2010 records lack price information, making swap direction difficult to identify; accordingly, my main sample begins in 2010.

ing; 2010-IRS-0119" indicates receive-fixed). Using this procedure, I classify approximately 90.8% of swap positions; unclassified observations are excluded.

4. **Compute notional exposure.** For each swap, I use the reported notional amount in Schedule DB as the position size.

Following these steps, I identify 505,485 receive-fixed interest rate swap positions and 384,781 pay-fixed swap positions. These positions are held by 116 life insurers over 2010Q1–2024Q4.

Identify Future Positions I extract life insurers' US Treasury futures positions from Part B of NAIC Schedule DB (Futures Contracts). The coverage spans 2008Q1–2024Q4. I identify Treasury futures in four steps:

1. **Identify Treasury futures.** NAIC reports the contract's "Type(s) of Risk." and treasury futures are labeled as *interest-rate* risk. I retain positions labeled as *interest-rate* risk and exclude positions labeled *equity/index*, *foreign exchange*, or *currency*. Within interest-rate risk, some contracts reference foreign sovereigns; I exclude positions whose ticker or description contains foreign identifiers (e.g., `CAN`, `EUR`, `JPY`, `GBP`, `BRL`, `JPN`, `Gilt`, `AUS`, `AUD`, `SWE`, etc.). I also drop positions with neither ticker nor descriptive information. The remaining positions are US Treasury futures.

2. **Identify the maturity of the underlying Treasury bond.** I first identify the futures contract type using the ticker reported in Schedule DB, as listed in Table C.1. When the ticker is missing, I rely on the contract description, which typically includes the contract family (e.g., "US 10YR ULTRA FUT," "US ULTRA BOND"). These steps assign maturities for approximately 95% of positions identified in step 1.

3. **Determine position direction.** I infer long versus short using the "row number" and "row description" fields, which classify derivative positions into long-futures and short-futures exposures.

4. **Compute notional exposure.** Schedule DB reports both the number of contracts and a notional amount per position, but the notional-amount field exhibits inconsistent units over time. I therefore rely on the number of contracts and compute notional exposure as (number of contracts) $\times$ (contract size from Table C.1).

Following these steps, I identify 32,497 long US Treasury futures positions and 19,002 short posi-

tions. Those positions are held by 100 life insurers over 2008Q1–2024Q4.

C.5 Other Data Sources

1. **Treasury future positions of market participants**. Collected from Commodity Futures Trading Commission (CFTC) Traders in Financial Futures (TFF) report: https://www.cftc.gov/MarketReports/CommitmentsofTraders/HistoricalCompressed/index.htm.
2. **Primary Dealer Treasury Positions**. Collected from Federal Reserve Bank of New York, Weekly Primary Dealer Statistics: https://www.newyorkfed.org/markets/counterparties/primary-dealers-statistics
3. **Daily Interest rate and interest rate swap rate**. Interest rates are collected from FRED: 10 year treasury yield (DGS10) and 30 year treasury yield (DGS30). Interest rate swap rate collected from LSEG Refinitiv workspace (ticker: `USDAM3L10Y`). I use the middle of the bid and ask yield for the swap rate.
4. **Corporate bond supply.** Collected from LSEG Debt New Issues Deals data. I select corporate bond issues from 1990 onward, retaining US-domiciled, USD-denominated bonds and excluding floating-rate bonds. This yields approximately 1.55 million deals from 1990Q1 to 2024Q4. The dataset provides maturity, issue date, and face value information and allows me to track corporate bond supply over time.
5. **Corporate bond index**. Collected from ICE Bank of America Merrill Lynch.

D Supplementary Results

D.1 Swap Spread Decomposition Via Structural VAR model

I follow Hanson et al. (2024) to decompose 10-year swap spread into latent demand factors and supply factors. Assume a bivariate VAR involving (1) 10-year swap spreads s_t and (2) end-users' net position in receive-fixed swaps proxied with primary dealers' net position in Treasuries $\hat{d}_t$ = PD-UST-Net$_t$:

$$\overbrace{\begin{bmatrix} s_t \\ \hat{d}_t \end{bmatrix}}^{\mathbf{y}_t} = \mathbf{c} + \sum_{l=1}^{L} \mathbf{C}_l \overbrace{\begin{bmatrix} s_{t-l} \\ \hat{d}_{t-l} \end{bmatrix}}^{\mathbf{y}_{t-l}} + \overbrace{\begin{bmatrix} \xi_t^s \\ \xi_t^{\hat{d}} \end{bmatrix}}^{\xi_t}. \tag{D.1}$$

where the shocks $\boldsymbol{\xi}_t$ reflect a combination of structural shocks to both end-user demand and intermediary supply.

Assume the equilibrium outcomes are driven by unobserved demand and supply factors $\mathbf{z}_t$

$$\overbrace{\begin{bmatrix} s_t \\ \hat{d}_t \end{bmatrix}}^{\mathbf{y}_t} = \mathbf{a} + \mathbf{A} \overbrace{\begin{bmatrix} z_t^d \\ z_t^w \end{bmatrix}}^{\mathbf{z}_t}, \tag{D.2}$$

which follow law of motion

$$\overbrace{\begin{bmatrix} z_t^d \\ z_t^w \end{bmatrix}}^{\mathbf{z}_t} = \sum_{l=1}^{L} \mathbf{D}_l \overbrace{\begin{bmatrix} z_{t-l}^d \\ z_{t-l}^w \end{bmatrix}}^{\mathbf{z}_{t-l}} + \overbrace{\begin{bmatrix} \varepsilon_t^d \\ \varepsilon_t^w \end{bmatrix}}^{\varepsilon_t}, \tag{D.3}$$

where ε_t is a vector of orthogonal structural shocks that each have unit variance, i.e., $\text{Var}_{t-1}[\varepsilon_t] = \text{Var}[\varepsilon_t] = \mathbf{I}$. I then obtain a bivariate structural VAR to take to the data:

$$\mathbf{y}_t = \left(\mathbf{I} - \sum_{l=1}^{L} \mathbf{A}\mathbf{D}_l\mathbf{A}^{-1}\right)\mathbf{a} + \sum_{l=1}^{L} \left(\mathbf{A}\mathbf{D}_l\mathbf{A}^{-1}\right)\mathbf{y}_{t-l} + \mathbf{A}\varepsilon_t, \tag{D.4}$$

We can identify this structural VAR by imposing the sign restrictions on $\mathbf{A}$ matrix that maps structural shocks ε_t into reduced-form shocks. Specifically, assume the four elements of $\mathbf{A}$ satisfy the

following sign restrictions:

$$\overbrace{\begin{bmatrix} \xi_t^s \\ \xi_t^{\hat{d}} \end{bmatrix}}^{\xi_t} = \overbrace{\begin{bmatrix} - & + \\ + & + \end{bmatrix}}^{\mathbf{A}} \overbrace{\begin{bmatrix} \varepsilon_t^d \\ \varepsilon_t^w \end{bmatrix}}^{\varepsilon_t}. \tag{D.5}$$

Intuitively, a positive (negative) shocks to end-user demand ε_t^d leads to negative (positive) innovation to swap spread s_t and positive (negative) innovation to net position $\hat{d}_t$. A positive (negative) shocks to intermediary supply ε_t^w leads to positive (negative) innovation to both swap spread s_t and net position $\hat{d}_t$.

We then identify $\mathbf{A}$ using the pure sign restrictions approach of Uhlig (2005). Since $\text{Var}[\varepsilon_t] = \mathbf{I}$ -i.e., the structural shocks are assumed to be orthogonal and we are only attempting to identify their impact "up to scale"-the observed variance of reduced-form shocks, $\text{Var}[\boldsymbol{\xi}_t] = \mathbf{A}\mathbf{A}'$, provides us with three restrictions on the four elements of $\mathbf{A}$. The sign restrictions D.5 do not allow us to point identify $\mathbf{A}$. However, they provide a partial identification, ruling out many candidates that satisfy $\mathbf{A}\mathbf{A}' = \text{Var}[\boldsymbol{\xi}_t]$ and leaving us with an identified set of As. Following Hanson et al. (2024), I select the $\mathbf{A}$ in this set that is closest to the median value in the set.

