Demand-Driven Risk Premia in FX and Bond Markets

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Abstract

We use high-frequency price changes around U.S. Treasury auctions to identify shifts in demand for U.S. safe assets and analyze their effects on foreign exchange and bond markets. A positive demand shock for U.S. Treasuries leads, on average, to a 2-basis-point depreciation of the U.S. dollar against a portfolio of G9 currencies, with the price impact increasing with the maturity of the issued security. Countries with highly correlated short-term interest rates to the U.S. experience weaker currency appreciation but stronger bond yield co-movement with U.S. Treasuries, compared to countries with lower short-rate correlations. These findings provide robust support for segmented markets models, where global arbitrageurs act as marginal investors in both foreign exchange and bond markets, and highlight the critical role of risk premia in driving the co-movement of exchange rates and bond yields.

Keywords: Foreign exchange markets, risk premia, Treasury auctions, safe asset demand

JEL codes: F30, F31, G12, G15

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I. Introduction

The co-movement of exchange rates and bond yields is conceptually well understood, as both are strongly influenced by changes in short-term interest rates. Building on this shared interest-rate sensitivity, recent work by Gourinchas et al. (2022) and Greenwood et al. (2023) develops a theoretical framework that links risk premia in exchange rate and bond markets. Their work provides clear predictions regarding the strength and direction of the co-movement between bond yields and exchange rates in response to shifts in investors' demand for bonds. Central to the approach are global arbitrageurs, who absorb demand shocks from preferred-habitat investors in domestic and foreign bond markets as well as in foreign exchange (FX) markets. As marginal investors, these arbitrageurs play a pivotal role in setting the price of risk across all three markets, with variations in risk premia arising from changes in their portfolios

The tight link across these markets implies that shifts in the demand for U.S. government bonds can generate significant spillover effects into both global bond yields and exchange rates. In this paper, we exploit high-frequency price changes within narrow windows around U.S. Treasury auctions to measure the impact of unexpected shifts in investor demand for short- and long-term U.S. government securities on FX rates and government bond yields. As a novel fact we document that the U.S. dollar systematically depreciates in response to unexpected demand shifts for U.S. Treasuries. The effect is substantial in magnitude, persistent over time, and observable across a broad cross-section of currencies, with spillovers extending into foreign bond markets. We further show that whether unexpected shifts in demand for U.S. Treasuries mostly transmit to a foreign country through changes in its exchange rate with the U.S. dollar or through changes in its government bond yields depends on how correlated the country's short-term interest rate is with that of the U.S..

To establish this finding, we follow Ray et al. (2024) and posit that the institutional setup of Treasury auctions offers a quasi-ideal environment to isolate and observe shifts in investor demand. These auctions are regular, pre-scheduled events, closely monitored by market participants worldwide, where the supply of safe assets is fixed and publicly known in advance. Ray et al. (2024) show that any observed fluctuations in U.S. Treasury prices around the time of the auction reflect unexpected shifts in investor demand revealed at auction rather than information about macro fundamentals.

To examine the impact of demand shifts on FX and global bond markets, we utilize granular, high-frequency data on U.S. Treasury futures across various maturities and exchange rates for G9 currencies against the U.S. dollar over the period 2002–2018. Together, these currencies account for nearly 70% of total daily global FX market turnover, reflecting the majority of global activity. By focusing on these highly liquid and actively traded currency pairs, our analysis provides a detailed view of how FX and bond markets jointly respond to shifts in demand for U.S. safe assets. This approach also offers a unique opportunity to use both markets to empirically test the predictions of segmented market models within a well-defined conceptual framework.

Our findings can be summarized as follows. First, by focusing on price changes of U.S. Treasury futures within short windows around U.S. Treasury auctions, we document that in response to unexpected demand shocks the U.S. dollar depreciates by approximately 2 basis points against a broad cross-section of foreign currencies. This depreciation is highly statistically significant and remains a robust feature of the data. We demonstrate that the U.S. dollar depreciation persists across various measures of demand shocks and withstands a range of robustness tests. We extend the analysis to global bond markets and find that global bond returns increase, on average, by over 8 basis points. This provides evidence that demand shocks for U.S. safe assets spill over to global fixed income markets.

Second, we demonstrate that the impact of demand shocks varies with the maturity of issued Treasury instruments. For 2-year auctions, the U.S. dollar depreciates by only 0.70 basis points (statistically insignificant), but this response increases consistently with maturity, reaching 3.66 basis points around 30-year Treasury auctions (significant at the 1% level). In bond markets, a similar pattern emerges: the impact of increased Treasury demand rises from just over 1 basis point for 2-year bonds to more than 37 basis points for 30-year bonds.

Having established the significant price impact of Treasury demand on currency and bond markets, we address two key robustness concerns. First, we show that auction days are unique, as there is no consistent relationship between Treasuries and these markets during the usual auction times but evaluated on non-auction days. To verify this, we perform a block-bootstrap exercise on non-auction days, constructing placebo demand shocks and repeating our baseline regressions. Across 10,000 randomly drawn samples, we find average coefficients of -0.25 for FX and 2.34 for bond markets, which are statistically distinct from the observed demand shock coefficients on auction days.

We proceed assessing the persistence of demand shocks beyond the auctions. Using local projections, we find that foreign currency appreciation and bond market effects last for several days. In panel regressions across currencies, U.S. dollar depreciation peaks at nearly 20 basis points around day 10, gradually reverting to insignificance after 14 days. In bond markets, foreign bond yields increase by over 8 basis points initially, remain elevated for about a week, and taper off to insignificance after approximately 28 days. These results demonstrate strong and persistent effects of demand shifts across both market segments. The prolonged impact highlights the interconnectedness of global financial markets, where shifts in U.S. safe asset demand trigger enduring spillover effects in foreign bond yields and currencies as global investors presumably adjust their portfolios.

Third, we identify a distinct cross-sectional pattern in how currencies and bonds respond to Treasury demand shifts during auctions. While the U.S. dollar depreciates against all currencies, the magnitude of depreciation varies. For example, the U.S. dollar weakens by only 0.55 and 0.92 basis points against the CAD and AUD, respectively (not statistically significant), but shows much larger declines of 2.20 and 3.43 basis points against the NOK and JPY. In bond markets, this pattern is reversed: the demand impact ranges from 2.96 and 6.25 basis points for the JPY and NOK to as high as 10.97 and 13.55 basis points for the CAD and GBP.

We attribute these variations to differences in short-rate correlations between the foreign country and the U.S. In the cross-section, currencies of countries with lower short-rate correlations to the U.S. exhibit stronger depreciation, whereas bonds from these same countries show weaker yield changes. Conversely, higher short-rate correlations are associated with smaller currency movements but larger bond yield responses. The correlation between short-rate correlations and FX responses is strongly negative (-0.92), while the correlation with bond yield responses is strongly positive (0.84). Using fixed-effects panel regressions, we confirm that the impact of Treasury demand shocks is systematically linked to short-rate correlations. The regression results show that currencies and bonds respond in opposite directions, with the bond market impact increasing with the maturity of the instrument.

Our findings align with the quantity-driven theory of risk premia (Gourinchas et al., 2024; Greenwood et al., 2023). A positive demand shock for U.S. Treasuries lowers Treasury yields and weakens the U.S. dollar. This occurs because global arbitrageurs, holding fewer Treasuries, face reduced exposure to U.S. short-term interest rate risk, which lowers the term premium.

Simultaneously, their diminished interest rate risk also reduces the exchange rate risk premium, causing the U.S. dollar to depreciate.

The strength of this negative relationship between U.S. Treasury yields and the U.S. dollar weakens when U.S. and the foreign country's short-term interest rates are highly correlated. A higher correlation leads to a weaker response of the bilateral interest rate differential when the U.S. short rate changes, thereby reducing the interest rate risk of foreign currency positions as the uncovered interest parity (UIP) channel is mitigated. This dampens the co-movement between Treasury yields and the exchange rate in response to Treasury demand shocks.

Finally, the positive co-movement between U.S. and foreign bond yields becomes stronger as the correlation between their short-term interest rates increases. Greater alignment in short-term rates brings the expectations components of both countries' yields closer, synchronizing risk exposures. This amplifies the co-movement between U.S. and foreign term premia following Treasury demand shocks.

Having established our main findings, we extend our analysis to further explore the dynamics of Treasury demand shocks. Using alternative measures, we proxy shifts in investor demand with unexpected changes in the bid-to-cover ratio, distinguishing between bidder types. We find that indirect bidders, such as foreign central banks and institutional investors, play a key role in the pass-through to FX and global bond markets. Additionally, the FX market response is amplified when a larger share of Treasuries is allocated to foreign investors and investment funds, underscoring the role of U.S. Treasuries as safe-haven assets.

To further evaluate this mechanism, we replicate the stock-bond correlation measure from Hu et al. (2024) and re-examine price impact regressions, distinguishing between auction days when Treasuries are perceived as safe or risky assets. Our findings indicate that the results are generally robust to investors' perceptions of riskiness; however, the price-impact coefficients in FX markets are, on average, smaller on safe days compared to risky days. In bond markets, demand shocks exhibit a similar impact across different types of days, but the cross-sectional divergence in short-rate correlations between countries widens on safe days. These results align with Jiang et al. (2021), suggesting that demand from global investors increases the U.S. dollar's value during periods of distress due to its higher convenience yield. Using measures from Diamond and Tassel (2022), we confirm that foreign currency depreciation on auction days is less pronounced when convenience yields rise.

Literature Review. Our paper adds to the existing literature in various dimensions. First, following Gourinchas et al. (2024) and Greenwood et al. (2023), we highlight the importance of quantity-driven demand shifts and assess to what extent heterogeneous investors' excess demand for U.S. Treasuries impact exchange rate movements. The theoretical frameworks in these papers serve as guideline for our empirical assessment. In contrast to the motivating empirical analysis in Greenwood et al. (2023) we exploit high-frequency changes in FX spot rates around auctions to identify demand shocks for U.S. Treasury securities, and also track the impact on global bond markets. In this sense, the paper is closely related to Phillot (2023) and Ray et al. (2024) which show that high-frequency price changes around auction dates capture unexpected shifts in investor demand for safe assets. While these papers' discussion primarily focuses on changes in domestic yields, we assess the impact of investors' demand changes on the U.S. dollar and the cross-section of G9 currencies and bonds. This way, our paper also relates to a recent literature on demand-based approaches in currency markets (e.g., Jiang et al. (2024)) and financial markets more generally (Koijen and Yogo (2019)).

Second, our paper contributes to the growing literature assessing the demand for safe government debt (see, e.g., Eren et al. (2023), Jansen et al. (2024), Antolin-Diaz (2024)). Unlike these studies, we focus specifically on U.S. Treasury auction days and evaluate the implications of safe asset demand shocks on other asset classes. In this regard, our work is also related to recent studies by Somogyi et al. (2024) and Zou (2024), but it differs in at least three different important dimensions. First, we examine the pass-through effects of U.S. Treasury auction demand shocks on both FX and global bond markets. We analyze these events through the conceptual lens of a segmented market model with global arbitrageurs linking FX and bond markets. Second, we employ high-frequency identification methods and granular intraday data of Treasury futures and FX rates to isolate unexpected demand shocks and to track their exogenously caused responses. Akin to the methodology used in the monetary policy shock literature (e.g., Gürkaynak et al. (2005)), where high-frequency price changes around policy announcements identify unexpected news about policy shifts, we use high-frequency price variation within a narrow window around auctions to capture unexpected demand shifts for the offered contract. Third, to the best of our knowledge, we are the first to empirically uncover the relationship between the cross-sectional responses in FX and bond markets linked to the correlation of a country's short-rate with that of the U.S..

Third, our paper contributes to the growing body of literature examining the impact of quantitative easing (QE) and unconventional monetary policies on foreign exchange (FX) markets. For instance, Dedola et al. (2021) investigate how quantitative easing and relative changes in central banks' balance sheets influence the EUR/USD exchange rate, highlighting the critical role of balance sheet dynamics in currency valuation. Similarly, Bauer and Neely (2014) explore the spillover effects of unconventional monetary policy measures on international yields, emphasizing the importance of signaling channels and portfolio re-balancing effects in shaping global financial markets. Complementing these perspectives, Ferrari et al. (2021) focus on the implementation of unconventional policies during the zero-lower bound period, offering valuable insights into how such measures affect market dynamics under constrained monetary conditions. We differ from these studies by using a high-frequency approach to assess the impact of QE-like shocks on FX markets, and we analyze how these shock ultimately spillover to international bond markets.

This paper proceeds as follows. Section II describes the data and the methodology that we use to identify demand shocks around U.S. Treasury auctions. Section III develops the hypotheses and documents the main empirical findings. Section IV provides further analysis and a discussion of the economic mechanism. Section V concludes the discussion.

II. Methodology and Data

This section introduces the methodology used to measure demand shocks in the U.S. Treasury market, and describes the data that we obtained from various data sources.

A. Methodology

Our study exploits high-frequency variation in prices in Treasury futures around Treasury auctions to measure shifts in investor demand for U.S. safe assets. While institutional details of these auctions are well-documented in Ray et al. (2024), for the purpose of this paper, the following characteristics about Treasury auctions are worth highlighting. First, Treasury auctions are frequent and pre-announced events at which the U.S. Treasury offers newly issued debt to the public. Over our sample period, which spans 2002 to 2018, we observe 944 auctions, resulting in approximately one event per week, on average. Second, the maturity of offered contracts varies across auction dates. Contracts include 2-, 3-, 5-, and 7-year notes and 10- and 30-year bonds. The frequency of debt issuance varies over time and across contracts. During our sample, contracts with maturities of 2-years are most frequently issued (36%), followed by 7- to 10-year notes and bonds (31%), 3- to 5- year notes (20%), and 30-year bonds (13%). Third, a variety of different market participants with different objectives actively engages in auctions by submitting competitive and non-competitive bids. The difference between these types of bids are relevant for our identification strategy. Noncompetitive bidder are limited to $5 million per bidder and subject to the terms settled at the auction. Competitive bids, in contrast, are associated with specific amounts that market participants aim to purchase. The submission cut-off times for the different types of bids varies, and competitive bids usually can be submitted until the closing time. Lastly, the vast majority of auctions take place at 13:00 (96% of all auctions in our sample), while the remaining number of auctions takes place at 11:30 or 11:00. Figure 1 puts the point in time of auctions into perspective relative to other intraday events in financial markets, and which have been the center of previous work.

Daily events during the U.S. trading hours include the opening of local stock markets (e.g. NYSE opening at 9:30 ET), expiry time of FX options (10:00 ET), and the publication of the WM/R London fixing rate (11:00). The afternoon is comparably quieter with the closing of stock markets (16:00) and the cut-off point in time of interest rate differentials at (17:00). In addition, on pre-announced dates major U.S. macroeconomic releases are published at 8:30 in the morning and FOMC interest rate decisions area announced at 14:00 in the afternoon. During our sample, 4% of auction dates fall on the same day as FOMC announcements while about 8% occur on the same day as major macroeconomic U.S. releases, yet as indicated by Figure 1 these major events are generally spaced out over the trading day and do not overlap with the time of auctions.

