Assessing Liquidity Risks in Markets and Financial Firms

Abstract

This study examines liquidity risks in both markets and financial firms through two approaches. First, it assesses the relationship between liquidity and volatility in the U.S. Treasury market, a key benchmark for fixed-income securities. By analyzing measures such as market depth, bid-ask spreads, and price impact, the research evaluates the liquidity-volatility relationship, with particular attention to periods of heightened volatility and policy interventions. Advanced econometric techniques, including GARCH models, are employed to capture the dynamic and persistent characteristics of market volatility, while current policy developments and stress testing insights are integrated to contextualize the findings.

Second, it analyses the impact of illiquidity on the returns of financial firms. With a goal of creating liquidity stress tests for financial firms, the study examines the relationships between the returns of financial firms, a market factor and an illiquidity factor.

1. Introduction

Liquidity-Volatility

The relationship between liquidity and volatility is a critical aspect of financial markets, influencing market efficiency, risk management, and policy decisions. Understanding this relationship is particularly important in the U.S. Treasury market, which serves as a benchmark for global fixed-income securities due to its size, depth, and pivotal role in financial stability. Liquidity and volatility are interdependent, with fluctuations in one often impacting the other, especially during periods of market stress. However, the nature of this relationship remains an area of ongoing inquiry.

This study aims to deepen the understanding of the liquidity-volatility relationship by analyzing key market metrics, including market depth, bid-ask spreads, and price impact. Drawing inspiration from established liquidity measurements, the research evaluates how these measures behave under varying market conditions and whether their interactions exhibit nonlinear characteristics. Additionally, the project employs advanced econometric methods, including GARCH models, to capture the persistence and dynamics of market volatility.

The findings from this study have implications for both market participants and policymakers. For market participants, they offer insights into managing liquidity risk and volatility during stressed conditions. For policymakers, they provide a foundation for designing robust liquidity stress tests that complement existing solvency frameworks, helping to uncover vulnerabilities and strengthen market resilience. By focusing on the U.S. Treasury market, this research contributes to a deeper understanding of the interplay between liquidity and volatility in a critical segment of the financial system.

Illiquidity and Returns of Financial Firms

The second part of the study examines the sensitivity of financial firms' returns to illiquidity, controlling for market factors. The methodology involves regressions on these two factors using daily data. In roughly half the cases, the illiquidity factor has the correct (negative sign), though the degree of statistical significance varies across model specification. Firms that have trading/market-making businesses generally have larger illiquidity sensitivity.

2. Literature review

The relationship between liquidity and volatility has long been a focal point of financial market research due to its implications for market efficiency, stability, and risk management. While liquidity reflects the ease with which assets can be traded without significantly affecting prices, volatility captures the degree of price fluctuations over time. Understanding the interaction between these variables is crucial, particularly in the U.S. Treasury market, which serves as a benchmark for global financial stability.

Historical Perspectives on Market Liquidity

Market liquidity is a cornerstone of well-functioning financial systems. Early works, such as Amihud (2002), established the importance of liquidity in asset pricing, highlighting its role in determining the cost of capital and overall market efficiency[1]. Over the past decades, empirical research has expanded to incorporate bid-ask spreads, market depth, and price impact as core liquidity measures. Adrian, Fleming, and Vogt (2023) utilized 30 years of order book data to construct a daily liquidity index, underscoring how events like the global financial crisis (GFC), the COVID-19 pandemic and the banking turmoil of 2023 significantly disrupted Treasury market liquidity[2].

Recent studies emphasize the evolution of market dynamics due to electronification and regulatory changes. Fleming et al. (2024) documented the decline in order book depth and widening bid-ask spreads during the March 2020 "dash for cash," a period marked by severe market stress and mismatches between dealer intermediation capacity and rapid growth in sovereign debt[4]. This highlights the fragility of liquidity during crises, particularly in the context of high-frequency trading and limited dealer intermediation capacity.

Volatility and Its Drivers

Volatility has been extensively studied as a reflection of market uncertainty and risk. Engle's (1982) introduction of ARCH models revolutionized the analysis of volatility by capturing its clustering nature[3]. Subsequent developments, such as GARCH models, have further elucidated the persistence and dynamic characteristics of volatility. The MOVE Index, introduced by Bank of America Merrill Lynch, has become a key benchmark for measuring Treasury market volatility, providing insights into market expectations and systemic stress[5].

The relationship between volatility and macroeconomic factors, such as interest rate shocks and policy announcements, has also been a significant area of research. Fleming and Remolona (1999) demonstrated the sensitivity of Treasury yields to Federal Open Market Committee (FOMC) announcements, linking them to spikes in volatility[5]. Additionally, regulatory measures like the Supplementary Leverage Ratio (SLR) have been shown to influence market dynamics by altering dealer behaviors during periods of stress[8].

The Liquidity-Volatility Nexus

The interaction between liquidity and volatility is inherently complex and often nonlinear. During periods of heightened market stress, liquidity tends to diminish as volatility rises, and price volatility increases as liquidity declines, creating feedback loops that exacerbate market disruptions. Fleming et al. (2023) identified this phenomenon in the U.S. Treasury market, where the "dash for cash" highlighted the limitations of dealer balance sheets in absorbing liquidity shocks[2]. This aligns with the findings of Aliyev et al. (2024), who noted an increase in the frequency of illiquidity episodes across asset classes, driven by higher skewness and kurtosis in bid-ask spread distributions[6].

Furthermore, policy responses, such as central bank interventions and regulatory adjustments, play a pivotal role in mitigating these dynamics. For instance, the temporary SLR exemptions during the COVID-19 pandemic alleviated some balance sheet constraints, enabling dealers to better manage liquidity demands[8]. However, the retraction of these measures underscores the ongoing vulnerability of financial markets to liquidity shocks[9].

Knowledge Gaps and Future Directions

Despite extensive research, critical gaps remain in understanding the liquidity-volatility relationship. Existing studies often focus on average market conditions, overlooking the nuances of specific tenors, maturities, and systemic stress periods. Additionally, the role of emerging technologies, such as algorithmic trading, in shaping this relationship warrants further exploration. Future research could benefit from integrating advanced econometric techniques, like GARCH models, with high-frequency trading data to uncover hidden patterns and nonlinearities.

3. Methodology

This study adopts a rigorous analytical framework to investigate the relationship between liquidity and volatility in the U.S. Treasury market. The methodology is designed to test the hypothesis that this relationship is nonlinear, particularly during periods of heightened market stress. To achieve this, the research utilizes advanced econometric techniques and liquidity metrics to provide a comprehensive analysis of market dynamics.

3.1 Key Metrics and Variables

3.1.1 Liquidity Measures

Market liquidity is a multidimensional concept that reflects the ease with which assets can be traded without significantly affecting prices. Different metrics provide complementary perspectives on liquidity in financial markets.

Market Depth

Market depth measures the volume of buy and sell orders available at various price levels. Greater market depth implies that larger trades can be executed with minimal price impact, indicating robust liquidity. Fleming et al. (2024) highlighted the importance of market depth in the U.S. Treasury market, noting significant declines during stress periods like the March 2020 "dash for cash," when trading volumes surged but liquidity plummeted[4][6].

Bid-Ask Spreads

Bid-ask spreads capture the cost of immediate transactions and are a critical indicator of transaction costs. Wider spreads typically signal deteriorating liquidity. Adrian, Fleming, and Vogt (2023) found that during market disruptions, bid-ask spreads widened significantly, reflecting reduced willingness among market participants to trade due to uncertainty and risk aversion[2].

Liquidity Ratio

This measure, defined as price volatility divided by trading volume, offers insights into how efficiently the market absorbs trading activity. Higher ratios indicate that price movements are more sensitive to trading volumes, suggesting lower liquidity [10].

ILLIQ (Amihud Illiquidity Ratio)

The Amihud Illiquidity Ratio measures the price impact per unit of trading volume, making it a widely used metric for assessing market liquidity under different conditions[1]. A higher ILLIQ indicates that trading activities lead to more significant price changes, often reflecting stress or inefficiencies in the market.

