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ABSTRACT

Historically high debt-to-GDP levels in the U.S. have raised concerns about future financial market stability and fiscal sustainability. We use high-frequency data and consider Treasury futures price changes within narrow windows around auction announcements in order to identify two distinct Treasury supply shocks: debt volume shocks that capture changes in the level of public debt, and maturity adjustment shocks that reflect changes in the maturity structure. We find that debt expansion shocks raise yields across the curve by increasing term premia, leading to tighter financial conditions. These shocks crowd out private sector activity by reducing investment and production, particularly during periods of rapid debt growth. In contrast, maturity extension shocks steepen the yield curve while lowering credit risk premia and fiscal uncertainty. By reducing risk premia, these shocks stimulate near-term investment and production, even as higher long-term borrowing costs weigh on longer-horizon investment. We also show that the Treasury debt management policy can meaningfully interact with the Federal Reserve's asset purchase programs.

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1 Introduction

U.S. federal debt has risen to historically high levels, fueling concerns about fiscal sustainability and financial market stability. Jerome Powell, Chair of the Federal Reserve, has noted that while debt is not yet unsustainable, it is on an unsustainable path.[1] Elevated debt burdens can raise borrowing costs and crowd out private investment, yet Treasury securities also serve as the world's preeminent safe and liquid asset. Short- and long-term securities may provide different safety and liquidity services, and their issuance decisions can carry informational content about fiscal risk. These factors highlight that the macro-financial effects of Treasury issuance depend not only on the amount of debt but also on its maturity structure. Thus, it is important to understand the distinct channels through which Treasury issuance and its maturity structure can impact the financial market and the economy at large.

In this paper, we employ a high-frequency identification strategy exploiting Treasury futures price movements within narrow windows around Treasury auction announcements, to examine how Treasury supply shocks affect financial and macroeconomic conditions. A key innovation of our analysis is to distinguish between two types of Treasury supply shocks: changes in the overall level of public debt and adjustments in the maturity composition of issuance. We show that both types of shocks have significant and persistent effects on financial conditions and borrowing costs, which in turn translate into substantial macroeconomic effects on investment and output. These dynamics operate primarily through the *portfolio-rebalancing (crowding-out)*, *safe-asset*, and *signaling* channels. Importantly, the relative strength of these mechanisms differs sharply across the two shocks: the crowding-out channel dominates in response to debt expansion shocks, particularly during periods of rapid debt growth such as the one the U.S. is currently experiencing, whereas the signaling as well as the safe-asset channels are more prominent for longer-term securities and play a central role in the transmission of maturity adjustment shocks. Finally, we demonstrate that Treasury maturity adjustments can meaningfully interact with the Federal Reserve's asset purchase programs, as both influence long-term yields and broader financial conditions.

We leverage the strategy of Phillot (2025) to identify Treasury supply shocks. Despite the routine and predictable nature of Treasury auctions, announcements about upcoming auctions may convey new information about the size and maturity structure of Treasury issuance. We use Treasury futures contracts, which provide a near-instantaneous measure of market reactions to the Treasury market, in order to isolate futures price movements across different maturities within a short window around Treasury auction announcements, for a time period spanning October 1998 and February 2025. Employing a factor model, we identify two types of supply shocks: debt volume shocks and maturity adjustment shocks. These components reflect distinct aspects of government debt management and have different implications for financial markets and macroeconomic conditions.

To organize the empirical analysis, we introduce a simple theoretical framework based on a

[1] See Chair Jerome Powell's testimony before the U.S. Senate Committee on Banking, Housing, and Urban Affairs, December 2023.

preferred-habitat model of the term structure (see Vayanos and Vila (2021), and Greenwood, Hanson, and Vayanos (2024)). Treasury supply shocks alter the amount and composition of duration risk absorbed by arbitrageurs, therefore affecting risk premium and macroeconomic outcomes through portfolio rebalancing, safe-asset provision, and signaling channels. Embedding this structure in a New Keynesian environment highlights how maturity-specific movements in term premia and credit spreads translate into real activity. The model yields testable implications for yields, spreads, and investment responses across maturities, which are borne out in our empirical findings.

First, we find that debt expansion shocks tend to tighten financial conditions and dampen economic activity through the portfolio-rebalancing (crowding-out) channel.[2] Unexpected increases in Treasury issuance raise yields and term premia across all maturities. A supply shock that leads to an increase in government debt-to-GDP by 1 percentage point in two years raises the 10-year Treasury yield by 1.7 basis point on impact and 2.8 basis points at the peak, with a large fraction of it driven by the 10-year term premium that rises by about 1.5 basis point at the peak. Treasury convenience yields decline, indicating a reduction in the scarcity value of safe assets. Excess bond premium also declines, reflecting an improved risk-bearing capacity of the financial sector through the safe asset channel. However, yield spreads between BAA and AAA-rated bonds widen, as the portfolio-rebalancing channel tightens financial conditions for bonds with higher default risk. All these transmission channels are especially pronounced during periods of rapid debt growth. While the safe-asset channel suggests that greater Treasury supply eases risk premia, our results indicate this mechanism is limited, particularly when fiscal sustainability concerns weaken the perceived safety of additional Treasury issuance. Instead, the crowding-out channel prevails, as higher Treasury issuance crowds out private investment, production, and consumption.

Second, maturity adjustment shocks affect financial and macroeconomic outcomes through a combination of safe-asset, portfolio-rebalancing (crowding-out), and signaling channels, with their relative strength depending on the direction of the maturity shift. On average, a maturity extension shock that extends the weighted average maturity by 1 month over two years raises the 10-2 year Treasury spread by 1.7 basis points on impact. By shifting issuance toward longer-term securities, such shocks raise long-term yields and steepen the yield curve. Higher long-term rates dampen business loans and construction spending, consistent with the crowding-out channel. On the other hand, an increased supply of longer-term Treasuries, which are a better hedge against future economic shocks, signal a stronger near-term fiscal outlook. Through this signaling channel, excess bond premium and stock market volatility decline, while equity prices edge higher. These easing credit conditions support economic activity, leading to sustained gains in short-horizon investment such as equipment spending and industrial production.

The effects of maturity compression shocks are dominated by a crowding-in channel, as less long-term issuance reduces yields at the long end, eases borrowing costs, and stimulates construction and broader investment. Together, these patterns reveal an asymmetry in how maturity adjustments

[2]We refer to the portfolio-rebalancing channel, through which higher Treasury supply raises yields as arbitrageurs absorb additional duration risk, as the crowding-out channel when focusing on its macroeconomic implication that higher government borrowing raises financing costs and reduces private investment.

transmit: extensions operate mainly through signaling and safe-asset channels, while compressions act primarily through lower long-term yields. These distinctions highlight that changes in the maturity structure of Treasury issuance alter the balance between risk absorption and crowding-out, with important macro-financial implications.

We also show that the effects of Treasury supply shocks depend on the fiscal stance. When debt-to-GDP is stable, announcements about issuance volume and maturity have muted effects, consistent with Treasury's "regular and predictable" debt management strategy (see Garbade (2007)). During periods of rapid debt growth, however, supply shocks have pronounced macro-financial consequences. Debt expansion shocks lead to more persistent increases in yields and term premia, wider credit spreads, and sharp contractions in private investment, especially construction, as the safe-asset channel weakens and the crowding-out channel dominates amid heightened fiscal risk concerns. The effects of maturity adjustment shocks also intensify during periods of high debt growth, as shifts toward longer-term issuance reduce rollover risk and risk premium, supporting short-horizon investment and industrial production, but higher long-term yields raise borrowing costs and weigh more heavily on interest-sensitive sectors. As a result, maturity adjustments involve a sharper tradeoff between improved risk conditions and tighter long-term financing.

Overall, these patterns are consistent with preferred-habitat models in which changes in the supply and maturity composition of Treasuries affect term premia and credit spreads through limited arbitrage capacity, while also highlighting an important role for fiscal signaling in shaping risk perceptions.

Treasury issuance decisions also have important interactions with monetary policy, as changes in the size and maturity of debt supply can reinforce or offset the Federal Reserve's actions in shaping interest rates. Notably, we show how Treasury's issuance decisions interact with Federal Reserve policy through their maturity adjustment. Quantitative Easing (QE) by the Federal Reserve in recent years compressed long-term yields by removing duration risk from the market, but contemporaneous maturity extension by the Treasury leaned in the opposite direction. We estimate that Treasury announcements related to maturity adjustments offset roughly one-third of the average effect of Federal Reserve QE announcements on long-term yields over the period 2008-2020. This provides direct evidence of monetary-fiscal interplay operating through the maturity structure of government debt.

Our findings carry important implications for fiscal and monetary policymakers. We show that debt expansion shocks lead to a rise in Treasury yields, particularly through increases in the term premium. This aligns with recent studies documenting similar effects of debt expansion on yields and convenience premia, though our identification approach is distinct. One of our key contributions is to demonstrate that such Treasury supply shocks tighten financial conditions and raise borrowing costs, translating into significant macroeconomic effects with clear crowding-out implications for private investment and activity. Another major contribution of the paper is to identify maturity adjustment shocks and uncover their distinct propagation mechanisms, highlighting the importance of Treasury debt management decisions and the communication surrounding them. In addition, we show that these maturity adjustments can either offset or amplify the effects of monetary policy, as both have the potential to shape long-term yields and broader financial conditions. Lastly, our findings take on heightened relevance in the current environment of rapid debt accumulation, as we show that in periods of rapid debt growth, Treasury's decisions over issuance volume and maturity structure exert especially strong and persistent effects on financial conditions and the broader economy. Overall, these results provide important insights in guiding discussions on the effects of rising debt levels and optimal debt management strategies for the Treasury.

Related literature: This paper contributes to a large literature that employs high-frequency identification methods to obtain policy surprises from financial market reactions. In monetary policy, Kuttner (2001) pioneered the use of Fed funds futures to disentangle anticipated from unanticipated policy rate changes, and Gürkaynak, Sack, and Swanson (2005) showed that policy surprises affect both current rates and future rate expectations. More recently, high-frequency identification approach has been extended beyond monetary policy to fiscal policy. Ray, Droste, and Gorodnichenko (2024) construct Treasury demand shocks using intraday changes in yields around Treasury auction close times. Gomez Cram, Kung, and Lustig (2025) use market responses to Congressional Budget Office cost-estimate releases to identify the effects of news about future revenues and expenditures on Treasury yields. Weigand (2025) studies daily yield movements around fiscal news during the budget appropriation process, while Hartley and Rigon (2025) estimate the impact of Treasury supply surprises using short windows around Quarterly Refunding announcements.

Phillot (2025) is the first to apply high-frequency identification to Treasury auction *announcements* and uses intraday price changes to identify Treasury supply shocks. Our paper extends Phillot (2025) by disentangling shocks to the level of debt issuance from those to its maturity structure.[3] Relatedly, Joyce and Lengyel (2024) examine yield reactions to UK debt auction announcements and quantify the impact of quantitative tightening via duration-risk and local-supply channels. In addition, our paper is closely related to concurrent work by Mustafi (2025), who uses heteroskedasticity-based restrictions tied to a narrative classification of announcements and finds that both volume and maturity shocks raise yields across the curve. Instead, we estimate a factor model, and the identified shocks align closely with yield curve dynamics as the volume factor resembles a level shift and the maturity factor a slope twist.[4]

This paper also relates to the broader macro-financial literature on the effects of Treasury supply. Treasury securities provide safety and liquidity services that may stimulate economic activity, as argued in Longstaff (2004), Krishnamurthy and Vissing-Jorgensen (2012b), Nagel (2016), Du, Im, and Schreger (2018), and Choi, Kirpalani, and Perez (2025) among others. Fleckenstein and

[3] Using a similar identification as in Phillot (2025), Endo, Pallara, Sfregola, and Zanotti (2026) show that the impact of Treasury supply shock closely mirrors conventional monetary policy tightening.

[4] Moreover, while we both use Treasury futures for identification, Mustafi (2025) includes 3-month Eurodollar futures to capture short-term maturities. We omit these, as they reflect monetary policy expectations rather than Treasury issuance. In Mustafi (2025), the Eurodollar contract is needed to reject the one-factor hypothesis, whereas we reject it using Treasury futures alone. Finally, our sample extends through 2025, including the post-COVID period when Treasury issuance faced significant market scrutiny.

Longstaff (2024) estimate Treasury convenience premia across the term structure and find that near-money liquidity plays an important role. An increase in government debt, however, can also raise interest rates and crowd out private investment, see Laubach (2009), Cecchetti, Mohanty, and Zampolli (2011), and Hubert de Fraisse (2024) among others. More recently, Li, Ma, and Zhao (2023), and Choi and Robatto (2024) identify the crowding-out channel in the banking sector, as Treasury supply crowds out bank deposits, curtails bank lending, and reduces firm investment. Greenwood and Vayanos (2014), Greenwood, Hanson, Rudolph, and Summers (2015), Vayanos and Vila (2021), all emphasize the importance of maturity structure for yield curve dynamics, with changes in the supply of long-term Treasuries affecting yields across maturities through portfolio-rebalancing effects and preferred habitat models. Our focus is on documenting the effects of Treasury supply shocks, both debt volume and maturity structure, and their distinct transmission channels, and to further consider the macroeconomic effects.

A growing macro-finance literature analyzes the effects of government debt using models with rich financial and fiscal sectors, including Nguyen (2021) and Bretscher, Hsu, and Tamoni (2020). In a general equilibrium asset-pricing model, Liu, Schmid, and Yaron (2021) show that fiscal risk weakens the safety value of Treasuries, especially during periods of fiscal stress. Our causal empirical analysis complements their theoretical investigations.

Our analysis of Treasury maturity adjustment shocks is closely related to the extensive literature on quantitative easing, which studies how Federal Reserve purchases of long-term government debt affect financial markets and the macroeconomy.[5] D'Amico and King (2013) document local supply effects along the yield curve following large-scale asset purchases (LSAPs), consistent with market segmentation or imperfect substitution across maturities. Bauer and Rudebusch (2014) show that LSAPs can also affect the economy through a signaling channel.

The remainder of the paper is organized as follows. Section 2 describes the U.S. Treasury auction process and outlines the high-frequency identification strategy used to measure Treasury supply shocks. Section 3 provides a theoretical framework to understand how Treasury supply shocks can affect financial and macroeconomic variables. Sections 4 and 5 present our main results on the financial and macroeconomic effects of debt expansion and maturity adjustment shocks, respectively. Section 6 examines how the transmission of Treasury supply shocks varies during periods of rapid debt-to-GDP growth as well as the role of Quarterly Refunding Statements. Section 7 studies the interaction between Federal Reserve's quantitative easing and Treasury maturity adjustment shocks in recent years. Finally, Section 8 concludes.

2 Data and Identification Methodology

This section describes the institutional setting of U.S. Treasury auctions and outlines our identification strategy. We first present key features of the auction process and the information contained

[5] A non-exhaustive list includes Gagnon, Raskin, Remache, and Sack (2011), D'Amico, English, López-Salido, and Nelson (2012), Christensen and Krogstrup (2018), Krishnamurthy and Vissing-Jorgensen (2012a), Swanson (2021), Swanson (2023), Bauer and Swanson (2023), and Kim, Laubach, and Wei (2023).

in announcements. We then explain how we use high-frequency movements in Treasury futures to identify supply shocks.

2.1 U.S. Treasury Auction Process: Institutional Details

The U.S. Treasury's primary objective, in their own words, is to finance the government at the lowest cost over time. It aims to be "regular and predictable" in its debt issuance, which discourages an opportunistic approach to issuance.[6] However, the Treasury's cash flows are subject to unavoidable uncertainty due to irregular outlays from federal programs and fluctuations in tax receipts, even though the Federal government has a budget process and the Congressional Budget Office provides frequent cost estimates on legislatures.[7] At the same time, for a given level of issuance, the Treasury also chooses the maturity structure by trading off lower servicing costs from short-term debt against lower rollover risk from long-term debt. This balance depends on economic conditions and fiscal capacity, with maturity decisions adjusting to new information about the fiscal outlook. Appendix A.1 provides more narrative evidence to highlight that 1) the Treasury faces a nontrivial amount of uncertainty in cash flows, and 2) it makes the discretionary decisions on maturity structure based on the fiscal outlook.

We use Treasury auction announcements to extract new information about the size and maturity structure of issuance. The Treasury finances government spending and manages debt through public auctions of bills, notes, bonds, Treasury inflation-protected securities (TIPS), and floating-rate notes (FRN). The Treasury auction process consists of three steps:

- **Announcement:** The Treasury announces auction details, including security type, maturity, offered amounts, auction date, issue date, and for coupon securities, the coupon rate.
- **Auction:** Investors submit competitive and noncompetitive bids. Competitive bidders (i.e., primary dealers) specify the yield they are willing to accept, while noncompetitive bidders agree to accept the yield determined at auction.
- **Issuance:** Winning primary dealers as well as noncompetitive bidders receive their securities in exchange for payment.

We focus on the first step of announcements, which typically come with a report published on the same day. Figure 1 presents an example of such an announcement for a 10-year Treasury note auction dated November 1, 2023, with a time stamp of exact data release, 8:30 AM ET. It discloses important details about the security being issued, including the offering amount ($40 billion), auction date (November 8, 2023), issuance date (November 15, 2023), and maturity date (November 15, 2033).[8]

[6] See Garbade (2007) for a historical account of U.S. Treasury debt management policies.

[7] The challenge is nicely captured by the Treasury's Quarterly Refunding Statement (QRS) in 2002Q3: "*We believe that Treasury's policy of issuing debt in a regular pattern and in predictable quantities fulfills this mission. The risk to regular and predictable issuance are the result of unexpected changes in our borrowing requirements, changes in the demand for our securities, and anything that inhibits timely sales of our securities. To reduce these risk, we closely monitor economic conditions, fiscal policy and market activity, and, when necessary, respond with changes in debt*

Figure 1: U.S. Treasury Announcement: November 1, 2023

TREASURY NEWS

Department of the Treasury • Bureau of the Fiscal Service

Embargoed Until 08:30 A.M.
November 01, 2023

CONTACT: Treasury Auctions
202-504-3550

TREASURY OFFERING ANNOUNCEMENT [1]

Term and Type of Security	10-Year Note
Offering Amount	$40,000,000,000
Currently Outstanding	$0
CUSIP Number	91282CJJ1
Auction Date	November 08, 2023
Original Issue Date	November 15, 2023
Issue Date	November 15, 2023
Maturity Date	November 15, 2033
Dated Date	November 15, 2023
Series	F-2033
Yield	Determined at Auction
Interest Rate	Determined at Auction
Interest Payment Dates	May 15 and November 15
Accrued Interest from 11/15/2023 to 11/15/2023	None
Premium or Discount	Determined at Auction
Minimum Amount Required for STRIPS	$100
Corpus CUSIP Number	912821NP6
Additional TINT(s) Due Date(s) and	None
CUSIP Number(s)	None
Maximum Award	$14,000,000,000
Maximum Recognized Bid at a Single Yield	$14,000,000,000
NLP Reporting Threshold	$14,000,000,000
NLP Exclusion Amount	$0
Minimum Bid Amount and Multiples	$100
Competitive Bid Yield Increments [2]	0.001%
Maximum Noncompetitive Award	$10,000,000
Eligible for Holding by Treasury Retail	Yes
Estimated Amount of Maturing Coupon Securities Held by the Public	$102,174,000,000
Maturing Date	November 15, 2023
SOMA Holdings Maturing	$32,629,000,000
SOMA Amounts Included in Offering Amount	No
FIMA Amounts Included in Offering Amount [3]	Yes
Noncompetitive Closing Time	12:00 Noon ET
Competitive Closing Time	1:00 p.m. ET

2.2 Treasury Supply Shocks: High Frequency Identification

For the identification of Treasury supply shocks, we rely on Treasury futures contracts. These futures contracts on U.S. Treasuries, available on the Chicago Board of Trade (CBOT) since 1977, specify a settlement price at which the buyer agrees to take delivery of eligible securities on settlement month. We focus on 2-, 5-, 10-year T-notes, and 30-year T-bonds, for which we have data available for a long enough sample. Because these futures do not bear coupon payments and are acquired for speculative or hedging purposes, they represent an ideal "synthetic" metric of expectations about Treasury prices.

issuance that are based on thorough analysis and discussions with market participants."

[8] The announcement specifies that the yield and interest rate will be determined at auction, and it outlines bidding rules like competitive and noncompetitive bid limits, the minimum bid amount ($100), and yield increments (0.001%). It contains additional information about maturing securities, System Open Market Account (SOMA) holdings, and Foreign and International Monetary Authority (FIMA) participation.

Figure A3 in the Appendix plots the evolution of these Treasury futures prices.

Under the efficient market hypothesis following Fama (1970), Treasury futures prices reflect market expectations about interest rates and government debt supply. As such, price movements in Treasury futures around U.S. Treasury auction announcements provide natural experiments to study market reactions to surprises in debt issuance. These announcements convey new information about the volume and maturity of Treasury securities, potentially differing from prior market expectations.

Importantly, Treasury issuance quantities themselves adjust only gradually and are shaped by a "regular and predictable" debt management strategy, with changes in auction sizes typically implemented cautiously and sustained over multiple periods rather than as one-off surprises (see Appendix A.3). As a result, realized issuance quantities are a noisy and delayed measure of underlying news about fiscal financing needs and maturity strategy. By contrast, auction announcements convey forward-looking information about the Treasury's assessment of fiscal conditions, borrowing requirements, and maturity tradeoffs, which markets immediately incorporate into asset prices (see examples in Appendix A.1). Primary dealer surveys further indicate that investors interpret unexpected changes in issuance plans as signals about the future path of Treasury supply, not merely contemporaneous auction sizes (see Appendix A.2).[9]

In this spirit, analyzing Treasury futures price changes in tight windows around auction announcements allows us to isolate the effects of unexpected Treasury supply news – information that extends beyond headline auction amounts to broader implications for future issuance, fiscal outlook, and interest rate expectations – while avoiding the confounding inertia and endogeneity inherent in quantity-based measures.

But do financial markets closely monitor U.S. Treasury auction announcements? Using the November 2023 quarterly refunding as an example, Figure 2 provides direct evidence that Treasury auction announcements cause immediate market reactions, comparable to other major macroeconomic events.[10] The solid lines in the top panel represent the Treasury futures yield change relative to 8:00 AM (ET), while the vertical dashed lines mark four key events on that day: the Treasury quarterly refunding announcement, the release of job openings data, the FOMC announcement, and the subsequent press conference. The intraday dynamics reveal that the Treasury announcement, despite the Treasury's policy framework that prioritizes regularity and predictability, led to an immediate increase in traded volumes as shown in the bottom panel and measurable shift in yields, similar in magnitude to the reactions following macroeconomic data release and the FOMC decision. As reported by the Wall Street Journal, "Stocks and bonds both staged rallies last week, getting a boost when the Treasury increased the size of longer-term debt auctions by a smaller amount than

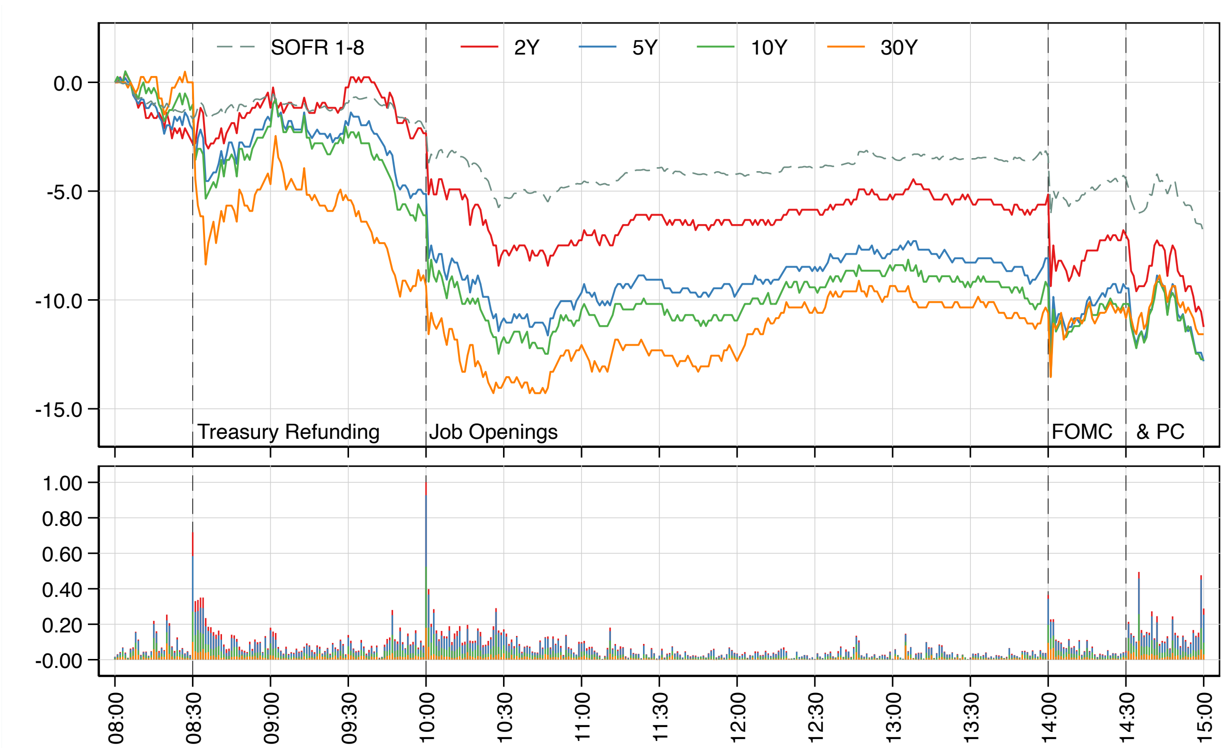
[9] As shown by Gürkaynak, Kisacikoğlu, and Wright (2020), macroeconomic announcements are multi-dimensional events that transmit a rich set of signals beyond headline numbers, and thus price movements in narrow windows around announcements capture market responses to multi-dimensional information rather than merely headline numbers.

[10] Section A.4.1 provides more details on the case study of November 1, 2023. Several other studies have demonstrated that communications related to debt management policies, including the quarterly refunding announcements, significantly move markets, see for instance, Haddad, Moreira, and Muir (2024) and Hartley and Rigon (2025).

many had expected".[11] The article further notes that the Treasury also indicated greater flexibility in short-term bill issuance, which investors interpreted as a shift in funding strategy.

The example from Figure 2 further underscores the importance of focusing on price changes in a narrow time window, in order to ensure that the observed movements reflect the Treasury announcement itself rather than unrelated market developments later in the day.[12]

Figure 2: Movements of Treasury Futures on November 1, 2023



Note: The solid lines in the top panel represent the Treasury futures yield change in basis points relative to 8:00 AM (ET), while the dotted lines capture shifts in monetary policy expectations through the average of futures-implied SOFR rates. The vertical dotted lines mark the precise timing of four key events on that day: the Treasury quarterly refunding announcement, the release of job openings data, the FOMC policy announcement, and the subsequent press conference. The vertical bars in the bottom panel are the volumes of traded Treasury futures, min-max normalized over that day.

To further assess the broad market relevance of Treasury announcements, we conduct a placebo exercise following Känzig (2021) and Phillot (2025). We compare 30-minute Treasury futures returns around auction announcements to returns around a fixed benchmark time (11:00 am ET) on randomly selected non-announcement business days.[13] As shown in Appendix C.3, in terms of various distributional measures, announcement-window returns are significantly more volatile and

[11] Goldfarb, S. (2023, November 5). *Markets got an unexpected boost from Washington. Will it mark a turning point?* The Wall Street Journal.

[12] In Appendix B.1, we show that we isolate Treasury supply shocks from major data releases to mitigate contamination. We also provide additional examples of Treasury announcements on debt volume and maturity structure as well as market movements in Figure A4 in the Appendix.

[13] Figure B7 in the Appendix shows that this is the time of the day with the most frequent Treasury announcements.

feature more extreme outcomes across all maturities, allowing us to reject equality of variances at conventional levels.

We build on these insights and the strategy employed in Phillot (2025) for our identification of Treasury supply shocks which we describe next. Let ΔP_t^k be the k-year Treasury futures return in a narrow time-window around announcements by the Treasury. We have:

$$\Delta P_t^k = P_t(+)^k - P_t(-)^k$$

where $P_t(-)^k$ is the log-price of the k-year Treasury futures contract just before the auction announcement at time t, and $P_t(+)^k$ is the log-price just after the announcement.[14] Note that a positive price change for maturity k implies that the supply for that maturity is lower than expected. Hence, we switch the sign of $\xi_t^k = -\Delta P_t^k$ to reflect a k-year Treasury supply surprise. We use a 30 minute window. The window selection is based on our identification assumption that there is a fixed demand for debt securities in a short time window around the announcement. Also, we need to ensure that there is no other market-moving news during this time. We consider announcements about bonds with maturities of 2, 3, 5, 7, 10, 20 and 30-years. Our data spans October 1998-February 2025.[15]

2.3 Factor Analysis

Debt management strategy has two crucial dimensions: debt volume and maturity structure. Debt volume reflects the Treasury's refinancing needs in response to time-varying deficits, which are inherently unpredictable due to fiscal policy changes, uncertain macroeconomic conditions, and other shocks. Maturity structure reflects the tradeoff between minimizing debt servicing costs and managing rollover risk: issuing short-term debt lowers interest costs but increases refinancing risk, especially under uncertain interest rate paths.