This observation is crucial, as the high-frequency demand shocks are constructed based on the assumption that shifts in prices are Treasury auctions solely reflects changes in market beliefs about the demand for maturity-specific safe assets. Since the Treasury announced the offered amount well in advanced of the auction, i.e., fixing the supply of safe assets, any changes in prices between the announcement and the close of the auction reflects changes in safe asset demand. Akin to the literature on identifying monetary policy shocks (e.g., Gürkaynak et al. (2005)), the high-frequency price variation during a tight window around the auctions, therefore, captures unexpected demand shifts for the offered contract. Thus, following Ray et al. (2024) the baseline shock specification is defined as

$$D_t = p_{t+10} - p_{t-10} \tag{1}$$

where D_t refers to the (log) change of prices in Treasury futures from 10 minutes before the time of the auction (i.e., say at 13:00) until 10 minutes after the auction.

[INSERT FIGURE 1 HERE]

We match the response in FX markets to the high-frequency shock in Treasuries using the exact same short window around auctions, i.e., FX (log) returns are defined as $\Delta s_{i,t} = s_{i,t+10} - s_{i,t-10}$, where $s_{i,t+10}$ and $s_{i,t-10}$ denote (log) exchange rates 10-minutes before and after the the auction, respectively. When focusing on dynamics in global bond markets, we rely on daily data. Following Hanson and Stein (2015) and Albagli et al. (2024), who use bond returns based on daily low-frequency data as the dependent variable around monetary policy announcements, we allow for additional time post-auction to account for potential delays in market absorption of new information.[1]

B. Data

We construct a comprehensive database on Treasury auctions, relying on information from TreasuryDirect (https://www.treasurydirect.gov/auctions/). The website provides a detailed historical record of Treasury auctions dating back to 1975. We collect date and time stamps for each individual auction and track additional details about the auctions and the securities issued on each date. Specifically, we gather data on the amounts offered, tendered, and accepted; the maturity of the issued debt instruments; and their CUSIP codes.

Since 2003, the website has also included information on the bid-to-cover ratio and the types of bidders. This ratio represents the total bids received by the Treasury relative to the total bids accepted, with higher values indicating stronger demand. Additionally, we collect information on bidder types using two distinct datasets. First, we document the breakdown of the bid-to-cover ratio by bidder type, distinguishing among direct bidders, indirect bidders, and primary dealers. Second, we track the fraction of accepted bids by bidder type (though this data is published with a significant delay), categorizing them as depository institutions, individuals, dealers, pensions, investment funds, foreign institutions, and others.

Further, we use on high-frequency prices of Treasury futures with maturities of 2-, 5-, 10-, and 30-futures to measure the impact of investor demand changes around auction dates,. The data is

[1]Our results are not sensitive to these modeling choices. We perform a range of robustness tests using alternative measures for both markets, demonstrating the consistency and validity of our findings across various specifications.

obtained from LSEG Tickhistory and sourced at the tick-level frequency.[2] After cleaning the data for significant outliers, we construct end-period prices for each five minute interval over the course of the trading day.

Next, we source data on intraday foreign exchange rates from LSEG spanning more than 17 years of high-frequency data from January 2002 to December 2018. We focus on the G9 currencies, i.e., the Australian dollar (AUD), the Canadian dollar (CAD), the euro (EUR), the Japanese yen (JPY), the New Zealand dollar (NZD), the Norwegian krone (NOK), the Swedish krona (SEK), the Swiss franc (CHF), and the British pound (GBP), all vis-à-vis the U.S. dollar. The cross-section represents most of the most liquid and heavily-traded currencies and, in aggregate, cover close to two-thirds of the average total daily turnover in foreign exchange markets (BIS (2022)).

We transform the tick-by-tick data from LSEG in the following way. We obtain the best bid and ask quote recorded to the nearest even second. After applying a number of filters to correct the data for outliers, the price at each five-minute tick is obtained by linearly interpolating from the average of the bid and ask quotes for the two closest ticks. If no quote was submitted during a specific interval, we fill the gap with the most recent available price.

Following previous studies (see, e.g., Andersen et al., 2003) we exclude quotes that are submitted on days that are associated with low trading activity. For example. we remove all quotes on weekends between Friday 17:00 and Sunday 17:05 (Eastern Time, ET). Similarly, we drop quotes around fixed holidays, i.e., Christmas (24 to 26 December), New Year (31 December to 2 January), and 4 July, and around flexible holidays, such as Good Friday, Easter Monday, Memorial Day, Labor Day, and Thanksgiving (including the day after).

We define currencies as U.S. dollar per foreign currencies, i.e., an increase of the exchange rate (i.e., positive returns) reflects an appreciation of the foreign currency vis-à-vis the U.S. dollar.

Lastly, we obtain daily data on zero-coupon bonds from Bloomberg for the G9 foreign bond markets and the United States. We collect fixed income instruments with maturities ranging from 3-months to 30-years, providing us with detailed information on the yield curve for each of the ten major economies.

[2] The RICs of Treasury futures contracts are TU, FV, TY and US.

C. Summary Statistics

Table I reports summary statistics about the Treasury auctions, demand shocks, and (high-frequency) responses in FX and global bond markets. Starting with Panel A the average amount offered at auctions ranges between 5 and 44 billion U.S. dollar, with an average of 24.88 billion U.S. dollar. The amount offered tends to be systematically smaller than what is regularly demanded by participants. The average amount tendered amounts to 69.20 billions, ranging between 11.62 and 160.69 billion U.S. dollar. The exceeding demand for safe assets is also reflected by the bid-coverage ratio, averaging at 2.66. The value implies participants tend to bid more than one-and-a-half times the amount that is offered. The fact that demand exceeds supply throughout the distribution of auction can also be inferred from the percentiles, which show the lowest value of 1.22 and the maximum value peaking at 4.07. Distinguishing between different types of bidders, we note the largest share contributing to the bid-coverage ratio is coming from primarily dealers (1.42), followed by indirect (0.53) and direct (0.21) bidders.

Panel B summarizes our main variable measuring investor demand for Treasuries, based on high-frequency price changes of Treasury futures. Demand shocks are reported for different auction tenors, matching the maturity of the futures contract with the maturity of the issued Treasury instrument. For example, the average shock ranges between -0.21 bps for short-term futures contracts (2-year) and to 1.45 bps for 10-year futures contracts.

Panel C shows the response in FX markets around Treasury auctions. On average, the dollar portfolio ("DOL"), i.e., the unconditional average of foreign-currency denominated returns, is -0.05 bps. It indicates the price changes are on average close to 0, with a slight depreciation of foreign currency against the U.S. dollar. In the cross-section, there are noticeable differences in reactions around Treasury auctions, with the AUD and NZD appreciating the most, while the JPY and CHF slightly depreciate against the U.S. dollar.

Lastly, Panel D shows the reaction in global bond markets, as measured by returns of bonds with 10-year maturity. On average, bond returns are positive, ranging between 0.59 bps to 7.70 bps, though the dispersion of responses varies substantially, as indicated by the large range of the distribution.[3]

[INSERT TABLE I HERE]

[3] For bond returns, we exclude days with more than one auction taking place. This conservative approach leads to a slightly lower number of observations (916 observations).

Complementing the previous table, Figure 2 provides further insights into the time series of demand dynamics and responses in FX and bond markets. Panel A shows demand shocks, Panel B shows the time series dynamics of the raw bid-coverage ratio by bidder type, Panel C shows the response of the dollar portfolio within a 20-minute window around the auctions, and Panel D shows the average daily response in global bond markets. As illustrated by the figure, returns in Panel A, B, and D can be quite sizable, as suggested by the y-axis, ranging between -200 and 250 bps. Unsurprisingly, movements in Treasury futures, currencies, and bond markets have been large during the period of the great financial crisis, but we observe additional outliers in all markets later during our sample. With respect to the bidder type, Panel B confirms that the majority of bid-coverage ratio comes from primary dealers, while the proportion of indirect (direct) bidders appears to have slightly increased (decreased) over time.

[INSERT FIGURE 2 HERE]

III. Unexpected Treasury Demand Shifts and FX Dynamics

In this section, we investigate how prices in currency and government bond markets react to investor demand shifts around U.S. Treasury auctions. Our empirical analysis is guided by the predictions quantity-driven theories of risk premia (Gourinchas et al., 2024; Greenwood et al., 2023) make for the co-movement of exchange rates and bond yields. First, we use this framework to postulate three empirical hypotheses and then, second, we show that they are confirmed in our data. In particular, we show that the U.S. dollar depreciates and the yields of G9 government bonds fall in response to increase in investor bond demand. The strength of these effects depends on the correlation of a country's short-term interest rate with that of the U.S.. The higher this correlation, the stronger is the bond yield channel and the weaker is the exchange rate channel. We provide a stylized model of this mechanism in Appendix AH.

A. Hypothesis Development

To derive the testable implications for the co-movement of exchange rates and bond yields in response to investor demand shifts, we see the unexpected changes in bond demand at auctions as demand shocks from preferred habitat investors which are absorbed by specialized arbitrageurs. Absorbing these shocks changes arbitrageurs portfolios. As they are the marginal investors in both currency and bond markets, risk premia in both markets adjust to reflect the change in their risk exposures. The central risk factor in currency and bond markets is short-term interest rate risk. In bond markets, arbitrageurs are exposed to changes in interest rates through term structure trades - invest in long-dated bond positions financed by short-term. When short-term interest rates increase, they make losses as long-dated bond prices fall. The term premium compensates for this risk. In currency markets, their interest rate risk exposure derives from uncovered-interest rate parity (UIP) trades - borrow in domestic currency, invest in foreign currency. These trades make losses when domestic short-term interest rates increase as financing the position becomes more expensive. A risk premium in exchange rates compensates for this risk.

Changes in arbitrageurs' exposure to interest rate risk in response to investor demand shifts hence moves exchanges rates and bond yields through common changes in risk premia. The above framework makes the following predictions for the co-movement of exchange rates and bond yields:

Hypothesis 1. *The U.S. depreciate dollar against foreign currencies in response to an unexpected increase in demand for U.S. Treasury securities.*

Hypothesis 2. *Foreign government bond yields decrease in response to an unexpected increase in demand for U.S. Treasury securities.*

As arbitrageurs now hold fewer Treasury bonds their exposure to U.S. short-term interest rate risk goes down the which lowers price of U.S. short rate risk. This reduces the U.S. term premium but also the term premium of foreign bonds to the extent the foreign country's short-rate is positively correlated with that of the U.S. Simultaneously, as arbitrageurs are also the marginal investors in currency markets, their reduced exposure to short rate risk in UIP trades also decreases the exchange rate risk premium, leading to a depreciation of the U.S. dollar.

Hypothesis 3a. *The strength of the negative relationship between U.S. Treasury yields and the USD weakens when U.S. and foreign short-term interest rates are highly correlated.*

Hypothesis 3b. *The positive co-movement between U.S. and foreign bond yields becomes stronger as the correlation between their short-term interest rates increases.*

A stronger correlation of the short-rate of a foreign country with that of the U.S. lowers the volatility of the interest rate differential between the two countries. This lowers the exposure of the UIP trade to interest rate risk and reduces the sensitivity of the exchange rate to changes in the price of interest rate risk. Conversely, a stronger correlation of the short-rates implies a stronger co-movement of the foreign country's term premium with that of the U.S. as the foreign long-term bond prices co-move more strongly with U.S. long-term bond prices in response to changes in the U.S. short-rate.

B. The Impact of Treasury Demand Shocks on Currency and Bond Markets

As a first step, we document that FX markets instantaneously react to demand shift around Treasury auctions. Table II reports results to the following panel regression

$$\Delta s_{i,t} = \beta D_t + \alpha_i + \varepsilon_{i,t} \tag{2}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t and D_t refers to demand measures based on changes in prices or quantities. The regression includes currency fixed effects (α_i) and we account for heteroscedasticity and autocorrelation using Driscoll and Kraay (1998)-adjusted standard errors. We report results for each individual auction tenor and for a "pooled" regression that includes all auction dates, independent of the maturity of the debt instrument.

[INSERT TABLE II HERE]

First, we show in Panel A that in response to a one standard deviation increase in Treasury futures prices, foreign currencies appreciate by 1.77 bps ("Pooled"). The impact varies across auction tenors, and the coefficients are monotonically increasing from the short- to long-term instrument. In fact, for 2-year auctions the coefficient is insignificant (0.97), and increases to 3.66 for the 30-year auctions.

In Panel B, we re-estimate the baseline regression of Equation 2, substituting the left-hand side variable with the change in bond yields for each foreign country around auction days,

$$\Delta y_{i,t} = \gamma D_t + \alpha_i + \varepsilon_{i,t+1} \tag{3}$$

where $\Delta y_t = y_{i,t+1} - y_{i,t-1}$ and $y_{i,t+1}$ and $y_{i,t-1}$ refer to the bond yield with maturity m of foreign country i on the day after and the day before the auction. We match the maturity of the bond, with the maturity of the Treasury instrument, which is auctioneed on the day.

As shown, across auctions ("Pooled") global bond returns increase by 21.61 bps. The estimate is highly statistically significant, suggesting that an increase in demand for U.S. Treasuries spillovers to foreign bond markets. Further, similar to the results in Panel A, we observe a monotonic increase of coefficients across maturities. For 2-year maturities, foreign bonds increase by approximately 1 bps (significant at 10%), while the impact on 30-year maturity bonds increases to more than 37 bps (significant at 1%). The rising economic and statistical impact from short- to long-maturities point toward the substantial impact of the term premium component, which proportionally has a larger impact on long-term debt instruments.

While Table II documents the overall appreciation of foreign currencies against the U.S. dollar and global bonds in response to demand shocks, we proceed in Table III and report the impact of demand shocks for individual countries. Panel A reports results for the foreign exchange market, while Panel B documents results for global bond markets, focusing on bonds with 10-year maturity.

[INSERT TABLE III HERE]

Both panels confirm the demand pressure in Treasuries have a market-wide impact and are not driven by a single currency or bond market. In Panel A, we find all estimates are positive and they are statistically significant for 7 currencies. For example, in response to a one-standard deviation shock to unexpected demand for Treasury futures, foreign currencies systematically appreciate between 0.55 bps (CAD) to 3.43 (JPY) bps. The average effect, as measured by the dollar portfolio (DOL) shows an average appreciation of foreign currencies of 1.78 bps. In Panel B, the responses across all markets are statistically significant and even larger in magnitude. Bond returns increase, on average by 8.47, with responses from individual bond markets range between 2.96 bps (JPY) and 13.55 basis points (GBP).

In sum, Table II and III provide strong empirical evidence that demand shifts in Treasury markets affect global currency and bond markets. Collectively, the findings support the predictions of Hypothesis 1 and 2.

C. Placebo Exercise

While the positive link between U.S. Treasury demand shocks and currency and global bond markets appears to be a robust feature across countries, one might be concerned that the results are driven by a general positive link between Treasury futures and prices in the two asset classes in the afternoon of U.S. trading hours. To alleviate this concern we conduct a block-bootstrap exercise assessing the link between Treasury futures and both market segments markets on days when no auction is scheduled. To this end, we resample (with replacement) from "non-auction" days 10,000 times, construct shocks of Treasury futures (i.e., $D^{Placebo}$) around 13:00, and re-estimate Equation 2 for each draw. For each iteration we randomly pick Treasury futures with different maturities, ensuring that the proportion of maturities of the random sample matches the proportion of maturities on auction days. We record the β- and γ-coefficients from each panel regression and plot the distribution in Figure 3. Panel A (Panel B) shows results for FX (Bond) markets. The black dashed line indicates the average values across draws, and the red-dashed lines indicate the 95% confidence bounds. The dotted line refers to the coefficient estimates obtained on auction dates.

