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Dollar and Government Bond Liquidity: Evidence from Korea

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Abstract

Using unique tick-by-tick data from an exchange, this paper examines the relationship between the US dollar and liquidity in the Korean government (Treasury) bond market. We find that a strong US dollar deteriorates the Treasury market's liquidity by increasing the bid-ask spread and the price impact and lowering market depth. The effects of fluctuations in the broad US dollar index on Treasury market liquidity become more pronounced when funding liquidity conditions are tighter, when banks' total capital ratio is lower with greater foreign currency risk, or when there is a larger sell-off of Korean Treasury bonds by foreign investors. The empirical evidence supports the financial channel of exchange rates affecting Treasury market liquidity. In particular, a strong dollar as a global risk factor is likely to limit the market intermediation capacity of emerging market dealers through the currency exposures of borrowers or dealers and thus tighten market conditions.

Keywords: dollar; exchange rate; Treasury bond liquidity; funding liquidity; foreign investors

JEL Codes: E58, F34, G12

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1. Introduction

Since 2020, the Covid-19 pandemic, the aggressive monetary policy tightening in advanced economies (AEs) and a strong US dollar have tightened emerging market economy (EME) financial conditions and impaired market liquidity[1], even in their government bond markets where most benchmark bonds are traded. During times of stress, EME central banks used various market interventions in currency and domestic bond markets[2], which suggests the importance of accurately estimating market liquidity and using this as a barometer to assess the overall health of the financial system (Borio et al, 2000; CGFS, 2014). Yet, the liquidity of EME government bond markets and its linkage to exchange rate fluctuations have received less attention in the literature than those of major AEs.[3] Therefore, this paper aims to examine how the US dollar affects EME government bond liquidity and when the effect becomes stronger by using the unique tick-by-tick dataset from the Korean government bond market, a representative market among EMEs.

How a strong US dollar affects EMEs' government bond liquidity depends on dealers' market intermediation capacity. Market microstructure theory posits that dealers or market makers widen the bid-ask spread when adverse selection or inventory holding costs are high (e.g., Ho and Stoll, 1981; Glosten and Milgrom, 1985) and that the constrained market intermediation capacity of dealers can adversely affect bond market liquidity (e.g., Adrian et al, 2013; Deuskar and Johnson, 2021; He et al, 2022; Bessembinder et al, 2018; Goldberg, 2020; Duffie, 2020). The financial channel of exchange rates explains how exchange rate movements influence domestic financial conditions by changing in the risk capacity of market participants, implying that a dollar appreciation leads to a reduction in the global supply of dollar credit (Bruno and Shin, 2015) and tightens financial conditions by lowering EME asset returns (e.g., Bruno et al, 2022; Hofmann et al, 2020; Avdjiev et al, 2019). Based on these two strands of literature, we conjecture that a strong

[1] Market liquidity is defined as one in which trading is immediate and where large trades have little price impact with lower trading costs. Simply speaking, it estimates the ease with which an asset is traded.

[2] On March 12, 2020, when the COVID-19 pandemic was declared, central banks actively implemented various market stabilization measures, including relieving dealers of some of their inventories, expanding the types of eligible securities for the repo market, dollar swaps, and foreign exchange interventions in the domestic bond and currency market.

[3] The seminal papers on market microstructure that focus on liquidity (e.g., Demsetz,1968; Stoll, 1978; Ho and Stoll, 1981) have developed mainly in the US stock market. Additionally, Goyenko et al (2009) test the relationship between liquidity and the value, and Fleming and Remolona (1999) and Balduzzi et al (2001) examine the macroeconomic announcement effect. Adrian et al (2013) and He et al (2022) propose the concept of bond market illiquidity related to limited dealer intermediation among others.

dollar can dampen government bond liquidity if it is expected to increase liquidity provision costs or limit dealers' market intermediation capacity.

Economic theory further suggests three channels through which a strong dollar can be linked to worsening government bond liquidity, particularly restricting dealers' market-making capacity. The first channel is funding liquidity conditions. That is, the ability of the market-making sector to intermediate relies on its ability to raise funding (Adrian et al, 2023). Previous studies find that an interconnection between market liquidity, volatility, and funding liquidity can explain a sudden drop in market liquidity (Brunnermeier and Pedersen, 2009; Hameed et al, 2010; Chuwonganant and Chung, 2014). When volatility increases or market returns drop significantly, lenders may face higher funding costs through higher haircuts and repo rates. These higher funding costs can make it difficult for market makers to finance their inventories, which in turn can reduce market liquidity and create a self-reinforcing feedback mechanism between funding liquidity and market liquidity. Similarly, Pelizzon et al (2016) examine the dynamic relationship between credit risk and liquidity and changes in the relationship following European Central Bank (ECB) interventions in the Italian sovereign bond market. They find that credit default swap (CDS) spreads worsen market liquidity and the sensitivity between CDS spreads and market liquidity weakens after ECB interventions. Additionally, prior studies show that dealer funding costs and balance sheet constraints have been regarded as the determinants of the market liquidity dynamics during turbulence times (Gromb and Vayanos, 2002; Duffie, 2010). Therefore, the positive association between the dollar and government bond illiquidity becomes more pronounced when funding liquidity tightens, especially in a strong dollar environment.

The second channel is related to the original sin. That is, EMEs cannot borrow from abroad in their own currency, implying that EME borrowers are more exposed to currency mismatch, which increases their vulnerability to exchange rate fluctuations (Eichengreen and Hausman, 1999). Recent papers have shown that original sin persists among EME corporates but has slowly disappeared for major EME sovereign issuers (Du and Schreger, 2022; Onen et al, 2023), implying that EME dealer banks are still likely to be exposed to foreign currency risk because they provide foreign currency-denominated loans to non-financial firms. Furthermore, they are mainly domestic banks or securities companies, which may be exposed to foreign currency risk through foreign currency-denominated loans or currency hedge rollovers (McGuire et al, 2021), need to raise additional funds to meet regulatory requirements or face the reduced global supply of dollar credit (Bruno and Shin, 2015), especially during dollar appreciation periods. Such burdens can limit the intermediation capacity of dealers, thereby dampening government bond liquidity. Therefore, we conjecture that these effects can be more pronounced when dealers face greater exposure to foreign currency risk and have a lower capital adequacy ratio.

The third channel is related to the original sin redux that EMEs can borrow from abroad in their own currency, but currency mismatch lies on the balance sheet of foreign investors in EME local currency bonds (Carsten and Shin, 2019). When EME currencies depreciate against the dollar, foreign investors sell EME local currency bonds which lowers EME bond returns, triggering the return-amplifying role of the dollar exchange rate (Hofmann et al, 2020). In an extreme case, this may lead to panic selling by foreign investors, reducing dealers' market-making capacity due to the high possibility of unwanted inventory holding, and thus worsening liquidity in the government bond market during periods of foreign investor sell-offs. Therefore, we expect that the effects become more pronounced when there is a large sell-off of local currency government bonds by foreign investors.

The objective of this paper is to test hypotheses regarding the direct relationship between the dollar and EMEs' government bond liquidity and the aforementioned three channels, using the unique real-time trade and quote data of 3-, 5- and 10-year on-the-run bonds from the Korea Exchange (KRX). We focus on the Korea Treasury bond market for our empirical analyses, which provides an ideal setting among EMEs for several reasons. First, Korea is a representative EME in terms of the size and liquidity of its Treasury bond market.[4] Second, Korea has the unique market structure under which the exchange rather than the over-the-counter (OTC) market is more developed, which is different from other EMEs. In fact, the Korean authorities introduced a bond exchange to ensure greater transparency and more efficient price discovery and the primary dealer (PD) system to maintain orderly market functioning. More specifically, PDs, mainly banks or securities companies, have an obligation to quote a narrower bid-ask spread for the benchmark Treasury bonds and hold a certain inventory level (over KRW 1 trillion). Third, the availability of real-time quote and trade data provided by the Korea Exchange's electronic trading platform enables us to test the extant market microstructure theories based on the stock market in the government bond market. Fourth, the sensitivity of the Korean won (KRW) as a global "high beta" currency makes

[4] The size of Korea's local currency bond market is the second largest in Asia after China and reached USD 2.3 trillion (156.4% of GDP) at end-June 2023 (ADB Bond Online). The turnover ratio for KR, US, UK and FR are 302.2%, 690.1%, 499.5% and 176.4%, respectively, in 2021 according to Korea Ministry of Economy and Finance.

it suitable for verifying the linkage between the global factors and financial conditions.[5] Last, the substantial share of KTB (Korea Treasury Bond) holding by foreign investors (about 20% as of 2022) enables us to test the notion of original sin redux.

Using high-frequency trade and quote data from the KRX, we estimate four liquidity measures—bid-ask spreads, price impact, market depth and composite illiquidity index— for on-the-run KTBs over the sample period from 2 January 2012 to 28 December 2022. We then conduct regression analyses to identify the role of a trade-weighted index of the US dollar exchange rate relative to other world currencies (i.e., the broad US dollar index) in determining market liquidity. We further focus on the three channels through which the financial channel of exchange rates becomes stronger.

The main results of the paper are as follows. First, our baseline regression of daily aggregated liquidity measures on the broad US dollar index returns (henceforth, broad dollar returns) and other covariates shows that the coefficients on the dollar returns are positive and significant in the illiquidity regressions. [6] Specifically, a 10 percentage point increases in the broad dollar returns on one day leads to the bid-ask spread widening by 0.7 basis points on the same day. This finding is robust when we use alternative liquidity measures, a different number of key domestic and global factors and lagged changes in the dollar returns and other economic variables. This supports our hypothesis that a strong dollar is likely to worsen Treasury market liquidity in Korea, possibly due to the limited intermediation capacity of dealers. Indeed, even when we compare the broad dollar returns and the bilateral dollar exchange rate returns as explanatory variables simultaneously, the broad dollar as a global risk factor plays a more critical role in explaining market liquidity than the bilateral exchange rate, both statistically and economically.

Our empirical investigation further highlights when the financial channels of exchange rates affecting Treasury bond liquidity become more pronounced. Due to the limited availability of dealer balance sheet data, we construct three different sets of proxies for dealers' market intermediation capacity—funding liquidity constraints, the original sin hypothesis and the original sin redux hypothesis. We then conduct time-series analyses after including the interaction terms between the dollar and proxies of the channels. First, we use volatility, bond yield and bank-level

[5] This sensitivity arises because Korea is a small open economy heavily reliant on exports, deeply integrated into the global supply chain, and susceptible to external shocks.

[6] The illiquidity (liquidity) regression uses illiquidity measures as the dependent variables, with larger values indicating lower (higher) liquidity.

credit default swap (CDS) spread as the proxies for funding liquidity constraints that can reflect credit conditions in the capital markets (e.g., Hammed et al, 2010; Hofmann et al, 2022; Pelizzon et al, 2016; Duffie et al, 2023). We find that the coefficients on the interaction terms between the dollar and all proxies for funding liquidity constraints are all positive and significant in the illiquidity regressions, indicating that the positive effects of the dollar on government bond illiquidity become stronger when credit conditions in the capital market are tightened.

Second, we introduce two proxies for original sin hypothesis: banks' foreign currency-denominated loans and the total capital ratio (the ratio of total regulatory capital to risk-weighted assets (RWAs)) at the bank level. Both measures are directly related to dealer banks' vulnerability to a strong dollar, which can arise from currency mismatch. This mismatch may be amplified when dealer banks provide more foreign currency loans to non-bank sectors and, in turn, lower total capital ratios, largely driven by increases in foreign currency-denominated RWAs (BOK, 2022). Consistent with our conjecture, we find that the coefficients on the interaction terms between the dollar and foreign currency loans are positive while those on the total capital ratio are negative for illiquidity measures.

Third, we find that the coefficients on the interaction term between the dollar and the dummy of foreign sells are positive and significant while those on the interaction terms including the dummy of foreign buys or the change in foreign bondholding are all insignificant, supporting the channel of original sin redux hypotheses. That is, a large foreign sell-off can limit dealers' capacity to intermediate trades and reduce market liquidity. This result supports previous studies that massive customer selling of US Treasuries limits dealers' capacity to intermediate trades, reducing market liquidity (Duffie, 2020; Breckenfelder and Ivashina, 2021).

This study contributes to multiple strands of literature. First, this paper sheds light on EME dealers' intermediation capacity in the local government bond market, showing that a strong dollar can work as an additional funding constraint to financial intermediaries. Some recent papers examine how funding conditions affect government bond liquidity, using bank credit spreads (Dick-Nielsen et al, 2012; Pelizzon et al, 2016), monetary policy variables (Chordia et al, 2005; Goyenko and Ukhov, 2009), and short-term-borrowing cost (Deuskar and Johnson, 2021). Second, this study tests the "original sin" and "original sin redux" hypotheses simultaneously (Eichengreen and Hausman, 1999; Carsten and Shin, 2019). Dealers can be exposed to foreign currency risk through both channels because their business models consider both EMEs' corporations and foreign investors as their counterparty, which can increase their vulnerability to a strong dollar. Third, previous papers have examined how the fluctuations of the bilateral exchange rates against the US dollar or the broad dollar index affect the local currency bond market (Hofmann et al, 2020), local currency stock returns (Bruno et al, 2022), capital flows (Bertaut et al, 2022), and corporate investment (Avdjiev et al, 2019) in EMEs. To the best of our knowledge, few studies have examined the relationship between the dollar exchange rate and Treasury liquidity in EMEs. Fourth, a strong association between the dollar and EMEs' government bond liquidity suggests policy implications that stabilizing currency market can improve local government bond liquidity, which supports the use of macroprudential foreign exchange policies in EMEs (Borio et al, 2022). Finally, this paper contributes to the literature on bond liquidity estimation (Fleming, 2001; Diaz and Escribano, 2017; Schestag et al, 2016; Adrian et al, 2017, 2023) by providing evidence from the Korea Exchange's trade and quote data over a long time span of about ten years.

The remainder of the paper is organized as follows. Section 2 explains the background of the Korea Treasury bond market. Section 3 describes the data sources and variables for estimation. Section 4 presents the empirical results. Finally, Section 5 concludes the paper and provides some policy implications.

2. A background to the Korea Treasury bond market

The Korea Treasury bond (KTB) market has experienced remarkable growth since the first-time issuance of government bonds in 1950. KTBs can be traded either on the Korea Exchange (KRX) or in the over-the-counter (OTC) market.[7] In the early stages[8], KTBs were traded in the OTC market through brokerage by banks, securities companies and other firms. However, after the 1997 financial crisis, the Korean government aimed to have greater control over their finances by developing local bond markets and reducing its reliance on bank-led short-term financing that left them vulnerable in 1990s. The government focused its efforts on developing an exchange rather than the OTC market in order to enhance transparency and price discovery. As a result, most of on-the runs are now traded on the KRX, while the remaining bonds are traded on the OTC market.

The current KRX KTB market was formed in 1990s with the introduction of various new systems. In March 1999, the Korean government launched the KTB exchange, along with the primary dealer

[7] The KRX KTB operates as an auction market or an order-driven market, where buyers and sellers participate in competitive auctions simultaneously. By contrast, the OTC market consists of a network of brokers and dealers who negotiate the sales of securities among themselves.

[8] Government bonds are traded on the OTC market because they are difficult to standardize due to the various terms and conditions in most countries.

(PD) system (introduced in 1999) and the mandatory exchange trading system for the benchmark bonds (introduced in 2000).[9] The KTB exchange is an electronic platform[10] that consolidates quotes in a limit order book and an inter-dealer market. This platform enables real-time trading by licensed dealers such as banks or securities companies through competitive bidding and provides simultaneous real-time display of all quotes and executions to the public, ensuring high pre- and post-trade transparency. KTB dealers are categorized into primary dealers (PDs), who act as market maker, preliminary primary dealers (PPDs) and general dealers.[11] As of the end of December 2021, there are 17 PDs (7 banks and 10 securities companies), 4 PPDs and 40 general dealers. PDs enjoy certain privileges in the primary market, including exclusive underwriting rights for government bonds. They are also obligated to provide liquidity in the secondary market by offering two-way market-making quotes for on-the-run KTB issues[12] and holding KTBs with a value exceeding KRW 1 trillion as inventory to facilitate effective trading.[13]

Thanks to the government-led initiatives to establish an efficient or well-functioning market structure and systems as well as the active role of PDs as market makers, the KTB market has rapidly developed compared to the government bond market in other AEs (Panel A of Figure 1). Particularly, the KRX KTB market becomes one of the largest and most liquid markets among global bond exchanges. As of 2020, its annual trading value amounted to $ 1.8 trillion, making it the largest among the members of the World Federation of Exchanges (WFE) which use the central limit order book (CLOB) system[14] (Benos et al, 2022). In fact, as of April 2019, about 76% of the KTB benchmark is traded on the exchange (Panel B of Figure 1) and 3-, 5-, and 10-year Treasury

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[9] Kang et al (2005) find that the fungible system and the mandatory exchange trading system for benchmarks contribute to improving government bond trading activity and liquidity in the exchange. Jang et al (2016) show that the 2010 new quote rule imposed on the primary dealers for the KTB has enhanced the exchange market quality by narrowing spread and increasing trading volume in the exchange as well as in the OTC market.