While each Treasury supply shock ξ_t^k obtained at high frequency reflects a supply surprise for an individual maturity, the distribution of these surprises across maturities provides insights into shifts in the expected U.S. debt maturity structure. Thus, in order to effectively capture these two dimensions, we estimate a factor model in which the observed surprises ξ_t^k are expressed as a linear combination of two latent factors $\tilde{F}_1$ and $\tilde{F}_2$:

$$\xi_t^k = \lambda_1^k \tilde{F}_1 + \lambda_2^k \tilde{F}_2 + \epsilon_t^k$$

where λ_1^k and λ_2^k are the loadings on the two factors, and ϵ_t^k is a mean-zero idiosyncratic error term.

[14] Treasury futures traded on the Chicago Board of Trade (CBOT) reflect market expectations of future interest rates for U.S. government bonds with maturities of 2, 5, 10, and 30 years. Treasury futures are cash-settled or can be physically delivered at contract maturity, with settlement based on the price of the cheapest-to-deliver (CTD) bond in the delivery basket. They provide exposure to Treasury yields without holding the actual bonds. Log-price differentials in futures contracts reflect percentage point returns, which proxy changes in implied yields. For small windows around auction announcements, these returns capture surprises in Treasury supply. Appendix C.1 shows that converting prices variations into CTD yield changes makes no material difference to our results.

[15] Relative to the data considered in Phillot (2025), we additionally consider announcements about bonds with 3, 7 and 20 year maturities. We also extend the sample until 2025 to include the fiscal expansion during the COVID period and subsequent years, while Phillot (2025) used data until 2020.

Table 1: Factor Loadings - Volume and Maturity of Treasury Supply Shocks

Maturity k shock	Factor loading on F_1	Factor loading on F_2
ξ_t^2	0.8066	-0.3091
ξ_t^5	0.9649	-0.1377
ξ_t^{10}	0.9769	0.1068
ξ_t^{30}	0.8370	0.3229

To interpret the factors, we apply an oblique rotation, allowing for potential correlations between them. The rotation transforms the unrotated factors $\tilde{F}_1$ and $\tilde{F}_2$ into rotated factors F_1 and F_2, as follows:

$$F_1 = \mathbf{R}_{11}\tilde{F}_1 + \mathbf{R}_{12}\tilde{F}_2 \quad \text{and} \quad F_2 = \mathbf{R}_{21}\tilde{F}_1 + \mathbf{R}_{22}\tilde{F}_2$$

The rotation matrix $\mathbf{R}$ is chosen to simplify interpretation and align the factors with the economic meaning of debt volume and maturity.[16]

Table 1 presents the loadings of F_1 and F_2 on the ξ_t^k. We find that F_1 loads positively and similarly across all ξ_t^k, corresponding to a parallel shift in yields driven by unexpected changes in total debt issuance, i.e., an overall shift in debt volume. Conversely, F_2 loads positively on longer maturities and negatively on shorter ones, corresponding to a change in the slope of the yield curve driven by shifts toward long-term versus short-term issuance, i.e., changes in the maturity structure.[17]

2.4 Interpreting the Factors: Debt Expansion and Maturity Extension The top panel of Figure 3 shows the first factor, F_1, which we associate with a shift in debt level, cumulated to monthly frequency to improve readability. As indicated in the figure, the spikes coincide with major fiscal events. Notably, some of the large positive spikes coincide with fiscal expansionary events such as significantly higher borrowing needs during the Global Financial Crisis (4/2008), the Emergency Economic Stabilization Act (10/2008), the American Recovery and Reinvestment Act (4/2009), and the Coronavirus Aid, Relief, and Economic Security Act as well as extension of IRS tax payments (3/2020).[18] Some of the large negative spikes coincide with fiscal contractions or a stop in fiscal expansions, such as notable debt pay down (8/1997), hitting the debt limit with extraordinary measures being used to finance the government on a temporary basis (12/2017), and similarly being subject to debt limit related constraints (2/2023).

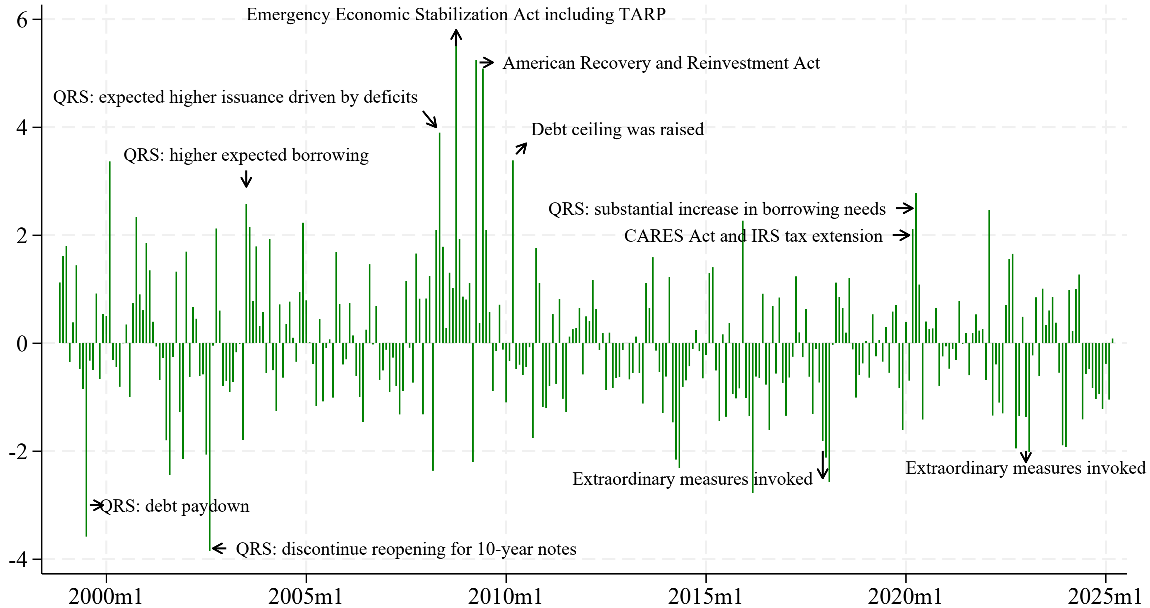
[16] We assess whether the observed variation in high-frequency futures price changes can be adequately captured by a limited number of latent by performing a Cragg and Donald (1997) rank test. The test rejects the null hypothesis of one or fewer factors, so we retain two factors. These factors jointly account for almost all of the common variation in the surprise matrix. See Appendix C.2 for details.

[17] While we allow the factors to be correlated, they are estimated to be orthogonal, with a correlation of 0.01 that is not statistically significant. We also test the robustness of our factors to considering the first two principal components of our Treasury surprises, which have a very high correlation of 0.99 and 0.98 with our estimated first and second factors, respectively.

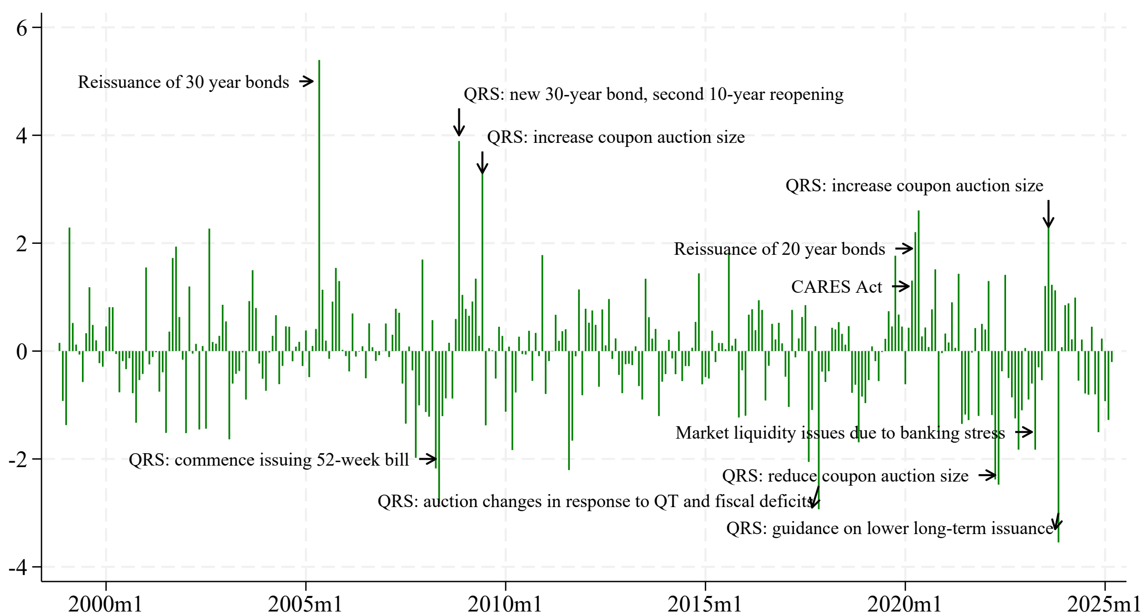
[18] The speed at which Congress passed the CARES Act in March 2020 was widely viewed as unprecedented and there was high frequency communication around it. Thus, our Treasury supply shocks, which are constructed based on Treasury auction announcements, may not capture the full scope of changes in the Treasury supply associated

Figure 3: Narrative Events around Large Treasury Supply Shocks

a. Debt Expansion Factor



b. Maturity Extension Factor



Note: The figure shows the two Treasury supply shocks aggregated to monthly frequency, along with the context for the large shocks. In some cases, we provide information and guidance provided in the corresponding Quarterly Refunding Statement (QRS).

with the CARES act.

The bottom panel of Figure 3 shows the second factor, F_2, aggregated analogously to the monthly frequency. As indicated in the figure, the spikes correspond to events predominantly associated with changes in the maturity structure of debt issuance. Notably, some of the large positive spikes coincide with events such as re-issuance of 30 year bonds (5/2005), the re-issuance of the 20 year bonds (5/2020), additional reopening of 30 year bonds (11/2008) and the announcement of an increase in long-term issuance (8/2023). Some of the large negative spikes coincide with guidance on a slower pace in long-term issuance (11/2023) and market liquidity issues due to banking stress (3/2023).

To gain further insight into what the two factors capture, Figure 4 shows the factors together with additional variables. The left-hand plot shows debt expansion shocks, alongside the cumulative debt expansion shocks and detrended debt-to-GDP. Debt volume shocks series (F_1) account well for the evolution of the debt supply in the U.S. between 1998 and 2025 around a trend. Notably, they do a reasonably good job at capturing the large increases in public debt-to-GDP during the Great Recession and then during the COVID period.

The right-hand plot shows the maturity extension shocks (F_2) against the demeaned share of long-term debt over this period, which is given by the share of notes and bonds in total marketable debt. The cumulated maturity extension shocks capture the fall in the long-term debt share in 2008-2009, and the subsequent reversal. The cumulated factor also accounts for the evolution of long-term debt share around the COVID period and its aftermath. Since the shocks reflect news about debt volume and maturity issuance, their effects materialize in the relevant macroeconomic series with a lag.

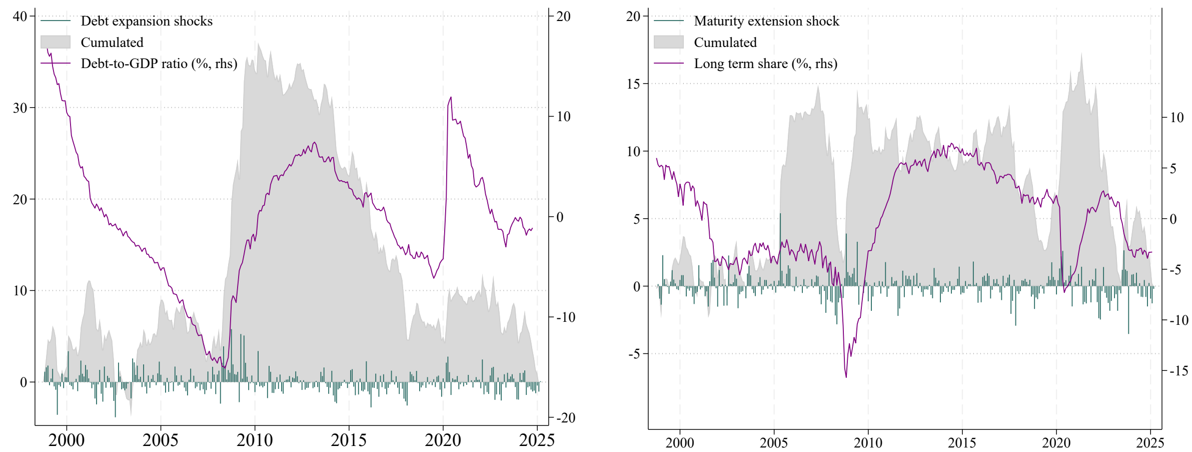
2.5 Further Validation of the Treasury Supply Shocks

In order to assess whether our Treasury supply shocks are exogenous, we consider the contemporaneous correlation of both F_1 and F_2 surprises with other structural shocks identified in the literature that might be related, including high frequency monetary policy shocks capturing surprises to the federal funds rates, forward guidance and LSAPs from Swanson (2023), and shocks to Treasury demand from Ray, Droste, and Gorodnichenko (2024) that capture the intraday change in Treasury yields before and after the close of a Treasury auction. We find no statistically significant correlation with these shocks. In order to test whether our Treasury supply shocks are predictable, we provide further evidence that we can reject the null that financial variables Granger-cause our shocks. We also test and find no significant evidence of auto-correlation in the two identified shock series. These exercises are shown in Appendices C.4, C.5, and C.6.

3 Theoretical Framework for Interpreting the Treasury Supply Shocks

This section introduces a theoretical framework to interpret the effects of Treasury supply shocks. Building on the identification strategy, the framework highlights the distinct transmission channels associated with debt expansion and maturity adjustment shocks.

Figure 4: Debt Expansion and Maturity Extension Treasury Supply Shocks



Note: The left-hand plot shows volume expansion shocks (green spikes) on the left-hand scale, alongside the cumulative volume shocks (grey area) and detrended debt-to-GDP (purple line, right-hand scale), between 1998 and 2025. Similarly, the right-hand plot shows the maturity extension shocks (green spikes) on the left-hand scale, alongside the cumulative volume shocks (grey area) against the demeaned share of long-term debt (purple line, right-hand scale) over this period over the same period.

3.1 Model Setup The model has two key features. First, following Vayanos and Vila (2021), financial assets are traded between two sets of investors: preferred-habitat clientele with idiosyncratic demand for specific assets and maturities, and risk-averse arbitrageurs who absorb the residual supply left by these investors. Second, we consider a new-Keynesian model extension in line with Ray, Droste, and Gorodnichenko (2024), where segmented financial markets and limited arbitrage imply that households' intertemporal decisions depend on maturity-weighted expected excess returns determined by preferred-habitat demand and intermediary balance-sheet constraints. This implies Treasury supply shocks are transmitted to output through asset price movements.[19]

In this model, government debt supply fluctuates over time driven by Treasury supply shocks:

$$S_t(\tau) = \zeta(\tau) + \theta(\tau)s_t \tag{3.1}$$

where supply shocks s_t evolves according to Ornstein-Uhlenbeck processes. Here $\zeta(\tau)$ captures the average supply for maturity τ and $\theta(\tau)$ measures sensitivity of Treasury supply on the risk factor s_t across maturities.[20]

We have two types of assets, risk-free and risky bonds with zero coupons and maturity of

[19]We thank our discussant, Walker Ray, for laying out the basics of a model with preferred habitat investors and arbitrageurs in a discussion of the paper. Appendix Section E provides more details on the model framework which builds on Vayanos and Vila (2009) and Greenwood, Hanson, and Vayanos (2024).

[20]Note that we assume that $\int_0^T \theta(\tau)d\tau \geq 0$, and there exists a $\tau^* \in [0, T)$, such that $\theta(\tau) < 0$ for $\tau < \tau^*$ and $\theta(\tau) > 0$ for $\tau > \tau^*$. See Greenwood and Vayanos (2014) for more details on this setup and how it allows us to introduce the two types of shocks we are interested in.

$\tau \in (0, T)$.[21] Following the literature, the price of risk-free bonds, $P_t^{(\tau)}$, is conjectured to take the form of affine functions of the state variables:

$$\frac{dP_t(\tau)}{P_t(\tau)} = \mu_t(\tau)\,dt - \sigma(\tau)\,dB_t, \tag{3.2}$$

where B_t are Brownian motion processes for risk factors in the model. Note $\mu_t(\tau)$ is the instantaneous expected return, and $\sigma(\tau)$ are the exposure of a τ-maturity bond to shocks and capture how sensitive the return of a τ-maturity bond is to risk factors. Both terms are determined endogenously in the model. Analogously, the price for risky assets (e.g., corporate bonds) $\tilde{P}_t^{(\tau)}$ follows a similar pricing relation.

Turning to the two types of investors, preferred-habitat investors have inelastic, maturity-targeted demand $Z_t(\tau)$ for Treasuries and $\hat{Z}_t(\tau)$ for risky assets. On the other hand, risk-averse arbitrageurs with risk aversion, $a > 0$, absorb the residual supply after preferred-habitat investors, and choose portfolios of bonds across maturities to trade off expected returns against risk. The risk aversion parameter a captures the imperfect risk-bearing capacity of arbitrageurs. Their portfolio optimization yields the following pricing restrictions,

$$\mu_t(\tau) - r_t = \sigma(\tau)\Lambda_t, \qquad \hat{\mu}_t(\tau) - r_t = \hat{\sigma}(\tau)\Lambda_t, \tag{3.3}$$

where r_t is the short rate, and Λ_t is the market price of risk,

$$\Lambda_t = a \int_0^T \left[\sigma(\tau)X_t(\tau) + \hat{\sigma}(\tau)\hat{X}_t(\tau)\right] d\tau,$$

where $X_t(\tau)$ denotes arbitrageur holdings of Treasuries, and $\hat{X}_t(\tau)$ of risky assets. The optimization conditions highlight that expected excess returns are driven by factor loadings of shocks on bond returns, $\sigma(\tau)$ and $\hat{\sigma}(\tau)$, as well as the market price of risk, Λ_t. A larger a means a lower risk-bearing capacity of arbitrageurs, leading to higher market price of risk and higher expected returns.

Following Ray, Droste, and Gorodnichenko (2024), on the macroeconomic side, the Euler equation reflects that households hold portfolios of assets with different maturities and transact through financial intermediaries. With segmented financial markets and arbitrageurs facing limited risk-bearing capacity, households cannot fully arbitrage across maturities. Consequently, intertemporal consumption depends on a maturity-weighted average of expected excess returns across assets, yielding the following IS equation:

$$E_t\,dx_t = \varsigma^{-1}\left(\int_0^T [\eta(\tau)\mu_t(\tau) + \hat{\eta}(\tau)\hat{\mu}_t(\tau)]\,d\tau - r_t^n\right) dt, \tag{3.4}$$

Here x_t is the output gap, r_t^n is the natural rate of interest and $\varsigma > 0$ governs the slope of the

[21] A τ-maturity risk-free bond has price $P_t^{(\tau)}$ and pays \$1 at maturity with certainty at period $t + \tau$. A risky τ-maturity bond has price $\tilde{P}_t^{(\tau)}$ and instead pays a stochastic value in period $t + \tau$.

IS curve. Importantly, $\eta(\tau)$ and $\hat{\eta}(\tau)$ capture the maturity composition of the household asset portfolio. An economy that is dominated by long-term assets, such as mortgages or long-term Treasuries, has a higher $\eta(\tau)$ at long horizons, whereas those relying more on short-term credit or floating-rate contracts place greater weight on short maturities.[22] Therefore, $\eta(\tau)$ and $\hat{\eta}(\tau)$ weigh how returns at maturity τ affect household's consumption decision, through which Treasury term premia feed into the output gap.

Next we consider the two types of Treasury supply shocks in this framework to predict their effects on financial and macroeconomics variables.

3.2 Debt Expansion Shocks

Consider a debt expansion shock F_1 that raises Treasury supply uniformly across all maturities,

$$dS_t(\tau) > 0 \quad \forall\tau,$$

leading to a rise in the net supply faced by arbitrageurs, $X_t(\tau) = S_t(\tau) - Z_t(\tau)$.[23]

The model predicts that such a debt expansion shock would raise yields across the curve. As arbitrageurs' net duration exposure rises, the market price of risk increases, $d\Lambda_t > 0$. It raises bond excess returns across maturities, $d(\mu_t(\tau) - r_t) = \sigma(\tau)d\Lambda_t > 0$, and therefore leads to a rise in yields for all maturities. The relative impact across the yield curve depends on the factor loading $\sigma(\tau)$, which is a function of shock persistence and underlying model parameters. Greenwood, Hanson, and Vayanos (2024) show that the impact of a persistent but not permanent supply shock on yields tends to be hump-shaped.

Turning to yield spreads between risky and risk-free bonds, the model prediction is more nuanced, as it depends on the relative factor loadings of $\hat{\sigma}(\tau) - \sigma(\tau)$, which in turn hinge on the market price of risk Λ_t. The response of credit spreads depends on how the payoffs of risky bonds co-move with Treasury supply shocks.

If Treasury supply shocks reduce the payoff of risky corporate bonds, investors require greater compensation to hold those bonds, leading to wider credit spreads. This scenario is consistent with findings in the sovereign-corporate risk linkage literature (see Bocola (2016), Acharya, Eisert, Eufinger, and Hirsch (2018), and others) and can be particularly relevant for lower-rated corporate bonds with high default risk. In contrast, if higher Treasury issuance leads arbitrageurs to substitute away from risky bonds toward safe assets, the dollar duration of risky bonds held by intermediaries declines. This shift reduces the market price of risk for corporate bonds and compresses risk premia, resulting in narrower credit spreads, consistent with the *safe-asset* channel emphasized by Krishnamurthy and Vissing-Jorgensen (2012b). More generally, when risky bond payoffs are weakly correlated with, or hedge against, Treasury supply shocks, the safe-asset channel dominates

[22] $\eta(\tau)$ and $\hat{\eta}(\tau)$ are determined by institutional savings vehicles (pensions, money market funds), household debt structure (mortgages vs. short-term credit), and regulatory constraints that shape the portfolios of intermediaries through which households invest. We consider them as model primitives, but one could think of model extensions where they adjust endogenously to developments in the economy- including some potential channels that we highlight below.

[23] This is an increase in s_t in Equation 3.1, and setting the threshold τ^* to zero so that $\theta(\tau) > 0$ for all τ.

and spreads fall.[24]

In addition, if Treasuries provide non-risk-based convenience benefits, the model predicts that a debt expansion shock reduces convenience yields. Following Greenwood, Hanson, and Vayanos (2024), introducing non-pecuniary benefits from holding Treasury securities implies that higher issuance lowers the marginal convenience value of Treasuries. This is consistent with Krishnamurthy and Vissing-Jorgensen (2012b), who show that an increase in Treasury supply can accommodate investors' demand for safe and liquid assets, thereby reducing the liquidity premium.

From the perspective of the real economy, the new-Keynesian IS curve predicts that output gap falls, $dx_t < 0$, as the effective rate rises for households and financial conditions tighten. The higher the risk aversion a, the lower the risk-bearing capacity of arbitrageurs, and the stronger the impact on yields and macroeconomic conditions. This prediction is consistent with the *portfolio-rebalancing (crowding-out)* channel. Higher government Treasury issuance can crowd out private sector funding by raising Treasury yields and increasing excess returns across various asset classes (see Greenwood, Hanson, and Vayanos (2024), Croce, Nguyen, Raymond, and Schmid (2019), among others).[25] The pass-through of yields to aggregate demand also depends on the maturity composition of asset portfolio in the economy, $\eta(\tau)$ and $\hat{\eta}(\tau)$.

3.3 Maturity Adjustment Shocks Consider a maturity extension shock that raises long-term issuance and reduces short-term issuance with total issuance unchanged,[26]

$$dS_t(\tau_L) > 0, \qquad dS_t(\tau_S) < 0.$$

A maturity shock can have a global impact on Treasury yields through changes in the common market price of risk, as emphasized in Greenwood, Hanson, and Vayanos (2024). Even when total issuance is unchanged, a maturity extension increases the duration exposure that must be absorbed by arbitrageurs, raising the compensation required for holding interest rate risk. As a result, yields tend to move in the same direction across maturities, with larger responses at longer maturities. At the same time, yield responses need not be uniform across the curve. If markets are segmented across maturities or if multiple risk factors are priced, the effects of supply shocks can become more localized, with the largest yield changes occurring near the maturities where issuance shifts the most, because it becomes costly for arbitrageurs to fully smooth the effects across the term structure.[27] In this case, a maturity extension that shifts issuance toward longer maturities tends to steepen the yield curve.

[24] By modeling corporate bond defaults in a preferred-habitat framework, Cavaleri (2025) shows that a decline in Treasury supply can raise the price of credit risk through a safety channel, thereby increasing corporate yields.

[25] The crowding-out channel is also consistent with macro models with financial frictions, such as Gertler and Karadi (2011) among others. As financial intermediaries face balance sheet constraints, a higher Treasury supply may crowd out business lending and reduce investment.

[26] This is an increase in s_t in Equation 3.1 that leaves total supply, S_t unchanged, by setting $\int_0^T \theta(\tau)d\tau$ to zero.

[27] If arbitrageur intermediation capacity is segmented or state-dependent, localization can be amplified, as emphasized in Ray, Droste, and Gorodnichenko (2024). In this case, a maturity extension shock that increases exposure to long-maturity risk leads to larger yield responses at the long end of the curve, with more muted or even negative effects at short maturities.

Additionally, Treasury announcements about the maturity structure of issuance may also propagate through financial markets and the broad economy through a *signaling channel*. Greenwood, Hanson, Rudolph, and Summers (2015) argue that the Treasury's debt management decisions reflect the trade-off between its desire to lower financing costs through issuing cash-like short-term securities and its desire to manage fiscal risk through issuing long-term debt. Asymmetric information between the Treasury and the private sector on government financing risk can give rise to a signaling channel, which can be reflected in the correlations between risky bond payoffs and Treasury supply shocks in the model. For instance, if a maturity extension announcement is viewed by the market as positive fiscal development, the correlation between corporate bond payoffs and Treasury announcements are positive. In this case, the model predicts that a maturity extension shock may reduce credit spreads.

At the same time, if the non-risk-based convenience or safety attribute of Treasuries are dependent on the maturity, then the *safe-asset* channel will also affect yields and spreads across different maturities differently.

The macroeconomic effects of a maturity extension shock will depend on the weights $\eta(\tau)$ and $\tilde{\eta}(\tau)$ that govern how returns at different maturities enter the intertemporal Euler equation. With greater weights on long maturities, increases in long-term yields translate into a tightening of financial conditions and a contraction in the output gap. Conversely, with larger weights at short maturities, macroeconomic outcomes are primarily driven by short-term rates, and narrowing credit spreads can be expansionary for near-term investment. Overall, the aforementioned *portfolio-rebalancing* and *safe-asset* channels are both at play, and their relative importance depends on the *signaling channel* as well as the maturity composition in the economy.

3.4 Takeaways This framework of a preferred-habitat structure embedded in a new-Keynesian model highlights that Treasury supply shocks matter not only through the volume of issuance but also through the maturity composition. Debt expansion shocks increase the total amount of duration risk that must be absorbed by arbitrageurs, raising the market price of risk, term premia, and yields across the curve, and tightening financial conditions through a *portfolio-rebalancing* channel. These effects are amplified when arbitrageur risk-bearing capacity is low. Maturity-adjustment shocks, however, can propagate through a broader set of forces at play: *signaling*, *safe-asset*, and *portfolio-rebalancing* channels. On one hand, a maturity extension announcement increases long-term yields, which may weigh on long-term investment and macroeconomic conditions. On the other hand, if maturity extension announcements are interpreted as positive fiscal development, credit spreads may decline through the *signaling* and *safe-asset* channels. Loosening financial conditions as well as lower yields at the short end can be expansionary for near-term investment. We explore these potential mechanisms empirically in the following sections.

4 Financial and Macroeconomic Effects of Debt Expansion Shocks

In this section, we study the impact of debt volume expansion shocks (F_1) on financial markets and the broader real economy, and explore the associated transmission mechanisms.