As illustrated by Figure 3, dynamics between both markets and Treasury futures are systematically different on non-auction days, highlighting the importance of auction days for the co-movement across asset classes. In both figures, the distribution of coefficients is largely shifted towards the left compared to the coefficient obtained from auction days. For example, in FX, the average coefficient from the bootstrap exercise is negative (-0.34), and the 95% confidence interval comprises values between -0.95 and 0.34. In contrast, the coefficient obtained on auction days is positive and close to the value of 2. Similar inferences can be observed for bond markets where coefficients from from auction days clearly lays outside of the 95% range of the distribution. The exercise adds confidence to our approach exploiting high-frequency variation around auctions as a measurement of excess demand, as these price movements are systematically different from price movements on any other day around the same time.

[INSERT FIGURE 3 HERE]

D. Shock Persistence

The previous section establishes a significant impact of safe asset demand shocks on global FX markets across currencies in short-windows around Treasury auctions. In a next step, we assess the persistence of these shocks. To this end, we follow Ray et al. (2024) and compute long-difference in exchange rates return as the difference in (log) prices on day $t+h$ for currency i, i.e. $s_{i,t+h}$ and the (log) price before the auction at the beginning of the day, i.e., $s_{i,t}$. We vary h between 1 day and increase it to up to 30 days, and plot the estimate of panel regressions Figure 4. The blue shaded area refers to 10% confidence intervals based on Driscoll and Kraay (1998) standard errors.[4] As illustrated, the impact of demand shocks are not dissipating immediately but point towards a great deal of persistence. On the next day ($h = 1$), the beta coefficient shows a value of 5. It increases and almost doubles within the next trading week, before turning dropping slightly, and then increases again up to day 11, before declining thereafter. The coefficient remains significant for up to 14 days, with only day 8 showing a slight drop in significance levels. Following day 15, the coefficient remains positive almost constantly (exception: day 25), though the confidence intervals are widening and levels of statistical significance are declining. Taken together, 4 provides evidence that demand shocks have persistent impacts on currency markets.

We repeat the exercise for global bond markets in Panel B and similar to the FX market, the impact of quantity shocks is not short-lived. However, the spillover pattern across foreign bond markets behave slightly differently. The price impact coefficient (γ) rises sharply the day after the auction, reaching a peak over 8 basis points. It continues to climb for a few days before starting a gradual decline. Despite this decline, the coefficient remains positive and statistically significant for almost the entire 30-day period. Only on day 30 does the confidence interval widen significantly, making the price impact coefficient statistically insignificant.

This figure suggests that quantity-driven demand shocks have a lasting and persistent effect on foreign bond markets, causing spillovers that endure across a prolonged period. The extended positive impact indicates that these shocks influence bond yields globally and that the markets take time to fully absorb the effects of such demand shocks. It is evidence that capital moves slowly and that speed varies across different capital market segments.

[INSERT FIGURE 4 HERE]

[4] Results of time-series regressions for individual currencies are delegated to the appendix.

E. Robustness

We run a battery of tests, providing additional evidence that our results are robust to different measurement specifications. First, in the baseline specification we closely follow Ray et al. (2024) and measure high-frequency changes in prices in a 20-minutes window around auctions. Our results are not restricted by the choice of the window length. Table A-II repeats the baseline regressions exercise but allows for alternative window lengths. We find that extending the window length or allowing for longer (shorter) pre- (post-) auction windows does not affect our baseline results substantially.

Second, one other concern might stem from the fact that FX intraday prices are based on indicative quotes and not accurately reflect short-term price intervals. To alleviate these concerns, we re-estimate the regression with traded prices and firm quotes that are obtained from LSEG Matching database, an interdealer trading platform, which has been historically been particularly popular for trading Commonwealth currencies. The availability of data from this platform varies across currencies, but for a reasonably large cross-section is available from 2010 onward. Table A-III reports the results based on alternative data sources. For comparability we repeat the same regression on the same indicative quote data but smaller time-series and cross-section in the first row ("LSEG"), while the second and third row uses firm, executable quotes (LSEG Quotes) or value-weighted average traded prices (LSEG VWAP) instead. While the magnitude of the coefficients tend to be slightly smaller for the value-weighted prices, overall the level of significance remains high and the positive link between quotes and trades remains strong. This evidence suggests that our findings are not driven by unusual price patterns of indicative quotes or stale prices, but are a robust feature of the market.

Third, the results in bond markets remain consistent across alternative windows for calculating returns, as shown in Table A-IV. Specifically, for shorter windows (e.g., $\Delta y_t = y_t - y_{t-1}$) and longer windows (e.g., $\Delta y_t = y_{t+2} - y_{t-1}$), demand shocks in Treasury markets consistently lead to an appreciation in foreign bond markets. The magnitude of the coefficients increases with the window size, lending support to the conjecture that the transmission of information across markets is not always immediate but may unfold over time. The gradual incorporation of information suggests that investors and market participants might require additional time to fully process and respond to Treasury market shocks, ultimately affecting foreign bond valuations.

Lastly, we consider the impact of particular sub-periods throughout the sample. Table A-V repeats the baseline regressions for both markets but excludes crisis periods, as one might be concerned that results are driven by a small number of months. Yet, significant coefficients of similar magnitude are obtained for currency (Panel A) and bond (Panel B) markets. In Table A-VI we explore the impact of end-of-month seasonality and show results are not driven by unusual investor demand (e.g., due to portfolio re-balancing) during this time of the month. For both markets we find that the impact of end-of-month dynamics is either small or not significant.

E.1. Bilateral short rate correlations and the impact of bond shocks on FX premia

While assessed currency and bond markets, in isolation, in a next step we evaluate their joint dynamics. This added layer of complexity is crucial to assess Hypothesis 3a and 3b against the backdrop of Greenwood et al. (2023) and Gourinchas et al. (2024), as market segmentation in these models constrains investors' capacity to intermediate shocks across various markets. This approach allows us to examine how demand shocks may propagate differently across foreign exchange and bond markets, highlighting the roles that investor preferences and market structure play in shaping price dynamics.

Figure 5 contrasts the estimated price impact coefficients from both markets relative to each country's short-rate correlation with the United States. Short rate correlations are computed using a 5-year rolling window of monthly changes in 3-month changes.[5] The left panel shows results for FX markets, while the right-panel shows country-specific estimates for foreign bonds with maturity of 10-years.[6] Several key observations emerge. First, in the cross-section of currencies, the price impact is negatively correlated (-0.92) with the correlation of short-term rates. In contrast, in the cross-section of bond markets, the price impact is positively correlated with short-rate correlations, reaching a positive cross-sectional correlation of 0.84. Second, countries exhibiting a high price impact in FX markets tend to have low price impact coefficients in bond markets. Focusing on the extreme cases, the price impact coefficient for the JPY in FX markets is close to 3.5 basis points, the highest among all currencies, while in bond markets, the coefficient is smaller than 3 basis points, ranking lowest in the cross-section. At the other end of the spectrum, for the CAD, the country with the highest short-rate correlation, the price impact in currency markets is 0.55 basis points, whereas it reaches almost 11 basis points in bond markets. Third, the differing scales of the y-axis across the two market segments suggest that shocks propagate from currency markets

[5]The results are robust to alternative approaches for computing short-rate correlations.

[6]We show in Figure A-3 in the Appendix that the pattern is consistent across bond maturities.

to foreign bond markets, driving notable shifts in yields on a global scale.

[INSERT Figure 5 HERE]

To provide further evidence for the significant role of the short-rate correlation between the two market segments, we regress the responses in FX and bond markets on an interaction term between the demand shock and the short-rate correlation of each foreign country with the U.S. The coefficient of this interaction term captures how demand dynamics in Treasury markets propagate to currency and bond markets, conditional on the degree of interest rate co-movement between the two countries.

The results, reported in Table IV, strongly support the asymmetric effects of demand shocks across the two markets. In the foreign exchange market, a positive demand shock has a smaller impact on currencies with higher short-rate correlations. The coefficient of the interaction term is negative and highly statistically significant (β =-0.408). In contrast, foreign bonds respond more strongly to demand shocks in countries with higher short-rate correlations. This pattern is consistent across maturities, with coefficients increasing monotonically from 2- to 30-year bonds. The larger coefficients for long-term maturities relative to short-term bonds highlight the role of the term premium component in the transmission of demand shocks. Table IV quantitatively confirms the significant and non-negligible role of relative short-rate correlations in shaping the responses in both markets.

[INSERT TABLE IV HERE]

Collectively, these findings lend strong support to the predictions of preferred habitat models, and confirming hypotheses 3a and 3b. Figure 5 and Table IV suggest that shocks to the quantity of safe assets have a more (less) significant impact on the exchange rates (government bond) of countries whose short rates are less correlated with those of the United States. The mechanism is straightforward: when short rates exhibit lower correlation, domestic quantity shocks exert a smaller effect on the price of risk associated with foreign short-term rates. Consequently, less of the shock is absorbed into the foreign country's long-term yields, and the impact manifests more prominently in the exchange rate.

IV. Further Discussion

In this section, we explore further the economic drivers of the pass-through from demand shocks to global financial markets. To this end, we use unexpected changes of the bid-to-cover ratio as a quantity-based measure of demand shocks, differentiate between different types of investors that are participating in auctions, and highlight the heterogeneous impact on prices from different agents. Further, we assess how the pass-through of demand shocks from Treasuries to global bond markets vary over time.

A. Bid-To-Cover Ratio

While the previous section relies on high-frequency data in Treasury futures to measure the impact of demand shocks, this section follows Ray et al. (2024) and employs the unexpected component of the bid-to-cover ratio as an alternative measure of excess demand. This measure is derived from the residuals of an AR(3) process, effectively accounting for varying levels of Treasury demand, as illustrated in Figure 2. By capturing deviations from expected bidding behavior, the measure provides a more nuanced understanding of shifts in demanded quantities. The measure directly informs about changes in demanded quantities and allows to further dig into the underlying nature of demand, which we explore even further in the next subsection.[7]

Table V summarizes the results for currency in bond markets. It providing strong support for our baseline regressions. While the coefficients are slightly smaller in magnitude, we again find a significant average impact of demand shocks on currencies (Panel A: 1.33) and bond markets (Panel B: 5.53), which is also significant for the majority of individual countries (FX: 8 out of 9; bonds: 5 out of 9).

[INSERT TABLE V HERE]

B. Nature of demand shocks - heterogeneous investor landscape

To further investigate the nature of demand shocks, we re-estimate the baseline regression, accounting for the heterogeneous characteristics of investors participating in U.S. Treasury auctions. This analysis focuses on two key dimensions of heterogeneity.

[7] Additional summary statistics of these measures are provided in Table A-VII in the Appendix.

First, we decompose the unexpected bid-to-cover ratio by bidder type, distinguishing between primary dealers, direct bidders, and indirect bidders. This decomposition allows us to understand how each category of participants contributes to variations in excess demand.

Second, we leverage data on the allocation amounts to different investor types. While this measure does not directly reveal the amounts that specific groups bid for and is only published with a delay, we hypothesize that a higher allocation to a particular group still provides meaningful insights into their demand for safe assets. This measure also offers a more granular breakdown of investor categories, distinguishing between investment funds, foreign investors, and "miscellaneous", which include depository institutions, individuals, dealers, pension funds, investment funds, foreign investors, and other investors. By analyzing these subgroups, we gain a deeper understanding of whose changes in demand cause propagation of shocks across different segments of the market. Tables VI and VII summarize the results, which are based on the following types of regressions:

$$\Delta s_t = \alpha + \beta_j \sum D_t^j + \varepsilon_t \qquad \Delta s_t = \alpha + \psi_k \sum All_t^k + \varepsilon_t$$
$$\Delta y_t = \alpha + \gamma_j \sum D_t^j + \varepsilon_t \qquad \Delta y_t = \alpha + \phi_k \sum All_t^k + \varepsilon_t$$

where D_t^j and All_t^k refer to the unexpected demand shock from bidder type j and the unexpected allocated amount to investor type k.

[INSERT TABLES VI and VII HERE]

Table VI confirms the heterogeneous impact of bidder types in both market segments. For currency (Panel A) and global bond markets (Panel B), it is particular the behavior of indirect bidders driving the pass-through from Treasury auctions to global markets. The impact of direct bidders and primary dealers, in contrast, is negligible and coefficients are not significant across almost all currencies and countries. These results highlight the pivotal role of foreign and global investors in Treasury markets, as indirect bidders, include demand from foreign central banks, sovereign wealth funds, and global financial institutions.

We further explore this conjecture in Table VII, by assessing the unexpected component that is allocated to a particular type of investor. In currency markets together with investment funds, foreign investors appear to be actively driving the appreciation of foreign currencies. Across all specification, the coefficients of foreign investors are positive, highly statistically significant, and slightly larger in magnitude compared to investment funds. In bond markets, the evidence is slightly weaker. Across countries, a larger allocation of Treasuries to investment funds increases bond returns (0.41), while the impact of foreign investors is more muted.

C. Exchange rates movements and the convenience demand for U.S. safe assets

Changes in foreign investors' demand for the relative safety of U.S. dollar assets can provide an alternative explanation for the co-movement of bond yields and exchange rates. Theoretical frameworks centered around changes in the convenience yields of U.S. and foreign safe assets predict that the U.S. dollar appreciates when the demand for U.S. Treasuries increases because of a higher convenience yield (Jiang et al., 2021). Our empirical results show that, on average, the U.S. dollar depreciates when investor demand for U.S. Treasuries unexpectedly increases at auction. These results are not necessarily mutually inconsistent. Changes in the relative convenience yields of U.S. Treasuries over foreign bonds are not the only driver of bond demand. Recent research on the time variation in the stock-bond correlation finds that the safety demand for U.S. Treasuries is a less important factor for the pricing of Treasuries and the U.S. dollar during days when the covariance of Treasury returns with the aggregate U.S. stock market return is high (Acharya and Laarits, 2023; Hu et al., 2024).

We follow Hu et al. (2024) and classify days in our sample into "risky days" and "safe days" depending on the correlation between equity and bond markets. To achieve this classification, we leverage high-frequency 5-minute data of equity and Treasury futures, and compute daily correlations between the two market segments.[8] Following Hu et al. (2024), we then compute an exponentially weighted average of the daily correlations, in order to reduce the level of noise in the estimate. As the correlation is mostly positive during our sample, we use the median to identify safe and risky regimes. Days, on which the co-movement between markets is above the median, are considered risky days, while days with a correlation below the median indicate safe days.