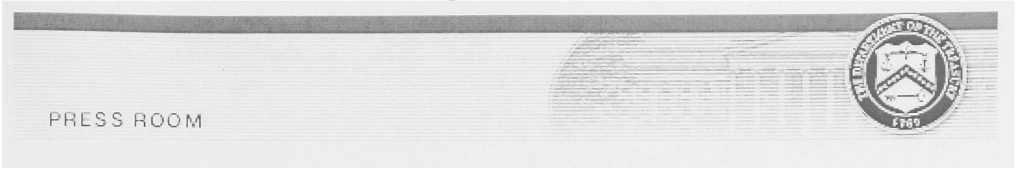
In the end, the swap spread can be decomposed into the demand factor and supply factor:

$$s_t - E[s_t] = \underbrace{\hat{A}_d \hat{z}_t^d}_{\textbf{Demand}} + \underbrace{\hat{A}_w \hat{z}_t^w}_{\textbf{Supply}}. \tag{D.6}$$

I restrict the data sample to weekly 10-year swap spread from January 2009 to July 2025. The decompositions are shown in the Figure 12c.

D.2 Additional Figures and Tables

Figure D.1: Sample of the Quarterly Market Financing Estimate



FROM THE OFFICE OF PUBLIC AFFAIRS

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February 2, 2004
JS-1133

Treasury Announces Market Financing Estimates

The Treasury Department announced today that it expects net borrowing of marketable debt to total $177 billion in the January – March 2004 quarter. The projected cash balance on March 31 is $20 billion. In the last quarterly announcement on November 3, 2003, Treasury announced that it expected net borrowing to total $160 billion with an end-of-quarter cash balance of $20 billion. This increase in borrowing is due to lower receipts, primarily from an increase in tax refunds, and higher outlays.

Treasury also announced that it expects net borrowing of marketable debt to total $75 billion in the April – June 2004 quarter. The projected cash balance on June 30 is $45 billion.

During the October – December 2003 quarter, Treasury's net marketable borrowing totaled $113 billion and the cash balance on December 31 was $33 billion. On November 3, Treasury announced that it expected net marketable borrowing to total $117 billion with an ending quarter cash balance of $35 billion. The decrease in borrowing is primarily attributable to lower outlays.

Additional financing details relating to Treasury's Quarterly Refunding will be released at 9:00 A.M. on Wednesday, February 4.

Related Documents:

- Supplemental Release: Treasury's Market Financing Estimates

Note: This document presents the Department of the Treasury's market borrowing estimates for the first and second quarters of 2004, released at 3:00 p.m. ET on February 2, 2004. The PDF is sourced from the FRASER archive (Federal Reserve Bank of St. Louis); the text is also available on the Treasury website.

Figure D.2: Sample of the Tentative Auction Plan Released on Quarterly Refunding Conference

US TREASURY FINANCING SCHEDULE FOR 1ST QUARTER 2004
BILLIONS OF DOLLARS

ISSUE	ANNOUNCEMENT DATE	AUCTION DATE	SETTLEMENT DATE	OFFERED AMOUNT 4-WK		3-MO		6-MO		MATURING AMOUNT		NEW MONEY
4-WEEK AND	12/24	12/29	1/2	12.00	A	16.00	A	15.00	A	51.00		-8.00
3&6 MONTH BILLS	12/31	1/5	1/8	9.00	A	17.00	A	16.00	A	45.00		-3.00
	1/8	1/12	1/15	8.00	A	17.00	A	16.00	A	44.00		-3.00
	1/15	1/20	1/22	9.00	A	18.00	A	16.00	A	46.00		-3.00
	1/22	1/26	1/29	14.00	A	18.00	A	16.00	A	46.00		2.00
	1/29	2/2	2/5	19.00	A	19.00	A	17.00	A	43.00		12.00
	2/5	2/9	2/12	20.00		19.00		18.00		40.00		17.00
	2/12	2/16	2/19	22.00		19.00		20.00		41.00		20.00
	2/19	2/23	2/26	24.00		19.00		20.00		46.00		17.00
	2/26	3/1	3/4	25.00		19.00		20.00		51.00		13.00
	3/4	3/8	3/11	25.00		19.00		20.00		51.00		13.00
	3/11	3/15	3/18	22.00		18.00		18.00		51.00		7.00
	3/18	3/22	3/25	18.00		18.00		18.00		54.00		0.00
						693.00				609.00		84.00
CASH MANAGEMENT BILLS												
13-Day Bill	12/29 Matures 1/15	12/30	1/2			15.00				15.00		0.00
11-Day Bill	3/2 Matures 3/15	3/3	3/4			20.00				20.00		0.00
COUPONS												
								CHANGE IN SIZE				
5-Year Note	1/5	1/7	1/15			16.00	A			15.22		0.78
10-Year TIPS	1/5	1/8	1/15			12.00	A	+ 1.00				12.00
2-Year Note	1/26	1/29	2/2			26.00	A			24.55		1.45
3-Year Note	2/4	2/10	2/17			24.00						24.00
5-Year Note	2/4	2/11	2/17			16.00						16.00
10-Year Note	2/4	2/12	2/17			17.00				11.82		5.18
2-Year Note	2/23	2/25	3/1			26.00				23.74		2.26
5-Year Note	3/8	3/15	3/17			16.00						16.00
10-Year Note (R)	3/8	3/15	3/22			13.00						13.00
2-Year Note	3/22	3/24	3/31			27.00		1.00		24.54		2.46
						193.00				99.87		93.13

R = Reopening
A = Announced

Treasury announced a Q1 borrowing need of $177 billion on 2/2/04

NET CASH RAISED THIS QUARTER: 177.13

Note: This document presents a sample tentative auction plan for the 1st quarter of 2004, released during the quarterly refunding conference around 9:00 a.m. ET on February 4, 2004.

Figure D.3: Sample of the Treasury Auction Announcement

HIGHLIGHTS OF TREASURY OFFERINGS TO THE PUBLIC OF
5-YEAR NOTES AND 9-YEAR 11-MONTH 4% NOTES TO BE ISSUED MARCH 15, 2004

March 8, 2004

Offering Amount	$16,000 million	$11,000 million
Maximum Award (35% of Offering Amount)	$ 5,600 million	$ 3,850 million
Maximum Recognized Bid at a Single Yield	$ 5,600 million	$ 3,850 million
NLP Reporting Threshold	$ 5,600 million	$ 3,850 million
NLP Exclusion Amount	None	$ 5,600 million
Description of Offering		
Term and type of security	5-year notes	9-year 11-month 4% notes (reopening)
Series	F-2009	B-2014
CUSIP number	912828 CC 2	912828 CA 6
Auction date	March 10, 2004	March 11, 2004
Issue date	March 15, 2004	March 15, 2004
Dated date	March 15, 2004	February 15, 2004
Maturity date	March 15, 2009	February 15, 2014
Interest rate	Determined based on the highest accepted competitive bid	4%
Amount currently outstanding	Not applicable	$17,082 million
Yield	Determined at auction	Determined at auction
Interest payment dates	September 15 and March 15	August 15 and February 15
Minimum bid amount and multiples	$1,000	$1,000
Accrued interest payable by investor	None	$3.18681 per $1,000 (from February 15 to March 15, 2004)
Premium or discount	Determined at auction	Determined at auction
STRIPS Information:		
Minimum amount required	$1,000	$1,000
Corpus CUSIP number	912820 JZ 1	912820 JX 6
Due date(s) and CUSIP number(s) for additional TINT(s)	March 15, 2009 - - 912833 2B 5	Not applicable

The following rules apply to all securities mentioned above:

Submission of Bids:

Noncompetitive bids: Accepted in full up to $5 million at the highest accepted yield.