4.1 Financial Market Impact of Debt Expansion Shocks: Daily Regressions

We use daily local projections to explore the effects of debt expansion shocks on financial markets.

$$y_{t+h} - y_{t-1} = \alpha_{1,h} + \beta_{1,h} F_{1,t} + \sum_{j=1}^{J} \theta_{1,h}^{j} X_{t-j} + \epsilon_{1,t+h}, \text{ for } h = 0, 1, 2, ... \tag{4.1}$$

Here y_t is the financial variable of interest. F_1 is the Treasury supply shock that captures debt volume expansion. The coefficient $\beta_{1,h}$ represents the impulse response of the variable of interest to the shock F_1 at the horizon h. In addition, we include J lags of the Treasury supply factor variable and various yields and term premia in the set of control variables, X_t, in order to account for potential interaction among other financial variables. We consider $J = 1$ in our baseline specification. $\alpha_{1,h}$ is the fixed effect to control for time-invariant factors. $\epsilon_{1,t+h}$ is an idiosyncratic error term. Because the error terms in the local projection regressions are serially correlated across horizons, we compute heteroskedasticity and autocorrelation consistent (HAC) standard errors. We run our regression for a sample period that covers October 28, 1998 to February 22, 2025.

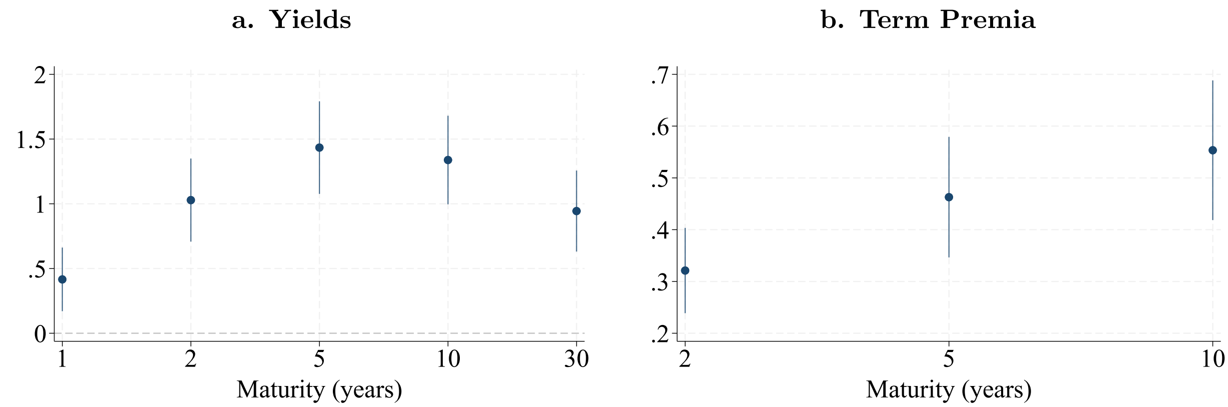
Figure 5 shows the impact responses of yields and term premium following a debt volume expansion shock.[28] The left panel shows that Treasury yields increase across all maturities, leading to an upward shift in the yield curve. The impact on yields is hump shaped: the greatest effect is on the intermediate maturity of 5-10 year term, while the impact is smaller at both longer as well as shorter maturities. The right panel shows that higher than expected debt supply raises term premia across the curve. The longer the maturity, the higher the term premium. The rise in term premium accounts for much of the yield increase, reflecting that investors require greater compensation for bearing duration risk.

Both responses of yields and term premia are consistent with predictions from preferred-habitat models, as discussed in Section 3. Following a supply shock, the term premium increases more for longer-term bonds because their prices are more sensitive to changes in supply, as shown in the right panel. Unless a supply shock is permanent, the risk premium is expected to decline at some point and remains elevated over only a fraction of the life of a longer-term bond. Therefore, the maximum impact is on intermediate-term Treasuries, and the impact on yields is hump-shaped.

In terms of magnitude, a one-standard deviation shock on Treasury issuance, which raises the marketable debt-to-GDP by about 0.8 percentage points in two years as shown in our monthly

[28] Figure D15 in the appendix provides impulse responses for a range of variables over time. Figure 5 highlights the impact effect following the shock, while the responses of yields and term premium peak at a later date.

Figure 5: Impact Responses to a Debt Expansion Shock (F_1)



Note: Impact responses of yields (left) and term premia (right) with 90% confidence bands. The x-axis shows maturities and the y-axis is in terms of basis points.

analysis in Section 4.2, raises the 10-year Treasury yield by close to 1.4 basis point on impact and 2.2 basis points at peak. After normalization, this suggests that a shock that leads to a 1 percentage point increase in debt-to-GDP in two years raises the 10-year Treasury yield by 2.8 basis points. This suggests a non-trivial effect on yields and is consistent with other findings in the literature.[29] The same shock also increases the 10-year term premium by close to 0.6 basis point on impact and 1.2 basis point at the peak, accounting for 40 to 55 percent of the 10-year yield increase. Figure 3 shows that the Emergency Economic Stabilization Act passed after the 2008 financial crisis represents a 5-standard deviation shock, while the higher than expected outlays around the Coronavirus Aid, Relief, and Economic Security Act in 2020 is around a 2-standard deviation shock.

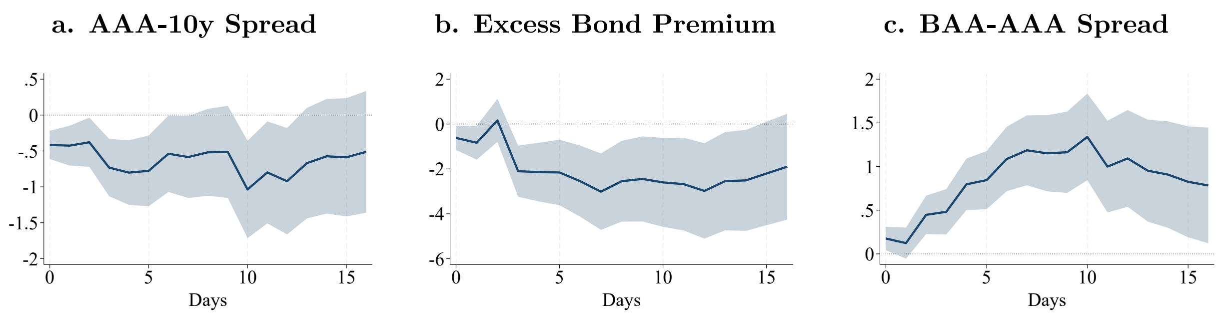
It is also important to note that our constructed supply shocks capture information beyond the immediate changes in auction amounts. First, Treasury announcements can contain broader communications on issuance strategy that goes beyond auction sizes for upcoming quarters, see Section A.5 for further discussion. Second, changes in auction sizes are persistent and sticky, thus a surprise change in Treasury issuance can mean a much larger shift in the debt level over time. Changes in Treasury auction sizes are rarely one-offs; instead, once the Treasury decides to alter auction sizes, it is most likely to continue changing issuance in the same direction for many subsequent periods.[30]

[29]Gomez Cram, Kung, and Lustig (2025) estimate that a 1 percentage point one-time increase in the deficit-to-GDP ratio raises the 10-year yield by 0.75 bps, implying a 6.75 bps rise for a persistent deficit shock. Based on the budget resolution process, Weigand (2025) finds a 1 % increase in the 5-year cumulative deficit-to-GDP ratio raises 2- and 10-year yields by about 2 basis points. By focusing on lower frequency estimates of the effects of rising projected debt on interest rates, Plante, Richter, and Zubairy (2025) find that a 1 percentage point increase in the debt-to-GDP ratio is associated with a rise in the 5-year-ahead, 5-year Treasury rate by about 3 basis points.

[30]There is likely a signaling channel at play as well, as the markets read information about the future fiscal outlook in a surprise issuance shock, see Section A.3. In addition, the magnitude of the effects of a surprise Treasury issuance shock we find are also consistent with information in the Treasury's primary dealer survey, which suggests they expect that a surprise additional issuance of $1 billion 10-year bond would raise 10-year yield by 3 basis points: see discussion

Higher than expected Treasury issuance also has implications for the private bond market. The spread between AAA bond and 10-year Treasury yields, known as the convenience yield, reflects the payoff that investors are willing to forego in order to hold highly liquid assets. As shown in panel (a) of Figure 6, we find that as the supply of U.S. Treasuries increases, the convenience yield declines. This is in line with Krishnamurthy and Vissing-Jorgensen (2012b) and the model prediction in Section 3. However, the increase in 10-year Treasury yield is more significant than the decline in the spread between AAA and 10-year Treasury bonds, leading to higher yields for AAA corporate bonds. Thus, a greater supply of Treasury securities raises funding costs for firms.

Figure 6: IRFs to a Debt Expansion Shock (F_1): daily frequency



Note: The x-axis shows days after the shock hits. The y-axis gives the response in terms of basis points. 90% confidence bands are shown for all IRFs.

Importantly, the preferred-habitat model in Section 3 highlights that a higher supply of Treasury securities can potentially affect risk premium and credit risk through two opposing forces. Suppose safety is a price attribute for Treasury securities, as highlighted in Krishnamurthy and Vissing-Jorgensen (2012b). When arbitrageurs substitute away from risky bonds into safe assets, increases in Treasury supply reduces risky bond duration risk and risk premium. On the other hand, if Treasury issuance leads to a "risk-off" co-movement in risky corporate bonds, then investors would require higher compensation to hold those bonds, raising credit spreads. Some papers find that a higher level of government debt is associated with rising excess returns and credit spread in many asset classes, see Croce, Nguyen, Raymond, and Schmid (2019) and Liu, Schmid, and Yaron (2021).

Using a high-frequency identification approach, we contribute to this debate by showing that both safe-asset demand effects and portfolio-rebalancing effects are at play. In response to a debt expansions shock, the excess bond premium, constructed by Gilchrist and Zakrajšek (2012), declines which reflects an improved risk-bearing capacity of the financial sector in general through the safe asset channel. However, the increases in BAA-AAA spread highlight the portfolio-rebalancing channel for corporate bonds with lower ratings and higher default risk. We further explore the two channels in Section 6.1, and find that the distinction between the two channels are particularly relevant when government debt grows fast.

Overall, we have shown that debt expansion shocks have clear financial consequences. They raise

in Section A.2.

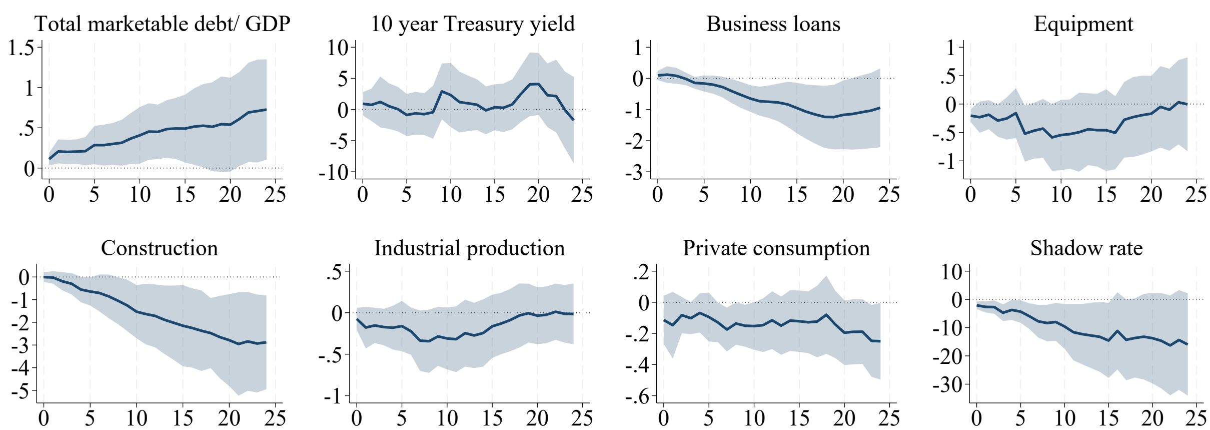
Treasury yields and term premia, reduce convenience yields, widen credit spreads, while narrowing risk premium. The resulting increase in borrowing costs tightens financial conditions, with the portfolio-rebalancing channel dominating over safe asset effects for bonds with lower ratings and higher default risk.

4.2 Macroeconomic Impact of Debt Expansion Shocks: Monthly Regressions

Next, we study the effects of Treasury supply shocks on the broad economy at monthly frequency using Equation (4.1), the same framework as in the daily analysis. In the monthly regressions, the set of controls X_t include the lags of federal funds rate, 10 year Treasury rate, industrial production and CPI to control for macroeconomic and monetary conditions as well as the lags of variable of interest. We also add lags of the Treasury supply shock to account for any autocorrelation in the Treasury supply shock as a result of aggregation to monthly frequency. We use 2 lags in our baseline specification.[31]

Figure 7 shows that a debt expansion shock increases the government debt level steadily over time. A one-standard deviation shock raises the debt-to-GDP ratio by 0.8 percentage point after 2 years.

Figure 7: IRFs to a Debt Expansion Shock (F_1): monthly frequency



Note: The x-axis shows months after the shock hits. The y-axis gives the response in percentage points for debt-GDP ratio, basis points for 10-year Treasury yield and shadow rate, and percent deviations for other variables. 90% confidence bands are shown for all IRFs.

We find that the crowding-out channel dominates the macroeconomic effects on average over our data sample, as a surprise increase in Treasury issuance crowds out private economic activity. A higher level of government debt reduces private investment. Business loans, which include commercial and industrial loans extended by all commercial banks, decline notably and reach close to 1.3 percent at the trough. As a result, both real equipment spending and construction expenditure

[31] As shown in Figure B7 in the Appendix, Treasury announcements can be on different days of the month, which can potentially introduce temporal aggregation bias. We follow the approach of Gertler and Karadi (2015) to aggregate high-frequency Treasury supply shocks to a monthly frequency.

decline. The impact on construction is particularly notable, as it steadily declines in the next 20 months and reaches a loss of 3 percent. The debt expansion shock reduces industrial production and private consumption expenditure.[32] These responses underscore how debt expansion shocks crowd out private sector activity, and Section 6.1 shows that the crowding-out effects are largely driven by periods of high debt growth.

In response to the deceleration in economic activity, the Federal Reserve eases monetary policy. The shadow rate measure, following Wu and Xia (2016) to account for the ZLB periods in our sample, steadily declines as a debt expansion shock leads to a broad deceleration in the economy.[33]

Higher Treasury supply also raises the 10-year Treasury yield, though the increase appears only in the point estimates and is not statistically significant. The muted response may reflect an offsetting monetary policy reaction, captured by the movements in the shadow rate. This is consistent with Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2024), who find that Treasury values do not respond to news about future fiscal surpluses in aggregate quarterly data and argue that endogenous monetary policy actions likely offset fiscal shocks at lower frequencies.

5 Financial and Macroeconomic Effects of Maturity Adjustment Shocks

Next, we study the impact of maturity adjustment shocks (F_2) on the financial market and the broader economy, as the Treasury tilts its issuance towards short- or long-term securities.

5.1 Financial Market Impact of Maturity Adjustment Shocks: Daily Regression

We run daily regressions with maturity adjustment shocks, F_2, in a similar way as debt expansion shocks in Section 4.1. A positive F_2 shock means maturity extension, as Treasury announces the issuance of more bonds at the long end which are offset by lower issuance at the short end.

$$y_{t+h} - y_{t-1} = \alpha_{2,h} + \beta_{2,h} F_{2,t} + \sum_{j=1}^{J} \theta_{2,h}^{j} X_{t-j} + \epsilon_{2,t+h}, \text{ for } h = 0, 1, 2, ... \tag{5.1}$$

In response to a maturity adjustment shock, Treasury yields decline at the short end, while increasing at the long end, as shown in the left panel of Figure 8.[34] A one-standard-deviation shock reduces 2-year Treasury yields by 0.9 basis points on impact, while raising 10-year yield by about 0.3 basis points and 30-year yield close to 1 basis points. In terms of magnitude, the same maturity adjustment shock increases the weighted average maturity by 0.7 month in two years as shown in our analysis at monthly frequency in Section 5.2. Therefore, after normalization, a Treasury supply shock that extends the maturity by 1 month in two years increases the 10-year to 2-year spread by

[32] In addition, the deceleration in economic activity reduces inflation, although the impact is not statistically significant.

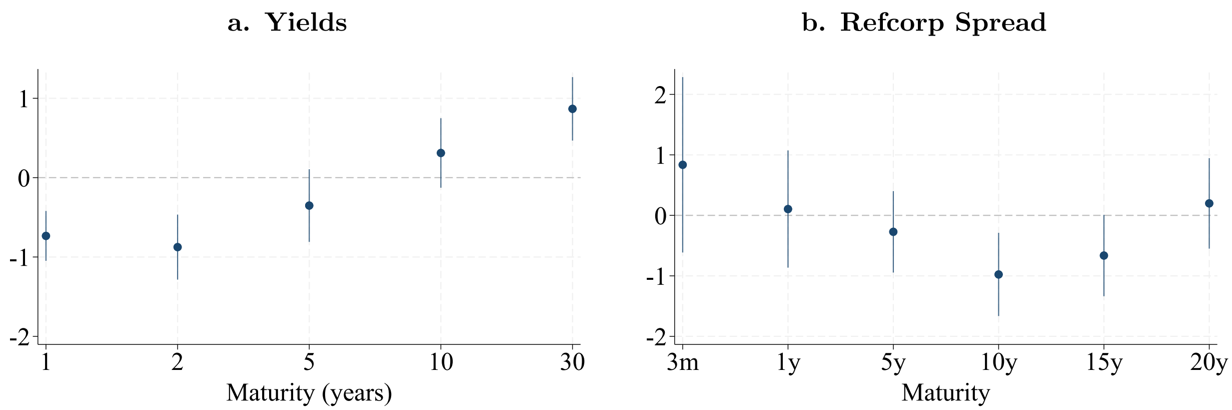
[33] The response of federal funds rate is very similar to that of shadow rate in the first 10 months, beyond which the estimate becomes less statistically significant.

[34] Figure D16 in the appendix provides impulse responses for a range of variables across longer horizons.

about 1.7 basis points on impact. The steepening yield curve reflects some localized yield responses as Treasury issuance unexpectedly shifts from the short to the long end.

The impact of a maturity adjustment shock on liquidity premia also varies across maturity. The right panel of Figure 8 highlights that the spread between Refcorp bonds and Treasury securities, following Longstaff (2004), increases for 3-month security, as a lower issuance at the short end raises Treasury liquidity premium. The impact declines with maturity and turns negative as issuance at the long end increases.

Figure 8: Responses to a Maturity Adjustment Shock (F_2): daily frequency



Note: Impact responses of yields (left) and Refcorp spreads at peak (right) across maturities. The x-axis shows maturities at various horizons and the y-axis is in terms of basis points. 90% confidence bands are shown.

In addition, more abundant issuance at the long end also reduces credit risk premium and the market expectation of volatility. A maturity adjustment shock leads to a decline in excess bond premium, as shown in Appendix Figure D16. The narrowing spread suggests a high risk-bearing capacity in the corporate market. Similarly, VIX declines in the days following the shock, consistent with lower economic uncertainty and a risk-on sentiment. Both the safety channel as well as the signaling channel may be at play. Since long-term Treasury securities are a better hedge against future economic and fiscal shocks than short-term debt, shifting issuance from the short to the long end may convey positive fiscal outlook and reduce credit and volatility risk. We explore these channels further in Section 5.3.

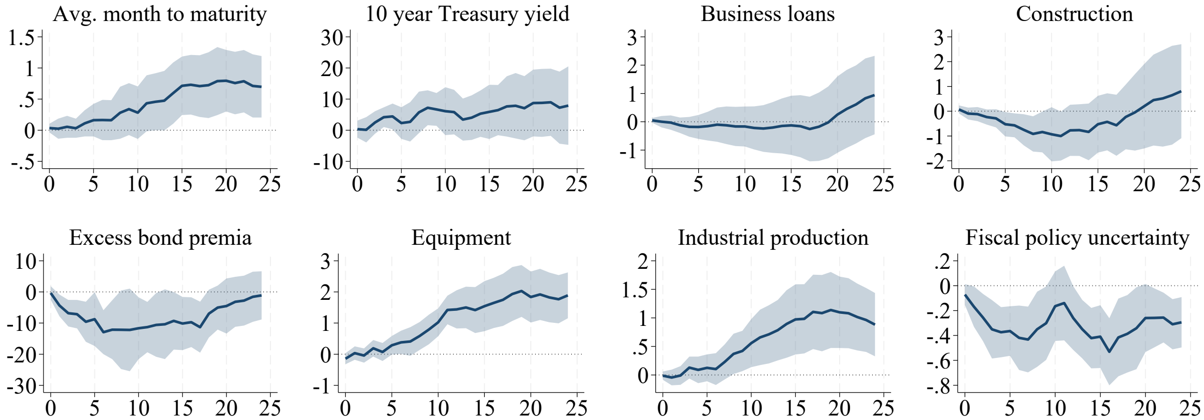
5.2 Macroeconomic Impact of Maturity Adjustment Shocks: Monthly Regressions

Next, we turn to the effects of maturity adjustment shocks on the broad macroeconomy at the monthly frequency as shown in Figure 9. Following a maturity adjustment shock, the average maturity of Treasury securities increases by 0.7 months in 2 years.[35]

We find that shifting issuance from short- to long-term securities reduces credit risk in the financial market, supporting production and near-term investment. Figure 9 shows that in response

[35] The share of Treasury bonds over the total marketable debt also increase steadily over time as shown in Figure D19.

Figure 9: IRFs to a Maturity Adjustment Shock (F_2): monthly frequency



Note: The x-axis shows months after the shock hits. The y-axis gives the response in basis points for excess bond premium and 10-year yield, and it is in percent deviations for other variables. 90% confidence bands are shown for all IRFs.

to a maturity adjustment shock, the excess bond premium declines steadily within the first 15 months.[36] In addition, the improved risk-taking capacity is supported by evolving fiscal risk. The bottom right panel shows that in response to a maturity shock, fiscal policy uncertainty declines, consistent with the notion that longer-term Treasury securities are a better instrument than short-term bills in hedging fiscal and rollover risk, see Greenwood, Hanson, Rudolph, and Summers (2015).[37] The channel of easing credit risk supports near-term investment and production. Real equipment spending increases by about 2 percent after 2 years, while industrial production rises by 1 percent at the peak.

At the same time, Figure 9 also presents evidence on the offsetting channel of crowding-out. As the Treasury issues more longer-term securities, the 10-year Treasury yield increases over time, weighing on business loans and longer-term investment, such as construction expenditure.

5.3 Maturity Extension versus Maturity Compression Shocks

The analysis in the previous section suggests that the relative importance of the competing channels - *portfolio-rebalancing (crowding-out)*, *safety* and *signaling* - is potentially different for short- versus long-term Treasury securities. Therefore, maturity adjustment shocks may have an asymmetric impact on the economy. In this section, we differentiate maturity extension shocks from compression shocks and run the

[36]Figure D19 in the appendix shows that alternative credit risk measures, such as the spread between BAA and AAA corporate bonds, show a similar decline as the excess bond premium.

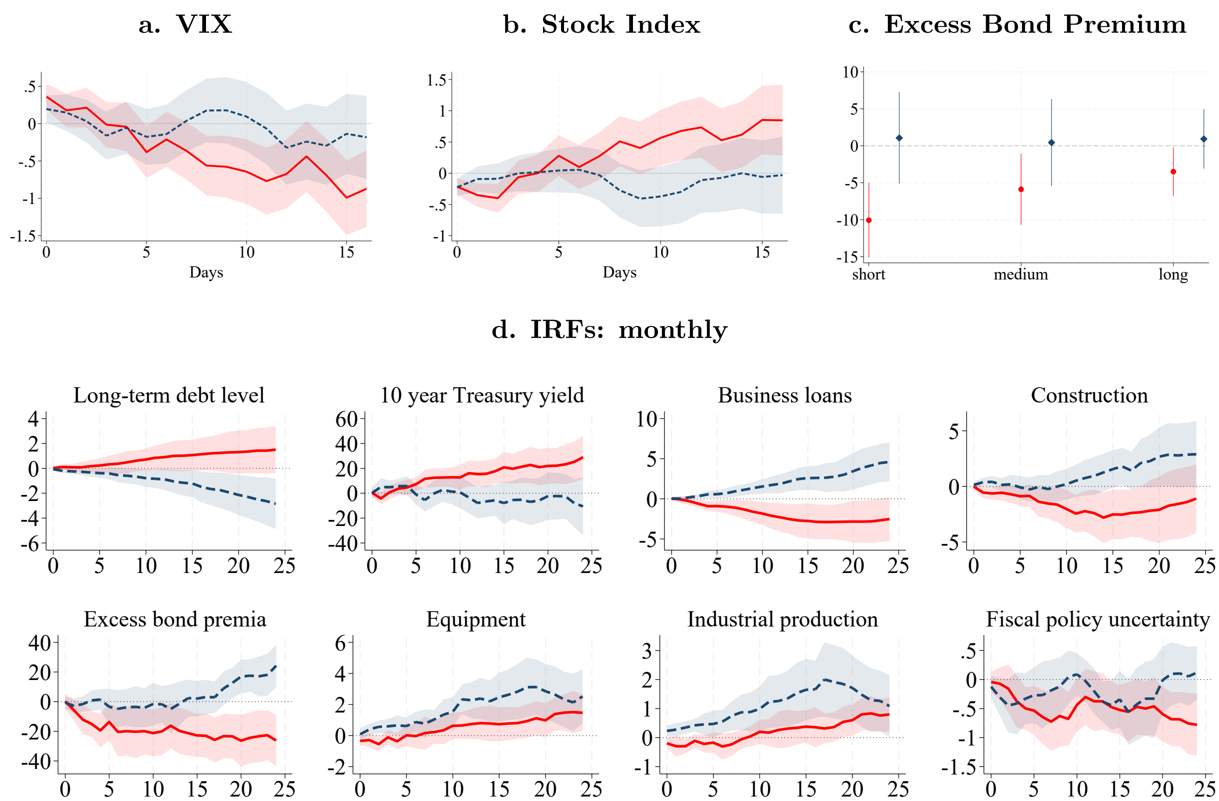
[37]Fiscal Policy uncertainty is measured by the Economic Policy Uncertainty Index for the Categorical Index: Fiscal Policy (Taxes OR Spending), i.e. EPUFISCAL, from Baker, Bloom, and Davis (2016). We smooth the uncertainty index with a 4-month moving average to attenuate noise similar to Baker, Bloom, Davis, and Kost (2019).

following local projection:

$$y_{t+h} - y_{t-1} = \alpha_{2,h} + \beta^P_{2,h} F^+_{2,t} + \beta^N_{2,h} F^-_{2,t} + \sum_{j=1}^{J} \theta^j_{2,h} X_{t-j} + \epsilon_{2,t+h}, \text{ for } h = 0, 1, 2, ... \quad (5.2)$$

where $F^+_{2,t}$ is a positive maturity adjustment shock, and $F^-_{2,t}$ is a maturity adjustment shock that takes a negative value. Thus, the coefficient β^P captures the response to maturity extension shocks and β^N represents the response to compression shocks.

Figure 10: IRFs to Maturity Extension vs. Compression Shocks



Note: Red dots/lines represent responses to a maturity extension shock, while blue dots/lines show responses to a maturity compression shock. 90% confidence bands are shown. (Top left and middle) IRFs of the VIX uncertainty index and NASDAQ composite index with the x-axis showing days after the shock hits and y-axis in basis points. (Top right) responses of excess bond premia at peak across maturities from daily regressions and y-axis in basis points. (Bottom) IRFs at monthly frequency with the x-axis showing months after the shock hits. The y-axis is in percentage points for debt-GDP ratio, basis points for yields and excess bond premia, and percent deviations for the rest.

The top panels of Figure 10 show the two types of maturity adjustment shocks have distinct impact on financial variables at a daily frequency. Maturity extension shocks (given in red) seem to be interpreted as a brighter future outlook. Market volatility (panel (a)) declines, while the stock index (panel(b)) rises. Importantly, the excess bond premium (panel (c)) declines across maturities, with the effect more notable at shorter horizons, indicating a higher risk-bearing capacity of financial intermediaries in the near term. In contrast, maturity compression shocks seem to be interpreted less benign with muted responses in VIX, stock index, as well as excess bond premium.

The responses of the VIX and stock index indicate that both signaling and safety channels may be at play, while the different responses of excess bond premium across horizons provides direct evidence on the signaling channel.[38] Following Greenwood, Hanson, Rudolph, and Summers (2015), the Treasury may shift its issuance from the short- to the long-term debt when it has a stronger capacity to manage fiscal risk and cheap financing becomes relatively less important at the margin. Therefore, maturity extension shocks may convey positive near-term fiscal information to the market. By capturing this signaling channel, the model in Section 3 shows that maturity extension shocks can reduce risk premia, consistent with our empirical finding.

The signaling channel is also reflected in the expected future short rates. In Figure D17, we consider the response of 10-year Treasury yield and its decomposition into a fitted term premium and expected short term rates, based on the model of Christensen and Rudebusch (2012). For both types of shocks, the adjustment in the 10-year yield operates primarily through changes in expectations about the path of short-term interest rates. Maturity extension shocks raise expected future short rates, consistent with markets interpreting them as a reflection of stronger future economic prospects.