Hu et al. (2024) show that pricing on "risky days" is dominated by heightened interest-rate risk. As discussed in the previous section, we see our results about the co-movement of bond yields and exchanges rates as being consistent with changes in the price of interest risk as the underlying economic driver. Hence, we expect these results to strengthen if we restrict our sample to auction days where interest rate risk is the dominant pricing factor, that is "risky days" in the terminology

[8] As futures are traded almost 24-hours, the correlation measure is based on almost 288 intraday observations every day.

of Hu et al. (2024). In this subsection we show that this is indeed the case. Interestingly, we also show that on "safe days" the U.S. dollar appreciate in response to positive demand shifts at U.S. Treasury auction and the pass-through of price increases from U.S. Treasuries to global bonds is muted. These pricing patterns point to the safety properties of U.S. safe assets as being an important driver of U.S. Treasury demand on these days.

Table VIII reports results to the regression

$$\Delta s_t^{DOL} = \alpha + \beta_1 D_t^m + \beta_2 \rho_t^{SP500,m} + \gamma D_t^m \times \rho_t^{SP500,m} + \varepsilon_t$$

where Δs_t^{DOL} refers to returns of the dollar portfolio, D_t^m refers to the demand shock for Treasuries with maturity m, $\rho_t^{SP500,m}$ measures the daily correlation between equity futures and Treasuries with maturity m, and $D_t^m \times \rho_t^{SP500,m}$ is the interaction term between the two variables. We repeat the regression for Treasuries with maturities of 2-years to 10-years. The regression setup allows us to disentangle how the transmission of demand for U.S. Treasuries changes across safe and risky days.

[INSERT TABLE VIII HERE]

Across maturities we observe a similar pattern of the following form. Without the interaction term, the regressions resemble the previous benchmark results, i.e., an increase in demand for Treasuries as captured by changes in prices of Treasuries in a short window around auctions lead to an appreciation of foreign currencies. However, the regressions including the intercept terms suggest the response varies, depending on whether Treasuries are considered a risky or safe asset. Across the regression specifications we find that the pass-through of UST demand shocks to foreign exchange markets is higher when Treasuries are considered risky, while it the combined impact is negative when Treasuries are considered a safe haven. For example, focusing on Treasuries with maturities of 2-years, the combined effect of the demand shock when Treasuries are extremely risky (i.e., $\rho_t^{SP500,m} = 1$) is 6.14. In contrast, it is -2.17 when U.S. Treasuries are considered as safe (i.e., $\rho_t^{SP500,m} = -1$). A similar diverging pattern can be observed for the longer maturities, whereby the appreciation of the U.S. dollar becomes smaller the longer the maturities of the Treasuries.

Complementing the results on the pattern of the dollar portfolio, Figure 6 decomposes the cross-sectional pattern across currencies into safe and risky periods. Specifically, the blue (orange) scatters refer to periods classified as risky (safe). The following observations are worth noting:

First, the documented cross-sectional pattern is robust across different types of days and confirm our findings in Section III. In FX (global bond) markets, the cross-sectional relationship is negative (positive) across the two sub-sample periods. That said, in FX markets, the magnitude of the coefficient in the price impact regressions becomes notably smaller, as indicated by the level shift between the top-left and top-right panels. During days when Treasuries are considered risky assets, the price impact coefficients range between 1.5 and 6 bps, whereas during periods when Treasuries are considered safe, the cross-sectional average is closer to 1 bps. Second, the strongest divergence between different types of days can be observed for the typical investment currencies, AUD and NZD. Third, focusing on dynamics in bond markets, the magnitude of price impact coefficients declines only marginally across different types of days, but we find that the cross-sectional regression line is steeper on risky days. On safety days, short-rate correlations are higher, and there is stronger dispersion among countries. In particular GBP, CAD, AUD, and EUR yields co-move more strongly with those in the U.S., while the opposite movements in yields can be observe for the other countries.

Taken together, the results suggest that during times distress investor demand around Treasuries lead to weaker depreciation of foreign currencies, as investors seek to hold U.S. Treasuries due to the assets unique properties, such as its convenience yields.

[INSERT FIGURE 6 HERE]

Table IX provides evidence for this conjecture, accounting for the dynamics of convenience yields by using the measure by Diamond and Tassel (2022), i.e., it reports results to the regression

$$\Delta s_t^{DOL} = \alpha + \beta_1 \tilde{D}_t + \beta_2 CY_t^m + \gamma D_t^m \times CY_t^m + \varepsilon_t$$

where Δs_t^{DOL} refers to returns of the dollar portfolio and CY^m measures the convenience yields with maturity m, and $\tilde{D}_t$ refers to the first principal component of the demand shocks across Treasuries with different maturities.[9] As in the previous specification, we allow for an interaction term between the demand shock and, in this case, convenience yield measure, whereby their maturity ranges between 6-month and 2-years.

Overall, results in Table IX confirm the conjecture that the appreciation of foreign currencies is significantly dampened during times of distress when convenience yield turn positive and increase

[9] We use the first principal component for these regressions, as the maturities of the convenience yield measure don't align perfectly with the maturity of the debt instruments.

in magnitude. Across specifications, we find the interaction term has a negative sign, largely offsetting the unconditional effect captured by $\tilde{D}$. Further, the results confirm that the appreciation of foreign currencies is largely driven by periods when U.S. Treasuries are considered risky and demand of domestic and foreign investors for U.S. assets is low.

[INSERT TABLE IX HERE]

V. Conclusion

In this paper, we use high-frequency price changes in short windows around Treasury auctions to measure the impact of unexpected shifts in investor demand on foreign exchange and global bond markets. We find that an unexpected increase in demand for U.S. safe assets results in an immediate appreciation of foreign currencies relative to the U.S. dollar by approximately 2 basis points, and foreign bonds appreciate on average by over 8 basis points.

Through various analyses, we demonstrate that this relationship is a robust feature of the data. All major G9 currencies and foreign bonds appreciate following shifts in demand for U.S. safe assets, with the impact of shocks increasing monotonically with the maturity of the issued debt instruments—ranging from less than 1 basis point following auctions for 2-year Treasuries to nearly 4 basis points for 30-year Treasuries for currencies and more than 37 basis points for bonds. Moreover, these effects are not transitory or limited to the short window around auctions. In fact, demand shifts produce persistent and sizable effects, resulting in a significant appreciation of foreign currencies that lasts for up to two trading weeks.

Having established the statistical and economic significance of demand shifts on exchange rates and bonds, we proceed to analyze the underlying economic mechanisms, particularly focusing on the role of changes in risk premia. Treasury auctions, as regular and pre-scheduled events where the supply of assets is fixed and well-known to market participants, offer a quasi-ideal environment for testing theories of segmented markets and preferred-habitat investors.

Consistent with predictions of these models, we find that the price impact on currencies is stronger when short-term interest rates of the foreign country and the United States are less correlated. The opposite pattern can be observed for foreign bond markets. i.e., the price impact is more pronounced for foreign bonds when short-rate correlations between the two countries are high. In these cases, shifts in domestic bond supply exert a larger effect on the price of foreign short-term risk, resulting in a greater proportion of the effect being reflected in long-term foreign yields rather than in exchange rate movements. Consequently, this mechanism channels more of the demand shock into bond yields, diminishing its immediate impact on the exchange rate, while amplifying its effect for foreign bonds.

Collectively, our results provide support for the influence of investor demand shocks on exchange rates and bond markets, highlighting the role of market segmentation and preferred-habitat behavior in driving price dynamics.

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VI. Figures

Figure 1. FX Intraday Events and Treasury Auctions.
The figure illustrates the timeline of major intraday events in the foreign exchange market taking place during the main U.S. trading hours. Major macroeconomic releases and FOMC announcement are marked in grey as they commonly take place on regular pre-announced dates, while the other time stamps refer to daily events. All times refer to in Eastern Time (ET).

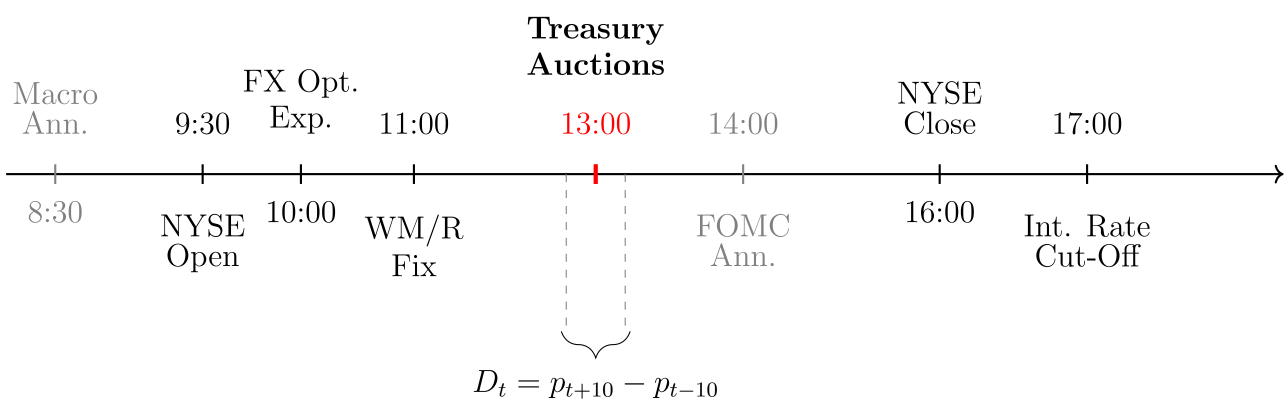


Figure 2. High-Frequency Measures and Demand Dynamics.
The figure shows the time-series of demand dynamics on auction days and responses in FX and bond markets. Panel A shows high-frequency returns of Treasury futures around auctions where different colors indicate different maturities of futures contract. Panel B shows the time series dynamics of the bid-to-cover ratio, distinguishing between indirect bidders, direct bidders and primary dealers. In Panel C, positive (negative) values refer to foreign currency appreciation, i.e., FC > 0 (FC < 0) and are marked in green (red) in a short window around auctions. In Panel D, shows the average reaction in global bond markets. The sample period is 2002 to 2018.

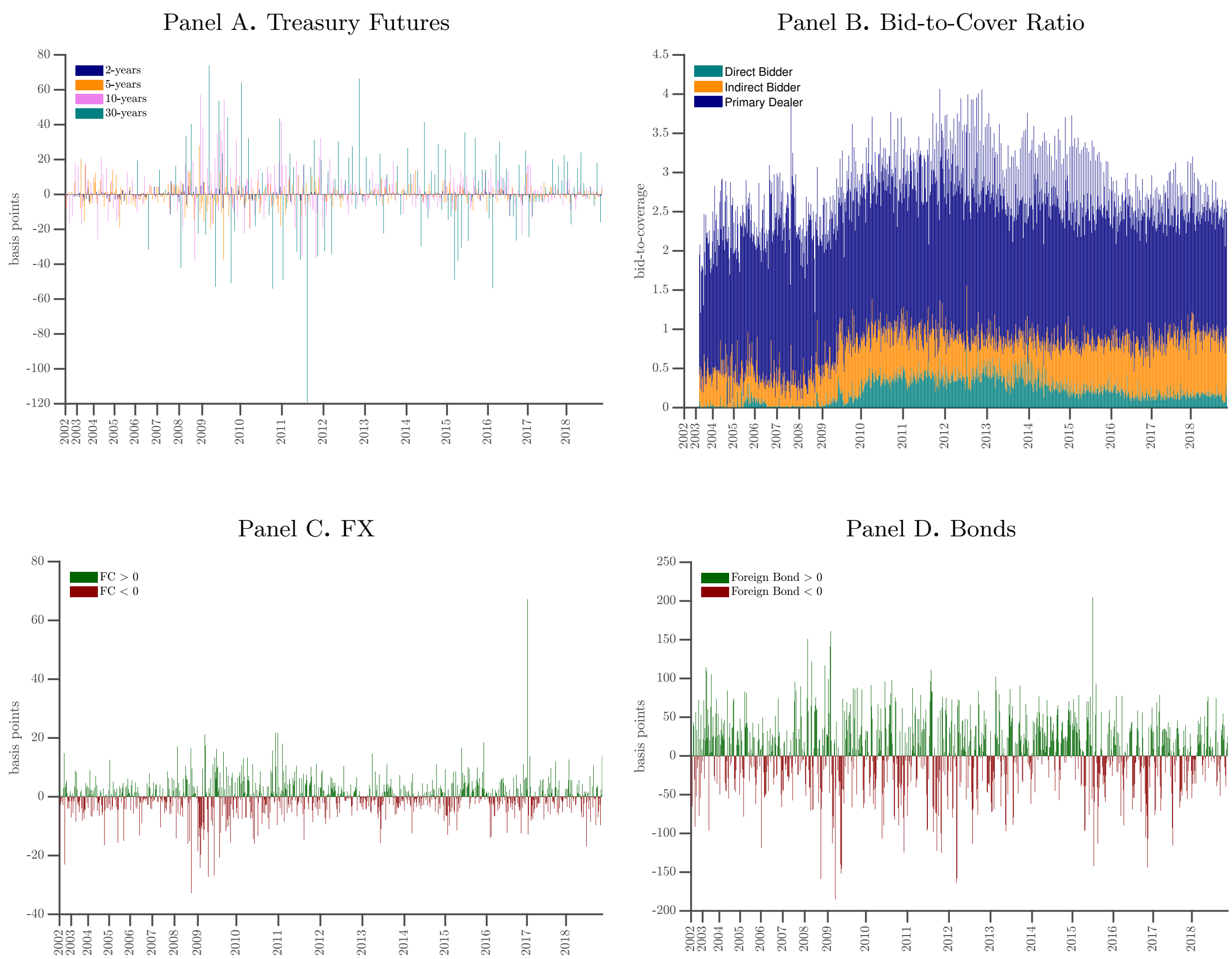
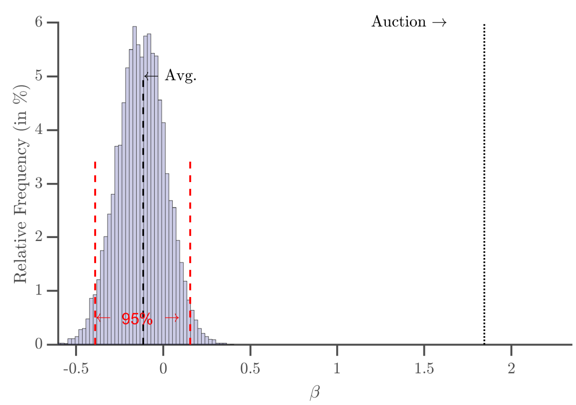


Figure 3. Placebo Exercise: Treasury Shocks on Non-Auction Days.
The figure shows the distributions of the β- and γ-coefficients from price impact panel regressions of the form

$$\Delta s_{i,t} = \alpha_i + \beta D_t^{Placebo} + \varepsilon_{i,t} \qquad \Delta y_{i,t} = \alpha_i + \gamma D_t^{Placebo} + \varepsilon_{i,t}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around the timing of auctions on non-auctions days (Panel A), and $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and $t+1$ on non-auction days (Panel B). $D_t^{Placebo}$ refers to a placebo demand shock, constructed for the same time frame as when Treasury auctions typically occur, but based on Treasury futures data from non-auction days. The distributions are obtained from repeating each regression 10,000 times, each time randomly drawing samples (with repetition) from non-auction days. The red-dashed line indicate the 95% confidence intervals, the black dashed line is the average of the distribution, and the dotted line indicates the size of the coefficient on auction days. The sample period is 2002 to 2018.