[10] Electronic system reduces trading costs and has the merit of enhancing market transparency by providing the benchmark interest rate through real-time distribution of yield information and disclosing quotes that are actually executable.

[11] Preliminary PDs are allowed to participate in the primary market with limited scope and relieved of the obligation of market making, while general dealers are allowed to participate in the secondary market as a broker or dealer but not in the primary market.

[12] On-the-run issues are those considered to be most appropriate in producing benchmark interest rates in the secondary market owing to their abundant liquidity. They include the most recently issued bond by maturity. PDs are obliged to place ten or more bid and ask quotes, respectively, for each on-the-run issue by maturity. These quotes must have the face value of KRW 1 billion or more and be placed on every trading day in the KRX KTB market continuously.

[13] The obligations support the view that PDs are marginal liquidity providers in the Indian government bond market so that their borrowing or funding conditions can affect their intermediation (Deuskar and Johnson, 2021).

[14] A central limit order book (CLOB) is a trading mechanism used by most exchanges to facilitate trading between buyers and sellers in financial markets, acting as a central hub where all orders are matched against each other based on specific rules.

bonds account for 82% of the entire Treasury bond trading market (Panel C). In addition, the share of KTB holding by foreign investors has increased from 14% in 2016 to 20% in 2022, which is suitable for testing the concept of "original sin redux" (Figure 2).

3. Data and variable construction

3.1 Data

Our initial sample contains Korea Treasury bonds traded in KRX from 2 January 2012 to 28 December 2022. We obtain a comprehensive record of real-time trade and quote data from the *Bond Market Information System* (BOMIS).[15] The trade data include millisecond-level time stamp, price and quantity. The quote data include limit order book changes on a tick-by-tick basis such as bid/ask quotes and bid/ask size. We construct our sample to include on-the-run 3-, 5- and 10-year Treasury bonds, which are traded during regular trading session between 9:00 and 15:30. The trading unit is the multiple of face value of KRW 1 billion. *Infomax*, one of Korea's data providers, provides bond characteristic variables such as the issuance date, issuance maturity and whether securities are on-the-runs. Global factors include the dollar index which is the trade-weighted nominal exchange rate of the US dollar index from the FRED; the Treasury-Eurodollar (TED) spread which is the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury bill interest rate; the VIX index, an indicator of implied volatility of the S&P index options; and the MOVE index, the Merrill Lynch Option Volatility Estimate index, which is the implied volatility of the US bond market obtained from *Bloomberg*. Local factors include the VKOSPI (similar to the VIX), the KOSPI 200 implied volatility index as a measure of market volatility from *Bloomberg*; the credit spread (CS), which is the difference between the 3-year Korean corporate bond (AA-rated) yield and the 3-year Korea Treasury bond yield; Korean TED (KTED), which is the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month yield of monetary stabilisation bonds and used as a proxy for estimating risk-free arbitrage transactions excluding the risk of bankruptcy from the *Economic Statistics System (ECOS) of the Bank of Korea.* Finally, we obtain the bank-level CDS spread from *Markit*, the bank-level foreign currency denominated loans and the total capital ratio from *Financial Supervisory Service* and security-level foreign bond holdings from *Infomax*.

[15] In 2006, the BOK established the BOMIS, a comprehensive database from various sources related to the bond market, including the real-time trade and quote data, which has contributed greatly to reinforcing the BOK's monitoring and implementing market-friendly monetary policy.

3.2 Treasury bond liquidity estimates

Market liquidity is defined as the ability to execute sizable securities transactions at a low cost and with little price impacts, which indicates that there is no single measure that can capture its multiple aspects. Following previous studies using the real-time trade and quote data in the US Treasury market (Adrian et al, 2023; Fleming and Ruela, 2020), we estimate four liquidity measures in the Korea Treasury bond market: the bid-ask spread, quoted depth, the price impact of trades and a composite liquidity index.

The bid-ask spread—the gap between the highest bid and lowest ask—estimates the cost dimension of liquidity for single trades of limited size. Quoted depth is the quantity of bonds that can be transacted at the highest bid and the lowest ask. The price impact of trades is the extent to which the price changes in response to trades, thereby measuring both the cost and quantity aspects of liquidity. In order to minimise errors when estimating market liquidity, we exclude the following quotes and trades from the central limit order books referring to the classification of Chordia et al (2001): quotes if either the ask or bid price is nonpositive; quotes if either the ask or bid size is nonpositive; quotes if the ratio of effective spread[16] to bid-ask spread is greater than 4; quotes and trades if they are placed during non-regular trading hours; and if the number of transactions is less than 30. The relative quoted spread and quoted depth are computed based on the following formulas:

$$\text{Relative Quoted Spread (QS)}_{it} = \frac{(Ask_{it} - Bid_{it})}{M_{it}},$$

$$\text{Quoted Depth (QD)}_{it} = M_{it}\,(Bid\ size_{it} + Ask\ size_{it})/2,$$

where Ask_{it} and Bid_{it} are the best ask and bid price of bond i at time t, respectively; M_{it} is the quote midpoint, $(Bid_{it} + Ask_{it})/2$ of bond i at time t; $Ask\ size_{it}$ and $Bid\ size_{it}$ are the average quantity sought at the best ask and bid prices for bond i at time t, respectively. Relative quoted spread (QS) is the bid-ask spread divided by the midpoint of the bid and ask quotes, which is calculated at the par-value for all trades of KRW 1 billion and is also computed at the bond-day level by taking the average of trade-level spread and multiplying 10000 to convert the unit into basis points.

Quoted depth (QD) is the value of order at the best bid and best ask price in inter-dealer transactions in billions of the Korean won, adjusted for inflation in 2020 using the consumer price

[16] Absolute value of the difference between trade prices and quote midpoint.

index. The intraday bid-ask spread and depth for each bond is aggregated to a daily frequency by weighting all ticks equally, implicitly giving greater weight to more active time of day.

The price-impact proxy is Kyle's lambda using the following formula, which is the slope coefficient (λ_i^k) in a regression of price changes on the size of transaction multiplied by the signed trade volume (Kyle, 1985):

$$\Delta P_{ik} = \lambda_i^k (D_{ik} * V_{ik}) + e_{ik}$$

where ΔP_{ik} is the log price changes of bond *i* at trade *k* within a trading day, and D_{ik} is an indicator variable that equals +1 for buy orders and –1 for sell orders. We estimate D_{ik} by applying the algorithm in Lee and Ready (1991) with no allowance for a trade-reporting lag. V_{it} is the trading volume (in KRW 10 billion) at trade *t*. If λ_i^k is negative, it is set to zero. This slope, Kyle's lambda, can arise from information considerations, inventory issues or both (Kyle, 1985; Glosten and Harris, 1988; Subrahmanyam, 1991). These studies document that a security with higher information asymmetry or more informed trading is likely to have a greater price impact parameter. For our main analyses, we construct daily liquidity indices by applying a volume-weighted average across 3-, 5- and 10-year bonds for each liquidity metric.

Following Adrian et al (2023), we construct a composite illiquidity index combining the bid-ask spread, depth, and price impact measures because a single measure cannot capture multi-dimensional liquidity. After converting depth to negative depth to measure illiquidity, we standardise each liquidity measure to have mean zero and variance one for each security (3-, 5- 10-year bond). We then construct a composite liquidity index by averaging across the three metrics for each security and standardise the index itself.

3.3. Proxies for the channels through dollar affects market liquidity

In this section, we introduce three sets of proxies for funding liquidity conditions, original sin, and original sin redux to understand the channel through which the dollar affects market liquidity. The first set of proxies for funding liquidity conditions includes implied volatility, bond yield, and the bank-level CDS spread. Several studies provide evidence that uncertainty and bond yields are associated with domestic financial conditions that can be a trigger to a feedback loop between funding liquidity and market liquidity (Brunnermeier and Pederson, 2009; Hammed et al, 2010; Chung and Chuwonganant, 2014, 2018) or that can be proxies as funding constraints to limit market-making activities or limits-to-arbitrages (Jensen and Moorman, 2010; Gromb and Vayanos, 2010). Similarly, extant papers have highlighted the link between funding liquidity, credit risk, and government bond liquidity (e.g., Dick-Nielsen et al, 2012; Pelizzon et al, 2016). Furthermore, recent papers have found that bond market illiquidity can be driven by limited dealer intermediation capacity when funding conditions are tightened (Adrian et al, 2013; He et al, 2022; Bessembinder et al, 2018; Duffie, 2020). Therefore, increases in volatility, government bond yields and the CDS spread imply tighter financial conditions, making it difficult for dealers to provide liquidity to the financial market.

The second set is the proxies for original sin such as FXLOAN_RATIO (foreign currency denominated loans/total loans) and the BIS_RATIO or the total capital ratio (total capital (which is the sum of Tier1 equity and Tier 2 equity)/risk-weighted asset (which is the sum of Korean won denominated RWAs and foreign currency RWAs)) at the bank level. Dealer banks with higher FXLOAN_RATIOs are likely to be more vulnerable to exchange rate fluctuations to the extent that the corporates borrowing from the banks in foreign currency are subject to currency mismatches, which can lead to losses to the banks and in turn financial instability, while those with higher BIS_RATIOs are likely to be better able to withstand losses and absorb shocks. Figure 3 shows that overall dollar strength tends to be positively related to FXLOAN_RATIO, while it tends to be negatively related to BIS_RATIO. This suggests that the foreign currency denominated loans have a negative impact on banks' BIS ratio. When the dollar strengthens, banks tend to hold more foreign currency denominated loans, which increase foreign currency risk-weighted assets (the denominator of BIS_RATIO), lowering the BIS ratio overall. Therefore, both measures are likely to be related to the original sin channel that can increase dealer banks' vulnerability to exchange rate fluctuations and affect dealers' market-making activities.

The third set is the proxies for original sin redux such as a dummy for foreign investor sell-offs because EMEs can face vulnerability to exchange rates as increases in foreign bond holding, which can increase external funding in the local currency, can increase risk of capital outflow or foreign investor sell-offs during times of turbulence or dollar appreciation. Carsten and Shin (2019) mention that EMEs that have developed local currency government bond markets are still vulnerable to capital outflows and sensitive to global financial conditions because of the "original sin redux". When the dollar appreciates, foreign investors who hold foreign currency bonds suffer losses relative to local investors because they evaluate their total returns in dollar terms (Bruno et al, 2022). This may lead to panic selling from foreign investors (Bertaut et al, 2022), reducing dealers' market-making capacity through the high possibility of unwanted inventory holding, and thereby worsening liquidity in the government bond market during periods of foreign investor sell-offs. During times of stress, especially in March 2020, US Treasury bond liquidity declined significantly due to liquidity imbalances created by massive customer selling amid "dash for cash", which limited dealers' balance sheet capacity (Duffie, 2020; Schrimpf et al, 2020). To capture asymmetric responses of government bond liquidity to trade positions of foreign investors and the increased vulnerability of dealers during times of a strong dollar, we use dummy variables for foreign investor sell-offs as the proxies for original sin redux.

3.4. Descriptive statistics

Table 1 reports the descriptive statistics of the key variables over about 2,698 trading days. Panel A shows that the average value and standard deviation of the relative quoted spread are 1.011bps and 0.495bps, respectively, those of the price impact 0.167 and 0.108, respectively, and those of quoted depth KRW 19.947 billion and KRW 15.752 billion, respectively. These liquidity measures exhibit strong variability with large standard deviation. Specifically, Figure 4 plots four liquidity metrics as well as the association of each liquidity with the broad dollar index, which are the main variables in our analyses.

Our liquidity measures have similar features that are found in prior studies (Adrian et al, 2023; Duffie et al, 2023). First, four liquidity metrics (the relative quoted spread, the price impact, quoted depth and the composite liquidity index) display significant co-movements. Second, liquidity declined significantly during times of market turbulence. More specifically, the quoted spread and the price impact have shown several spikes, while quoted depth has been plunged during the times of market stress such as the Taper Tantrum in 2013, the Chinese stock sell-off in 2015, the election for Donald Trump in 2016, the Covid-19 pandemic in 2020 and the Legoland event or project financing-asset backed commercial paper (PF-ABCP) distress in 2022. Third, our liquidity measures have shown that liquidity is better for securities with short-term maturity (3-year) rather than long-term maturity (10-year) bonds as shown in Appendix C. Finally, a tick size reduction was implemented on 27 June 2016 to improve market quality and transparency, resulting in significant reductions in the bid-ask spread and price impact. In particular, the minimum tick size was reduced to KRW 0.1 for Treasury bonds with maturity less than 2 years, to KRW 0.5 for those with maturity between 2 years and less than 10 years, and to KRW 1.00 for those with more than 10 years. The rule of tick size changes therefore has been applied to 3- and 5-year bonds, but not to 10-year bonds. We find that around the time of tick size changes, liquidity improved dramatically in terms of the quoted spread and the price impact. This is consistent with prior studies which show that a tick size reduction results in lower bid-ask spreads and transaction costs (Harris, 1994; Bessembinder 2000; Chung and Chuwonganant, 2002, 2004) and lower information asymmetry (Chakravarty et al, 2005).

In addition, broad dollar returns—a higher value means a stronger dollar—have spiked several times such as during the Taper Tantrum, the COVID-19 pandemic, and monetary policy tightening by AE central banks which coincided with significant drops in liquidity. This implies that the broad dollar returns seem to move in tandem with market liquidity measures. Panel B of Table 1 shows the correlation matrix across our various market liquidity, funding liquidity and market uncertainty measures. First, we find that various market liquidity measures are highly correlated with each other. For instance, the correlation coefficient between QS and log(PI) is 0.74 and significant while that between the quoted spread and log(QD) is –0.55 and significant. Especially, a composite liquidity index is strongly correlated with all liquidity measures, with the correlation coefficient close to 0.8. Second, a strong dollar tends to be negatively associated with liquidity, showing it is positively correlated with the bid-ask spread, the price impact, and the composite liquidity index while negatively related with quoted depth. Third, elevated domestic market uncertainty reduces market liquidity. We find that the correlation between QS and dlog(VKO) is positive and significant, but that between QS and dlog(VIX) is insignificant, indicating that domestic market implied volatility, rather than global market implied volatility, is strongly associated with market liquidity. In sum, our preliminary analyses reveal that our liquidity measures are reliable and perform well, supporting the general features of liquidity from the prior studies.

3.5 Central bank policy responses and market dynamics in March 2020: dollar swap

To further understand the US dollar's role in domestic financial market, we focus on how the central bank's market interventions including dollar swaps affected Treasury market liquidity in Korea during the initial stage of the COVID-19 pandemic from January 2020 to May 2020. Like many other central banks (e.g., Duffie, 2020; Fleming and Ruela, 2020), the Bank of Korea (BOK) took various market stabilization measures to enhance overall market liquidity during the pandemic.

Figure 5 shows the evolution of the bid-ask spread, the price impact, quoted depth, and the composite liquidity index during the pandemic. The solid vertical line represents significant events that occurred during the period: (1) the declaration by World Health Organization (WHO) of Covid-19 as a pandemic on 11 March, (2) a 50 basis point cut in the policy rate and the expansion of types of eligible bonds for repurchase agreements (RPs) on 16 March, (3) the implementation of a foreign exchange swap agreement between the US Federal Reserve and the BOK on 19 March 19 (red line), (4) outright purchases of Korean government bonds on 20 March, and (5) the broadening of the types of financial institutions eligible for repos on 26 March. The bid-ask spread responded to the pandemic announcement and the BOK's market stabilisation measures. Specifically, the bid-ask spread began to increase in early March around the time of the pandemic announcement on 11 March and then it peaked at more than four times its pre-pandemic level, from 1.04 bp on 10 March to 4.5 bp on 19 March. After the implementation of the dollar swap and outright government bond purchases on 19 and 20 March, respectively, the bid-ask spread decreased to 2.0 bp and eventually returned to its pre-pandemic level of 1.0 bp by 1 April. This indicates that it took about two weeks for the spread to recover to its pre-pandemic level after the implementation of the market stabilisation measures. The other liquidity measures show the similar trends to the bid-ask spread. Overall, the market stabilisation measures taken by the BOK during the COVID-19 pandemic were successful in stabilising the short-term funding market and foreign exchange market, in reducing Treasury market volatility and in enhancing liquidity. Especially, the introduction of the dollar swap contributed to improving Treasury bond liquidity, highlighting the important role of US dollar funding in stabilising the exchange rate and also the domestic financial market.