3.1.2 Volatility Measures

Volatility quantifies the extent of price fluctuations and serves as a key indicator of market uncertainty. Various metrics and models are used to capture different dimensions of volatility:

Realized Volatility

Realized volatility is computed using daily price data to measure actual fluctuations over a given time frame. It provides a historical perspective on market dynamics, helping to identify patterns during calm and stressed periods[5][6].

MOVE Index

The BofA Merrill Lynch Option Volatility Estimate (MOVE) Index tracks the implied volatility of U.S. Treasury options over a one-month horizon. It is a widely regarded benchmark for Treasury market risk and often spikes during periods of uncertainty or macroeconomic policy shifts[6][9].

GARCH Models

Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models are used to account for the persistence and clustering of volatility. Engle's (1982) foundational work on ARCH and subsequent advancements in GARCH modeling have enabled researchers to capture volatility dynamics with precision, particularly in high-frequency data[3]. These models are especially useful for exploring nonlinear relationships between volatility and other market variables.

3.1.3 Other Variables

Policy Changes (e.g., SLR Exemption Periods)

Policy changes can significantly influence market behavior. For example, during the COVID-19 pandemic, the Supplementary Leverage Ratio (SLR) exemption allowed banks to exclude Treasury securities and reserves from their leverage calculations. To analyze the effects of such policies, dummy variables can be employed:

Exemption Dummy = 1 if the observation falls during the exemption period (April 2020-March 2021); Exemption Dummy = 0 otherwise.

These variables enable researchers to isolate the impact of regulatory interventions on liquidity and volatility[8].

Stress Periods

High-stress periods, such as the March 2020 liquidity crisis, can be captured using dummy variables that identify specific events. These variables help quantify how systemic stress affects dealer behavior and intermediation capacity. Fleming et al. (2023) emphasized the utility of such variables in modeling market disruptions[2][4].

Additional Variables

Other variables can capture nuances in the liquidity-volatility relationship:

- Nonlinear Effects: Exploring whether changes in volatility lead to disproportionate changes in liquidity.
- Residual Terms: To account for unexplained variations in econometric models.
- Tenors and Maturities: Analyzing differences across short-term and long-term securities, as longer tenors typically exhibit lower liquidity and higher volatility[4][6].

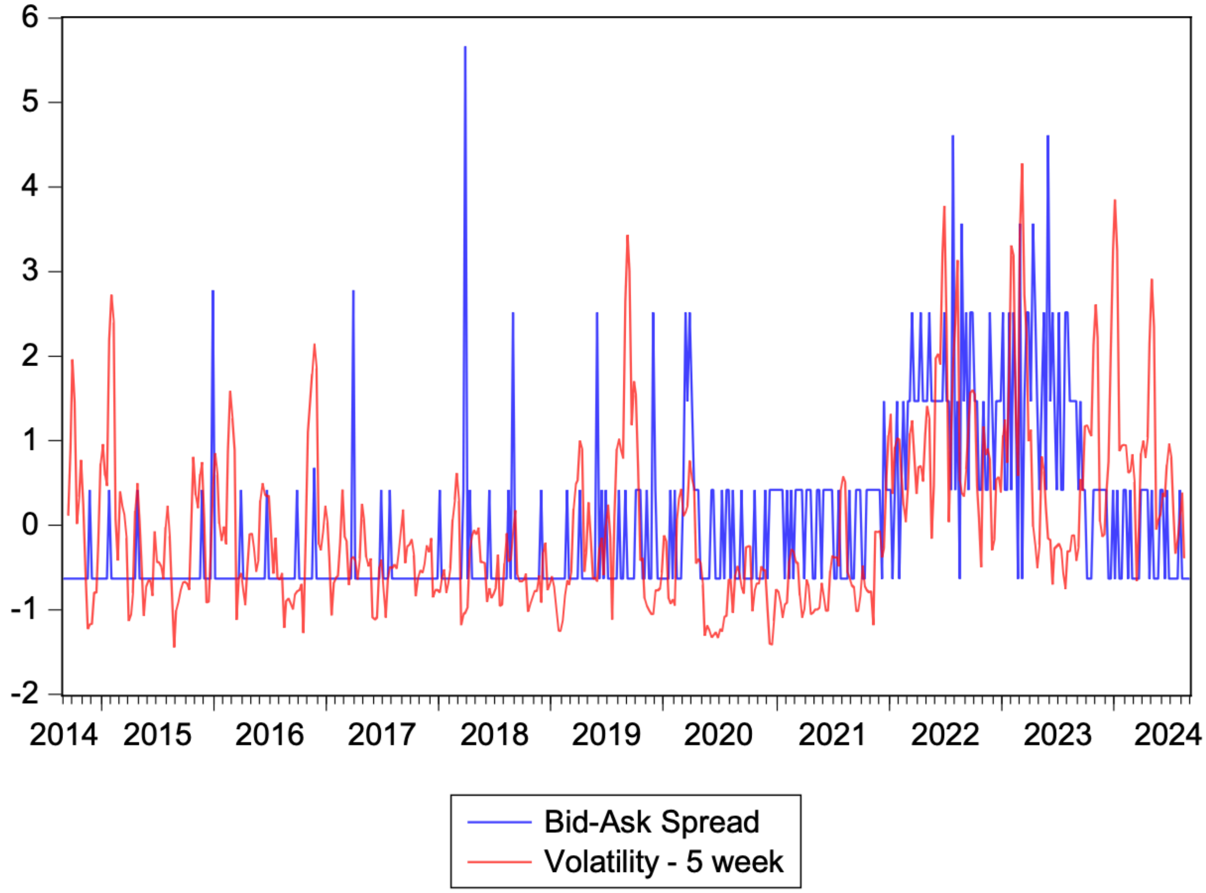
3.2 Data Sources

To comprehensively analyze the liquidity-volatility relationship in the U.S. Treasury market, this study employs data from multiple credible and well-established sources. These data sources are selected to provide complementary insights into liquidity and volatility metrics, their interrelationships, and patterns during stress periods.

3.2.1 Bloomberg

Bloomberg Terminal is a subscription-based platform offering real-time and historical market data. The high-frequency data from Bloomberg allows precise measurement of bid-ask spreads and volatility. Bid-ask spreads are critical for analyzing transaction costs and immediate liquidity.

Graph 1: US 7 Year Treasury Bid-ask spread and volatility (After z-score standardization)



3.2.2 TRACE

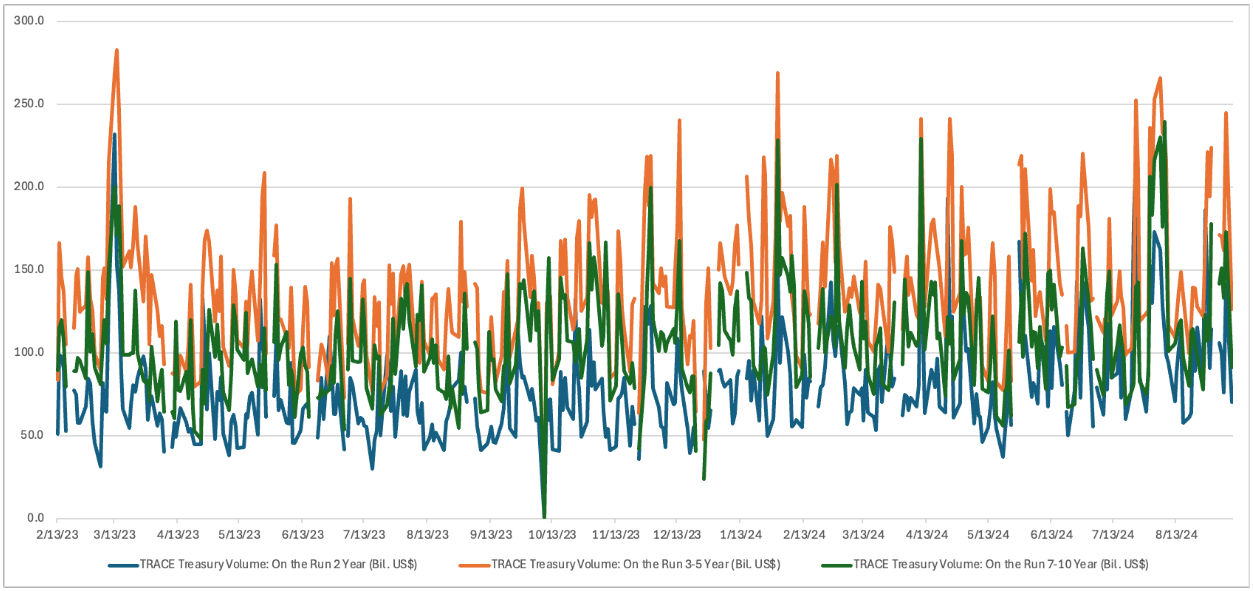
Operated by FINRA, TRACE is the authoritative source for real-time trade data in the fixed-income market. TRACE data enables the analysis of liquidity and trading patterns, particularly how transaction volumes relate to volatility. TRACE data will be visualized to show time-series trends in trading volumes and their correlation with price volatility, highlighting the hypothesized negative liquidity-volatility relationship. Two key applications of trading volume from TRACE data in this study are:

