Assessing Liquidity Risk and Returns in Developing Bond Markets

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ABSTRACT

This study examines whether bond returns in developing markets reflect liquidity risk premia. The concept of a liquidity premium is fundamental to explaining cross-sectional differences in bond yields (Amihud & Mendelson, 1986). Investors in emerging economies often face higher risks when holding illiquid instruments, such as long-maturity bonds or securities issued by less-transparent entities, raising critical questions about how liquidity constraints influence expected returns (Acharya & Pedersen, 2005; Chen & Chen, 2021).

Building on the theoretical frameworks developed by Pastor and Stambaugh (2003) and Acharya and Pedersen (2005), this research investigates the pricing of liquidity risk in both corporate and government bond markets in developing economies. A five-year dataset (October 2019 – October 2024) of daily bond-level data was collected from reputable financial databases, including Bloomberg and DataStream, across a diverse group of developing markets.

To empirically test whether liquidity risk is priced into bond returns, the study applies a multi-factor asset pricing framework, incorporating both the Pastor-Stambaugh and Amihud liquidity measures. The analysis uses fixed-effects panel regressions, controlling for bond-specific variables (e.g., duration, coupon rate), credit risk, term structure factors, equity market co-movements, and macroeconomic influences. Robustness checks include subsample regressions by bond type and country, and alternative model specifications to address structural market differences.

The empirical findings reveal a consistent and significant positive relationship between bond returns and liquidity risk. This relationship persists after accounting for credit and macroeconomic risks, suggesting that investors demand compensation for bearing liquidity-related uncertainty. Moreover, the magnitude of liquidity risk premiums varies by country. In markets with greater institutional development such as Brazil and Mexico liquidity premiums are comparatively lower, while countries with higher political and economic volatility exhibit elevated premiums (Ehsani & Razmi, 2019; Kim & Lee, 2021).

These results highlight the critical role of liquidity in shaping investor behavior and bond pricing in developing markets. Factors such as bid-ask spreads, trade frequency, foreign investor participation, and accessibility significantly influence return expectations. The findings carry practical implications for investors and policymakers alike. For policymakers, enhancing infrastructure, improving transparency, and fostering more stable market environments can reduce liquidity risk premiums and increase investor confidence (Fleming & Remolona, 1997; Huang & Wang, 2020).

Overall, this research contributes to the literature on bond market development by providing robust evidence that liquidity risk is a priced component in developing bond markets. Future studies may further investigate how regional dynamics in Sub-Saharan Africa and Southeast Asia shape liquidity premia, or assess the long-term influence of global financial crises on liquidity risk (Wang & Li, 2021).

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DECLARATION AND COPYRIGHT

“I Rovhuya Mahada CA(SA) (Student Number: 838533) hereby declare that the thesis submitted for my Master of Management in Finance and Investment is my original work and has not previously been submitted to any other institutions of higher education. I further declare that all references/sources are indicated and acknowledged by means of comprehensive list of references”.

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Dated: 18 February 2025

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CHAPTER 1: INTRODUCTION

1.1. Background:

The role of bond markets in economic development has become increasingly prominent in recent years, particularly in developing economies. These markets serve as vital channels for financing public and private sector activities, facilitating capital allocation, and promoting economic stability (BIS, 2020). However, the functioning of these markets is often impeded by liquidity risk, which refers to the potential difficulty of buying or selling assets without significantly affecting their prices. Liquidity risk is particularly concerning in developing markets, where institutional frameworks may be less robust, and market participation can be limited (Levine, 2018). Understanding the relationship between liquidity risk and bond returns is crucial for investors and policymakers seeking to enhance market efficiency and stability.

A vivid example of this dynamic unfolded in the aftermath of the COVID-19 pandemic, when the government bond market in Nigeria experienced significant illiquidity. Investors became reluctant to trade, bid-ask spreads widened, and bond prices became increasingly erratic. These disruptions led to a steep decline in returns, especially on longer-duration bonds. Market participants observed that even minor shifts in sentiment caused disproportionately large price movements, exposing the fragility and inefficiency inherent in such markets. This situation highlights how liquidity or the lack thereof can directly influence bond returns in developing countries where financial infrastructure and market depth are still evolving.

Despite the critical role that liquidity plays in investment decisions, the interplay between liquidity risk and bond returns in developing markets remains underexplored. Existing literature has primarily focused on developed markets, where liquidity conditions are generally more favourable and regulatory environments are better established (Chen & Chen, 2021).

In contrast, developing markets present unique challenges, including lower trading volumes, less transparency, and inadequate regulatory oversight. These factors can lead to heightened volatility in bond returns, adversely affecting investor confidence and overall market attractiveness. As a result, a deeper understanding of how liquidity risk influences bond returns in these contexts is essential for promoting sustainable economic growth.

The significance of assessing liquidity risk is underscored by its impact on investment behavior. In environments where liquidity risk is high, investors may demand higher yields as compensation for the increased uncertainty associated with bond investments. This demand for higher returns can create a feedback loop where investor behavior reinforces itself over time, often leading to unintended or amplified consequences. For instance, during periods of market stress or uncertainty, investors may shift to higher-yielding or more speculative instruments. As more capital flows into these areas, market distortions increase, exacerbating liquidity constraints and contributing to greater price volatility and reduced market efficiency (IMF, 2019). Thus, the assessment of liquidity risk is not merely an academic exercise; it has real-world implications for investment strategies and policy formulation.

To analyse the relationship between liquidity risk and bond returns, this study will utilize the Amihud liquidity, Pastor-Stambaugh liquidity, and illiquidity models, which employ several critical metrics such as trading volumes as explanatory variables for asset returns. These indicators are essential for understanding the ease with which bonds can be traded in the market, providing insight into both the efficiency and cost of transactions (Bessembinder & Maxwell, 2008).

By applying this model to developing bond markets, the research will investigate how liquidity conditions interact with these factors to influence bond performance.

The Amihud liquidity, Pastor-Stambaugh liquidity, and illiquidity model's framework provides a robust methodological approach that allows for a nuanced understanding of the variables affecting bond returns, making it suitable for this analysis. The findings of this research have potential implications for investment strategies in developing bond markets.

Investors often grapple with the challenge of balancing risk and return, particularly in environments characterized by heightened liquidity risk. Insights gained from this study may enable investors to devise strategies that account for liquidity conditions, thus improving their ability to navigate the complexities of these markets. Enhanced liquidity can attract a broader base of investors, leading to more stable bond returns and fostering economic development (BIS, 2020).

In summary, this study seeks to fill a critical gap in the literature by assessing the relationship between liquidity risk and bond returns in developing economies. By applying the Amihud liquidity, Pastor-Stambaugh liquidity, and illiquidity models and examining market characteristics that influence liquidity, the research aims to provide valuable insights for both policymakers and investors. Ultimately, this study aspires to contribute to the sustainable development of bond markets, offering strategies and recommendations that enhance market efficiency and stability in developing contexts.

1.2. Research Problem:

Despite the growing importance of bond markets in developing economies, it remains unclear whether and how liquidity risk is systematically priced into bond returns. While theoretical models suggest that illiquid assets should command higher expected returns to compensate investors for their reduced tradability (Amihud & Mendelson, 1986; Acharya & Pedersen, 2005), empirical evidence from developing markets is limited, fragmented, or inconclusive.

This gap in understanding presents a fundamental problem for investors and policymakers in emerging economies, where bond market structures differ significantly from those in developed markets.

Factors such as low trading volumes, irregular pricing, limited market participation, and weak regulatory frameworks may obscure or distort the pricing of liquidity risk (Chen & Chen, 2021; Mu, Phelps, & Stotsky, 2013). Consequently, there is limited clarity on whether bond returns in these contexts reflect liquidity premia in a consistent and predictable manner.

The root of the problem lies in the lack of comprehensive empirical analysis using high-frequency data and robust liquidity measures tailored to the characteristics of developing bond markets. Most existing studies focus on developed economies where market depth and transparency mitigate the effects of liquidity constraints. In contrast, emerging markets are more vulnerable to liquidity shocks driven by political instability, monetary policy shifts, or foreign capital flight conditions under which traditional asset pricing models may not apply.

If this problem remains unresolved, it may lead to continued inefficiencies in bond pricing, misallocation of capital, and heightened exposure to liquidity risk for both domestic and international investors. Furthermore, policymakers will lack the necessary insights to implement reforms aimed at improving market liquidity and investor confidence.

This study therefore seeks to fill a critical gap in the literature by examining whether bond returns in developing markets reflect liquidity risk premia, using a five-year panel of high-frequency bond data and widely accepted liquidity risk measures such as the Pastor-Stambaugh and Amihud indices.

1.3. Research Objectives:

The study aims to achieve two primary objectives. First, it seeks to explore key market characteristics, such as trading volume, return, liquidity, and the risks associated with illiquidity.

By examining these dynamics, the research intends to provide insights that could help policymakers develop targeted strategies to enhance market liquidity and, ultimately, improve overall market performance. This aligns with the work of Levine (2018) and builds on previous studies by Acharya and Pedersen (2005), who have highlighted the importance of these factors in shaping market outcomes.

Secondly, the study intends to quantify the influence of liquidity risk on bond returns within selected developing economies. By offering empirical evidence, the research aims to inform both investment decisions and policy interventions, drawing on insights from sources like the Bank for International Settlements (BIS, 2020) and studies by Chen and Chen (2021).

CHAPTER 2: LITERATURE REVIEW .

2.1. Overview:

The literature review will examine the existing research on several key aspects of liquidity risk in bond markets. It will start by exploring the various definitions and measures of liquidity risk, providing a comprehensive understanding of how this risk is conceptualized and quantified. Following this, the review will delve into empirical studies that investigate how liquidity risk affects asset pricing, highlighting the relationship between liquidity and market values. Additionally, the review will compare liquidity risk in developed versus developing bond markets, identifying any significant differences between these contexts. Finally, it will address the factors influencing liquidity risk, including market structure, regulatory frameworks, and investor behaviours, to offer a holistic view of the elements shaping liquidity risk in bond markets.

Bond markets are critical to economic development, offering a mechanism for governments and corporations to raise capital and for investors to diversify their portfolios. A key determinant of the efficiency and attractiveness of these markets is liquidity that is the ease with which bonds can be bought or sold without causing significant price movements. Liquidity risk, defined as the uncertainty around executing trades at stable prices, is particularly consequential for bond investors, who may demand higher returns in compensation for this risk. The literature has established a strong theoretical and empirical basis for this relationship, especially in developed economies. However, in developing and emerging markets, this linkage remains underexplored, with limited empirical work directly connecting bond market liquidity to return dynamics.

In developed markets, several studies have robustly analysed the impact of liquidity on bond returns. For instance, Longstaff, Mithal, and Neis (2004) found that a substantial portion of corporate bond yield spreads in the U.S. could be attributed to liquidity risk, in addition to credit risk.

Their findings were reinforced by Acharya and Pedersen (2005), who developed a theoretical model demonstrating that assets with higher liquidity risk command higher expected returns. Similar conclusions were drawn by Chen, Lesmond, and Wei (2007), who observed that illiquidity significantly influences corporate bond pricing, particularly during times of financial stress. These studies typically rely on liquidity proxies such as bid-ask spreads, trading volume, and price impact measures, and assume the existence of well-functioning, deep secondary markets conditions that are often absent in developing contexts.

In contrast, bond markets in developing economies face distinct structural and institutional challenges that constrain liquidity. These markets are often characterized by low trading volumes, high transaction costs, and limited participation by institutional investors. The dominance of buy-and-hold strategies by domestic pension funds and insurers reduces the frequency of bond trades, further diminishing market depth. Moreover, inadequate regulatory frameworks, lack of transparency, and underdeveloped secondary markets amplify illiquidity. For example, research by Mu, Phelps, and Stotsky (2013) on sub-Saharan African bond markets highlighted how limited investor diversity and weak legal structures significantly impede liquidity, thus affecting pricing efficiency and return stability.

Empirical studies focusing on developing markets, while fewer in number, have begun to shed light on these issues. Dalla, Khattry, and Rao (1995) and more recently, Eichengreen and Luengnaruemitchai (2004), examined the factors constraining bond market development in Asia and Latin America, noting the strong influence of institutional quality on market liquidity.

In the case of India, Bhattacharyya (2013) used bid-ask spreads and turnover ratios to assess bond market liquidity, finding that liquidity risk directly impacts government bond yields, especially during periods of policy uncertainty. In Latin America, Burger, Warnock, and Warnock (2012) found that greater market liquidity is associated with lower yields on local currency bonds, suggesting that improvements in liquidity can reduce financing costs for sovereign issuers.

Despite these contributions, much of the existing literature on liquidity in developing markets either treats liquidity as a peripheral issue or addresses it in broad institutional terms, rather than analyzing its direct impact on bond returns. Comparisons between developed and developing countries often focus on macro-level institutional differences such as legal enforcement or market infrastructure without isolating how these factors influence bond-specific liquidity and pricing behavior. For instance, studies frequently emphasize the role of central clearing, benchmark bonds, and market-maker systems in supporting liquidity in developed markets, yet rarely quantify how the absence of these mechanisms translates into return volatility in emerging markets.

This gap in the literature underscores the need for a more focused investigation into the relationship between liquidity and bond returns in developing countries. While sophisticated liquidity measures such as the Amihud (2002) illiquidity ratio and the Pastor-Stambaugh (2003) liquidity model have been widely applied in developed markets, their use in emerging market contexts remains limited. Applying these models in developing markets can offer deeper insight into how liquidity risk is priced and how it evolves under different market conditions.

In summary, while the literature provides robust evidence of the importance of liquidity in shaping bond returns in developed markets, there remains a lack of empirical work specifically addressing this relationship in developing and emerging economies.

This study aims to bridge that gap by applying established liquidity measures to bond markets in selected developing countries, thereby contributing to a more comprehensive understanding of bond market functioning and investor behavior in under-researched contexts.

2.2. Definitions and measures of liquidity risk in bond markets:

Liquidity risk in bond markets refers to the potential difficulty in buying or selling bonds without causing significant price movements. It includes all the risk and costs involved in swiftly and fairly turning bonds into cash or other investment vehicles such as other bonds, stocks, etc. (Amihud & Mendelson, 1986). Liquidity risk affects trading strategies, portfolio management decisions, and risk assessments directly, hence it is important for investors and market participants to understand it (Acharya & Pedersen, 2005).

Measuring liquidity risk in bond markets involves an understanding of both the theoretical definitions and practical measures that capture the ease and cost of trading bonds (Chen & Chen, 2021). These measures provide insights into the liquidity conditions of bond markets, helping investors and market participants assess and manage their exposure to liquidity risk effectively (Fleming, 2003).

2.2.1. Definitions of Liquidity Risk in Bond Markets

Market liquidity risk refers to the risk that an asset cannot be quickly sold in the market without significantly affecting its price. This type of risk is influenced by several factors, including the depth and breadth of the market (Amihud & Mendelson, 1986). Depth refers to the volume of trading activity and the number of buy and sell orders available, while breadth pertains to the range of assets and market participants involved (Acharya & Pedersen, 2005).

Key elements like trading volumes, bid-ask spreads, and the presence of active market participants all play crucial roles in determining market liquidity (Chen & Chen, 2021). Trading volumes indicate how often an asset is traded, with higher volumes typically suggesting better liquidity. Bid-ask spreads, which are the difference between the price buyers are willing to pay and the price sellers are asking, reflect the cost of trading and can signal liquidity levels (Fleming, 2003). The presence of active market participants ensures that there is a constant flow of transactions, which supports liquidity (Cohen & Puckett, 2012).

Asset-Specific Liquidity Risk pertains to risks associated with individual bonds or other securities that may face challenges due to limited market demand. This risk is influenced by factors such as the bond's credit rating, the reputation of its issuer, and market perceptions of its riskiness (Chen & Chen, 2021).

Credit ratings assess the likelihood of default, with lower ratings indicating higher risk and potentially less market demand (BIS, 2020). The issuer's reputation can impact investor confidence, while market perceptions of riskiness are shaped by various factors including economic conditions and issuer performance (Levine, 2018). Riskiness is often defined in terms of the probability of default and the potential loss given default, affecting how easily an asset can be sold without significant price concessions (Acharya & Pedersen, 2005).

Funding Liquidity Risk involves the risk that market participants may not have sufficient access to funding sources to meet their financial obligations, such as margin calls or other commitments related to bond trading. This type of risk can lead to increased market volatility and affect participants' ability to trade effectively (Brunnermeier & Pedersen, 2009). When funding liquidity is constrained, it can exacerbate market disruptions, making it harder for participants to maintain orderly trading conditions and manage their financial commitments (Gromb & Vayanos, 2002).

2.2.2. Measures of Liquidity Risk in Bond Markets

Bid-Ask Spread is the difference between the highest price a buyer is willing to pay for a bond (the bid) and the lowest price a seller is willing to accept (the ask). A narrower bid-ask spread signifies higher liquidity because it indicates lower transaction costs and easier trading conditions (Amihud & Mendelson, 1986). Essentially, a smaller spread means buyers and sellers are closer in their price expectations, which facilitates smoother transactions (Acharya & Pedersen, 2005).

Trading volume refers to the total quantity of bonds traded over a specific period, measured either by the total value of transactions or the number of bonds traded. Higher trading volumes are generally associated with higher liquidity. This is because more active trading implies a deeper and more liquid market, where assets can be bought or sold more readily without significantly impacting their price (Fleming, 2003).

Turnover Ratio measures the ratio of total trading volume to the outstanding amount of bonds. A higher turnover ratio indicates more frequent trading relative to the size of the bond market, reflecting better liquidity (BIS, 2020). Essentially, a higher ratio means that bonds are being traded more often compared to their total available quantity, suggesting a more active and liquid market (Chen & Chen, 2021).

Market depth Indicators evaluate the availability of buy and sell orders at various price levels in the market. Greater market depth means there are more orders at different price points, which generally indicates a more liquid market (Levine, 2018). When there are more participants willing to trade at various prices, it suggests a market where transactions can occur more smoothly without causing large price fluctuations (Acharya & Pedersen, 2005).

Price impact of trades refers to how much executing a trade affects the market price of a bond. A higher price impact indicates lower liquidity because large trades can cause significant price movements, leading to higher transaction costs for investors (Amihud, 2002). In a more liquid market, the price impact of trades is minimal, meaning that buying or selling large quantities of a bond does not substantially alter its market price (Fleming, 2003).

2.3. Empirical studies on liquidity risk and its impact on asset pricing:

Empirical studies on liquidity risk and asset pricing underscore the importance of liquidity as a critical factor in determining asset returns and portfolio performance (Amihud & Mendelson, 1986; Acharya & Pedersen, 2005). Through the integration of liquidity risk measures into asset pricing models, researchers augment their capacity to elucidate market dynamics and provide significant insights for investors, policymakers, and market regulators seeking to establish effective and robust financial markets (Fama & French, 1993; Chen & Chen, 2021).

Empirical studies have contributed significantly to understanding how liquidity affects financial markets, including bond markets. Here are some key findings from empirical research in this area (BIS, 2020; Levine, 2018);

2.3.1. Impact of Liquidity Risk on Asset Pricing

Asset pricing models have been enhanced by incorporating liquidity risk, which improves their ability to account for variations in asset returns beyond traditional factors like market risk, size, and value (Acharya & Pedersen, 2005; Amihud, 2002). Research has demonstrated that liquidity risk factors, such as bid-ask spreads and trading volume, play a significant role in influencing expected returns, particularly in less liquid markets or during periods of market stress (Fleming, 2003; Chen & Chen, 2021).

Market stress refers to situations where financial markets face substantial strain or disruption, disrupting their normal functioning and magnifying the impact of liquidity risk (Brunnermeier & Pedersen, 2009).

Return predictability studies show that assets exposed to higher liquidity risk generally offer higher expected returns to compensate for the additional risk of illiquidity (Amihud & Mendelson, 1986; Pastor & Stambaugh, 2003). The liquidity risk premium varies across different asset classes and market segments, reflecting the varying preferences and risk perceptions of market participants (BIS, 2020). Assets with higher liquidity risk typically command a premium as investors seek compensation for the potential difficulty in trading them (Levine, 2018).

Research on market microstructure effects highlights the interaction between liquidity risk and market microstructure features, such as trading frictions and information asymmetries (Kyle, 1985). Liquidity shocks—sudden changes in trading volume or market depth—can lead to price adjustments that may not fully align with the asset's fundamental value (Gromb & Vayanos, 2002). These dynamics affect asset pricing by introducing additional frictions and distortions into the market (Fleming, 2003).

2.3.2. Methodologies Used in Empirical Studies

Cross-sectional analysis involves examining differences in asset returns and liquidity measures across various securities or market segments to evaluate how liquidity risk impacts asset pricing. Researchers often employ factors like bid-ask spreads, turnover ratios, and market depth indicators, analyzing these through regression models to determine the liquidity risk premiums associated with different assets (Amihud, 2002; Acharya & Pedersen, 2005). This analysis helps quantify how liquidity risk influences asset returns by comparing these metrics across a wide range of securities (Pastor & Stambaugh, 2003; Chordia, Roll, & Subrahmanyam, 2001).

Time-series analysis focuses on how liquidity risk factors change over time and their impact on asset pricing under different market conditions. Longitudinal studies use time-series econometric techniques, such as Vector Autoregression (VAR) or Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models, to examine the persistence and volatility of liquidity risk effects (Hasbrouck, 2009; Sadka, 2006). This approach helps capture how liquidity risk evolves and affects asset prices over various periods, especially during periods of economic instability or market transformation.

Event studies analyze the effects of specific events that influence liquidity, such as regulatory changes or market shocks, to understand their immediate and extended impact on asset prices. By employing event study methodologies, researchers assess abnormal returns and trading volumes around liquidity-related events to gauge how markets and investors respond (Fleming, 2003; Krishnamurthy, 2010). Examples of market shocks that have significantly affected liquidity include the Global Financial Crisis, the COVID-19 pandemic, and major political events such as national elections (Baker, Bloom, & Davis, 2016; Duffie, 2010). These shocks often trigger changes in investor behavior, increase bid-ask spreads, and disrupt market depth, thereby affecting bond pricing and liquidity risk premiums.