4. Empirical model and regression results

4.1 Effects of the dollar on Treasury market liquidity

To further investigate the effect of the dollar on Treasury bond liquidity after controlling for the variables that are associated with Treasury bond liquidity, we estimate our baseline regression model for the sample period from 2 January 2012 to 28 December 2022 in daily frequency, referring to Adrian et al (2023):

$$LIQ_t = \alpha_0 + \alpha_1 dlog(BROAD_t \; or \; BER_t) + b'X + \gamma_{time} + \gamma_{announce} + \epsilon_t \qquad (1)$$

where LIQ is one of the four liquidity measures, QS, log(PI), log(QD), LIQIDX; subscript *t* is day; *BROAD* is the broad US dollar index; *BER* is the bilateral exchange rate of the Korean Won against the US dollar; *X* is a vector containing other variables that are associated with market liquidity. Several previous papers in market microstructure (Chordia et al, 2001; Chordia et al, 2005; Adrian et al, 2023) conduct their analyses in daily frequency. We use control variables that are commonly used in market microstructure studies such as market uncertainty (dlog(VKO), dlog(VIX), and dlog(MOVE)), funding liquidity (dTED, dKTED), credit risk (dCS), bond characteristic variables and macroeconomic announcement. Bond characteristic variables include the aggregated bond yields (dYIELD) and the trading volume (dlog(TVOL)) in Korean won[17] for 3-, 5-, 10- year maturities; TIME dummies (γ_{time}) includes the day of the week effect (e.g, the dummies for Monday, Tuesday, Wednesday, and Thursday, respectively), the dummies for month and year and the dummy for TICK, two days before and after the tick size reduction on 27 June 2016; ANNOUNCEMENT ($\gamma_{announce}$) includes the dummies for the days of monetary policy announcements and macroeconomic announcements such as GDP, inflation, employment and trade. Referring to Adrian et al (2023) and Chordia et al (2005), we regress each of market liquidity metric on the broad dollar index after controlling for market uncertainty, funding liquidity proxies, individual bond characteristics, time and macroeconomic announcement effects. We estimate regression model (1) using Newey and West (1987) adjusted standard errors.[18]

Table 2 reports the results of the baseline regression from model (1). Columns (1) through (4) focus on the results when using the US dollar return as a key exchange rate variable. Consistent with hypothesis being tested in this paper, a strong dollar leads to declines in Treasury market liquidity in Korea: the broad dollar returns are positively associated with the bid-ask spread, price impact, and a composite liquidity index (i.e., the illiquidity regression) while they are negatively associated with the quoted depth (i.e., the liquidity regression). This evidence supports the notion of the financial channel of exchange rate, indicating that the dollar is the global risk factors that reduce market participants' risk capacity (Hofmann et al, 2020; Bruno et al, 2022). That said, dealers tend to reduce liquidity provision when the US dollar is strong because their market-making costs increase through financial channels of exchange rate. More specifically, column (1) shows that a 10 percentage point increase in the broad dollar returns is associated with an increase in the relative quoted spread by 0.7 basis points on average per day, at the 5% significance level. The coefficient on dlog(VKO), different from dlog(VIX), is positive and significant in the bid-ask spread and price impact regression, while negative in the quoted depth regression. This is consistent with prior studies that volatility is one of the main drivers of market liquidity (Chung

[17] We include YIELD and TVOL as control variables because these are known to have a significant effect on liquidity in market microstructure (See Benston and Hagerman, 1974; Stoll, 2000).

[18] Our main results about the relationship between the dollar and government bond liquidity are robust regardless of different model specifications including models with domestic factors only or models with global factors only or both domestic and global factors.

and Chuwonganant, 2014; Adrian et al, 2023). In other words, volatility in the local financial market increases the risk of intermediating markets, leading to wider bid-ask spreads and reduced depth. Adrian et al (2023) show that changes in the implied US Treasury volatility explain over 20% of the fluctuations in the Treasury liquidity index which is a combined measure of the bid-ask spread, depth, and the price impact. In addition, we control for the individual bond characteristic variables based on the market microstructure literature (e.g., Stoll, 1978; Chordia et al, 2005) and find that the coefficients on dlog(TVOL) (dYIELD) are negative (positive) and significant for the bid-ask spread and price impact regression while those on market depth are positive (negative) and significant. However, the coefficients of dTED, dKTED and dCS are insignificant, indicating that proxies of economy-wide funding liquidity as local or global factors are unlikely to be related with liquidity. Overall, our results are qualitatively similar, regardless of whether including them as explanatory variables or not. Referring to the literature on bond market liquidity (Fleming and Remolona, 1999; Chordia et al, 2005), we control time and macroeconomic announcement effects. Among the economic news releases, we find that the coefficients on the monetary policy announcement days are significantly positive in the illiquidity regressions, implying that monetary policy announcements led to a significant deterioration in liquidity compared to other days when no such announcement was made. This result supports the idea that liquidity impairment arises as informed trading on the monetary policy announcement days increases (Chung et al, 2013; Lee and Ryu, 2019).

Columns (5) through (8) in Table 2 show the results on the impact of the bilateral exchange rate on Korean government bond liquidity. Consistent with our conjecture, the coefficients on the bilateral exchange rate (dlog(BER)) are positive in the illiquidity regression while they are negative in the quoted depth regression although their significance varies with model specifications. Columns (9) through (12) conduct horseracing regressions between the broad US dollar index returns and the bilateral exchange rate returns to shed light on the role of the two exchange rates for Korea Treasury bond liquidity. As expected, both the broad dollar returns and the bilateral exchange rate returns show all positive coefficients except for the market depth model (column (11)). However, the coefficients on dlog(BROAD) are larger than those on dlog(BER) in most models, explaining that the broad dollar returns have greater explanatory power than the bilateral exchange rate returns. This suggests that the broad dollar index as a global factor plays an important role in explaining changes in Treasury market liquidity.[19] This is consistent with the finding of Hofmann et al (2022) who compare the explanatory power of the two variables in explaining local currency bond spreads for 20 EMEs, and Bruno et al (2022) who compare the explanatory power of the two variables in explaining stock returns for 50 EMEs. Both papers highlight the essential role of the broad dollar as a global factor in the financial channels.

4.2 The channels through which the impacts of the dollar on liquidity are amplified

From the earlier results, we find that the dollar, as a global factor, has a significant impact on liquidity in the Korea Treasury bond market. In this section, our focus is when the impact of the dollar on market liquidity becomes more pronounced possibly through limited dealer intermediation capacity. Specifically, this paper proposes three financial channels of exchange rates affecting government bond liquidity: funding liquidity conditions, original sin and original sin redux.

4.2.1 Funding liquidity conditions

To empirically investigate the possible financial channel of the dollar movements on Korea Treasury bond market liquidity via funding liquidity conditions, we add an interaction term between the dollar and a proxy for funding liquidity to the baseline regression model (1). The specific regression model is as follows:

$$LIQ_t = \alpha_0 + \alpha_1 dlog(BROAD_t) + \alpha_1 dlog(BROAD_t) * FUNDING_t + b'X + \gamma_{time} + \gamma_{announce} + \epsilon_t \quad (2)$$

where FUNDING is one of the following three proxies for funding liquidity conditions: dYIELD, dlog(VKO), and dCDS.[20] We use the same set of control variables as in the baseline regression model (1). Columns (1) through (4) of Table 3 show that both coefficients on the dlog(BROAD) and the interaction term between dlog(BROAD) and dYIELD[21] are positive and significant in the bid-ask spread and price impact regressions (columns (1), (2) and (4)), while they are negative and significant in the quoted depth regression (column (3)). These results support our conjecture that

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[19] We conduct regression analyses using the volatility of dollar returns computed over 22-day rolling window instead of the dollar returns themselves. Appendix D shows that higher dollar volatility dampens government bond liquidity.

[20] We also test the proxies of funding liquidity that have been commonly used such as TED, KTED and the credit spread, but the coefficients on the interaction terms are all insignificant in these regressions. The results are available from the author upon request.

[21] We conduct the same analysis including the level of yields and its interaction with dollar returns and find that the coefficients on the dollar returns and its interaction terms with the level of yields are insignificant. The results are available from the author upon request.

the effects of the dollar on market liquidity are more pronounced when government bond yields increase, meaning that liquidity providers are likely to reach their capital constraints in response to a strong dollar when domestic financial conditions tighten. Columns (5) through (8) show that as expected, the coefficients on the dlog(BROAD) and the interaction term of dlog(BROAD) and dlog(VKO) are all positive (negative) and significant for the illiquidity (liquidity) measures. These results are consistent with the implication of the theoretical model proposed by Brunnermeier and Pedersen (2009) and empirical evidence of Adrian et al (2023) who use 30-year real-time transaction data and show that the implied US Treasury volatility is a significant driver of liquidity in the US Treasury bond market. Similar to uncertainty and bond yield, Columns (9) through (12) show that both the coefficient on dlog(BROAD) and the interaction term of dlog(BROAD) and dlog(CDS) are all positive (negative) and significant for illiquidity (liquidity) metrics. This indicates that dealer banks are likely to reduce liquidity provision in an environment of a dollar appreciation, especially when they face greater credit risk. Overall, our evidence supports that the adverse impacts of the dollar appreciation on government bond illiquidity can be amplified by tightened domestic funding liquidity conditions.

4.2.2 Original sin

To test our original sin channel, we introduce two bank-level proxies: FXLOAN_RATIO (foreign currency denominated loans/total loans) and BIS_RATIO (total capital/risk-weighted assets (RWAs)). A higher FXLOAN_RATIO indicates greater vulnerability to exchange rate fluctuations. Conversely, a higher BIS_RATIO indicates greater ability to withstand losses and absorb shocks, given that a weak dollar tends to be associated with a higher BIS_RATIO. Consequently, banks with higher foreign currency exposure and lower capital ratios are likely to provide less liquidity.

In regression equation (2), we replace the interaction term dlog(BROAD)*dFXLOAN_RATIO or dlog(BROAD)*dBIS_RATIO for dlog(BROAD)*FUNDING. Consistent with our conjecture, Table 4 shows that the coefficients on the interaction term between dlog(BROAD) and dFXLOAN_RATIO are positive (columns (1), (2) and (4)) and those of dlog(BROAD) and dBIS_RATIO are negative in the illiquidity regressions (columns (5), (6) and (8)), while these results are reversed in the liquidity regression (columns (3) and (7)). This indicates that the effects of the dollar on liquidity appear to be more pronounced when banks have greater foreign currency exposure and a lower total capital ratio. Since two proxies are likely to be sensitive to exchange rate fluctuations as shown in Figure 3, the effects of the dollar on government bond liquidity become stronger in an environment of the dollar appreciation.

This is consistent with the notion of original sin that EMEs cannot borrow from in their own currency, which implies the greater exposure of EME borrowers to currency mismatch and increases in their vulnerability to exchange rate fluctuations. Recent papers have shown that original sin persists for EME corporates, who rely on foreign currency denominated loans, unlike major sovereign issuers, who issue government bonds in the local currency (Du and Schreger, 2022; Onen et al, 2023). Du and Schreger (2022) show that large foreign currency corporate borrowing increases sovereign default risk in a sample of 14 EMEs, even when government bond issuances in local currency have increased. This implies that banks that provide foreign currency corporate lending are likely to face foreign currency risk when corporates' default risk increases. Recent papers have shown that post-crisis bank regulations raised market-making costs for dealer banks in the US corporate bond market (Adrian et al, 2017; Bessembinder et al, 2018). More stringent capital requirements have also reduced incentives for dealers to profitably operate large inventory positions and thereby reduced dealer liquidity provision (Andersen et al, 2019; Benos and Zikes, 2018). Therefore, our empirical results support that dealer intermediation capacity would be limited when banks are more exposed to foreign currency risk and have a lower total capital ratio, leading to a stronger relationship between the dollar and Treasury bond liquidity in EMEs.

4.2.3 Original sin redux

To find out the implications of the original sin redux hypothesis, we assess how foreign investors affect the relationship between the dollar and government bond liquidity. Figure 2 shows that the share of foreign bond holdings, which is the ratio of the Korea Treasury bonds that are held by foreign investors to the total outstanding amount of the bonds. The figure shows that foreign bond holdings have gradually increased, especially from 2016 onwards. Between 2016 and 2021, the share of foreign bond holdings increased from 14% to 20%, implying greater reliance on foreign investors in the KTB market. However, there are concerns that increases in foreign bond holdings may pose financial stability risks due to sudden stops or flight (Forbes et al, 2012).

For our empirical analyses, we focus on changes in foreign bond holdings and dummies for foreign buy (DUM_FBUY) and foreign sell (DUM_FSELL) to capture asymmetric responses of liquidity to trade positions. DUM_FBUY (DUM_FSELL) is equivalent to 1 if changes in foreign bond holdings are positive (negative), otherwise 0. In the baseline regression model (1), we add an interaction term between the dollar returns and one of the three foreign bond holding variables. Table 5 reports the results of the role played by foreign investors in the Korea Treasury bond market. Columns (1) through (8) show the results when we add the changes in foreign ownership variable, while columns (9) through (12) show the results when we add the interaction terms between the dollar and dummies for the changes in foreign bond holdings in the baseline regression equation (1).

Our results show that the coefficients on dlog(BROAD) are positive and significant in the illiquidity regression models, even after controlling for the behavior of foreign investors. Columns (1) through (8) show that the coefficients on dFHOLDING and dFHOLDING*dlog(BROAD) are insignificant regardless of liquidity measures. This indicates that the overall changes in foreign bond holding do not substantially affect liquidity or its relationship with the dollar.

However, the results may differ depending on whether foreign investors are selling or buying. Foreign bond sales are expected to have a more substantial effect on liquidity than foreign bond purchases, because large selling pressure by foreign investors can drive a drop in liquidity. Also, the dollar's effects on Treasury liquidity may be stronger when foreign investors sell their holdings during times of a strong dollar due to the financial channel of exchange rates (Hofmann et al, 2022). Columns (9) through (12) show the results of separating foreign trading into foreign sells and foreign buys. The coefficients on dlog(BROAD)*DUM_FSELL are positive and significant in the bid-ask spread, the price impact and the composite liquidity index regressions (Columns (9), (10) and (12)), but negative and significant in the quoted depth regression (Column (11)). By contrast, those on dlog(BROAD)*DUM_FBUY are all insignificant. The evidence supports the hypothesis that dealers tend to reduce liquidity provision by increasing the bid-ask spread and the price impact of trades, possibly due to the increased inventory risk. In other words, dealers are more likely to be left with illiquid positions when foreign investors sell bonds to reduce their risk of losses. This effect would be even worse during times of a strong dollar when foreign investors sell their bonds, supporting the concept of original sin redux.

In addition, to assess whether heightened market volatility exerts an impact on market liquidity associated with the broad dollar index and foreign investors, we construct three-way interactions among market volatility, the broad dollar index and changes in foreign bond holding variables in the regression models. Table 6 shows that the coefficients on dlog(BROAD) and dlog(BROAD)*dlog(VKO) are positive in the illiquidity regressions (columns (1), (2) and (4)) and negative and significant in the quoted depth regression (column (3)), consistent with the earlier results. The coefficients on the interaction term, dlog(BROAD)*dFHOLDING, and the triple interaction term, dlog(BROAD)*dFHOLDING*dlog(VKO), are insignificant regardless of liquidity metrics (column (1) through (4)). However, in columns (5) through (8) which show the results with dummies for foreign buys and sells, we find that the coefficients on the interaction terms, dlog(BROAD)*DUM_FSELL and dlog(BROAD)*DUM_FSELL*dlog(VKO), are positive and significant in the illiquidity regressions while they are negative and significant in the quoted depth regression. This indicates that the effects of market volatility and the broad dollar index on market liquidity is stronger with larger foreign sell, implying the importance of market volatility associated with foreign bond sells. Overall, we find that the effects of the broad dollar return that are associated with foreign sells are positive (negative) and significant when volatility increases in the bid-ask spread (quoted depth) regression. That is, large foreign sell-offs associated with market volatility can limit dealers' capacity to intermediate trades and reduce their liquidity provision to the government bond market, consistent with Duffie (2020).

4.3 Dollar and Treasury market liquidity during stress periods

In the previous sections, we confirm that market uncertainty, such as dollar appreciation, can lead to a drop in liquidity. Koosakul and Shim (2021) show that volatility leads to an increase in trading volume on average, but a decrease in trading volume at high levels of volatility in the Thai foreign exchange market, indicating that the effects of the dollar on liquidity may differ depending on the severity of stress. During times of market turmoil and dollar appreciation, dealers may face even greater difficulty in providing liquidity because sell pressure from global investors can be much stronger than usual (e.g., Hofmann et al, 2020; Bertaut et al, 2022) and because additional capital may be needed to meet bank regulation as the total capital ratio and liquidity coverage ratio decline with dollar appreciation (Adrian et al, 2017). Some papers have shown that less market-making by banks can amplify itself in market illiquidity during stress periods (Bao et al, 2018 and Dick-Nielsen and Rossi, 2019). We therefore conjecture that the effects of the stronger dollar on liquidity can be more pronounced during times of market stress because dealers are likely to be more risk-averse and face tighter financial constraints, which reduces liquidity provision to the government bond market.

To test our conjecture, we focus on five episodes during our sample period: the Taper Tantrum in 2013, the Chinese stock sell-off in 2015, the Trump presidential election in 2016, the outbreak of the COVID-19 pandemic in 2020, and the Legoland PF-ABCP distress in 2022 which coincide with Ferriani (2021) who focuses on market turmoil in EMEs except for the PF-ABCP event and examines the behaviour of mutual funds and finds that investors drive abnormal negative flows in the aftermath of each episode. We construct one dummy for each of the five episodes, which takes value 1 when it is on the episode day or twenty days after, and 0 otherwise, as well as interaction terms between the dollar and an episode dummy.