Panel A. FX



Panel B. Bonds

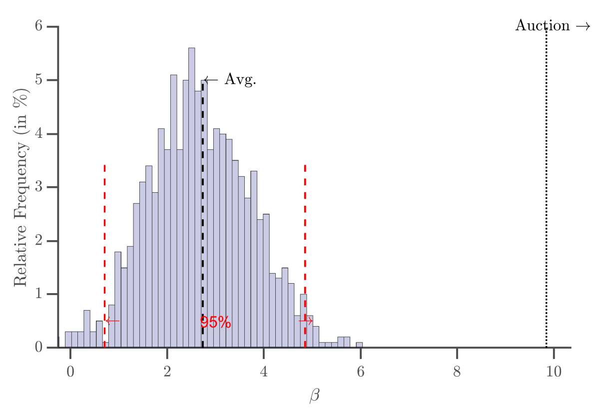
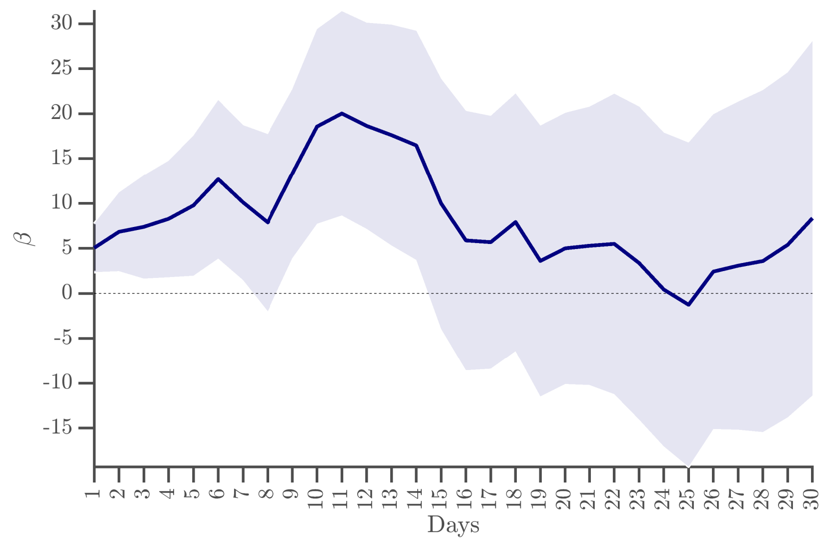


Figure 4. Persistence Shock Impact.

The figure shows the persistence impact of demand shocks obtained from local projections. In FX markets, returns are calculated using the price change between 8:00 a.m. on auction days and the end-of-day price for each of the following 30 days. In bond markets, returns are calculated using the price change between the end-of-day price before the auction and the end-of-day price for each of the following 30 days. In Panel A (Panel B), the solid blue (red) line refers to the estimated coefficient, while the blue shaded area (black-dashed lines) indicate 10% confidence intervals. The sample period is 2002 to 2018.

Panel A. FX



Panel B. Bonds

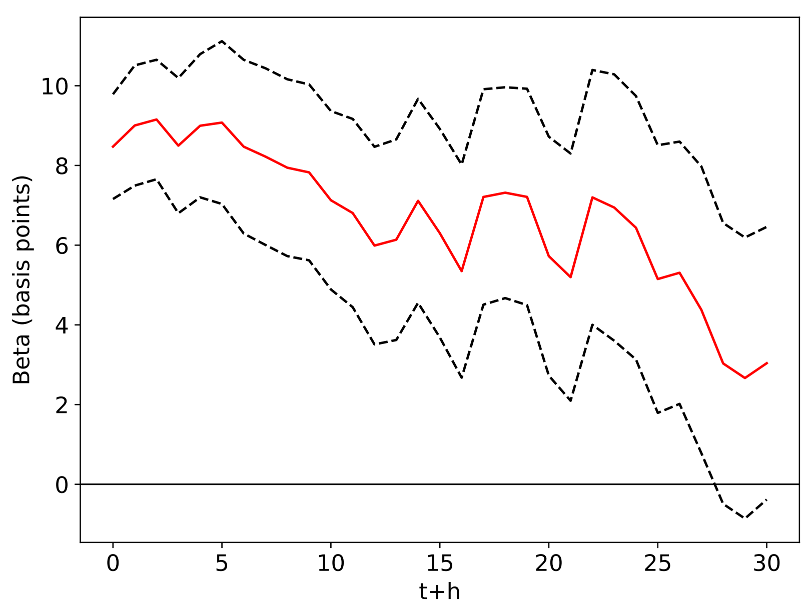


Figure 5. Short Rate Correlations and Demand Shocks.
The figure shows the relationship between short rate correlations and the price-impact of US Treasury demand shocks on FX (panel A) and 10-year government bonds (panel B). Short rate correlations are computed using a 5-year rolling window of monthly changes in 3-months yields. The price-impact of US Treasury demand shocks are the beta coefficients from regressing each G9 country's currency and 10-year government bond returns on the high-frequency US Treasury futures returns around auction. High-frequency currency returns around the auction deadline are used as the dependent variable for panel A, while daily 10-year government bond returns around the auction day are used for panel B. The sample period is 2002 to 2018.

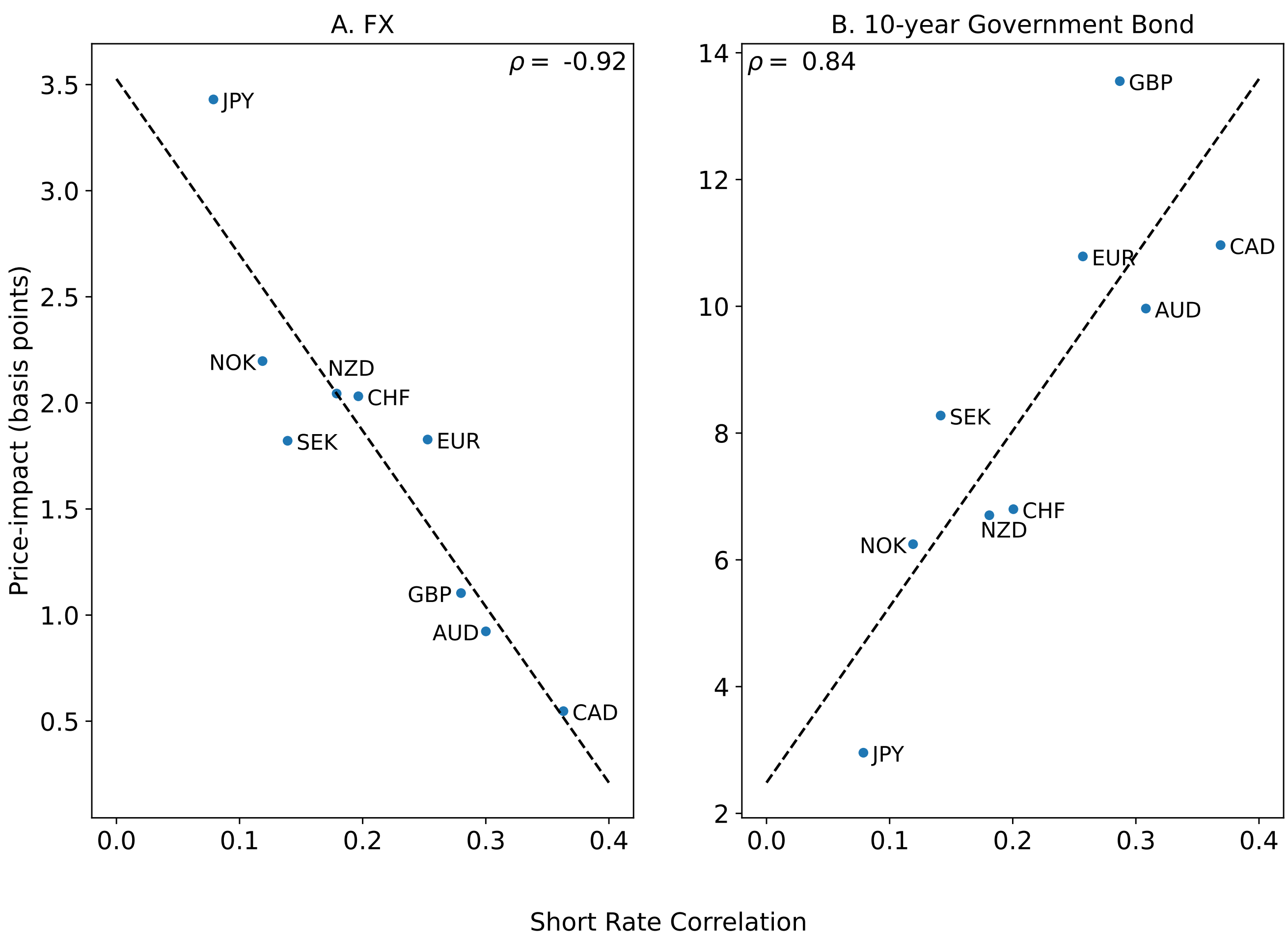
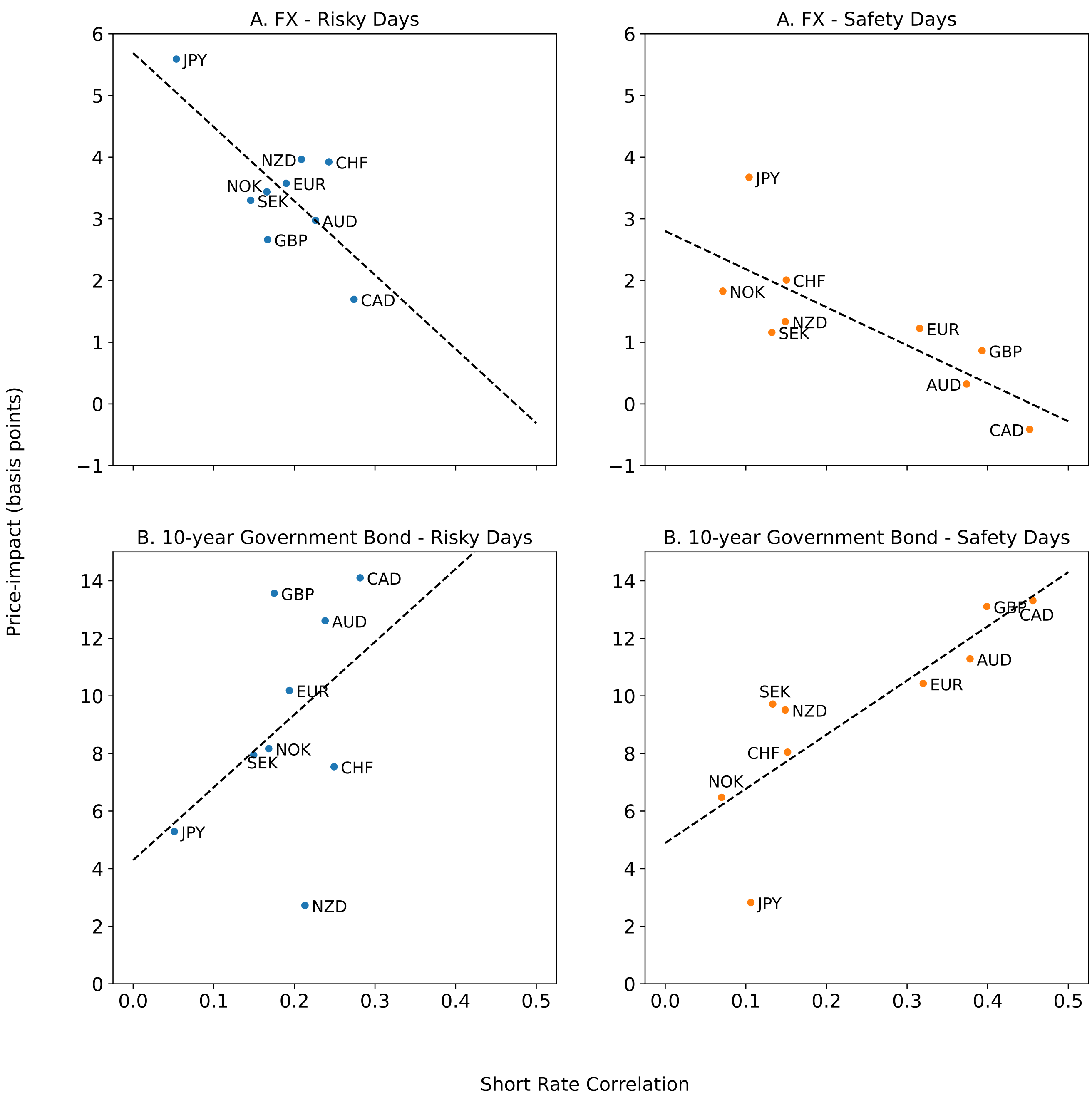


Figure 6. Short Rate Correlations and Demand Shocks: Safe and Risky Days

The figure shows the relationship between short rate correlations and the price-impact of US Treasury demand shocks on FX (top panels) and 10-year government bonds (bottom panels), distinguishing between auction days when treasuries are considered risky assets (left blue) or safe assets (right, orange). Short rate correlations are computed using a 5-year rolling window of monthly changes in 3-months yields. The price-impact of US Treasury demand shocks are the beta coefficients from regressing each G9 country's currency and 10-year government bond returns on the high-frequency US Treasury futures returns around auction. High-frequency currency returns around the auction deadline are used as the dependent variable for panel A, while daily 10-year government bond returns around the auction day are used for panel B. Treasuries are considered safe or risky, based on their intraday correlation with equity futures. The sample period is 2002 to 2018.



VII. Tables

Table I
Summary Statistics

This table reports summary statistics about treasury auctions (Panel A), for demand measures based on high-frequency (log) changes in US Treasury futures prices with different maturities (Panel B), for high-frequency foreign exchange (log) returns around auctions (Panel C), and for daily bond returns (Panel D). Returns for Treasury futures and FX rate are calculated based on a 20-minute window around the auction (expressed in basis points). In Panel C, a positive return means the currency appreciated vis-à-vis the USD. The sample period varies across panels, covering the years from 2002 to 2018.