Foreign and International Monetary Authority (FIMA) bids: Noncompetitive bids submitted through the Federal Reserve Banks as agents for FIMA accounts. Accepted in order of size from smallest to largest with no more than $100 million awarded per account. The total noncompetitive amount awarded to Federal Reserve Banks as agents for FIMA accounts will not exceed $1,000 million. A single bid that would cause the limit to be exceeded will be partially accepted in the amount that brings the aggregate award total to the $1,000 million limit. However, if there are two or more bids of equal amounts that would cause the limit to be exceeded, each will be prorated to avoid exceeding the limit.

Competitive bids:

(1) Must be expressed as a yield with three decimals, e.g., 7.123%.
(2) Net long position (NLP) for each bidder must be reported when the sum of the total bid amount, at all yields, and the net long position equals or exceeds the NLP reporting threshold stated above.
(3) Net long position must be determined as of one half-hour prior to the closing time for receipt of competitive tenders.

Receipt of Tenders:

Noncompetitive tenders.....Prior to 12:00 noon eastern standard time on auction day
Competitive tenders.....Prior to 1:00 p.m. eastern standard time on auction day

Payment Terms:.....By charge to a funds account at a Federal Reserve Bank on issue date, or payment of full par amount with tender. *TreasuryDirect* customers can use the Pay Direct feature which authorizes a charge to their account of record at their financial institution on issue date.

Note: This document presents a treasury auction announcement for 5-year and 10-year treasury notes to be issued on March 15, 2004. The announcement was made at 11:00 a.m. ET on March 8, 2004.

Figure D.4: Sample of the Treasury Auction Result

PUBLIC DEBT NEWS

Department of the Treasury • Bureau of the Public Debt • Washington, DC 20239

TREASURY SECURITY AUCTION RESULTS
BUREAU OF THE PUBLIC DEBT - WASHINGTON DC

FOR IMMEDIATE RELEASE
March 11, 2004

CONTACT: Office of Financing
202-691-3550

RESULTS OF TREASURY'S AUCTION OF 9-YR 11-MONTH NOTES

This issue is a reopening of a note originally issued February 17, 2004.

Interest Rate:	4%	Issue Date:	March 15, 2004
Series:	B-2014	Dated Date:	February 15, 2004
CUSIP No:	912828CA6	Maturity Date:	February 15, 2014

High Yield: 3.752% Price: 102.034

All noncompetitive and successful competitive bidders were awarded securities at the high yield. Tenders at the high yield were allotted 34.31%. All tenders at lower yields were accepted in full.

Accrued interest of $ 3.18681 per $1,000 must be paid for the period from February 15, 2004 to March 15, 2004.

AMOUNTS TENDERED AND ACCEPTED (in thousands)

Tender Type	Tendered	Accepted
Competitive	$ 19,852,035	$ 10,956,550
Noncompetitive	43,495	43,495
FIMA (noncompetitive)	0	0
SUBTOTAL	19,895,530	11,000,045 1/
Federal Reserve	0	0
TOTAL	$ 19,895,530	$ 11,000,045

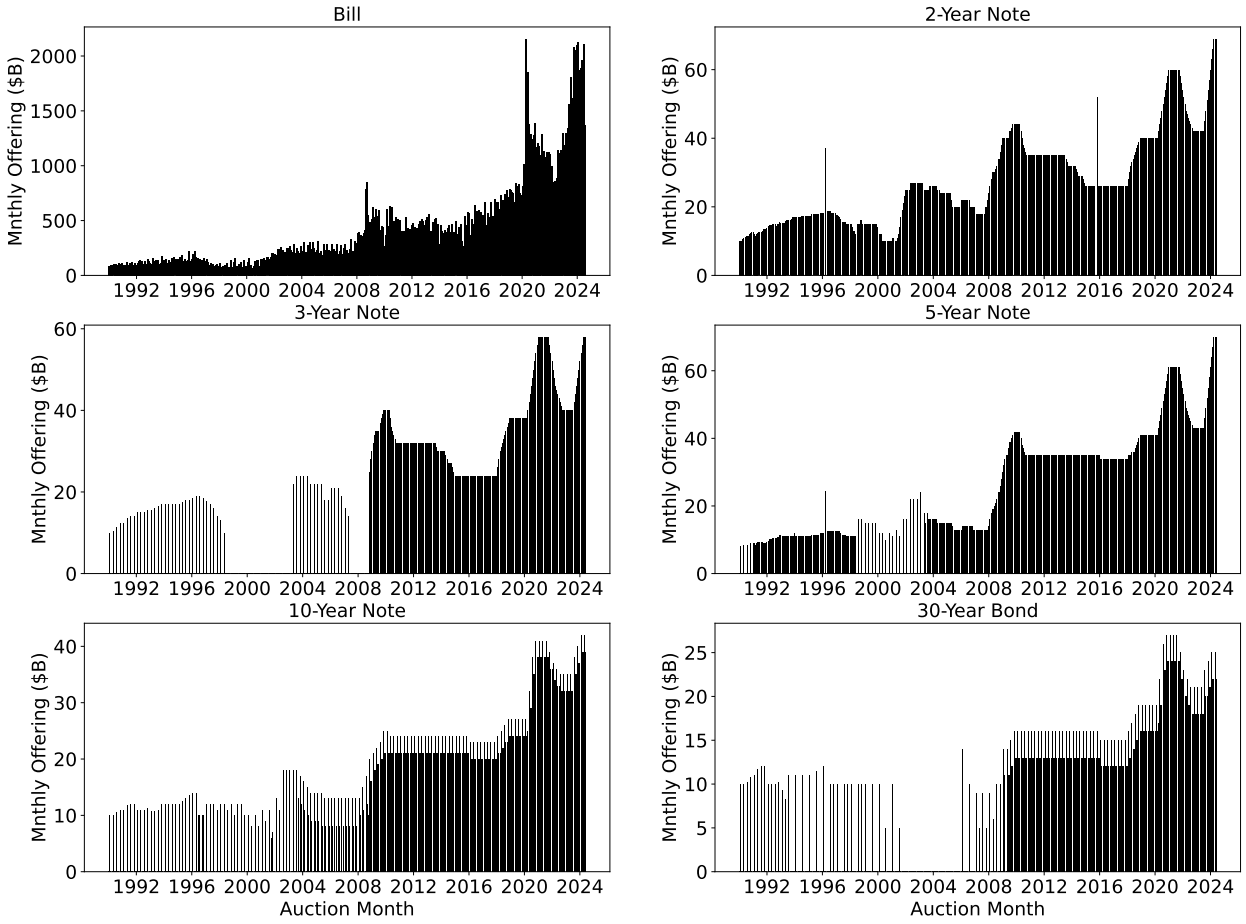
Median yield 3.730%: 50% of the amount of accepted competitive tenders was tendered at or below that rate. Low yield 3.660%: 5% of the amount of accepted competitive tenders was tendered at or below that rate.