Table 7 shows the results from regressions using the composite liquidity index as the dependent variables. The regression models include the episode dummies and interaction terms between the episodes and the broad dollar index. Columns (1) through (5) show the results for five different episodes in chronological order. The coefficients on the broad dollar index are mostly positive and significant after controlling for one of the five episodes at a time. The coefficients on the five episode dummies such as TAPER, CN, TRUMP, COVID and PF-ABCP are all positive and significant. This suggests that primary dealers tend to face difficulties in liquidity provision due to high inventory risk and asymmetric information during market turmoil. In addition, we find that the coefficients on the interaction terms between the dollar index and episode dummies vary across episodes. The coefficient on the interaction term, dlog(BROAD)*TAPER, is positive and significant, different from that for the other episodes. This can be interpreted that Treasury market liquidity in Korea is likely to respond strongly to dollar fluctuations during times of US monetary tightening. However, the impacts of the dollar on liquidity are insignificant during other episodes. One possible explanation is that since the Taper Tantrum, EMEs have become more resilient to global shocks associated with dollar appreciation thanks to their strong fundamentals, the accumulation of foreign exchange reserves, and interventions in the currency market during times of stress.

4.4 Robustness checks

4.4.1 Lagged independent variables

In the previous section, we examine the contemporaneous relationship between the dollar and government bond liquidity. To consider the possibility of lagged macroeconomic variables affecting government bond liquidity,[22] we also include the one-day lagged value of each control variable in the baseline regression model (1). Table 8 shows that the coefficients on the current

[22] Since the US broad dollar index is calculated based on the trade-weighted average of daily bilateral exchange rates for 26 countries (https://www.federalreserve.gov/releases/h10/weights/), which can cause timing issues with information releases, we run regressions that include both the one-day lead and lagged broad dollar returns simultaneously. However, the coefficients of lead dollar returns are insignificant. The results are available from the author upon request.

broad dollar returns are significantly larger than those on the lagged broad dollar returns in the illiquidity regressions (Columns (1), (2) and (4)), possibly due to the real-time impact of exchange rates fluctuations. By contrast, the coefficients of the current market uncertainty (VKO) are significantly smaller than those on lagged market uncertainty. For other variables, we find that most of them are insignificant regardless of whether we include contemporaneous macroeconomic variables only or both contemporaneous and one-day lagged macroeconomic variables. Therefore, our main results on the relationship between the dollar and government bond liquidity are robust to the inclusion of lagged macroeconomic variables.

4.4.2 Dollar and Treasury market liquidity by issuance maturity

We analyse the relationship between the dollar and government bond liquidity for each maturity: 3-, 5-, and 10-year Treasuries. We estimate the same regression model (1) for each maturity. Columns (1) through (3) of Table 9 show the results for the bid-ask spread, columns (4) through (6) those for the price impact, and columns (7) through (9) those for quoted depth. Columns (1), (4) and (7) show the results for 3-year Treasury bonds, columns (2), (5) and (8) those for 5-year Treasury bonds, and columns (3), (6) and (9) those for 10-year Treasury bonds. In the bid-ask spread regression, we find that the coefficient on dlog(BROAD) is positive and significant for 3-, 5- and 10-year Treasuries (columns (1) through (3)). In the price impact regression, the coefficient on dlog(BROAD) is positive and significant for 3- and 5-year Treasuries, but insignificant for 10-year Treasuries (columns (4) through (6)). In the depth regression, the coefficient on dlog(BROAD) is negative and significant only for 3-year Treasury bond (column (7)). These results imply that primary dealers tend to adjust the bid-ask spread in response to the dollar appreciation for all Treasuries, while they are likely to adjust quoted depth only for 3-year Treasuries. Overall, our key results about the relationship between the dollar and government bond liquidity are robust when we consider different maturities.

5. Conclusion

This paper investigates the impact of the US dollar on Treasury market liquidity as well as the various channels through which this impact is amplified in Korea, a representative EME. We conduct daily time-series regression analyses using various high-frequency liquidity metrics estimated based on real-time order book and transaction data over the sample period from 2 January 2012 to 28 December 2022.

Our two key findings are as follows. First, we find that a strong dollar deteriorates Korean government bond liquidity, even after controlling for market uncertainty, funding liquidity and individual bond characteristics. In a horse race regression between the dollar index returns and bilateral exchange rate returns, the former has greater explanatory power than the latter, indicating that the dollar, as a key barometer of risk-taking capacity, play an important role in explaining EME government bond liquidity.

Second, we investigate various channels through which the impacts of a strong dollar on illiquidity are more pronounced and find that they are stronger when uncertainty and government bond yields increase, when banks have the lower total capital ratio with greater exposure to foreign currency risk, and when there are large foreign investor sell-offs. This implies that funding liquidity conditions, especially in the strong dollar environment, are an important factor in determining dealers' market-making capacity. Notably, our result indicates that EME dealers can be more vulnerable to exchange rate fluctuations because their business counterparts are both corporates, who may also be affected by the original sin, and foreign investors, who are subject to original sin redux. In such circumstances, the impact of the dollar on bond market liquidity can be stronger due to limited market intermediation capacity of EME dealers and their reduced liquidity provision to the financial market.

Our empirical evidence suggests that the dollar, acting as a global risk factor, plays a pivotal role in EME's government bond market. Such a strong linkage between the exchange rate and local financial market highlights that policy measures aimed to stabilise the foreign exchange market can help maintain government bond market liquidity and thus domestic financial stability in EMEs.

References

Adrian, T., Fleming, M., Goldberg, J. E., Lewis, M., Natalucci, F. M., & Wu, J. J. (2013). Dealer balance sheet capacity and market liquidity during the 2013 selloff in fixed-income markets. *Liberty Street Economics*.

Adrian, T., Fleming, M., Shachar, O., & Vogt, E. (2017). Market liquidity after the financial crisis. *Annual Review of Financial Economics,* 9, 43-83.

Adrian, T., Fleming, M., & Vogt, E. (2023). The evolution of Treasury market liquidity: evidence from 30 years of limit order book data. *Federal Reserve Bank of New York*.

Andersen, L., Duffie, D., & Song, Y. (2019). Funding value adjustments. *Journal of Finance*, 74(1), 145-192.

Avdjiev, S., Bruno, V., Koch, C., & Shin, H. S. (2019). The dollar exchange rate as a global risk factor: evidence from investment. *IMF Economic Review*, 67, 151-173.

Avdjiev, S., Du, W., Koch, C., & Shin, H. S. (2019). The dollar, bank leverage, and deviations from covered interest parity. *American Economic Review*: Insights, 1(2), 193-208.

Balduzzi, P., Elton, E. J., & Green, T. C. (2001). Economic news and bond prices: Evidence from the US Treasury market. *Journal of Financial and Quantitative Analysis*, 36(4), 523-543.

Bank of Korea (2022) Transmission channels of exchange rate risk to the financial sector and its impacts. *Financial Stability Report*, December, 2022, 165-180.

Bao, J., O'Hara, M., & Zhou, X. A. (2018). The Volcker rule and corporate bond market making in times of stress. *Journal of Financial Economics*, 130(1), 95-113.

Benos, E., & Žikeš, F. (2018). Funding constraints and liquidity in two-tiered OTC markets. *Journal of Financial Markets*, 39, 24-43.

Benos, E., Gurrola-Perez, P., & Alderighi, S. (2022). Centralising bond trading. *World Federation of Exchanges Research.*

Benston, G. J., & Hagerman, R. L. (1974). Determinants of bid-asked spreads in the over-the-counter market. *Journal of Financial Economics*, 1(4), 353-364.

Bertaut, C, Bruno, V., & Shin, H.S. (2022). Original sin redux, Manuscript SSRN, April.

Bessembinder, H. (2000). Tick size, spreads, and liquidity: An analysis of Nasdaq securities trading near ten dollars. *Journal of Financial Intermediation*, 9(3), 213-239.

Bessembinder, H., Jacobsen, S., Maxwell, W., & Venkataraman, K. (2018). Capital commitment and illiquidity in corporate bonds. *Journal of Finance*, 73(4), 1615-1661.

Borio, C. (2000). Market liquidity and stress: selected issues and policy implications. *BIS Quarterly Review*.

Borio, C., Shim, I., & Shin, H. S. (2022). Macro-financial stability frameworks: experience and challenges. *BIS Working Paper*, No 1057.

Breckenfelder, J., & Ivashina, V. (2021). Bank balance sheet constraints and bond liquidity. *ECB Working Paper Series* No. 2021/2589.

Brunnermeier, M. K., & Pedersen, L. H. (2009). Market liquidity and funding liquidity. *Review of Financial Studies*, 22(6), 2201-2238.

Bruno, V., & Shin, H. S. (2015). Cross-border banking and global liquidity, *Review of Economic Studies*, 82 (2), 535–64.

Bruno, V., Shim, I., & Shin, H. S. (2022). Dollar beta and stock returns. *Oxford Open Economics*, 1.

Carstens, A., Shin, H.S. (2019). Emerging markets aren't out of the woods yet. Foreign Affairs, 15 March.

Chakravarty, S., Panchapagesan, V., & Wood, R. A. (2005). Did decimalization hurt institutional investors?. *Journal of Financial Markets*, 8(4), 400-420.

Chordia, T., Roll, R., & Subrahmanyam, A. (2001). Market liquidity and trading activity. *Journal of Finance*, 56(2), 501-530.

Chordia, T., Sarkar, A., & Subrahmanyam, A. (2005). An empirical analysis of stock and bond market liquidity. *Review of Financial Studies*, 18(1), 85-129.

Chung, K. H., & Chuwonganant, C. (2002). Tick size and quote revisions on the NYSE. *Journal of Financial Markets*, 5(4), 391-410.

Chung, K. H., & Chuwonganant, C. (2004). Tick size, order handling rules, and trading costs. *Financial Management*, 47-62.

Chung, K. H., Elder, J., & Kim, J. C. (2013). Liquidity and information flow around monetary policy announcement. *Journal of Money, Credit and Banking*, 45(5), 781-820.

Chung, K. H., & Chuwonganant, C. (2014). Uncertainty, market structure, and liquidity. *Journal of Financial Economics*, 113(3), 476–499.

Chung, K. H., & Chuwonganant, C. (2018). Market volatility and stock returns: The role of liquidity providers. *Journal of Financial Markets*, 37, 17–34.

Committee on the Global Financial System (2014). Market-making and proprietary trading: industry trends, drivers and policy implications, Basel, November.

Demsetz, H. (1968). The cost of transacting. *Quarterly Journal of Economics*, 82(1), 33-53.

Deuskar, P., & Johnson, T. C. (2021). Funding liquidity and market liquidity in government bonds. *Journal of Banking and Finance*, *129*, 106-165.

Diaz, A., & Escribano, A. (2017). Liquidity measures throughout the lifetime of the US Treasury bond. *Journal of Financial Markets*, 33, 42-74.

Dick-Nielsen, J., Feldhütter, P., & Lando, D. (2012). Corporate bond liquidity before and after the onset of the subprime crisis. *Journal of Financial Economics*, 103(3), 471-492.

Dick-Nielsen, J., & Rossi, M. (2019). The cost of immediacy for corporate bonds. *Review of Financial Studies*, 32(1), 1-41.

Du, W., & Schreger, J. (2022). Sovereign risk, currency risk, and corporate balance sheets. *Review of Financial Studies,* 35(10), 4587-4629.

Duffie, D. (2010). Presidential address: Asset price dynamics with slow‐moving capital. *Journal of Finance*, 65(4), 1237-1267.

Duffie, D., (2020), Still the world's safe haven? *Hutchins Center Working Paper* No. 62.

Duffie, D., Fleming, M., Keane, F., Nelson, C., Shachar, O., & van Tassel, P. (2023). Dealer capacity and U.S. Treasury market functionality. *Federal Reserve Bank of New York Staff Reports*, No. 1070.

Eichengreen, B., & Hausmann, R. (1999). Exchange rates and financial fragility.

Ferriani, F. (2021). From taper tantrum to Covid-19: Portfolio flows to emerging markets in periods of stress. *Journal of International Financial Markets, Institutions and Money*, 74, 101391.

Fleming, M. J., & Remolona, E. M. (1999). Price formation and liquidity in the US Treasury market: The response to public information. *Journal of Finance*, *54*(5), 1901-1915.

Fleming, M. J. (2001). Measuring treasury market liquidity. *FRB of New York Staff Report*, (133).

Fleming, M., & Ruela, F. (2020). Treasury market liquidity during the COVID-19 crisis, *Liberty Street Economics,*

Forbes, K. J., & Warnock, F. E. (2012). Capital flow waves: Surges, stops, flight, and retrenchment. *Journal of International Economics*, 88(2), 235-251.

Glosten, L. R., & Harris, L. E. (1988). Estimating the components of the bid/ask spread. *Journal of Financial Economics*, 21(1), 123-142.

Glosten, L. R., & Milgrom, P. R. (1985). Bid, ask and transaction prices in a specialist market with heterogeneously informed traders. *Journal of Financial Economics*, 14(1), 71-100.

Goldberg, J. E. (2020). Dealer inventory constraints during the COVID-19 pandemic: Evidence from the Treasury market and broader implications," *FEDS Notes.* Board of Governors of the Federal Reverse System.

Goyenko, R. Y., & Ukhov, A. D. (2009). Stock and bond market liquidity: A long-run empirical analysis. *Journal of Financial and Quantitative Analysis*, 44(1), 189-212.

Gromb, D., & Vayanos, D. (2002). Equilibrium and welfare in markets with financially constrained arbitrageurs. *Journal of Financial Economics*, 66(2-3), 361-407.

Gromb, D., & Vayanos, D. (2010). A model of financial market liquidity based on intermediary capital. *Journal of the European Economic Association*, 8(2‐3), 456-466.

Hameed, A., Kang, W., & Viswanathan, S. (2010). Stock market declines and liquidity. *Journal of Finance*, 65(1), 257-293.

Harris, L. E. (1994). Minimum price variations, discrete bid–ask spreads, and quotation sizes. *Review of Financial Studies*, 7(1), 149-178.

He, Z., Nagel, S., & Song, Z. (2022). Treasury inconvenience yields during the COVID-19 crisis. *Journal of Financial Economics*, 143(1), 57-79.

Ho, T., & Stoll, H. R. (1981). Optimal dealer pricing under transactions and return uncertainty. *Journal of Financial Economics*, 9(1), 47-73.

Hofmann, B., Shim, I., & Shin, H. S. (2020). Bond risk premia and the exchange rate. *Journal of Money, Credit and Banking*, 52(S2), 497-520.

Hofmann, B., Patel, N., & Wu, S. P. Y. (2022). Original sin redux: a model-based evaluation. *BIS Working Paper,* No. 1004.

Jang, W. W., Kim, H. K., & Kang, Y. J. (2016). Developing the exchange traded market for government bonds: Effect of recent quote rule changes in South Korea. *Finance Research Letters*, 19, 130-138.

Jensen, G. R., & Moorman, T. (2010). Inter-temporal variation in the illiquidity premium. *Journal of Financial Economics*, 98(2), 338-358.

Kang, K., Kim, G., & Rhee, C. (2005). Developing the government bond market in South Korea: History, challenges, and implications for Asian countries. *Asian Economic Papers*, 4(2), 91-113.

Koosakul, J., & Shim, I. (2021). The effects of asset price volatility on market participation: Evidence from the Thai foreign exchange market. *Journal of Banking and Finance*, 124.

Kyle, A. S. (1985). Continuous auctions and insider trading. *Econometrica*, 53(6), 1315-1335.

Lee, C. M., & Ready, M. J. (1991). Inferring trade direction from intraday data. *Journal of Finance*, 46(2), 733-746.

Lee, J., & Ryu, D. (2019). The impacts of public news announcements on intraday implied volatility dynamics. *Journal of Futures Markets,* 39(6), 656-685.

McGuire, P., Shim, I., Shin, H. S., & Sushko, V. (2021). Outward portfolio investment and dollar funding in emerging Asia. *BIS Quarterly Review*, December, 53-67.

Newey, W. K., & West, K. D. (1987). Hypothesis testing with efficient method of moments estimation. *International Economic Review*, 777-787.

Onen, M., Shin, H. S., & von Peter, G. (2023). Overcoming original sin: insights from a new dataset. *BIS Working Papers* No. 1075.

Pelizzon, L., Subrahmanyam, M. G., Tomio, D., & Uno, J. (2016). Sovereign credit risk, liquidity, and European Central Bank intervention: Deus ex machina? *Journal of Financial Economics*, 122(1), 86-115.

Schestag, R., Schuster, P., & Uhrig-Homburg, M. (2016). Measuring liquidity in bond markets. *Review of Financial Studies*, 29(5), 1170-1219.

Schrimpf, A., Shin, H., & Sushko, V. (2020). Leverage and margin spirals in fixed income markets during the Covid-19 crisis. *BIS Bulletin* No. 2.

Stoll, H. R. (1978). The supply of dealer services in securities markets. *Journal of Finance*, 33(4), 1133-1151.

Stoll, H. R. (2000). Presidential address: friction. *Journal of Finance*, 55(4), 1479-1514.

Subrahmanyam, A. (1991). Risk aversion, market liquidity, and price efficiency. *Review of Financial Studies*, 4(3), 417-441.