- Liquidity Ratio: Calculated as price volatility divided by trading volume, this ratio reflects the sensitivity of price movements to trading activity. A higher liquidity ratio indicates reduced liquidity, emphasizing the importance of volume data in this calculation.
- ILLIQ (Amihud Illiquidity Ratio): This measure assesses the price impact of trades relative to their volume. TRACE volume data is integral to determining how much price

change occurs per unit of trading volume, providing a direct measure of market illiquidity.

By leveraging TRACE trading volume data, the study evaluates liquidity conditions across different Treasury maturities and their relationship with volatility, contributing to a comprehensive analysis of the liquidity-volatility nexus.

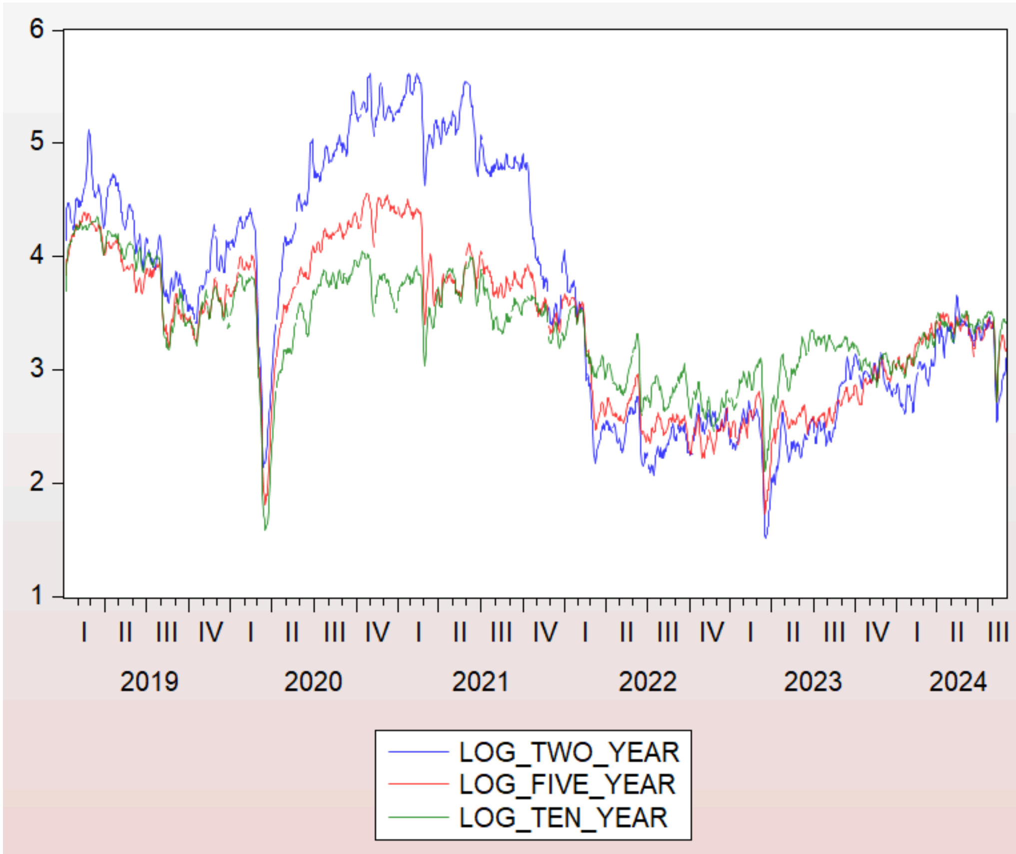
Graph 2: Daily Trading Volume for On-the-Run Treasury Securities Across 2-Year, 3-5 Year, and 7-10 Year Maturities (TRACE Data)



3.2.3 Fleming Measuring Depth

Fleming Measuring Depth provides detailed order book data for the U.S. Treasury market, capturing buy and sell volumes at various price levels. This measure is critical for understanding liquidity, as it reflects the market's capacity to absorb trades without significant price impact. This study uses Fleming's data to analyze trends in market depth across different maturities. By linking market depth to volatility and bid-ask spreads, the study highlights how liquidity fluctuates under stress, offering insights into the nonlinear relationship between liquidity and volatility.

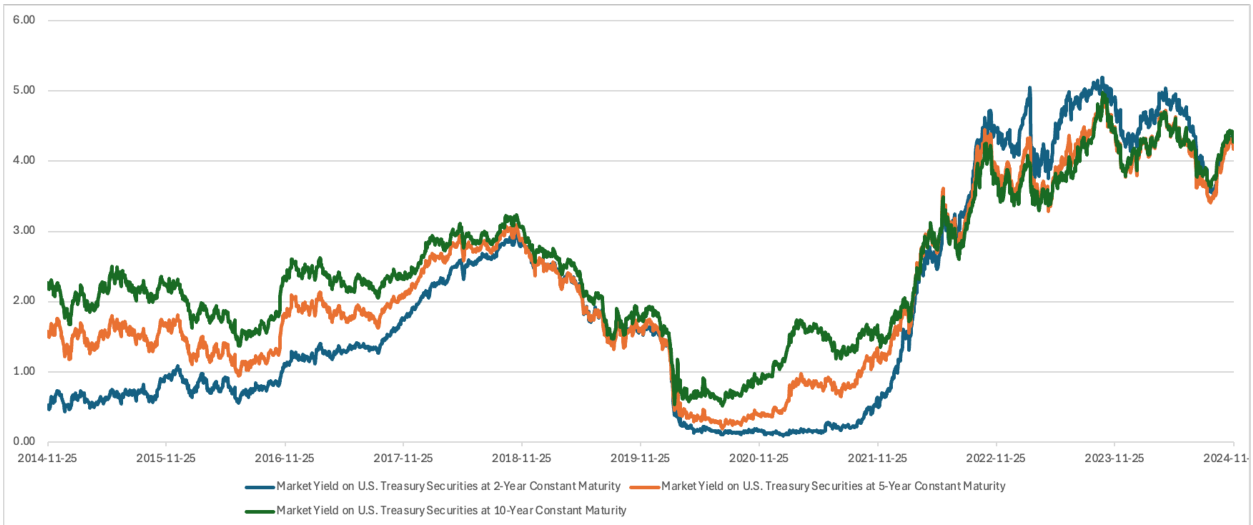
Graph 3: Log of Market Depth for On-the-Run Treasury Securities Across 2-Year, 5-Year, and 10-Year Maturities (Five-Day Moving Averages)



3.2.4 Federal Reserve Economic Data (FRED)

FRED provides key macroeconomic data, including interest rates and policy variables, which contextualize Treasury market dynamics. FRED is publicly accessible and hosted by the Federal Reserve Bank of St. Louis. This study uses FRED data to examine how macroeconomic shocks, such as Federal Reserve policy shifts, influence liquidity and volatility. Indicators like GDP growth and interest rate changes are linked to Treasury market metrics, while dummy variables for events like the SLR exemption provide additional insights into systemic stress periods. FRED's comprehensive data enables a nuanced analysis of liquidity-volatility interactions within the broader economic landscape.