Bid-to-Cover Ratio = 19,895,530 / 11,000,045 = 1.81

1/ Awards to TREASURY DIRECT = $26,573,000

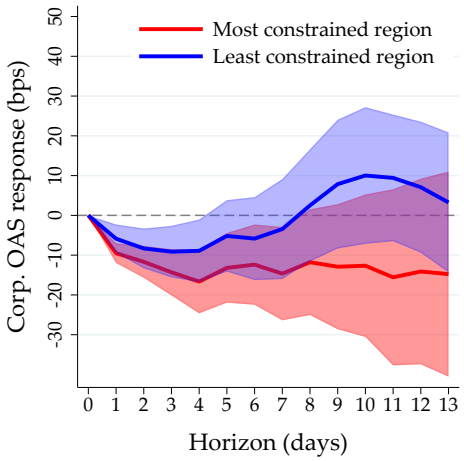
Note: This document presents a treasury auction results for 10-year treasury notes to be issued on March 15, 2004. The announcement was made shortly after the auction at 1:00. ET on March 11, 2004.

Figure D.5: US Treasury Monthly Auction Amounts



Note: The panel plots monthly auction amounts of US Treasury securities, by maturity, from January 1990 through June 2024. Treasury bills and the 2-, 3-, 5-, 10-, and 30-year coupon securities were offered throughout the sample period. The Treasury Department discontinued the 7-year note in April 1993 and the 20-year bond in 1986, reintroducing them in February 2009 and May 2020, respectively; these two maturities are thus excluded. Data are drawn from the US Department of the Treasury's auction dataset: https://fiscaldata.Treasury.gov/datasets/Treasury-securities-auctions-data/Treasury-securities-auctions-data.

(a) Pass-through from Treasuries to IG corporate bonds



(b) Pass-through from Treasuries to BBB corporate bonds

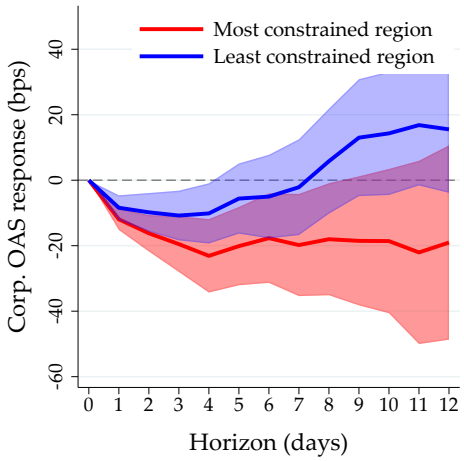


Figure D.6: Passthourgh from Treasuries to Lower Quality Corporate Bonds

Note: The shaded areas in the right panel represent 90% confidence intervals. Reported standard errors are based on Newey–West estimation with 9 lags.

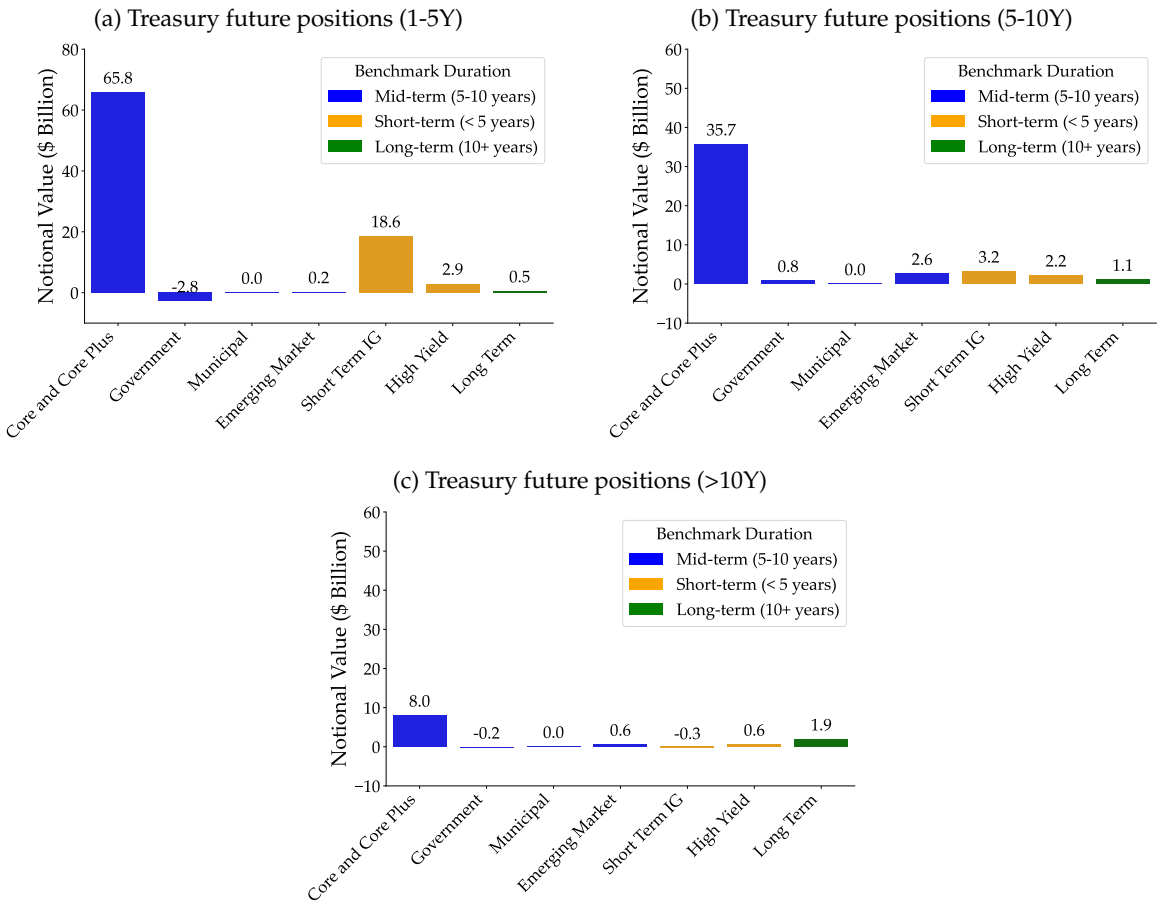


Figure D.7: Mutul Funds Treasury Future Positions by Maturity

Note: These figure Treasury futures positions of representative funds by future maturity bins. Benchmark indices are classified as short-term (below five years), medium-term (five to ten years), and long-term (above ten years) based on duration. All data are from MorningStar holdings reports as of 2024Q2.

Table D.1: Relation Between Swap Spreads and Treasury Share

VARIABLES	(1) $Swap\ Spread_t^{10Y}$	(2) $Swap\ Spread_t^{10Y}$	(3) $Swap\ Spread_t^{10Y}$	(4) $Swap\ Spread_t^{10Y}$
$\Delta UST\ Share_t^{2Y}$	-10.35***	-6.189***		
	(1.158)	(1.618)		
$\Delta UST\ Share_t^{3Y}$			-17.01***	-16.55***
			(1.180)	(1.858)
Observations	131	131	131	131
R-squared	0.322	0.453	0.546	0.564
Controls	N	Y	N	Y
Time Span	2009-2025	2009-2025	2009-2025	2009-2025

Note: This table reports regressions of the 10-year swap spread on changes in the rolling average of the Treasury share in the long-term bond market. Treasury share is measured using the composition of the Bloomberg U.S. Long Government/Credit Float-Adjusted Index. I use a rolling average to capture the combined effects of bond flows and outstanding bond stocks. Controls include the Treasury bill rate, the 10-year Treasury yield, the MOVE index, and the VIX index. The sample spans 2009–2025. All series are monthly. Newey-West standard errors with nine lags are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table D.2: Treasury Yield Responses to Three Shock Series

VARIABLES	Shock 1 (1) $\Delta y_{10\ \text{min}}$	Shock 2 (2) $\Delta y_{10\ \text{min}}$	Shock 3 (3) $\Delta y_{10\ \text{min}}$
$Shock_t$	0.187**	7.811***	-1.369**
	(0.0734)	(2.890)	(0.531)
$Shock_t \times \Delta Treasury\ Share_t$	0.320**	14.66*	-0.414*
	(0.151)	(8.594)	(0.180)
$\Delta Treasury\ Share_t$	-0.214*	-0.00848	0.883
	(0.123)	(0.123)	(0.495)
Observations	433	1,013	1,233
R-squared	0.0887	0.057	0.095
Maturity FE	Y	Y	Y