Table 1. Summary statistics

Panel A. Key variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Aggregate Treasury bond					
QS(bp)[1]	2698	1.011	.495	.509	8.44
PI[1]	2698	.167	.108	.018	1.137
QD(billion ₩)[1]	2698	19.947	15.752	2.373	145.986
LIQIDX	2698	0	1	-1.777	11.061
YIELD(%)	2698	2.203	.786	.862	4.548
TVOL(trillion ₩)[2]	2698	6.049	3.588	.5	52.332
Macroeconomic variables					
BROAD	2698	108.494	10.148	89.597	128.321
FXRATE	2698	1143.789	68.873	1008.9	1436.6
VIX	2698	17.851	7.07	9.14	82.69
VKO	2698	16.784	5.697	9.72	69.24
KTED	2698	.126	.11	-.056	.715
TED	2698	28.181	15.031	-1.364	144.763
CS(%)	2698	5.978	.258	5.31	6.411
MOVE	2698	70.211	21.753	36.62	163.7

Notes: [1] Volume-weighted average of each variable for 3-year, 5-year, and 10-year on-the run Treasury bonds. [2] Sum of daily trading volume for 3-, 5- and 10-year on-the runs. [3] Sum of the number of trades per day for 3-, 5- and 10-year on-the-runs.

Panel B. Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) QS	1.00									
(2) log(PI)	0.74***	1.00								
(3) log(QD)	-0.55***	-0.85***	1.00							
(4) LIQIDX	0.85***	0.82***	-0.78***	1.00						
(5) dlog(BROAD)	0.07***	0.05***	-0.04*	0.04**	1.00					
(6) dlog(BER)	0.02	0.05**	-0.04**	0.03	0.03*	1.00				
(7) dlog(VIX)	-0.01	0.00	-0.01	-0.01	0.20***	-0.01	1.00			
(8) dlog(VKOSPI)	0.04**	0.04**	-0.03	0.02	0.15***	0.00	0.16***	1.00		
(9) dYIELD	0.09***	0.17***	-0.17***	0.05***	0.06***	-0.02	-0.02	0.07***	1.00	
(10) dlog(TVOL)	-0.12***	-0.21***	0.17***	-0.11***	0.00	-0.01	0.03	0.02	-0.32***	1.00

Note: ***, **, and * indicate statistical significance at 1, 5, and 10 per cent, respectively.

Table 2. The impact of dollar on Treasury liquidity: baseline results

VARIABLES	(1) QS	(2) log(PI)	(3) log(QD)	(4) LIQIDX	(5) QS	(6) log(PI)	(7) log(QD)	(8) LIQIDX	(9) QS	(10) log(PI)	(11) log(QD)	(12) LIQIDX
dlog(BROAD)	0.071**	0.046*	-0.068*	0.126**					0.071**	0.044	-0.065*	0.123**
	(2.00)	(1.66)	(-1.81)	(2.01)					(1.98)	(1.59)	(-1.75)	(1.99)
dlog(BER)					0.018	0.048***	-0.060**	0.055	0.016	0.047**	-0.058**	0.052
					(0.74)	(2.60)	(-2.49)	(1.34)	(0.68)	(2.58)	(-2.46)	(1.28)
dlog(VKO)	0.004**	0.003**	-0.003	0.005*	0.004**	0.003**	-0.003*	0.006**	0.004**	0.003**	-0.003	0.005*
	(2.29)	(2.19)	(-1.50)	(1.92)	(2.51)	(2.30)	(-1.68)	(2.15)	(2.29)	(2.19)	(-1.51)	(1.92)
dCS	-0.784	-2.668	6.429***	-5.236	-0.629	-2.517	6.221***	-4.931	-0.760	-2.598	6.342***	-5.159
	(-0.37)	(-1.48)	(2.82)	(-1.23)	(-0.30)	(-1.37)	(2.70)	(-1.14)	(-0.36)	(-1.43)	(2.79)	(-1.21)
dKTED	-1.647	0.397	-0.899	-1.861	-1.601	0.471	-0.995*	-1.750	-1.628	0.454	-0.970*	-1.798
	(-0.87)	(0.72)	(-1.64)	(-0.79)	(-0.85)	(0.85)	(-1.78)	(-0.75)	(-0.87)	(0.84)	(-1.77)	(-0.77)
dlog(VIX)	-0.002	-0.000	-0.000	-0.002	-0.001	-0.000	-0.001	-0.002	-0.002	-0.000	-0.000	-0.002
	(-1.52)	(-0.52)	(-0.05)	(-1.30)	(-1.10)	(-0.20)	(-0.41)	(-0.88)	(-1.52)	(-0.49)	(-0.08)	(-1.29)
dlog(MOVE)	0.001	-0.000	0.001	-0.002	0.001	0.000	0.001	-0.001	0.001	-0.000	0.001	-0.002
	(0.32)	(-0.13)	(0.58)	(-0.68)	(0.62)	(0.15)	(0.28)	(-0.34)	(0.34)	(-0.06)	(0.52)	(-0.64)
dTED	0.005	0.002	-0.003	0.003	0.005	0.002	-0.003	0.003	0.005	0.002	-0.003	0.003
	(1.06)	(0.45)	(-0.65)	(0.39)	(1.06)	(0.48)	(-0.68)	(0.39)	(1.08)	(0.50)	(-0.70)	(0.41)
dYIELD	0.331	0.887***	-1.366***	-0.088	0.354	0.908***	-1.395***	-0.044	0.334	0.896***	-1.376***	-0.078
	(1.14)	(7.13)	(-8.81)	(-0.23)	(1.23)	(7.31)	(-9.07)	(-0.11)	(1.16)	(7.26)	(-8.95)	(-0.20)
dlog(TVOL)	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.003***	-0.002***
	(-3.70)	(-11.47)	(9.51)	(-5.13)	(-3.68)	(-11.36)	(9.42)	(-5.07)	(-3.72)	(-11.45)	(9.49)	(-5.15)
TICK	-0.358***	-0.773***	0.606***	-0.738***	-0.351***	-0.767***	0.597***	-0.726***	-0.357***	-0.771***	0.602***	-0.735***
	(-12.15)	(-6.32)	(3.27)	(-5.95)	(-11.84)	(-6.32)	(3.25)	(-5.92)	(-12.19)	(-6.36)	(3.28)	(-6.04)
MP	0.297***	0.296***	-0.420***	0.665***	0.298***	0.298***	-0.422***	0.668***	0.298***	0.297***	-0.422***	0.667***
	(5.04)	(9.14)	(-10.15)	(7.26)	(5.03)	(9.19)	(-10.22)	(7.27)	(5.03)	(9.15)	(-10.19)	(7.27)
CPI	-0.003	0.037	-0.052	0.038	-0.005	0.037	-0.051	0.035	-0.003	0.038	-0.053	0.039
	(-0.15)	(1.20)	(-1.19)	(0.66)	(-0.23)	(1.18)	(-1.18)	(0.62)	(-0.14)	(1.23)	(-1.22)	(0.68)
GDP	0.073	-0.039	0.047	-0.061	0.070	-0.041	0.050	-0.068	0.074	-0.038	0.046	-0.061
	(0.58)	(-0.87)	(0.73)	(-0.54)	(0.55)	(-0.92)	(0.78)	(-0.59)	(0.58)	(-0.86)	(0.72)	(-0.53)
TRADE	-0.024	-0.013	0.051	-0.009	-0.026	-0.012	0.051	-0.011	-0.023	-0.010	0.048	-0.006
	(-1.01)	(-0.42)	(1.23)	(-0.17)	(-1.11)	(-0.40)	(1.22)	(-0.22)	(-0.97)	(-0.34)	(1.15)	(-0.12)
EMP	-0.053*	-0.043	0.051	-0.010	-0.060*	-0.051	0.062	-0.024	-0.055*	-0.049	0.058	-0.016
	(-1.68)	(-1.24)	(1.15)	(-0.17)	(-1.82)	(-1.47)	(1.39)	(-0.40)	(-1.69)	(-1.39)	(1.30)	(-0.27)
Observations	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656
Time	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.470	0.600	0.610	0.560	0.470	0.600	0.610	0.560	0.470	0.600	0.610	0.560

Notes: This table provides regression results for the effect of the dollar on various Treasury liquidity metrics, together with other control variables from 3 Jan 2012 to 28 Dec 2022. The dependent variable is the daily liquidity measure. QS is the volume-weighted average relative quoted spread across different maturity bonds; log(PI) is the log of volume-weighted average of Kyle's lambda (1985); log(QD) is the log of volume-weighted average quoted depth; and LIQIDX is the composite index of 9 liquidity measures. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad dollar index; dlog(BER) is the log difference of the bilateral spot exchange rate of KRW against the dollar; dlog(VKO) is the log difference of the implied volatility of the KOSPI 200; dCS is the change in the difference between 3-year corporate bond yield and 3-year government bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilization bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average yield for on-the-run 3-, 5- and 10-year Treasuries; dlog(TVOL) is the log difference of sum of trading volume across securities; TICK is the dummy for two days before and after tick size reduction on 27 June 2016; MP, CPI, GDP, TRADE, and EMP are the dummies for economic announcement days (e.g., monetary policy, inflation, GDP, trade balance, and employment); TIME={Year, Month, Weekday, Holiday}; Newey-West (1987) *t*-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5 and 10 per cent, respectively.

Table 3. The effect of the dollar on liquidity: funding liquidity

	dYIELD				dlog(VKO)				dCDS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	QS	log(PI)	log(QD)	LIQIDX	QS	log(PI)	log(QD)	LIQIDX	QS	log(PI)	log(QD)	LIQIDX
dlog(BROAD)	0.067**	0.044	-0.066*	0.117**	0.070**	0.045	-0.067*	0.124**	0.052*	0.039	-0.061*	0.094*
	(2.05)	(1.62)	(-1.78)	(2.05)	(2.00)	(1.63)	(-1.79)	(1.99)	(1.73)	(1.46)	(-1.67)	(1.71)
dlog(BROAD)*dYIELD	1.820*	0.783*	-0.933*	3.393**								
	(1.69)	(1.93)	(-1.73)	(2.35)								
dlog(BROAD)*dlog(VKO)					0.009*	0.010***	-0.009	0.016*				
					(1.66)	(2.85)	(-1.42)	(1.86)				
dlog(BROAD)*dCDS									0.069***	0.042***	-0.049***	0.128***
									(3.53)	(3.20)	(-2.81)	(6.28)
dYIELD	0.256	0.855***	-1.328***	-0.227	0.328	0.885***	-1.363***	-0.092	0.284	0.861***	-1.335***	-0.173
	(0.93)	(6.77)	(-8.40)	(-0.61)	(1.13)	(7.10)	(-8.75)	(-0.24)	(1.00)	(6.94)	(-8.58)	(-0.46)
dlog(VKO)	0.004**	0.003**	-0.003	0.005*	0.003*	0.003*	-0.002	0.004	0.003*	0.003**	-0.003	0.003
	(2.19)	(2.14)	(-1.46)	(1.83)	(1.94)	(1.84)	(-1.25)	(1.56)	(1.80)	(2.04)	(-1.42)	(1.42)
dCDS									0.012*	-0.000	0.002	0.016
									(1.84)	(-0.05)	(0.33)	(1.41)
dCS	-0.690	-2.628	6.381***	-5.062	-0.850	-2.740	6.494***	-5.356	-1.428	-2.991*	6.791***	-6.373
	(-0.33)	(-1.46)	(2.82)	(-1.20)	(-0.41)	(-1.53)	(2.88)	(-1.27)	(-0.68)	(-1.67)	(3.03)	(-1.52)
dKTED	-1.671	0.387	-0.887	-1.906	-1.679	0.363	-0.868	-1.918	-1.725	0.359	-0.857	-1.997
	(-0.86)	(0.69)	(-1.58)	(-0.78)	(-0.88)	(0.65)	(-1.57)	(-0.81)	(-0.89)	(0.64)	(-1.53)	(-0.83)
dlog(VIX)	-0.002	-0.000	-0.000	-0.002	-0.002	-0.001	-0.000	-0.002	-0.002**	-0.001	0.000	-0.003*
	(-1.41)	(-0.47)	(-0.10)	(-1.18)	(-1.59)	(-0.58)	(-0.02)	(-1.36)	(-1.97)	(-0.72)	(0.10)	(-1.69)
dlog(MOVE)	0.000	-0.000	0.001	-0.003	0.000	-0.000	0.001	-0.002	-0.000	-0.001	0.002	-0.004
	(0.20)	(-0.18)	(0.63)	(-0.81)	(0.26)	(-0.20)	(0.63)	(-0.75)	(-0.26)	(-0.37)	(0.77)	(-1.21)
dTED	0.005	0.002	-0.003	0.003	0.006	0.002	-0.003	0.004	0.006	0.002	-0.003	0.004
	(1.09)	(0.46)	(-0.66)	(0.41)	(1.17)	(0.61)	(-0.76)	(0.51)	(1.15)	(0.50)	(-0.69)	(0.48)
dlog(TVOL)	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.002***	-0.002***
	(-3.80)	(-11.42)	(9.43)	(-5.26)	(-3.71)	(-11.68)	(9.66)	(-5.18)	(-3.59)	(-11.29)	(9.33)	(-4.92)
Observations	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656
Time	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.480	0.600	0.610	0.570	0.480	0.600	0.610	0.560	0.490	0.600	0.620	0.570

Notes: This table provides regression results for the effect of the dollar on various Treasury liquidity metrics, together with other control variables. The dependent variable is the daily liquidity measure. QS is the volume-weighted average relative quoted spread across different maturity bonds; log(PI) is the log of volume-weighted average of Kyle's lambda (1985); log(QD) is the log of volume-weighted average quoted depth; LIQIDX is the composite index of 9 liquidity measures. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad dollar index; dYIELD is the log difference of the volume-weighted average bond yield; dlog(VKO) is the log difference of the implied volatility of the KOSPI 200; dCDS is the difference of the 5-year credit default swap (CDS) spread at the bank level; dCS is the change in the difference between 3-year corporate bond yield and 3-year government bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilization bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average yield for on-the-run 3-, 5- and 10-year Treasuries; dlog(TVOL) is the log difference of sum of trading volume across securities; TIME={TICK, Year, Month, Weekday, Holiday}; ANNOUNCEMENT={MP, CPI, TRADE, GDP, and EMP}. Newey-West (1987) t-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

Table 4. The effect of the dollar on liquidity: FX loan and BIS capital ratio

	dFXLOAN_RATIO				dBIS_RATIO			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	QS	log(PI)	log(QD)	LIQIDX	QS	log(PI)	log(QD)	LIQIDX
dlog(BROAD)	0.089**	0.049	-0.016	0.095	0.087**	0.058*	-0.045	0.118
	(2.21)	(1.44)	(-0.33)	(1.27)	(2.17)	(1.72)	(-0.90)	(1.56)
dlog(BROAD)*dFXLOAN_RATIO	0.197*	0.226*	-0.209	0.436				
	(1.66)	(1.87)	(-1.24)	(1.53)				
dlog(BROAD)*dBIS_RATIO					-0.186**	-0.171*	0.282**	-0.364*
					(-2.17)	(-1.87)	(2.05)	(-1.77)
dFXLOAN	0.147	0.537***	-0.951***	0.813***				
	(1.57)	(5.60)	(-7.08)	(4.35)				
dBIS					-0.276***	-0.490***	0.698***	-0.715***
					(-3.63)	(-6.32)	(5.63)	(-4.54)
dlog(VKO)	0.003*	0.002	-0.002	0.004	0.003*	0.002	-0.002	0.004
	(1.67)	(1.42)	(-0.87)	(1.39)	(1.68)	(1.43)	(-0.91)	(1.43)
dCS	1.156	-2.595	11.974***	-4.375	2.706	0.075	8.366**	-0.531
	(0.35)	(-0.96)	(3.51)	(-0.71)	(0.82)	(0.03)	(2.34)	(-0.09)
dKTED	-1.837	0.246	-0.770	-2.187	-1.723	0.353	-0.810	-2.045
	(-0.82)	(0.27)	(-0.73)	(-0.70)	(-0.77)	(0.38)	(-0.73)	(-0.64)
dlog(VIX)	-0.002*	-0.001	-0.000	-0.002	-0.002*	-0.001	-0.000	-0.002
	(-1.76)	(-0.76)	(-0.09)	(-1.30)	(-1.71)	(-0.71)	(-0.09)	(-1.25)
dlog(MOVE)	0.000	-0.000	0.001	-0.003	0.000	-0.000	0.001	-0.002
	(0.22)	(-0.20)	(0.46)	(-0.77)	(0.25)	(-0.02)	(0.29)	(-0.63)
dTED	0.006	0.001	-0.001	0.002	0.005	0.002	-0.003	0.003
	(0.96)	(0.27)	(-0.08)	(0.17)	(0.94)	(0.50)	(-0.50)	(0.31)
dYIELD	0.486*	1.052***	-1.728***	0.454	0.471*	1.045***	-1.710***	0.432
	(1.72)	(5.77)	(-7.34)	(0.97)	(1.69)	(5.62)	(-6.94)	(0.92)
dlog(TVOL)	-0.001***	-0.003***	0.002***	-0.002***	-0.001***	-0.003***	0.002***	-0.002***
	(-3.61)	(-10.99)	(8.37)	(-4.56)	(-3.57)	(-10.85)	(8.00)	(-4.44)
Observations	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656
Time	YES	YES	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.0700	0.210	0.250	0.130	0.100	0.220	0.220	0.140

Notes: This table provides regression results for the effect of the dollar on various Treasury liquidity metrics. The dependent variable is the daily liquidity measure. QS is the volume-weighted average relative quoted spread across different maturity bonds; log(PI) is the log of volume-weighted average of Kyle's lambda (1985); log(QD) is the log of volume-weighted average quoted depth; LIQIDX is the composite index of 9 liquidity measures. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad US dollar index; dFXLOAN is the change in the ratio of foreign loans (converted in KRW) to the sum of foreign loans and domestic currency loans by bank; dBIS_RATIO is the ratio of capital to risk-weighted assets (RWAs) by bank; dlog(VKO) is the log difference of the implied volatility of the KOSPI 200; dCS is the change in the change in difference between 3-year corporate bond yield and 3-year government bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilization bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average bond yield; dlog(TVOL) is the log difference of sum of trading volume; TIME={Tick, Month, Weekday, Holiday}; ANNOUNCEMENT={MP, CPI, TRADE, GDP, and EMP}. Newey-West (1987) *t*-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 per cent, respectively.