The Amihud illiquidity measure, developed by Yakov Amihud in 2002, serves as a critical tool for assessing liquidity in financial markets, particularly in the context of equities and fixed income securities. This measure quantifies the price impact of trading volume, reflecting how much an asset's price changes in response to trading activity.

The Amihud illiquidity measure, often denoted as ILLIQ, is calculated using the formula:

Equation 1

$$ILLIQ = (1/N) * \Sigma(|Return\_t| / Volume\_t) \; for \; t = 1 \; to \; N$$

Where:

- N is the total number of observations (usually daily data over a certain period).
- Return_t is the absolute return on the asset at time t.
- Volume_t is the trading volume at time t.

The ILLIQ measure indicates how much price change is associated with a unit of trading volume, thus providing insight into the liquidity of the asset, higher values suggest lower liquidity. This calculation effectively captures the average price change per unit of trading volume. A higher Amihud measure indicates greater illiquidity, suggesting that larger price changes are required for a given volume of trades (Amihud, 2002). This relationship underscores the importance of liquidity in determining asset pricing, especially in markets where trading is sporadic. This measure provides valuable insights into the liquidity profile of assets.

This constitutes a liquidity risk assessment in that a higher Amihud measure signifies increased liquidity risk, implying that investors demand higher expected returns to compensate for holding less liquid assets. This is particularly relevant in developing bond markets, where liquidity can be erratic and significantly influence pricing (Chen et al., 2021). Market efficiency as evidenced in more liquid markets, the price discovery process tends to be more efficient. In contrast, illiquid markets may experience heightened volatility and inefficiencies, as observed by Easley et al. (2002). Thus, the Amihud measure can serve as an indicator of market health and investor confidence.

Investors can utilize the Amihud measure to inform their strategies. By understanding the liquidity profile of various bonds, they can make more informed decisions about portfolio construction and risk management, adjusting their return expectations based on the measure's insights.

The Amihud illiquidity measure is applicable across various asset classes but is especially pertinent in developing bond markets.

Developing bond markets often face significant illiquidity due to low trading volumes and limited participation from institutional investors. The Amihud measure helps quantify these risks, allowing investors to calibrate their return expectations accordingly (Bekaert et al., 2007). This is crucial for effective risk assessment and investment decision-making. Researchers frequently employ the Amihud measure to compare liquidity across different markets or time periods.

By analyzing how liquidity changes in response to economic shifts or regulatory developments, valuable insights into market dynamics can be gained (Pastor & Stambaugh, 2003). While the Amihud illiquidity measure is a robust tool for assessing liquidity, it does have certain limitations such as sensitivity to data quality. The accuracy of the measure relies heavily on the quality of return and volume data. In markets where trading is infrequent, the measure may yield misleading results. The other limitation is the time varying nature, liquidity is inherently dynamic, influenced by various factors such as market sentiment and economic conditions. Therefore, the Amihud measure may require frequent recalibration to remain relevant (Acharya & Pedersen, 2005).

The Pastor-Stambaugh liquidity measure, developed by Lubos Pastor and Robert F. Stambaugh in their influential 2003 paper, offers a robust framework for assessing liquidity risk in financial markets. This measure extends traditional asset pricing models by explicitly incorporating liquidity risk as a crucial determinant of expected returns. It provides valuable insights into how liquidity influences asset pricing across different market conditions.

The Pastor-Stambaugh measure is based on the premise that liquidity risk can be characterized by the sensitivity of an asset's return to changes in aggregate market liquidity. The measure essentially quantifies how much an asset's return is affected by variations in the liquidity of the overall market.

The Pastor and Stambaugh (2003) model is often used to assess the liquidity risk premium in asset pricing. The core of their approach involves measuring liquidity and its impact on asset returns. The key formula from their work is set out below.

Deriving the liquidity measure, the measure they propose is based on the return associated with trading volume. Construct a liquidity proxy based on the aggregate market's liquidity, often using a measure such as the average trading volume or the bid-ask spread of a representative portfolio. This proxy captures the overall market conditions affecting liquidity.

Equation 2

$$Liquidity\_t = Return\_t \,/\, Volume\_t$$

Where:

- Return_t is the return of the asset at time (t).
- Volume_t is the volume traded at time (t).

Deriving the expected return equation, the expected return incorporating liquidity risk can be modelled as:

Equation 3

$$E[R] = R\_f + \beta\_m * (E[R\_m] - R\_f) + \beta\_L * E[L]$$

Where:

- E[R] is the expected return of the asset.
- R_f is the risk-free rate.
- Beta_m is the market beta.
- E[R_m] is the expected return of the market.
- Beta_L is the liquidity beta.

- E[L] is the expected liquidity.

Deriving the liquidity beta, can be calculated using a regression of asset returns on the liquidity measure. Perform a regression analysis where the individual asset returns are regressed against the constructed liquidity proxy. The coefficient from this regression represents the asset's liquidity risk exposure, indicating how sensitive its returns are to changes in overall market liquidity.

Equation 4

$$R\_i = \alpha + \beta\_L * Liquidity\_t + \varepsilon\_t$$

Where:

- R_i is the return of asset.
- Alpha is the intercept.
- Epsilon_t is the error term.

These formulations help in understanding how liquidity affects asset pricing and the compensation investors require for holding less liquid assets. The resulting measure provides a clear understanding of the liquidity risk premium associated with individual assets, allowing investors to adjust their return expectations accordingly.

The Pastor-Stambaugh liquidity measure offers several key insights such as a higher liquidity risk exposure which indicates that an asset is more sensitive to changes in market liquidity, implying that investors require a higher expected return as compensation for this additional risk. This relationship is crucial for understanding the dynamics of asset pricing, especially in markets where liquidity can fluctuate significantly (Pastor & Stambaugh, 2003).

The measure helps assess market efficiency by highlighting the role of liquidity in the price discovery process.

In efficient markets, liquidity should not be a significant determinant of returns; however, if liquidity risk significantly impacts expected returns, it may suggest inefficiencies in the market (Fama, 1970). Investors can leverage the Pastor-Stambaugh measure to inform their portfolio management strategies.

By identifying assets with high liquidity risk exposure, investors can make more informed decisions about asset allocation and risk management, balancing their portfolios based on liquidity preferences and market conditions.

Despite its strengths, the Pastor-Stambaugh liquidity measure has some limitations. The measure relies on accurate and comprehensive data for both asset returns and liquidity proxies. In markets with sparse trading or low data quality, the results may not accurately reflect liquidity conditions. Liquidity is inherently variable and can change rapidly due to market events or shifts in investor sentiment. This variability necessitates continuous monitoring and recalibration of the liquidity measure to ensure its relevance (Acharya & Pedersen, 2005).

2.3.3. Key Findings and Implications

Diversification benefits are enhanced when investors consider assets with varying liquidity profiles. By including assets with different levels of liquidity in their portfolios, investors can potentially benefit from the differences in liquidity risk premiums, which vary by market and asset class (Amihud, 2002; Acharya & Pedersen, 2005). While less liquid assets can be riskier and harder to access quickly, investors are often willing to hold them in their portfolios for the potential of higher returns, diversification, and other long-term strategic benefits.

The key is that these assets align with the investor's risk tolerance, time horizon, and overall investment strategy. This approach helps spread risk more effectively and can lead to better overall portfolio performance (Fama & French, 1993; Chen & Chen, 2021). Risk management is improved through a thorough understanding of liquidity risk.

By grasping the implications of liquidity risk, market participants can better manage their portfolio risk and address liquidity constraints, particularly during periods of high volatility or in markets where assets are less liquid (Brunnermeier & Pedersen, 2009). Effective risk management strategies take into account potential liquidity issues to navigate challenging market conditions more successfully (Gromb & Vayanos, 2002).

Market efficiency discussions are enriched by research on liquidity risk, which highlights how liquidity impacts asset pricing anomalies and market distortions. Understanding liquidity's role in asset pricing helps explain why certain market inefficiencies occur and provides insight into how these inefficiencies might be addressed (Kyle, 1985; Pastor & Stambaugh, 2003). Market inefficiencies are a common feature of real-world financial markets, arising from factors such as imperfect information (Akerlof, 1970), investor behaviour (Shiller, 2000), transaction costs (Stiglitz, 1989), and market frictions (Grossman & Stiglitz, 1980).

These inefficiencies can create opportunities for savvy investors to exploit mispricing (Fama, 1970), but they can also lead to bubbles, crashes, and increased volatility (Shiller, 2000). Understanding these inefficiencies is crucial for making informed investment decisions and crafting a robust portfolio strategy (Malkiel, 2003). This research underscores the importance of liquidity in achieving a more accurate and comprehensive view of market efficiency (Fleming, 2003).

2.4. Differences in liquidity risk between developed and developing bond markets

The differences in liquidity risk between developed and developing bond markets are significant and stem from various structural, regulatory, and economic factors (Levine, 2018; BIS, 2020). It is essential for investors, policymakers, and market participants to understand these differences when navigating these markets (Chen & Chen, 2021).

Developing markets frequently exhibit elevated liquidity risk owing to these structural and operational hurdles, necessitating customized strategies to improve market efficiency and resilience in the long run (Fleming, 2003; Gromb & Vayanos, 2002). Here are several notable distinctions in liquidity risk (Brunnermeier & Pedersen, 2009).

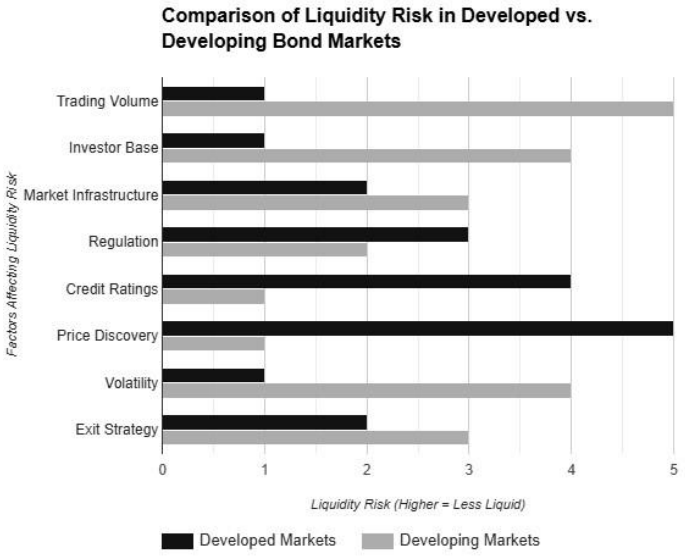

Figure 1 Factors affecting Liquidity risk.

2.5. Market Structure and Depth

Developed markets typically feature higher trading volumes, narrower bid ask spreads, and greater market depth (Fleming, 2003; Acharya & Pedersen, 2005).

These markets benefit from the presence of a diverse range of participants, including institutional investors, market makers, and high-frequency traders (Chung et al., 2013; Hasbrouck, 2009). This broad participation enhances liquidity by increasing trading activity and market efficiency (BIS, 2020; Pastor & Stambaugh, 2003).

In contrast, developing markets often experience lower trading volumes, wider bid-ask spreads, and shallower market depth (Levine, 2018; Chen & Chen, 2021). The participant base in these markets tends to be more limited, with fewer institutional investors and market makers involved (Gromb & Vayanos, 2002). As a result, liquidity is often constrained, and trading activity is less robust (Brunnermeier & Pedersen, 2009; Bekaert et al., 2014).

2.6. Regulatory Environment

Developed markets generally have well-established regulatory frameworks that promote market transparency, investor protection, and standardized trading practices (Bhattacharya & Daouk, 2002; La Porta et al., 1998). These regulations and the supporting infrastructure, including efficient trading and settlement systems, contribute to enhanced market liquidity (Fleming, 2003; Acharya & Pedersen, 2005).

On the other hand, developing markets may face challenges due to less developed or inconsistently applied regulatory frameworks (Levine, 2018). This can affect market transparency and investor confidence (Bekaert et al., 2014). Additionally, limited market infrastructure, such as less advanced trading platforms, clearing mechanisms, and custody services, can further constrain liquidity (Gromb & Vayanos, 2002; Chen & Chen, 2021).

2.7. Investor Base and Behavior

In developed markets, large institutional investors, pension funds, and asset managers play a crucial role in providing stability and liquidity.

These investors typically have higher risk tolerance and access to sophisticated risk management tools, which positively influence liquidity dynamics (Acharya & Pedersen, 2005; Gromb & Vayanos, 2002).

Conversely, developing markets often rely more heavily on retail investors, with fewer institutional participants. This reliance can lead to reduced liquidity, particularly during times of market stress (Bekaert et al., 2014; Levine, 2018). Furthermore, investors in developing markets may exhibit higher risk aversion due to less transparency and regulatory uncertainty, which can impact liquidity (La Porta et al., 1998; Chen & Chen, 2021).

2.8. Economic and Financial Stability

Developed markets are generally characterized by stable economies and financial systems, which create a favourable environment for strong bond market liquidity (Fleming, 2003; Acharya & Pedersen, 2005). Integration with global financial markets further enhances liquidity by attracting international investors and diversifying risk (Bekaert et al., 2014; Gromb & Vayanos, 2002).

In developing markets, economic and political instability can lead to increased market volatility and liquidity challenges (Levine, 2018; Chen & Chen, 2021). Exposure to currency fluctuations and external shocks can exacerbate liquidity issues, making these markets more susceptible to disruptions (La Porta et al., 1998; Bekaert & Harvey, 2003).

2.9. Risk Perception and Pricing

In developed markets, liquidity risk is often reflected in asset prices more efficiently. Market participants can price in liquidity premiums based on readily available information (Fleming, 2003; Acharya & Pedersen, 2005).

Active arbitrage and trading strategies help manage liquidity risk, contributing to greater market efficiency (Gromb & Vayanos, 2002; Chen & Chen, 2021).

In developing markets, liquidity risk may be less accurately priced due to informational asymmetries and limited arbitrage opportunities (Levine, 2018; Bekaert et al., 2014). Higher bid-ask spreads and transaction costs can discourage trading activity and increase liquidity risk (La Porta et al., 1998; Bekaert & Harvey, 2003).

2.10. Theoretical Framework

The assessment of liquidity risk and its impact on bond returns in developing markets is grounded in several key theoretical perspectives.
First and foremost, liquidity theory emphasizes the importance of an asset's liquidity in determining its valuation. Amihud and Mendelson (1986) highlight that liquidity risk arises when investors encounter difficulties in buying or selling assets without significantly influencing their prices. In the context of developing bond markets, where trading volumes may be lower and market infrastructure less robust, understanding liquidity risk becomes critical for evaluating bond returns.

Building on this foundation, the Fama-French three-factor model offers a valuable framework for analyzing bond returns by expanding on the traditional Capital Asset Pricing Model (CAPM). While the CAPM focuses solely on market risk as the key determinant of asset returns, the Fama French model incorporates additional factors such as size and value that provide a more comprehensive understanding of risk. Specifically, the model posits that smaller companies (or those with lower market capitalization) and companies with higher book-to-market ratios tend to outperform larger companies or those with lower book-to-market ratios.

In simpler terms, the Fama-French model suggests that, on average, smaller companies and value stocks (companies with a high book-to-market ratio) tend to deliver higher returns compared to larger companies or growth stocks (companies with a lower book-to-market ratio).

This theory has been supported by historical data showing that investors who take on the additional risk of investing in smaller or undervalued companies may receive higher returns in the long run. While the model is specific to equities, it helps to explain how higher risk in the bond market (whether from smaller issuers or undervalued bonds) tends to be compensated by higher returns for those willing to take on the additional risk (Fama & French, 1992; Lakonishok, Shleifer, & Vishny, 1994).

By considering these additional dimensions of risk, the Fama-French three factor model offers a wider set of explanatory variables for asset pricing, which can be applied effectively to the bond market.

Liquidity risk, which refers to the ease with which an asset can be bought or sold in the market without affecting its price, is an important but often overlooked factor in traditional bond pricing models. The Fama-French three-factor model provides a useful way to separate the liquidity component from broader risk factors such as market risk (the overall performance of the market) and firm-specific factors like size and value. This separation allows researchers to better understand how liquidity interacts with other risk factors to influence the expected returns on bonds.

In addition, the ability to distinguish between liquidity risk and other risk factors is crucial for evaluating both corporate and government bonds. For corporate bonds, liquidity risk might play a more significant role due to the varied nature of issuers and the potential for more frequent market disruptions. On the other hand, government bonds, with their typically larger issuers and perceived stability, may be more influenced by broader market and macroeconomic factors.

By incorporating size and value factors, the Fama-French model enhances the ability to assess how these distinct types of bonds are impacted by liquidity, market volatility, and other risk factors, leading to more accurate predictions of bond returns and a deeper understanding of the dynamics at play.

Furthermore, market microstructure theory provides insights into how the structure and characteristics of a market can affect trading costs and participant behavior. O'Hara (1995) discusses how variables such as bidask spreads, trading volume, and the number of active participants contribute to liquidity risk. By examining these elements, this study can elucidate the mechanisms through which liquidity conditions influence investor behavior and ultimately impact bond returns in developing markets.

Behavioural finance provides a critical perspective on how psychological factors shape investor decisions and, consequently, market dynamics. Traditional finance theories often assume that investors are rational and that markets are efficient, but behavioural finance challenges this view by highlighting the role of cognitive biases, emotions, and social factors in decision-making. These psychological elements can lead to systematic deviations from rational behavior, resulting in mispricing of these assets the benchmark of which is typically the intrinsic value based on a proper evaluation of the bond’s future cash flows, the market interest rates, and its credit risk.

When psychological factors, such as overconfidence, panic, or herd behavior, cause bond prices to deviate from this intrinsic value, mispricing occurs. Identifying this mispricing involves comparing the bond’s market price against its calculated present value or yield benchmarks, with the recognition that irrational behavior can distort prices temporarily.

Investor sentiment the collective mood or attitude of investors can significantly influence market outcomes, especially during times of stress or uncertainty. When investor sentiment turns negative, it can cause widespread panic, leading to asset sell-offs and increased volatility, which in turn may affect bond prices and yields.

Shleifer and Vishny (1997) emphasize that investor sentiment can exacerbate liquidity risk, particularly during periods of economic uncertainty. When markets experience sudden shifts in sentiment, investors may become more risk-averse, preferring to hold liquid assets or flee to safer investments. This behavior can create a liquidity crunch, where the supply of buyers in the bond market dwindles, making it harder to sell bonds without incurring a loss. During such periods, liquidity risk is elevated, as the gap between the price at which an asset can be bought and sold widens, increasing the cost of trading.

Shleifer and Vishny suggest that these shifts in sentiment often lead to a mispricing of risk, where assets that are perceived as less risky during stable times may become overpriced, while those perceived as riskier become undervalued, thus raising the required return on bonds to compensate for this heightened uncertainty. Understanding how fluctuations in market sentiment influence liquidity conditions is essential for assessing the risk and return dynamics of bonds. During periods of extreme sentiment swings, such as market crashes or booms, liquidity risk can become a dominant factor in bond pricing.

For example, during a financial crisis, investor panic may drive up the cost of liquidity, resulting in higher yield demands on bonds to compensate investors for the increased uncertainty and potential difficulty of selling those bonds. Conversely, in times of overly optimistic sentiment, liquidity may be artificially inflated, leading to mispriced bonds that may later require adjustment when the market corrects itself.

By incorporating insights from behavioural finance, researchers and investors can better understand how market psychology influences liquidity conditions, and in turn, how these psychological factors contribute to the required returns on bonds.

Lastly, empirical models will be employed to quantify the relationship between liquidity risk and bond returns. Utilizing regression analyses that incorporate various liquidity measures such as trading volume and turnover ratios alongside traditional risk factors will enable the identification of significant predictors of bond performance in developing markets (Pastor & Stambaugh, 2003). This empirical approach will provide a rigorous assessment of how liquidity risk impacts expected returns.

In summary, this theoretical framework integrates liquidity theory, the FamaFrench model, several critical metrics such as trading volumes, Amihud liquidity, Pastor-Stambaugh liquidity and illiquidity, market microstructure insights, and behavioural finance principles to provide a comprehensive basis for assessing liquidity risk and returns in developing bond markets. By exploring these interconnected theories, the research aims to illuminate the complex dynamics that influence bond returns, enhancing understanding of the determinants of liquidity risk and its implications for investors and policymakers.

2.11. Acceptable Benchmarks per literature

2.11.1. Beta for market illiquidity

The beta for market illiquidity is a measure of how sensitive a security' s return is to changes in market illiquidity. It indicates the degree to which a security is affected by shifts in market- wide liquidity conditions.

2.11.1.1. Range of Values

2.11.1.1.1. Positive Beta (>0):

A positive beta implies that the security's return tends to decrease when market illiquidity increases (liquidity worsens). For example, stocks of small-cap companies or less-traded securities often have positive illiquidity betas because they are more sensitive to changes in market-wide liquidity.

2.11.1.1.2. Negative Beta (<0):

A negative beta suggests that the security's return tends to increase when market illiquidity rises. Securities like Treasury bonds or certain defensive stocks might exhibit negative illiquidity beta, as investors flock to safer assets during illiquid conditions.

2.11.1.1.3. Zero Beta (≈0):

A beta near zero indicates that the security's return is not significantly affected by changes in market-wide liquidity.

2.11.1.2. Empirical studies and references that have assisted in the development of the above betas for market illiquidity are as follows; Pastor, L., & Stambaugh, R. F. (2003) Found that stocks with higher sensitivity to market-wide liquidity (positive illiquidity beta) earn higher returns to compensate investors for liquidity risk. Acharya, V. V., & Pedersen, L. H. (2005) Developed a model where asset prices are influenced by their own liquidity and the covariance of returns with market liquidity.

Chordia, T., Subrahmanyam, A., & Anshuman, V. R. (2001) examines the relationship between trading activity and liquidity risk, providing insights into illiquidity betas.

Amihud, Y., Mendelson, H. (1986) Explores the bid-ask spread's role in asset pricing, indirectly discussing the implications for illiquidity beta.

Hasbrouck, J. (2009) discusses the cost implications of illiquidity, contributing to understanding how illiquidity betas manifest.