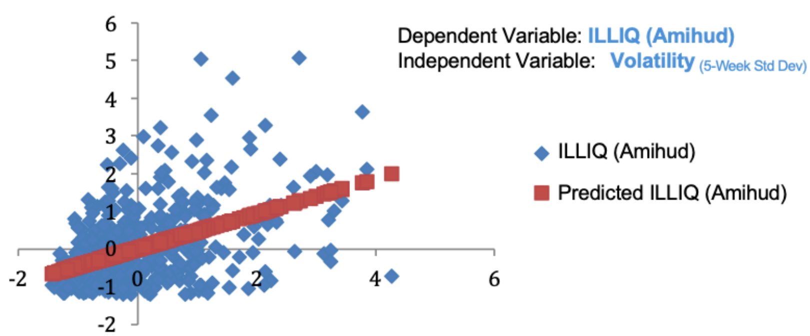
Graph 4: Market Yield for On-the-Run Treasury Securities Across 2-Year, 5-Year, and 10-Year Maturities (Constant Maturity)



4 Results

4.1 Positive Correlation Between Volatility and Illiquidity

Graph 5: U.S. 7-Year Treasury - ILLIQ (Y) and Price Volatility (X)



Graph 6: U.S. 7-Year Treasury – Bid-Ask Spread (Y) and Price Volatility (X)

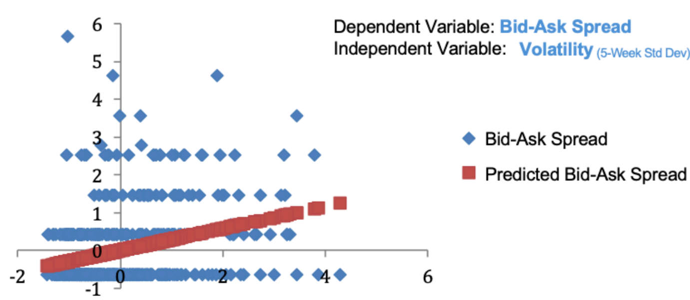


Table 1: U.S. 7-Year Treasury – Correlation Matrix

	MOVE (1-month)	Volatility (5-Week Std Dev)	Liquidity Ratio	ILLIQ (Amihud)	Bid-Ask Spread
MOVE	1.000000	0.594530	0.515618	0.470989	0.542455
Volatility	0.594530	1.000000	0.779376	0.461088	0.289742
Liquidity Ratio	0.515618	0.779376	1.000000	0.407672	0.246480
ILLIQ (Amihud)	0.470989	0.461088	0.407672	1.000000	0.269711
Bid-Ask Spread	0.542455	0.289742	0.246480	0.269711	1.000000

- The analysis reveals a **positive correlation between volatility and illiquidity** in the U.S. Treasury market. As volatility increases, liquidity metrics such as ILLIQ (Amihud Illiquidity Ratio), and bid-ask spreads widen.
- After **standardization**, the MOVE Index explains:

Table 2: U.S. 7-Year Treasury – Liquidity Ratio (Y) and Volatility (X) (Standardized)

Dependent Variable: Liquidity Ratio ($= \frac{\text{Price Volatility}}{\text{Trading Volume}}$)
Method: Least Squares
Sample (adjusted): 9/17/2014 8/14/2024
Included observations: 518 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001353	0.037719	0.035879	0.9714
MOVE (1-month)	0.515264	0.037693	13.66986	0.0000

R-squared	0.265862	Mean dependent var	-4.61E-16
Adjusted R-squared	0.264439	S.D. dependent var	1.000967
S.E. of regression	0.858477	Akaike info criterion	2.536541
Sum squared resid	380.2835	Schwarz criterion	2.552950
Log likelihood	-654.9641	Hannan-Quinn criter.	2.542970
F-statistic	186.8650	Durbin-Watson stat	1.350397
Prob(F-statistic)	0.000000		

  - **27% of the variance** in the liquidity ratio, indicating its effectiveness as a predictor of liquidity conditions.

Table 3: U.S. 7-Year Treasury – ILLIQ (Y) and Volatility (X) (Standardized)

Dependent Variable: ILLIQ (Amihud)
Method: Least Squares
Sample (adjusted): 9/10/2014 8/28/2024
Included observations: 521 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000417	0.038876	-0.010715	0.9915
MOVE (1-month)	0.463975	0.038847	11.94356	0.0000

R-squared	0.215596	Mean dependent var	-5.30E-16
Adjusted R-squared	0.214084	S.D. dependent var	1.000961
S.E. of regression	0.887371	Akaike info criterion	2.602724
Sum squared resid	408.6746	Schwarz criterion	2.619061
Log likelihood	-676.0096	Hannan-Quinn criter.	2.609123
F-statistic	142.6486	Durbin-Watson stat	2.105591
Prob(F-statistic)	0.000000		

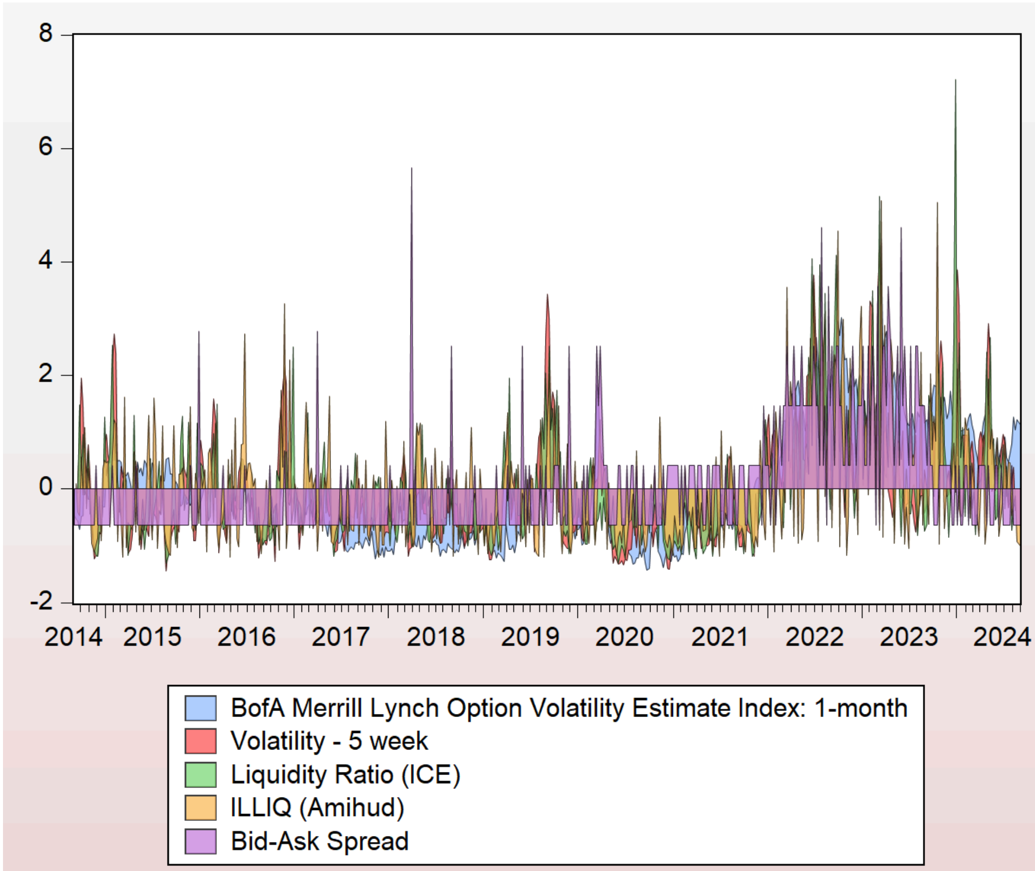
- **20% of the variance** in the Amihud Illiquidity Ratio, reinforcing its role in capturing price sensitivity to trading volume.