Panel A: Treasury Auctions								
	Mean	Std	Min	P25	P50	P75	Max	N
Offering Amount (billions)	24.88	8.55	5.00	18.00	25.00	32.00	44.00	944
Total Tendered (billions)	69.20	29.13	11.62	43.66	69.53	89.70	160.96	944
Total Accepted (billions)	26.53	8.89	6.76	20.00	27.95	33.99	45.49	944
Term (Years)	8.52	8.83	1.99	3.00	5.00	9.92	30.02	944
High Yield	2.38	1.29	0.22	1.38	2.27	3.23	5.24	944
Bid-To-Cover Ratio	2.66	0.46	1.22	2.37	2.61	2.91	4.07	944
Direct Bidders	0.22	0.16	0.00	0.09	0.19	0.34	0.84	918
Indirect Bidders	0.55	0.18	0.03	0.43	0.54	0.68	1.11	918
Primary Dealers	1.90	0.34	0.97	1.65	1.86	2.09	3.12	918
Panel B: Demand Measures - Treasury Futures								
2-year	-0.21	2.84	-36.92	-0.73	0.00	0.71	7.88	339
5-year	-0.61	6.96	-38.16	-3.74	0.00	2.85	23.76	191
10-year	1.45	11.95	-59.93	-4.96	1.18	7.40	55.26	288
30-year	1.33	26.33	-114.51	-14.54	5.14	16.60	64.85	126
Panel C: Returns - Currency Markets								
DOL	-0.05	6.33	-32.74	-3.02	0.00	2.95	67.19	944
AUD	0.33	8.72	-53.22	-3.81	0.00	4.46	65.70	944
CAD	-0.40	7.43	-40.32	-3.75	-0.40	3.28	55.46	944
CHF	-0.15	7.71	-34.35	-4.11	-0.41	3.70	58.20	944
EUR	0.21	7.35	-40.33	-3.56	0.00	3.91	64.27	944
GBP	0.04	7.33	-43.51	-2.97	0.00	3.19	80.29	944
JPY	-0.21	8.93	-48.83	-4.00	0.00	3.43	106.57	944
NOK	-0.39	9.58	-68.70	-4.79	-0.18	4.52	55.05	944
NZD	0.27	9.67	-41.38	-4.62	0.00	4.44	93.99	944
SEK	-0.11	9.02	-41.43	-4.39	0.13	4.35	56.43	944
Panel D: Returns - Global Bond Markets								
DOL	3.54	45.93	-177.74	-25.62	7.65	33.57	155.78	916
AUD	7.70	74.36	-335.74	-37.68	10.65	56.84	217.50	916
CAD	0.70	61.13	-316.66	-34.43	4.90	35.44	199.73	916
CHF	0.59	45.36	-187.60	-24.89	2.97	29.33	198.83	916
EUR	2.83	61.88	-238.92	-30.43	7.98	41.92	262.27	916
GBP	4.49	71.61	-259.97	-37.34	8.61	49.93	384.23	916
JPY	2.87	30.52	-155.91	-11.99	3.95	18.19	140.86	916
NOK	5.29	63.32	-253.71	-27.72	7.88	39.45	263.93	916
NZD	2.98	77.70	-578.41	-31.93	5.83	43.35	470.09	916
SEK	4.37	59.57	-205.28	-32.75	9.94	41.99	185.02	916

Table II

Demand Shocks in Currency and Bond Markets

The table reports results to the following regressions:

$$\Delta s_{i,t} = \alpha_i + \beta D_t + \varepsilon_{i,t} \qquad \Delta y_{i,t} = \alpha_i + \gamma D_t + \varepsilon_{i,t}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t (Panel A), and $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and $t+1$ (Panel B). D_t refers to demand measures based on (log) changes in Treasury futures in a short window around an auction. Columns refer to auctions of Treasuries with tenors ranging between 2- to 30-years, and the column "Pooled" combines all auctions in one regression. In Panel B, 10-year bond returns are used for the column "Pooled". Numbers in parentheses refer to Driscoll and Kraay (1998)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is 2002-2018.

Panel A: Currency Markets					
	2-year	5-year	10-year	30-year	Pooled
D	0.70	1.72***	2.24**	3.66***	1.77***
	(0.51)	(0.51)	(0.90)	(0.63)	(0.37)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	3051	1719	2592	1134	8496
R^2	0.01	0.05	0.05	0.19	0.04
Panel B: Global Bond Markets					
	2-year	5-year	10-year	30-year	Pooled
D	1.05*	4.74***	7.01***	37.34***	8.47***
	(0.58)	(1.82)	(2.59)	(9.15)	(1.96)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	2952	1683	2475	1134	8244
R^2	0.00	0.02	0.01	0.04	0.02

Table III

Demand Shocks in Currency and Bond Markets: by Country

The table reports results to the following regressions:

$$\Delta s_{i,t} = \alpha_i + \beta D_t + \varepsilon_{i,t} \qquad \Delta y_{i,t} = \alpha_i + \gamma D_t + \varepsilon_{i,t}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t (Panel A), and $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and $t+1$ (Panel B). D_t refers to demand measures based on (log) changes in Treasury futures in a short window around an auction. Numbers in parentheses refer to t-statistics, based on Newey and West (1987)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is

Panel A: Currency Markets										
	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
D	0.92	0.55	2.03***	1.83***	1.10***	3.43***	2.20***	2.04***	1.82***	1.78***
	(0.70)	(0.42)	(0.41)	(0.38)	(0.42)	(0.70)	(0.40)	(0.57)	(0.46)	(0.39)
N	944	944	944	944	944	944	944	944	944	944
R^2	0.01	0.01	0.07	0.06	0.02	0.15	0.05	0.04	0.04	0.08
Panel B: Global Bond Markets										
	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
D	9.96***	10.97***	6.80***	10.79***	13.55***	2.96**	6.25***	6.70***	8.28***	8.47***
	(2.51)	(2.87)	(2.19)	(2.68)	(3.20)	(1.37)	(2.22)	(2.04)	(2.51)	(1.93)
N	916	916	916	916	916	916	916	916	916	916
R^2	0.02	0.03	0.02	0.03	0.04	0.01	0.01	0.01	0.02	0.03

Table IV

Short-Rate Correlation and Demand Shock Pass-Through

The table reports results to the following regressions:

$$\Delta s_{i,t} = \alpha_i + \beta D_t \times \rho_{i,t}^{SR} + \varepsilon_{i,t} \qquad \Delta y_{i,t} = \alpha_i + \gamma D_t \times \rho_{i,t}^{SR} + \varepsilon_{i,t}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t, and $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and $t+1$. $D_t \times \rho_{i,t}^{SR}$ refers to an interaction term between demand measures based on (log) changes in Treasury futures in a short window around an auction and the short-rate correlation between foreign country i and the U.S., using the past 5-year monthly changes of 3-month government yields. Numbers in parentheses refer to t-statistics, based on Newey and West (1987)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is

		Bonds			
	FX	2-year	5-year	10-year	30-year
$D_t \times \rho_{i,t}^{SR}$	-0.408***	0.066	0.388*	1.584***	3.124***
	(-7.79)	(0.80)	(1.81)	(3.99)	(3.17)
N	8,514	8,550	8,550	8,550	8,550
R^2	0.561	0.232	0.436	0.544	0.446

Table V

Bid-to-Cover Ratio: Currency and Global Bond Markets

The table reports results to the following regressions:

$$\Delta s_t = \alpha + \beta D_t^{BC} + \varepsilon_t \qquad \Delta y_t = \alpha + \gamma D_t^{BC} + \varepsilon_t$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t (Panel A), and $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and $t+1$ (Panel B). D_t^{BC} refers to demand measures based on unexpected changes in the total bid-to-cover ratio (BC). Numbers in parentheses refer to t-statistics, based on Newey and West (1987)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is 2002 - 2018.

Panel A: Currency Markets										
	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
Bid-to-Cover Ratio	0.90*	0.23	1.54***	1.29***	1.08***	2.27***	1.64***	1.92***	1.16***	1.33***
	(0.47)	(0.36)	(0.42)	(0.40)	(0.36)	(0.50)	(0.49)	(0.51)	(0.45)	(0.30)
N	944	944	944	944	944	944	944	944	944	944
R^2	0.01	0.01	0.02	0.02	0.01	0.03	0.04	0.02	0.01	0.03
Panel B: Global Bond Markets										
	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
Bid-to-Cover Ratio	7.42*	8.01***	5.66***	4.38	9.62***	0.79	4.00	5.15*	4.70	5.53**
	(4.09)	(3.02)	(2.13)	(2.79)	(3.21)	(1.68)	(3.01)	(3.02)	(3.00)	(2.17)
N	916	916	916	916	916	916	916	916	916	916
R^2	0.01	0.02	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.01

Table VI
Demand Shocks by Bidder Type

The table reports results to the following regressions:

$$\Delta s_t = \alpha + \beta_j \sum D_t^j + \varepsilon_t \qquad \Delta y_t = \alpha + \gamma_j \sum D_t^j + \varepsilon_t$$

Δs_t refers to the returns of currency in a small window around an auction on date t (Panel A) and Δy_t refers to the returns of foreign bonds between day $t+1$ and $t-1$ around an auction on date t (Panel B). D_t^j refers to demand measures based on changes of the bid-to-cover ratio of bidder type j. Numbers in parentheses refer to t-statistics, based on Newey and West (1987)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is 2003-2018.

Panel A: Currency Markets

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
Direct Bidders	0.26	-0.05	0.55	0.55	0.28	1.84**	0.47	0.17	0.86	0.55
	(0.71)	(0.63)	(0.52)	(0.48)	(0.50)	(0.73)	(0.65)	(0.78)	(0.71)	(0.48)
Indirect Bidders	2.02***	1.11***	1.39***	1.30***	1.19***	2.13***	1.98***	2.56***	1.55***	1.69***
	(0.51)	(0.39)	(0.44)	(0.41)	(0.44)	(0.48)	(0.52)	(0.52)	(0.49)	(0.35)
Primary Dealers	0.00	-0.22	0.61	0.34	0.31	1.16***	0.53	0.97*	0.15	0.43
	(0.44)	(0.39)	(0.38)	(0.32)	(0.37)	(0.43)	(0.44)	(0.50)	(0.38)	(0.28)
N	914	914	914	914	914	914	914	914	914	914
R^2	0.04	0.04	0.03	0.04	0.02	0.06	0.06	0.05	0.03	0.06

Panel B: Global Bond Markets

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
Direct Bidders	7.87	0.06	1.21	1.80	2.63	2.25	3.80	11.98**	-1.34	3.36
	(5.64)	(3.93)	(3.29)	(4.52)	(4.86)	(2.05)	(5.84)	(4.75)	(4.65)	(3.55)
Indirect Bidders	3.66	7.95**	3.63	8.10***	11.07***	1.35	2.95	3.50	7.67**	5.54**
	(3.55)	(3.52)	(2.29)	(3.01)	(3.80)	(1.48)	(3.18)	(3.41)	(3.12)	(2.30)
Primary Dealers	4.97	3.84	5.28**	3.15	5.59	-0.72	0.38	2.86	3.69	3.23
	(4.26)	(2.95)	(2.52)	(3.10)	(3.42)	(1.89)	(3.35)	(2.85)	(3.25)	(2.39)
N	886	886	886	886	886	886	886	886	886	886
R^2	0.03	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.02

Table VII

Auction Allocation: Heterogeneous Investor Types

The table reports results to the following regressions:

$$\Delta s_t = \alpha + \psi_j \sum All_t^k + \varepsilon_t \qquad \Delta y_t = \alpha + \phi_j \sum All_t^k + \varepsilon_t$$

Δs_t refers to the returns of currency in a small window around an auction on date t (Panel A) and Δy_t refers to the returns of foreign bonds between day $t+1$ and $t-1$ around an auction on date t (Panel B) All_t^k refers to the unexpected allocation of treasuries to investor group k. Numbers in parentheses refer to t-statistics, based on Newey and West (1987)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is

Panel A: Currency Markets										
	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Investment Funds	0.15***	0.03	0.10***	0.11***	0.10***	0.12***	0.18***	0.16***	0.15***	0.12***
	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)	(0.04)	(0.03)
Foreign Investors	0.19***	0.11**	0.11**	0.16***	0.11***	0.15***	0.19***	0.20***	0.15***	0.15***
	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)	(0.04)
Miscellaneous	-0.00	0.06**	0.05	0.04	0.02	0.04	0.02	-0.01	0.03	0.03
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.05)	(0.04)	(0.03)
N	944	944	944	944	944	944	944	944	944	944
R^2	0.04	0.03	0.02	0.04	0.02	0.03	0.04	0.04	0.03	0.05

Panel B: Global Bond Markets										
	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	DOL
Investment Funds	0.27	0.65**	0.20	0.58**	0.69**	0.11	0.33	0.40	0.45*	0.41**
	(0.31)	(0.27)	(0.19)	(0.25)	(0.31)	(0.13)	(0.31)	(0.33)	(0.26)	(0.20)
Foreign Investors	0.32	0.16	0.11	0.31	0.39	0.04	0.22	0.11	0.60**	0.25
	(0.37)	(0.36)	(0.22)	(0.29)	(0.39)	(0.16)	(0.28)	(0.33)	(0.28)	(0.23)
Miscellaneous	-0.00	0.33	0.03	0.13	0.20	-0.03	-0.15	-0.27	-0.17	0.01
	(0.51)	(0.37)	(0.28)	(0.35)	(0.39)	(0.25)	(0.37)	(0.47)	(0.35)	(0.29)
N	916	916	916	916	916	916	916	916	916	916
R^2	0.02	0.02	0.01	0.02	0.02	0.04	0.01	0.03	0.02	0.02

Table VIII

Treasury Demand Pass through on Safe and Risky Days

This table reports regression results of the form

$$\Delta s_t^{DOL} = \alpha + \beta_1 D_t^m + \beta_2 \rho_t^{SP500,m} + \gamma D_t^m \times \rho_t^{SP500,m} + \varepsilon_t$$

where Δs_t^{DOL} refers to returns of the dollar portfolio, D^m refers to the demand shock for Treasuries with maturity m, $\rho_t^{SP500,m}$ measures the daily correlation between equity futures and Treasuries with maturity m, and $D_t^m \times \rho_t^{SP500,m}$ is the interaction term between the two variables. Numbers in parentheses refer to t-statistics based on Newey and West (1987)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. For brevity the intercept term is omitted. The sample period is 2002-2018.

	DOL	DOL	DOL	DOL	DOL	DOL
D_t^{2Y}	0.570***	1.984***				
	(3.51)	(5.15)				
$\rho_t^{SP500,2Y}$		0.000				
		(1.10)				
$D_t^{2Y} \times \rho_t^{SP500,2Y}$		4.157***				
		(3.65)				
D_t^{5Y}			0.317***	0.805***		
			(5.14)	(4.56)		
$\rho_t^{SP500,5Y}$				0.000		
				(0.70)		
$D_t^{5Y} \times \rho_t^{SP500,5Y}$				1.286***		
				(3.00)		
D_t^{10Y}					0.209***	0.510***
					(5.76)	(4.65)
$\rho_t^{SP500,10Y}$						0.000
						(0.36)
$D_t^{10Y} \times \rho_t^{SP500,10Y}$						0.774***
						(2.90)
R^2	0.04	0.11	0.09	0.12	0.10	0.13

Table IX
Treasury Demand Pass through and Convenience Yields

This table reports regression results of the form

$$\Delta s_t^{DOL} = \alpha + \beta_1 \tilde{D}_t + \beta_2 CY_t^m + \gamma D_t^m \times CY_t^m + \varepsilon_t$$

where Δs_t^{DOL} refers to returns of the dollar portfolio, $\tilde{D}_t^m$ refers to the first principal component of the demand shock across Treasuries with different maturities, CY_t^m measures the convenience yields with maturity m, and $D_t^m \times CY_t^m$ is the interaction term between the two variables. Numbers in parentheses refer to t-statistics based Newey and West (1987)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. For brevity the intercept term is omitted. The sample period is 2002-2018.