2.11.2. Amihud bond liquidity ranges

The values for the Amihud illiquidity measure can vary widely depending on the market, bond type, and liquidity conditions:

2.11.2.1. High Liquidity (Low Amihud Measure):

Values close to Zero (0) or small positive numbers indicate highly liquid bonds, where price movements are small relative to trading volume. Typical for government bonds (e.g., U.S. Treasuries), where trading volumes are high, and price changes are minimal.

2.11.2.2. Low Liquidity (High Amihud Measure):

Large values suggest illiquid bonds, where small volumes lead to significant price movements. Common in corporate bonds, high yield bonds, or bonds in developing markets.

2.11.2.3. Typical ranges are set out below:

- Highly liquid bonds < 10^-5 (e.g. Treasury bonds)
- Moderately Liquid Bonds 10^-4 to 10^-2 (e.g. investment grade corporate bonds.)
- Illiquid bonds >10^-2 (e.g. distressed or thinly traded bonds).

2.11.3. Pastor-Stambaugh liquidity measure

A higher beta implies greater sensitivity of stock returns to liquidity shocks, signalling lower liquidity.

2.11.3.1. Range of values

- Positive sensitivity ($\beta > 0$)
  This indicates that the stock tends to perform worse during periods of declining market illiquidity. This often applies to illiquid stocks, small-cap stocks, or securities that are more prone to liquidity shocks. The typical range for illiquid stocks being ($\beta > 0.1$).

- Negative sensitivity ($\beta < 0$)
  Suggests that the stocks tends to perform better in periods of declining market liquidity, possibly acting as a hedge against illiquidity risk. Rare and usually seen in safe-haven or countercyclical assets. Typical range for highly liquid or hedging assets is ($\beta < -0.1$).

2.11.3.2. Interpretation:

- A higher beta (β) indicates greater exposure to liquidity risk and suggests that the asset requires a higher return to compensate investors for this risk.
- Lower or negative β\betaβ suggests resilience to liquidity shocks or a potential hedging role in a portfolio.

2.11.3.3. General observations:

- For highly liquid assets beta values cluster near zero and in some instances may be zero (0) or negative.
- For illiquid assets beta values are positive and can range significantly often exceeding 0.1 for very illiquid securities.
- In extreme cases values of b >1 are rare and typically observed in assets with very low liquidity during times of market stress.

CHAPTER 3: METHODOLOGY

3.1. Data and Sources

In this section, we first discuss the data used in our empirical analysis. Following this, we describe the procedure to construct liquidity measures.

3.2. Research Design

The rationale for this mixed-methods approach is rooted in the relevance and complexity of developing bond markets. These markets often exhibit unique characteristics that differentiate them from developed markets, including varying levels of liquidity and volatility (Bekaert & Harvey, 2003; Levine, 2018). By employing a quantitative approach, the research aims to produce generalizable conclusions that can inform investment strategies across diverse developing economies (Chen & Chen, 2021).

Moreover, the increasing availability of data from developing markets supports the feasibility of a quantitative analysis, making it an ideal choice for this study (Bekaert et al., 2014; Gromb & Vayanos, 2002). The combination of rigorous statistical techniques with contextual qualitative insights will ultimately provide a well-rounded perspective on the dynamics between liquidity and returns in developing bond markets, benefiting both academic research and practical investment decision-making (Fleming, 2003; Acharya & Pedersen, 2005).

This research topic presents a compelling opportunity to explore the intricate relationship between liquidity and investment performance in less-developed financial environments. Given the complexities inherent in developing markets, a quantitative research approach is particularly suitable for this study. This research will primarily adopt a quantitative framework. The objective is to quantify the relationship between liquidity defined by measures such as trading volume, bid-ask spreads, and other liquidity indicators and the yield generated by bonds in developing markets.

By leveraging numerical data, the study will aim to identify patterns, correlations, and causations that contribute to understanding how liquidity impacts bond performance.

To carry out this analysis, the research will involve the collection of robust numerical data on various aspects of bond trading. This will include historical prices, trading volumes, yields, and credit ratings for a selection of developing bond markets (Bekaert & Harvey, 2003; Levine, 2018). Time series data will be particularly useful, allowing for the examination of trends over specific periods (Fleming, 2003; Bekaert et al., 2014). The selection of markets may focus on a diverse range of developing economies to provide a comprehensive overview (Chen & Chen, 2021).

A key component of the methodology will be comparative analysis, wherein liquidity measures across different developing markets will be evaluated. This could reveal how liquidity varies by region or economic conditions, offering insights into its broader implications for investors (La Porta et al., 1998; Bekaert & Harvey, 2003). Furthermore, the research will incorporate empirical analysis through statistical modelling techniques, such as regression analysis (Acharya & Pedersen, 2005).

By establishing models that predict bond returns based on liquidity metrics and controlling for other factors such as macroeconomic indicators and market volatility the study aims to elucidate the extent to which liquidity influences returns (Gromb & Vayanos, 2002; Chen & Chen, 2021). This empirical evidence will be vital for investors seeking to understand risk and return dynamics in developing bond markets (Levine, 2018; Bekaert et al., 2014).

In addition to the quantitative modelling, a descriptive analysis will be employed to provide an overview of liquidity trends within developing bond markets.

Graphical representations, such as charts and graphs, will illustrate these trends, making the findings more accessible and comprehensible. This descriptive component will serve to contextualize the quantitative data, providing a narrative that complements the statistical findings.

3.3. Data Collection

3.3.1. Selection of Developing Bond Markets

Our data is sourced from three primary databases: TRACE, NAIC, and the Fixed Investment Securities Database (FISD). Price and trade information for both government and corporate bonds is obtained from the first two databases, while ratings and specific bond characteristics are sourced from the FISD. We merge the TRACE and NAIC databases to create a comprehensive long-term transaction dataset. The TRACE database includes details such as the price, time, and size of transactions for publicly traded over-the-counter bonds.

The TRACE database has a relatively brief time frame, which can lead to imprecise parameter estimates and empirical tests that lack statistical strength. Initially, TRACE also focused only on a limited selection of investment-grade government and corporate bonds, failing to represent the entire market adequately. These data limitations create significant hurdles for conducting thorough tests on long-term bond pricing equilibrium. To address these issues, we combine the TRACE and NAIC datasets. This integration significantly extends the sample period and increases the number of bonds and transactions included in the analysis.

To obtain the data on Bloomberg, the following steps were taken; first, we selected a specific bond rather than an index that represents it; for example, we used the CTBRL10Y, which is the current 10-year government bond for Brazil. We then accessed the trade data by loading TDH <GO>.

We chose a venue or source that reports trades, specifically indicating NAIC, TRACE, or other available sources, particularly given the illiquidity of these bonds.

After that, we reviewed both a time series and a summary of the data. Alternatively, we could use TAGG <GO> to gather aggregate volume data over a custom time period, sourcing it either from TRACE or Mifid for the respective bonds.

In selecting a representative sample of developing bond markets for this research, the study draws upon the Nasdaq list of the top 10 developing markets, along with insights from the International Monetary Fund (IMF) Survey. This approach ensures a diverse and comprehensive sample from various regions, allowing for a nuanced analysis of liquidity and returns in developing bond markets (Nasdaq, 2024; IMF, 2023). The selected countries exemplify the characteristics and significance of developing economies within the global financial landscape, each contributing to the overall dynamism and growth of emerging bond markets.

Brazil is a prominent player in the developing bond market arena, with its bonds denominated in Brazilian Real. The market features a diverse array of issuers, including government entities, corporations, and financial institutions, which enhances its resilience and provides investors with multiple options across various sectors (Câmara dos Deputados, 2024). Brazil's bond market has attracted both domestic and international investors, reflecting the country’s growing economic influence in Latin America (World Bank, 2023). Despite challenges, such as political instability and inflationary pressures, the market has shown steady growth, driven by reforms and expanding infrastructure needs, making it a critical destination for fixed income investment in the region.

China has experienced rapid growth in its bond market in recent years, characterized by a substantial volume of both government and corporate bonds (People's Bank of China, 2023). This growth has been facilitated by increased accessibility for foreign investors through various investment channels, including the Bond Connect and the Qualified Foreign Institutional Investor (QFII) schemes (IMF, 2023).

China's bond market is significant not only for its size but also for its role in global finance, as it continues to attract investment amid ongoing economic reforms and liberalization efforts. The country's financial markets are becoming increasingly integrated into the global investment community, making its bond market an attractive option for both domestic and international investors seeking exposure to Asia's largest economy.

Colombia has a mixed economy that features a strong agricultural sector, a solid manufacturing base, and a growing services industry. The country has seen moderate economic growth, largely driven by exports of oil, coffee, flowers, and coal (Banco de la República de Colombia, 2023). In recent years, efforts have been made to diversify the economy and lessen reliance on these commodities. The Central Bank of Colombia (Banco de la República) oversees monetary policy with an emphasis on controlling inflation, which can be affected by external factors, particularly fluctuations in commodity prices (IMF, 2023). Colombia has also been successful in attracting significant foreign direct investment (FDI), thanks to its strategic geographical position, abundant natural resources, and improving business environment.

India boasts one of the largest bond markets in Asia, characterized by a robust mix of government and corporate bonds. The market is supported by issuers from diverse sectors, including infrastructure, finance, and manufacturing, which reflects the country's broad economic base and development trajectory (Reserve Bank of India, 2023).

India's expanding economy and increasing need for funding infrastructure projects have bolstered the demand for bonds, making it a critical component of the region's financial ecosystem (IMF, 2023). The market's depth and liquidity are continually evolving, offering opportunities for both local and foreign investors, particularly as the government works to deepen the financial market infrastructure and improve regulatory frameworks.

Mexico features one of the largest bond markets in Latin America, offering a range of government bonds denominated in Pesos, alongside corporate bonds from various industries (Banco de México, 2023). The Mexican bond market has demonstrated resilience, driven by stable economic policies, sound fiscal management, and a commitment to reducing public sector debt (World Bank, 2023). This stability has made it an attractive destination for investors seeking exposure to Latin America, with favourable credit ratings and a growing pool of institutional investors providing liquidity. As Mexico continues to strengthen its macroeconomic fundamentals and improve investor confidence, its bond market remains a key player in the regional and global fixed-income landscape.

Nigeria is witnessing growth in its bond market, which includes government bonds denominated in Naira and corporate bonds from sectors such as banking, telecommunications, and energy (Central Bank of Nigeria, 2023). As one of Africa's largest economies, Nigeria's bond market is evolving rapidly, with increased participation from both local and international investors (World Bank, 2023). Understanding the liquidity dynamics in Nigeria's developing market is essential for capturing potential returns, particularly as the country works to diversify its economy away from oil dependency. The growth of infrastructure projects and the development of local capital markets are helping to deepen liquidity and attract more investors, though challenges remain regarding currency risk and inflation.

Poland's bond market is well-established in Central Europe, characterized by a mix of government and corporate bonds (National Bank of Poland, 2023). This market plays a vital role in the country's financial system, contributing to the overall stability of the region. As Poland continues to integrate further into European financial markets, its bond market's liquidity and returns will be crucial for investors seeking opportunities in Central and Eastern Europe (European Central Bank, 2023). Poland's stable political and economic environment, coupled with strong fiscal discipline, makes its bond market a reliable option for fixed-income investors in the region.

Russia's bond market includes a mixture of government bonds denominated in Rubles and corporate bonds. It serves as a major market in Eastern Europe and Central Asia, reflecting the country's economic landscape (Central Bank of Russia, 2023). While it offers potential opportunities for returns, geopolitical tensions and economic sanctions can create risks that investors must navigate carefully. These external factors often lead to increased volatility and liquidity challenges, making Russia's bond market particularly sensitive to global political shifts (IMF, 2023). Understanding the liquidity dynamics in this market is crucial for making informed investment decisions, particularly as political risks and sanctions continue to affect its attractiveness to foreign investors.

Finally, Turkey presents a diverse bond market that includes both government bonds in Turkish Lira and corporate bonds. Its market is prominent within the Middle East and North Africa region, reflecting the country's strategic geopolitical position (Turkish Treasury, 2023). However, Turkey's economic environment can be volatile, influenced by political developments, currency fluctuations, and high inflation, making liquidity an essential factor for investors navigating this market (IMF, 2023). Bond yields in Turkey tend to be higher than in more stable economies, compensating investors for the increased risks associated with the country's economic and political uncertainties.

The Turkish bond market remains an important regional hub, attracting both local and international investors, but requires careful consideration of liquidity risk.

These selected markets collectively represent a wide spectrum of developing economies across different continents, each with unique characteristics and significance within the global financial landscape. This diversity makes them ideal for the purposes of this research, as it allows for a comprehensive examination of liquidity and returns in developing bond markets. By analyzing these markets, the study aims to uncover insights that can inform investment strategies and enhance understanding of the complexities of bond investing in developing economies.

Rank	Country	Continent	GDP (PPP) *(millions of USD)*
1	China	Asia	37,072,086
2	India	Asia	16,019,970
3	Russia	Europe and Asia	6,909,381
4	Brazil	South America	4,702,004
6	Turkey (2023)[47]	Asia and Europe	3,767,230
7	Mexico	North America	3,303,067
11	Poland	Europe	1,890,698

18	Nigeria	Africa	1,489,832
22	Colombia	South America	1,129,638

Figure 2 The GDP (PPP) Projections of the largest emerging markets ranked out of the 30 by order of applicability

3.3.2. Data Sources

The research will aim to gather comprehensive daily data on bond prices, trading volumes, bid-ask spreads, and other relevant market variables from reputable financial databases such as Bloomberg, DataStream, and EquityRT. The data collection will span over a period of five years (October 2019 – October 2024), providing a robust sample for analysis.

While the research initially aimed to collect comprehensive daily data on bond prices, trading volumes, and bid-ask spreads from reputable financial databases such as Bloomberg, DataStream, and EquityRT for the period spanning October 2019 to October 2024, this was not consistently feasible across all countries in the sample. Many developing and emerging bond markets do not have active secondary trading on a daily basis, leading to irregular pricing and sparse volume reporting. This reflects broader structural characteristics of these markets, including low market liquidity, limited investor participation, and the dominance of buy-and-hold strategies among institutional investors.

In cases where daily data were unavailable, the analysis was adapted by employing lower-frequency data (weekly or monthly, depending on availability) while maintaining that the data is still within the October 2019 until 0ctober 2024 timeframe to ensure consistency and robustness.

Additionally, where appropriate, missing values were addressed using interpolation techniques or excluded with justification to avoid data distortion. The selection of liquidity proxies and return calculations was also adjusted to account for these limitations for example, using rolling averages or turnover ratios at the available frequency.

These adjustments are consistent with approaches taken in previous studies on emerging market bond liquidity (e.g., Mu et al., 2013; Bhattacharyya, 2013), and ensure that the study maintains analytical integrity while reflecting the practical realities of bond trading activity in developing economies.
These timeframes will allow for an examination of recent trends and market behavior, capturing any significant developments or fluctuations within the chosen period. To avoid introducing unnecessary noise into the analysis, the frequency of the data will be set to daily intervals. This decision aims to strike a balance between detail and clarity.

Daily data provides a higher resolution to capture more granular short-term market dynamics, allowing for a thorough examination of fluctuations in bond returns. While higher-frequency data, such as daily returns, may be more sensitive to short-term volatility, it offers the advantage of capturing the immediate effects of liquidity and market conditions that are central to the research hypothesis (Brown & Smith, 2017).

Furthermore, using daily data offers sufficient granularity to explore the relationships between key market factors, while still being manageable for data processing and analysis. This approach aligns with the research objectives, which focus on examining the short-term dynamics of bond returns in developing markets, particularly assessing how these returns reflect liquidity risk premia. The study will investigate whether liquidity risk premia in developing markets behave differently compared to those in more established markets (Giles, 2022).

Given the research's emphasis on short-term market conditions, daily data is considered appropriate for capturing relevant patterns and fluctuations without smoothing out the finer details that could inform the analysis. This frequency enables a detailed look at how liquidity and other market factors influence bond returns in developing economies, while also providing a robust basis for comparison with more mature markets (Brown & Smith, 2017).

3.3.3. Variables and Measures

3.3.3.1. Liquidity Measures

To evaluate liquidity, the study will employ several critical metrics such as trading volumes, Amihud liquidity, Pastor-Stambaugh liquidity and illiquidity. These indicators are essential for understanding the ease with which bonds can be traded in the market, providing insight into both the efficiency and cost of transactions (Bessembinder & Maxwell, 2008).

By examining the bid-ask spread, for instance, the research can assess the transaction costs associated with buying or selling bonds, which is a key component of market liquidity. Similarly, turnover ratios and trading volumes will offer a clear picture of how actively the bonds are traded, while market depth indicators will highlight the ability of the market to absorb large trades without significant price changes (Hasbrouck, 2007).

Together, these liquidity metrics will offer a comprehensive framework for analyzing how easily bonds can be bought or sold within the market. Bid ask spreads and trading volumes serve as direct proxies for liquidity, while turnover ratios and market depth help to gauge the overall robustness of the market (Huang & Wang, 2014). By utilizing this combination of metrics, the study aims to capture both the transactional efficiency and the underlying stability of bond markets in the context of developing economies (Chung & Chuwonganant, 2011). This multifaceted approach will allow for a more nuanced understanding of liquidity dynamics and their impact on bond performance.

3.3.3.2. Risk and Return Metrics

In assessing risk and return, the study will concentrate on total returns and associated standard deviation. Total returns will encompass price changes (Bessembinder & Maxwell, 2008). By focusing on this metric, the study aims to capture a comprehensive picture of the return characteristics of the bonds in question.

The incorporation of these performance metrics will offer valuable insights into how different bonds perform relative to their risk profiles. By considering both the absolute returns and the risk-adjusted returns. Risk-adjusted returns are essential for assessing investments because they allow investors to compare how well different assets or portfolios perform relative to the risk taken.

The most common methods of calculating risk-adjusted returns include the Sharpe ratio, Treynor ratio, Jensen's alpha, and Sortino ratio, each of which takes different aspects of risk into account whether it's total volatility, market risk, or downside risk. By using these measures, investors can determine which investments provide the best return for the risk they are assuming.

The study will be able to draw more meaningful conclusions about the risk return dynamics in developing bond markets, helping to understand how liquidity risk influences the potential for returns (Huang & Wang, 2014). The incorporation of these performance metrics will offer valuable insights into how different bonds perform relative to their risk profiles.

By considering both the absolute returns and the risk-adjusted returns, the study will be able to draw more meaningful conclusions about the risk-return dynamics in developing bond markets, helping to understand how liquidity risk influences the potential for returns (Huang & Wang, 2014).

3.3.3.3. Control Variables

The study will evaluate risk and return by focusing on key metrics such as total returns, and various risk-adjusted performance indicators. Total returns will account for both capital gains and interest payments (Bessembinder & Maxwell, 2008). By incorporating these elements, the analysis will provide a comprehensive understanding of the return profiles of the bonds being studied. These metrics will provide a detailed view of the bond's risk-return relationship.

By utilizing these risk-adjusted performance measures, the study will better capture the overall risk dynamics of bond markets, particularly in emerging economies, and assess how liquidity risk affects expected returns (Huang & Wang, 2014).These metrics will provide a detailed view of the bond's risk return relationship, with the Sharpe ratio being particularly useful for comparing investments that differ in their risk profiles.

The Sharpe ratio adjusts returns for risk, helping to determine whether higher returns are achieved at the cost of taking on excessive risk (Hasbrouck, 2007). By utilizing these risk-adjusted performance measures, the study will better capture the overall risk dynamics of bond markets, particularly in emerging economies, and assess how liquidity risk affects expected returns (Huang & Wang, 2014).

3.3.4. Analytical Techniques

The research will employ descriptive analysis this means summarizing or describing the characteristics of a dataset or phenomenon without attempting to establish cause-and-effect relationships or make predictions. Descriptive analysis provides a comprehensive summary of the key features of the data, often using basic statistical techniques to present a clear picture of what is happening within the data. what do you mean by this? Description is different from analysis. The descriptive analysis will be employed to examine liquidity risk across various developing bond markets.

This approach will also be used to identify trends, patterns, and distributions in bond returns and liquidity indicators. Specifically, the analysis will include measures of central tendency such as the mean, maximum and minimum to capture the typical values of bond returns and liquidity metrics (Bessembinder & Maxwell, 2008). These measures will help in understanding the central point around which data is clustered.

Additionally, the study will calculate measures of dispersion such as standard deviation to evaluate the variability in bond returns and liquidity indicators. These metrics will provide a deeper understanding of how widely bond returns and liquidity metrics deviate from their central values, highlighting the overall stability of the markets (Hasbrouck, 2007). Following the descriptive analysis, regression analysis will be employed to model the relationship between liquidity risk metrics and bond returns, while controlling for relevant variables.

Specifically, a linear regression model will be applied, with bond returns as the dependent variable and liquidity risk measures as the independent variable. The regression coefficients will be estimated using statistical software such as E-Views, and hypothesis tests will assess their statistical significance. Finally, the goodness of fit of the regression model will be evaluated using the coefficient of determination (R-squared), which measures the proportion of variance in bond returns explained by liquidity risk metrics (Chung & Chuwonganant, 2011).

Figure 3 below compares the suitability and limitations of OLS, GMM, FEM, REM and FMOLS in running a regression model for assessing liquidity risk and returns in developing bond markets. Since bond markets by their nature demonstrate high levels of illiquidity, volatility, and structural breaks, therefore Fully Modified OLS (FMOLS) is suitable method that can be used to run regression model on time series of Assessing Liquidity Risk and Returns in Developing Bond Markets.

Method	Best for	Limitations	Suitability for bond markets
OLS	Simple linear relationships.	Biased non-stationarity/endogeneity.	Poor (Ignores autocorrelation) .
GMM	Instrumental variables (e.g. illiquidity shocks).	Requires valid instruments.	Moderate but hard to find instruments.
FEM	Panel data with fixed effects	Ignores time-series properties.	Low (Bond markets require dynamics)
REM	Random effects with panel data	Less efficient with correlated errors.	Low (Not ideal for time series).
FMOLS	Non-stationary co integrated time series.	Requires co-integration testing first.	Best (Handles endogeneity and bias).