Note: This table reports the results for the following specification:

$$\Delta y_t^m = \alpha + \beta_1\ Shock_t + \beta_2 \Delta TreasuryShare_t + \beta\ Shock_t \times \Delta TreasuryShare_t + \lambda_m + \varepsilon_{m,t}$$

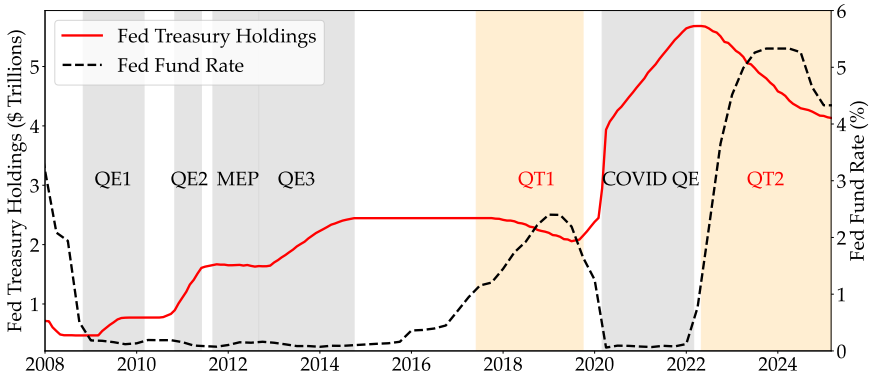
where Δy_t^m is the yield change for the treasury of maturity m within a 10-minute window around quarterly borrowing estimate announcement; $\Delta TreasuryShare_t$ the change in the 2-year rolling average of UST share in the Vanguard Long-Term Bond ETF (BLV); and λ_m are maturity fixed effects. The data sample covers from January 2009 to March 2024. The global financial crisis quarter (2008Q4) and the COVID quarter (2020Q2) are excluded. Standard errors, reported in parentheses, are clustered at the event-date level for columns (1) and (2), and at the bond-maturity level for column (3). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

D.3 QE QT Asymmetry

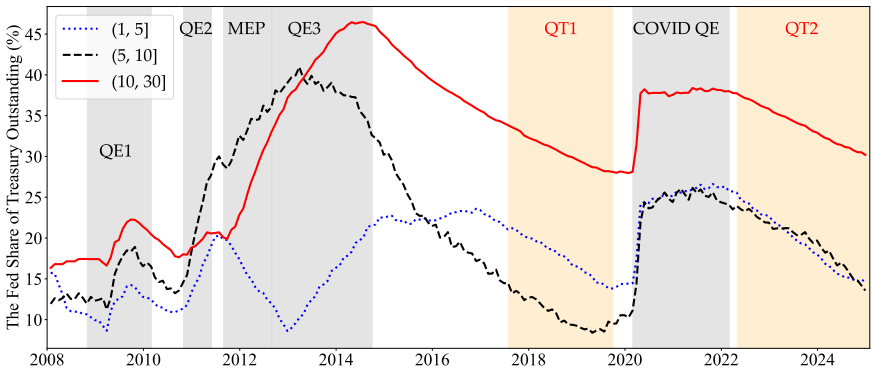
In this Section, I compare Treasury market elasticity and debt market segmentation in QT versus QE, the periods in which debt-market composition shifts most sharply. First, using the Treasury-supply shocks identified in Section 5, I document that the Treasury market is less elastic during QT. Second, I document weaker pass-through from Treasuries to corporate bonds during QT.

Figure D.8: Quantitative Easing and Tightening

(a) The Treasury holdings of the Federal Reserve



(b) The share of the Federal Reserve in the total Treasury outstanding



Notes: Figure D.8a shows Treasury holdings by the Federal Reserve. Figure D.8b shows the Federal Reserve share in total Treasury outstanding by maturity. Grey shading denotes QE periods; orange shading denotes QT periods. Data source: Federal Reserve System Open Market Account (SOMA), US Treasury Monthly Statement of the Public Debt (MSPD).

QE QT timeline In response to the recessions following the Global Financial Crisis and the pandemic, the Federal Reserve cut the federal funds rate to zero. To further stimulate the economy, it launched multiple rounds of quantitative easing (QE), purchasing large volumes of long-term bonds. To normalize the balance sheet and regain policy space, the Fed later turned to quantitative tightening (QT), first in 2017–2019 and again beginning in mid-2022. Table D.3 documents the timeline of the Federal Reserve's QE and QT programs, which I use to define QE and QT periods in the empirical analysis. These programs markedly shifted the composition of the U.S. debt mar-

ket: by June 2022 the Fed had accumulated roughly $4.7 trillion in Treasuries (Figure D.8a) and had become a major holder of long-maturity Treasuries (Figure D.8b).

Table D.3: Timeline of the Federal Reserve QE and QT programs

Region	Operation Period	Major Event	FOMC Date
QE1	Dec 2008 - Mar 2010	QE1 start	Nov 25, 2008
		QE1 extension	Mar 18, 2009
		QE1 slow down	Aug 12, 2009
		QE1 extension	Nov 4, 2009
		QE1 completion	March 16, 2010
QE2	Nov 2010 - Jun 2011	QE2 start	Nov 3, 2010
		QE2 completion	Jun 22, 2011
MEP	Sep 2010 - Dec 2012	MEP start	Sep 21, 2011
		MEP extension	Jun 20, 2012
QE3	Sep 2012 - Oct 2014	QE3 MBS purchase start	Sep 13, 2012
		QE3 UST purchase start	Dec 12, 2012
		QE3 tapering	Dec 18, 2013
		QE3 tapering at each FOMC	Jan - Jul 2014
		QE3 completion	Oct 29, 2014
QT1	Oct 2017 - Aug 2019	QT1 pace communication	Jun 14, 2017
		QT1 start	Sep 12, 2017
		QT1 tapering	Mar 20, 2019
		QT1 early stop	Jul 31, 2019
COVID QE	Mar 2020 - Mar 2022	COVID QE start	Mar 15, 2020
		COVID QE extension	Jun 10, 2020
		COVID QE extension	Dec 16, 2020
		COVID QE tapering	Nov 03, 2021
		COVID QE tapering	Dec 15, 2021
		COIVD QE completion	Mar 16, 2022
QT2	Jun 2022 -	QT2 pace communication	Apr 6, 2022
		QT2 start	May 4, 2022
		QT2 tapering	May 1, 2024
		QT2 tapering	Mar 19, 2025

Note: This table presents the timeline of major events during the Federal Reserve QE and QT programs from June 2008 to June 2025. "Operation Period" denotes the duration of each program. "FOMC Date" lists the meeting dates on which policy announcements were made. Specifically, (i) Within QE1, Treasury purchases began in March 2009; prior purchases were limited to agency MBS and agency debt. (ii) In 2014, the Fed reduced QE3 purchases at each successive FOMC meeting from January through July, and on October 29, 2014 it announced the end of the program. (ii) For QT2, the pace was discussed at the March 2022 FOMC meeting, and operational details were released in the April 6, 2022 FOMC minutes.

D.3.1 Treasury Market Elasticity

Treasury market responses to quarterly borrowing Estimate Revisions. First, I examine how Treasury yields respond to revisions in the quarterly borrowing estimates in Equation (31). Figure D.9 shows the high-frequency responses of long-term Treasury yields (10Y, 20Y, 30Y) to these revisions under QE and QT. The relationship is essentially flat during QE and noticeably steeper during QT.