	DOL	DOL	DOL	DOL
$\tilde{D}_t$	1.115***	1.721***	1.889***	2.108***
	(-5.72)	(-6.83)	(-7.25)	(-6.86)
CY_t^{6M}		0.004		
		(-0.26)		
$\tilde{D}_t \times CY^{6M}$		-1.248**		
		(-2.32)		
CY_t^{1Y}			-0.007	
			(-0.40)	
$\tilde{D}_t \times CY_t^{1Y}$			-1.721***	
			(-3.05)	
CY_t^{2Y}				-0.011
				(-0.68)
$\tilde{D}_t \times CY_t^{2Y}$				-1.982***
				(-3.40)
R^2	0.10	0.12	0.12	0.14

AH. Appendix: Stylized Model and Hypothesis Building

In this section we briefly review a basic version of Greenwood et al. (2023) where shocks to the foreign and domestic short-term risk-free interest rates (short rates) are the only risk factor. This simple model demonstrates how risk premia in bonds and exchange rates react in response to unexpected shifts in the demand for domestic bond. It allow shows how the sensitivity of bond yields and the exchange rate to these demand shock vary with the correlation of the domestic and foreign risk-free short-term interest rates.

Risk averse global arbitrageurs[10] absorb excess demand from preferred habitat investors in domestic and foreign bond market as well as the foreign exchange market. They are the marginal investors in all markets. Their respective portfolio holdings of domestic bond, foreign bonds and foreign exchange contracts (borrow domestic at short rate, lend at foreign short rate) are s^y, s^{y^*}, and s^q, respectively, and are treated as constant and exogenous. To study the effect of an increase in preferred habitat investors' demand for domestic bonds we perform comparative statics of equilibrium prices with respect to the parameter s^y. Specifically, we check how bond yields and the exchange rate change when s^y goes down, that is when arbitrageurs hold fewer domestic bonds.

Arbitrageurs are engaged in three types of trades: (i) domestic term structure trades, (ii) foreign term structure trades, and (iii) uncovered interest rate parity (UIP) trades. Term structure trades involve borrowing at the local short rate and investing into the local long-term bond. In the UIP trade arbitrageurs borrow at the domestic short rate, convert the funds into foreign currency and invest them at the foreign short rate.

The linearized excess log returns for the three trades are

$$rx_{t+1}^{y} = \left(\frac{1}{1-\delta}\right) y_t - \left(\frac{\delta}{1-\delta}\right) y_{t+1} - i_t, \qquad \text{(domestic term structure)}$$

$$rx_{t+1}^{y^*} = \left(\frac{1}{1-\delta}\right) y_t^* - \left(\frac{\delta}{1-\delta}\right) y_{t+1}^* - i_t^*, \qquad \text{(foreign term structure)}$$

$$rx_{t+1}^{q} = (q_{t+1} - q_t) + (i_t^* - i_t), \qquad \text{(UIP)}$$

where y_t is the yield-to-maturity of the domestic bond, a risk-free perpetuity with payments

[10] Arbitrageurs has mean-variance preferences over next period wealth with risk tolerance τ. They are modeled similar to arbitrageurs in the canonical Vayanos and Vila (2021) segmented-markets model.

declining at a geometric rate of δ.[11] y_t^* is the yield-to-maturity of an equivalent foreign bond. i_t and i_t^* are the domestic and foreign short rates. q_t is the exchange rate in terms of units of domestic currency per unit of foreign currency.

The domestic and foreign short rates are exogenous auto-regressive processes with constant volatility and correlated shocks,

$$i_{t+1} = \bar{i} + \phi(i_t - \bar{i}) + \varepsilon_{t+1},$$
$$i_{t+1}^* = \bar{i} + \phi(i_t^* - \bar{i}) + \varepsilon_{t+1}^*,$$

where $Var_t(\varepsilon_{t+1}) = Var_t(\varepsilon_{t+1}^*) = \sigma$ and $Corr(\varepsilon_{t+1}, \varepsilon_{t+1}^*) = \rho > 0$.

Greenwood et al. (2023) show that, in equilibrium, expected excess log returns have the following form

$$\begin{aligned}
\mathbb{E}_t(rx_{t+1}^y) &= \frac{1}{\tau}\left(V_y\, s^y + C_{y,y^*}\, s^{y^*} + C_{y,q}\, s^q\right), \\
\mathbb{E}_t(rx_{t+1}^{y^*}) &= \frac{1}{\tau}\left(C_{y,y^*}\, s^y + V_y\, s^{y^*} - C_{y,q}\, s^q\right), \\
\mathbb{E}_t(rx_{t+1}^q) &= \frac{1}{\tau}\left[C_{y,q}(s^y - s^{y^*}) + V_q\, s^q\right],
\end{aligned}$$

where

$$\begin{aligned}
V_y = Var_t(rx_{t+1}^y) = Var_t(rx_{t+1}^{y^*}) &= \left(\frac{\delta}{1-\delta\phi}\right)\sigma^2, \\
V_q = Var_t(rx_{t+1}^q) &= 2\left(\frac{1}{1-\phi}\right)^2 (1-\rho)\sigma^2, \\
C_{y,y^*} = Cov_t(rx_{t+1}^y, rx_{t+1}^{y^*}) &= \left(\frac{\delta}{1-\delta\phi}\right)^2 \rho\,\sigma^2, \\
C_{y,q} = Cov_t(rx_{t+1}^y, rx_{t+1}^q) = -Cov_t(rx_{t+1}^{y^*}, rx_{t+1}^q) &= \left(\frac{\delta}{1-\delta\phi}\right)\left(\frac{1}{1-\phi}\right)(1-\rho)\sigma^2.
\end{aligned}$$

These expressions can be used to compute comparative statics of the expected excess log

[11] $D = 1/(1-\delta)$ is the duration of the bond.

returns with respect to arbitrageurs' domestic bond holdings s_y:

$$\frac{d\,\mathbb{E}_t\, rx^{y}_{t+1}}{d\,s^y} = \frac{V_y}{\tau} > 0,$$

$$\frac{d\,\mathbb{E}_t\, rx^{y*}_{t+1}}{d\,s^y} = \frac{C_{y,y^*}}{\tau} > 0, \qquad \text{(Hypothesis 1)}$$

$$\frac{d\,\mathbb{E}_t\, rx^{q}_{t+1}}{d\,s^y} = \frac{C_{y,q}}{\tau} > 0. \qquad \text{(Hypothesis 2)}$$

When arbitrageurs' exposures to the interest rate risk contained in domestic bond increases, i.e., s^y goes up, the price of domestic interest rate risk. Both domestic and foreign term structure trades and the UIP trade are negatively exposed to this interest rate risk. As short rates are positively correlated, term structure trades suffer losses if the domestic short rate goes up. The UIP trade also makes losses as domestic and foreign short rates are not perfectly correlated which implies that domestic financing costs for the UIP trade increase by more than the returns on the foreign investment. Consequently, expected excess log returns for all three trades have to increase. This is the mechanism that underlies Hypotheses 1 and 2 of section III.

To obtain the results that underpin Hypotheses 3a and 3b, we can perform comparative statics with respect to the short-rate correlation ρ for the sensitivities of foreign bond yields and the exchange rate to shifts in domestic bond demand:

$$\frac{d}{d\,\rho}\left(\frac{d\,\mathbb{E}_t\, rx^{y*}_{t+1}}{d\,s^y}\right) = \frac{1}{\tau}\left(\frac{\delta}{1-\delta\phi}\right)^2 \sigma^2 > 0, \qquad \text{(Hypothesis 3a)}$$

$$\frac{d}{d\,\rho}\left(\frac{d\,\mathbb{E}_t\, rx^{q}_{t+1}}{d\,s^y}\right) = -\frac{1}{\tau}\left(\frac{\delta}{1-\delta\phi}\right)\left(\frac{1}{1-\phi}\right) \sigma^2 < 0. \qquad \text{(Hypothesis 3b)}$$

As the correlation between the domestic and the foreign short rate increases, the exposure to losses from interest rate increase in domestic and foreign term structure trades become more aligned. Hence, their term premia co-move more strongly. The UIP trade has a negative exposure to domestic short-rate risk but a positive exposure to foreign short rate risk. An increase in the correlation of the short rates means that the two risk factors offset each other to a greater extent implying a lower exchange rate risk premium.

AI. Appendix: Figures

Figure A-1. Local Projections: Individual Currencies

The figure shows results from local projections for individual currencies whereby the independent variable is the shock in demand in Treasury markets, as measured by changes in Treasury futures in a short window around auctions. The dependent variable is the change in log prices at the start of the trading day of the auction at 8:00 (EST) and to the end of the trading day h days after the auction $(t + h)$. The sold blue line refers to the regression coefficient while the dashed-area indicate 10% confidence intervals. The sample period is 2002 to 2018.

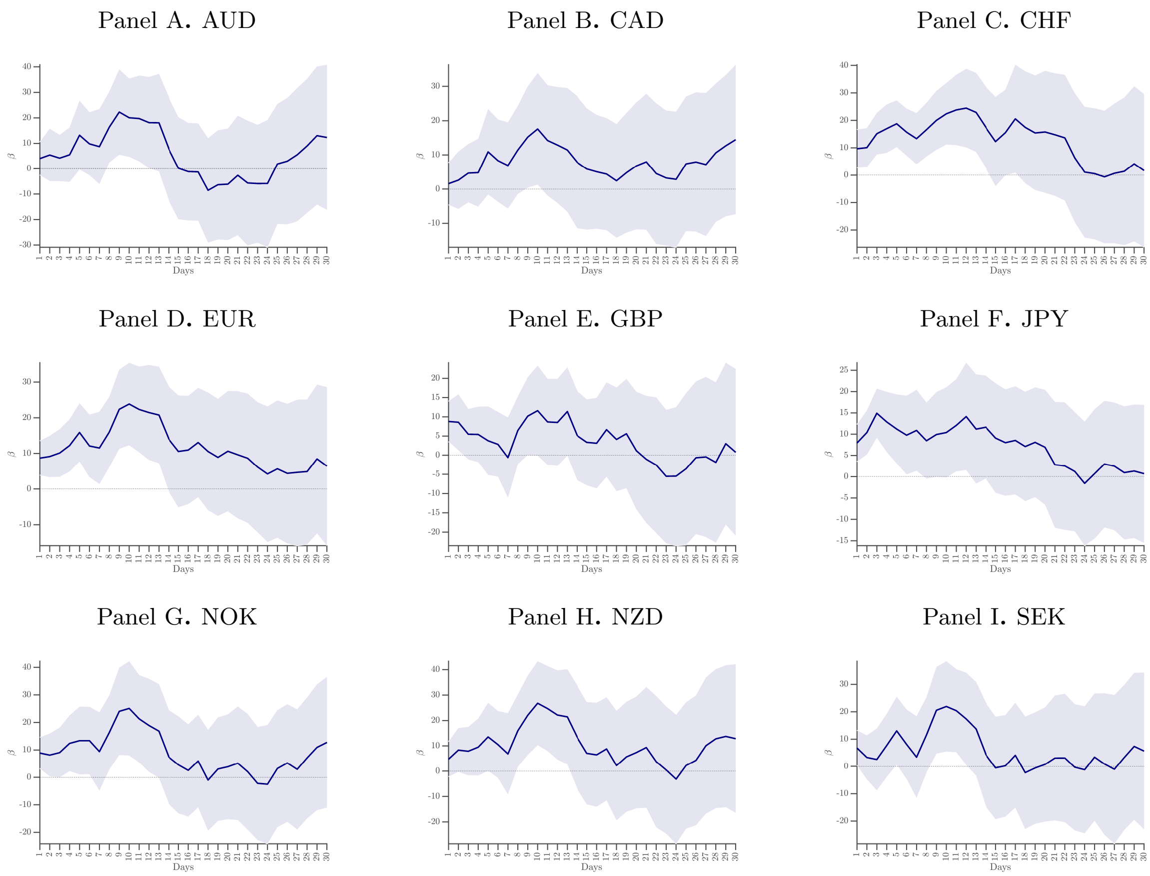
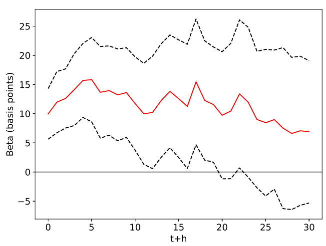
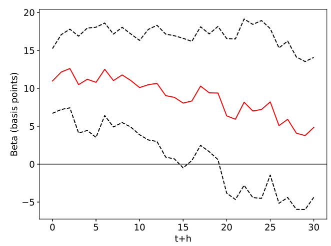


Figure A-2. Local Projections: Foreign Bond Markets - Individual Countries
The figure shows results from local projections for individual foreign bond markets whereby the independent variable is the shock in demand in Treasury markets, as measured by changes in Treasury futures in a short window around auctions. The dependent variable is the change in foreign yields between the day before the auction $t-1$ and h days after the auction $(t+h)$. The red line refers to the regression coefficient while the black lines are 10% confidence intervals. The sample period is 2002 to 2018.