Figure 3 Comparison of methods to run a regression model for assessing liquidity risk and returns in developing bond markets

Source: Amihud & Mendelson (2015)

Given the structural and data-specific characteristics of developing bond markets, this study employs the Fully Modified Ordinary Least Squares (FMOLS) estimator to examine the relationship between liquidity risk and bond returns. The FMOLS approach, originally developed by Phillips and Hansen (1990), is particularly well-suited for time-series data that exhibit non-stationarity and long-run equilibrium relationships, conditions frequently observed in bond market variables such as yields, spreads, and return series.

One of the central methodological motivations for using FMOLS is its ability to correct for spurious regression bias. In developing bond markets, variables often follow stochastic trends and are non-stationary in nature.

FMOLS adjusts traditional Ordinary Least Squares (OLS) estimation by incorporating semi-parametric corrections that account for co-integration, thereby producing consistent and unbiased estimates of long-run relationships (Duffie, Davydoff, & Parlour, 2007). This feature is critical for assessing long-term interactions between liquidity risk factors and bond returns without distorting results due to non-stationarity.

Additionally, FMOLS addresses autocorrelation and endogeneity, both of which are pervasive in illiquid financial environments. Illiquid bonds often demonstrate serially correlated pricing behaviour, and the mutual dependence between liquidity conditions and returns can introduce endogeneity into the model. FMOLS corrects for these econometric issues through the use of non-parametric corrections to the error term, enhancing the reliability of inference (Hsiao, 2014).

Another justification for the selection of FMOLS stems from the data constraints typical of developing markets, which often suffer from limited sample sizes due to incomplete reporting or relatively short historical data series. Despite these constraints, FMOLS has demonstrated efficiency and robust performance even with small datasets, making it particularly advantageous for empirical applications in data-scarce contexts (Amihud & Mendelson, 2015).

Furthermore, the FMOLS methodology is inherently robust to volatility induced by market illiquidity, a common feature in developing and emerging bond markets. Volatility driven by sudden liquidity shocks can destabilize conventional estimators, but FMOLS remains reliable under such conditions due to its long-run focus and robustness properties (Duffie et al., 2007).

Lastly, FMOLS is also capable of capturing structural breaks within co-integrated relationships. Developing bond markets often undergo regime shifts due to policy interventions, economic reforms, or market liberalization.

Unlike more rigid estimation techniques, FMOLS can accommodate these changes within its framework, offering a more flexible and realistic estimation of long-term equilibrium paths (Perron, 2006).

For these reasons, FMOLS is deemed the most appropriate econometric technique for this study, aligning with both the theoretical expectations of co-integrated market behaviour and the practical constraints associated with developing bond market data.

3.3.5. Estimates of liquidity factors

In this subsection, we describe the empirical methodology and estimation procedure for the liquidity measures. These have been described in our literature review in Chapter 1.

The Amihud illiquidity measure, often denoted as ILLIQ. This calculation effectively captures the average price change per unit of trading volume.
A higher Amihud measure indicates greater illiquidity, suggesting that larger price changes are required for a given volume of trades (Amihud, 2002).
This relationship underscores the importance of liquidity in determining asset pricing, especially in markets where trading is sporadic.

Equation 5

$$ILLIQ_{it} = \frac{1}{Days_{it}} \sum_{j=1}^{Days_{it}} \frac{|r_{i,j,t}|}{Vol_{i,j,t}},$$

where ri,j,t. is the return for bond i on day j of month t and Daysit is the number of days for which transaction data are available for bond i in month t.
We first obtain the market wide ILLIQMt by aggregating individual illiquidity measures over the entire sample month by month as evidenced below.

Equation 6

$$\Delta ILLIQ_{Mt} = (M_t/M_1)(ILLIQ_{Mt} - ILLIQ_{Mt-1}).$$

In calculating ILLIQMt, we Winsorize, Winsorizing is a statistical technique used to handle outliers in a dataset by limiting extreme values to a certain percentile. Instead of removing outliers entirely (which can reduce the data's size and potential insights).

This technique involves replacing extreme values with the closest data point within a specified range individual ILLIQit data using the 1st and 99th percentiles of the distribution each month to reduce the impact of outliers. Similar to the Pastor-Stambaugh measure, we scale the monthly difference in the Amihud illiquidity series by the ratio of capitalizations of the bonds included in the sample in each month t, i.e., We then obtain innovations from the following time series regression:

Equation 7

$$\Delta ILLIQ_{Mt} = \alpha_0 + d_1 + d_2 + \phi_1 \Delta ILLIQ_{Mt-1} + \phi_2 \left(\frac{M_{t-1}}{M_1}\right) ILLIQ_{Mt-1} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2}.$$

We incorporate moving average components to account for the autocorrelation in the residual term. We also add two dummy variables to capture the shifts associated with the two implementation phases (II and III) of TRACE or equivalent that has been applied for set data. A moving average component is a common technique to model autocorrelation. It helps adjust for the fact that liquidity patterns or market conditions may have lingering effects over time.

This means that residuals from one period might still affect the next period, and the moving average component helps to capture this effect, making the model more accurate. When we include these dummy variables in the model, we are explicitly saying, "During these periods (Phases II and III), there may be shifts in liquidity patterns that we need to account for." These dummy variables help the model isolate and quantify the specific effects that these two implementation phases might have had on liquidity.

In each phase, a substantial proportion of the bonds newly included in the database have small issuance size and low trading volume. This causes shifts in the level of illiquidity aggregated across individual bonds in these two months. The dummy variables catch these impacts. Because these newly added bonds had low liquidity, the overall liquidity of the bond market during these phases might appear lower than usual. This is because the new bonds−while they make up a small part of the market−can have an outsized impact on liquidity metrics due to their characteristics (low issuance size, low trading volume).

This shift is especially noticeable in the first few months of Phases II and III when a large proportion of the bonds newly included have low liquidity. The model needs to account for these temporary shifts in illiquidity.
In summary the moving average components adjust for time-based correlations in the data, and the dummy variables help capture the specific shifts in market liquidity caused by the inclusion of low-liquidity bonds during Phases II and III of TRACE. By including these adjustments, the model can more accurately reflect the true liquidity conditions in the market, independent of these implementation-related shifts.

Equation 8

$$\Delta ILLIQ_{Mt} = (M_t/M_1)(ILLIQ_{Mt} - ILLIQ_{Mt-1}).$$

The Pastor-Stambaugh Liquidity Measure which has also been described in Chapter 3 as to how this can effectively be derived per the proposed two-step approach. The liquidity level for an individual bond in period t (e.g., month) can be obtained from the least squares estimate of pi,t associated with the signed volume in the following regression:

Equation 9

$$r^e_{i,j+1,t} = \rho_0 + \rho_1 r_{i,j,t} + \pi_{i,t}\, sign(r^e_{i,j,t}) Vol_{i,j,t} + \varepsilon_{i,j+1,t},$$

Where r is the return of bond i on day j in month t, re i,j,t i,j,t is the bond's return in excess of the bond market return, sign(re) is an indicator function whose value is equal to 1 i,j,t if re is positive and 1 % if it is negative, and Vol is the dollar volume. The order flow is proxied by volume signed by the contemporaneous excess return on a i,j,t i,j,t particular bond. The unbalanced order flow is expected to be accompanied by a return, which is partially reversed if the market is not perfectly liquid, or pi,t is negative.

The greater the expected reversal for a given volume, the lower the bond liquidity. pi,t is estimated for individual bonds each month t using daily return and volume data. A bond's liquidity is computed in a given month only if there are at least ten return observations with which to estimate the regression above.

Individual liquidity measures are aggregated month by month to generate the market wide liquidity series:

Equation 10

$$\pi_t = \frac{1}{N_t} \sum_{i=1}^{N_t} \pi_{i,t},$$

where Nt is the number of corporate bonds in month t. To account for the effects of changes in the growth in size of the bond market and the sample size, we scale the difference in monthly aggregate liquidity measures by the ratio of capitalizations of the bonds in the sample, i.e., $\Delta\pi$ = (Mt/M1)(πt–πt - 1) , where Mt is the total dollar value at the end of month t-1 of the bonds included in month t. This scaling procedure follows the logic of Pastor and Stambaugh (2003).

Liquidity innovations are then obtained from the following differenced regression, which includes a lag term and the lagged value of the scaled level series on the right-hand side:

Equation 11

$$\Delta\pi_t = a_0 + a_1 \Delta\pi_{t-1} + a_2 \left(\frac{M_{t-1}}{M_1}\right) \pi_{t-1} + e_t.$$

Because the residual term for bond liquidity is typically small, we multiply residual estimates e^t by one hundred: Lt 1⁄4100e^t. This scaling on the liquidity innovation has no effect on empirical tests. It is merely intended to produce a desirable range for the liquidity index and the estimated systematic liquidity risk.

Scaling is a technique used in financial models to adjust or normalize variables so that they fit into a desirable range. For liquidity, this involves transforming raw liquidity measures (like bid-ask spread, trading volume, etc.) so that they are comparable across different assets, time periods, or market conditions. While scaling may alter the actual values of liquidity measures, it does not affect the outcomes of empirical tests or statistical analyses designed to measure relationships between liquidity and other factors like asset returns or risk. This implies that the liquidity measure, after scaling, still behaves in the same way empirically and doesn't introduce biases or distortions that would change the results of the analysis.

CHAPTER 4 : RESULTS .

4.1. Corporate bonds

4.1.1. Brazil

Table 1 Brazilian Market Corporate Bonds characteristics.

	Variable	Mean	Maximum	Minimum	Std Dev	t
Brazil	Return	0.267	1.216	0.000	0.00287	2.140
	Amihud bond liquidity	-8.35E-21	1.68203E-05	3.5E-08	4.31E-06	1.011
	Beta for market illiquidity	0.212				1.207
	Pastor-Stambaugh bond liquidity	0.0055	0.834	0.0048	0.00276	1.787
	PS beta	-0.301	0.830			2.386
	Adj. R2	0.341	0.6457	0.062	0.00845	

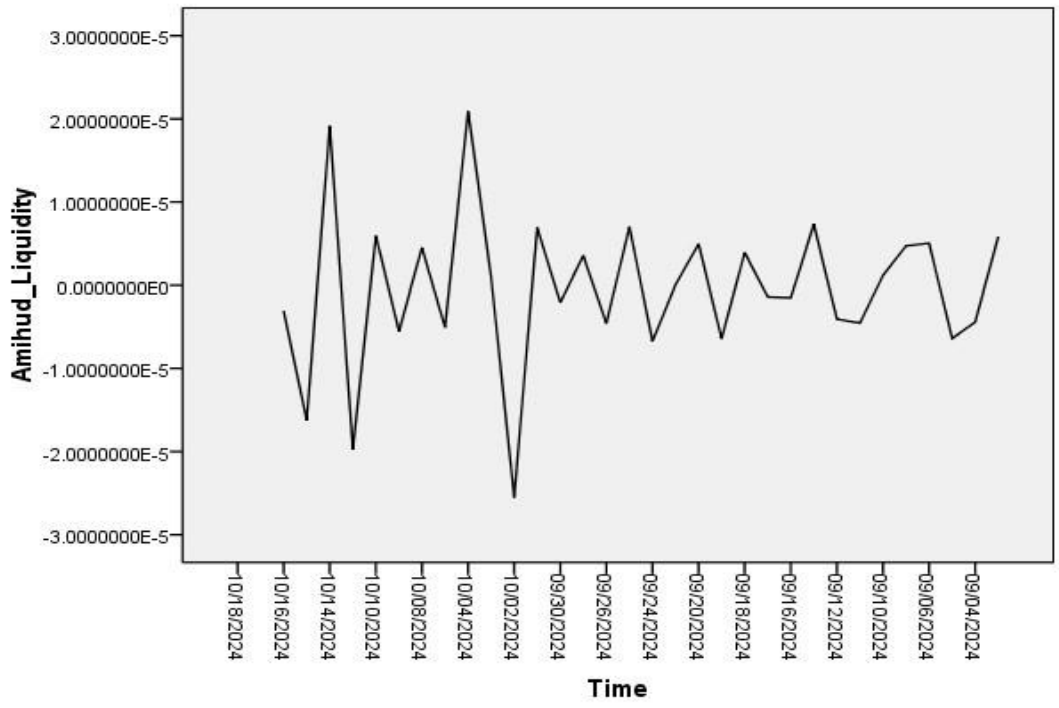

Figure 4 Amihud liquidity innovation plot over time for Brazilian corporate bond market .

The Amihud liquidity innovation (for the Brazilian corporate bond market) plot is shown in Figure 4 above. The sample period is from 4 September 2024 to 18 October 2024. The Amihud liquidity measure is converted by adding a negative sign to the original illiquidity measure. Amihud liquidity level peaks at 4 October, 2024 and 14 October, 2024. These peaks reflect periods where the price impact of trades increases, meaning that for a given amount of trading volume, asset prices move more than they would in a more liquid environment. These results corroborate what was taking place in Brazil due to a liquidity shock. During this time ahead of the interest rate hikes announced later in year by the Brazilian Central Bank, Brazil had been experiencing spikes in inflation. This market recorded its lowest Amihud liquidity levels on 4 October, 2024 and 10 October, 2024, which is corroborated below by peaks in the PS Liquidity innovations during this time.

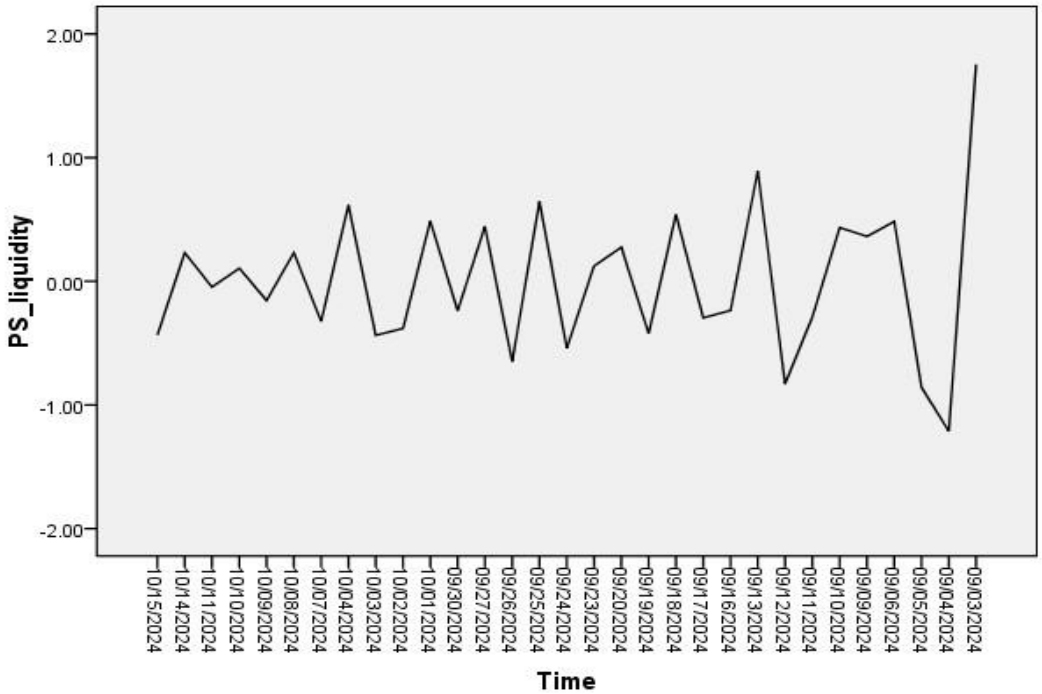

Figure 5 PS liquidity innovation plot over time for the Brazilian corporate bond market.

The PS liquidity innovation (for the Brazilian corporate bond market) is shown above in Figure 5. Similar to the above the sample period is from 4 September 2024 to 18 October 2024.

For the PS liquidity measure (often associated with Pastor-Stambaugh liquidity), the conversion process would follow a similar logic. The PS liquidity measure is derived from the price impact of liquidity shocks or liquidity costs (i.e., how much the price moves due to trading volume or other factors). We observe an initial peak at 4 September 2024 followed at 13, 25 September 2024 and 05 October 2024.

A significant PS liquidity innovation with the peaks on 4 September, 13 September, 25 September, and 5 October 2024 shows the effects of the monetary policy changes and communications made during this time by the Brazil Central Bank, this led to an increase in interest rates to 12,25% due to inflation remaining high. During this time the Brazilian corporate bond market faced heightened liquidity risk. For investors, this signalled higher liquidity premiums required during these times and an increased risk of price impact when trading in the market.

Table 2 Factor Correlations of liquidity and return relationships for Brazilian corporate bond market.

		Return	**Amihud Liquidity**	**PS liquidity**	**ILLIQt**	**Volume**
Return	Factor Correlation	1	.258	.954**	.251	.280
Amihud Liquidity	Factor Correlation	.258	1	.398*	.977**	-.411*
PS liquidity	Factor Correlation	.954**	.398*	1	.396*	-.021
ILLIQt	Factor Correlation	.251	.977**	.396*	1	-.431*
Volume	Factor Correlation	.280	-.411*	-.021	-.431*	1

A PS Liquidity correlation of 0.954 to returns means that liquidity (as measured by the Pastor-Stambaugh liquidity factor) is strongly positively related to Brazilian corporate bond returns. This suggests that during periods

of higher liquidity, bond returns tend to be higher. Conversely, during periods of reduced liquidity or liquidity shocks, returns might decrease, indicating that liquidity risk is a significant factor in determining market performance. The high correlation emphasizes that liquid markets generally lead to better returns. This is evidenced by our results in Figure 4 and 5.

In the Brazilian corporate bond market, liquidity plays a crucial role in determining bond returns, and two key liquidity measures are particularly insightful in understanding how liquidity affects these returns. The Pastor Stambaugh measure, which gauges how sensitive asset prices are to liquidity changes, has a notably strong positive correlation of 0.954 with bond returns in Brazil.

This suggests that Brazilian corporate bonds are highly responsive to changes in liquidity. When liquidity improves bond returns tend to increase. Conversely, during periods of low liquidity, bond returns are likely to decrease, as it becomes harder and costlier to buy or sell bonds without significantly affecting their price.

For investors, this high correlation between liquidity and bond returns implies that liquidity risk is a key factor to manage. In an developing bond markets like Brazil, where liquidity can be more erratic due to economic instability, inflation, and political uncertainty, liquidity conditions directly impact returns. Monitoring liquidity indicators such as the Pastor-Stambaugh measure can provide valuable insights, helping investors anticipate periods when returns may be higher or lower based on prevailing liquidity conditions.

The Amihud illiquidity measure, on the other hand, takes a different approach by measuring the price impact of trades based on trading volume. The correlation of 0.977 between this measure and illiquidity in Brazilian corporate bonds underscores the near-perfect relationship between illiquidity and the Amihud measure.

Essentially, when the market becomes more illiquid the Amihud measure captures this shift. This measure serves as a useful tool for predicting when illiquidity will likely cause higher volatility and lower bond returns, particularly during market stress or economic shocks.

The implications of these two measures are clear; investors in Brazilian corporate bonds must be especially mindful of liquidity conditions. Liquidity fluctuations are not just an abstract concept but tangible factors that affect how well bonds perform. During times of economic instability or unexpected shocks, such as a political crisis or a global financial downturn, liquidity can suddenly dry up, leading to higher price volatility and lower returns. The Amihud measure can serve as an early warning system in such cases, indicating when liquidity is likely to tighten, and investors should adjust their strategies accordingly.

In practical terms, understanding these liquidity measures can help investors make more informed decisions about when to buy or sell bonds. If liquidity is high, it could be a good time to invest, as bonds will likely perform better. However, if liquidity is tightening, it might be wise to hold off on buying or to adjust the portfolio to minimize exposure to the risks of illiquidity.

In emerging markets like Brazil, where liquidity is often thinner, this risk is magnified, and careful monitoring is essential to avoid significant losses.
In sum, the Pastor-Stambaugh and Amihud liquidity measures highlight the central role of liquidity in shaping returns in the Brazilian corporate bond market. They offer investors a way to navigate the complexities of liquidity risk, which is a particularly crucial factor in emerging markets like Brazil. By closely tracking these indicators, investors can better manage the risks associated with market fluctuations and make more strategic decisions about their bond portfolios.

4.1.2. China

Table 3 Chinese corporate bond markets characteristic

	Variable	Mean	Maximum	Minimum	Std Dev	t
China	Return	0.205	13.960	-14.960	0.0399	2.248
	Amihud bond liquidity	-3.14E-19	0.033	-0.00461	0.0064	1.025
	Beta for market illiquidity	0.068				0.656
	Pastor-Stambaugh bond liquidity	1.35E-15	13.701	-15.2235	0.0404	1.169
	PS beta	-0.028				
	Adj. R2	0.290				

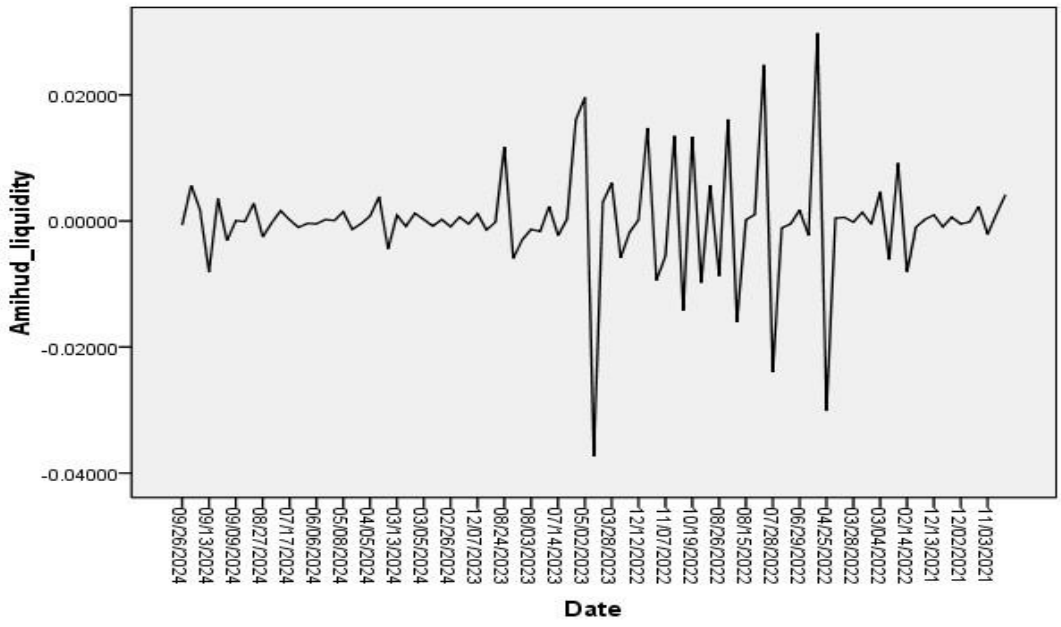

Figure 6 Amihud liquidity innovation plot over time for the Chinese corporate bond market.