4.2 Maturity-Based Insights

- **Longer-maturity Treasuries (5–10 years)** consistently exhibit:
  - **Lower liquidity**: These securities have thinner markets, reflected in reduced market depth and higher bid-ask spreads.
  - **Higher volatility**: Longer maturities are more sensitive to macroeconomic factors, such as interest rate fluctuations, contributing to greater price variability.
- **Shorter-maturity Treasuries (2 years)** tend to:
  - Exhibit **higher market depth** during normal periods, as these are often considered safer and more liquid.
  - Face pronounced volatility during stress periods, especially in events like quarter-end rebalancing or macroeconomic announcements.
- **Market depth analysis** shows significant variation across maturities:
  - **2-year Treasuries** displayed the highest volatility in market depth.
  - Post-March 2022, the market depth fluctuations across maturities **converged**, suggesting a homogenization in liquidity patterns.

4.3 Temporal Trends

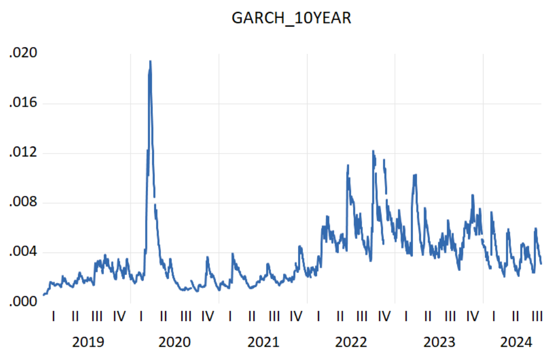
Graph 7: U.S. 7-Year Treasury – Illiquidity and Volatility (Standardized)

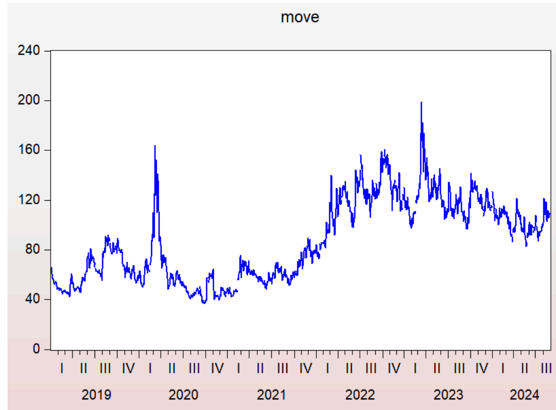


- **March 2022 onward**:
  - Both the liquidity ratio and Amihud Illiquidity Index increased significantly, indicating declining liquidity despite market normalization efforts.
  - However, a **recent downward trend** in these metrics suggests gradual improvement in liquidity conditions.
- **April 2020 to January 2022 (SLR exemption period)**:
  - Market depth for **2-year U.S. Treasuries** increased significantly (see Graph 4), attributed to temporary regulatory relief that enhanced dealer capacity.
  - Both the liquidity ratio and Amihud Illiquidity Index decreased during this period, reflecting improved market conditions facilitated by policy interventions.

4.4 Volatility Patterns

Graph 8: U.S. 10-Year Treasury GARCH Variances and MOVE Comparison





- The GARCH variance series of U.S. Treasury yields strongly resembles MOVE Index data, validating the use of GARCH models for capturing the persistence of volatility in this market.
- **Quarter-end effects**:
    - Higher volatility and illiquidity are observed, driven by increased trading activity and balance sheet constraints among market participants.

4.5 SLR Exemptions Analysis

During the COVID-19 pandemic, concerns about liquidity strains in the U.S. Treasury market prompted the Federal Reserve to temporarily exclude U.S. Treasuries and reserves from the SLR calculation between April 1, 2020, and March 31, 2021.

The study hypothesizes the following:

- During the SLR exemption period, market depth increased due to reduced balance sheet constraints, reflecting improved liquidity conditions.
- The negative relationship between market volatility and market depth becomes more pronounced during the SLR exemption period, as volatility shocks amplify despite improved liquidity.

To assess the effect of the SLR exemption on market depth, data from January 2, 2019 to August 30, 2024 were analyzed and three models were estimated:

Model Without SLR_EXEMPT (Baseline):

Tests the relationship between volatility (MOVE) and market depth (U.S. 2-Year Treasury).

$$MarketDepth_t = \alpha + \beta_1 MOVE_t + \epsilon_t$$

Results:

Table 4: Model Without SLR_EXEMPT Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	203.7504	3.257170	62.55442	0.0000
MOVE	-1.580827	0.035047	-45.10594	0.0000

R-squared	0.589801	Mean dependent var	65.94600
Adjusted R-squared	0.589511	S.D. dependent var	66.35132
S.E. of regression	42.51090	Akaike info criterion	10.33881
Sum squared resid	2557154.	Schwarz criterion	10.34623
Log likelihood	-7323.046	Hannan-Quinn criter.	10.34158
F-statistic	2034.546	Durbin-Watson stat	0.053370
Prob(F-statistic)	0.000000		

MOVE coefficient: -1.5808 (p = 0.000).

- Volatility significantly reduces market depth, aligning with the expectation that higher volatility discourages liquidity provision.

R-squared: 0.589

- MOVE alone explains approximately 59% of the variation in market depth.

Model With SLR_EXEMPT:

Incorporates the SLR exemption dummy to assess its independent effect.

$$SLR\_EXEMPT_t = \begin{cases} 1 \; during\ the\ SLR\ exemption\ period\ (April\ 1, 2020 - \ March\ 31, 2021) \\ 0 \; otherwise \end{cases}$$

$$MarketDepth_t = \alpha + \beta_1 MOVE_t + \beta_2 SLR\_EXEMPT_t + \epsilon_t$$

Table 5: Model With SLR_EXEMPT Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	164.9255	3.619611	45.56442	0.0000
MOVE	-1.249198	0.036381	-34.33615	0.0000
SLR_EXEMPT	56.20404	3.075450	18.27506	0.0000

R-squared	0.668176	Mean dependent var	65.94600
Adjusted R-squared	0.667706	S.D. dependent var	66.35132
S.E. of regression	38.24816	Akaike info criterion	10.12818
Sum squared resid	2068571.	Schwarz criterion	10.13931
Log likelihood	-7172.817	Hannan-Quinn criter.	10.13234
F-statistic	1423.646	Durbin-Watson stat	0.052003
Prob(F-statistic)	0.000000		

SLR_EXEMPT coefficient: 56.2040 (p = 0.000).

- The SLR exemption period is associated with a significant increase in market depth, indicating that balance sheet relief improved liquidity.

MOVE coefficient: -1.2492 (p = 0.000).

- The negative effect of volatility on market depth remains, but its magnitude is reduced when the exemption is considered.

R-squared: 0.668

- The addition of SLR_EXEMPT improves the model fit, confirming its relevance in explaining market depth.

Model With Interaction Term:

Adds an interaction term to test whether the effect of volatility on market depth changes during the exemption period.

$$MarketDepth_t = \alpha + \beta_1 MOVE_t + \beta_2 SLR\_EXEMPT_t + \beta_3 (MOVE_t \times SLR\_EXEMPT_t) + \epsilon_t$$

Table 6: Model With Interaction Term Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	161.5300	3.602141	44.84278	0.0000
MOVE	-1.213309	0.036244	-33.47579	0.0000
SLR_EXEMPT	142.3868	13.32619	10.68474	0.0000
MOVE*SLR_EXEMPT	-1.614379	0.243090	-6.641074	0.0000

R-squared	0.678220	Mean dependent var	65.94600
Adjusted R-squared	0.677536	S.D. dependent var	66.35132
S.E. of regression	37.67818	Akaike info criterion	10.09886
Sum squared resid	2005959.	Schwarz criterion	10.11370
Log likelihood	-7151.041	Hannan-Quinn criter.	10.10440
F-statistic	992.7308	Durbin-Watson stat	0.057429
Prob(F-statistic)	0.000000		

SLR_EXEMPT coefficient: 142.3868 (p = 0.000).