The bottom panel of Figure 10 shows the macroeconomic responses to the two types of maturity adjustment shocks. We see that safety, signaling and crowding-out channels are all at play in response to a maturity extension shock. A one standard deviation shock increases the level of Treasury bonds steadily over 2 years. Excess bond premia decline steadily throughout the horizon, as the maturity extension shock conveys a positive fiscal outlook to the market and increases the risk-bearing capacity of financial markets. As a better instrument in hedging fiscal and rollover risk, the higher long-term security supply also reduces fiscal policy uncertainty. Lower fiscal risk and a decline in risk premia support near-term investment and production, with equipment spending and industrial production increasing over time.[39] On the other hand, the maturity extension shock raises 10-year Treasury yield consistently. Higher funding costs at the long end crowd out business loans and weigh on construction investment throughout the horizon.

With a maturity compression shock, Treasury tilts issuance towards more short-term securities. Excess bond premia declines slightly, although the response is not statistically significant. In addition, the shock also reduces 10-year Treasury yield. Overall, the lower supply of longer-term Treasuries has a crowd-in effect with rising private business loans and higher industrial production. Investment expenditure is higher with rising equipment and construction spending.

By differentiating maturity extension shocks from maturity compression shocks, our analysis

[38] From the safety channel alone, we would expect credit risk to decline more at the long end, as the safety attribute can drive credit risk to decline in the supply of safe assets as suggested by Krishnamurthy and Vissing-Jorgensen (2012b).

[39] Focusing on a low frequency dynamics, Hubert de Fraisse (2024) shows that an increase in the supply of long-term government debt crowds out long-duration investment but reallocates capital towards short-duration investment, consistent with our finding.

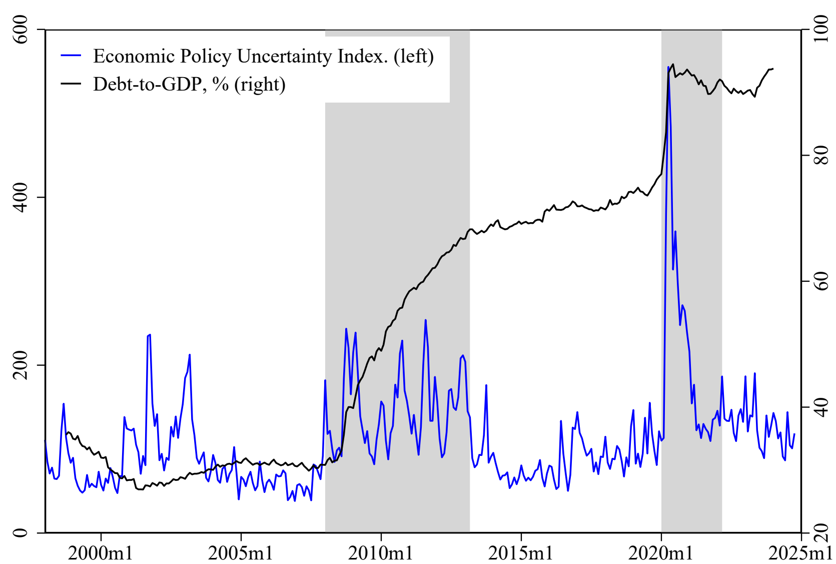
highlights that the signaling channel plays an important role, as the Treasury conveys fiscal outlook information through the discretionary maturity decisions. In response to a maturity extension shock, the easing credit risk, together with lower fiscal uncertainty, help to mitigate the crowding-out channel associated with higher borrowing costs at the long end.

6 Further Explorations of Transmission Channels

In this section, we further study the transmission channels by zooming into periods of elevated debt growth, which is relevant for the current fiscal environment, and explore the information content in Treasury announcements by differentiating between Quarterly Refunding Statement (QRS) dates from non-QRS announcement dates.

6.1 Evidence from Periods of High Debt Growth When debt is growing rapidly, as it has in recent years, additional increases in Treasury issuance may have larger effects on financial markets and the real economy than when government debt is stable. As discussed in Section 3, the transmission channels of Treasury supply shocks can be amplified, or their relative importance may shift, depending on the fiscal environment, for example through changes in arbitrageurs' risk-bearing capacity or in the strength of safety and signaling channels. In this section, we examine whether the effects of Treasury supply shocks vary with the underlying fiscal stance.

Figure 11: Federal Debt/GDP ratio and Economic Uncertainty



Note: The figure show federal debt held by the public as a percent of GDP (black line, right axis). It also shows the Economic Policy Uncertainty Index (blue line, left axis).

The federal government debt as a share of GDP has seen large changes since 1998, which marks the start of our sample. As shown in Figure 11, government debt-to-GDP fluctuated around 40 percent until the Global Financial Crisis. Lower tax revenue collections as well as higher government spending between 2008 and 2013 led to a steady increase of government debt by more than 30 percent of GDP. In the following years, the debt level remained around 80 percent of GDP until the COVID pandemic which brought a sharp rise in government debt. Figure 11 highlights the two periods of high debt growth. Notably, these periods also coincide with crisis and heightened economic policy uncertainty, as measured by the Policy Uncertainty Index of Baker, Bloom, and Davis (2016).[40] This is another reason to expect salience of Treasury announcements to market participants during these periods of high debt growth.

In order to test whether the responses to debt expansion shocks differ across high and low debt growth periods, we run the following local projection:

$$y_{t+h} - y_{t-1} = \alpha_{i,h} + I_t \beta^H_{i,h} F_{i,t} + (1 - I_t)\beta^L_{i,h} F_{i,t} + \sum_{j=1}^{J} \theta^j_{i,h} X_{t-j} + \epsilon_{i,t+h}, \text{ for } h = 0, 1, 2, ... \quad (6.1)$$

where F_i with $i = 1, 2$ are debt expansion and maturity extension shocks, respectively. I_t takes a value of 1 during high debt growth periods, which we classify to extend from January 2008 to April 2013, and from January 2020 to April 2022. Thus the coefficient β^H captures the response to the shock F_i during high debt growth periods and β^L captures the response during low debt growth periods.

6.1.1 Effects of Debt Expansion Shocks based on Debt-to-GDP Growth

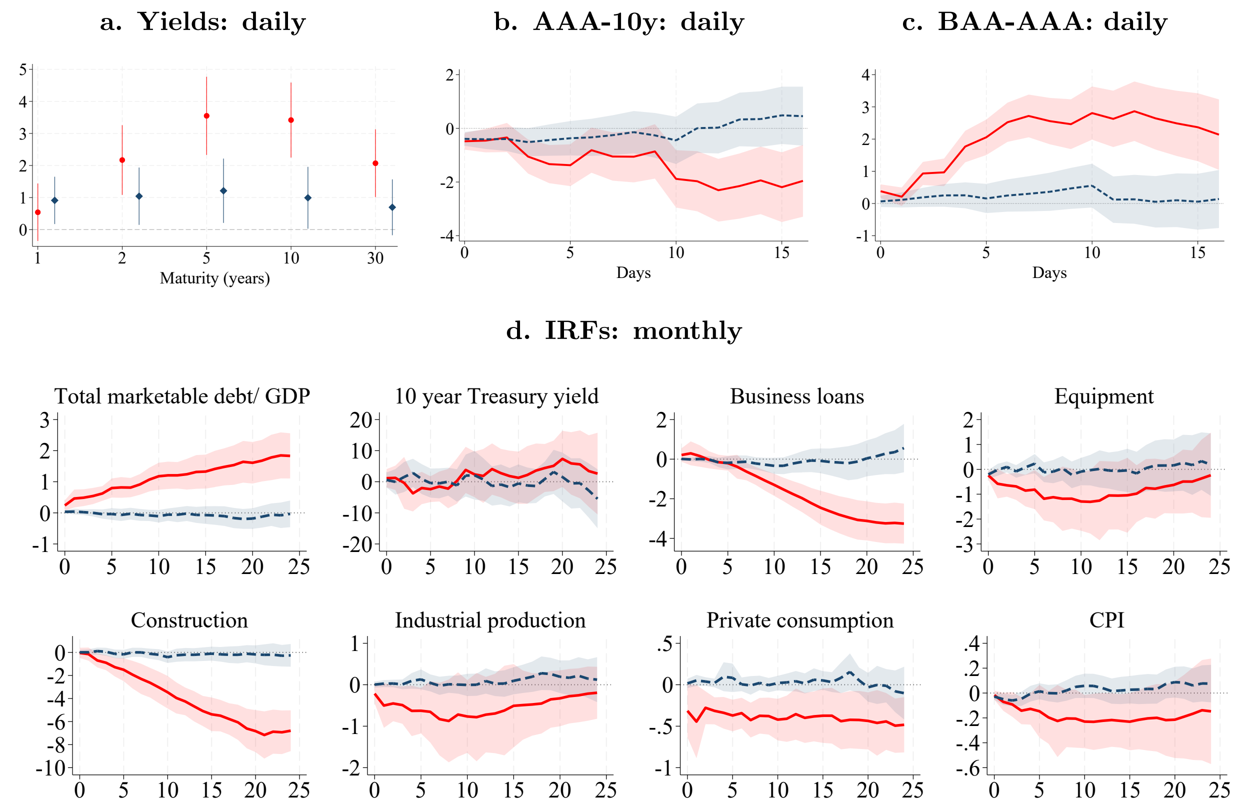
We start with debt expansion shocks, F_1. Figure 12 shows that in response to a debt expansion shock, the portfolio-rebalancing channel is amplified during high debt growth periods. Panel (a) shows that a shock to Treasury debt issuance raises yields across all maturities on impact, but the increases are more pronounced in the high debt-growth period.[41] This shock raises the 10-year yield by 4 basis points at the peak in high debt growth periods, but about 1 basis points when debt-to-GDP ratio is stable.

On the other hand, the safe asset channel is diminished in the high debt growth period. Panel (b) shows that in response to a higher Treasury issuance, the spread between AAA corporate and 10-year Treasury bonds declines during high debt growth periods, while largely unchanged when debt-GDP ratio is stable. It highlights that the Treasuries' safety attribute depends on the government's fiscal stance, and that markets value Treasuries more as safe assets when the government debt share is stable. In addition, panel (c) shows that the response of spread between BAA and AAA corporate bond yields reaches 3 basis points at the peak when government debt grows rapidly, while the responses are muted otherwise. Consistent with the model discussion in Section 3, credit spreads widen when Treasury issuance leads to a risk-off co-movement in risky corporate bonds, supporting the portfolio-rebalancing channel. And it is particularly relevant

[40] If we look at the distribution of shocks across high and low debt growth periods, we see that on average the debt expansion shocks tend to be larger and more positive during high debt growth periods (shown in Figure C14 in the Appendix.)

[41] Panel (a) in Figure 12 shows responses at day 4 following the shock, which coincides with the peak response for 10-year Treasury yields.

Figure 12: Responses to Debt Expansion Shock (F1): Debt-to-GDP Growth



Note: Red dots/lines represent the case of high-debt growth periods, while blue dots/lines are when debt-to-GDP ratios are stable. 90% confidence bands are shown. **Top left panel:** Peak responses of yields across maturities at day 4 following the shock with the x-axis showing maturities and the y axis in basis points. **Top middle and right panels:** IRFs of AAA and 10-year Treasury spreads as well as BAA and AAA corporate bond spreads with the x-axis showing days after the shock and the y axis in basis points. **Bottom panel:** IRFs at monthly frequency with the x-axis showing months after the shock hits. The y-axis is in percentage points for debt-GDP ratio, basis points for yield, and percent deviations for the rest.

during high fiscal stress periods.

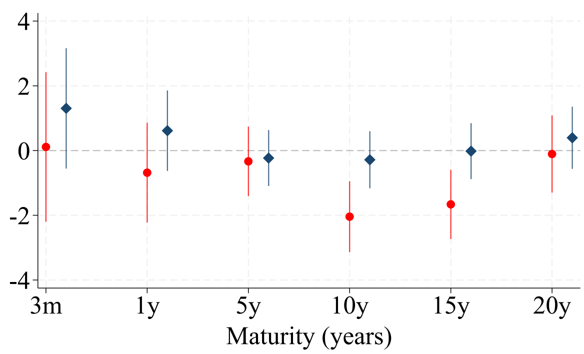
Turning to the macroeconomic effects, an amplified crowding-out channel as well as a diminished safe asset channel during high debt growth periods play a key role. Panel (d) of Figure 12 shows that when debt-to-GDP ratio is stable, a debt expansion shock leads to subdued macroeconomic responses. If government debt has is growing at a fast pace, however, a one-standard deviation shock in Treasury issuance steadily increase the government debt level, reaching 2 percent of GDP after 2 years. Higher government debt crowds out private production, consumption and investment throughout the projection horizon. The impact on construction investment is substantial.

6.1.2 Effects of Maturity Extension Shocks based on Debt-to-GDP Growth

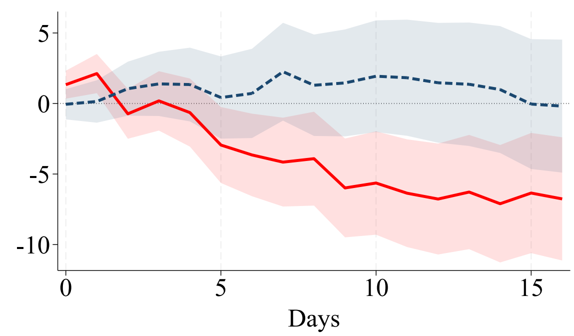
Next we explore maturity extension shocks F_2. Figure 13 shows that in response to a maturity adjustment shock, all three channels – portfolio-rebalancing (crowding-out), safe asset, and signaling – are more pronounced during high debt growth periods.

Figure 13: Responses to Maturity Adjustment Shock (F_2): Debt-to-GDP Growth

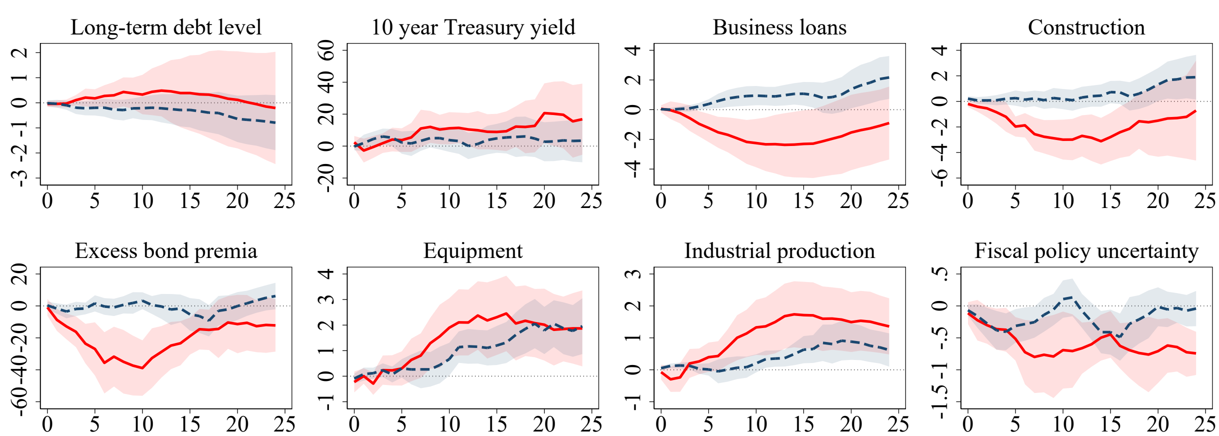
a. Refcorp Spread: daily



b. Excess Bond Premium: daily



c. IRFs: monthly



Note: Red dots/lines represent the case of high-debt growth periods, while blue dots/lines are when debt-to-GDP ratios are stable. 90% confidence bands are shown. **Top left panel:** Responses of Refcorp spread across maturities at day 15 following the shock with the x-axis showing maturities and the y axis in basis points. **Top right panel:** IRFs of BAA and AAA corporate bond spreads with the x-axis showing days after the shock and the y axis in basis points. **Bottom panel:** IRFs at monthly frequency with the x-axis showing months after the shock hits. The y-axis is in percentage points for debt-GDP ratio, basis points for yield, and percent deviations for the rest.

A shift from short- to long-term Treasury securities reduces the convenience yield at the long end, driven largely by the high debt growth periods. The liquidity premium, measured by the spread between Refcorp bonds and Treasuries, are largely unchanged when debt-to-GDP ratios are steady. In a high debt growth period, on the other hand, the measure declines notably at the longer-end maturity. For instance, the liquidity spread declines by 4 basis points for 15-year bonds during high debt growth periods, but remains unchanged when debt-GDP ratio is stable.

In addition, the safe asset channel is more pronounced in the high debt growth period. When the government issues more long- rather than short-term debt, the spread between BAA and AAA bonds declines in the high debt growth period, but remains muted when debt-to-GDP is stable.

Turning to the macroeconomic impact, the bottom panel of Figure 13 highlights that all transmission channels are amplified during the high debt growth period. A relatively higher issuance in longer-term securities reduces the excess bond premium more significantly during the high debt growth period. Fiscal policy uncertainty also declines, as longer-term Treasury securities provide a better hedging instrument for fiscal risk. These responses are consistent with a stronger signaling channel that we highlight in the model discussion and also find in the daily regressions. The lower fiscal risk lead to higher economic activity, as equipment spending and industrial production see more sustained increases. On the other hand, the crowding-out channel is also stronger in the high debt growth period. 10-year Treasury yield sees a more sustained increase. As a result, business loans and construction spending experience more notable declines.

Overall, we have shown that the effects of debt expansion shocks are markedly stronger when debt-to-GDP growth is high, suggesting that heightened fiscal risk amplifies market responses by tightening arbitrage limits and weakening the safe-asset channel.[42] On the other hand, maturity extension shocks during high debt growth periods may send a stronger signal about improved fiscal fundamentals, thus reducing fiscal and credit risk.

6.2 Information Content: QRS versus Non-QRS Announcements

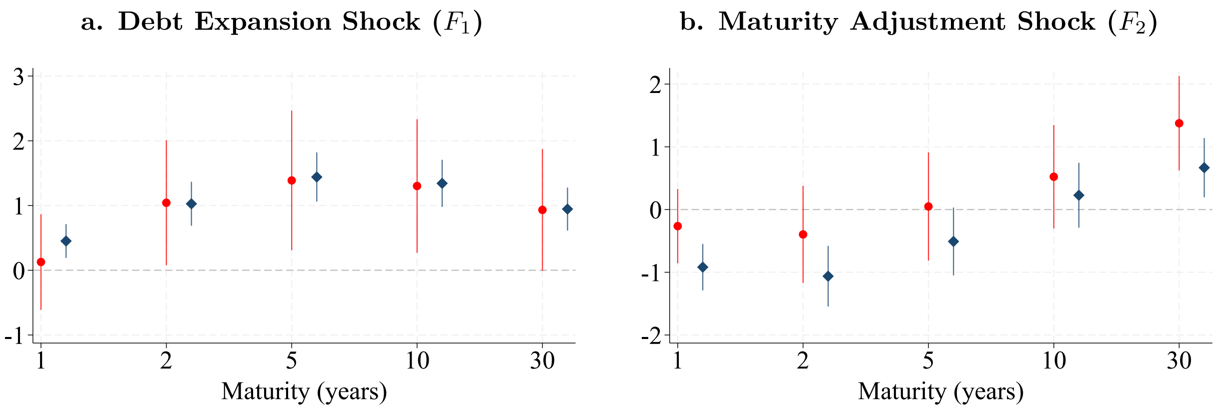
Treasury auction announcements are made either standalone or together with the Quarterly Refunding Statement (QRS). Compared to the standalone auction announcements, the QRS contains broader communications from the Treasury, including near-term fiscal outlook, issuance strategy and sizes for upcoming quarters, and factors influencing its debt management decisions. For this reason, some of the literature has focused exclusively on information released on those days (see Haddad, Moreira, and Muir (2024), Hartley and Rigon (2025), and Wang and Zhao (2025)). Our approach employs both types of auction announcements. In order to shed light on whether there are fundamental differences in the types of Treasury announcements, we leverage the differentiation between QRS and non-QRS announcements by splitting the Treasury supply shocks into two groups.

To assess whether financial markets respond to Treasury auction announcements outside of the Quarterly Refunding Statement (QRS) releases, we conduct a placebo test using non-QRS announcements. Specifically, we compare Treasury futures price movements around these non- QRS announcements to those on "normal" days. Figure C11 in the appendix shows that for both QRS and non-QRS announcements, we can reject equality of the distribution for futures of all maturities. Price movements around Treasury announcements are statistically more volatile than on normal

[42] Consistent with this interpretation, Ray, Droste, and Gorodnichenko (2024) show that Treasury demand shocks, unexpected shifts in private purchases that mimic QE-type interventions around Treasury auctions, have localized yield curve effects that intensify during periods of financial stress, reflecting limited arbitrage and preferred-habitat behavior. Similarly, Joyce and Lengyel (2024) find that in the U.K. gilt market, yield reactions to debt issuance surprises operate through both duration-risk and local-supply channels and become up to five times larger under high market stress. Additionally, Bräuning and Stein (2024) highlight that shocks to primary dealers' risk-bearing constraints have significant effects on the U.S. Treasury market. Thus, compared to steady debt levels, rapid government debt growth can tighten dealer constraints and impairs financial intermediation, amplifying the crowding-out channel.

(non-announcement) days, and this this is true for both types of announcements. Notably, non-QRS announcements also generate statistically meaningful price responses, indicating that markets react to information conveyed in routine auction communications, not only to the more prominent QRS releases.

Figure 14: Yield Responses to Treasury Supply Shocks: QRS vs. non-QRS



Note: Impact responses of yields with 90% confidence bands. The x-axis shows maturities and the y-axis is in terms of basis points. The figures show the daily response of yields to shocks that coincide with the Quarterly Refunding Statement (QRS) given by red dots, and otherwise given by blue diamonds.

Next we consider the movements in yields for these two types of announcements. We find that standalone Treasury auction announcements convey meaningful information, as the associated yield effects move in the same direction as those on QRS dates. Figure 14 shows the effects of Treasury supply shocks on and outside QRS dates, respectively, on Treasury yields of various maturities. Following a debt expansion shock (left panel), the responses of yields are similar across QRS announcements (red dots) and non-QRS announcements (blue diamonds). On the other hand, maturity adjustment (right panel) shocks coincide with larger yield responses from QRS announcements, reflecting either a stronger signaling channel or a greater salience of these announcements to market participants. It is notable that for both types of shocks, the non-QRS estimates are associated with much tighter confidence bands, probably due to their larger number of observation. Overall, this highlights the importance of including non-QRS announcements in the estimation.

In addition, examining the distribution of shocks, we find that some of the largest debt expansion (F_1) shocks occur on non-QRS dates, whereas many of the largest positive and negative maturity adjustment (F_2) shocks coincide with QRS announcements, as shown in Figure C13. In particular, several major maturity adjustment shocks, linked to news about the re-issuance or discontinuation of specific maturities, are made in the QRS.

Finally, we find that shocks extracted from both types of Treasury announcements generate largely similar macroeconomic responses. In our baseline case, aggregation at the monthly level inevitably combines QRS and non-QRS shocks within the same month. Figure D20 instead separates the two types of shocks. Debt expansion shocks that occur outside QRS dates lead to stronger portfolio-rebalancing (crowding-out) effects reflecting, in part, the distribution of shocks. For F_2 shocks, the macroeconomic effects are broadly similar regardless of whether they coincide with QRS announcements or not.

The analysis in this section highlights that relying only on QRS events may underestimate the information content of Treasury announcements, and exploiting the broader set of issuance communication provides a more comprehensive picture of how debt management decisions affect yields and financial conditions.

7 Quantitative Easing and Treasury Maturity Adjustments

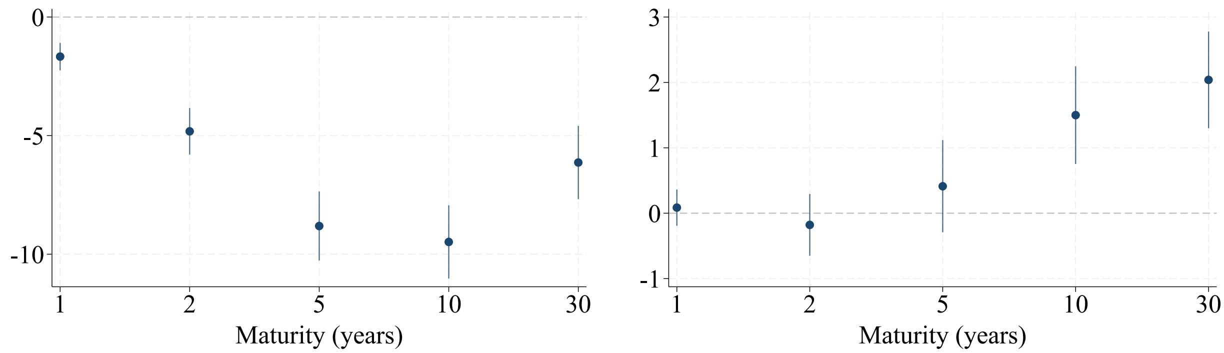
One of the contributions of this paper is to identify Treasury supply shocks not only in terms of the overall level of debt issuance but also in terms of the maturity structure of issuance, an aspect that has received relatively less attention in the prior literature. This distinction is important, because the maturity composition of debt supply interacts directly with the Federal Reserve's large-scale asset purchases (LSAPs) that alter the demand for long duration Treasuries and thereby the maturity profile of securities available to the public. As Greenwood, Hanson, Rudolph, and Summers (2014) emphasize, when talking about the period post-Great Recession, "Treasury's decision to lengthen the average maturity of the debt (to mitigate fiscal risk associated with the government's growing debt) has partially offset the Federal Reserve's attempts to reduce the supply of long-term bonds held by private investors through its policy of quantitative easing."

We build on this insight to provide quantitative estimates of this effect, by examining high-frequency market responses to QE-related announcements between November 25, 2008 and April 9, 2020. We consider Federal Reserve policy announcements on QE1, QE2, the Maturity Extension Program, QE3, and the pandemic-era interventions, as shown in Table B3. Following our identification approach on Treasury supply shocks, we measure Treasury futures price changes in a 30-minute window around these announcements, for which we have the specific associated time stamps. With the exception of QE1, which triggered unusually large responses, the magnitude of futures movements around QE announcements is broadly comparable to those observed around Treasury issuance announcements. Consistent with the portfolio-rebalancing channel, the largest futures price changes occur at the long end, with 30-year and 10-year contracts responding more strongly than shorter maturities.

To summarize these comovements, we extract a factor from the 2-, 5-, 10-, and 30-year futures contracts. This first factor, which we denote Q_1, explains about 90 percent of the variation and loads positively across maturities. Yet, once we consider the effects on yields, it is clear that Q_1 primarily shifts the slope of the yield curve. The left panel of Figure 15 shows that on average, a one standard deviation Q_1 shock lowers the 10-year Treasury yield by about 10 basis points and steepens the 10-2 year spread by 5 basis points on impact.[43] Restricting ourselves to the same

[43]The effect on the 10-year yield is consistent with the findings of Swanson (2021), who, using a slightly different sample (2009-2015) and methodology, finds that a one-standard-deviation LSAP shock lowers the 10-year yield

Figure 15: Yield Responses: daily frequency



Note: Impact responses of yields with 90% confidence bands. The x-axis shows maturities and the y-axis is in terms of basis points. The sample period considered for both sets of shocks spans November 25, 2008 and April 9, 2020.

sample period, our Treasury maturity extension shock (F_2) on average raises the 10-year yield by 2 basis points and steepens the spread between the 10-2 year Treasury yields by the same magnitude, as shown in the right panel of Figure 15.

Taken together, these results imply that Treasury maturity adjustment shocks based on Treasury announcements, offset roughly one third of the average effects of QE announcements on long-term yields during the 2008-2020 period. In other words, while QE announcements compressed long rates by shifting duration risk onto the central bank's balance sheet, Treasury's simultaneous decision to extend the maturity of issuance leaned in the opposite direction, undoing a material share of those effects. This finding provides direct evidence of monetary-fiscal interaction operating through the maturity structure of government debt.

Our results contribute to the existing literature by leveraging the maturity structure. Gomez Cram, Kung, and Lustig (2025) show that Treasury yields rise substantially in response to projected deficit news, as revealed in CBO cost releases, for the period 1997-2022, while monetary policy offsets much of these fiscal news as yields decline following FOMC days. Our evidence adds another dimension to this story by focusing on the maturity structure of debt. Not only does monetary policy drive long yields at high frequency, but debt management decisions by the Treasury also have significant effects in shaping how much monetary policy transmits to long-term rates.

8 Conclusion

This paper provides new evidence on how Treasury debt management decisions transmit to financial markets and the broader economy. Using high-frequency futures data around Treasury auction announcements, we identify two distinct Treasury supply shocks: debt expansion shocks that capture changes in issuance volume and maturity adjustment shocks that reflect shifts in the

between 6 and 7 basis points.

maturity structure. We find that Treasury issuance decisions, both in scale and composition, play an important macro-financial role.