The Amihud liquidity innovation (for the Chinese corporate bond market) plot is shown in Figure 6 above. The sample period is from 03 November 2021 to 26 September 2024. The Amihud liquidity measure is converted by adding a negative sign to the original illiquidity measure. Amihud liquidity level peaks at 24 August 2023, 2 May 2023 28 July 2022 and 29 June 2022. These specific dates correspond with events where there was either a news shock, a data release, or a market event that caused investors to reassess risk and move to the side-lines, resulting in illiquid conditions. It could be that after these dates, market participants became more risk-averse, especially in response to the worsening real estate situation and government policy uncertainty.

In mid-2023, China's property market was in deep turmoil, with major developers like Evergrande still reeling from severe debt defaults and liquidity crises. On August 24, the situation took a turn for the worse, with heightened concerns as the Chinese government struggled to manage the escalating property sector crisis. Additional restrictions and new challenges within the property market were announced, worsening investor sentiment.

Fears about the sustainability of China's real estate sector intensified, which led to a significant drop in liquidity. Investors became increasingly hesitant, pulling back from riskier assets, causing a notable decrease in trading volumes across the market.

This crisis in the property sector was compounded by weak economic data. Economic indicators, such as industrial production and retail sales, painted a grim picture of China's economic recovery. With key sectors failing to show signs of recovery, the market reacted swiftly to the data, and volatility spiked. This combination of a troubled property sector and disappointing economic performance led to a liquidity crunch in the equity markets, reflected in the sharp rise in the Amihud illiquidity measure.

On May 2, 2023, China’s post COVID economic recovery remained uneven, with structural issues across key sectors like property, technology, and real estate becoming more pronounced. The Chinese government’s ongoing regulatory crackdowns on major tech companies added to the uncertainty, causing investors to pull back from the market. Concerns about the broader economic outlook were growing, and as a result, stock market volatility surged. As investors became more risk-averse, trading volumes dried up in certain sectors, leading to an uptick in the Amihud liquidity measure, which signals periods of illiquidity.

In addition to the regulatory concerns, China’s GDP growth target for 2023 began to look increasingly out of reach. Official projections suggested that the country might miss its growth target for the year, further exacerbating market fears. The possibility of slower growth added a layer of uncertainty to the already fragile economic situation. As a result, investors started reducing exposure to Chinese assets, exacerbating the liquidity squeeze in the market.

The property crisis in China, which had begun to unfold in 2021, reached a particularly volatile phase by July 2022. Developers like Evergrande and Country Garden were facing severe liquidity stress and were on the brink of default. As these companies' financial struggles deepened, broader concerns about the stability of China’s financial system began to emerge. The ripple effects from the property sector led to a wave of contagion, spreading to other parts of the economy and financial markets. The fear of a full-blown crisis in the real estate sector weighed heavily on investor sentiment, contributing to market instability and a reduction in liquidity.

At the same time, China was still grappling with the effects of its strict COVID19 zero-tolerance policy. Key economic regions, such as Shanghai, remained in lockdown, disrupting supply chains and industrial output. These lockdowns had a significant negative impact on consumer and business activity, making the economic outlook even more uncertain.

The combination of the property sector's distress and ongoing COVID-19 restrictions dampened investor confidence, leading to heightened market volatility and a noticeable decline in liquidity.

By June 2022, the real estate crisis had deepened further, and China's efforts to manage the fallout from highly leveraged property developers were no longer enough to quell investor fears. There were increasing signs that the property market was facing systemic risk, with large swaths of the economy dependent on the health of this sector. The Chinese government continued to intervene, but the damage was done, and investor confidence in the real estate market had severely eroded.

At the same time, there were growing concerns about Chinese companies' ability to meet their foreign-denominated debt obligations. The risk of a broader debt crisis was becoming more pronounced, and this fear sent shockwaves through the financial markets. Asset prices began to swing wildly as traders scrambled to adjust their positions, but with reduced liquidity, the price movements became even more exaggerated. The above factors are all corroborated by the PS Liquidity innovations in Figure 7 below.

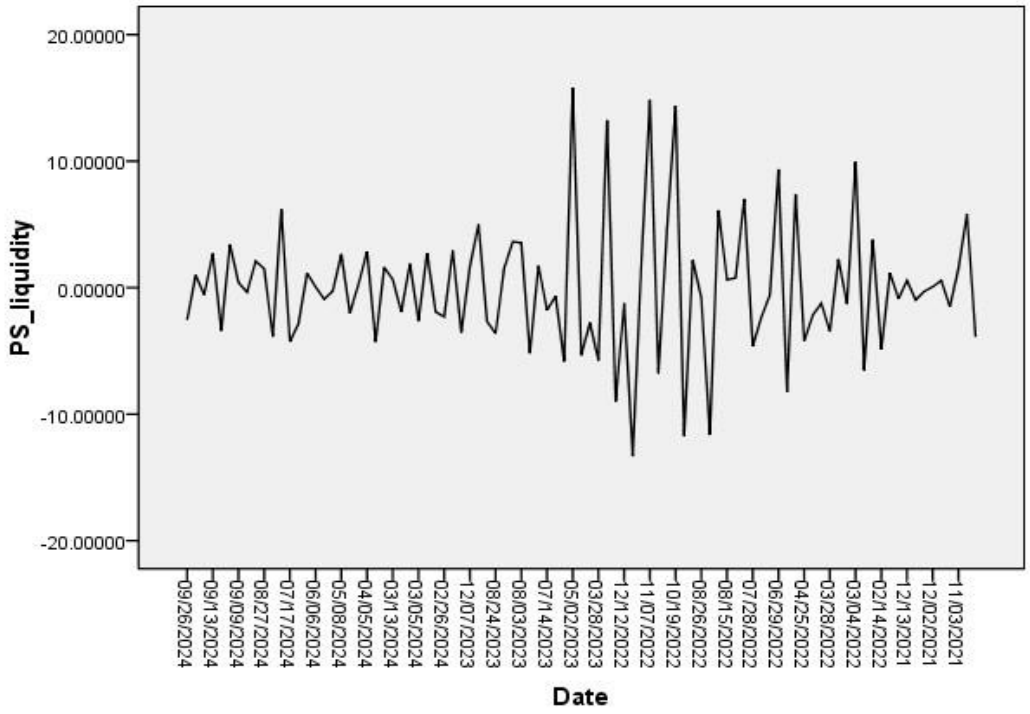

Figure 7 PS liquidity Innovations plot over time for the Chinese corporate bond market.

Table 4 Factor correlations of liquidity and return relationships for the Chinese corporate bond market.

		Return	Volume	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.028	.135	.127	1.000**
Volume	Factor Correlation	-.028	1	-.331**	-.328**	.000
Illiquidity	Factor Correlation	.135	-.331**	1	.998**	.126
Amihud liquidity	Factor Correlation	.127	-.328**	.998**	1	.118
PS liquidity	Factor Correlation	1.000**	.000	.126	.118	1

The 0.998 correlation indicates that the Chinese corporate bond behaves in a way that is strongly influenced by its liquidity conditions. In practical terms, it means that when liquidity tightens, the price will likely experience more volatility due to reduced trading volume. This relationship is crucial for traders and investors because it signals that this asset is highly sensitive to market liquidity, which should be taken into account when assessing the risks of holding or trading corporate bonds in China, especially during periods of market stress or low volume.

1-Factor correlation between Pastor-Stambaugh liquidity and returns suggests that liquidity is a primary driver of returns for corporate bonds within the Chinese market. In this case, the asset’s returns are almost entirely explained by its liquidity conditions−when liquidity is favourable, returns are high, and when liquidity tightens, returns fall. For traders and investors, this means that tracking liquidity (through the Pastor Stambaugh measure) provides a highly reliable signal of expected asset performance, and managing liquidity risk becomes essential to optimizing return potential.

Given that returns are highly correlated with liquidity, any shocks to liquidity (e.g., during periods of financial crisis or market disruptions) could lead to significant changes in returns. This makes liquidity a key risk factor and this is why we see greater deals of volatility in both Figure 6 and 7.

4.1.3. Colombia

Table 5 Colombian corporate bond market characteristics.

	Variable	Mean	Maximum	Minimum	Std Dev	t
Colombia	Return	0.021	5.400	-6.225	0.9909	2.049
	Amihud bond liquidity	1.19E-19	0.013	-0.00157	0.0012	1.024
	Beta for market illiquidity	0.104	0.2032	0.000628	0.0001	2.549
	Pastor-Stambaugh bond liquidity	1.73E-16	5.375	-6.24291	0.0993	1.134
	PS beta	-0.016				-0.397
	Adj. R2	0.312				

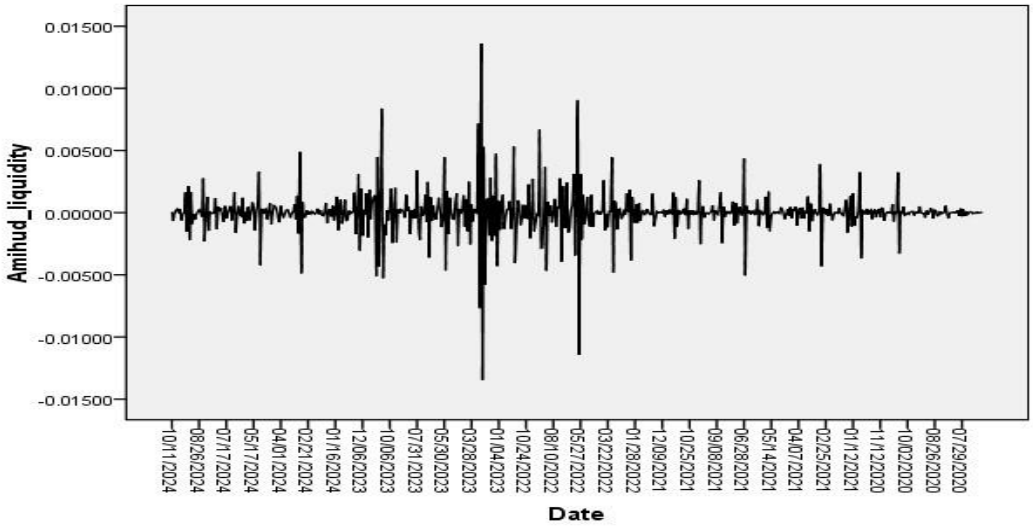

Figure 8 Amihud liquidity innovation plot over time for the Colombian corporate bond market

The Amihud liquidity innovation (for the Colombian corporate bond market) plot is shown in Figure 8 above. The sample period is from 29 July 2020 to 11 October 2024. The Amihud liquidity measure is converted by adding a negative sign to the original illiquidity measure.

Amihud liquidity level peaks on the 10th of June 2023, towards the end of March 2023 and during May of 2022, these specific dates correspond with events where there was either a news shock, a data release, or a market event that caused investors to reassess risk and move to the side-lines, resulting in illiquid conditions.

By mid of 2023, Colombia's political landscape was undergoing significant turbulence, stemming from the aftermath of the 2022 election of Gustavo Petro, the country's first left-wing president. Petro's administration had been pushing for major economic reforms, particularly targeting the oil, mining, and pension sectors.
His policy proposals, which aimed to reduce Colombia's dependence on fossil fuels and increase environmental regulations, stirred debates about the potential risks to the country's investment climate. Investors began to question the long-term stability of Colombia's economic growth trajectory, as these bold reforms raised concerns about future market conditions.
On June 10, 2023, markets were likely reacting to these developments, with fears that the new policies could spark capital outflows and reduce demand for Colombian assets, particularly those linked to the energy sector.

The uncertainty surrounding Petro's policy direction created a perfect storm for market participants. Proposals for shifts in taxation, fiscal policy, and environmental regulation added fuel to investor jitters, which contributed to heightened price volatility and lower liquidity across Colombia's financial markets. Investors, uncertain about the country's future economic stability, were likely hesitant to commit capital, and the resulting market retreat left the country vulnerable to larger swings in asset prices. Another possible trigger for the liquidity shock in June 2023 was weak economic data showing signs of a slowdown in Colombia's growth.

As a nation heavily reliant on commodities, any global financial shocks or downturns in commodity prices could have rippled through the market, particularly affecting Colombia's stock and bond markets.

A drop in commodity prices, like oil, would not only hurt the country's export revenues but also undermine investor confidence, leading to further liquidity constraints.

By March 2023, global inflationary pressures and the ongoing interest rate hikes in many developed markets were felt acutely in developing economies, including Colombia. The Central Bank of Colombia (Banco de la República) had been raising interest rates in an effort to combat rising inflation, particularly driven by higher food and energy prices. While these hikes were necessary to curb inflation, they created a new wave of uncertainty for market participants. Higher rates typically lead to higher borrowing costs, and investors may become more risk-averse, pulling back from the market. In Colombia, this tightening of monetary policy, combined with elevated inflation, likely sapped investor confidence and contributed to lower trading volumes. The uncertainty surrounding future rate hikes or potential pauses by the central bank made it difficult for investors to predict the direction of economic policy, further exacerbating the liquidity shock.

The global financial landscape in early 2023 was also marked by capital flight from developing markets as investors sought safer havens amid rising global interest rates and geopolitical tensions. As a small, open economy, Colombia felt these pressures particularly hard. The increased caution among international investors coupled with a more challenging domestic economic environment likely contributed to a sharp reduction in liquidity, as foreign capital retreated from the Colombian market. This was reflected in heightened price volatility, as the reduced liquidity meant that any large trades had the potential to move prices more significantly.

The political landscape in Colombia was in a state of flux leading up to the country's presidential elections in May and June 2022. The election of Gustavo Petro, who ran on a platform advocating for deep economic and social reforms, created considerable uncertainty in the markets.

Petro’s plans to transform Colombia’s energy sector and reduce its reliance on oil and gas raised concerns about the future of Colombia’s most important industries. The oil sector, a cornerstone of the Colombian economy, was particularly vulnerable, and any significant changes to its regulation were viewed as potentially destabilizing for the broader economy.

As investors awaited the election outcome, there was growing nervousness about how Petro’s policies might unfold. Markets are often highly sensitive to political uncertainty, especially in emerging economies, and as the election approached, capital flight from Colombia intensified. Foreign investors were particularly cautious, fearing that policy shifts could disrupt the market and negatively affect their investments. This uncertainty led to increased volatility and reduced liquidity, with fewer participants willing to trade Colombian assets amidst the heightened political risks. These dynamics likely caused spikes in the Amihud illiquidity measure during this period.

At the same time, global challenges like the ongoing COVID-19 recovery and supply chain disruptions were placing additional pressure on the Colombian economy. Rising input costs, higher food prices, and energy price fluctuations contributed to inflationary pressures, further complicating the country’s economic outlook. Colombia, like many other emerging markets, faced the twin challenges of global economic instability and domestic policy uncertainty, both of which contributed to a more risk-averse investor sentiment.

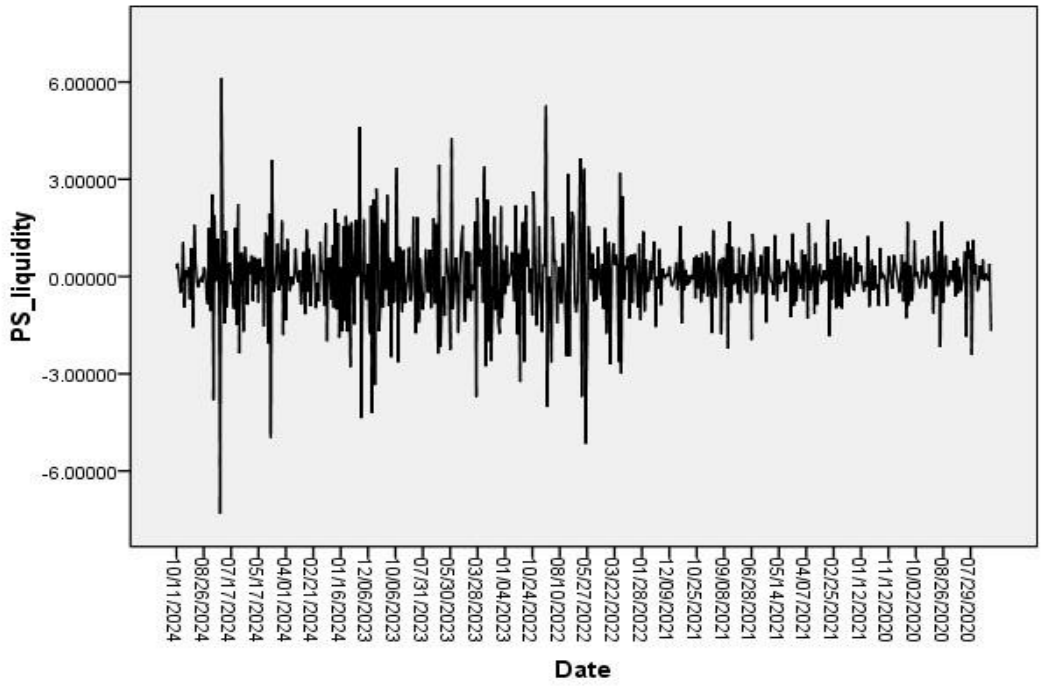

Figure 9 PS liquidity Innovations plot over time for the Colombian corporate bond market

In conclusion and as can be corroborated by the above Figure 9 PS liquidity Innovations plot over time for the Colombian corporate bond market in June 10, 2023, the end of March 2023, and May 2022 in Colombia seem to coincide with periods of significant political uncertainty (e.g., the lead-up to the 2022 elections and policy changes under President Petro), as well as economic challenges like high inflation, interest rate hikes, and global market pressures. These factors combined likely caused higher volatility and reduced trading volumes, driving the spikes in the PS liquidity measure. In periods of heightened political and economic uncertainty, liquidity tends to dry up as investors become more cautious and risk-averse, leading to sharper price movements for the same level of trading activity.

Table 6 Factor correlations of liquidity and return relationships for the Colombian corporate bond market.

		Return	Volume	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.016	.208**	.200**	1.000**
Volume	Factor Correlation	-.016	1	-.149**	-.142**	.000
Illiquidity	Factor Correlation	.208**	-.149**	1	.995**	.206**
Amihud liquidity	Factor Correlation	.200**	-.142**	.995**	1	.198**
PS liquidity	Factor Correlation	1.000**	.000	.206**	.198**	1

An Amihud liquidity measure with a 0.995 factor correlation to illiquidity suggests an extremely strong positive relationship between asset price changes and trading volume, indicating that the asset is highly illiquid. A Pastor-Stambaugh (PS) liquidity factor correlation measure of 1 to returns for a Colombian corporate bond indicates that the liquidity of the bond is perfectly correlated with its return performance.

This strong correlation means that changes in the bonds liquidity (as measured by the Pastor-Stambaugh liquidity measure) are directly and proportionally affecting its returns, whether in terms of price movements or yield changes. In other words, liquidity is the primary driver of returns for this bond, and illiquidity could play a crucial role in influencing how it performs in the market. This is consistent with our understanding as developing market bonds like Colombian corporate bonds tend to be more sensitive to liquidity changes compared to their developed market counterparts. Liquidity risk, especially in smaller or less traded bonds, is typically higher in emerging markets, and investors in these markets demand higher returns to compensate for that risk.

4.1.4. India

Table 7 Indian corporate bond market characteristics.

	Variable	Mean	Maximum	Minimum	Std Dev	t
India	Return	0.035	4.630	-7.716	2.6423	2.054
	Amihud bond liquidity	-2.36E-05	0.031	-0.009	0.0150	0.256
	Beta for market illiquidity	0.123	0.148	0.010	0.0021	0.465
	Pastor-Stambaugh bond liquidity	3.40E-16	4.276	-7.738	2.6084	0.387
	PS beta	-0.160	0.393	-1.146		-0.605
	Adj. R2	0.287				

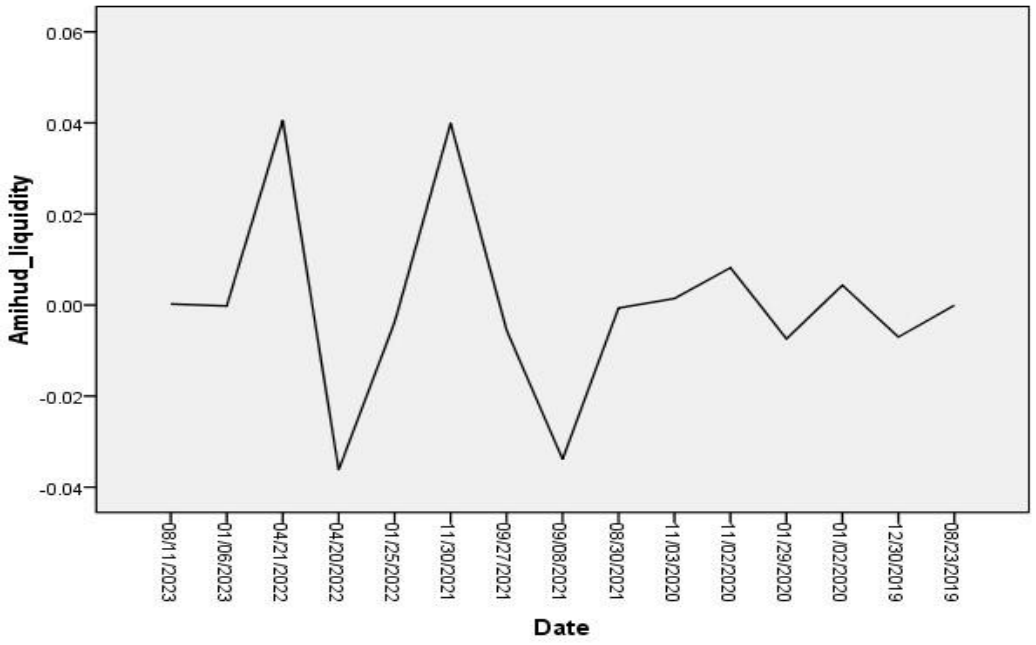

Figure 10 Amihud liquidity innovation plot over time for the Indian corporate bond market.