- The exemption has a strong positive effect on market depth.

MOVE × SLR_EXEMPT coefficient: -1.6144 (p = 0.000).

- The negative relationship between volatility and market depth intensifies during the exemption period, suggesting heightened market fragility despite improved liquidity.

R-squared: 0.678

- The interaction model has the highest explanatory power, indicating that both the SLR exemption and its interaction with volatility are critical for understanding market depth dynamics.

Overall, volatility (MOVE) has a significant negative effect on market depth. Adding the SLR_EXEMPT dummy improves the model, showing that the exemption period enhanced market depth by easing balance sheet constraints. The interaction term highlights a critical trade-off: while liquidity improved, market depth became more sensitive to volatility shocks during the exemption period.

4.6 Illiquidity and Returns of Financial Firms

The daily return of SPY_US, a widely used exchange-traded fund that tracks the S&P 500 Index, is employed as the market factor, while the V-Lab ILLIQ Composite Liquidity Index [11] serves as the liquidity factor. The sample period spans from June 15, 2007, to February 28, 2025. The regressions are estimated using the Least Squares method. Three regression specifications are presented as follows.

Regression Model of Stock Returns on Market Factors and COMPOSITE_ILLIQ:

$$Stock\ Return_t = \alpha + \beta_1 SPY\_US_t + \beta_2 COMPOSITE\_ILLIQ_t + \epsilon_t$$

Dependent Variable: Financial Firms stock return

Independent Variable: SPY_US, COMPOSITE_ILLIQ

Table 7: Regression Results of Stock Returns on SPY_US and COMPOSITE_ILLIQ

Name	Ticker	SPY_US			COMPOSITE_ILLIQ		
		Coefficient	*t-Statistic*	*Prob.*	*Coefficient*	*t-Statistic*	*Prob.*
Ally Financial Inc.	ALLY:US	1.3868	41.8279	0.0000	-0.0025	-1.2094	0.2266
Apollo Global Management	APO:US	1.2878	46.5481	0.0000	-0.0006	-0.5199	0.6031
Ares Management	ARES:US	1.1370	37.3963	0.0000	-0.0021	-1.1331	0.2573
American Express Company	AXP:US	1.3377	85.3144	0.0000	-0.0002	-0.3478	0.7280
Bank of America Corp	BAC:US	1.4669	68.4552	0.0000	-0.0002	-0.2641	0.7917
Franklin Resources, Inc.	BEN:US	1.3098	86.0049	0.0000	0.0010	2.1617	0.0307
Bank of New York Mellon Corp/The	BK:US	1.2798	76.0458	0.0000	0.0000	0.0841	0.9330
BlackRock	BLK:US	1.1020	65.6815	0.0000	0.0008	1.5941	0.1110
Bridge Investment Group	BRDG:US	0.9630	12.0719	0.0000	-0.0055	-0.5148	0.6068
Blackstone	BX:US	1.4630	57.7909	0.0000	-0.0005	-0.5605	0.5752
Citigroup Inc	C:US	1.5880	70.5255	0.0000	-0.0006	-0.8555	0.3923
CBRE Group	CBRE:US	1.7454	60.6004	0.0000	-0.0001	-0.1204	0.9042
Citizens Financial Group, Inc.	CFG:US	1.3472	41.5528	0.0000	-0.0002	-0.0953	0.9241

The Carlyle Group	CG:US	1.3396	46.5502	0.0000	-0.0010	-0.6641	0.5067
Capital One Financial Corporation	COF:US	1.5334	66.8782	0.0000	-0.0004	-0.5404	0.5889
Discover Financial Services	DFS:US	1.5341	64.1685	0.0000	-0.0002	-0.1974	0.8435
Fifth Third Bancorp	FITB:US	1.4647	56.4402	0.0000	-0.0002	-0.2826	0.7775
Golub Capital	GBDC:US	0.5194	28.2220	0.0000	-0.0001	-0.0834	0.9336
Goldman Sachs	GS:US	1.3189	81.5545	0.0000	0.0003	0.7031	0.4820
Huntington Bancshares Incorporated	HBAN:US	1.3461	49.4506	0.0000	-0.0002	-0.1982	0.8429
Hamilton Lane	HLNE:US	1.1537	34.1287	0.0000	0.0032	1.0608	0.2889
Invesco	IVZ:US	1.6069	78.2899	0.0000	0.0007	1.0887	0.2763
Jones Lang LaSalle Incorporated	JLL:US	1.2564	58.6181	0.0000	0.0003	0.4102	0.6817
JP Morgan Chase	JPM:US	1.3789	82.5206	0.0000	-0.0001	-0.1068	0.9149
KeyCorp	KEY:US	1.4396	61.7391	0.0000	0.0003	0.4150	0.6782
KKR & Co. Inc.	KKR:US	1.4149	58.4591	0.0000	-0.0010	-0.9186	0.3584
MetLife	MET:US	1.3403	69.0070	0.0000	0.0007	1.2516	0.2108
Monroe Capital	MRCC:US	0.5854	19.5925	0.0000	-0.0004	-0.2456	0.8060
Morgan Stanley	MS:US	1.7257	84.7894	0.0000	0.0006	0.9457	0.3443
M&T Bank Corporation	MTB:US	1.0108	60.3276	0.0000	0.0003	0.6240	0.5327
Northern Trust Corporation	NTRS:US	1.2446	79.4619	0.0000	0.0002	0.4303	0.6670
Blue Owl Capital	OWL:US	1.3139	20.7428	0.0000	-0.0022	-0.2614	0.7938
The PNC Financial Services Group, Inc.	PNC:US	1.2054	66.1320	0.0000	0.0000	0.0303	0.9758
Prudential Financial	PRU:US	1.5499	74.7792	0.0000	0.0004	0.6112	0.5411
Regions Financial Corporation	RF:US	1.4219	56.6199	0.0000	0.0001	0.0765	0.9390
The Charles Schwab Corporation	SCHW:US	1.4343	71.0967	0.0000	0.0000	-0.0562	0.9552
SLR Capital Partners	SLRC:US	0.7514	33.9250	0.0000	0.0005	0.5747	0.5655
State Street Corp	STT:US	1.4275	66.6556	0.0000	0.0006	0.8945	0.3711
Truist Financial Corporation	TFC:US	1.1815	69.4022	0.0000	0.0005	0.9729	0.3306
TPG Inc.	TPG:US	1.4299	23.3883	0.0000	0.0047	0.5895	0.5557
T Rowe Price	TROW:US	1.4205	94.7343	0.0000	0.0007	1.6940	0.0903
U.S. Bancorp	USB:US	1.1248	65.5341	0.0000	0.0004	0.7108	0.4772
Wells Fargo & Co	WFC:US	1.2363	66.1358	0.0000	0.0003	0.5642	0.5727

Among the 43 financial firms studied, 21 exhibit a negative coefficient for illiquidity. One firms have an illiquidity coefficient significant at the 95% level, and two firms have a coefficient significant at the 90% level. The market factor is statistically significant for the returns of all firms.

Regression Model of Stock Returns on Market Factors and D(ILLIQ(-3)):

$$Stock\ Return_t = \alpha + \beta_1 SPY\_US_t + \beta_2 D(ILLIQ(-3))_t + \epsilon_t$$

Where $D(ILLIQ(-3))_t$ represents the first difference of the illiquidity variable lagged by three periods, capturing the change between its values at t−3 and t−4.