Table 5. The effect of the dollar on liquidity: foreign investors

VARIABLES	(1) QS	(2) log(PI)	(3) log(QD)	(4) LIQIDX	(5) QS	(6) log(PI)	(7) log(QD)	(8) LIQIDX	(9) QS	(10) log(PI)	(11) log(QD)	(12) LIQIDX
dlog(BROAD)	0.071**	0.047*	-0.068*	0.126**	0.071**	0.045	-0.068*	0.124**				
	(2.00)	(1.67)	(-1.81)	(2.02)	(1.97)	(1.64)	(-1.81)	(1.98)				
dFHOLDING	0.015	-0.127	0.017	-0.198	0.006	-0.148	0.028	-0.230				
	(0.16)	(-1.11)	(0.10)	(-1.03)	(0.06)	(-1.29)	(0.17)	(-1.23)				
dlog(BROAD)*dFHOLDING					0.198	0.463	-0.248	0.701				
					(0.39)	(1.18)	(-0.47)	(0.84)				
dlog(BROAD)*DUM_FSELL									0.122**	0.091***	-0.121***	0.216**
									(2.19)	(2.73)	(-2.66)	(2.51)
dlog(BROAD)*DUM_FBUY									0.017	-0.001	-0.011	0.029
									(0.42)	(-0.03)	(-0.22)	(0.35)
dlog(VKO)	0.004**	0.003**	-0.003	0.005*	0.004**	0.003**	-0.003	0.005*	0.004**	0.003**	-0.003	0.005*
	(2.30)	(2.21)	(-1.50)	(1.95)	(2.29)	(2.19)	(-1.50)	(1.94)	(2.30)	(2.20)	(-1.51)	(1.94)
dCS	-0.786	-2.647	6.426***	-5.204	-0.782	-2.637	6.420***	-5.189	-0.834	-2.712	6.482***	-5.327
	(-0.37)	(-1.46)	(2.82)	(-1.23)	(-0.37)	(-1.46)	(2.82)	(-1.22)	(-0.40)	(-1.50)	(2.84)	(-1.26)
dKTED	-1.647	0.395	-0.899	-1.864	-1.640	0.412	-0.908*	-1.839	-1.676	0.372	-0.869	-1.913
	(-0.87)	(0.72)	(-1.64)	(-0.79)	(-0.86)	(0.74)	(-1.65)	(-0.78)	(-0.88)	(0.69)	(-1.61)	(-0.82)
dlog(VIX)	-0.002	-0.000	-0.000	-0.002	-0.002	-0.000	-0.000	-0.002	-0.002	-0.000	-0.000	-0.002
	(-1.52)	(-0.52)	(-0.05)	(-1.30)	(-1.52)	(-0.54)	(-0.05)	(-1.31)	(-1.49)	(-0.49)	(-0.08)	(-1.27)
dlog(MOVE)	0.001	-0.000	0.001	-0.002	0.001	-0.000	0.001	-0.002	0.001	-0.000	0.001	-0.002
	(0.32)	(-0.11)	(0.58)	(-0.67)	(0.31)	(-0.14)	(0.59)	(-0.69)	(0.39)	(-0.06)	(0.52)	(-0.61)
dTED	0.005	0.002	-0.003	0.003	0.005	0.002	-0.003	0.003	0.005	0.002	-0.003	0.003
	(1.06)	(0.48)	(-0.65)	(0.41)	(1.06)	(0.46)	(-0.65)	(0.40)	(1.06)	(0.44)	(-0.64)	(0.38)
dYIELD	0.331	0.885***	-1.366***	-0.092	0.330	0.883***	-1.365***	-0.095	0.332	0.888***	-1.367***	-0.086
	(1.14)	(7.11)	(-8.82)	(-0.24)	(1.14)	(7.09)	(-8.81)	(-0.24)	(1.15)	(7.17)	(-8.86)	(-0.22)
dlog(TVOL)	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.003***	-0.002***
	(-3.70)	(-11.48)	(9.51)	(-5.13)	(-3.71)	(-11.49)	(9.52)	(-5.14)	(-3.74)	(-11.39)	(9.44)	(-5.15)
Observations	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656
Time	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R2	0.470	0.600	0.610	0.560	0.470	0.600	0.610	0.560	0.480	0.600	0.610	0.560

Notes: This table shows regression results for the effect of dollar on various Treasury liquidity measures. The dependent variable is one of the liquidity measure where QS is the relative quoted spread; log(PI) is the log of Kyle's lambda (1985); log(QD) the log of quoted depth; LIQIDX the composite indices of 9 liquidity measures. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad US dollar index; dFHOLDING is the change in the ratio of the foreign investors' Treasury bond balance to the total outstanding share in the entire markets; DUM_FSELL is the dummy variable equals to 1 when the change in foreign bond holding decreases, and otherwise 0; DUM_FBUY is the dummy variable equals to 1 when the change in foreign bond holding increases, and otherwise 0; dlog(VKO) is the log difference of the implied volatility of the KOSPI 200; dCS is the change in credit spread, the difference between 3- year government bond yield and 3-year corporate bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilisation bond yield;

dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average bond yield; dlog(TVOL) is the log difference of sum of trading volume; TIME={TICK, Year, Month, Weekday, Holiday}; ANNOUNCEMENT={MP, CPI, TRADE, GDP, and EMP}. Newey-West (1987) *t*-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 per cent, respectively.

Table 6. Dollar, foreign investors, and market liquidity under the market uncertainty

VARIABLES	(1) QS	(2) log(PI)	(3) log(QD)	(4) LIQIDX	(5) QS	(6) log(PI)	(7) log(QD)	(8) LIQIDX
dlog(BROAD)	0.068*	0.042	-0.066*	0.117*				
	(1.91)	(1.54)	(-1.76)	(1.89)				
dlog(VKO)	0.003*	0.003*	-0.002	0.004	0.003*	0.003*	-0.002	0.004
	(1.89)	(1.80)	(-1.25)	(1.51)	(1.93)	(1.83)	(-1.24)	(1.57)
dlog(BROAD) * dFHOLDING	0.097	0.364	-0.164	0.552				
	(0.19)	(0.95)	(-0.31)	(0.66)				
dlog(BROAD) * dlog(VKO)	0.008	0.008**	-0.008	0.014				
	(1.45)	(2.48)	(-1.34)	(1.51)				
dFHOLDING * dlog(VKO)	0.007	0.003	0.005	0.004				
	(0.27)	(0.18)	(0.22)	(0.11)				
dlog(BROAD)*dFHOLDING*dlog(VKO)	0.072	0.074	-0.022	0.163				
	(0.65)	(1.14)	(-0.23)	(0.93)				
dlog(BROAD)*DUM_FSELL					0.121**	0.090***	-0.120***	0.215***
					(2.26)	(2.80)	(-2.81)	(2.59)
dlog(BROAD)*DUM_FSELL*dlog(VKO)					0.014**	0.014***	-0.021***	0.025**
					(2.24)	(2.76)	(-2.78)	(2.12)
dlog(BROAD)*DUM_FBUY					0.017	-0.003	-0.015	0.028
					(0.43)	(-0.06)	(-0.28)	(0.34)
dlog(BROAD)*DUM_FBUY*dlog(VKO)					0.004	0.006	0.002	0.009
					(0.57)	(1.16)	(0.24)	(0.76)
dCS	-0.804	-2.669	6.482***	-5.224	-0.973	-2.837	6.709***	-5.561
	(-0.38)	(-1.49)	(2.88)	(-1.24)	(-0.46)	(-1.59)	(3.00)	(-1.32)
dKTED	-1.681	0.369	-0.873	-1.912	-1.703	0.341	-0.851	-1.962
	(-0.88)	(0.66)	(-1.57)	(-0.81)	(-0.89)	(0.62)	(-1.57)	(-0.83)
dlog(VIX)	-0.002	-0.001	-0.000	-0.002	-0.002	-0.000	-0.000	-0.002
	(-1.59)	(-0.59)	(-0.02)	(-1.37)	(-1.58)	(-0.55)	(-0.05)	(-1.34)
dlog(MOVE)	0.000	-0.000	0.001	-0.003	0.001	-0.000	0.001	-0.002
	(0.22)	(-0.25)	(0.64)	(-0.82)	(0.33)	(-0.13)	(0.58)	(-0.68)
dTED	0.006	0.002	-0.003	0.005	0.006	0.002	-0.003	0.004
	(1.19)	(0.65)	(-0.77)	(0.54)	(1.15)	(0.59)	(-0.72)	(0.49)
dYIELD	0.318	0.870***	-1.359***	-0.122	0.342	0.894***	-1.393***	-0.071
	(1.09)	(6.92)	(-8.68)	(-0.31)	(1.17)	(7.23)	(-9.10)	(-0.18)
dlog(TVOL)	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.002***	-0.002***
	(-3.75)	(-11.73)	(9.68)	(-5.22)	(-3.69)	(-11.50)	(9.43)	(-5.12)
Observations	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656
Time	YES	YES	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.470	0.600	0.610	0.560	0.480	0.600	0.620	0.560

Notes: This table shows regression results for the effect of dollar on various Treasury liquidity measures using daily data from 3 Jan 2012 to 28 Dec 2022. The dependent variable is the liquidity measure. QS is the volume-weighted average of the relative quoted spread for on-the-run 3-, 5- and 10-year Treasuries; log(PI) is the log of volume-weighted average of Kyle's lambda (1985) for 3-, 5- and 10-year on-the-runs; log(QD) is the log of volume-weighted average of quoted depth for 3-, 5- and 10-year on-the-runs; LIQIDX the composite liquidity indices of 9 liquidity measures. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad US dollar index; dFHOLDING is the change in the ratio of the foreign investors' Treasury bond balance for all maturities to the total outstanding share in the entire markets; DUM_FSELL is the dummy variable equals to 1 when the change in foreign bond holding decreases, and otherwise 0; DUM_FBUY is the dummy variable equals to 1 when the change in foreign bond holding increases, and otherwise 0; dlog(VKO) is the log difference of the implied volatility of the Korean market (KOSPI 200); dCS is the change in the credit spread, the difference between 3- year government bond yield and 3-year corporate bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilisation bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average bond yield; dlog(TVOL) is the log difference of sum of trading volume for 3-, 5- and 10- year on-the- runs; TIME={Year, Weekday, Holiday, Month}; ANNOUNCEMENT={MP, CPI, TRADE, GDP, and EMP}. Newey-West (1987) *t*-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 per cent, respectively.

Table 7. Stress periods

VARIABLES	(1) LIQIDX	(2) LIQIDX	(3) LIQIDX	(4) LIQIDX	(5) LIQIDX	(6) LIQIDX
dlog(BROAD)	0.129*	0.155*	0.142*	0.121	0.157**	0.086
	(1.67)	(1.87)	(1.74)	(1.50)	(2.11)	(1.17)
dlog(VKO)	0.006*	0.005	0.006*	0.004	0.006**	0.006*
	(1.71)	(1.60)	(1.75)	(1.35)	(2.01)	(1.93)
dCS	-5.496	-5.139	-5.067	-6.411	-5.041	-7.113
	(-1.02)	(-0.94)	(-0.93)	(-1.23)	(-0.90)	(-1.33)
dKTED	-2.324	-2.291	-2.224	-2.359	-1.614	-1.597
	(-0.72)	(-0.71)	(-0.69)	(-0.75)	(-0.63)	(-0.64)
dlog(VIX)	-0.002	-0.002	-0.001	-0.002	-0.002	-0.002
	(-1.01)	(-0.96)	(-0.77)	(-1.13)	(-0.81)	(-1.12)
dlog(MOVE)	-0.002	-0.001	-0.001	-0.002	-0.001	-0.002
	(-0.53)	(-0.32)	(-0.34)	(-0.47)	(-0.22)	(-0.60)
dTED	0.005	0.005	0.005	-0.002	0.004	-0.003
	(0.37)	(0.35)	(0.37)	(-0.20)	(0.34)	(-0.27)
dYIELD	0.370	0.465	0.415	0.475	0.672	0.552
	(0.64)	(0.80)	(0.72)	(0.82)	(1.31)	(1.08)
dlog(TVOL)	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(-3.87)	(-3.88)	(-3.92)	(-3.81)	(-3.76)	(-3.67)
TAPER	0.565***					0.572***
	(3.85)					(3.85)
dlog(BROAD)*TAPER	1.387***					1.434***
	(2.86)					(2.95)
CN		0.237***				0.252***
		(2.75)				(2.87)
dlog(BROAD)*CN		-0.193				-0.138
		(-1.33)				(-0.98)
TRUMP			1.071***			1.084***
			(3.67)			(3.69)
dlog(BROAD)*TRUMP			-0.135			-0.068
			(-0.35)			(-0.18)
COVID				1.100***		1.098***
				(2.88)		(2.89)
dlog(BROAD)*COVID				0.223		0.244
				(0.54)		(0.61)
PF-ABCP					4.619***	4.620***
					(17.99)	(18.18)
dlog(BROAD)* PF-ABCP					0.116	0.202
					(0.18)	(0.31)
Observations	2,656	2,656	2,656	2,656	2,656	2,656
Time	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES
Adj. R^2	0.0800	0.0700	0.0800	0.0800	0.230	0.260

Notes: This table shows regression results for the effect of dollar on various Treasury liquidity measures. The dependent variable is the liquidity measure. QS is the volume-weighted average of the relative quoted spread for on-the-run 3-, 5- and 10-year Treasuries; log(PI) is the log of volume-weighted average of Kyle's lambda (1985) for 3-, 5- and 10-year on-the-runs; log(QD) is the log of volume-weighted average of quoted depth for 3-, 5- and 10-year on-the-runs; LIQIDX the composite indices of 9 liquidity measures. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad US dollar index; dlog(VKO) is the log difference of the implied volatility of the Korean market (KOSPI 200); dCS is the change in credit spread, the difference between 3-year government bond yield and 3-year corporate bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilisation bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average bond yield; dlog(TVOL) is the log difference of sum of trading volume; Five episode dummies are constructed for the episode of the Taper Tantrum (TAPER), the Chinese sell-off (CN), the Trump presidential election (TRUMP), the COVID-19 pandemic (COVID) and the Legoland PF-ABCP event (PF-ABCP). The episode dummies are 1 for 20 days after the episode days, and 0 otherwise; TIME={Weekday, Holiday, Month}; ANNOUNCEMENT={MP, CPI, TRADE, GDP and EMP}. Newey-West (1987) *t*-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5 and 10 per cent, respectively.