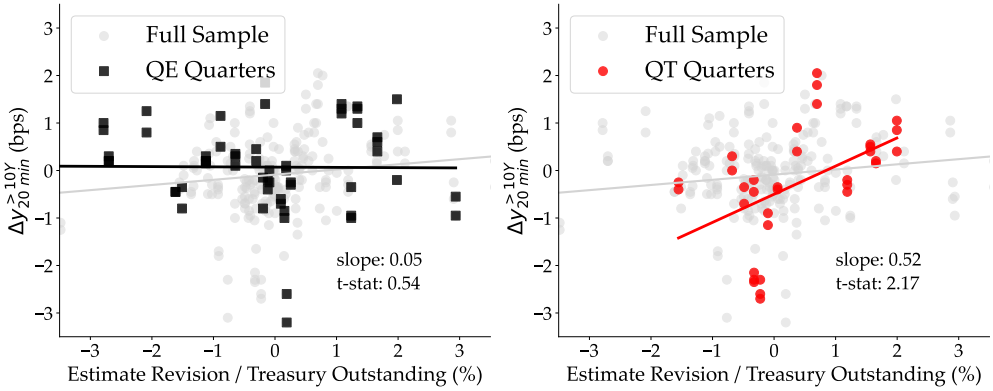


Figure D.9: Treasury Yield Responses to Net Borrowing Estimate Revisions.

Note: The scatter plots show the high frequency change in the long-term Treasury yield (10Y, 20Y, 30Y) against scaled revisions to quarterly borrowing estimates. The sample runs from 1991Q4 to 2024Q1, with each point representing a response. Black points in the left panel denote QE periods; red points in the right panel denote QT periods; light grey points are observations outside QE and QT. Reported slopes and t-statistics come from regressions with maturity fixed effects.

I then estimate the yield responses across maturities in Table D.4 for the full sample (1991–2024), QE periods, and QT periods. In the full sample, positive supply shocks drive up Treasury yields; the effects are stronger in QT and statistically insignificant in QE, and the difference between QE and QT is statistically significant. Columns (5)–(8) restrict the sample to long-term Treasuries; the pattern is more pronounced, reflecting that long-term bonds are more sensitive to supply shocks.

Treasury market responses to auction announcement shocks. A caveat with borrowing estimate shocks is that they include total financing across bills and coupons, while in practice the Treasury keeps coupon issuance relatively stable and primarily adjusts bills to meet near-term needs.[52] Shocks measured on auction announcement days help address this concern. Although these surprises are smaller in size (typically within 5 billions), they pertain directly to coupon supply. The scatter plots in Figure D.10 show the high-frequency responses of the 10-year Treasury to supply shocks in long maturities, as in equation (**??**). The pattern mirrors the quarterly estimate

[52] See Figure D.5 in the appendix for the monthly auction amounts of US Treasuries.

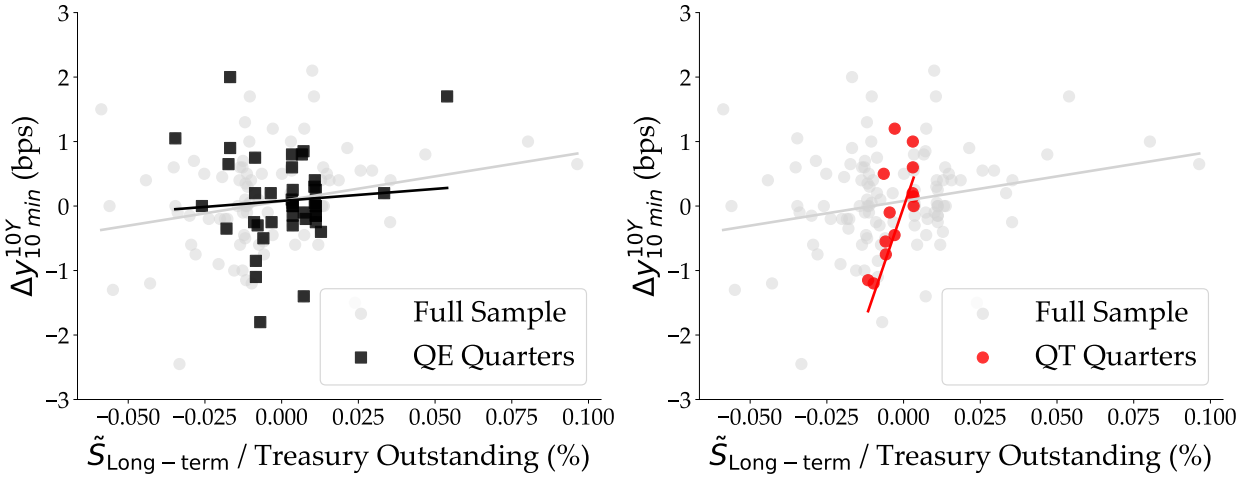


Figure D.10: 10-year Treasury yield response to supply shocks at auction announcements.

Note: The scatter plots show the ten minute change in 10Y Treasury yields against the supply shock $\frac{\tilde{S}_{Long-term}}{D_t}$. The sample runs from 1993Q3 to 2024Q1, where Treasury released auction results less than two minutes after the auction close. Each point is one announcement. Black points denote QE periods; red points denote QT periods; light grey points are observations outside QE and QT.

results: yield responses are much stronger in QT than in QE.

I re-estimate the yield responses across maturities to supply shocks, $\tilde{S}_{\text{long-term},t}$. The results are presented in Table D.5. Columns (1)–(4) pool all maturities, and Columns (5)–(8) restrict the sample to long-term Treasuries. The pattern mirrors borrowing estimate shocks: positive supply shocks raise Treasury yields, the effects are strongest in QT and insignificant in QE, and the QT–QE difference is statistically significant. Moreover, long-term Treasuries are more sensitive to supply shocks. To interpret the magnitude, note that the average outstanding US federal debt during QT quarters is about $26.8 trillion. Given the estimated 145.3 bps response of long-term Treasury yields to a 1% excess Treasury supply, a $100 billion unexpected increase in long-term Treasury supply (with an average maturity of seven years) would raise long-term Treasury yields by about 54.2 basis points.

Treasury market responses to auction result releases. Figure D.11 plots the Treasury yield response within a 10 minutes window to the auction result releases. In the aggregate, stronger demand, reflected by higher bid-to-cover ratio, is associated with a decline in yields. Comparing policy regimes, Treasury yields are noticeably more sensitive to the bid-to-cover ratio during QT than QE, and this pattern is robust across notes and bonds with maturities above five years.

Table D.6 estimates the yield responses to variations in the bid-to-cover ratio. Columns (1)–(2) pool all maturities; Columns (3)–(4) restrict the sample to long-term Treasury auctions. Yields