Debt expansion shocks, which raise the overall level of public debt, tighten financial conditions by increasing Treasury yields and term premia, lowering convenience yields, and widening corporate spreads. The resulting rise in borrowing costs crowds out private investment and dampens economic activity, particularly in interest-sensitive sectors such as construction. These effects are amplified when debt is already growing rapidly, as the safe-asset properties of Treasuries weaken amid heightened fiscal concerns.

In contrast, maturity adjustment shocks – changes in the maturity structure of issuance – operate through a richer set of mechanisms. While they steepen the yield curve, maturity extension shocks may convey improved fiscal fundamentals, easing fiscal uncertainty and risk premium. By increasing the supply of long-duration safe assets and lowering the excess bond premium, these shocks stimulate short-term investment and production through improved financial conditions, despite increases in long-term borrowing costs which depresses some sectors like construction. Maturity compressions, in turn, ease financing conditions by lowering long yields, though they may signal short-term funding stress. This asymmetry underscores that the composition of Treasury issuance can shift the balance between portfolio-rebalancing and safe-asset channels in opposite directions.

We also show that Treasury issuance interacts meaningfully with monetary policy. Treasury's maturity choices can either reinforce or offset the Federal Reserve's actions: during 2008-2020, maturity extension announcements by the Treasury are estimated to have undone roughly one-third of the yield-lowering effects of the Fed's quantitative-easing program announcements. This highlights a direct fiscal-monetary linkage operating through the maturity structure of government debt.

From a policy perspective, our analysis underscores that Treasury debt management plays an active role in macro-financial stabilization. Decisions over the volume and maturity composition of issuance can either reinforce or offset broader financial conditions, depending on the prevailing fiscal and monetary environment. The results thus point to the importance of coordination between debt management, fiscal policy, and monetary operations, particularly as public debt remains elevated and financial markets continue to navigate post-pandemic normalization and ongoing balance-sheet adjustments.

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APPENDIX

A Institutional Background

A.1 Treasury Quarterly Refunding Statements: Narrative Evidence Treasury auction announcements are made either standalone or together with a QRS. Four times a year, the Department of the Treasury issues QRS and holds a quarterly refunding press conference to discuss Treasury marketable security auctions. This usually happens on the first Wednesday in February, May, August, and November. Through the QRS, the Treasury communicates a broad range of topics, including fiscal outlook, issuance strategy and sizes for upcoming quarters, and factors influencing its debt management decisions. It usually gives the tentative auction schedule for the next six months.

We read through the QRS reports between 1998Q1 and 2025Q2 and provide examples of narrative evidence in this section to highlight: 1) The Treasury faces a nontrivial amount of uncertainty in cash flows. 2) The Treasury makes the discretionary decisions on maturity structure based on incoming information on fiscal outlook.

A.1.1 Cash Flow Uncertainty Even with a federal budget and frequent cost estimates on legislatures from the Congressional Budget Office, the Treasury's cash flows are subject to unavoidable uncertainty due to irregular outlays from federal programs and fluctuations in tax receipts. The challenge is nicely captured by the QRS in 2002Q3: "*We believe that Treasury's policy of issuing debt in a regular pattern and in predictable quantities fulfills this mission. The risk to regular and predictable issuance are the result of unexpected changes in our borrowing requirements, changes in the demand for our securities, and anything that inhibits timely sales of our securities. To reduce these risk, we closely monitor economic conditions, fiscal policy and market activity, and, when necessary, respond with changes in debt issuance that are based on thorough analysis and discussions with market participants.*" We provide more examples below.

- 2022Q3: "*Since the May refunding, Treasury has continued to receive information regarding projected borrowing needs, including an additional quarter of tax receipts and clarity on the timing and pace of redemptions of Treasury securities from the Federal Reserve System Open Market Account. Based on this updated information, Treasury intends to continue reducing auction sizes of nominal coupon securities during the upcoming August - October 2022 quarter.*"

- 2022Q2: "*During this period, we have also received important information regarding Treasury's projected borrowing needs, most notably recent strong tax receipts and public communications from the Federal Open Market Committee regarding potential redemptions of Treasury securities from the Federal Reserve System Open Market Account (SOMA). Based on this updated information, Treasury intends to continue reducing auction sizes of nominal coupon* *securities during the upcoming May - July 2022 quarter, though by smaller increments than in previous quarters.*"

- 2021Q4: "*Accordingly, Treasury intends to reduce auction sizes across all nominal coupon securities, starting with modest reductions over the upcoming November 2021 to January 2022 quarter. This approach reflects Treasury's desire to preserve flexibility to adjust future financing plans in light of the remaining uncertainty in the fiscal outlook.*"

- 2021Q2: *"Treasury continues to face uncertain and sizable borrowing needs due to expenditures associated with the government's response to COVID-19 as well as the impact of the pandemic on economic activity and government receipts.*"

- 2020Q4: "*Consistent with its guidance in the August refunding statement, Treasury continues to take a precautionary, risk-management driven approach by maintaining large cash balances in light of the unprecedented size and ongoing uncertainty regarding COVID-19 related outlays. ... While Treasury expects its cash balance to decline over the quarter, the extent of the decline will depend on several uncertain factors, including the pace of outflows under current law and the potential for additional legislation.*"

- 2019Q2: "*Based on currently available information, Treasury expects that extraordinary measures will be exhausted sometime in the second half of 2019.*"

- 2014Q3: "*Over the last quarter, in response to improvements in the fiscal outlook, Treasury reduced coupon offering sizes in the 2- and 3-year maturity offerings.*"

- 2014Q2: "*The magnitude and duration of offering-size reductions will depend on the pace and extent of the fiscal improvement.*"

- 2014Q1: "*In light of the improving fiscal outlook, however, Treasury will continue to monitor projected financing needs and will consider further modest reductions in coupon auction sizes.*"

- 2013Q3: "*Given improvements in the fiscal outlook, Treasury expects to gradually decrease coupon auction sizes over the coming quarter.*"

- 2013Q2: "*Depending on how the fiscal situation develops, Treasury may decide to gradually decrease coupon auction sizes.*"

- 2008Q4: "*In response to the large increase in projected financing needs, to better manage the overall debt portfolio, and to create additional flexibility in meeting uncertainty in borrowing requirements, Treasury is instituting the following changes to the auction calendar ... Treasury conducted a series of unscheduled reopenings of four off-the-run securities in October. This action was taken to address upcoming borrowing needs.*"

- 2008Q3: "*Treasury will continue to monitor projected financing needs and make adjustments as necessary including, but not limited to, considering a second reopening of the 10-year note* *in the month following the first reopening and moving to quarterly new issue 30-year bond auctions.*"

- 2007Q1: "*In response to ongoing strength in receipts, Treasury has made recent cuts in nominal and TIPS coupon issuance. Continued strength in the fiscal outlook may necessitate additional adjustments to our marketable borrowing.*"

- 2001Q4: "*As a consequence of the further weakening of the economy and the increased federal outlays that have occurred since the attacks of September 11th, the near-term financing requirements of the federal government are larger than we anticipated just three months ago at our last quarterly refunding in August.*"

A.1.2 Maturity Structure Information The Treasury's goal in debt management policy is to finance the government at the lowest cost over time. It faces the tradeoffs between issuing short-term securities to reduce debt servicing costs and issuing long-term securities to lower rollover risk. How to balance the tradeoffs depends on the economic conditions and government's fiscal capacity. Therefore, the Treasury makes the discretionary decisions on maturity structure based on incoming information on fiscal outlook.

- 2017Q4: "*The magnitude and allocation of increases to auction sizes will depend in part on projections for the fiscal outlook, as well as feedback from market participants. Based on current fiscal forecasts and internal Treasury modeling, it is anticipated that these changes will likely result in a stabilization of the weighted average maturity (WAM) of debt outstanding at or around the current levels, with the caveat that unexpected large changes in borrowing needs could have an unforeseen impact on future issuance and ultimately the level of WAM.*"

- 2015Q2: "*The supply of bills outstanding as a percentage of the total Treasury portfolio is at a multi-decade low of approximately 11 percent. Demand for Treasury bills is high and is expected to grow even more significant. Therefore, Treasury believes that it is prudent to increase the level of Treasury bills outstanding, at least somewhat, within the total amount of securities issued for authorized purposes.*"

- 2011Q1: "*Treasury expects to keep coupon auction sizes stable in the coming months, despite a residual financing need created by the passage of recent tax legislation. Treasury plans to address this incremental borrowing need through increases in regular-bill auction sizes.*"

- 2009Q2: "*To address the rapid changes that have occurred in short-term borrowing needs, Treasury raised the issuance sizes of regular weekly and monthly bills and increased the frequency, tenor, and issuance sizes of cash management bills. At the same time, in response to greater medium and longer term financing requirements as well as overall portfolio considerations, Treasury gradually increased the issuance sizes of nominal coupon security offerings, and also adjusted the securities offering calendar.*"

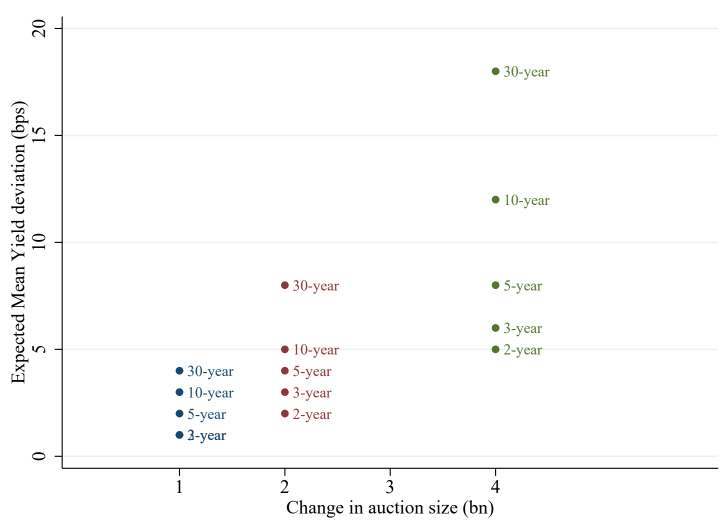
- 2008Q1: "*Treasury is also contemplating the optimal method of financing should Congress pass an economic growth package. The nature of the financing will largely be dictated by the scope and timing of any such package. Based on current forecasts, additional borrowing needs can be addressed through changes in issuance sizes of the existing menu of securities, including cash management bills.*"

A.2 Primary Dealers Surveys During the quarterly refunding process, the Treasury solicit views from the primary dealers, and those market participants provide their estimates on issuance sizes for the upcoming auctions. The Treasury publishes the primary dealer auction size survey twice a year (the second and fourth quarters) for the period since 2015.

Between 2015 and 2017, the Treasury conducted the survey to gauge the maximum and minimum auction sizes for maintaining steady market functioning. Since 2018, the Treasury has changed their survey and explicitly asked about primary dealers' estimates on auction sizes for the current and next two fiscal years.

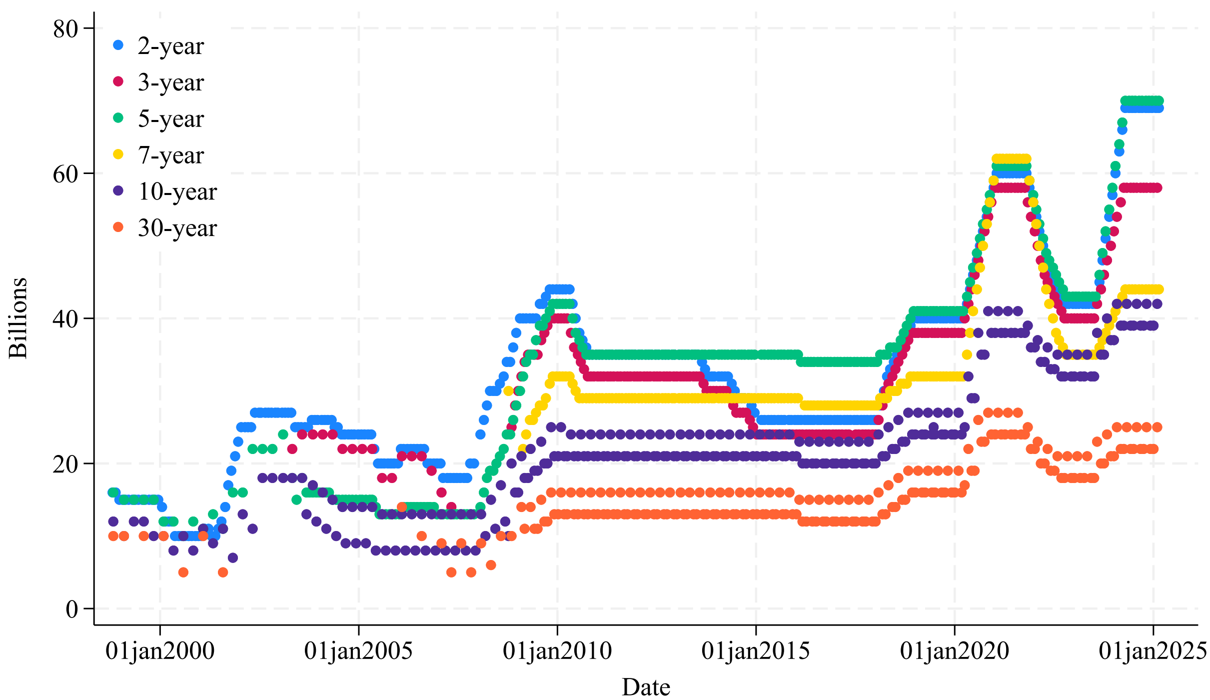
In 2016 Q4, the survey questionnaire solicited estimates on alternative scenarios: "All else equal, estimate the changes in auction stop out rates given small, intermediate and large changes in auction offering amounts. For purposes of these estimates, assume that the change values in the table below represent consecutive monthly increases in offering amounts for a particular tenor relative to current auction sizes and that those increases would be applied for one year. For each tenor, estimate the changes in the stop out rates at the end of 1 year relative to where stop out rates would have been absent any changes to issue sizes." Figure A1 summarizes the responses published by the Treasury. Primary dealers expected that an addition issuance of $1 billion 2-year Treasury note would raise 2-year yield by 1 basis point and the same increase for 10-year coupon would raise 10-year yield by 3 basis points. Similarly, a larger increase in the issuance would lead to a larger rise in yields.

Figure A1: Primary Dealer Auction Survey (2016 Q4)



A.3 Auction Data Figure A2 plots the historical Treasury auction amounts across maturities during our data sample period. A few observations stand out. First, outside of economic recessions, the auction sizes remain remarkably stable for the most part, in particular at longer maturities. For instance, the auction sizes remained entirely unchanged between September 2010 and February 2016 for coupons with maturities of 5 years and longer. Second, once the Treasury decides to alter auction sizes, it is most likely to continue change issuance in the same direction for a consecutive period of time, instead of one-off changes. During recession, the auction sizes usually increase steadily, as higher fiscal spending and lower tax revenue prompt the Federal government to issue more debt. Even outside of recessions, changes are rarely one-off, for instance the sequence of changes during the recalibration in 2023. Third, the Treasury almost never reverse its changes on auction sizes. That is, if it decides to increase issuance, it is very rare to see auction size decline in the following period.

Figure A2: Auction amounts for various maturities



A.4 Treasury Futures Prices Figure A3 plots the historical price of the four financial instruments we use in this paper.

Figure A4 illustrates the two types of Treasury supply shocks that we aim at identifying in this paper. The left panel shows an announcement about debt volume primarily on April 30, 2014, where the Treasury trimmed the size of debt auctions, as the fiscal outlook brightened. The right panel shows an announcement on May 4, 2005 affecting maturity structure primarily, where they announced plans to re-introduce the 30 year bonds.

Figure A3: Treasury futures prices for various maturities

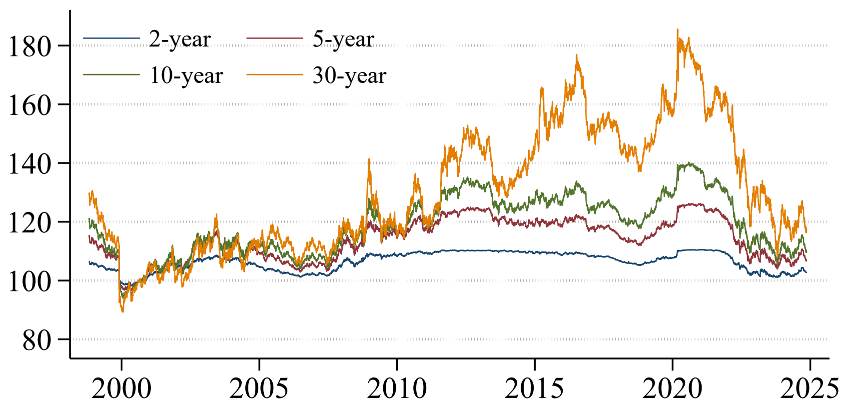
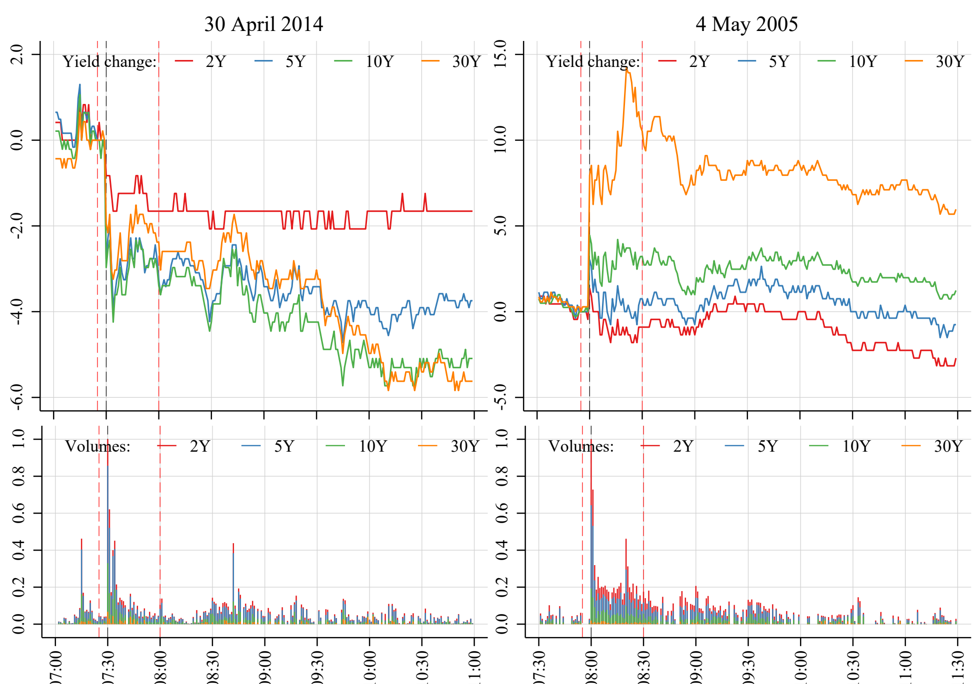


Figure A4: Treasury Announcement Effects on Treasury Futures



Note: The left panel shows an announcement about debt volume primarily on April 30, 2014 when Treasury trimmed the size of debt auctions, as the fiscal outlook brightened. The right panel shows an announcement on May 4, 2005 affecting maturity structure primarily, where they announced plans to re-introduce the 30 year bonds

A.4.1 Case Study of November 1, 2023 Here we provide further details on how Treasury announcements reshape market expectations, by continuing to take November 1, 2023 as a case-study. As mentioned in the main text, there were large movements in the Treasury futures prices in response to the announcement. Additional excerpts from Goldfarb, S. (2023, November 5). *Markets got an unexpected boost from Washington. Will it mark a turning point?* The Wall Street Journal are shown in Figure A5, which provide more context from a market perspective. Note that it clearly states that: "Just based on dollar amounts, the difference between what Wall Street had anticipated and what Treasury delivered was small. But investors embraced what they saw as the underlying message." This further provides justification for our focus on prices instead of quantities in capturing the Treasury supply shocks, since the QRS has explicit forward guidance that is hard to capture by projection errors on quantities alone.

Figure A5: Excerpt from Goldfarb, S. (2023, November 5) WSJ article

Markets Got an Unexpected Boost From Washington. Will It Mark a Turning Point?

By Sam Goldfarb Follow

Nov. 5, 2023 5:30 am ET

The Treasury Department handed investors a happy surprise last week. Now the question is how far they can run with it.

Stocks and bonds both staged rallies last week, getting a boost when the Treasury increased the size of longer-term debt auctions by a smaller amount than many had expected.

Heading into last week, there had been debate about what had caused yields to surge in recent months. Some analysts pointed mostly to the strong economy and expectations for a higher path of short-term interest rates set by the Fed.

Others emphasized what they saw as an imbalance in the supply and demand for Treasurys, worsened by a recent increase in the size of longer-term debt auctions needed to fund a widening federal budget deficit.

Whatever the answer, investors seized on a normally overlooked event—Treasury's quarterly announcement of its coming borrowing plans—as an important moment for markets.

As it turned out, Treasury on Wednesday not only announced smaller-than-expected increases to longer-term debt auctions but also suggested that it was willing to overstep informal guideposts for how much in short-term Treasury bills to issue.

Just based on dollar amounts, the difference between what Wall Street had anticipated and what Treasury delivered was small. But investors embraced what they saw as the underlying message.

For further context, the 2023Q3 QRS on August 2, 2023 expected Treasury to increase coupon auction size beginning in Q3 and indicated further gradual increases would be necessary. They said:

"*Based on projected intermediate- to long-term borrowing needs, Treasury intends to gradually increase coupon auction sizes beginning with the August to October 2023 quarter. While these* *changes will make substantial progress towards aligning auction sizes with intermediate- to long-term borrowing needs, further gradual increases will likely be necessary in future quarters. The scale of these increases will depend on a variety of factors, including the evolution of the fiscal outlook and the pace and duration of future SOMA redemptions.*"

It surprised the market and led to large increases in yields, and is reflected in a positive F2 surprise in our data.

Then 2023Q4 QRS came out on November 1, 2023 and changed the guidance. They only expected one additional quarter of increase to coupon sizes and then no more. They said:

"*Based on projected intermediate- to long-term borrowing needs, Treasury intends to continue gradually increasing coupon auction sizes in the upcoming November 2023 to January 2024 quarter. As these changes will make substantial progress towards aligning auction sizes with projected borrowing needs, Treasury anticipates that one additional quarter of increases to coupon auction sizes will likely be needed beyond the increases announced today. Treasury issuance plans will continue to depend on a variety of factors, including the evolution of the fiscal outlook and the pace and duration of future SOMA redemptions.*"

This announcement led to large declines in yields, as results in a negative F2 shock in our data generated by the Treasury futures movements explicitly shown in Figure 2.

A.5 Treasury Borrowing Advisory Committee The Treasury Borrowing Advisory Committee (TBAC) is an advisory committee that meets quarterly with the Treasury Department. The committee includes senior representatives from a variety of buy and sell side institutions, such as banks, broker-dealers, asset managers, hedge funds, and insurance companies. On the day before the Treasury issues QRS and holds a quarterly refunding press conference, the TBAC presents their observations to the Treasury on the overall strength of the U.S. economy and provide recommendations on technical debt management issues including its financing recommendation for the upcoming quarters. The recommended financing table is published the next day at the same time as QRS.

One might think that the TBAC recommended financing tables could potentially reflect the private market's expectation about Treasury issuance plan. In that case, comparing the actual auction announcements against the TBAC financing tables would capture Treasury supply shocks in issuance amounts. However, there are several considerations to that argument. First, those recommended financing tables should be considered as *input* to the Treasury issuance decisions, rather than private market expectations, because the role of TBAC is to advise the Treasury on Treasury issuance and debt management. Second, since the TBAC only publishes the financing table once per quarter, it reflects one snapshot of the TBAC's information set, which may become stale in later dates of the quarter. Therefore, it can be challenging to use those financing tables to construct Treasury supply shocks, even if the TBAC financing tables reflected the private market's expectation. Finally, the Treasury auction announcements can contain more information than the TBAC financing tables. Beyond the auction amounts for selected maturities in the next month, the Treasury's QRS contain broader communications on factors influencing its debt management decisions and issuance strategy that goes beyond auction sizes for upcoming quarters. Those forward guidance information would be captured by our Treasury supply shocks, but is unlikely to be reflected in the TBAC financing tables. This is consistent with the finding from Gürkaynak, Kisacikoğlu, and Wright (2020), as they highlight that observed surprises in headline numbers cannot capture the full extent of macroeconomic news announcements which are elaborate and multi-dimensional.

Keeping those caveats in mind, Figure A6 compares our Treasury supply shocks, F_1 and F_2, to the deviations between actual issuance and TBAC recommendations. In the top panel, we construct a level gap (in billions of dollars), which is defined as the difference between the actual issuance amounts and the TBAC recommended financing amounts, for each auction date. In the bottom panel, we construct a weighted average maturity gap by comparing the actual issuance amounts and the TBAC table.[44] The correlations between our Treasury supply shocks and the constructed TBAC gap measures vary over time.

- Prior to 2010, F_2 is weakly positively correlated with the TBAC WAM gap, while the correlation is insignificant for F_1 and the level gap. The weak correlations may reflect that our Treasury supply shocks capture forward guidance information in the Treasury announcements, which is absent in the TBAC gap measures. For instance, in order to accommodate large financing needs following the GFC, the Treasury announced important changes to the auction calendar on February 4, 2009, including the introduction of a monthly 7-year note and also a regular 30-year bond reopening. On the other hand, the TBAC recommended larger issuance sizes on the existing maturities – which is reflected in the large negative gaps shown in both panels of Figure A6 – rather than an expansion of security types. To given another example, the Treasury's discussion on reintroducing regular issuance of a 30-year bond on May 4, 2005 is captured by a large positive F_2 shock, but it is entirely missed in the TBAC gap measures.

- Between October 2010 and April 2020, both the level gap and the WAM gap are zeros; that is, the TBAC recommended financing tables were fully in line with the Treasury's issuance announcements. It might reflect that the TBAC recommendations served as an more important input in Treasury's decision making process during this period.

- Since April 2020, our Treasury supply shocks and the TBAC gap measures are more positively correlated compared to previous periods. The large issuance following the COVID pandemic is captured by both approaches.

[44] The level and the WAM gaps are defined as following:

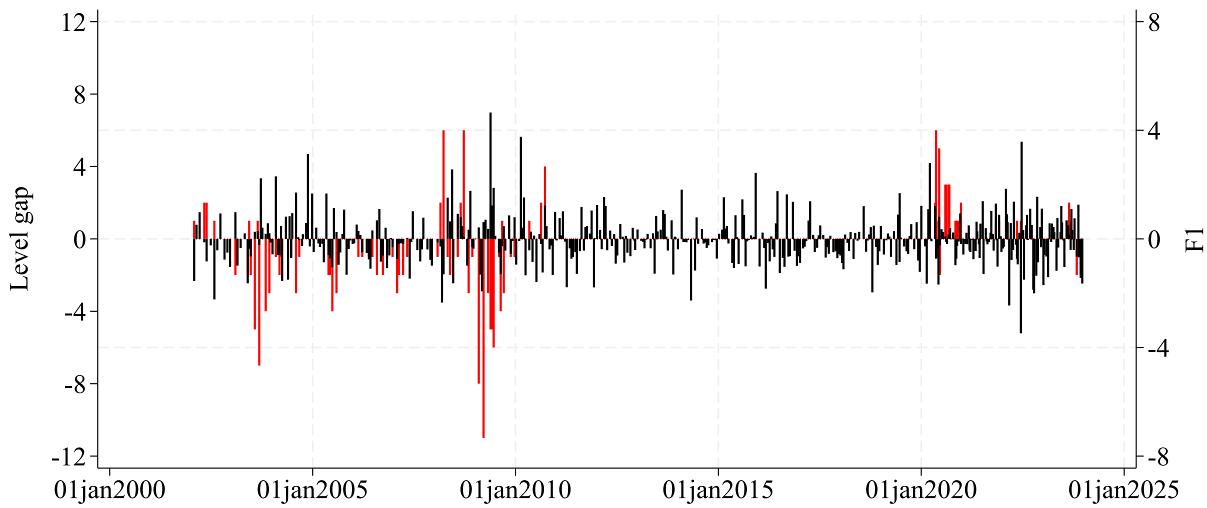
$$Level_{GAP} = \sum_{m=1,..,M} (Issuance_m - TBAC_m) \tag{A.1}$$

$$WAM_{GAP} = \frac{\sum_{m=1,..,M} (Issuance_m - TBAC_m) m}{GDP} \tag{A.2}$$

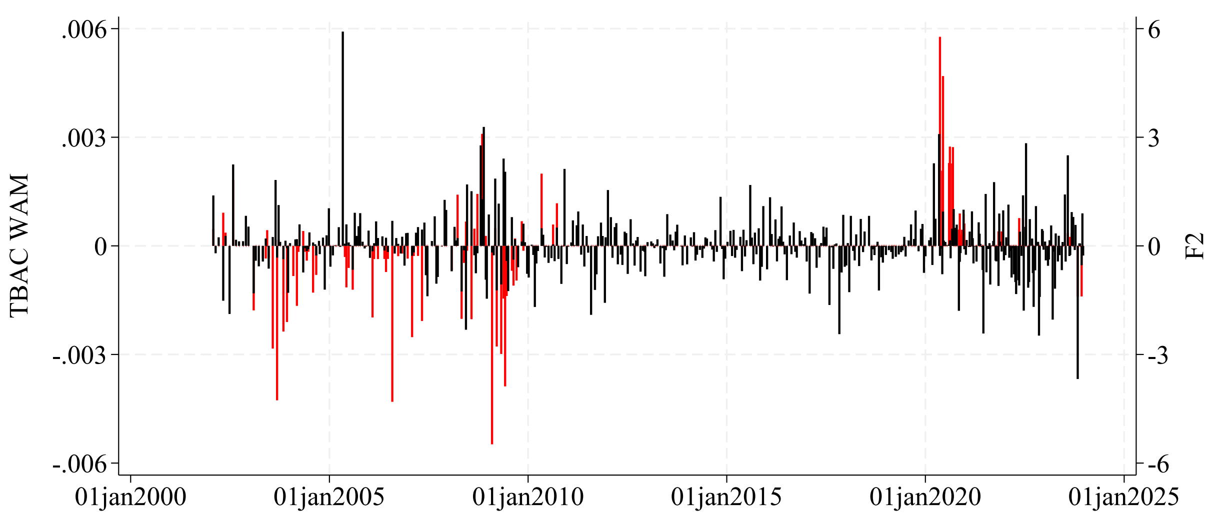
where m indicates maturity.