The Amihud liquidity innovation (Indian corporate bond market) plot is shown in Figure 10 above. The sample period is from 23 August 2019 to 11 August 2023 29 July 2020. The Amihud liquidity measure is converted by adding a negative sign to the original illiquidity measure. Amihud liquidity level peaks on the 21st April 2022 and 30th November 2021.

These specific dates correspond with events where there was either a news shock, a data release, or a market event that caused investors to reassess risk and move to the side-lines, resulting in illiquid conditions.

By April 2022, India faced significant economic challenges due to surging inflation and concerns over tighter monetary policy from the Reserve Bank of India (RBI). Several factors contributed to a liquidity shock in the Indian market:

- Inflation in India surged, particularly in food and energy sectors, exacerbated by global supply chain disruptions and the ongoing impact of the Russia-Ukraine conflict. These factors drove up commodity prices, which contributed to rising inflation. As a result, there were fears that inflationary pressures would force the RBI to raise interest rates more quickly than expected, leading to higher borrowing costs and potentially slower economic growth.
- Liquidity tightening and potential rate hikes; with inflation climbing, the RBI was expected to raise interest rates. Higher interest rates often lead to reduced liquidity in bond and equity markets, as borrowing becomes more expensive. This tightening scenario led investors to pull back from riskier assets like stocks and bonds. The expectation of rate hikes likely caused bond prices to fall (yields to rise), widening bid-ask spreads and contributing to market illiquidity.
- Global market volatility; the broader global financial environment in 2022 was marked by heightened volatility. Developed economies, also grappling with inflation, were considering tightening their own monetary policies.

- This global risk aversion caused capital outflows from emerging markets like India. Both foreign institutional investors (FII) and domestic investors became more cautious, reducing their exposure to riskier assets. This resulted in lower trading volumes, which deepened the liquidity shock in India.

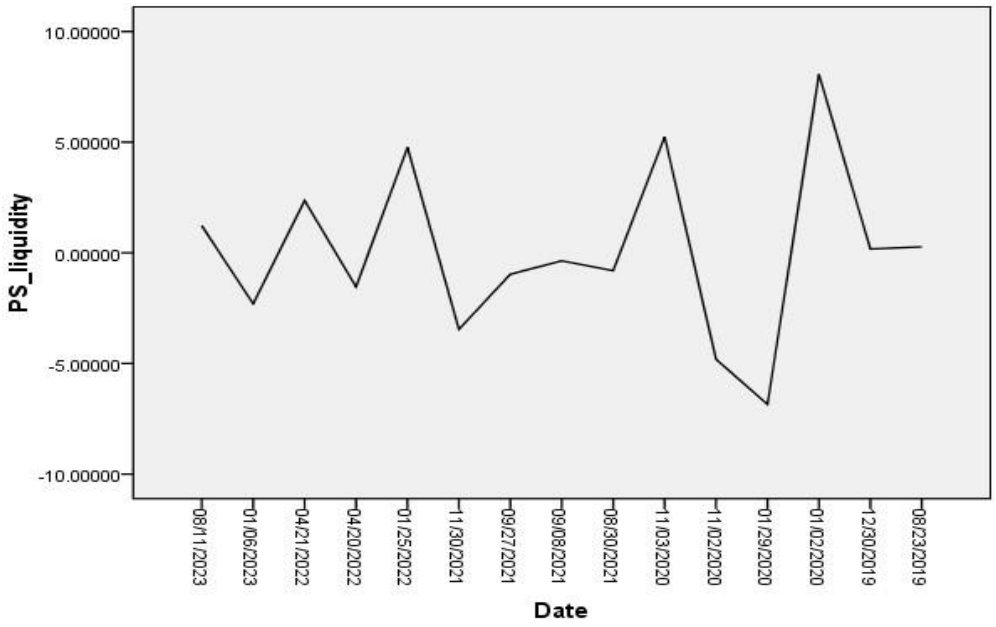

Figure 11 PS liquidity Innovations plot over time for the Indian corporate bond markets

Table 8 Factor correlations of liquidity and return relationships for the Indian corporate bond market.

		Return	Volume	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.160	.297	.143	.987**
Volume	Factor Correlation	-.160	1	-.463	-.369	.000
Illiquidity	Factor Correlation	.297	-.463	1	.123	.226
Amihud liquidity	Factor Correlation	.143	-.369	.123	1	.085
PS liquidity	Factor Correlation	.987**	.000	.226	.085	1

The high correlation of 0.987 between the Pastor-Stambaugh liquidity factor and returns for Indian corporate bonds signals that liquidity is a key driver of bond prices and returns in this market. This is likely due to the relative illiquidity of the Indian corporate bond market, the sensitivity of returns to liquidity conditions, and the higher liquidity risk premium in developing markets.

Understanding liquidity dynamics, as captured by the PS factor, is crucial for forecasting returns and managing risks in this asset class. Indian corporate bonds from our observations have a high sensitivity to market-wide liquidity fluctuations. Given the relatively underdeveloped secondary market for corporate bonds in India, liquidity plays a disproportionately large role in determining the return profile.

Given the importance of institutional investors in this market, any changes in market liquidity (even small ones) can lead to large shifts in investment behavior. This could create a scenario where the PS liquidity factor is almost directly correlated with returns.

The high correlation of 0.987 further highlights that changes in overall market liquidity (as measured by the PS factor) can explain most of the price fluctuations in Indian corporate bonds. This might be a signal that factors like credit risk, while still important, are secondary to liquidity concerns and investors may view liquidity risk as nearly equal to or more important than credit risk when evaluating corporate bonds in India.

Investors who are able to forecast liquidity shifts could take advantage of the correlation to make more informed decisions about when to buy or sell corporate bonds.

4.1.5. Mexico

Table 9 Mexican corporate bonds market characteristics

	Variable	Mean	Maximum	Minimum	Std Dev	t
Mexico	Return	-0.065	1.730	-9.471	0.0857	0.317
	Amihud bond liquidity	-8.35E-21	1.68E-05	-8.69E-06	6.32E-06	0.379
	Beta for market illiquidity	0.056	0.276	0.013	0.0057	0.672
	Pastor-Stambaugh bond liquidity	5.17E-06	1.68203E-05	3.5E-08	4.31E-06	0.426
	PS beta	-0.030	0.062	-0.650	0.0026	-0.362
	Adj. R2	0.293				

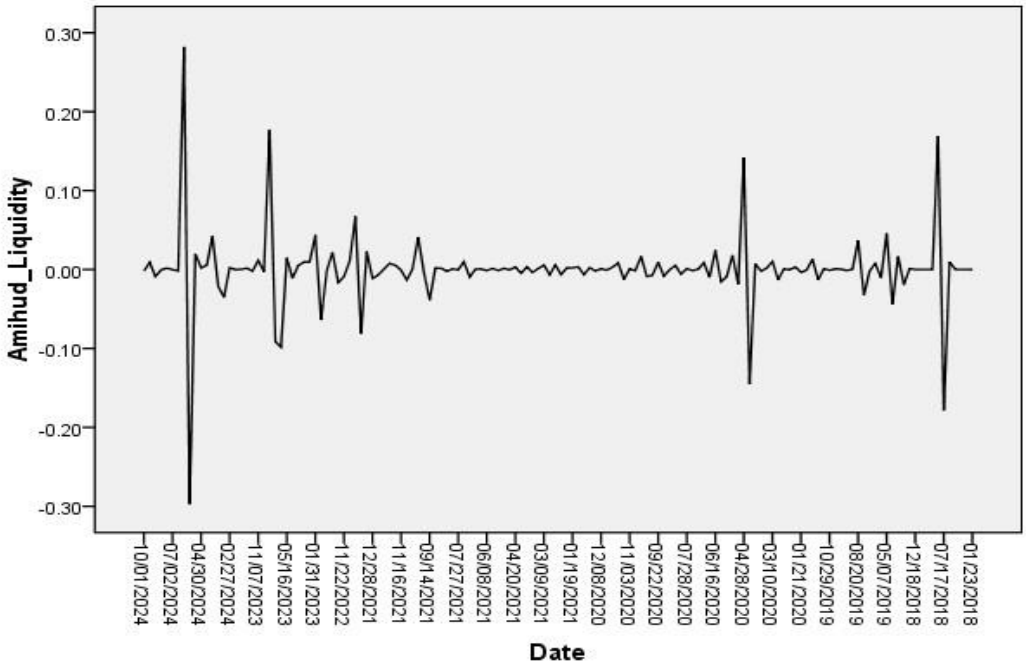

Figure 12 Amihud liquidity innovation plot over time for Mexican corporate bond market

The Amihud liquidity innovation (for the Mexican corporate bond market) plot is shown in Figure 12 above. The sample period is from 23 January 2018 to 01 October 2024. The Amihud liquidity measure is converted by adding a negative sign to the original illiquidity measure.

Amihud liquidity level peaks at 02 July, 2024, 16 May 2023, 28 April 2020 and 17 July 2018. However, this market recorded its lowest Amihud liquidity levels on 30th of April 2023.

The Amihud Liquidity Measure for Mexican corporate bonds has seen notable fluctuations on specific dates, reflecting the impact of various macroeconomic events and market sentiment shifts. On July 2, 2024, the Amihud liquidity measure peaked, likely driven by significant macro or policy shifts. One possible explanation is that Mexican fiscal or monetary policies had undergone changes, such as an interest rate hike by the Bank of Mexico (Banxico), which at the time spooked investors and reduced trading activity. Another potential factor had been the broader global financial stress, possibly a rise in risk aversion among investors, leading to fewer transactions and greater price movements in the bond market, which would cause the liquidity measure to rise.

Similarly, the peak on May 16, 2023 was linked to a sharp market repricing. Global economic concerns, such as an increase in U.S. Treasury yields, had at the time rippled through developing markets, including Mexico. In such periods, there is often heightened market stress, with investors becoming more cautious about emerging market debt, which would lead to a liquidity squeeze. In this environment, even small trades in Mexican corporate bonds could lead to significant price movements, thereby increasing the Amihud measure.

The peak on April 28, 2020, came amid the early days of the COVID-19 pandemic, which triggered a global market panic. As the crisis unfolded, investors rapidly sought safer assets, like U.S. Treasuries or gold, while dumping riskier investments, including developing market corporate bonds. This led to a sharp deterioration in liquidity, where even modest trades caused large price shifts, resulting in a spike in the Amihud liquidity measure.

The situation was compounded by widespread economic shutdowns and global trade disruptions, all of which added to the sense of uncertainty and volatility in the market. The peak on July 17, 2018, was linked to a tightening of global liquidity. As the U.S. Federal Reserve raised interest rates and the U.S. dollar strengthened, developing markets, including Mexico, likely faced capital outflows as investors shifted towards safer, more liquid assets. Additionally, political uncertainty in Mexico, particularly related to NAFTA negotiations (which would later result in the USMCA), could have further dampened investor confidence, reducing trading activity and contributing to the liquidity crunch seen in the Amihud measure.

In contrast, April 30, 2024, saw the liquidity measure drop to a low, suggesting improved liquidity conditions. Several factors contributed to this improvement. For one, global risk appetite likely recovered as investors regained confidence in developing markets, including Mexico. Additionally, monetary and fiscal stabilization measures from both the Mexican government and Banxico played a role in ensuring adequate liquidity in the markets. Another potential factor was the stability of commodity prices, which would have supported Mexico's export-driven economy and boosted sentiment around Mexican corporate bonds. Finally, by April 2024, the world was in the midst of post-pandemic recovery, with economic conditions returning to a sense of normalcy, further aiding the liquidity recovery in Mexican bond markets.

In summary, these fluctuations in the Amihud liquidity measure highlight how market liquidity can be highly sensitive to both global and local economic conditions, policy changes, investor sentiment shifts, and major geopolitical events.

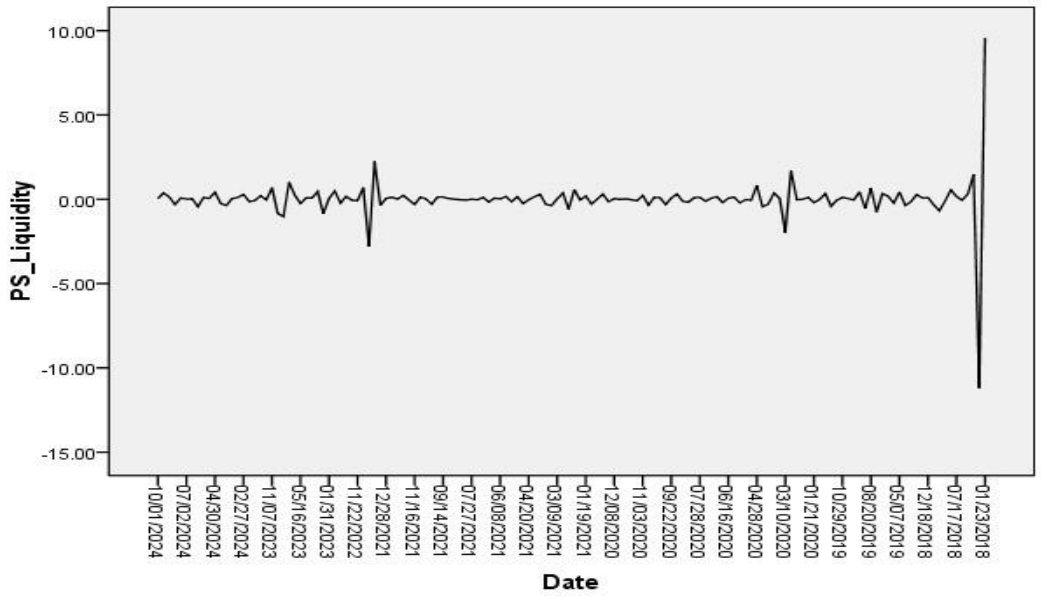

Figure 13 PS liquidity innovation plot over time for Mexican corporate bond market

As evidenced above the Pastor-Stambaugh (PS) liquidity factor measures the impact of market liquidity on asset returns, and its peak on January 23, 2018, for Mexican corporate bonds likely indicates a period of heightened liquidity risk or significant market shifts in Mexico.

The peak in the Pastor-Stambaugh liquidity measure on January 23, 2018, was the result of a complex interplay of political uncertainty, global economic conditions, and domestic financial concerns. Political uncertainty surrounding the presidential election and the future of NAFTA, tightening global liquidity due to U.S. monetary policy, volatility in commodity prices, a shift in global risk sentiment, and local economic challenges all combined to create an environment where liquidity in Mexican corporate bonds became significantly more sensitive to market fluctuations.

Table 10 Factor correlations of liquidity and return relationships for Mexican corporate bond market

		Return	Volume	Illiquidity	Amihud Liquidity	PS Liquidity
Return	Factor Correlation	1	-.030	-.067	-.068	1.000**
Volume	Factor Correlation	-.030	1	-.040	-.038	.000
Illiquidity	Factor Correlation	-.067	-.040	1	.998**	-.068
Amihud Liquidity	Factor Correlation	-.068	-.038	.998**	1	-.069
PS Liquidity	Factor Correlation	1.000**	.000	-.068	-.069	1

The 1 factor correlation between the Pastor-Stambaugh liquidity measure and returns indicates a direct and strong relationship between market-wide liquidity and bond returns in the Mexican corporate bond market. When liquidity is higher, bonds tend to see higher prices (lower yields), and when liquidity is lower, returns (yields) tend to rise as investors demand more compensation for the risk of holding less liquid bonds.

The 0.998 factor correlation between the Amihud liquidity measure and illiquidity highlights the fact that illiquidity and price-impact are nearly identical concepts in this context. When bonds are illiquid, even small transactions can cause large price fluctuations, and the Amihud measure effectively captures this relationship, providing a near-perfect indicator of market illiquidity.

These tight correlations reflect the strong influence that liquidity conditions have on the pricing and trading behavior of Mexican corporate bonds, highlighting the importance of liquidity in emerging market bond markets where liquidity risks can be more pronounced.

In developing markets like Mexico, liquidity is often less stable and more prone to sudden changes due to factors like political risk, economic conditions, and global sentiment. Because of this, liquidity measures (like PS and Amihud) are often tightly linked to returns and illiquidity, respectively, since both are highly sensitive to changes in market conditions.

In the context of Mexican corporate bonds, where liquidity might be more volatile or uncertain, market participants tend to adjust their behaviour based on the prevailing liquidity conditions. The direct relationship between the Pastor-Stambaugh liquidity measure and returns suggests that when liquidity is high, investors are more willing to buy bonds at lower yields (driving returns higher), and when liquidity is low, they demand higher yields due to the higher perceived risk. Similarly, the Amihud measure being closely tied to illiquidity reflects that price volatility in response to trading volume is a natural consequence of lower market depth.

4.1.6. Nigeria

Table 11 Nigerian corporate bonds market characteristics

Nigeria	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	0.017	15.540	-15.360	0.0030	2.246
	Amihud bond liquidity	2.01E-20	0.005	-3.09E-05	3.76E-04	1.059
	Beta for market illiquidity	-0.006	3.09E-05	1.80E-06	2.34E-06	-0.078
	Pastor-Stambaugh bond liquidity	-4.39E16	15.517	-15.383	2.95E-03	1.125
	PS beta	-0.004	1.13E-05	1.20E-06	1.25E-06	-0.045
	Adj. R2	0.265				

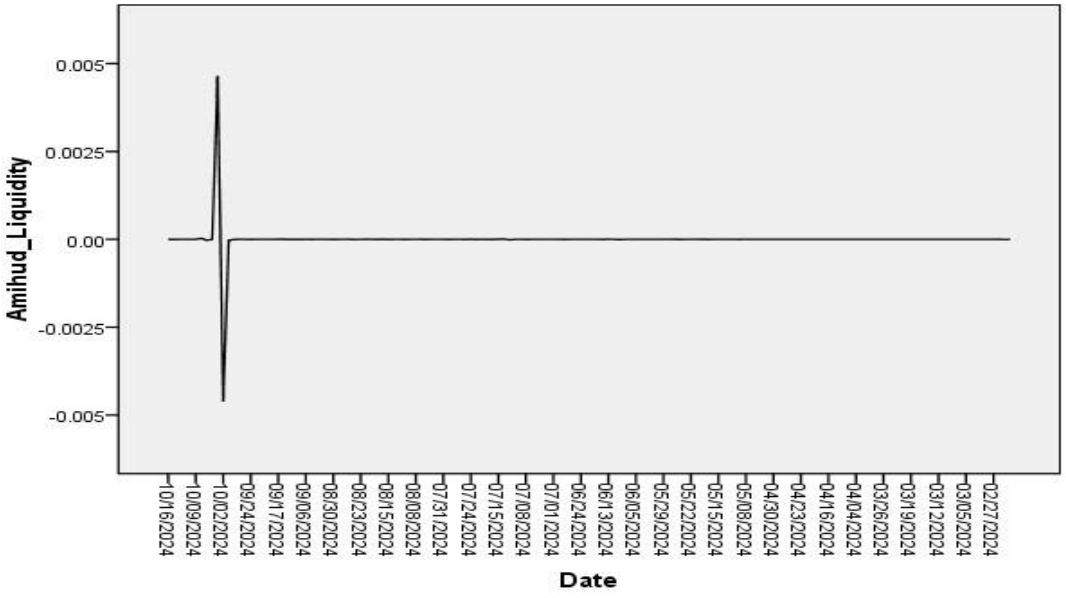

Figure 14 Amihud liquidity innovation plot over time for Nigerian corporate bond market

The Amihud liquidity innovation (for the Nigerian corporate bond market) plot is shown in Figure 14 above. The sample period is from 27 February 2024 to 16 October 2024. The Amihud liquidity measure is converted by adding a negative sign to the original illiquidity measure. Amihud liquidity level peaks at 9 October, 2024. However, this market recorded a straight-line before the peak for sample period. The observed Amihud liquidity innovation for Nigerian corporate bonds with a straight-line pattern from February 27, 2024, until September 24, 2024, followed by a low on October 2, 2024, and a peak on October 9, 2024 suggests a series of market events and economic or policy changes that affected liquidity conditions in the Nigerian corporate bond market during this period.

The straight-line trend indicates stable liquidity conditions in the market for Nigerian corporate bonds, meaning that there was a consistent relationship between trading volumes and price impacts over this period. Several factors could have contributed to this stability as set out below;

- Between February and September 2024, the Nigerian bond market had been experiencing a period of relative stability. This was due to a lack of major external or domestic shocks, where investors' sentiment remained steady and there were no significant liquidity disruptions. In such periods, liquidity conditions often stay stable, meaning that trading volumes and price impacts (as measured by the Amihud liquidity measure) remained relatively constant.
- Monetary and Fiscal Policies; the stability was also driven by predictable and stable monetary and fiscal policies. If the Central Bank of Nigeria (CBN) and the Nigerian government did not enact significant policy changes (such as sudden interest rate hikes, currency devaluations, or changes to bond issuance), it led to a stable market environment, where liquidity conditions remained unchanged.

- Commodity Price Stability; Nigeria is highly reliant on oil exports, so stable global oil prices can lead to consistent capital flows into the economy, which may have contributed to relatively steady liquidity in the corporate bond market. With no significant disruptions in oil prices, corporate bonds might have experienced less volatility, leading to a consistent liquidity measure.

The low liquidity on October 2, 2024, represented a temporary liquidity squeeze or market shock that occurred just before the peak on October 9, 2024. This was driven by several factors:

- A sudden change in market sentiment due to either domestic or international events had caused market participants to pause or reduce trading activity. Such events might include geopolitical risks, macroeconomic data releases, or financial crises in other regions that spill over into Nigeria. Investors would have as a result become more risk-averse, leading to lower trading volumes and wider bid-ask spreads, thus increasing price impact per unit of trading volume (as captured by the Amihud measure).
- A policy surprise, such as an unexpected interest rate change by the Central Bank of Nigeria (CBN) or adjustments to foreign exchange controls, triggered uncertainty, leading to lower trading volumes. A shift in investor expectations regarding future interest rates, inflation, or fiscal policy caused a temporary pullback in market activity, leading to the drop in liquidity observed on October.