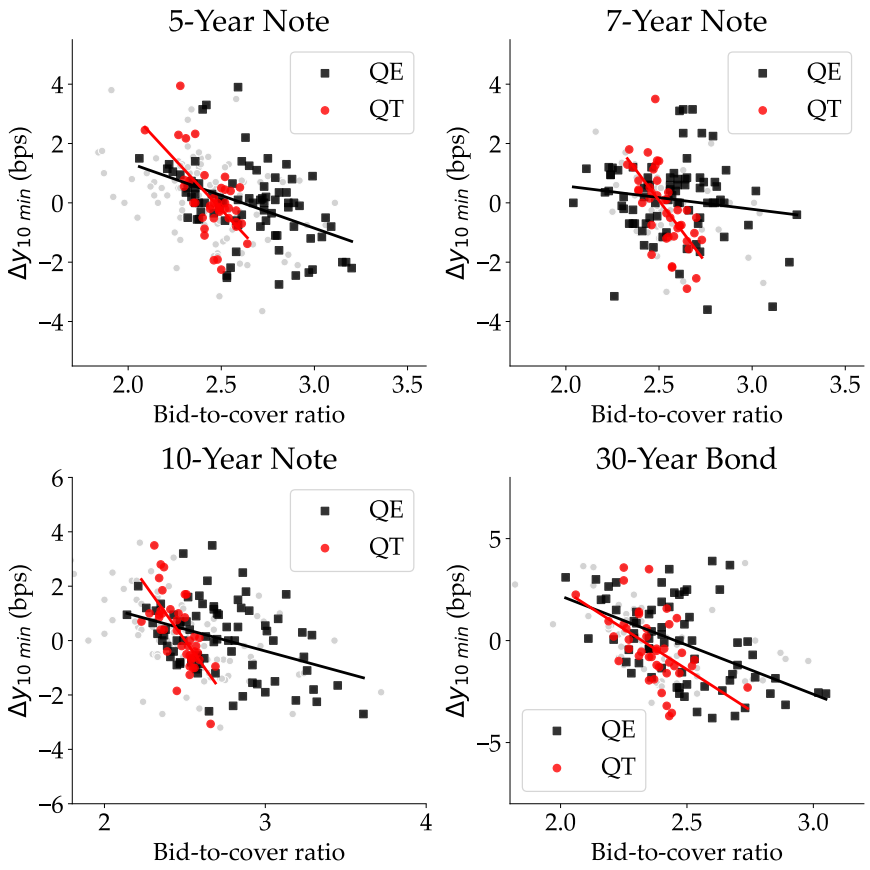


Figure D.11: Treasury Yield Responses to Auction Result Announcements

Note: These scatter plots show the ten minute change in Treasury yields against the bid to cover ratio for auctions of the same maturity. The sample covers 2003Q3 to 2024Q1, a period during which the Treasury released auction results within two minutes of closing. Each point is one announcement. Black points denote QE periods; red points denote QT periods; light grey points are observations outside QE and QT.

decline when primary market demand is stronger, with significantly greater sensitivity during QT. In addition, long-term Treasuries are more sensitive to primary-market demand.

In summary, across three designs: (i) revisions to quarterly borrowing estimates, (ii) auction announcement surprises, and (iii) auction result demand news, the evidence is consistent: Treasury yields are more sensitive to Treasury issuance shocks in QT than in QE, with stronger effects at longer maturities. Taken together, these results imply a less elastic Treasury market in QT.

Table D.4: Treasury Yield Responses to Shocks in Quarterly Borrowing Estimate

VARIABLES	(1) $\Delta y_{10\text{min}}$	(2) $\Delta y_{10\text{min}}$	(3) $\Delta y_{10\text{min}}$	(4) $\Delta y_{10\text{min}}$	(5) $\Delta y_{10\text{min}}$	(6) $\Delta y_{10\text{min}}$	(7) $\Delta y_{10\text{min}}$	(8) $\Delta y_{10\text{min}}$
$\frac{\widetilde{\text{Borr. Est.}_t}}{D_t}(\%)$	0.104**	0.0226	0.464**	0.0230	0.117**	0.0217	0.539**	0.0217
	(0.0480)	(0.0717)	(0.214)	(0.0708)	(0.0560)	(0.0934)	(0.234)	(0.0922)
$\frac{\widetilde{\text{Borr. Est.}_t}}{D_t}(\%) \times 1_{QT}$				0.427*				0.497**
				(0.218)				(0.243)
$1_{QT} = 1$				-0.307				-0.351
				(0.233)				(0.274)
Observations	686	160	97	257	458	110	67	177
Time Span	1991-2024	QE	QT	QE & QT	1991-2024	QE	QT	QE & QT
Sample	All maturities	All maturities	All maturities	All maturities	Long term	Long term	Long term	Long term
R-squared	0.021	0.017	0.168	0.113	0.023	0.017	0.178	0.119
Maturity FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table reports Treasury yield responses to revisions of the quarterly borrowing estimate within a 10-minute announcement window. The global financial crisis quarter (2008Q4) and the COVID quarter (2020Q2) are excluded. Columns (1)–(4) present results for all maturities (2Y, 3Y, 5Y, 7Y, 10Y, 20Y, 30Y). Columns (5)–(8) restrict to long-term bonds (5Y, 7Y, 10Y, 20Y, 30Y). Columns (2) and (6) report quantitative easing (QE) results; columns (3) and (7) report quantitative tightening (QT) results; columns (7)–(8) compare QE and QT. Standard errors clustered at the event date level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table D.5: Treasury Yield Responses to Auction Announcement Shocks

VARIABLES	(1) $\Delta y^{10\text{min}}$	(2) $\Delta y^{10\text{min}}$	(3) $\Delta y^{10\text{min}}$	(4) $\Delta y^{10\text{min}}$	(5) $\Delta y^{10\text{min}}$	(6) $\Delta y^{10\text{min}}$	(7) $\Delta y^{10\text{min}}$	(8) $\Delta y^{10\text{min}}$
$\frac{\tilde{S}_{\text{long-term},t}}{D_t}(\%)$	5.700**	1.917	117.5**	2.035	7.099**	4.699	145.3**	4.804
	(2.738)	(6.002)	(49.42)	(5.965)	(3.106)	(8.064)	(65.74)	(8.033)
$\frac{\tilde{S}_{\text{long-term},t}}{D_t}(\%) \times 1_{QT}$				115.5**				140.6**
				(48.60)				(64.62)
$1_{QT} = 1$				-0.00162				-0.0370
				(0.149)				(0.175)
Observations	1,667	466	199	665	1,101	320	139	459
Time Span	1991-2024	QE	QT	QE&QT	1991-2024	QE	QT	QE&QT
Sample	All maturities	All maturities	All maturities	All maturities	Long term	Long term	Long term	Long term
R-squared	0.010	0.002	0.059	0.030	0.015	0.004	0.177	0.100
Maturity FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table reports Treasury yield responses to supply shocks from auction announcement events within a 10-minute announcement window. The sample covers auction announcements from 1991Q3 to 2024Q1. Columns (1)–(4) present results for all maturities (2Y, 3Y, 5Y, 7Y, 10Y, 20Y, 30Y). Columns (5)–(8) restrict to long-term bonds (5Y, 7Y, 10Y, 20Y, 30Y). Columns (2) and (6) report quantitative easing (QE) results; columns (3) and (7) report quantitative tightening (QT) results; columns (7)–(8) compare QE and QT. Standard errors clustered at the event date level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table D.6: Treasury Yield Responses to Auction Demand News

VARIABLES	(1) $\Delta y^m_{t,10min}$	(2) $\Delta y^m_{t,10min}$	(3) $\Delta y^m_{t,10min}$	(4) $\Delta y^m_{t,10min}$
bid-to-cover ratio^m_t	-1.122**	-1.250**	-2.392***	-2.227***
	(0.459)	(0.463)	(0.451)	(0.303)
bid-to-cover ratio^m_t $\times 1_{QT}$		-1.759**		-3.697**
		(0.676)		(0.997)
bid-to-cover ratio^m_t $\times 1_{QE}$		0.120		-0.367
		(0.180)		(0.543)
$1_{QT} = 1$		4.518**		9.079**
		(1.734)		(2.586)
$1_{QE} = 1$		-0.0272		1.284
		(0.494)		(1.376)
Observations	1,310	1,310	865	865
Sample	All maturities	All maturities	Long term	Long term
R-squared	0.089	0.113	0.164	0.197
Maturity FE	Y	Y	Y	Y