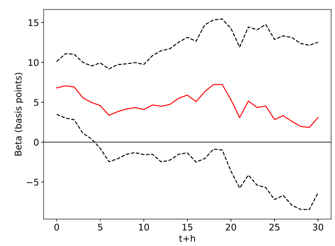
Panel A. AUD



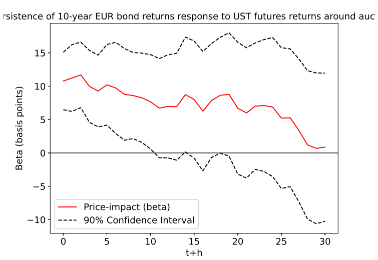
Panel B. CAD



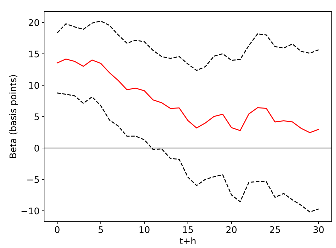
Panel C. CHF



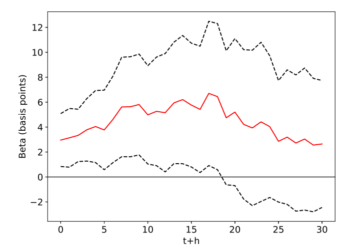
Panel D. GER



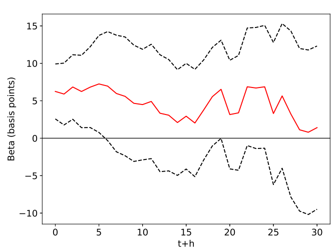
Panel E. GBP



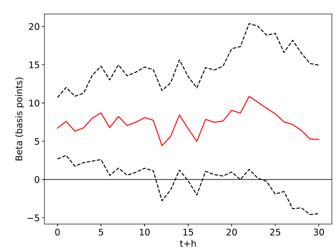
Panel F. JPY



Panel G. NOK



Panel H. NZD



Panel I. SEK

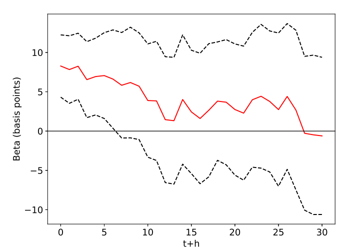
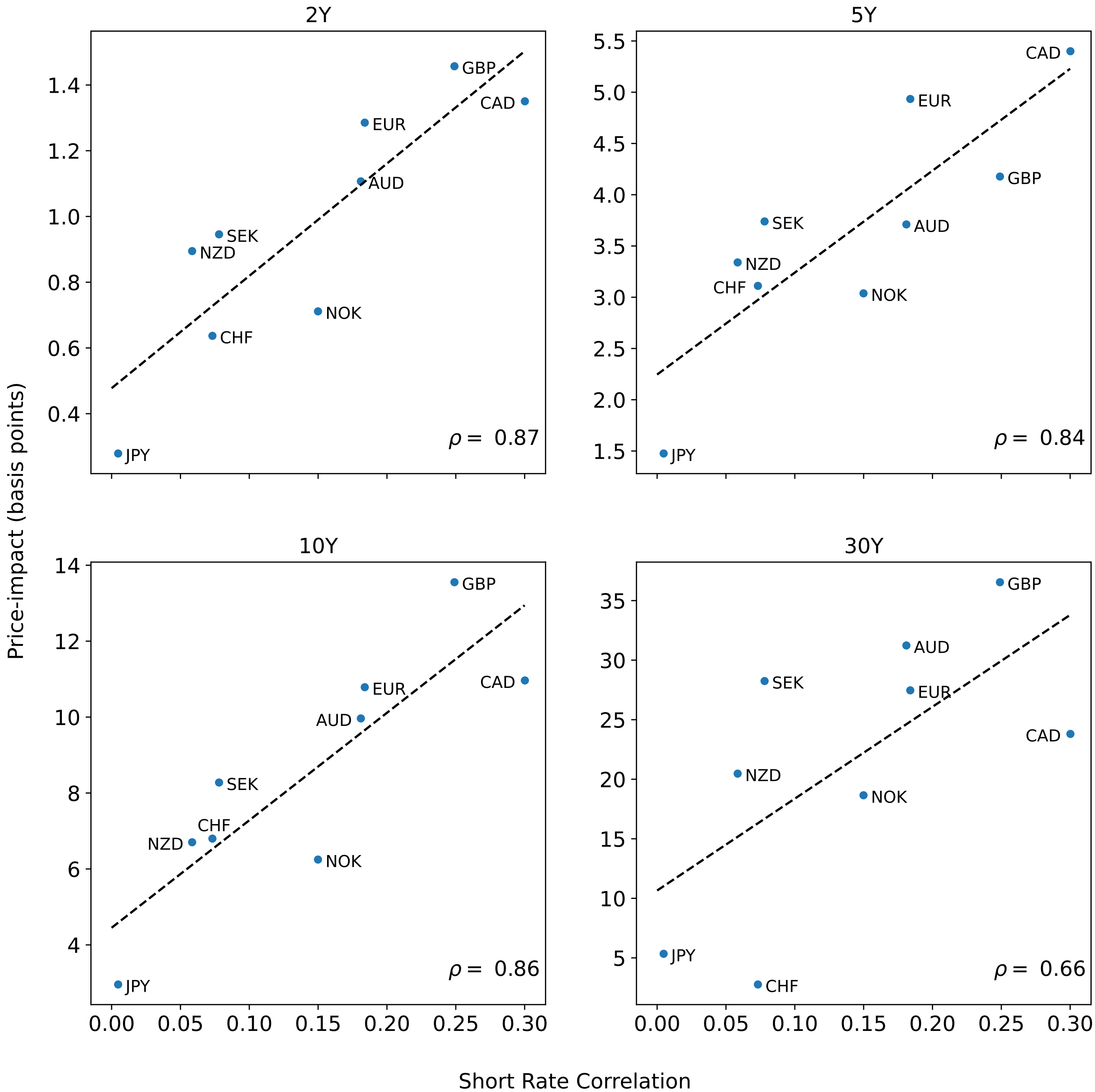


Figure A-3. Short Rate Correlations and Demand Shocks: Various Maturities The figure shows the relationship between short rate correlations and the price-impact of US Treasury demand shocks on government bonds with maturities ranging between 2- and 30-years. Short rate correlations are based on weekly changes in 3-month Treasury bill yields for each G9 country vis-à-vis the US. The price-impact of US Treasury demand shocks are the beta coefficients from regressing each countries government bond returns on the high-frequency US Treasury futures returns around auction. Government bond returns on auction days are based on price changes between day $t+1$ and $t-1$. The sample period is 2002 to 2018.



AJ. Appendix: Tables

Table A-I

Foreign Short Rates

This table reports regression results of daily returns in 3-month foreign country Treasury bills on intraday US Treasury futures returns (Panel A) and the bid-coverage ratio along with its 4-lags (Panel B). Columns 1-9 reports results for individual foreign countries. Column 10 reports the result for the DOL portfolio, defined as the average return across the 3-month Treasury bills of the countries reported in columns 1-9. Coefficients are standardized to represent a 1 standard deviation change in US Treasury futures return or the bid-to-cover ratio. Numbers in parentheses refer to Driscoll and Kraay (1998)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is 2002-2018.

Panel A: US Treasury Futures

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	USD	DOL
D	0.12**	0.02	0.02	-0.02	0.02	-0.00	-0.02	0.04	0.06	0.04	0.03
	(0.06)	(0.02)	(0.02)	(0.03)	(0.03)	(0.01)	(0.08)	(0.06)	(0.05)	(0.03)	(0.02)
N	916	916	916	916	916	916	916	916	916	916	916
R^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Panel B: Bid-to-Cover Ratio

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	USD	DOL
D	-0.00	-0.01	-0.01	0.07*	0.06	-0.02	-0.14	0.04	0.07	0.04	0.01
	(0.07)	(0.04)	(0.02)	(0.04)	(0.04)	(0.02)	(0.09)	(0.09)	(0.10)	(0.06)	(0.02)
N	916	916	916	916	916	916	916	916	916	916	916
R^2	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01

Table A-II

Demand Shocks: Alternative Window Sizes

The table reports results to the following regression:

$$\Delta s_{i,t} = \alpha_i + \beta D_t + \varepsilon_{i,t} \tag{4}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t and D_t refers to demand measures based on price changes of U.S. Treasury futures across different window lengths. Numbers in parentheses refer to t-statistics, based on Driscoll and Kraay (1998)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is January 2002 to December 2018.

Panel A: US Treasury Futures					
	2-year	5-year	10-year	30-year	Pooled
	(0.51)	(0.51)	(0.9)	(0.63)	(0.37)
-10mto+15m	0.77**	1.8***	2.29***	3.62***	1.82***
	(0.34)	(0.4)	(0.77)	(0.68)	(0.35)
-10mto+20m	0.05	2.08***	2.4**	3.97***	1.7***
	(0.37)	(0.49)	(1.12)	(0.57)	(0.52)
-15mto+15m	0.9**	1.54**	2.27***	3.66***	1.81***
	(0.44)	(0.6)	(0.83)	(1.04)	(0.37)
-15mto+30m	0.46	2.2***	2.55**	4.73***	2.02***
	(0.55)	(0.51)	(1.27)	(1.12)	(0.54)
-20mto+20m	0.65	2.04***	2.76***	4.0***	2.02***
	(0.43)	(0.54)	(1.06)	(0.77)	(0.48)

Table A-III
Alternative High-Frequency FX Datasets

This table reports beta coefficients from regressions of intraday returns of the DOL portfolio calculated from different datasets on intraday US Treasury futures returns. Column 1 reports the beta coefficient for the sample of 2-year auctions, column 2 for 3- and 5-year auctions, column 3 for 7- and 10-year auctions, column 4 for 20- and 30-year auctions, and column 5 pools all auctions. Numbers in parentheses refer to Driscoll and Kraay (1998)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is 2011-2018.

Panel A: US Treasury Futures					
	2-year	5-year	10-year	30-year	Pooled
	(1)	(2)	(3)	(4)	(5)
LSEG	1.11***	0.86*	2.88**	2.39***	1.87***
	(0.3)	(0.52)	(1.17)	(0.58)	(0.44)
LSEG Quotes	0.9***	0.73*	2.31***	2.25***	1.57***
	(0.3)	(0.44)	(0.8)	(0.61)	(0.34)
LSEG Trades	0.59***	0.29	1.67**	1.29***	1.02***
	(0.19)	(0.25)	(0.72)	(0.37)	(0.28)

Table A-IV

Alternative Bond Return Calculation

The table reports results to the regression $\Delta y_{i,t} = \alpha_i + \gamma D_t + \varepsilon_{i,t}$ where $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and t (Panel A) or $t-1$ and $t+2$ (Panel B) . D_t refers to demand measures based on (log) changes in Treasury futures in a short window around an auction. Columns refer to auctions of treasuries with tenors ranging between 2- to 30-years, and the column "Pooled" combines all auctions in one regression. Numbers in parentheses refer to Driscoll and Kraay (1998)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is 2002-2018.

Panel A: $\Delta y_t = y_t - y_{t-1}$					
	2-year	5-year	10-year	30-year	Pooled
	(1)	(2)	(3)	(4)	(5)
D	0.50**	3.11**	2.76	19.45***	12.11***
	(0.22)	(1.34)	(1.88)	(7.50)	(2.95)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	2952	1683	2475	1134	8244
R^2	0.00	0.02	0.00	0.02	0.01
Panel B: $\Delta y_t = y_{t+2} - y_{t-1}$					
	2-year	5-year	10-year	30-year	Pooled
D	1.31**	4.11*	8.69***	37.94***	23.33***
	(0.65)	(2.37)	(3.06)	(9.31)	(5.52)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	2952	1683	2475	1134	8244
R^2	0.01	0.01	0.01	0.04	0.01

Table A-V

Subsample Analysis - Excl. Global Financial Crisis

The table reports results to the following regressions:

$$\Delta s_{i,t} = \alpha_i + \beta D_t + \varepsilon_{i,t} \qquad \Delta y_{i,t} = \alpha_i + \gamma D_t + \varepsilon_{i,t}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t (Panel A), and $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and $t+1$ (Panel B). D_t refers to demand measures based on (log) changes in Treasury futures in a short window around an auction. Columns refer to auctions of Treasuries with tenors ranging between 2- to 30-years, and the column "Pooled" combines all auctions in one regression. In Panel B, 10-year bond returns are used for the column "Pooled". Numbers in parentheses refer to Driscoll and Kraay (1998)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level. The sample period is 2002-2018. excluding the months of the global financial crisis.

Panel A: Currency Markets					
	2-year	5-year	10-year	30-year	Pooled
	(1)	(2)	(3)	(4)	(5)
UST Fut	1.34***	0.97**	3.35***	2.72***	2.00***
	(0.28)	(0.47)	(1.04)	(0.49)	(0.40)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	2592	1395	2223	981	7191
R^2	0.04	0.01	0.09	0.12	0.05
Panel B: Global Bond Markets					
	2-year	5-year	10-year	30-year	Pooled
	(1)	(2)	(3)	(4)	(5)
D	0.96	4.85**	7.68**	31.34***	8.29***
	(0.63)	(2.28)	(3.31)	(9.88)	(2.33)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	2493	1359	2133	981	6966
R^2	0.00	0.02	0.01	0.03	0.02

Table A-VI

Seasonality - End of Month Effects

The table reports results to the following regression:

$$\Delta s_{i,t} = \alpha_i + \beta D_t + \alpha_{EOM} \times \mathbb{1}^{EOM} + \beta^{EOM} D_t \times \mathbb{1}^{EOM} + \varepsilon_{i,t}$$

or

$$\Delta y_{i,t} = \alpha_i + \gamma D_t + \alpha_{EOM} \times \mathbb{1}^{EOM} + \gamma^{EOM} D_t \times \mathbb{1}^{EOM} + \varepsilon_{i,t}$$

where $\Delta s_{i,t}$ refers to the returns of currency i in a small window around an auction on date t (Panel A), and $\Delta y_{i,t}$ refers to bond returns of country i between day $t-1$ and $t+1$ (Panel B). D_t refers to demand measures based on (log) changes in Treasury futures in a short window around an auction. $\mathbb{1}^{EOM}$ refers to an indicator variable, which equals to 1 during the last 5 days of the month, and zero otherwise. Columns refer to auctions with tenors from 2- to 30-years, while "Pooled" combines all auctions in one regression. Numbers in parentheses refer to Driscoll and Kraay (1998)-adjusted standard errors. ***, **, * refer to level of significance at the 1%, 5% and 10% level.

Panel A: Currency Markets					
	2-year	5-year	10-year	30-year	Pooled
	(1)	(2)	(3)	(4)	(5)
D	0.71	1.00**	2.09*	3.66***	1.85***
	(0.64)	(0.39)	(1.07)	(0.63)	(0.42)
End of Month	-1.21	0.46	0.51		0.21
	(1.11)	(0.68)	(0.82)		(0.50)
End of Month x D	0.18	1.37**	0.70		-0.04
	(0.94)	(0.69)	(1.34)		(0.54)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	3051	1719	2592	1134	8496
R^2	0.01	0.06	0.05	0.19	0.05

Panel B: Global Bond Markets					
	2-year	5-year	10-year	30-year	Pooled
	(1)	(2)	(3)	(4)	(5)
D	15.68***	11.48**	6.48**	12.74***	10.68***
	(5.38)	(4.71)	(3.25)	(3.82)	(1.88)
End of Month	-2.89	-5.70	4.48		-0.92
	(6.89)	(6.90)	(6.20)		(4.50)
End of Month x D	-15.05***	2.32	2.22		-5.78*
	(5.54)	(8.50)	(4.67)		(3.21)
Currency FE	Yes	Yes	Yes	Yes	Yes
N	2952	1683	2475	1134	8244
R^2	0.02	0.04	0.01	0.04	0.02

Table A-VII

Summary Statistics: Bid-to-Cover Ratio and Allocation

This table reports summary statistics for demand measures based on the bid-to-cover ratio (Panel A) and for the unexpected amount of Treasury contracts allocated to different investor types (Panel B). The sample period varies across panels, covering the years from 2002 to 2018.

Panel A: Bid-to-Cover Ratio - Disaggregated by Bidder Type								
	Mean	Std	Min	P25	P50	P75	Max	N
Bid-to-Cover Ratio	0.01	0.31	-1.18	-0.18	-0.01	0.19	1.80	944
Direct Bidders	0.00	0.08	-0.37	-0.03	-0.00	0.03	0.51	914
Indirect Bidders	0.01	0.13	-0.50	-0.08	0.00	0.08	0.56	914
Primary Dealers	0.01	0.24	-1.04	-0.13	0.00	0.13	1.37	914
Panel B: Allocation - Disaggregated by Investor Group								
	Mean	Std	Min	P25	P50	P75	Max	N
Broker-Dealers	0.43	10.88	-30.15	-6.64	0.12	6.87	56.45	944
Investment Funds	0.41	8.47	-23.80	-4.85	-0.63	4.98	33.49	944
Foreign Investors	0.78	8.02	-31.82	-3.51	1.02	5.50	38.46	944
Miscellaneous	0.84	6.70	-22.84	-1.56	0.14	2.88	26.39	944
Banks	0.32	1.87	-7.10	-0.01	0.02	0.22	31.54	944
SOMA	0.80	6.18	-19.89	-0.95	0.00	2.53	26.89	944
Individuals	0.08	0.80	-4.48	-0.18	-0.04	0.16	10.91	944
Pension Funds	0.09	0.67	-2.24	-0.00	0.00	0.07	19.34	944
Others	0.16	0.88	-1.33	-0.04	0.00	0.17	13.43	944