Figure A6: Treasury Supply Shocks vs. TBAC Recommendation Gaps

a. F_1 vs. Level Gap



b. F_2 vs. WAM Gap



Note: In both panel, F_1 and F_2 shocks are shown in black, while the TBAC gaps are shown in red. The level gap (in top) and the WAM gap (in bottom) are defined in Equations A.1 and A.2.

B Data

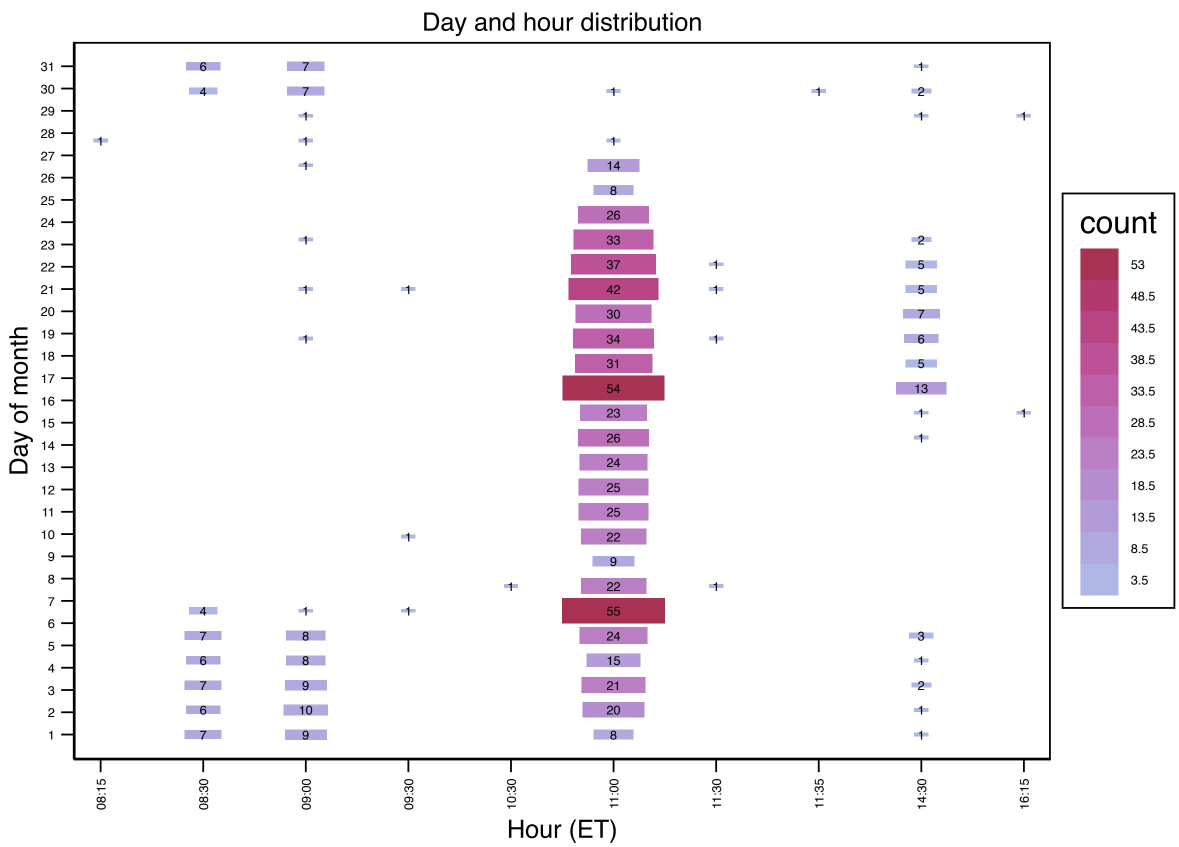
B.1 Major Data Release Treasury futures market may respond to other data releases besides Treasury announcements. If those data releases overlap with Treasury announcements within the 30-minute window, then the constructed Treasury supply shocks can be potentially contaminated. Therefore, we parse through the Treasury supply shocks according to major data release times.

Table B1 lists major macroeconomic data releases that can potentially move the Treasury futures market. For Treasury announcements in our dataset, Figure B7 summarizes the times when announcements were made. Most of announcements took place at 11:00am EST. For the construction window of 30 minutes, the possible overlapping announcements would be ones at 8:15am, 8:30am, and 9:00am. We find that the only overlapping incidents include 1) July 31, 2013, 2) April 30, 2014, 3) Jan 30, 2019, and 4) October 30, 2019, when Treasury announcements coincided with GDP data release.

Table B1: Major Macroeconomic Data Releases

Data Release	Time
GDP, Personal income and outlays, Retail sales Employment situation, CES report, Initial unemployment claims Housing starts, Trade balance, PPI, CPI	8:30am EST
Industrial production & capital utilizations	9:15am EST
Durable goods orders, New home sales, Construction spending Manufacturers' shipments, inventories, and orders University of Michigan consumer sentiment Conference Board consumer confidence, ISM manufacturing	10:00am EST
Government deficits	2:00pm EST
Consumer credit	3:00pm EST

Figure B7: Times of Treasury Announcements



B.2 Data definitions and sources Table B2 displays the data definitions and sources.

Table B2: Data Definitions and Sources

Variable Name	**Definition**	**Source**
a. Intraday Futures		
Treasury futures	Minute-level price data for continuous quarterly U.S. Treasury futures at 2-, 5-, 10-, and 30-year maturities, rolling from front-month to second-month contracts after the 5th calendar day of the delivery month [TUc1, TUc2, FVc1, FVc2, TYc1, TYc2, USc1, USc2]	LSEG Tick History
SOFR futures	Minute-level price data for continuous quarterly SOFR futures, for the first eight listed contracts [SRAcm1-SRAcm8]	LSEG Tick History
Stock market futures	Minute-level price data for S&P 500 E-mini futures (front-month) [ESc1]	LSEG Tick History
b. Daily Financial Market Variables		
Treasury bond yields	Yield on U.S. Treasury Securities at Constant Maturity for 1-, 2-, 5-, 10-, and 30-Year maturities [DGS1, DGS2, DGS5, DGS10, DGS30]	FRED
Corporate bond yields	Moody's Seasoned AAA and BAA Corporate Bond Yields [DAAA, DBAA]	FRED
Inflation expectations	5- and 10-Year Breakeven Inflation Expectations [T5YIE, T10YIE]	FRED
Term premium	Term Premium on 2-, 5-, and 10-Year Zero-Coupon Treasury Bonds [THREEFYTP2, THREEFYTP5, THREEFYTP10]	Federal Reserve Board via FRED
Refcorp spread	Spread between Refcorp Bond Yield and Treasury Zero-Coupon Bond Rate of the same maturity	Bloomberg
CIP spread	Covered Interest Parity (CIP) deviations for given maturity	Du, Im, and Schreger (2018)
Swap spread	Spread between Overnight Indexed Swap (OIS) rates and Treasury Zero-Coupon yields of the same maturity	Bloomberg
DV01	Sensitivity of Treasury futures price to changes in the CTD yield (Dollar value of a basis point)	Bloomberg
c. Monthly Macroeconomic and Financial Variables		
Industrial Production	Industrial Production Index [INDPRO]	FRED
Consumption	Nominal PCE deflated by the PCE price deflator [PCE / PCEPI]	FRED
Equipment	Manufacturer Shipments of Non-defense Capital Goods deflated by the PPI for Capital Equipment for Manufacturing Industry	FRED
Construction	Private Non-residential Construction Spending deflated by the PPI of Finished Goods	FRED
Business Loans	Commercial and Industrial Loans, All Commercial Banks, deflated by CPI	FRED
Commercial Paper	Non-financial Commercial Paper Outstanding, seasonally adjusted, deflated by CPI	FRED
Inflation expectations (model-based)	5- and 10-year model-based inflation expectations	Cleveland Fed via FRED
Short term share	Ratio of Treasury bills to total marketable debt	U.S. Treasury
Long-term share	Ratio of Treasury notes and bonds to total marketable debt	U.S. Treasury
Total ratio	Total marketable Treasury debt divided by GDP	U.S. Treasury / BEA

B.3 Quantitative Easing Dates and Times These are the dates and timestamps used in our analysis.

Table B3: List of QE related announcements

Date	Time	Event	Source
25-Nov-08	8:15 AM ET	QE1 launch: buy up to $100b agency debt, $500b MBS	KVJ-BPEA
1-Dec-08	1:45 PM ET	Bernanke speech	KVJ-BPEA
16-Dec-08	2:15 PM ET	FOMC mentions large-scale asset purchases	KVJ-BPEA
28-Jan-09	2:15 PM ET	FOMC ready to expand MBS, agency debt, LT Treasuries	KVJ-BPEA
18-Mar-09	2:15 PM ET	QE1 expansion: $1.25t MBS, $200b agency debt, $300b Treasuries	KVJ-BPEA
12-Aug-09	2:15 PM ET	Gradual slowdown of Treasury purchases, completion by Oct 2009	NY Fed
23-Sep-09	2:15 PM ET	Plan to slow agency debt and MBS purchases, end Q1 2010	NY Fed
4-Nov-09	2:15 PM ET	Agency debt target reduced from $200b to $175b	NY Fed
10-Aug-10	2:15 PM ET	Reinvest MBS/agency debt principal into Treasuries	KVJ-BPEA
21-Sep-10	2:15 PM ET	Statement (no detail)	KVJ-BPEA
3-Nov-10	2:15 PM ET	QE2: buy $600b Treasuries by mid-2011	KVJ-BPEA
12-Sep-11	2:15 PM ET	Operation Twist: $400b long-term Treasuries, sell short-term	NY Fed
20-Jun-12	2:15 PM ET	Extend maturity program through year-end	NY Fed
13-Sep-12	12:35 PM ET	QE3: buy $40b/month MBS until labor market improves	NY Fed
12-Dec-12	12:30 PM ET	QE3 extension: add $45b Treasuries per month	NY Fed
18-Dec-13	2:00 PM ET	Taper: reduce MBS to $35b, Treasuries to $40b	NY Fed
29-Oct-14	2:00 PM ET	End QE: conclude asset purchases	NY Fed
16-Dec-15	2:00 PM ET	First rate hike since crisis, reinvestment policy maintained	NY Fed
14-Jun-17	2:00 PM ET	Fed expects to begin balance sheet normalization	NY Fed
20-Sep-17	2:00 PM ET	Balance sheet normalization to start Oct 2017	NY Fed
3-Mar-20	10:00 AM ET	Emergency 50bp rate cut (unscheduled)	Collins & Gagnon
9-Mar-20	7:40 AM ET	Increased repo offerings by $75b	Collins & Gagnon
11-Mar-20	2:32 PM ET	Repo offerings increased further	Collins & Gagnon
12-Mar-20	1:10 PM ET	Extended maturity distribution, $1t repo operations	Collins & Gagnon
17-Mar-20	10:45 AM ET	Announced Commercial Paper Funding Facility	Collins & Gagnon
18-Mar-20	11:30 PM ET	Announced Money Market Mutual Fund Facility	Collins & Gagnon
19-Mar-20	9:00 AM ET	Dollar swap lines with more central banks	Collins & Gagnon
20-Mar-20	10:00 AM ET	Coordinated CB action on USD liquidity	Collins & Gagnon
20-Mar-20	11:00 AM ET	Expanded MMF Facility to muni funds	Collins & Gagnon
23-Mar-20	8:00 AM ET	Unlimited QE, new corporate/MBS/TALF/Main Street facilities	Collins & Gagnon
1-Apr-20	4:45 PM ET	Exclude Treasuries/deposits from bank leverage ratios	Haddad et al. (2021)
9-Apr-20	8:30 AM ET	$500b muni facility, extend corporate/MBS/TALF and loans	Haddad et al. (2021)

Source: KVJ:BPEA refers to Krishnamurthy and Vissing-Jorgensen (2012a). The other sources mentioned above are Federal Reserve Bank of New York (2023), Collins and Gagnon (2020) and Haddad, Moreira, and Muir (2021).

C Properties of the F1 and F2 shocks

C.1 Futures Price Variations & CTD Yield Changes Treasury futures contracts settle on the cheapest-to-deliver (CTD) bond within the delivery basket, adjusted by its conversion factor. A variation in the futures price consequently reflects a change in the implied value of the CTD bond. By contrast, the yield of the underlying CTD encompasses duration risk and yield curve exposure.

Relying on changes in futures prices for identification may theoretically skew the assessment of shocks. The sensitivity of the futures price to changes in the CTD yield depends on the CTD's duration, which fluctuates over time and across contracts. Changes in the CTD or its conversion factor can result in shifts in the dollar value of a basis point (DV01). Neglecting these shifts may result in shocks that are not entirely comparable over time or across maturities.

The link between futures price and yield changes can be formalized via the CTD's basis point value (BPV, also known as DV01):

$$\Delta\text{yield}_t^k = -\frac{\Delta P_t^k}{\text{BPV\_CTD}_t^k},$$

where ΔP_t^k is the time-t change in k-year futures price (in points), and BPV_CTD_t^k is the change in price (in points) associated with a 1 basis point change in the corresponding CTD yield. For example, suppose the CTD 10-year Treasury security has a BPV of 0.22 points per basis point. Then a 10-year futures price decline of 1.1 points ($\approx 1\%$ at a price of 110) corresponds to a yield increase of $-1.10/0.22 = 5$ basis points. This calculation scales intraday futures price moves into yield changes that are directly comparable across contracts and over time.

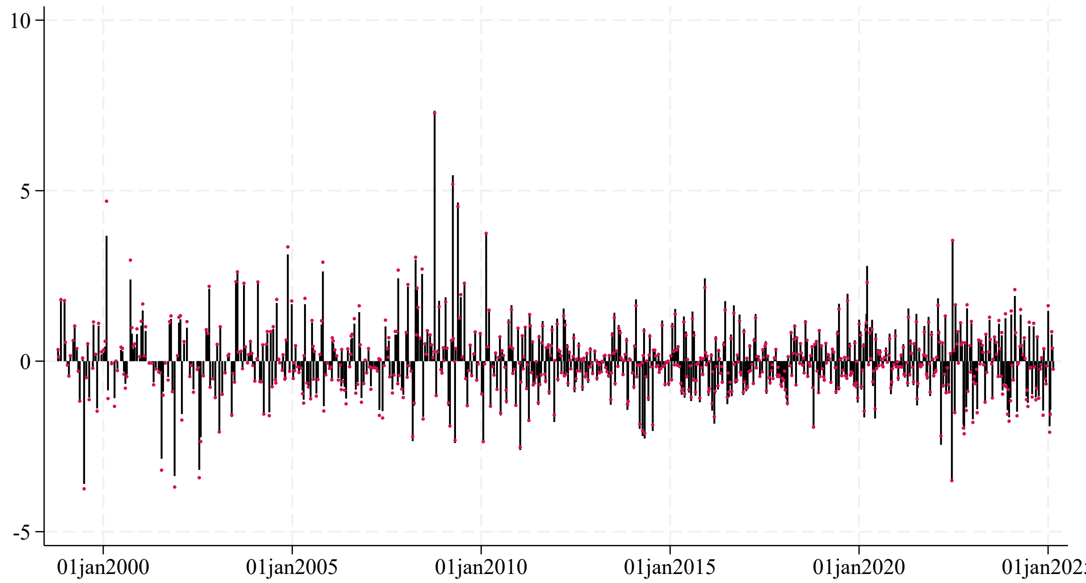
We obtain from Bloomberg daily CTD BPVs for the 2-, 5-, 10-, and 30-year Treasury futures, starting in 2004. To extend the series back to 1998, the beginning of our sample, we regress these daily BPV values on daily settlement prices and employ the fitted values to extrapolate backwards. The intuition is that both BPV and settlement price are driven by the CTD's duration, allowing us to approximate BPV for earlier years. Using this extrapolated series, we re-scale the 30-minute futures price returns around Treasury auction announcements into yield changes of the CTD. We then re-estimate the two-factor model with an otherwise identical methodology.

Figure C8 compares the baseline factors (based on price changes) with the adjusted factors (based on yield changes). All factors overlap almost exactly: divergences are small and limited to certain periods, and are unlikely to materially affect the results of the paper. Quantitatively, the factor loadings are nearly identical across specifications, and the correlations between the baseline and adjusted factors are virtually 1. These results confirm that using futures price changes as a proxy for yield changes is valid in practice.

C.2 Factor Number Selection To determine the number of latent Treasury supply shocks underlying high-frequency futures price changes, we apply the Cragg and Donald (1997) minimum-distance rank test. This test assesses whether the symmetric matrix of average Treasury futures

Figure C8: Shock Robustness to Converting Futures Price Changes into CTD Yield Changes

a. F_1



b. F_2

price reactions, denoted $\hat{A} = X'X/T$, can be approximated by a matrix of rank less than or equal to r_0, where X is the matrix of surprises across T announcements and N futures. The null hypothesis $H_0 : \text{rank}(\hat{A}) \leq r_0$ is tested against the alternative $H_1 : \text{rank}(\hat{A}) > r_0$ using a minimum-distance statistic constructed as the quadratic form:

$$\text{MD}_{r_0} = T \cdot \left(\text{vech}(\hat{A}) - \text{vech}(A_{r_0})\right)' \hat{V}^{-1} \left(\text{vech}(\hat{A}) - \text{vech}(A_{r_0})\right)$$

where A_{r_0} is the best rank-r_0 approximation to $\hat{A}$, obtained via truncated singular value decomposition, and $\hat{V}$ is the estimated asymptotic variance-covariance matrix of $\text{vech}(\hat{A})$. The test statistic follows a χ^2 distribution with degrees of freedom given by $\frac{(N-r_0)(N-r_0+1)}{2} - N$. We implement the test using an analytical (plug-in) estimator of $\hat{V}$ derived from the sample distribution of $x_t x_t'$, where x_t denotes the cross-section of futures price change on announcement t.

Table C4: Cragg–Donald Rank Test Results

Rank r_0	**Statistic**	**DF**	p**-value**	**Decision**
0	266.64	6	0.0000	Reject H_0
1	216.99	2	0.0000	Reject H_0
2	205.93	–	–	Not testable
3	145.97	–	–	Not testable

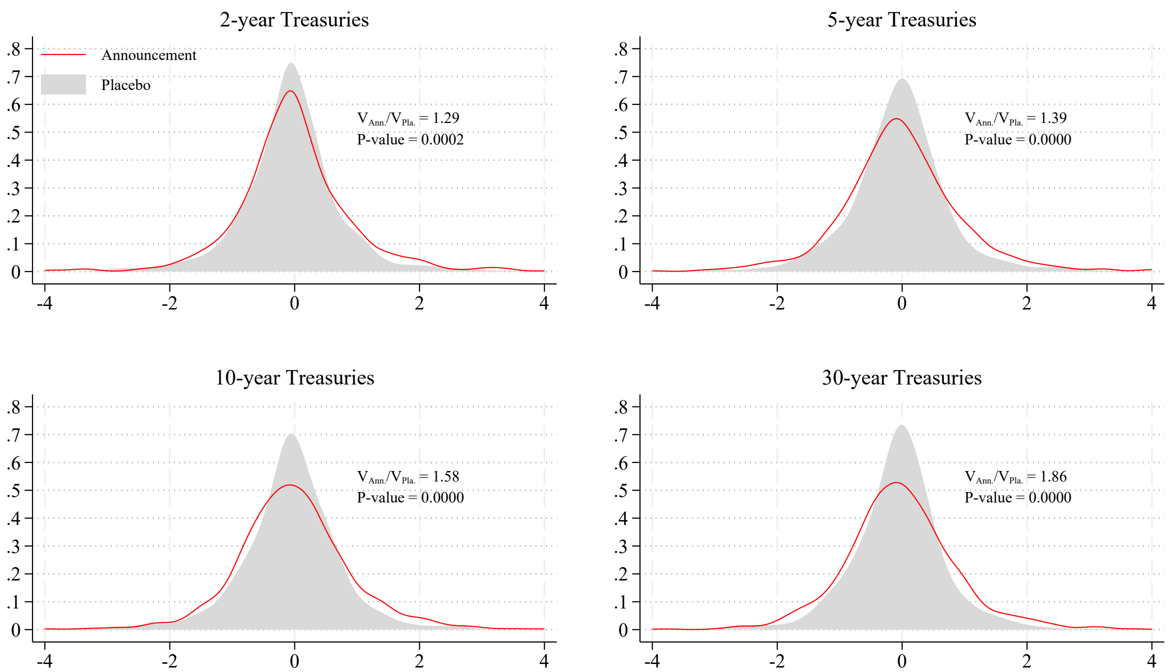
The results displayed in Table C4 indicate that the null hypothesis of one or fewer latent factors can be rejected at conventional significance levels. Specifically, the test rejects $H_0 : \text{rank}(\hat{A}) \leq 0$ and $H_0 : \text{rank}(\hat{A}) \leq 1$, suggesting that at least two underlying Treasury supply shocks are necessary to explain the systematic variation in Treasury futures price movements on announcement days. Tests for higher ranks ($r_0 = 2$ and $r_0 = 3$) are not identified, as the associated degrees of freedom are negative. We therefore conclude that two factors sufficiently capture Treasury supply shocks in our data.

C.3 Placebo Tests Following Känzig (2021) and Phillot (2025), we conduct a placebo exercise to gauge the extent of noise in our Treasury supply shocks. We draw a random set of business days that exclude the actual Treasury announcement days, and the number of placebo days is the same as the number of actual announcement events. For each placebo date, we compute the Treasury futures return within 30 minutes around a "benchmark" time that is fixed to 11:00 am CST, as it is relatively quiet without major data release and FOMC statements.

Figure C9 compares the empirical probability density functions of the placebo returns (gray shaded areas) to the density functions of the announcement returns in our sample (red lines). Our supply shock series are more volatile and capture more occurrences of rare events than the placebo set. We test whether variances on announcement days exceeds those on placebo days, and the corresponding variance ratios as well as the $p-$values are shown for each maturity. We can reject the null hypothesis of equal variance at conventional levels for all maturities.

Arguably, Treasury supply announcements might differ from placebo events not just in terms of dispersion, but also in other ways, such as how concentrated they are around zero, how thick the tails are, and the presence of rare events. To this end, we perform two-sample Kolmogorov–Smirnov (KS) tests on the absolute values of intraday shocks, comparing announcement days with

Figure C9: Treasury Supply Shocks Probability Density Functions



placebo days. The KS statistic tests the null hypothesis that the two samples come from the same underlying distribution by measuring the maximum distance between their empirical CDFs.

The results are shown in Figure C10. The figure overlays kernel density estimates of *absolute* shocks for announcement and placebo days across maturities. It also reports the KS statistics and p-values. The KS test rejects equality of the distributions in all cases. The statistics are constantly negative, which means that placebo shocks are more likely to happen near zero, while announcement shocks have thicker tails and a higher incidence of large price movements. These results support the idea that Treasury supply announcements provide information to markets beyond regular noise.

The distributional perspective of KS tests is especially helpful when we divide the sample into Quarterly Refunding Statements (QRS) and non-QRS announcements. Important insights into the future trajectory of government debt issuance may be predominantly found in QRS, whereas non-QRS announcements may be perceived as procedural. The KS framework enables us to evaluate whether the entire shock distribution (rather than only its variance) exhibits systematic differences from placebo events. This is particularly relevant if informational impacts manifest through infrequent yet significant occurrences, which may apply to QRS announcements.

Figure C11 presents the KS tests conducted for QRS (Panel A) and non-QRS (Panel B) Treasury supply announcements, respectively. The null hypothesis is rejected at conventional levels in both subsamples and across all maturities: Treasury supply releases give information about both QRS dates and non-QRS dates. The difference in distributions is clearer with QRS announcements, as

Figure C10: Distribution of Absolute Treasury Supply Shocks

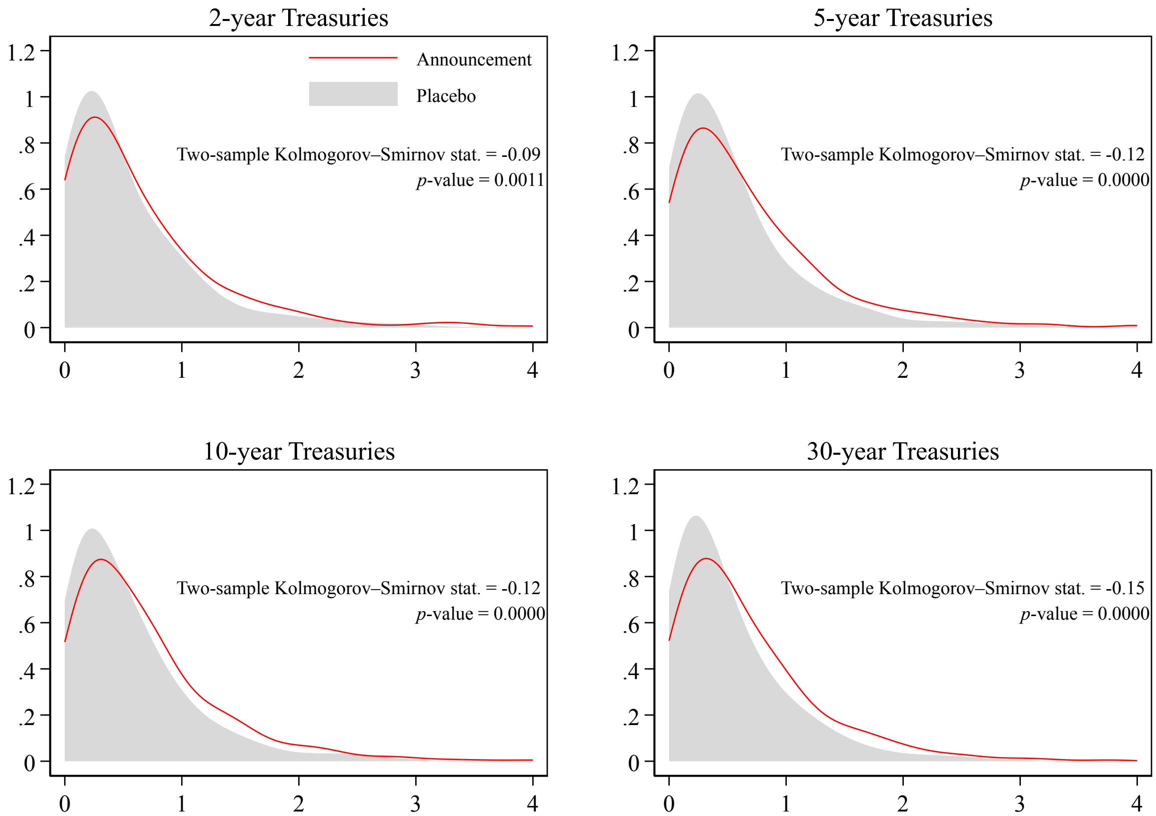
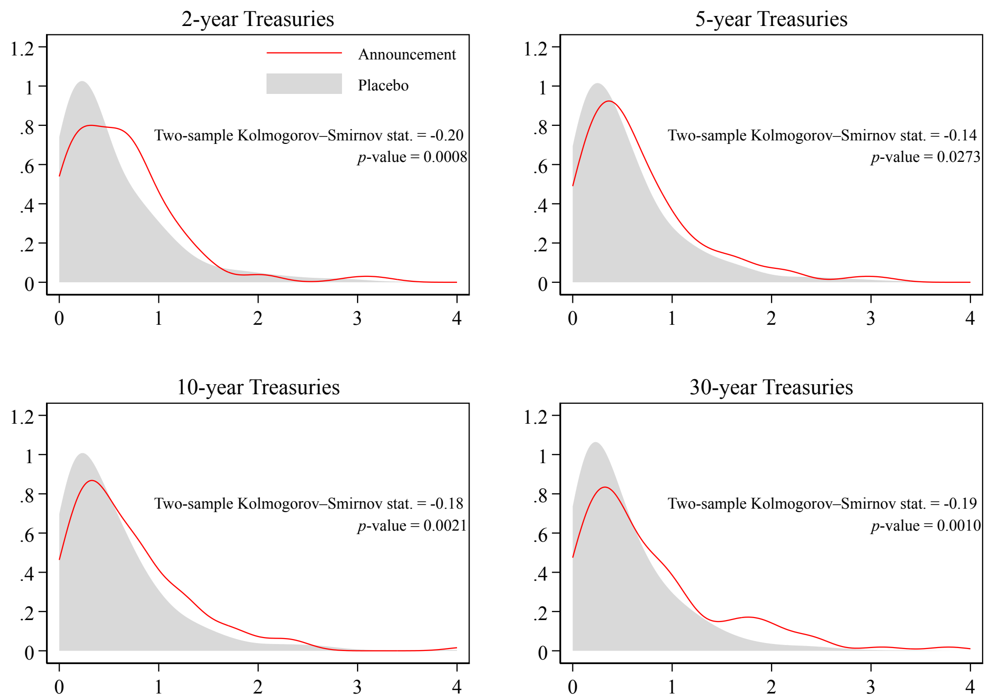


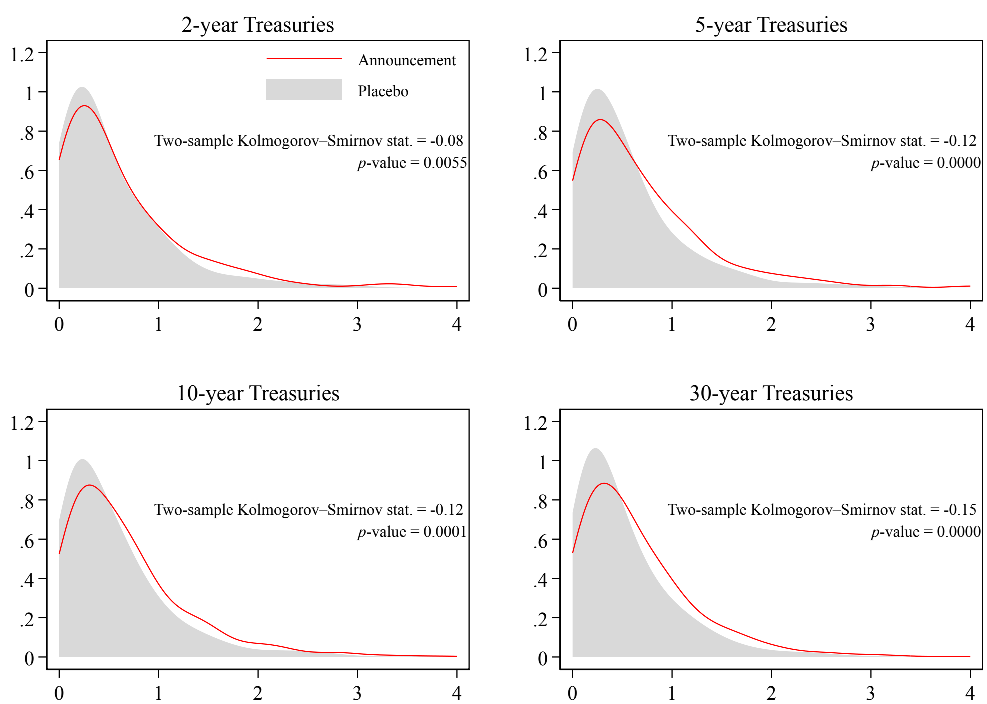
Figure C11 shows that QRS dates have larger tails and a greater number of big absolute price changes than placebo events.