Note: This table reports the results for the following specification:

$$\Delta y^m_t = \alpha + \beta_1 \text{ bid-to-cover}^m_t + \beta_2 \times 1^{QE}_t + \beta_3 \times 1^{QT}_t + \beta^{QE} \text{ bid-to-cover}^m_t \times 1^{QE}_t + \beta^{QT} \text{ bid-to-cover}t^m \times 1^{QT}_t + \lambda_m + \varepsilon_{m,t}$$

where Δy^m_t is the yield change for the treasury of maturity m within a 10-minute window around the auction result release, bid-to-cover^m_t is the announced bid to cover ratio, 1^{QE}_t and 1^{QT}_t indicate QE and QT periods, and λ_m are maturity fixed effects. The data sample covers auctions from August 2003 to March 2024. Columns (1)–(2) present results for all maturities (2Y, 3Y, 5Y, 7Y, 10Y, 20Y, 30Y). Columns (3)–(4) restrict to long-term bonds (5Y, 7Y, 10Y, 20Y, 30Y). Standard errors clustered at the bond maturity level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

D.3.2 Pass-through from Treasury to Corporate bond Market

I begin with supply shocks in the Treasury market to study their pass-through to corporate bonds. If pass-through is weak, a positive supply shock moves up Treasuries yields, yet with a limited effect on corporate bonds, therefore compressing credit spreads. With shocks $\frac{\widetilde{\text{Borr. Est.}_t}}{D_t}$ identified on Treasury borrowing estimate announcement days, I estimate their effects on credit spreads

$$\Delta OAS_t = \alpha + \beta \frac{\widetilde{\text{Borr. Est.}_t}}{D_t} + \gamma \, Controls_t + \epsilon_t \tag{D.7}$$

where ΔOAS_t is the one-day change in the option-adjusted spread of the corresponding corporate bonds.$Controls_t$ capture standard drivers of credit spreads, including the change in the business environment measured by the daily stock-market return $\Delta \log StockIndex_t$, the change in equity-market volatility measured by ΔVIX_t, and the change in interest-rate volatility measured by $\Delta MOVE_t$. Table D.7 presents the results. During QT, Treasury supply shocks significantly compress credit spreads across the rating spectrum. On non-QT days, point estimates also indicate compression, but are not statistically significant. Across credit qualities, pass-through is strongest statistically for investment-grade bonds (the index is largely BBB-and-above) and attenuates for lower-quality buckets (e.g., BBB and B), consistent with weaker substitutability between Treasuries and lower-rated corporate bonds.

Table D.7: Credit Spread Responses to Shocks in Quarterly Borrowing Estimate $\frac{\widetilde{\text{Borr. Est.}_t}}{D_t}$

Asset Type	Estimate	Standard Error	Observations	R-squared	Controls	Sample
Corporate IG	-0.232	(0.214)	106	0.030	Y	Full sample
Corporate IG	-0.406	(0.333)	26	0.211	Y	QE
Corporate IG	-0.823***	(0.224)	15	0.414	Y	QT
Corporate BBB	-0.054	(0.367)	106	0.038	Y	Full sample
Corporate BBB	-0.0782	(0.227)	26	0.258	Y	QE
Corporate BBB	-0.801**	(0.330)	15	0.360	Y	QT
Corporate B	-1.090	(0.988)	106	0.141	Y	Full sample
Corporate B	2.136	(1.383)	26	0.349	Y	QE
Corporate B	-3.826*	(2.319)	15	0.446	Y	QT

Note: This table presents the regression of one day changes in corporate bond option adjusted spreads (OAS) on shocks to quarterly borrowing estimates, $\frac{\widetilde{\text{Borr. Est.}_t}}{D_t}$(%). Indices: Corporate IG = ICE BofA US Corporate Index; Corporate BBB = ICE BofA BBB US Corporate Index; Corporate B HY = ICE BofA Single-B US High Yield Index. The sample spans 1997 to 2024, beginning when ICE BofA index OAS is available. The global financial crisis quarter (2008Q4) and COVID quarter (2020Q2) are excluded from regression. Newey-West standard errors with automatic bandwidth are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

A caveat of the preceding exercise is the limited frequency: the supply shocks $\frac{\widetilde{\text{Borr. Est.}_t}}{D_t}$(%)

are quarterly. The model in Section 3 suggests that this pass-through is not confined to Treasury supply shocks: any disturbance that shifts Treasuries' prices relative to corporate bonds triggers rebalancing by allocators. This generality allows me to extend the empirical test beyond Treasury supply shocks. Therefore, I turn to an alternative test that examines price pass-through from Treasuries to corporate bonds. The idea is straightforward: if a shock moves Treasury yields and spills over to corporate bonds, corporate yields should co-move with Treasuries. Under perfect pass-through, corporate yields move one-for-one with Treasury yields. When pass-through is weaker, positive Treasury shocks raise Treasury yields but move corporate yields by less.

Figure D.12 plots daily changes in AAA- and A-rated US corporate bond indices against daily changes in the US Treasury bond index, separately for QE and QT periods. In both regimes and ratings, corporate yields track Treasury yields closely, reflecting the close substitutability between investment-grade corporate bonds and Treasuries. The slope is significantly flatter during QT, indicating a weaker pass-through to high-quality corporate bonds. Pass-through also improves with credit quality: for AAA, the slope in QE lies near the 45° line, implying a near-perfect pass-through given its closest substitutability to Treasuries; for A-rated bonds, the slope is flatter, reflecting that A-rated bonds have weaker substitutability to Treasuries comparing with AAA-rated bonds.

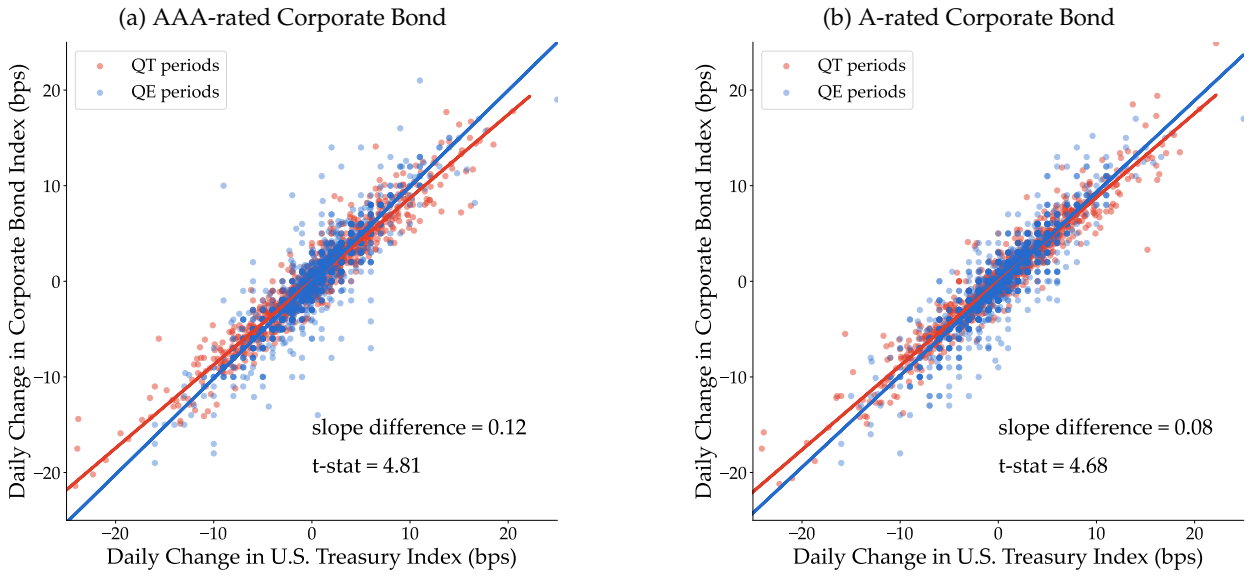


Figure D.12: Pass-through from Treasury Market to Corporate Bond Market

Note: These figures plot daily changes in corporate bond index yields and the US Treasury bond index yield. The AAA-rated series are from the ICE BofA AAA US Corporate Index, A-rated series from the ICE BofA Single-A US Corporate Index, and Treasury series from the ICE BofA US Treasury Index.