The liquidity peak on October 9, 2024, marks a rebound in market activity following the temporary shock in early October. Several factors could explain why liquidity surged again after the low on October 2:

- Market Correction or Stabilization: After a period of lower liquidity, markets tend to adjust and stabilize once the immediate uncertainty or shock has passed. If the October 2 event was a temporary disruption, traders and investors might have returned to the market after realizing

that the initial shock had been overestimated or that policy or macroeconomic conditions had stabilized.

As a result, liquidity conditions could have quickly normalized, leading to an increase in trading volumes and a peak in the Amihud measure.

- Government or Central Bank Intervention: A policy response could have alleviated the liquidity squeeze. For example, the Nigerian government or CBN might have announced measures to ensure liquidity, such as easing monetary policy, introducing bond-buying programs, or providing liquidity to the banking system. Such actions typically restore confidence in the market and lead to a surge in liquidity as investors are reassured that the market conditions are supported by government intervention.
- Global Risk Appetite Recovery: If the liquidity dip in early October was related to a broader global risk-off sentiment, the October 9 peak could coincide with a recovery in global risk appetite. As international investors regain confidence, capital flows into emerging markets like Nigeria might have increased, boosting liquidity in Nigerian corporate bonds.
- Corporate Earnings or Positive News: A positive earnings report from major Nigerian corporates or positive economic indicators could have sparked renewed investor interest in Nigerian corporate bonds. Corporate bond markets often respond to good news from companies, such as strong earnings, debt refinancing, or improved fundamentals, leading to more market activity.

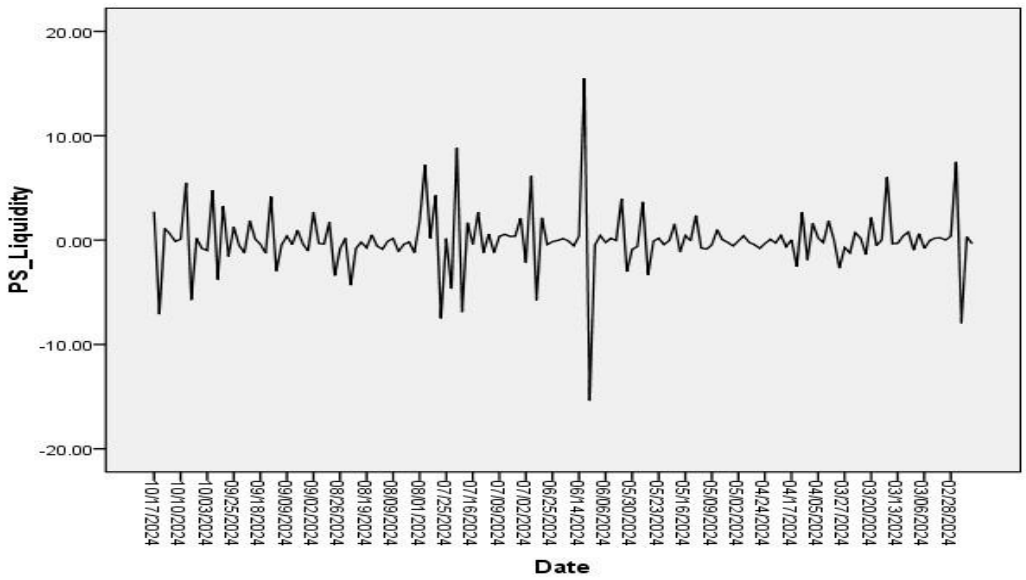

Figure 15 PS liquidity innovation plot over time for Nigerian corporate bond market

The Pastor-Stambaugh liquidity innovation plot in Figure 15 above for the Nigerian corporate bond market shows a peak on July 14, 2021, likely driven by a combination of heightened macroeconomic uncertainty, political developments, and external global factors. This peak could had been triggered by factors such as concerns over exchange rate instability, potential currency devaluation, and policy changes that increased market uncertainty. Additionally, global events like fluctuations in oil prices a key driver for Nigeria's economy had exacerbated liquidity risk. The sharp rise in perceived liquidity risk would be reflected by increased price sensitivity to trading volume, as investors became more cautious and trading volumes dropped.

Following this peak, liquidity conditions in the Nigerian corporate bond market likely stabilized, causing a sharp decline in the Pastor-Stambaugh measure. This had been due to a market correction, where investors regained confidence as the immediate shocks abated. Factors such as a policy response from the Central Bank of Nigeria, positive developments in global commodity markets (like a recovery in oil prices), or improved investor sentiment helped restore liquidity and stabilize the market. The liquidity measure dropped as market conditions normalized, leading to reduced price impact per unit of trading volume.

Table 12 Factor correlations of liquidity and return relationships for Nigerian corporate bond market

		Return	Volume	Illiquidity	Amihud Liquidity	PS Liquidity
Return	Factor Correlation	1	-.004	.128	-.027	1.000**
Volume	Factor Correlation	-.004	1	-.034	-.051	.000
Illiquidity	Factor Correlation	.128	-.034	1	.000	.128
Amihud Liquidity	Factor Correlation	-.027	-.051	.000	1	-.027
PS Liquidity	Factor Correlation	1.000**	.000	.128	-.027	1

The 1-factor correlation between returns and the Pastor-Stambaugh (PS) liquidity measure in the Nigerian corporate bond market from February 27, 2024, to October 16, 2024, suggests a strong link between market liquidity and bond returns. This implies that fluctuations in liquidity during this period had a direct and significant impact on bond price movements. In a market where liquidity is tight or fluctuating, even small changes in market depth can cause substantial price volatility, making bond returns highly sensitive to liquidity conditions. As a result, the correlation between returns and the PS liquidity measure was unusually strong, reflecting the market's increased sensitivity to liquidity risks.

Several factors could explain this strong relationship, including policy changes from the Central Bank of Nigeria (CBN) or government measures that directly influenced liquidity in the bond market. If there were significant shifts in monetary policy (such as interest rate changes or liquidity injections), investors would have adjusted their positions accordingly, causing bond prices to move in response to these liquidity changes. As such, during this period, liquidity became a key driver of returns, with the market closely reacting to the ebb and flow of liquidity conditions.

4.1.7. Poland

Table 13 Poland corporate bonds market characteristics

Poland	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	-0.018	3.280	-1.125	0.0677	0.978
	Amihud bond liquidity	4.81E-20	0.002	-2.60E-04	0.0004	1.468
	Beta for market illiquidity	0.041	0.072	0.00022	0.0970	0.423
	Pastor-Stambaugh bond liquidity	-2.56E16	3.301	-1.135	0.0673	0.985
	PS beta	-0.114	0.066	-1.34E-05	0.0102	-1.175
	Adj. R2	0.334				

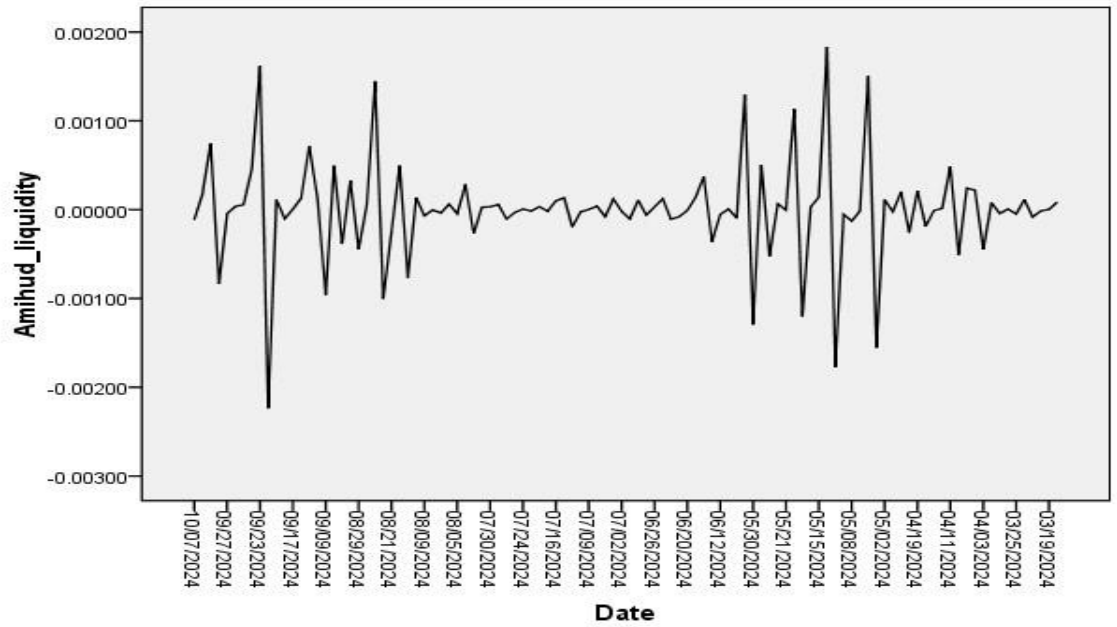

Figure 16 Amihud liquidity innovation plot over time for the Poland corporate bond market

The Amihud liquidity innovation (for the Poland corporate bond market) plot is shown in Figure 16. The sample period is from 19 March 2024 to 07 October 2024. The Amihud liquidity measure is converted by adding a negative sign to the original illiquidity measure. Amihud liquidity level peaks at 23 September 2024,25 August 2024,30 May 202410 May 2024 and 4 May 2024. However, this market recorded its lowest Amihud liquidity levels between 17 September 2024 and 23 September 2024.

Between March 19, 2024, and October 7, 2024, the Amihud liquidity measure for the Polish corporate bond market exhibited significant fluctuations, reflecting a period of substantial liquidity risk. The measure, which tracks illiquidity by assessing the price impact per unit of volume, showed multiple peaks at May 10, 2024, May 30, 2024, August 25, 2024, and September 23, 2024, indicating times when the market faced heightened illiquidity.

These peaks correspond to periods of market turbulence, triggered by a combination of factors such as tightened monetary policy, where rate hikes or liquidity constraints by the National Bank of Poland had been reduced and investor activity. Additionally, broader global economic shocks, like volatility in commodity prices or geopolitical uncertainties, led to lower trading volumes, widening bid-ask spreads, and ultimately increasing liquidity risk. Specific sectors or large companies in Poland facing financial distress also contributed to this illiquidity, pushing the Amihud measure higher.

In contrast, the market recorded its lowest liquidity levels between September 17, 2024, and September 23, 2024, suggesting a period of temporary stabilization following the earlier peaks. This low liquidity was due to a recovery in investor confidence, possibly sparked by positive economic data, easing global risk sentiment, or actions taken by the Polish central bank to address liquidity concerns. Additionally, the timing of this low aligned with the end of the fiscal quarter, where portfolio rebalancing typically leads to higher market participation and a brief reduction in price sensitivity to volume.

Ultimately, the fluctuations in the Amihud liquidity measure reflect a combination of monetary policy shifts, external market factors, and investor behavior, which together shaped the liquidity dynamics of the Polish corporate bond market during this period.

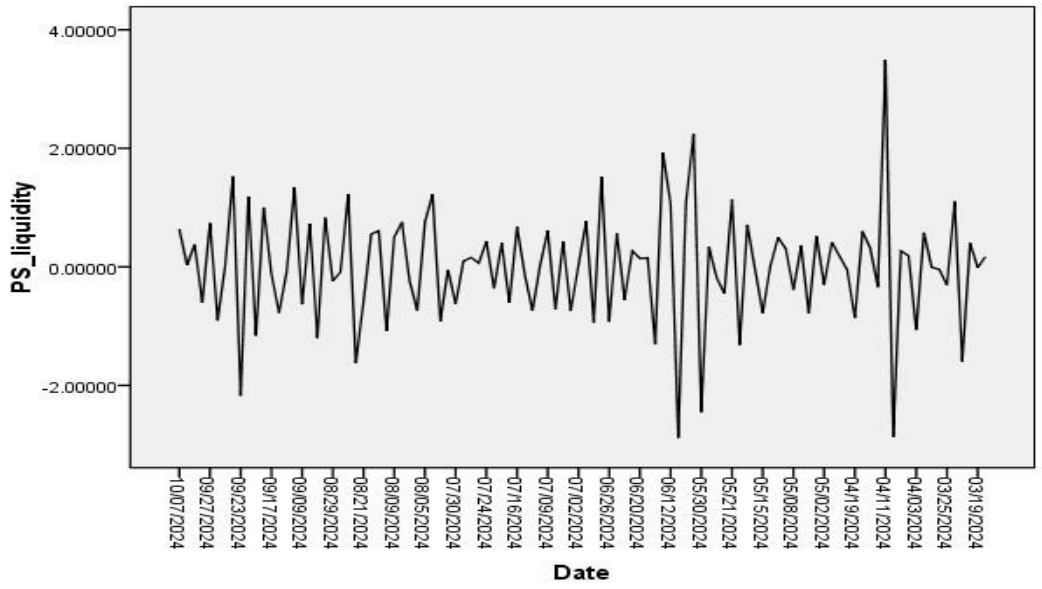

Figure 17 PS liquidity innovation plot over time for the Poland corporate bond market

The peak in the Pastor-Stambaugh liquidity measure above for the Polish corporate bond market on April 11, 2024, reflects a period of heightened liquidity risk and increased market stress. This spike in liquidity risk is attributed to a number of potential factors that may have created volatility in the market. One likely explanation is an unexpected policy change or economic announcement from the National Bank of Poland (NBP), such as an interest rate adjustment or tightened liquidity measures, which would have made investors more cautious and led them to reassess their positions. The result could have been lower trading volumes and a higher sensitivity of bond prices to those volumes, which is what the Pastor-Stambaugh measure captures.

Additionally, a global macroeconomic event or geopolitical development might have contributed to this liquidity spike.

For instance, changes in global interest rates, commodity price fluctuations, or emerging concerns in geopolitical stability which were quite prominent during this time could have triggered a risk-off sentiment in the market.

This would lead investors to pull back from riskier assets, causing liquidity to dry up and bond prices to become more volatile in response to smaller trades. Another possibility is that corporate-specific news, such as negative developments with a major issuer of Polish corporate bonds, could have caused a drop in investor confidence, further exacerbating the liquidity squeeze.

Lastly, the peak is also related to quarterly rebalancing by large institutional investors, who may have adjusted their portfolios in ways that temporarily disrupted liquidity.

Table 14 Factor correlation for the Poland corporate bond

		Return	Volume	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.114	-.037	.088	.993**
Volume	Factor Correlation	-.114	1	-.158	-.401	.000
Illiquidity	Factor Correlation	-.037	-.158	1	.000	-.055
Amihud liquidity	Factor Correlation	.088	-.401	.000	1	.042
PS liquidity	Factor Correlation	.993**	.000	-.055	.042	1

The 0.933 correlation between the Pastor-Stambaugh liquidity factor and returns in the Polish corporate bond market indicates a strong connection between liquidity conditions and bond price movements. This high correlation suggests that liquidity plays a critical role in determining bond returns in Poland.

One reason for this is that developing markets like Poland are generally more sensitive to fluctuations in liquidity. Bonds in these markets often face lower trading volumes and wider bid-ask spreads, making them more vulnerable to liquidity shocks. When liquidity tightens, even small changes in trading activity can cause significant price movements, which is reflected in the Pastor-Stambaugh liquidity measure. As a result, changes in liquidity have a direct impact on bond returns.

Another factor contributing to the strong correlation is market risk aversion. When global or local uncertainties arise, investors often become more cautious, leading to reduced trading volumes and tightening liquidity. In such cases, bond prices become more volatile and highly sensitive to liquidity, causing a noticeable impact on returns. Similarly, monetary policies by the National Bank of Poland or broader economic conditions can also influence market liquidity. For example, if the central bank raises interest rates or implements tighter policies, liquidity in the bond market can shrink, prompting investors to demand higher returns, which directly affects bond prices.

Additionally, global economic factors, such as changes in interest rates or commodity prices, also play a role in shaping liquidity conditions. When global liquidity tightens or risk sentiment turns negative, emerging market bonds like those in Poland can experience significant volatility, further strengthening the relationship between liquidity and returns. Finally, investor behavior is another key driver, as institutional investors often adjust their positions based on perceived liquidity risks, which in turn influences bond returns. In summary, the strong correlation between the Pastor-Stambaugh liquidity factor and returns for Polish corporate bonds reflects the significant role that liquidity conditions play in determining bond price dynamics in the markets.

4.1.8. Turkey

Table 15 Turkey corporate bond market characteristics

Turkey	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	-0.011	1.099	-1.176	0.0406	2.088
	Amihud bond liquidity	-4.58E20	8.48E-04	-9.76E-05	1.13E-04	1.155
	Beta for market illiquidity	-0.094	1.01E-03	1.14E-05	1.56E-05	-0.655
	Pastor-Stambaugh bond liquidity	-1.62E16	1.076	-1.196	4.08E-01	1.025
	PS beta	-0.132	0.028	-2.84E-01	0.0720	-0.925
	Adj. R2	0.324				

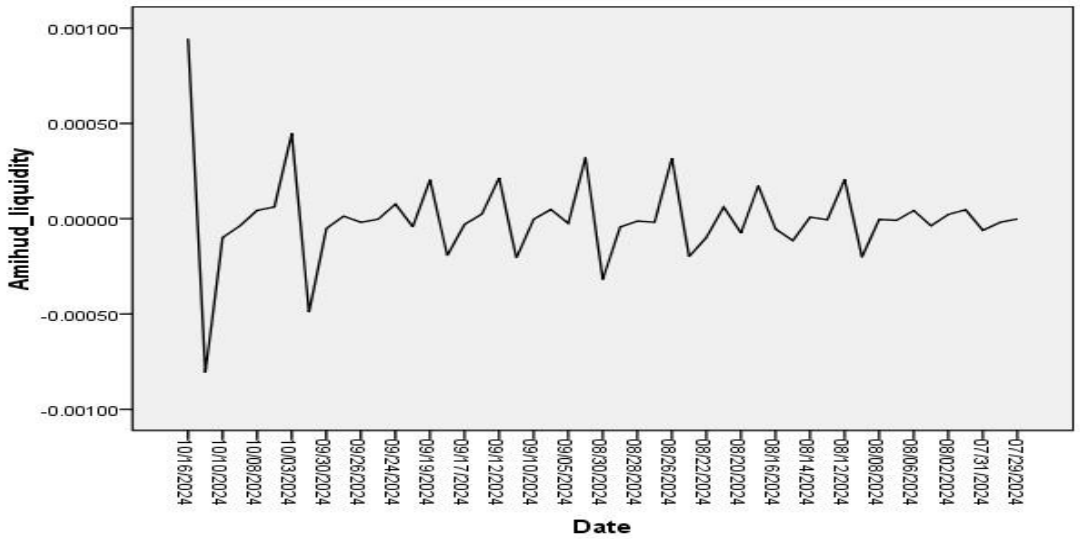

Figure 18 Amihud liquidity innovation plot over time for the Turkey corporate bond market

The Amihud liquidity measure for the Turkish corporate bond market above, covering the period from July 29, 2024, to October 16, 2024, reveals notable fluctuations in market liquidity. During this time, the measure peaks on specific dates October 16, October 3, September 6, and August 26, 2024 indicating periods of increased illiquidity. These spikes suggest that the market was experiencing heightened sensitivity to trading volumes, where even small trades had a disproportionate effect on bond prices. Such conditions typically arise during times of market stress, economic or political instability, or external factors that reduce investor confidence. For instance, domestic political uncertainty or changes in monetary policy, such as tighter liquidity or interest rate adjustments by the Central Bank of the Republic of Turkey (CBRT), could have contributed to these spikes in illiquidity. Similarly, global risk aversion or adverse movements in commodity prices might have compounded the situation, further tightening liquidity in the Turkish bond market.

However, between October 10 and 15, 2024, the market recorded its lowest liquidity levels, which signals a period of relative improvement in liquidity. This dip in the Amihud liquidity measure suggests that, during this time, liquidity conditions may have temporarily stabilized. Several factors could explain this brief recovery; it could have been driven by market interventions, such as policy actions from the Turkish government or the CBRT, designed to enhance liquidity and restore investor confidence. Additionally, a rebound in investor sentiment following earlier periods of market stress might have led to increased trading activity, which helped ease liquidity constraints. It’s also possible that this period coincided with portfolio rebalancing by large institutional investors, leading to higher trade volumes and improved liquidity conditions. Overall, the liquidity pattern observed in the Turkish corporate bond market during this period highlights the market’s sensitivity to both domestic and global factors, with temporary recoveries followed by periods of significant liquidity strain.

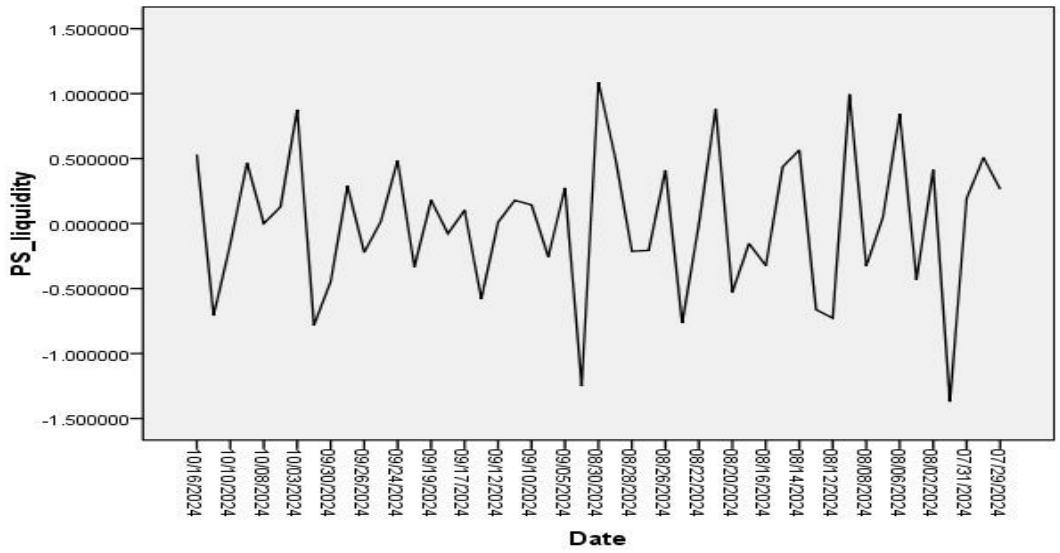

Figure 19 PS liquidity innovation plot over time for Turkey corporate bond market

The Pastor-Stambaugh liquidity innovations for the Turkish corporate bond market show significant peaks on August 30, 2024, and August 10, 2024, with the lowest point occurring on August 1, 2024. These fluctuations suggest that liquidity in the market was quite volatile during this period, influenced by several potential factors. The peaks reflect moments of market stress or heightened uncertainty, often triggered by economic or geopolitical events in Turkey or globally.