Figure C11: Distribution of Absolute Treasury Supply Shocks: QRS vs. non QRS

Panel A: Quarterly Refunding Statements



Panel B: Other Treasury Announcements



C.4 Granger Causality Tests We conduct Granger causality test for whether a set of financial variables have predictive power for our Treasury supply shocks, in a regression with lags of policy shocks and time fixed effects. Table C5 collects the p-values for the test that the row variable Granger-cause the column shock. The results support the lead-lag exogeneity assumption, as we can reject the null hypothesis at the 95% level in almost all cases. Note, this is done with daily data, with lag length of 5.

Table C5: Granger causality results

	F1	F2
1 year rate	0.25	0.60
2 year rate	0.72	0.58
5 year rate	0.90	0.46
10 year rate	0.98	0.44
30 year rate	0.99	0.36
2 year term premium	0.98	0.55
5 year term premium	0.97	0.59
10 year term premium	0.94	0.65
Moody's AAA yield	0.96	0.87
Moody's BAA yield	0.90	0.40
5 year breakeven inflation	0.65	0.11
10 year breakeven inflation	0.47	0.19
S&P 500	0.80	0.23
NASDAQ Composite Index	0.86	0.30
VIX	0.84	0.37

Note: Each cell displays the p-values for the test that the row variable Granger-causes the column shock.

C.5 Correlations with Other Structural Shocks We consider the contemporaneous correlation of both F1 and F2 surprises with other structural shocks identified in the literature that might be related, including high frequency monetary policy shocks capturing surprises to the federal funds rates, forward guidance and LSAPs from Swanson (2023) and shocks to Treasury demand from Ray, Droste, and Gorodnichenko (2024), who capture the intraday change in Treasury yields before and after the close of a Treasury auction. In Table C6, we find no significant correlation with these shocks at both daily and monthly frequencies.

C.6 Autocorrelation of the Shock series We consider the autocorrelation of both F1 and F2 shocks, shown in Figure C12. There is no evidence of significant autocorrelation, except at lag 14 for F1 shock, and at lags 9 and 14 for F2 shock.

C.7 Distribution of F_1 and F_2 In Figure C13, we plot the distribution of Treasury supply shocks by separating QRS and non-QRS dates. Larger shocks, in particular for F_2, tend to coincide with QRS announcements. Given the report and press conference, the QRS provides a venue for

Table C6: **Correlation with other shock measures from the literature**

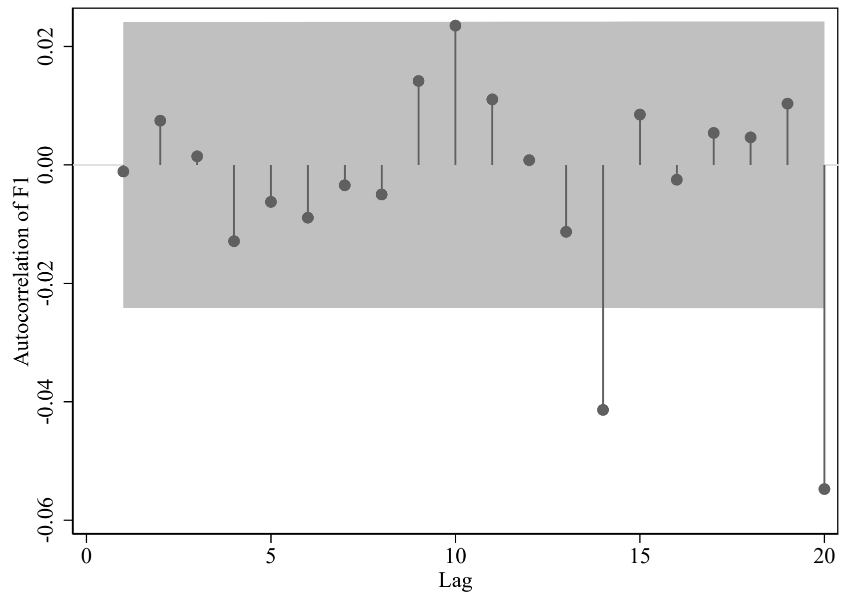
	FFR shock	**FG shock**	**-LSAP shock**	**Treasury demand**
		Panel A: daily frequency		
F1	-0.044 (0.000)	0.057 (0.000)	0.020 (0.108)	-0.008 (0.572)
F2	-0.018 (0.161)	-0.003 (0.841)	-0.011 (0.387)	-0.020 (0.163)
Sample	Oct 1998- Dec 2023	Oct 1998- Dec 2023	Oct 1998- Dec 2023	Oct1998 - Dec 2017
		Panel B: monthly frequency		
F1	-0.165 (0.003)	0.105 (0.063)	0.041 (0.468)	-0.058 (0.301)
F2	-0.069 (0.219)	-0.071 (0.206)	0.082 (0.144)	0.075 (0.181)
Sample	Oct 1998- Dec 2023	Oct 1998- Dec 2023	Oct 1998- Dec 2023	Oct1998 - Dec 2017

Note: The shocks refer to the federal funds rate (FFR), forward guidance (FG), and large-scale asset purchase (LSAP) shocks from Swanson (2023). Eric Swanson kindly provided the data. Treasury demand shocks are from Ray, Droste, and Gorodnichenko (2024), and capture the intraday change in Treasury yields before and after the close of an auction. Sample period is based on overlapping data available for the two series under consideration. Each entry reports the pairwise correlation coefficient. Numbers in parentheses denote p-values from a test of the null hypothesis of zero correlation.

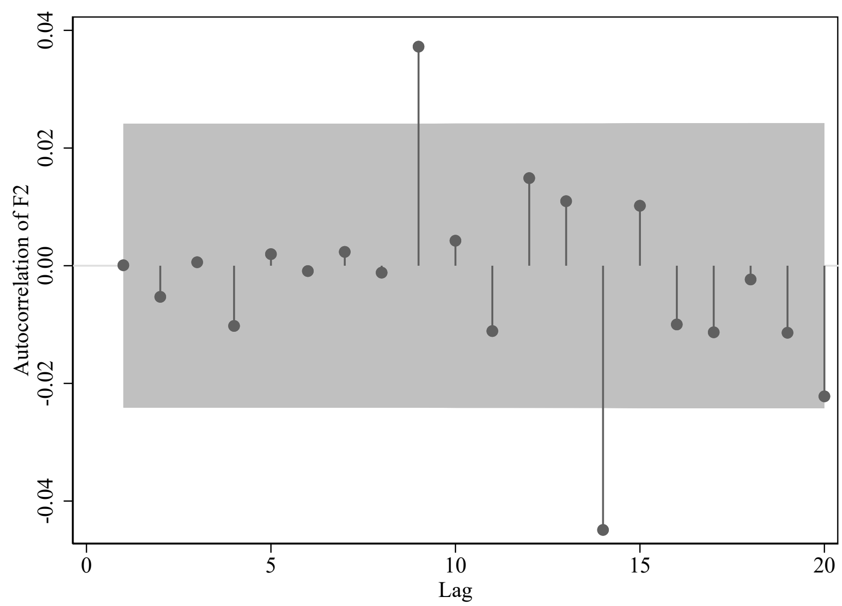
the Treasury to communicate the issuance strategy and is likely to contain richer information. In addition, Figure C14 split the distributions based on the debt-GDP growth. The two sets of distributions overlap with each other, suggesting no systematic differences in issuance surprises.

Figure C12: Autocorrelation of the Shock Series

Autocorrelation of Debt Expansion Shocks, F1



Autocorrelation of Maturity Adjustment Shocks, F2



Note: The figure shocks the autocorrelation of the daily shock series for the two types of Treasury supply shocks, with corresponding 95% confidence bands.

Figure C13: Conditional Distribution of F_1 and F_2: QRS (red) vs. non QRS (blue)

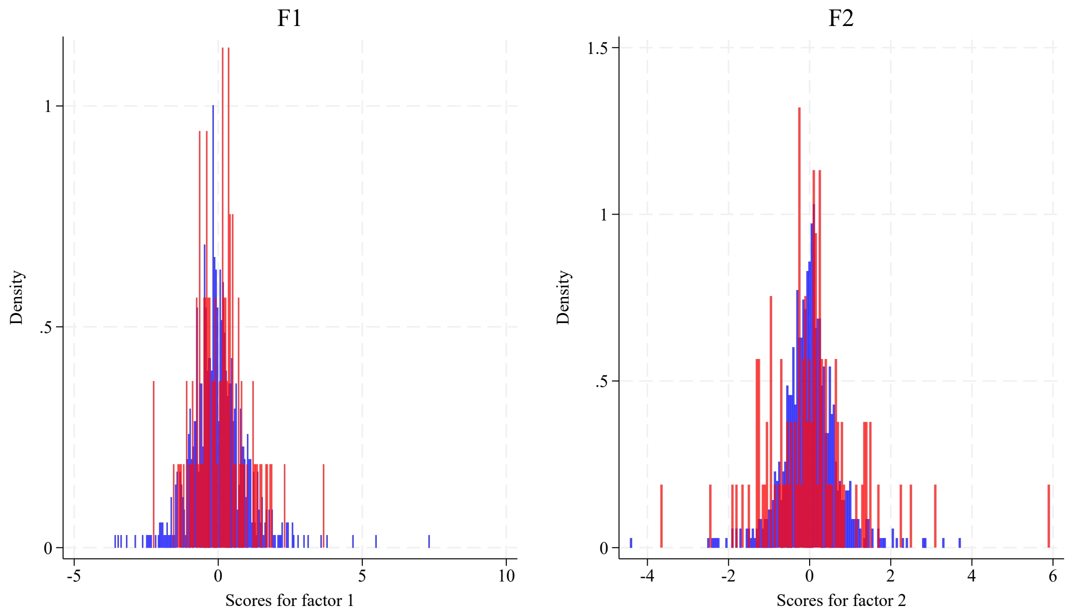
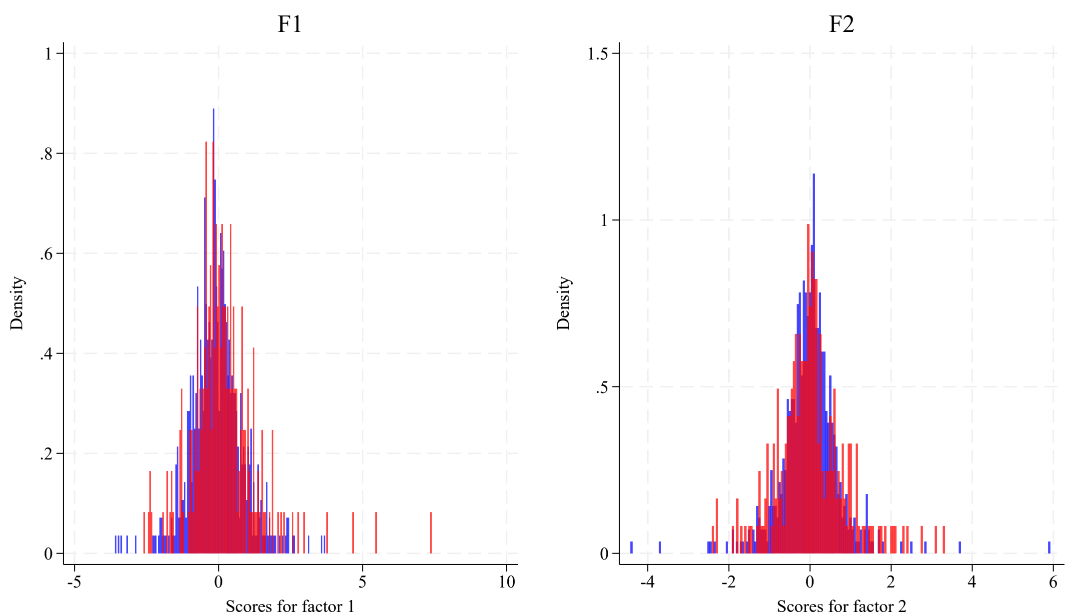


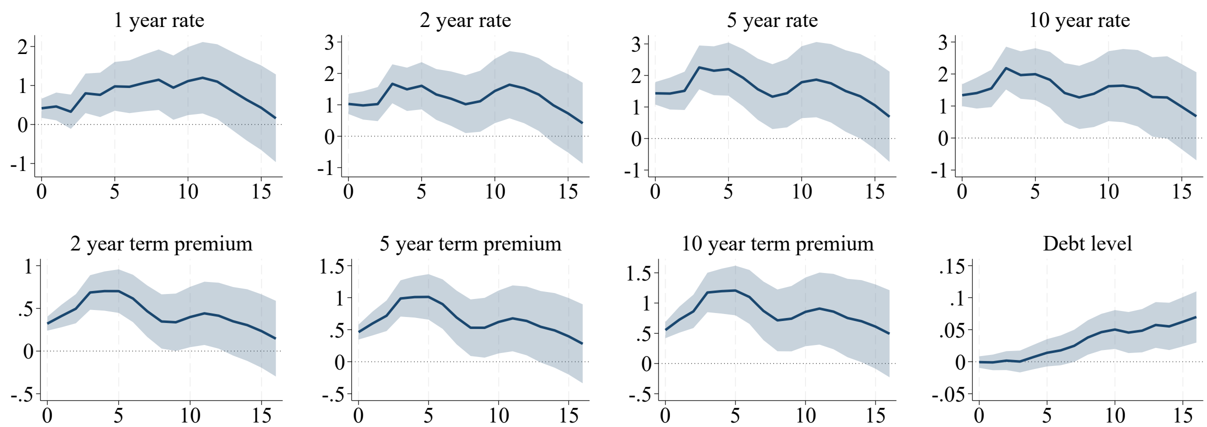
Figure C14: Conditional Distribution of F_1 and F_2: High-debt (red) vs. Low-debt (blue)



D Additional Impulse Responses

D.1 Daily Responses to F_1 Figure 6 shows that a debt volume expansion shock leads to a gradual but sustained increase in the level of government debt. The initial muted response is consistent with the fact that Treasury announcements are usually made days before the auctions. With a higher supply, Treasury yields increase across all maturities, leading to an upward shift in the yield curve. In addition, higher than expected debt issuance puts upward pressure on the Treasury market, and investors demand a higher term premium for compensation.

Figure D15: IRFs to a Debt Expansion Shock (F_1): daily frequency

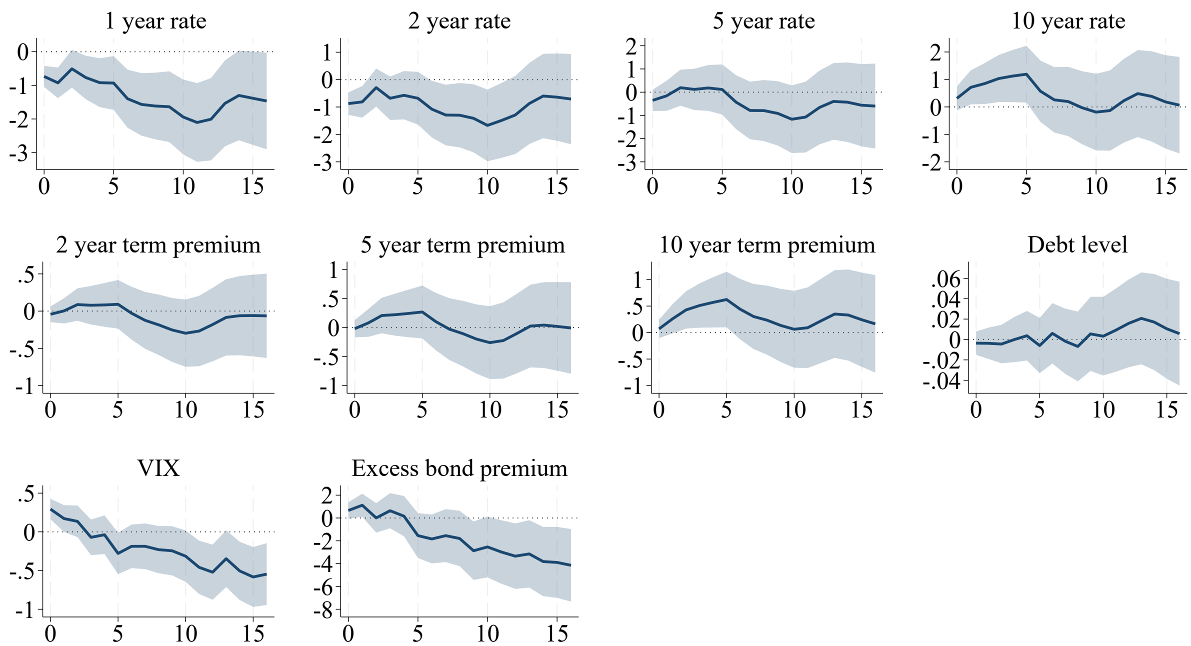


Note: The x-axis shows business days after the shock hits. The y-axis gives the response in terms of basis points for the yields, term-premia and spreads. 90% confidence bands are shown for all IRFs.

D.2 Daily Responses to F_2 Figure D16 shows the average responses of financial markets to a maturity extension shock of one standard deviation. A lower bill supply reduces 1-year Treasury yield by 2 to 3 basis points, while a higher bond supply raises 30-year yield by about 2 basis points. The steepening yield curve reflects Treasury issuance unexpectedly shifting from the short to the long end. Following the announcement, term premium rises for 10-year Treasury, while the response is largely muted for 2-year notes. In addition, the response of debt level is also muted, as F_2 shock captures a lengthening in the issuance maturity rather than an increase in the issuance volume.

Turning to corporate bonds, the spread between BAA and AAA bonds declines, reflecting lower credit risk in the financial market. The easing credit conditions are consistent with the safe asset channel (see Krishnamurthy and Vissing-Jorgensen (2012b)). Our result indicates that the safety attribute may be particularly relevant for longer-term Treasury securities, as the relative abundance of long-term safe assets helps to reduce corporate credit risk. Similarly, VIX declines in the days following the shock, consistent with a risk-on sentiment. Here both the safety channel as well as the signaling channel may be at play. Since Treasury coupons are a better hedge against future economic and fiscal shocks than bills, shifting issuance from the short to the long end may reduce

Figure D16: IRFs to a Maturity Extension Shock (F_2): Daily Frequency



Note: The x-axis shows business days after the shock hits. The y-axis gives the response in terms of basis points for the yields, term-premia and spreads. 90% confidence bands are shown for all IRFs.

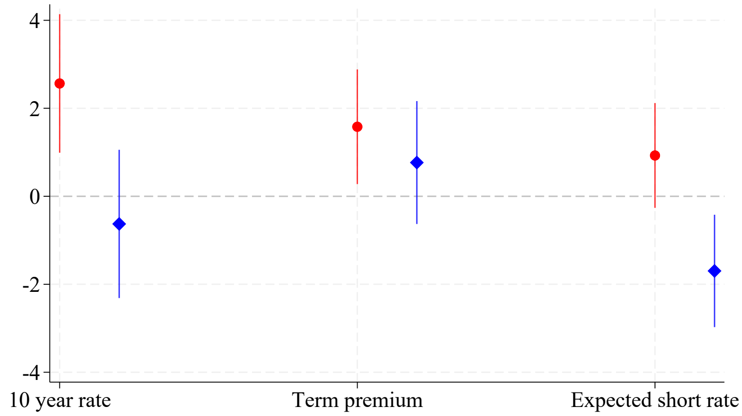
credit and volatility risk.

Using a range of liquidity measures, Figure D18 highlights that a maturity extension shock raises liquidity premia at the short end while reducing it at the long end. The first five panels show the response of spreads between Refcorp bonds and Treasury securities, following Longstaff (2004). We see an increase for 3-month and 1-year securities shortly after the announcement, as lower issuance at the short end raises Treasury liquidity premium. But they decline for 10-year and 15-year securities as issuance at the long end increases. Convenience yields constructed as covered interest parity (CIP) deviations such as in Du, Im, and Schreger (2018) increase for 3-month and 1-year securities while declining for 10-year bonds. Swap spreads, capturing the difference between OIS rates and zero-coupon Treasury yields of a given maturity, are also lower at the long end.

D.3 Monthly Responses to F_2 Figure D19 provides additional IRFs to a maturity adjustment shock. Long-term bonds as a share of total market debt increases steadily following a positive F_2 shock. Consistent with the response of excess bond premia, the spread between BAA and AAA spread also declines, reflecting easing credit constraint in the corporate bond market. Private consumption follows a similar dynamics as industry production.

D.4 Monthly Responses: QRS vs. non-QRS Figure D20 shows the responses to the two types of Treasury supply shocks, based on whether they coincide with the QRS announcement or

Figure D17: Yield Decomposition to a Maturity Adjustment Shock (F_2): daily



Note: Response of the 10 year Treasury rate, and based on the model of Christensen and Rudebusch (2012), the 10 year fitted term premium and 10 year ahead expected short rate, all in terms of basis points. Red whiskers show the responses under maturity extension shocks, while blue whiskers under maturity compression shocks. The y-axis is in basis points.

not.

D.5 Zero Lower Bound Periods There is a vast literature on the interaction between fiscal and monetary policy. One natural question is whether the prevailing stance of monetary policy has consequences for the propagation of Treasury supply shocks. Notably, during the time frame we consider in our analysis, monetary policy was subject to the zero lower bound. We now consider Equation 6.1 and define I_t to take a value of 1 when the economy was subject to ZLB.[45]

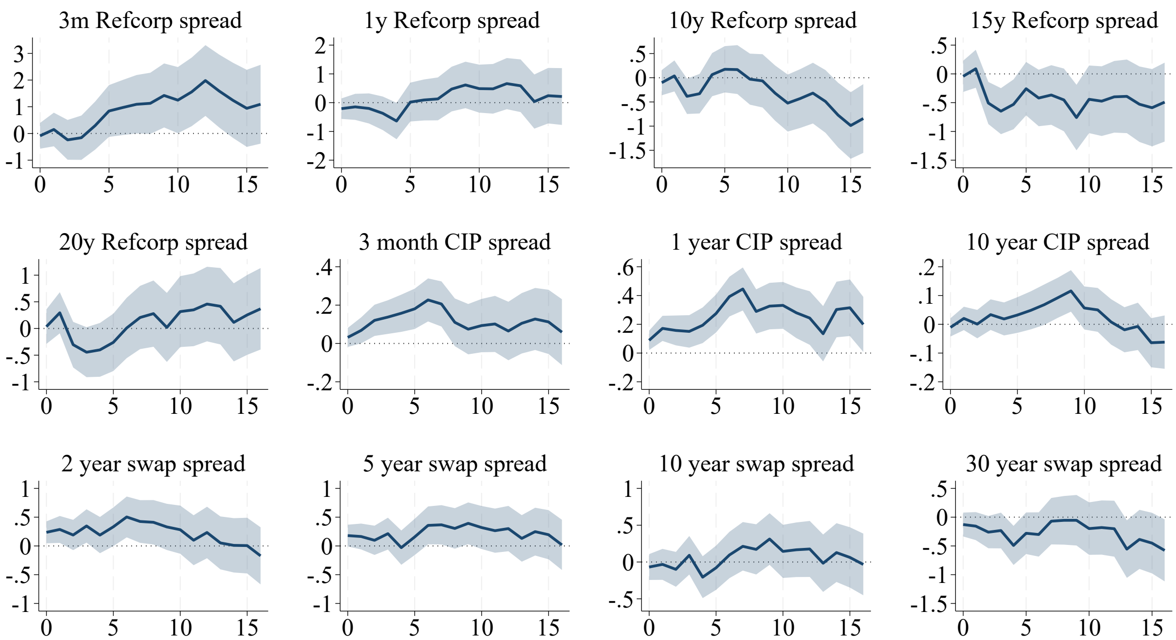
Panel (a) of Figure D21 shows the responses from the daily regressions. We see that during ZLB periods (red solid), the short-term yields do not respond but rise for longer maturities particularly on impact. In non-ZLB periods, conversely, we see a rise in yields across all maturities, which is statistically significantly positive. We also see a fall in the convenience yield given by the AAA-10Y spread during ZLB periods, while it is flat outside of ZLB periods. Importantly, the safe asset channel is more pronounced during the ZLB periods, as the BAA-AAA spread increases less and even start to decline after 10 days.

When we consider responses of macroeconomic variables at the monthly frequency, we find significant differences across the two periods. A debt expansion shock leads to a notable decline in excess bond premia and a rise in industrial production, while it has the opposite impact outside of the ZLB period.[46] The crowding-out of consumption is also muted during ZLB. This positive impact on private economic activity is consistent with the findings in the literature that consider fiscal multipliers at the ZLB (see, for instance, Christiano, Eichenbaum, and Rebelo (2011) for a theoretical framework and Ramey and Zubairy (2018) for empirical evidence). At the ZLB, theory

[45] These periods are defined as from January 1, 2009 to November 30, 2015 and from March 15, 2020 to March 15, 2022.

[46] A debt expansion shock also increases equipment spending during the ZLB period.