Table 8: Regression Results of Stock Returns on SPY_US and D(ILLIQ(-3))

Name	Ticker	SPY_US			D(ILLIQ(-3))		
		Coefficient	*t-Statistic*	*Prob.*	*Coefficient*	*t-Statistic*	*Prob.*
Ally Financial Inc.	ALLY:US	1.3863	41.8777	0.0000	-0.1192	-3.1621	0.0016
Apollo Global Management	APO:US	1.2883	46.6035	0.0000	-0.0595	-2.4028	0.0163
Ares Management	ARES:US	1.1367	37.3940	0.0000	0.0513	1.4790	0.1393
American Express Company	AXP:US	1.3391	85.3731	0.0000	-0.0225	-2.0478	0.0406
Bank of America Corp	BAC:US	1.4691	68.6036	0.0000	-0.0171	-1.1398	0.2544
Franklin Resources, Inc.	BEN:US	1.3134	86.3986	0.0000	-0.0313	-2.9377	0.0033

Bank of New York Mellon Corp/The	BK:US	1.2812	76.1618	0.0000	-0.0128	-1.0904	0.2756
BlackRock	BLK:US	1.1035	65.7969	0.0000	-0.0290	-2.4700	0.0135
Bridge Investment Group	BRDG:US	0.9637	12.0825	0.0000	-0.0594	-0.3653	0.7150
Blackstone	BX:US	1.4638	57.8274	0.0000	-0.0311	-1.5267	0.1269
Citigroup Inc	C:US	1.5894	70.5629	0.0000	-0.0050	-0.3162	0.7518
CBRE Group	CBRE:US	1.7470	60.7089	0.0000	-0.0731	-3.2504	0.0012
Citizens Financial Group, Inc.	CFG:US	1.3471	41.5549	0.0000	-0.0199	-0.5244	0.6001
The Carlyle Group	CG:US	1.3393	46.5429	0.0000	0.0058	0.2006	0.8410
Capital One Financial Corporation	COF:US	1.5355	66.9483	0.0000	-0.0323	-2.0126	0.0442
Discover Financial Services	DFS:US	1.5356	64.2914	0.0000	-0.0613	-3.1894	0.0014
Fifth Third Bancorp	FITB:US	1.4666	56.4573	0.0000	-0.0170	-0.9343	0.3502
Golub Capital	GBDC:US	0.5194	28.2222	0.0000	0.0005	0.0340	0.9729
Goldman Sachs	GS:US	1.3192	81.6499	0.0000	-0.0176	-1.5530	0.1205
Huntington Bancshares Incorporated	HBAN:US	1.3480	49.4751	0.0000	-0.0189	-0.9927	0.3209
Hamilton Lane	HLNE:US	1.1546	34.1469	0.0000	0.0242	0.5169	0.6052
Invesco	IVZ:US	1.6094	78.3510	0.0000	-0.0096	-0.6646	0.5063
Jones Lang LaSalle Incorporated	JLL:US	1.2580	58.6420	0.0000	0.0000	0.0004	0.9997
JP Morgan Chase	JPM:US	1.3806	82.6163	0.0000	-0.0033	-0.2826	0.7775
KeyCorp	KEY:US	1.4415	61.8038	0.0000	0.0114	0.6987	0.4847
KKR & Co. Inc.	KKR:US	1.4144	58.4340	0.0000	0.0077	0.3704	0.7111
MetLife	MET:US	1.3407	69.0370	0.0000	-0.0274	-2.0217	0.0432
Monroe Capital	MRCC:US	0.5855	19.5976	0.0000	0.0266	0.8688	0.3850
Morgan Stanley	MS:US	1.7267	84.8231	0.0000	-0.0316	-2.2204	0.0264
M&T Bank Corporation	MTB:US	1.0108	60.2585	0.0000	0.0154	1.3077	0.1910
Northern Trust Corporation	NTRS:US	1.2436	79.3717	0.0000	0.0093	0.8499	0.3954
Blue Owl Capital	OWL:US	1.3136	20.7652	0.0000	-0.2065	-1.7023	0.0890
The PNC Financial Services Group, Inc.	PNC:US	1.2067	66.1937	0.0000	-0.0006	-0.0439	0.9650
Prudential Financial	PRU:US	1.5502	74.7928	0.0000	-0.0174	-1.1965	0.2315
Regions Financial Corporation	RF:US	1.4229	56.5998	0.0000	-0.0013	-0.0735	0.9414
The Charles Schwab Corporation	SCHW:US	1.4379	71.2548	0.0000	-0.0371	-2.6279	0.0086
SLR Capital Partners	SLRC:US	0.7515	33.9329	0.0000	0.0070	0.3731	0.7091
State Street Corp	STT:US	1.4283	66.6467	0.0000	-0.0122	-0.8138	0.4158
Truist Financial Corporation	TFC:US	1.1827	69.4983	0.0000	-0.0030	-0.2531	0.8002
TPG Inc.	TPG:US	1.4301	23.4137	0.0000	0.1473	1.1814	0.2378
T Rowe Price	TROW:US	1.4217	94.7981	0.0000	0.0001	0.0087	0.9931
U.S. Bancorp	USB:US	1.1270	65.7468	0.0000	-0.0165	-1.3765	0.1687
Wells Fargo & Co	WFC:US	1.2369	66.1257	0.0000	-0.0030	-0.2320	0.8166

Among the 43 financial firms studied, 30 exhibit a negative coefficient for illiquidity. 11 firms have an illiquidity coefficient significant at the 95% level, and 12 firms have a coefficient significant at the 90% level. The market factor is statistically significant for the returns of all firms.

Regression Model of Stock Returns on Market Factors and D(LOG(ILLIQ(-3))):

$$Stock\ Return_t = \alpha + \beta_1 SPY\_US_t + \beta_2 D(LOG(ILLIQ(-3)))_t + \epsilon_t$$

Where $D(LOG(ILLIQ(-3)))_t$ represents the first difference of the natural logarithm of the illiquidity variable lagged by three periods, capturing the growth rate (or log change) between its values at t−3 and t−4.

Table 9: Regression Results of Stock Returns on SPY_US and D(LOG(ILLIQ(-3)))