Table 8. Adding lagged control variables

VARIABLES	(1) QS	(2) log(PI)	(3) log(QD)	(4) LIQIDX
dlog(BROAD)	0.090**	0.072**	-0.064	0.134*
	(2.19)	(2.12)	(-1.38)	(1.88)
dlog(BROAD), lag	0.056	0.064*	-0.054	0.082
	(1.36)	(1.82)	(-1.14)	(1.16)
dlog(VKO)	0.005**	0.004**	-0.006***	0.010***
	(2.50)	(2.36)	(-2.70)	(2.80)
dlog(VKO), lag	0.375***	0.443***	-0.829***	1.056***
	(8.09)	(6.90)	(-10.40)	(9.19)
dCS	1.893	-0.997	8.467***	-1.511
	(0.74)	(-0.50)	(2.75)	(-0.32)
dCS,lag	-1.799	-5.547***	11.188***	-7.835*
	(-0.78)	(-2.95)	(3.91)	(-1.89)
dKTED	-1.642	0.202	-0.745	-2.146
	(-0.77)	(0.20)	(-0.61)	(-0.69)
dKTED,lag	1.023	0.038	-0.978	0.733
	(0.93)	(0.04)	(-0.70)	(0.31)
dlog(VIX)	-0.001	0.001	-0.003	0.000
	(-0.88)	(0.80)	(-1.62)	(0.18)
dlog(VIX), lag	-0.001	0.001	-0.001	-0.001
	(-1.12)	(0.67)	(-0.75)	(-0.55)
dlog(MOVE)	0.001	0.001	-0.000	-0.000
	(0.54)	(0.31)	(-0.13)	(-0.11)
dlog(MOVE), lag	0.004*	0.004*	-0.004	0.007
	(1.86)	(1.92)	(-1.40)	(1.62)
dTED	0.005	0.001	-0.001	0.001
	(0.74)	(0.29)	(-0.13)	(0.06)
dTED, lag	0.005	0.009*	-0.005	0.008
	(0.71)	(1.68)	(-0.80)	(0.67)
dYIELD	0.485	1.054***	-1.755***	0.469
	(1.39)	(5.12)	(-6.83)	(0.88)
dlog(TVOL)	-0.001***	-0.003***	0.002***	-0.002***
	(-2.96)	(-9.06)	(7.12)	(-3.94)
Observations	2,655	2,655	2,655	2,655
Time	YES	YES	YES	YES
Announcement	YES	YES	YES	YES
Adj. R^2	0.100	0.160	0.200	0.150

Notes: This table shows regression results for the effect of dollar on various Treasury liquidity measures. The dependent variable is the liquidity measure. QS is the volume-weighted average of the relative quoted spread for on-the-run 3-, 5-, 10-year Treasuries; log(PI) is the log of volume-weighted average of Kyle's lambda (1985) for 3-, 5-, 10-year on-the-runs; log(QD) is the log of volume-weighted average of quoted depth for 3-, 5-, 10-year on-the-runs; LIQIDX the composite indices of 9 liquidity measures. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad US dollar index; dlog(VKO) is the log difference of the implied volatility of the Korean market (KOSPI 200); dCS is the change in credit spread, the difference between 3- year government bond yield and 3-year corporate bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilisation bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average bond yield; dlog(TVOL) is the log difference of sum of trading volume; TIME={TICK, Weekday, Holiday, Month}; ANNOUNCEMENT={MP, CPI, TRADE, GDP, and EMP}. Newey-West (1987) *t*-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 per cent, respectively.

Table 9. The impacts of dollar on market liquidity: issuance maturities

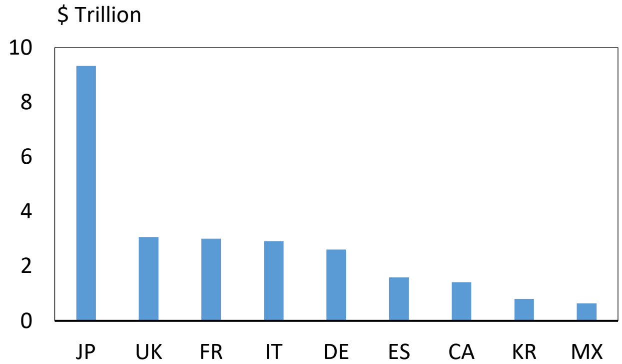
	QS			dlog(PI)			dlog(QD)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	3-YEAR	5-YEAR	10-YEAR	3-YEAR	5-YEAR	10-YEAR	3-YEAR	5-YEAR	10-YEAR
dlog(BROAD)	0.060**	0.117**	0.095**	0.129***	0.056**	0.022	-0.081*	0.015	-0.026
	(2.57)	(2.15)	(2.05)	(2.68)	(2.07)	(0.85)	(-1.76)	(0.30)	(-1.39)
dlog(VKO)	0.001	0.007**	0.005**	-0.000	0.002*	0.003**	-0.002	-0.003	-0.002*
	(1.21)	(2.45)	(2.00)	(-0.09)	(1.71)	(2.15)	(-0.90)	(-1.09)	(-1.71)
dCS	2.603	0.896	-1.351	-1.670	-1.404	-1.131	13.072***	8.465**	2.140*
	(1.62)	(0.24)	(-0.43)	(-0.51)	(-0.76)	(-0.62)	(4.12)	(2.43)	(1.70)
dKTED	-2.131***	-2.832***	-1.080	0.456	-0.490	0.023	-0.551	-0.300	-0.212
	(-5.02)	(-2.87)	(-1.29)	(0.52)	(-1.00)	(0.05)	(-0.66)	(-0.33)	(-0.64)
dlog(MOVE)	-0.000	0.004	-0.002	0.000	0.000	-0.001	0.000	-0.001	0.001
	(-0.29)	(1.10)	(-0.51)	(0.02)	(0.04)	(-0.67)	(0.00)	(-0.20)	(1.16)
dTED	0.003	0.012*	0.003	0.003	0.001	-0.001	-0.003	-0.000	0.000
	(1.05)	(1.88)	(0.58)	(0.51)	(0.44)	(-0.28)	(-0.53)	(-0.00)	(0.03)
dlog(VIX)	-0.001	-0.004*	-0.001	-0.002	-0.001	0.000	0.001	-0.001	-0.000
	(-0.77)	(-1.82)	(-0.40)	(-0.83)	(-0.97)	(0.31)	(0.38)	(-0.35)	(-0.60)
dYIELD	-0.169	1.613***	1.445***	0.402	0.977***	0.710***	-1.371***	-1.381***	-0.345**
	(-0.81)	(3.68)	(3.96)	(0.94)	(4.48)	(3.41)	(-3.34)	(-3.37)	(-2.39)
dlog(TVOL)	-0.001***	-0.002***	-0.001***	-0.002***	-0.002***	-0.002***	0.002***	0.002***	0.002***
	(-3.74)	(-3.44)	(-3.86)	(-5.98)	(-7.71)	(-9.50)	(7.02)	(3.87)	(10.39)
Observations	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656
Adj. R^2	0.06	0.06	0.08	0.08	0.151	0.095	0.13	0.043	0.106
Time	YES	YES	YES	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table shows regression results for the effect of dollar on various Treasury liquidity measures using daily data from Jan 3, 2012 through Dec 28, 2022. The dependent variable is the liquidity measure. QS is the volume-weighted average of the relative quoted spread for on-the-run 3-, 5- and 10-year Treasuries; log(PI) is the log of volume-weighted average of Kyle's lambda (1985) for 3-, 5- and 10-year on-the-runs; log(QD) is the log of volume-weighted average of quoted depth for 3-, 5- and 10-year on-the-runs. The independent variables are: dlog(BROAD) is the log difference of the trade-weighted nominal broad US dollar index; dlog(VKO) is the log difference of the implied volatility of the Korean market (KOSPI 200); dCS is the change in credit spread, the difference between 3- year government bond yield and 3-year corporate bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilisation bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average bond yield; dlog(TVOL) is the log difference of sum of trading volumes; TIME={TICK, Weekday, Holiday, Month}; ANNOUNCEMENT={MP, CPI, TRADE, GDP, and EMP}. t-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 percent, respectively.

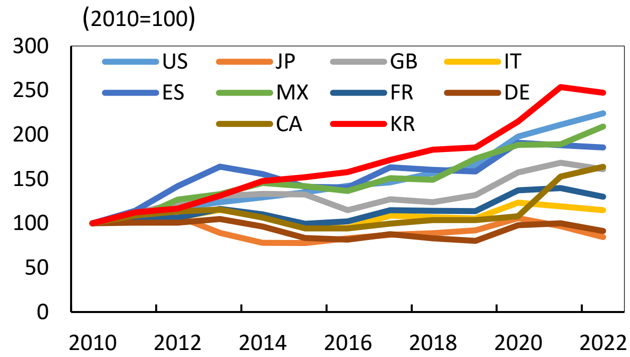
Figure 1. Trading volume of the Korea Treasury bonds

Panel A. Government bond outstanding amounts: cross-country comparisons

(LEVEL[1])

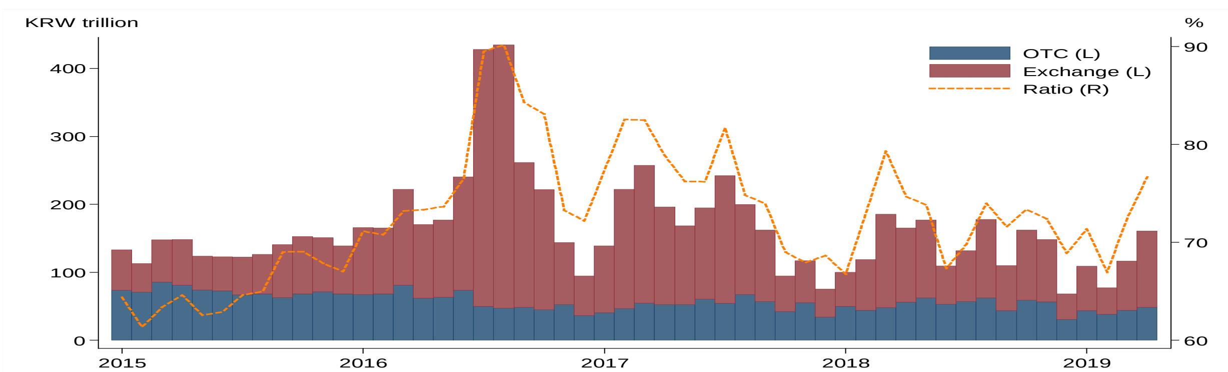


(Index)



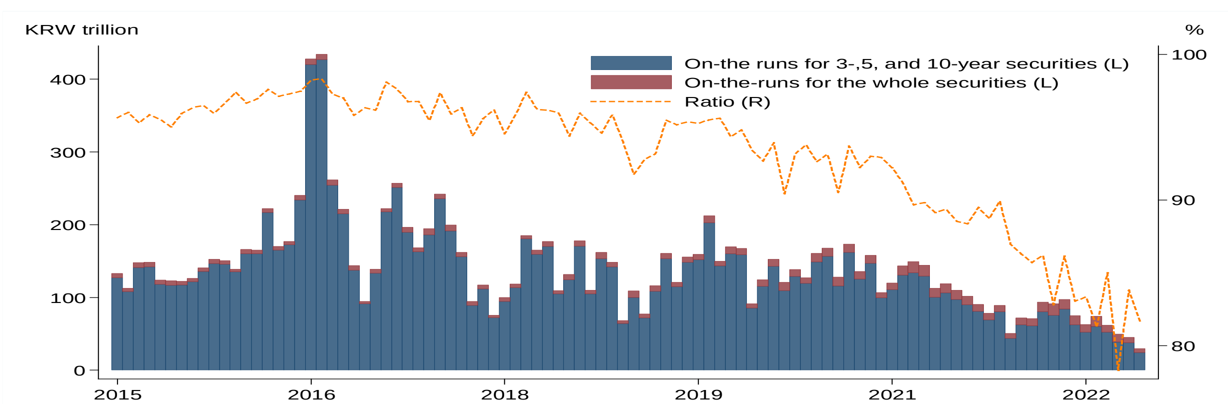
[1] OECD Top 10 countries in terms of outstanding amounts except for the US.
Source: MacroBond.

Panel B. Trading volume for on-the-runs[1]



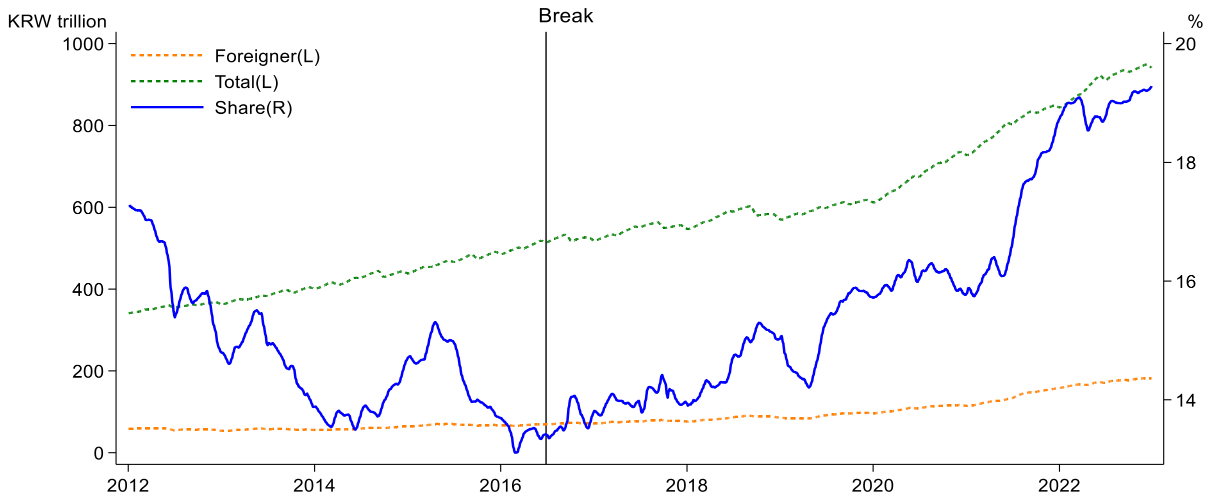
[1] Ratio is the ratio of trading volume of on-the-runs in the exchange to that of the total on-the-runs.
Source: Korea Exchange.

Panel C. Trading volume on the exchange[1]



[1] Ratio is the ratio of the trading volume for 3-, 5- and 10-year bonds in the exchange to the total trading volume in the exchange.
Source: KTB.

Figure 2. Foreign bond holdings[1]

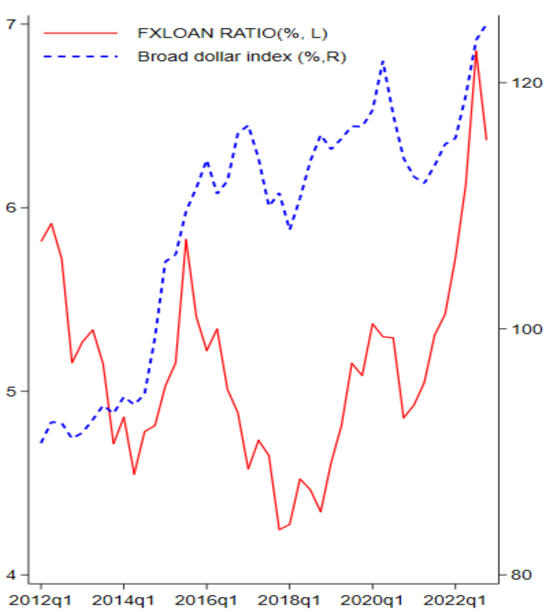


[1] Share is the ratio of the total amount outstanding of foreign investors' holdings of Korea Treasury bonds for all maturities to the total amount outstanding of exchange- and OTC-traded Korea Treasury bonds. [2] Plotted lines are 21-day moving averages.

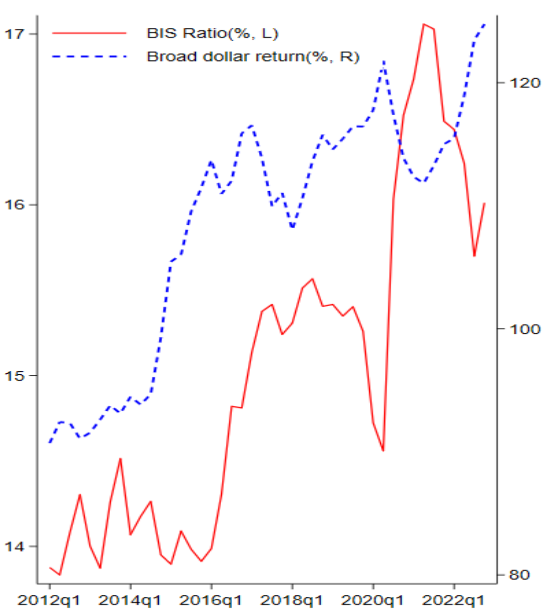
Source: Infomax.