Figure D18: IRFs to a Maturity Extension Shock (F_2): Liquidity Measures

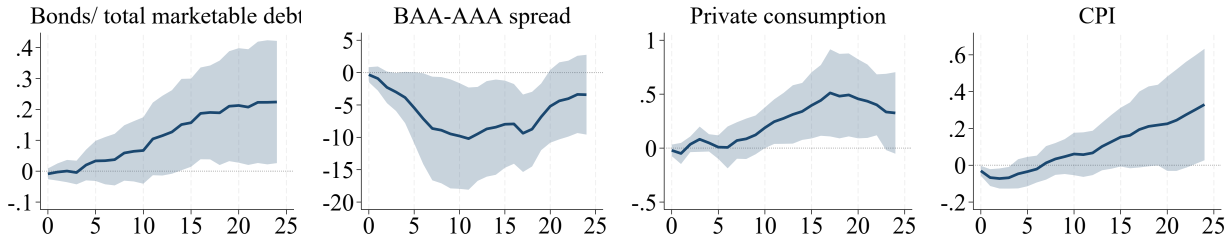


Note: The x-axis shows business days after the shock hits. The y-axis gives the response in terms of basis points for the yields, term-premia and spreads. 90% confidence bands are shown for all IRFs.

suggests that since short rates do not respond, then the real interest rate do not rise as much or even fall, and thus lead to a rise in private activity. Here we find that the expansionary impact from the safe asset channel is also stronger during the ZLB periods. On the other hand, we observe a crowding-out of construction during the ZLB period, suggesting its sensitivity to long-term interest rates. This also aligns with the rise in 10-year Treasury yields to the debt expansion shock during ZLB.

For maturity extension shocks, at the daily level we see differences in the responses of yields: shorter maturity yields have a flat response during ZLB periods, and longer maturities tend to rise more. During non-ZLB periods, we see a fall in the short-term maturities and a rise in longer-term maturities, which is smaller than the ZLB periods. Thus, overall the slope of the yield curve seems to move to the same degree across ZLB and on-ZLB periods. At the macroeconomic level, we do not find significant differences in responses to a maturity extension shock across ZLB and non-ZLB periods, as the two competing channels are largely offset, as shown in Figure D22.

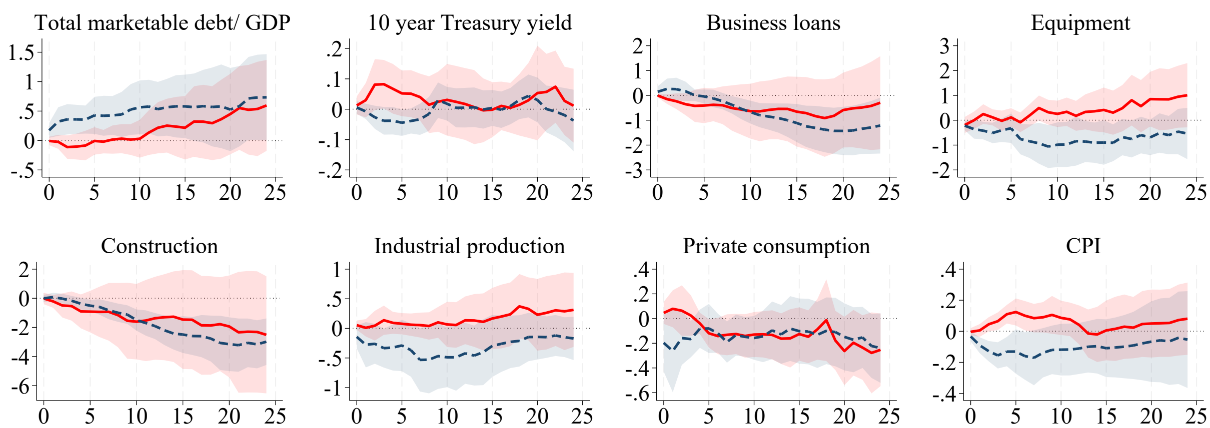
Figure D19: IRFs to a Maturity Shock (F_2): monthly frequency



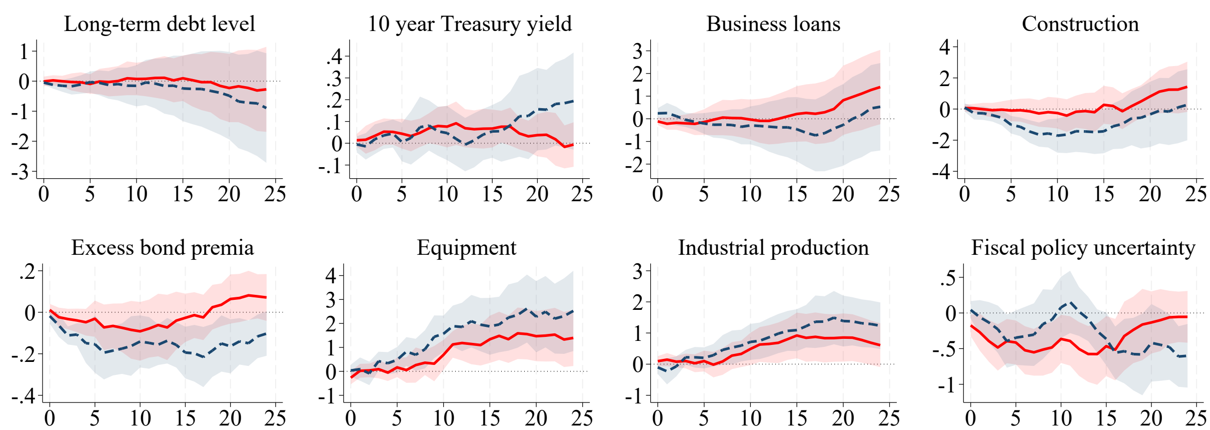
Note: The x-axis shows months after the shock hits. The y-axis gives the response in basis points for BAA-AAA spread, in percentage points for bonds/debt ratio, and in percent deviations for other variables. 90% confidence bands are shown for all IRFs.

Figure D20: IRFs to Treasury Supply Shocks: : QRS vs. non QRS dates

a. Debt Expansion Shock (F_1)



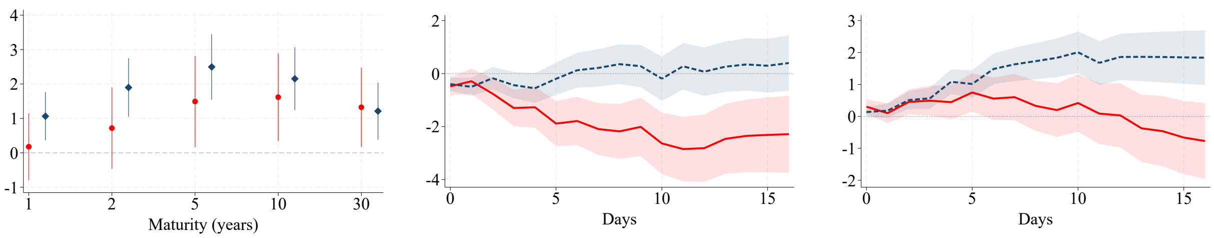
b. Maturity Extension Shock (F_2)



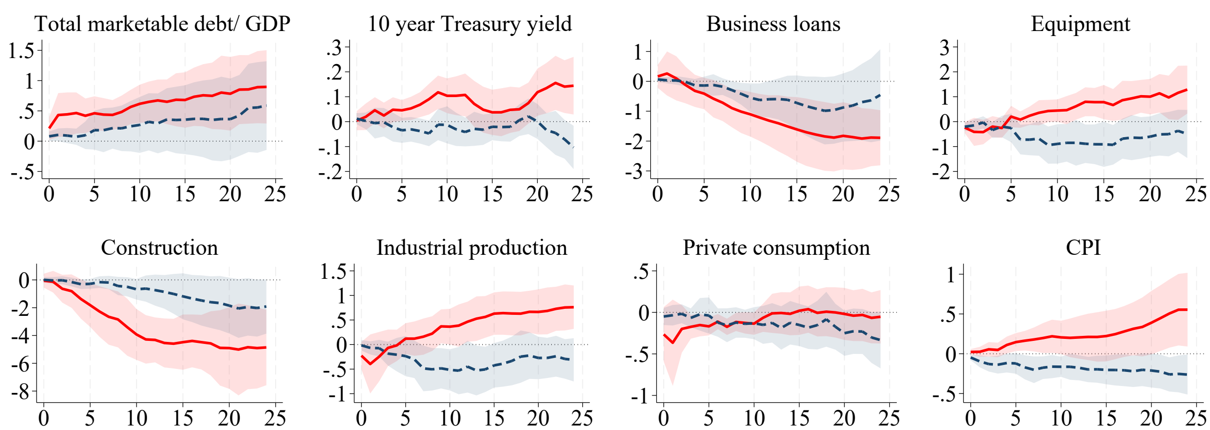
Note: The x-axis shows months after the shock hits. Red solid lines represent responses for debt expansion shocks that coincide with QRS, and dashed blue lines show responses for debt expansion shocks that do not coincide with QRS. 90% confidence bands are shown for all IRFs.

Figure D21: Responses to Debt Expansion Shock (F1): ZLB

a. Yields: daily **b. AAA-10y Spread: daily** **c. BAA-AAA Spread: daily**



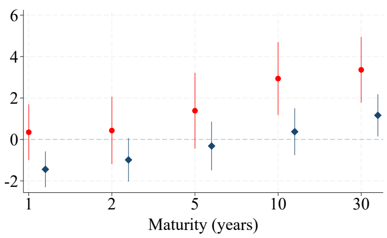
c. IRFs: monthly



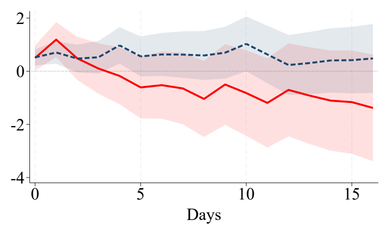
Note: Red dots/lines represent responses during ZLB periods, while blue dots/lines are outside of ZLB periods. 90% confidence bands are shown. (Top left) Responses of yields across maturities at day 4 following the shock with the x-axis showing maturities and the y axis in basis points. (Top middle/right) IRFs of AAA and 10-year Treasury spread as well as BAA and AAA corporate bond spreads with the x-axis showing days after the shock and the y axis in basis points. (Bottom) IRFs at monthly frequency with the x-axis showing months after the shock hits. The y-axis is in percentage points for debt-GDP ratio, basis points for yields, and percent deviations for the rest.

Figure D22: Responses to Debt Expansion Shock (F2): ZLB

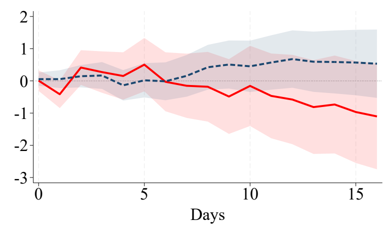
a. Yields: daily



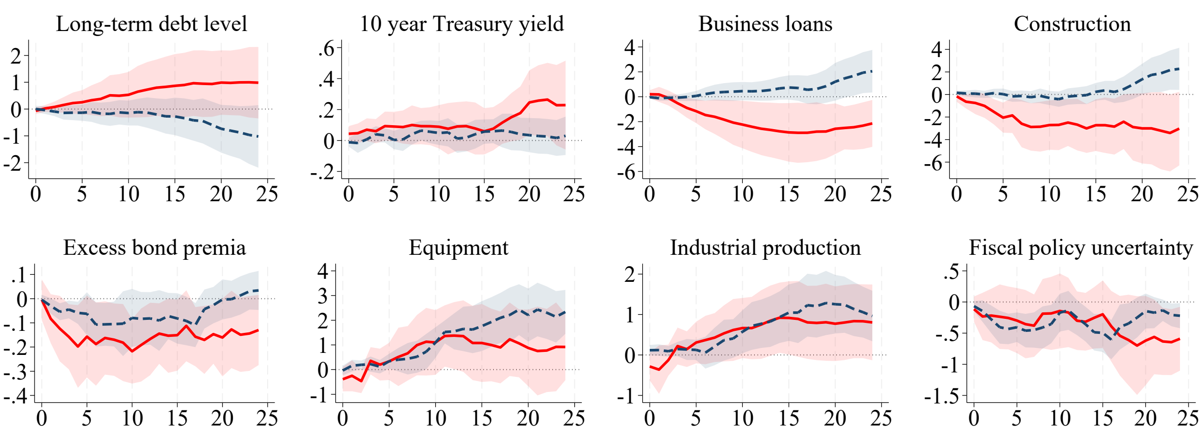
b. AAA-10y Spread: daily



c. BAA-AAA Spread: daily



c. IRFs: monthly



Note: Red dots/lines represent responses during ZLB periods, while blue dots/lines are outside of ZLB periods. 90% confidence bands are shown. (Top left) Responses of yields across maturities at day 4 following the shock with the x-axis showing maturities and the y axis in basis points. (Top middle/right) IRFs of AAA and 10-year Treasury spread as well as BAA and AAA corporate bond spreads with the x-axis showing days after the shock and the y axis in basis points. (Bottom) IRFs at monthly frequency with the x-axis showing months after the shock hits. The y-axis is in percentage points for debt-GDP ratio, yields, and excess bond premia, and percent deviations for the rest.

E Model Details

In this section, we extend the partial equilibrium framework in Vayanos and Vila (2021) to include risky corporate bonds in addition to Treasuries, similar to Ray, Droste, and Gorodnichenko (2024).

Affine Bond Prices and State Variables We have two types of assets, risk-free Treasury bonds and risky corporate bonds with zero coupons and maturity of $\tau \in (0, T)$. A τ-maturity risk-free bond has price $P_t^{(\tau)}$ and pays \$1 at maturity with certainty at period $t + \tau$. A risky τ-maturity bond has price $\tilde{P}_t^{(\tau)}$ and instead pays a stochastic value d_t in period $t + \tau$.

The economy is driven by three state variables: the short rate r_t, the supply factor s_t that captures variation in the net supply of Treasury bonds, and the stochastic payoff value d_t for risky bonds. These variables evolve according to Ornstein–Uhlenbeck processes,

$$
\begin{aligned}
ds_t &= -\kappa_s s_t \, dt + \sigma_s \, dB_{s,t}, \\
dr_t &= -\kappa_r (r_t - \bar{r}) \, dt + \sigma_r \, dB_{r,t}, \\
dd_t &= -\kappa_d (d_t - \bar{d}) \, dt + \sigma_d \, dB_{d,t}.
\end{aligned}
$$

where $B_{s,t}$, $B_{r,t}$ and $B_{d,t}$ are Brownian motions. We assume that $B_{r,t}$ is independent from other shocks, but $B_{d,t}$ can be correlated to $B_{s,t}$ with a correlation of ρ. Allowing payoff shocks to be correlated with supply shocks extends the baseline preferred-habitat framework and permits Treasury supply changes to affect risky bond returns through both duration and payoff channels.

If $\rho > 0$, then the Treasury supply factor is positively correlated with risky bond payoff factor; otherwise, they are negatively correlated. We consider a linear specification to link the supply factor to Treasury issuance across different maturities,

$$
S_t^{(\tau)} = \zeta(\tau) + \theta(\tau) s_t \tag{E.1}
$$

where $\theta(\tau)$ captures the maturity-specific impact of supply factor on Treasury issuance.

Following Vayanos and Vila (2021), the log prices of Treasury and corporate bonds are conjectured to take the form of affine functions of the state variables,

$$
\log P_t^{(\tau)} \equiv p_t^{(\tau)} = -\left[A_s(\tau) s_t + A_r(\tau)(r_t - \bar{r}) + C(\tau) \right] \tag{E.2}
$$

$$
\log \tilde{P}_t^{(\tau)} \equiv \tilde{p}_t^{(\tau)} = -\left[\tilde{A}_s(\tau) s_t + \tilde{A}_r(\tau)(r_t - \bar{r}) + \tilde{A}_d(\tau)(d_t - \bar{d}) + \tilde{C}(\tau) \right] \tag{E.3}
$$

where $A_i(\tau)$ and $\tilde{A}_i(\tau)$ are factor loadings that capture the sensitivity of bond prices to different risk shocks ($i \in \{s, r, d\}$), while $C(\tau)$ and $\tilde{C}(\tau)$ measure average compensations for bearing duration risk, term premium, and expected path of future short rates. These coefficients are determined endogenously in equilibrium.

Applying Ito's lemma, the instantaneous bond returns at time t are,

$$\frac{dP_t(\tau)}{P_t(\tau)} = \mu_t(\tau)\,dt - A_s(\tau)\sigma_s\,dB_{s,t} - A_r(\tau)\sigma_r\,dB_{r,t}, \tag{E.4}$$

$$\frac{d\tilde{P}_t(\tau)}{\tilde{P}_t(\tau)} = \tilde{\mu}_t(\tau)\,dt - \tilde{A}_s(\tau)\sigma_s\,dB_{s,t} - \tilde{A}_r(\tau)\sigma_r\,dB_{r,t} - \tilde{A}_d(\tau)\sigma_d\,dB_{d,t}. \tag{E.5}$$

where $\mu_t(\tau)$ and $\tilde{\mu}_t(\tau)$, the expected instantaneous returns, are functions of $A_i(\tau)$, $\tilde{A}_i(\tau)$, $C(\tau)$ and $\tilde{C}(\tau)$ $(i \in \{s, r, d\})$.[47]

Arbitrageurs Arbitrageurs choose portfolios of bonds across maturities in order to trade off expected returns against risk. Preferences are mean–variance over instantaneous wealth changes,

$$\max_{X_t^{(\tau)}, \tilde{X}_t^{(\tau)}} \; \mathbb{E}_t[dW_t] - \frac{a}{2}\mathrm{Var}_t(dW_t),$$

where $a > 0$ governs risk aversion. Let $X_t^{(\tau)}$ and $\tilde{X}_t^{(\tau)}$ denote arbitrageurs' holdings of Treasury and corporate bonds respectively. Their wealth evolves according to,

$$dW_t = W_t r_t\,dt + \int_0^T X_t^{(\tau)}\Big(\frac{dP_t^{(\tau)}}{P_t^{(\tau)}} - r_t\Big)d\tau + \int_0^T \tilde{X}_t^{(\tau)}\Big(\frac{d\tilde{P}_t^{(\tau)}}{\tilde{P}_t^{(\tau)}} - r_t\Big)d\tau.$$

The first-order conditions imply that expected excess returns depend on factor loadings of risk factors, $A_i(\tau)$ and $\tilde{A}_i(\tau)$, as well as common market prices of risk, $\lambda_{i,t}$.

$$\mu_t^{(\tau)} - r_t = \lambda_{s,t}A_s(\tau) + \lambda_{r,t}A_r(\tau) \tag{E.6}$$

$$\tilde{\mu}_t^{(\tau)} - r_t = \lambda_{s,t}\tilde{A}_s(\tau) + \lambda_{r,t}\tilde{A}_r(\tau) + \lambda_{d,t}\tilde{A}_d(\tau) \tag{E.7}$$

The market prices of risk reflect the covariance structure of shocks and the exposure of arbitrageurs' portfolio to each factor:

$$\lambda_{r,t} \equiv a\sigma_r \int_0^T \Big(X_t^{(\tau)}A_r(\tau) + \tilde{X}_t^{(\tau)}\tilde{A}_r(\tau)\Big)\,d\tau,$$

$$\begin{bmatrix}\lambda_{s,t}\\ \lambda_{d,t}\end{bmatrix} \equiv a\begin{bmatrix}1 & \rho\\ \rho & 1\end{bmatrix}\begin{bmatrix}\sigma_s\int_0^T \Big(X_t^{(\tau)}A_s(\tau) + \tilde{X}_t^{(\tau)}\tilde{A}_s(\tau)\Big)\,d\tau\\ \sigma_d\int_0^T \tilde{X}_t^{(\tau)}\tilde{A}_d(\tau)\,d\tau\end{bmatrix}.$$

[47]Specifically, $\mu_t(\tau)$ and $\tilde{\mu}_t(\tau)$ are,

$$\mu_t^{(\tau)} = A_r'(\tau)(r_t - \bar{r}) + A_s'(\tau)s_t + C'(\tau) + \kappa_r A_r(\tau)(r_t - \bar{r}) + \kappa_s A_s(\tau)s_t + \frac{1}{2}\Big(\sigma_r^2 A_r(\tau)^2 + \sigma_s^2 A_s(\tau)^2\Big),$$

$$\tilde{\mu}_t^{(\tau)} = \tilde{A}_r'(\tau)(r_t - \bar{r}) + \tilde{A}_s'(\tau)s_t + \tilde{A}_d'(\tau)(d_t - \bar{d}) + \tilde{C}'(\tau) + \kappa_r\tilde{A}_r(\tau)(r_t - \bar{r}) + \kappa_s\tilde{A}_s(\tau)s_t + \kappa_d\tilde{A}_d(\tau)(d_t - \bar{d}) + \frac{1}{2}\Big(\sigma_r^2\tilde{A}_r(\tau)^2 + \sigma_s^2\tilde{A}_s(\tau)^2 + \sigma_d^2\tilde{A}_d(\tau)^2 + 2\rho\,\sigma_s\sigma_d\,\tilde{A}_s(\tau)\tilde{A}_d(\tau)\Big).$$

The market prices of risk are proportional to arbitrageurs' risk aversion, shock variances, and the sensitivity of arbitrageurs' bond portfolio to different risk factors. The covariance matrix captures the potential correlation between supply shocks and risky payoff shocks.

Model Discussion We assume that arbitrageurs need to absorb bond issuance, and the market-clearing conditions lead to the following:

$$X_t^{(\tau)} = \zeta(\tau) + \theta(\tau)s_t, \qquad \tilde{X}_t^{(\tau)} = \tilde{\zeta}(\tau) + \tilde{\theta}(\tau)s_t,$$

where $\tilde{\theta}(\tau)$ captures the impact of Treasury supply to corporate bond issuance, under our assumption that corporate supply responds to Treasury supply. If it is negative/positive, then Treasury issuance crowds out/in corporate bond issuance. After applying the market-clearing conditions, the equilibrium prices of factor risk are affine in the supply factor s_t:

$$\lambda_{i,t} = \lambda_{is}\, s_t + \lambda_i, \qquad i \in \{r, s, d\}.$$

where λ coefficients are functions of model parameters as well as factor loadings.

Following Vayanos and Vila (2021), factor loadings and common market price of risk are solved according to a series of fixed-point conditions.

1. The short-rate loadings are the same for both risk-free and risky bonds:

$$A_r(\tau) = \tilde{A}_r(\tau) = \frac{1 - e^{-\kappa_r \tau}}{\kappa_r} > 0.$$

2. The risky bond payoff loading applies to risky bonds:

$$\tilde{A}_d(\tau) = -e^{-\kappa_d \tau} < 0.$$

3. The supply factor loading for the risk-free bond family is:

$$A_s(\tau) = \frac{\lambda_{rs}}{\kappa_r - \kappa_s^*} \left(\frac{1 - e^{-\kappa_s^* \tau}}{\kappa_s^*} - \frac{1 - e^{-\kappa_r \tau}}{\kappa_r} \right).$$

   where $\kappa_s^* \equiv \kappa_s - \sigma_s \lambda_{ss}$ can be interpreted as the mean-reversion rate of the supply factor under the risk-neutral measure. It depends on the physical persistence and the equilibrium price of supply risk.[48]

[48] This parameter determines how persistent supply shocks are from the perspective of asset pricing, and therefore plays a key role in shaping the response of yields across maturities. A more persistent supply shock corresponds to a smaller value of κ_s^*, implying that supply shocks have longer-lasting effects under the risk-neutral measure. When κ_s^* is small, long-maturity yields respond more strongly because they are more exposed to long-horizon risk.

4. The supply factor loading for risky bonds is:

$$\tilde{A}_s(\tau) = A_s(\tau) - \frac{\lambda_{ds}}{\kappa_s^* - \kappa_d}\Big(e^{-\kappa_d \tau} - e^{-\kappa_s^* \tau}\Big)$$

E.1 Debt Expansion Shocks Consider a debt expansion shock F_1 that raises Treasury supply uniformly across all maturities, leading to a rise in the net supply faced by arbitrageurs, $dX_t(\tau) > 0 \quad \forall \tau$. Below are model predictions on various financial variables.

First, such a debt expansion shock tends to raise Treasury yields across the curve, see Vayanos and Vila (2021). Since yields are defined as $y_t^{(\tau)} \equiv -\frac{p_t^{(\tau)}}{\tau}$, the response of yields to Treasury supply factor is captured by $\frac{A_s(\tau)}{\tau}$. As arbitrageurs' net duration exposure rises, the market price of risk increases, leading to a rise in yields for all maturities.[49] The relative impact across the yield curve depends on κ_s^*, the persistence of supply factor under risk neutral measure. Greenwood, Hanson, and Vayanos (2024) show that yields increases monotonically in τ if $\kappa^* < 0$ and is hump-shaped if $\kappa^* > 0$.

Second, the spread between risky and risk-free bonds can increase or decrease in response to a debt expansion shock. The yield spread between the two classes of bonds is,

$$\frac{\partial\Big(\tilde{y}_t^{(\tau)} - y_t^{(\tau)}\Big)}{\partial s_t} = -\frac{\lambda_{ds}}{\tau}\frac{e^{-\kappa_d \tau} - e^{-\kappa_s^* \tau}}{\kappa_s^* - \kappa_d}.$$

Whether a debt expansion shock narrows or widens the spread depends on λ_{ds},

$$\lambda_{ds} = a\Big(\rho\sigma_s \int_0^T \Big(\theta(\tau)A_s(\tau) + \tilde{\theta}(\tau)\tilde{A}_s(\tau)\Big)\, d\tau + \sigma_d \int_0^T \tilde{\theta}(\tau)\tilde{A}_d(\tau)\, d\tau\Big). \tag{E.8}$$

If the payoff shocks are independent from Treasury supply factor $\rho = 0$, then the spread would narrow, $\frac{\partial\left(\tilde{y}_t^{(\tau)} - y_t^{(\tau)}\right)}{\partial s_t} < 0$, if Treasury issuance crowds out corporate issuance ($\tilde{\theta} < 0$). The intuition is that if payoffs of risky bonds are isolated from Treasury supply shocks, and if arbitrageurs substitute away from risky bonds into safe assets, the resulting lower risky bond dollar duration can reduce the market price of risk and narrow credit spreads, consistent with the *safe-asset* channel highlighted in Krishnamurthy and Vissing-Jorgensen (2012b). On the other hand, if a higher Treasury supply leads to more risky bond issuance ($\tilde{\theta} > 0$), the spread would widen, as higher corporate bond issuance increase the market price of risk.

However, if the payoff shocks are negatively correlated with Treasury supply factor, the spread can potentially widen even if Treasury supply crowds out corporate bond issuance. With $\rho < 0$, a higher Treasury issuance reduces payoffs of risky bond, a "risk-off" comovement. This scenario is consistent with findings in the sovereign-corporate risk linkage literature (see Bocola (2016), Acharya, Eisert, Eufinger, and Hirsch (2018), and others). If the Treasury duration channel domi-

[49] Mathematically, yields increase in response to a debt expansion shock if $\lambda_{rs} > 0$, which is typically the case provided the duration-weighted supply increases.

nates the risky bond duration channel and payoff correlation channel, λ_{ds} turns negative, and then the yield spreads between risky and risk-free bonds widen in response to a higher Treasury supply.

E.2 Maturity Adjustment Shocks Next, we consider maturity-extension/twist shocks as following,

$$\theta(\tau) < 0 \text{ for short } \tau, \qquad \theta(\tau) > 0 \text{ for long } \tau, \qquad \int_0^T \theta(\tau)\, d\tau = 0.$$

Unlike debt expansion shocks, maturity shocks do not change total supply but change the duration composition of debt held by arbitrageurs.

The response of yields depends on the relative importance of duration risk and supply risk. With deterministic supply, changes in issuance affect yields only through the common price of duration risk, so yields tend to move in the same direction across maturities. When supply is stochastic, as in our setup, yield responses depend on both duration risk and supply risk, and the magnitude of the response differs across maturities because the loadings $A_r(\tau)$ and $A_s(\tau)$ vary with maturity. In particular, longer-maturity bonds are more sensitive to both duration risk and supply risk, so maturity shocks that increase long-term issuance tend to raise long yields more strongly when the persistence of supply shocks is high. Intuitively, because supply shocks introduce an additional risk factor that arbitrageurs must bear, it becomes more costly for arbitrageurs to smooth the effects across maturities, making the impact of supply shocks more localized along the yield curve, as emphasized in Greenwood, Hanson, and Vayanos (2024).

Finally, the model allows for a signaling channel through the correlation between risky bond payoffs and Treasury supply shocks. Greenwood, Hanson, Rudolph, and Summers (2015) argue that the Treasury's debt management decisions reflect the trade-off between its desire to lower financing costs through issuing cash-like short-term securities and its desire to manage fiscal risk through issuing long-term debt. Therefore, a maturity adjustment announcement may reflect information about fiscal conditions. We capture this by allowing payoff shocks to be correlated with supply shocks ($\rho \neq 0$). When $\rho > 0$, a maturity extension can be interpreted as positive fiscal news, which lowers risky bond risk premia and narrows credit spreads through the term λ_{ds} in equation (E.8).