Name	Ticker	SPY_US			D(LOG(ILLIQ(-3)))		
		Coefficient	*t-Statistic*	*Prob.*	*Coefficient*	*t-Statistic*	*Prob.*
Ally Financial Inc.	ALLY:US	1.1368	37.4057	0.0000	2.9390	1.8720	0.0613
Apollo Global Management	APO:US	1.4634	57.8212	0.0000	-2.3422	-1.5761	0.1151
Ares Management	ARES:US	1.3189	81.6342	0.0000	-1.0172	-1.0396	0.2986
American Express Company	AXP:US	1.2879	46.5749	0.0000	-2.5775	-1.8205	0.0688
Bank of America Corp	BAC:US	1.1027	65.7412	0.0000	-1.1659	-1.1477	0.2511
Franklin Resources, Inc.	BEN:US	1.5500	74.8047	0.0000	-2.0272	-1.6648	0.0960
Bank of New York Mellon Corp/The	BK:US	1.3393	46.5434	0.0000	0.3695	0.2567	0.7975
BlackRock	BLK:US	1.4218	94.8261	0.0000	-0.4681	-0.5156	0.6062
Bridge Investment Group	BRDG:US	1.4290	23.4116	0.0000	4.7649	1.4896	0.1367
Blackstone	BX:US	1.3127	86.3357	0.0000	-1.7344	-1.8836	0.0597
Citigroup Inc	C:US	1.4145	58.4400	0.0000	0.6909	0.5641	0.5727
CBRE Group	CBRE:US	0.5194	28.2239	0.0000	-0.2716	-0.2889	0.7726
Citizens Financial Group, Inc.	CFG:US	1.3144	20.7563	0.0000	-2.8282	-0.8877	0.3749
The Carlyle Group	CG:US	1.7261	84.8103	0.0000	-2.5569	-2.0744	0.0381
Capital One Financial Corporation	COF:US	0.5853	19.5913	0.0000	0.1687	0.1124	0.9105
Discover Financial Services	DFS:US	0.9640	12.0863	0.0000	-0.1465	-0.0354	0.9718
Fifth Third Bancorp	FITB:US	1.3807	82.6431	0.0000	-0.9237	-0.9129	0.3613
Golub Capital	GBDC:US	1.1545	34.1453	0.0000	0.8181	0.4484	0.6539
Goldman Sachs	GS:US	0.7516	33.9369	0.0000	-0.5048	-0.4485	0.6538
Huntington Bancshares Incorporated	HBAN:US	1.3403	69.0247	0.0000	-2.2514	-1.9250	0.0543
Hamilton Lane	HLNE:US	1.6092	78.3629	0.0000	-1.0115	-0.8134	0.4160
Invesco	IVZ:US	1.2580	58.6526	0.0000	0.0998	0.0768	0.9388
Jones Lang LaSalle Incorporated	JLL:US	1.7457	60.6248	0.0000	-2.5426	-1.5330	0.1253
JP Morgan Chase	JPM:US	1.4688	68.6067	0.0000	-1.5523	-1.1972	0.2313
KeyCorp	KEY:US	1.5894	70.5822	0.0000	-1.0324	-0.7570	0.4491
KKR & Co. Inc.	KKR:US	1.4280	66.6432	0.0000	-0.5291	-0.4078	0.6835
MetLife	MET:US	1.2369	66.1351	0.0000	-0.1645	-0.1453	0.8845
Monroe Capital	MRCC:US	1.2811	76.1785	0.0000	-1.5655	-1.5372	0.1243
Morgan Stanley	MS:US	1.3862	41.8350	0.0000	-3.6657	-2.1418	0.0323
M&T Bank Corporation	MTB:US	1.3387	85.3528	0.0000	-1.5595	-1.6419	0.1007
Northern Trust Corporation	NTRS:US	1.5350	66.9340	0.0000	-2.5323	-1.8234	0.0683
Blue Owl Capital	OWL:US	1.4371	71.2033	0.0000	-1.9747	-1.6156	0.1062
The PNC Financial Services Group, Inc.	PNC:US	1.3471	41.5530	0.0000	-0.2667	-0.1574	0.8749
Prudential Financial	PRU:US	1.5348	64.2723	0.0000	-4.5785	-3.2647	0.0011
Regions Financial Corporation	RF:US	1.4664	56.4581	0.0000	-1.4289	-0.9085	0.3637
The Charles Schwab Corporation	SCHW:US	1.3476	49.4641	0.0000	-0.7458	-0.4521	0.6512
SLR Capital Partners	SLRC:US	1.4417	61.8247	0.0000	0.7507	0.5316	0.5950
State Street Corp	STT:US	1.0112	60.2854	0.0000	0.9313	0.9168	0.3593
Truist Financial Corporation	TFC:US	1.2439	79.4005	0.0000	0.2324	0.2450	0.8065
TPG Inc.	TPG:US	1.2066	66.2025	0.0000	0.2960	0.2681	0.7886
T Rowe Price	TROW:US	1.4228	56.6071	0.0000	0.2567	0.1686	0.8661
U.S. Bancorp	USB:US	1.1827	69.5094	0.0000	-0.2561	-0.2486	0.8037
Wells Fargo & Co	WFC:US	1.1267	65.7357	0.0000	-1.0450	-1.0068	0.3141

Among the 43 financial firms studied, 31 exhibit a negative coefficient for illiquidity. Three firms have an illiquidity coefficient significant at the 95% level, and nine firms have a coefficient significant at the 90% level. The market factor is statistically significant for the returns of all firms.

5. Discussion

The empirical results confirm a robust, positive relationship between volatility and illiquidity in the U.S. Treasury market. Bid-ask spreads, the ILLIQ ratio, and the liquidity ratio all widen as volatility increases, especially during stress periods such as the COVID-19 crisis and the monetary policy normalization that began in 2022. These effects are consistent across different liquidity measures, reinforcing the hypothesis that volatility erodes liquidity by increasing uncertainty and discouraging intermediation.

The regression analysis also shows that regulatory interventions, particularly the Supplementary Leverage Ratio (SLR) exemption, significantly influence market depth. The interaction model reveals that while the SLR exemption improves liquidity, it simultaneously heightens the sensitivity of market depth to volatility shocks. This finding suggests that although balance sheet relief can temporarily enhance market conditions, it may also amplify market fragility in the face of volatility.

Recent studies, such as Bräuning and Stein [12][13], provide further evidence of how capital constraints limit dealer intermediation during stress. Their work shows that lower-SLR dealers increased Treasury holdings and liquidity provision significantly more than less constrained dealers during the SLR exemption. This reinforces the mechanism through which policy relief translates to improved liquidity, though not without trade-offs.

The discussion is particularly relevant in light of the Federal Reserve's 2025 exploratory scenario on non-bank financial institutions (NBFIs). These scenarios underscore the risk posed by opaque, highly-leveraged entities operating outside the regulatory perimeter [14]. The findings here complement those insights by showing that even in the highly regulated Treasury market, liquidity can deteriorate rapidly under stress, especially when structural constraints such as SLR limits bind.

These results underscore the value of high-frequency, market-based liquidity monitoring tools. Metrics such as the liquidity ratio and Amihud Illiquidity Ratio, when used alongside volatility indicators like the MOVE Index and GARCH variances, enable real-time tracking of market conditions. The nonlinear and procyclical dynamics revealed in this study highlight the need for forward-looking approaches to liquidity risk management.

Moreover, the maturity-based analysis reveals that longer-term Treasuries exhibit persistently thinner liquidity, indicating that liquidity stress tests should differentiate across maturities. The findings further suggest that regulatory and supervisory tools need to account for tenor-specific vulnerabilities.

This study also explores the influence of market liquidity on asset returns. The regression examines whether higher illiquidity is associated with lower future returns for select financial institutions. Firms engaged in trading or market-making activities generally exhibit greater sensitivity to illiquidity. While several results show limited statistical significance, the complex and multifactorial nature of stock returns suggests that further investigation is needed to assess whether illiquidity is a consistently priced risk factor. This extension adds a cross-asset dimension to the research, with important implications for asset pricing, portfolio construction, and risk management.

Together, these findings advocate for enhanced liquidity risk monitoring frameworks that incorporate real-time market data, recognize the heterogeneity across maturities, and integrate lessons from both regulated and shadow banking sectors. By doing so, policymakers and market participants can better anticipate and manage the feedback loops between liquidity and volatility.

6. Conclusions

This study provides compelling evidence of a significant, and often nonlinear, relationship between market volatility and liquidity in the U.S. Treasury market. High-frequency data, econometric modeling, and stress-period analysis show that volatility shocks correspond with deteriorating liquidity conditions, including widening bid-ask spreads, elevated Amihud Illiquidity Ratios, and diminished market depth.

Regulatory measures such as the SLR exemption during the COVID-19 crisis temporarily alleviated dealer constraints and improved liquidity conditions. However, the increased sensitivity of market depth to volatility during the exemption period highlights a fragile equilibrium: policy relief may improve liquidity but can also expose markets to heightened fragility under subsequent stress.

The regression results on financial firms show that illiquidity generally exerts a negative effect on stock returns, though the statistical significance varies across specifications. While the market factor consistently explains returns across all firms, the role of illiquidity as a priced risk factor appears more nuanced and merits further investigation.

The Federal Reserve's 2025 exploratory scenario on NBFIs signals growing recognition of liquidity-driven systemic risks. This study's findings provide empirical backing for those concerns, demonstrating that liquidity risk is dynamic, maturity-dependent, and amplified by policy and structural constraints. Future research should further integrate dealer balance sheet data, funding market dynamics, and the role of algorithmic trading in liquidity provision. Such insights will be essential for refining stress testing frameworks and enhancing market resilience in an evolving financial landscape.

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