Figure 3. FX loan ratio, BIS ratio, and the broad dollar index[1 2]

A. Dollar and foreign currency exposure

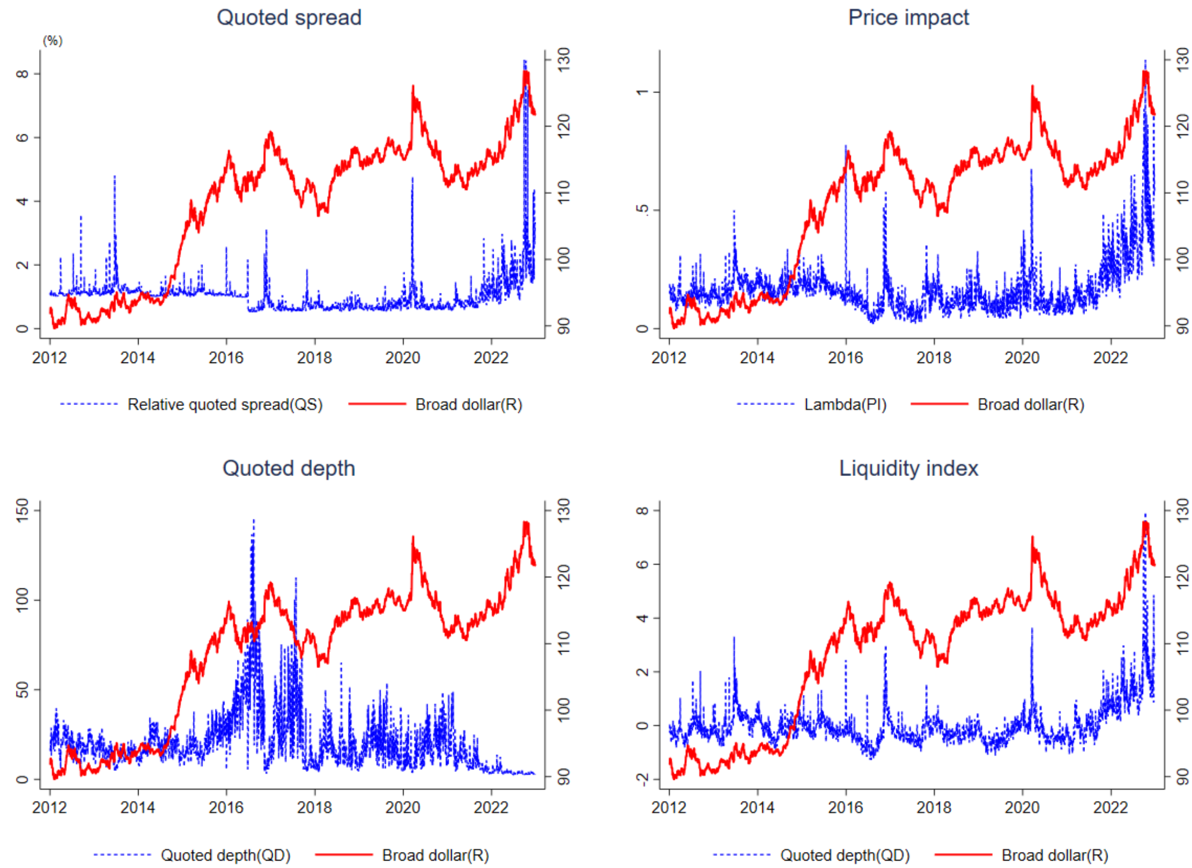


B. Dollar and the total capital ratio



[1] FXLOAN RATIO is the ratio of the foreign currency loans to the total loans by banks. [2] BIS RATIO is the total equity divided by risk-weighted assets by banks.

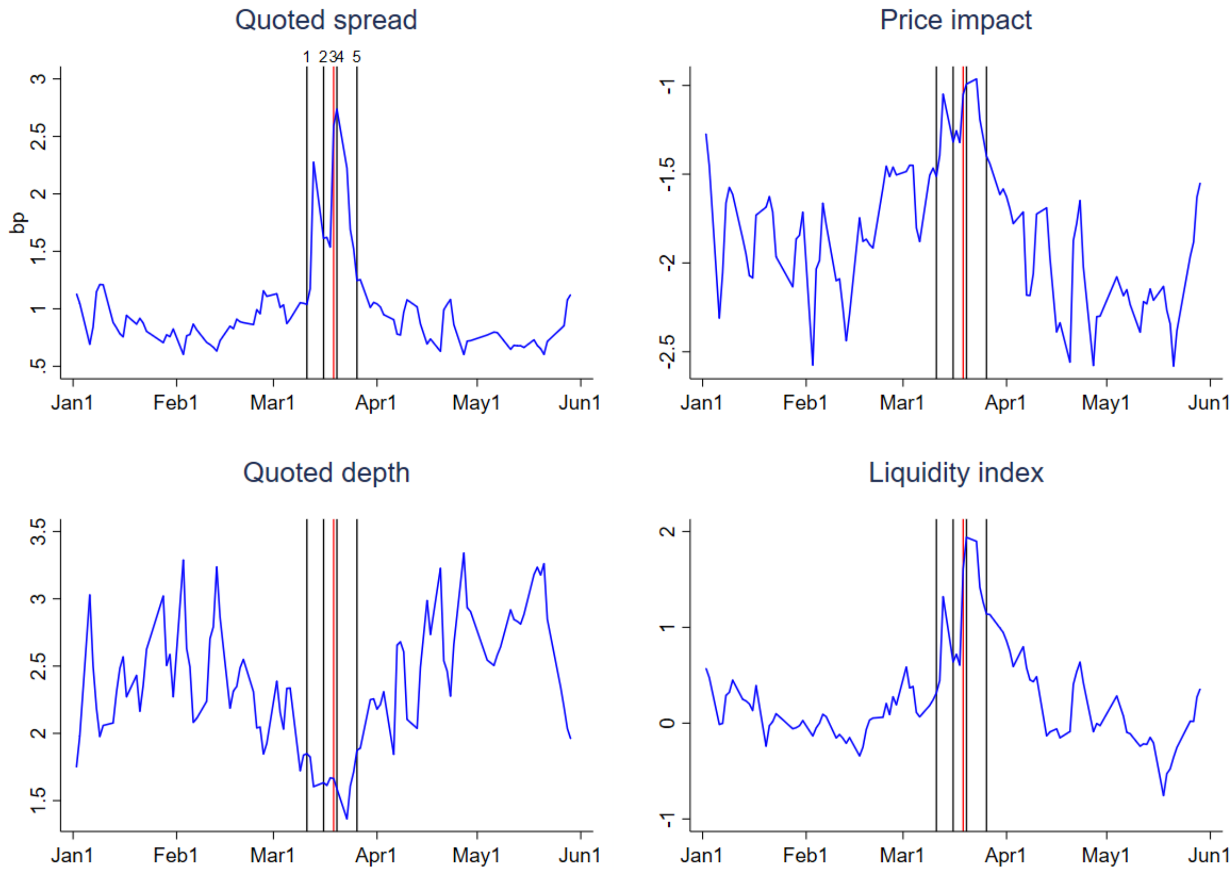
Figure 4. Time series of the broad US dollar index and Treasury market liquidity measures[1 2]



[1] Volume-weighted average of each liquidity measure for 3-, 5-, and 10-year Treasury bonds for quoted spread, price impact and quoted depth. Liquidity index is the composite index of 9 liquidity measures. Broad dollar is the level of the nominal broad US dollar index from FRED. [2] Plotted lines are 22-day moving averages.

Sources: BOMIS; Infomax; authors' calculation.

Figure 5. Market dynamics in March 2020 and dollar swap



Notes: This graph shows the three-day moving average of quoted spread, price impact, and quoted depth during the COVID-19 pandemics between January 2, 2020 and May 31, 2020. The five vertical lines show one WHO announcement and four central bank policy interventions in March 2023. 1: the WHO announcement of COVID-19 as a pandemic on March 11; 2: the BOK's cut in the policy rate and expansion of types of eligible bonds for RP on March 16; 3: foreign exchange (FX) swap between the FED and the Bank of Korea on March 19, 4: outright purchase of Korean government bonds on March 20; and 5: expansion of types of financial institutions for RP on March 26. Plotted lines are 3-day moving average.

Appendix

Appendix A. Variable description

Nomenclature
i: 3-, 5- and 10-year issuance maturity bonds, aggregate bond index (volume-weighted average of these bonds)
P_k: price of trade k
A_k: ask price of trade k
B_k: bid price of trade k
M_k: bid-ask quote midpoint ($\frac{B_k+A_k}{2}$) at time of trade k
V_k : volume (in billions of KRW) of trade k.
$BSIZE_k$: quoted depth (size) at the bid price at the time of trade k
$ASIZE_k$: quoted depth (size) at the ask price at the time of trade k
D_k: +1 if trade k is a buy and -1 if trade k is a sell

	Variables	Description	Data sources
Market Liquidity	Relative Quoted Spread (QS)	$QS_{it} = \frac{1}{N}\sum_{k=1}^{N}(A_k - B_k)/M_k$, where N is the total number of inside quotes of bond i on day t, QS is the volume-weighted quoted spread for 3-, 5- and 10-year on-the-runs.	BOMIS
	Price Impact (PI)	The regression coefficient (λ) of the following model: $\Delta P_{jk} = \lambda_j^k(D_{jk} * V_{jk}) + e_{jk}$ PI is the volume-weighted λ for 3-, 5- and 10-year on-the-runs.	BOMIS
	Quoted Depth (QD)	$QD_{it} = \frac{1}{N}\sum_{k=1}^{N} M_k(ASIZE_k + BSIZE_k)/2$, where N is the total number of inside quotes of bond i on day t, QD is the volume-weighted quoted depth for 3-, 5- and 10-year on-the-runs.	BOMIS
Global factors	Broad dollar index (BROAD)	Trade-weighted nominal broad US dollar index	FRED
	MOVE	Merrill Lynch option volatility estimate index from the US bond markets	Bloomberg
	Volatility index (VIX)	CBOE implied volatility index	Bloomberg
	TED	The difference between the 3-month London Interbank Offered rate and the 3-month U.S. Treasury bill rate	Datastream

Local factors	Bilateral exchange rate (FX)	Korean won exchange rate against the US dollar (USD/KRW)	ECOS
	Domestic Volatility index (VKO)	The implied volatility of the Korean market, similar to VIX, which is computed based on KOSPI200.	Bloomberg
	Foreign ownership (FOWN)	The ratio of the amount of the Treasury bonds held by foreign investors to the amount of the total Treasury outstanding	KTB
	Credit Spread (CS)	3-year corporate bond yield (rated AA-) – 3-year government bond yield	ECOS
	Korean TED (KTED)	The difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilisation bond yield	ECOS
	Daily Trade volume (TVOL)	Daily trade volume for bond i on day t	BOMIS
	Government bond yield (YIELD)	Log differences of daily local currency sovereign bond prices for bond i on day t	ECOS
	Tick size changes	TICK is the dummy for two days before and after tick size reduction on June 27, 2016; A tick size of KRW was reduced from on Jun 27, 2016 from KRW 1.00 to KRW 0.50 for 3-year and 5-year bonds while 10-year bonds are constant.	

Appendix B. Stress episodes

Event	Date	Description
Taper Tantrum	May 22, 2013~Jun 22, 2013	On May 22, 2013, Ben Bernanke announced that the Fed planned to gradually reduce its economic stimulus.
Chinese sell-off	Jun 13, 2015~ Aug 25, 2015	On June 13, 2015, the China Securities Regulatory Commission (CSRC) made an announcement regarding new regulations to limit shadow-financed margin trading to Black Monday and Friday.
Trump election	Nov 8, 2016~Dec 7, 2016	On November 8, 2016, Donald Trump unexpectedly won the US presidential election.
Covid-19	Feb 20, 2020~Mar 18, 2020	On February 20, 2020, the number of Covid-19 cases in Korea increased dramatically in reaction to the Shincheonji outbreak in Daegu metropolitan city.
PF-ABCP	Sep 28, 2022~Oct 20, 2022	The default of a Legoland theme park developer on September 28, 2022 exacerbated the ongoing PF-ABCP market stress in Korea.

Appendix C. Dollar volatility and government bond liquidity

Variable	Obs	Mean	Std. Dev.	Min	Max
3-Year Treasury bond					
QS(bp)	2698	.797	.367	.491	7.416
PI	2698	.084	.062	.007	.707
QD(billion ₩)	2698	26.847	20.262	2.636	163.558
YIELD(%)	2698	2.068	.775	.795	4.548
TVOL(trillion ₩)	2698	3.244	3.488	.152	48.031
5-Year Treasury bond					
QS(bp)	2698	1.052	.849	.483	24.259
PI	2698	.15	.101	.031	1.216
QD(billion ₩)	2698	10.566	8.432	1.901	45.138
YIELD(%)	2698	2.249	.761	1.031	4.638
TVOL(trillion ₩)	2698	1.903	1.237	.114	8.516
10-Year Treasury bond					
QS(bp)	2698	1.719	.735	.96	9.948
PI	2698	.477	.228	.081	3.057
QD(billion ₩)	2698	3.68	1.172	1.57	11.301
YIELD(%)	2698	2.488	.744	1.172	4.632
TVOL(trillion ₩)	2698	.902	.383	.106	3.843

Appendix D. Dollar volatility and government bond liquidity

VARIABLES	(1) QS	(2) log(PI)	(3) log(QD)	(4) LIQIDX	(5) QS	(6) log(PI)	(7) log(QD)	(8) LIQIDX	(9) QS	(10) log(PI)	(11) log(QD)	(12) LIQIDX
σ_{BROAD}	0.249***	0.269***	-0.356***	0.702***					0.193***	0.292***	-0.471***	0.696***
	(6.16)	(7.66)	(-7.35)	(9.00)					(4.60)	(6.69)	(-7.59)	(8.11)
σ_{BER}					0.014***	0.008***	-0.003	0.027***	0.007***	-0.003	0.014***	0.001
					(5.58)	(3.47)	(-1.15)	(4.63)	(2.80)	(-1.08)	(3.98)	(0.14)
dlog(VKO)	0.004***	0.004**	-0.003*	0.006**	0.004***	0.003**	-0.003*	0.006**	0.005***	0.004**	-0.003*	0.006**
	(2.67)	(2.47)	(-1.87)	(2.46)	(2.66)	(2.39)	(-1.71)	(2.34)	(2.70)	(2.45)	(-1.80)	(2.45)
dCS	-0.669	-2.599	6.325***	-5.049	-0.479	-2.484	6.262***	-4.678	-0.579	-2.635	6.506***	-5.039
	(-0.33)	(-1.53)	(2.94)	(-1.28)	(-0.23)	(-1.39)	(2.74)	(-1.13)	(-0.28)	(-1.54)	(2.98)	(-1.27)
dKTED	-1.607	0.430	-0.945*	-1.774	-1.578	0.439	-0.934*	-1.734	-1.589	0.423	-0.909*	-1.772
	(-0.86)	(0.83)	(-1.84)	(-0.77)	(-0.83)	(0.77)	(-1.66)	(-0.73)	(-0.85)	(0.82)	(-1.86)	(-0.77)
dlog(VIX)	-0.001	-0.000	-0.001	-0.001	-0.001	-0.000	-0.001	-0.001	-0.001	-0.000	-0.001	-0.001
	(-1.01)	(-0.04)	(-0.58)	(-0.70)	(-0.95)	(-0.09)	(-0.43)	(-0.69)	(-0.95)	(-0.07)	(-0.48)	(-0.70)
dlog(MOVE)	0.002	0.001	-0.000	0.000	0.001	0.000	0.001	-0.001	0.002	0.001	-0.000	0.000
	(0.91)	(0.50)	(-0.03)	(0.08)	(0.62)	(0.11)	(0.33)	(-0.39)	(0.85)	(0.52)	(-0.14)	(0.08)
dTED	0.005	0.001	-0.002	0.001	0.005	0.001	-0.003	0.002	0.004	0.001	-0.002	0.001
	(0.94)	(0.28)	(-0.49)	(0.17)	(0.97)	(0.36)	(-0.60)	(0.26)	(0.93)	(0.30)	(-0.56)	(0.17)
dYIELD	0.365	0.915***	-1.405***	-0.014	0.385	0.920***	-1.393***	0.012	0.378	0.910***	-1.377***	-0.012
	(1.29)	(7.49)	(-9.19)	(-0.04)	(1.35)	(7.48)	(-9.01)	(0.03)	(1.34)	(7.42)	(-9.09)	(-0.03)
dlog(TVOL)	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.003***	-0.002***	-0.001***	-0.003***	0.003***	-0.002***
	(-3.64)	(-11.24)	(9.28)	(-4.94)	(-3.58)	(-11.23)	(9.37)	(-4.91)	(-3.60)	(-11.26)	(9.43)	(-4.92)
Observations	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656	2,656
Time	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Announcement	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj. R^2	0.490	0.620	0.630	0.600	0.490	0.600	0.610	0.570	0.500	0.620	0.640	0.600

Notes: This table shows regression results for the effect of exchange rate volatility on various Treasury liquidity measures. The dependent variable is the liquidity measure. QS is the volume-weighted average of the relative quoted spread for 3-, 5- and 10-year on-the-runs; log(PI) is the log of volume-weighted average of Kyle's lambda (1985) for 3-, 5- and 10-year on-the-runs; log(QD) is the log of volume-weighted average of quoted depth for 3-, 5- and 10-year on-the-runs. The independent variables are: σ_{BROAD} is the dollar exchange rate volatility; σ_{BER} is the bilateral exchange rate volatility (Won per USD); dlog(VKO) is the log difference of the implied volatility of the Korean market (KOSPI 200); dCS is the change in credit spread, the difference between 3- year government bond yield and 3-year corporate bond yield; dKTED is the change in the difference between the 3-month Korean Interbank Offered Rate (KORIBOR) and the 3-month monetary stabilisation bond yield; dlog(VIX) is the log difference of the CBOE implied volatility index from US S&P500; dlog(MOVE) is the log difference of Merrill Lynch Option Volatility Estimate index from the US bond markets; dTED is the change in the difference between the 3-month London Interbank Offered Rate and the 3-month US Treasury Bill rate; dYIELD is the log difference of the volume-weighted average bond yield; dlog(TVOL) is the log difference of sum of trading volume; TIME={Tick, Weekday, Holiday, Month, Year}; ANNOUNCEMENT={MP, CPI, TRADE, GDP, and EMP}. Newey-West (1987) *t*-statistics are shown in parentheses. ***, **, and * indicate statistical significance at 1, 5, and 10 per cent, respectively.

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