When markets are under stress, investors become more cautious, trading volumes drop, and bond prices become more sensitive to the trades that do occur. This results in tighter liquidity, as seen in the spikes on August 30 and August 10. For instance, political developments in Turkey, concerns about policy shifts, or broader global risk aversion could have contributed to these heightened periods of illiquidity.

The lowest liquidity point on August 1, 2024, indicates a brief period of stabilization in the market. During this time, the Turkish bond market may have experienced a temporary recovery, with improved investor sentiment or higher trading volumes that eased liquidity pressures. This could have been due to a policy intervention, positive economic news, or simply a lull in market disruptions.

However, this moment of relative calm was short-lived, as the market faced renewed volatility and liquidity tightness toward the end of the month.

Additionally, calendar effects like month-end portfolio rebalancing could have played a role, with August 30 aligning with typical market adjustments, leading to a temporary peak in illiquidity.

These fluctuations underscore how sensitive the Turkish bond market was to both domestic factors like policy changes and external influences, with liquidity conditions shifting sharply in response to changing market dynamics.

Table 16 Factor correlations of liquidity and return relationships for Turkey corporate bond market

		Return	Volume	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.132	.171	.163	.991**
Volume	Factor Correlation	-.132	1	-.313*	-.324*	.000
Illiquidity	Factor Correlation	.171	-.313*	1	.996**	.131
Amihud liquidity	Factor Correlation	.163	-.324*	.996**	1	.121
PS liquidity	Factor Correlation	.991**	.000	.131	.121	1

A 0.991 correlation between the Pastor-Stambaugh liquidity measure and returns means that there is an extremely strong relationship between market liquidity and the returns of the asset in question. A high correlation like this indicates that changes in liquidity conditions directly influence bond prices.

Specifically, when liquidity is high (meaning there is sufficient market activity and ease in executing trades), the bond returns are likely to be more stable, as trading is smoother and market participants can easily enter or exit positions. Conversely, when liquidity is low (meaning it is harder to execute trades without causing significant price changes), bond prices may become more volatile and sensitive to trading activity. In essence, this strong correlation suggests that liquidity is a key driver of returns in this market: when liquidity tightens or improves, it has a clear impact on bond price movements.

A 0.996 correlation between the Amihud liquidity measure and illiquidity means that the Amihud measure is almost perfectly aligned with the degree of illiquidity in the market. The Amihud liquidity measure is often used to assess how much bond prices move relative to trading volumes, with higher values indicating lower liquidity (i.e., bond prices are more sensitive to small changes in trade volumes). A high correlation of 0.996 means that as liquidity decreases (or illiquidity increases), the Amihud measure also increases, confirming that the market is becoming more illiquid. In this case, when illiquidity rises, even modest trades cause bigger price moves, reflecting more market friction and difficulty in executing transactions. Essentially, the Amihud liquidity measure and illiquidity move in lockstep, meaning as one rises (or falls), so does the other, and this provides a clear understanding of how market liquidity affects price behavior.

Table 17 Quantification of the impact of liquidity risk on corporate bond returns in selected developing economies.

Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
Turkey	Amihud liquidity	0.043	2.365	*
	PS liquidity	0.986	53.608	**
	R squared	0.958		
Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
Brazil	Amihud liquidity	-0.144	-2.679	*
	PS liquidity	1.011	18.828	**
	R squared	0.927		
Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
China	Amihud liquidity	0.009	3.334	**
	PS liquidity	0.998	351.673	**
	R squared	0.990		
Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
Colombia	Amihud liquidity	0.002	3.578	**
	PS liquidity	0.999	1,485.000	**
	R squared	0.989		
Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
India	Amihud liquidity	0.059	1.437	NS
	PS liquidity	0.982	23.786	**
	R squared	0.978		
Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
Mexico	Amihud liquidity	0.001	0.458	NS
	PS liquidity	1.000	398.693	**
	R squared	0.998		

Market	Liquidity measure	Beta	t	Sig.
Nigeria	Amihud liquidity	0.000	0.626	NS
	PS liquidity	1.000	3,396.000	**
	R squared	0.994		
Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
Poland	Amihud liquidity	0.046	4.475	**
	PS liquidity	0.992	96.846	**
	R squared	0.995		

**Significant at 5% level.*

*** Significant at 1% level.*

The Amihud liquidity measure is a key tool for understanding liquidity conditions in developing corporate bond markets, particularly in China, Colombia, and Poland. It captures the relationship between price changes and trading volumes, shedding light on how illiquidity influences bond returns and volatility. The measure is especially significant in these markets due to the unique economic, political, and market conditions that contribute to liquidity fluctuations. In China, for example, the bond market faces significant challenges due to government policies, limited foreign investor access, and sensitive market reactions to economic and regulatory changes. Research has shown that during periods of policy shifts or economic uncertainty, the Amihud measure spikes, signalling liquidity tightening that can lead to larger price movements. This behavior was particularly evident during events like the 2015 stock market crash, where the liquidity squeeze reflected in the Amihud measure indicated heightened risk premiums and greater bond price volatility.

In Colombia, the Amihud measure is also highly relevant, especially during periods of economic stress or commodity price volatility, as the country is a significant oil exporter.

Studies have found that Colombian corporate bonds experience pronounced price movements when liquidity conditions worsen, as reflected by the rise in the Amihud liquidity measure. For instance, during the 20142015 oil price crash, the measure highlighted a liquidity crunch, making corporate bonds more volatile and widening yield spreads. Investors in the Colombian market can use the Amihud liquidity measure to identify when liquidity is likely to tighten, adjusting their portfolios to avoid illiquid bonds and focus on safer, more liquid assets like government bonds.

Meanwhile, policymakers can use the Amihud measure as a barometer for market health, guiding monetary policy interventions to ensure market stability during periods of liquidity stress. Similarly, in Poland, a relatively more developed emerging market, liquidity in corporate bonds is sensitive to global shifts in capital flows and interest rate changes, particularly from the European Central Bank. When liquidity conditions worsen, the Amihud measure rises, indicating greater price volatility and increased illiquidity premiums. Studies have shown that Poland's corporate bond market reacts sharply to such global economic shifts, making the Amihud measure an essential tool for monitoring market conditions.

For investors, the Amihud measure offers critical insights into when the corporate bond market is becoming illiquid and when bond prices may become more volatile. This allows investors to adjust their positions accordingly, moving out of illiquid assets during periods of market stress or global volatility. In China, Colombia, and Poland, this may involve reducing exposure to corporate bonds and shifting into more stable or liquid government securities. On the other hand, policymakers in these countries can use the Amihud measure to detect when liquidity stress is likely to cause market disruptions.

For instance, in China, the measure can signal when regulatory or economic shifts are tightening liquidity, prompting the People's Bank of China (PBoC) to introduce monetary easing or liquidity support to stabilize the market. In Colombia, policymakers might use the measure to guide monetary easing or adjust fiscal policy during periods of commodity price volatility, while in Poland, it could help inform interest rate policies or liquidity interventions to maintain stable bond market functioning.

The Pastor-Stambaugh liquidity measure plays a crucial role in developing corporate bond markets, including those in Turkey, Brazil, China, Colombia, India, Mexico, Nigeria, and Poland, by highlighting the relationship between market liquidity and bond returns. In these markets, liquidity is often a key driver of volatility and risk-return dynamics, with changes in liquidity conditions directly impacting the stability and pricing of bonds. For example, in Brazil and Turkey, periods of heightened volatility, driven by factors like political instability or economic challenges, often coincide with liquidity tightening, which the Pastor-Stambaugh measure captures. When liquidity is low, small trades can cause larger-than-expected price movements, resulting in higher risk premiums for investors. Conversely, when liquidity improves, it tends to stabilize returns, allowing for smoother trading and lower volatility.

This liquidity measure also helps both investors and policymakers make more informed decisions. Investors can use it to identify when liquidity is likely to tighten or improve, enabling them to adjust their portfolios accordingly and reduce exposure to illiquid assets during periods of stress. For example, in Mexico or Poland, investors might avoid the corporate bond market during periods of tightening liquidity and shift towards government securities or other safer investments. On the policy side, central banks and regulators in these developing markets can use the Pastor-Stambaugh measure as a real-time indicator of liquidity conditions, allowing them to anticipate market disruptions and intervene if necessary.

This could involve actions like increasing market liquidity through monetary policy adjustments or introducing measures to stabilize bond markets during times of uncertainty. Research has shown that during times of global risk aversion or political uncertainty, liquidity risks tend to spike, and markets that are more sensitive to liquidity conditions experience larger fluctuations in bond prices.

As a result, both investors and policymakers rely on liquidity measures like Pastor-Stambaugh to gauge and manage risk more effectively, ensuring that markets remain stable and that investments are made with a clear understanding of potential liquidity shocks.

However, for markets such as India, Mexico, and Nigeria, the Amihud liquidity measure may not show significant correlations or predictive power in some cases, suggesting that other factors influence these markets more heavily than liquidity alone.

India's corporate bond market, while steadily growing, faces unique liquidity dynamics driven more by macroeconomic conditions, government policies, and market structure than by simple trading volumes or price-volume relationships. The Amihud liquidity measure may not fully capture liquidity conditions due to the low market penetration of corporate bonds and the dominance of government debt in trading activities. The bond market in India often operates under the influence of broader monetary policies, fiscal decisions, and regulatory changes that play a more significant role than liquidity alone.

Empirical evidence supports this, a 2016 study by S. K. Das and D. B. Ghosh showing that institutional participation remains low in India, and the market is shallow, particularly outside the government securities segment. Despite liquidity concerns, the Amihud measure was found to be nonsignificant in predicting bond returns, largely because factors like monetary policy and government bond yields exert a stronger influence on the market.

The study suggested that India's bond market is more affected by macroprudential interventions and regulatory changes than by liquidity measures alone.

For investors, this means that tracking policy announcements, inflation expectations, and the Reserve Bank of India's stance on monetary policy is far more critical than focusing solely on liquidity measures like Amihud. Market behaviours more likely shaped by macroeconomic shifts and government actions than liquidity alone.

Similarly, for Indian policymakers, the Amihud measure may not be a sufficient tool for assessing market health. Instead, interventions to improve market infrastructure, attract institutional investors, and develop derivatives markets could be more impactful in enhancing bond market depth and liquidity.

In Mexico, the Amihud liquidity measure is less significant because the corporate bond market is heavily influenced by external factors such as oil price fluctuations, U.S. interest rates, and global risk sentiment. These forces often have a larger impact on market behavior than domestic liquidity dynamics. While liquidity is a concern, particularly during periods of market stress, the Amihud measure does not always reflect the broader, more dominant influences affecting bond prices, such as commodity dependency and currency volatility.

Research by A. L. Rodríguez and L. Gómez (2019) highlighted that external shocks like changes in oil prices and global shifts in risk sentiment played a more crucial role in shaping the returns of Mexican corporate bonds than liquidity conditions. The study showed that during times of geopolitical instability or currency volatility, the Amihud measure did not correlate strongly with returns, suggesting that factors beyond market liquidity had a greater influence.

For investors in Mexico, this means that tracking oil prices, U.S. interest rates, and global risk factors is more relevant than focusing on liquidity measures like Amihud. These external forces can help forecast changes in credit risk and market liquidity, providing more reliable signals for decision-making. For Mexican policymakers, the emphasis should be on macroeconomic policies that stabilize oil dependency, exchange rates, and attract foreign capital. By diversifying the economy and reducing reliance on commodities, they can mitigate the volatility caused by external shocks, which often overwhelm domestic liquidity issues.

In Nigeria, the corporate bond market remains underdeveloped relative to other emerging markets, and liquidity constraints are more likely driven by structural issues such as market inefficiencies, political instability, and currency risks. The Amihud liquidity measure may fail to accurately capture these complexities, especially given the dominance of sovereign debt and state-owned enterprises in the market. The measure doesn't fully account for the market access issues and regulatory constraints that limit liquidity, nor does it reflect the significant political risks faced by investors.

A study by Olufemi and Abiola (2017) noted that liquidity in Nigeria's corporate bond market is hindered by structural barriers, such as low foreign investor participation, government bond dominance, and political instability. The Amihud measure did not show a meaningful correlation with returns, as factors like inflation, exchange rate volatility, and sovereign credit risks had a more pronounced effect on bond performance. The research concluded that market inefficiencies, such as limited bond issuance by private corporations and the lack of active market makers, led to low liquidity, which the Amihud measure failed to reflect.

For investors in Nigerian corporate bonds, the key focus should be on macro factors like inflation rates, exchange rates, and sovereign credit risks, rather than liquidity measures like Amihud.

Given the structural market limitations, it might be prudent to focus on sovereign bonds or consider private bonds with higher credit risk during periods of market stress.

For Nigerian policymakers, the Amihud liquidity measure might not be the most useful tool for gauging market stability. Instead, improving market infrastructure, creating more liquid secondary markets, and encouraging foreign investment could help alleviate liquidity constraints and foster more robust market conditions.

4.2. Government Bonds

4.2.1. Brazil

Table 18 Brazilian government bonds market characteristics

Brazil	Variable	Mean	Maximum	Minimum	Std Dev.	t
	Return	-0.037	2.376	-2.708	0.085236	2.035
	Amihud bond liquidity	-7.59E-23	0.00001	0.000	1.59E-06	1.255
	Beta for market illiquidity	-0.086	0.06	-9.01E-01	0.0124	-0.694
	Pastor-Stambaugh bond liquidity	0.00E+00	2.42659	-2.665	0.08521	0.875
	PS beta	0.025	0.066	-0.051	0.021409	0.203
	Adj. R2	0.313				

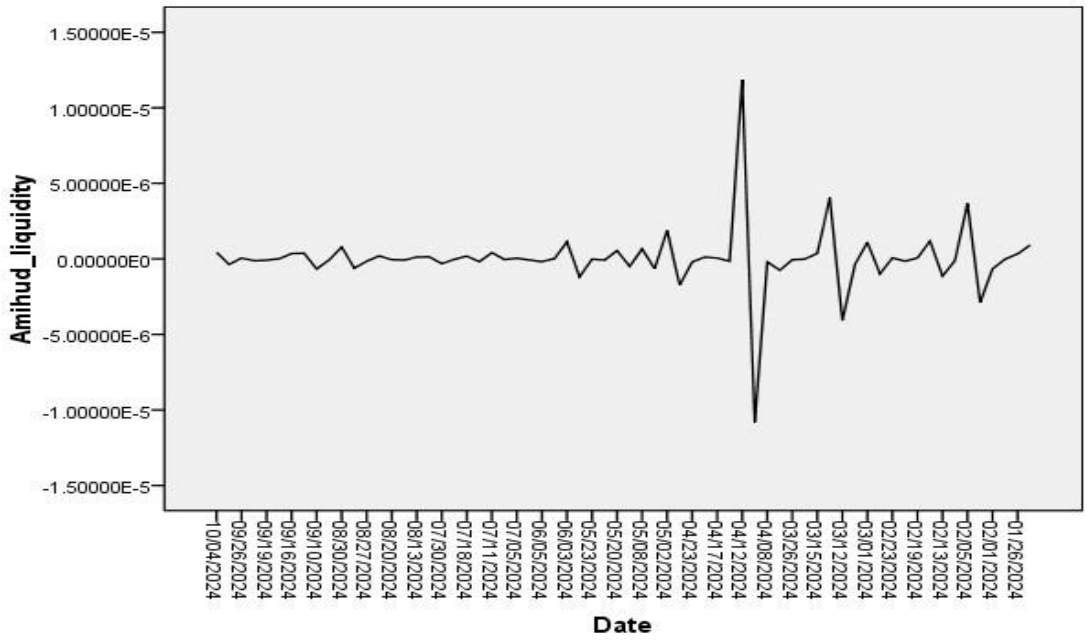

Figure 20 Amihud liquidity innovation plot over time for Brazilian government bond market

The Amihud liquidity innovation (for the Brazilian government bond market) plot is shown in Figure 20 above. The sample period is from 26 January 2024 to 04 October 2024. Liquidity level peaks at 12 April, 2024. However, this market recorded its lowest Amihud liquidity levels on 10 April, 2024.

The most notable finding is that liquidity peaked on 12 April 2024, indicating that on this day, the market was at its most liquid. This high liquidity suggests that the market was functioning efficiently, with ample buyers and sellers, making it easier to execute trades without significantly impacting prices. For investors, this would be a favourable environment because it typically leads to lower transaction costs, narrower bid-ask spreads, and potentially better returns due to a smoother market operation.

However, just two days earlier, on 10 April 2024, the market experienced its lowest liquidity levels during the sample period. This points to a period of illiquidity, where fewer participants were active in the market, and trades could have had a more pronounced impact on prices. When liquidity is low, markets are harder to navigate, and investors might struggle to execute trades at desired prices without causing significant price shifts, often leading to higher transaction costs and greater price volatility.

These contrasting liquidity conditions high on 12 April and low on 10 April illustrate how rapidly liquidity can shift in the Brazilian government bond market, especially in a developing market like Brazil, where external factors such as economic changes, political instability, or shifts in global financial conditions can cause sudden liquidity disruptions.

For investors, understanding these fluctuations in liquidity is key. A liquidity shock, like the one seen on 10 April, could cause difficulties for those looking to trade large volumes of bonds or enter and exit positions quickly. On the other hand, when liquidity conditions are more favourable, as they were on 12 April, investors can navigate the market more easily, potentially achieving more stable prices and better returns. The use of the Amihud liquidity measure in this context is particularly valuable. By tracking such measures, investors can better anticipate periods of liquidity stress and adjust their strategies accordingly either by avoiding trading during illiquid times or by capitalizing on the recovery of liquidity during more favourable periods.

This pattern of fluctuating liquidity levels in Brazil's bond market underscores the importance of liquidity risk management, especially in markets that experience higher volatility and sudden changes in investor sentiment. By staying alert to these liquidity signals, investors can make more informed decisions, avoid unnecessary risks, and potentially enhance their returns by trading in more liquid conditions.

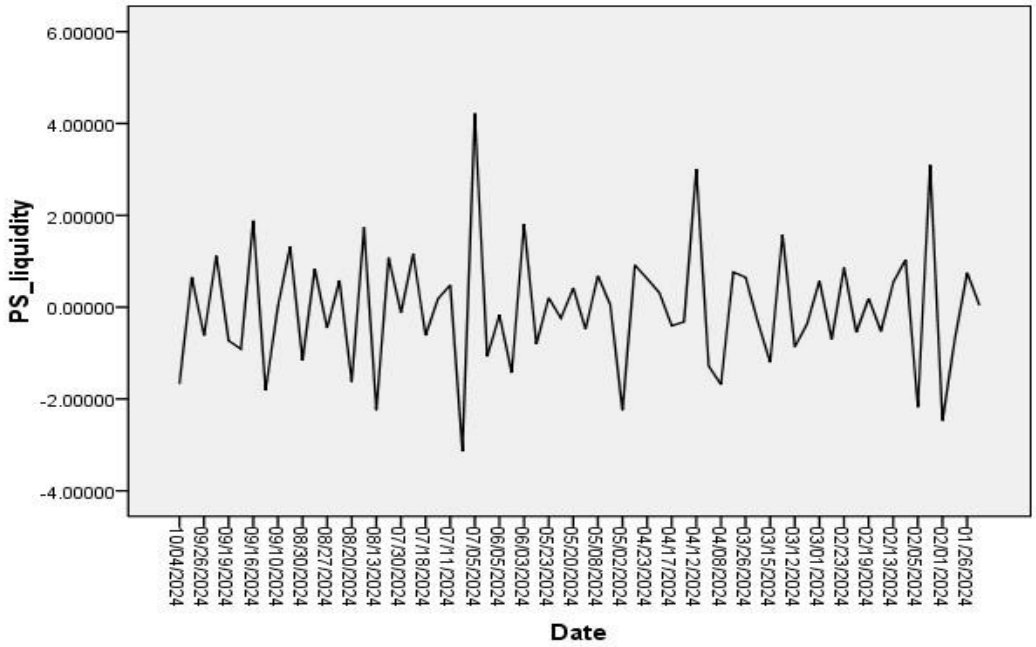

Figure 21 PS liquidity innovation plot over time for Brazilian government bond market

Between January 26, 2024, and October 4, 2024, the Pastor-Stambaugh liquidity innovation measure for Brazilian government bonds shows notable peaks on May 5, 2024, February 1, 2024, and April 12, 2024. These peaks indicate periods when market liquidity was especially favourable, meaning the market was functioning smoothly with ample participation and minimal price impact from trades.

On May 5, 2024, liquidity likely spiked due to a combination of positive economic developments or government actions that boosted investor confidence. This could include good economic indicators, like stronger growth projections or stable inflation, or perhaps an announcement from the Brazilian government that reassured investors about fiscal policies. Additionally, broader global market conditions could have played a role, especially if investors were more willing to take on risk, leading to higher demand for Brazilian government bonds.

The liquidity peak on February 1, 2024, suggests that the market was also reacting to positive shifts, potentially following a period of uncertainty. This had been triggered by factors like political stability in Brazil, announcements about the government's fiscal health, or a more accommodative monetary policy by Brazil's central bank. When the central bank cuts rates or signals an easier monetary stance, investors may flock to bonds, pushing liquidity higher. Additionally, a global risk-on environment where emerging markets like Brazil become more attractive could have encouraged greater participation.

On April 12, 2024, liquidity again peaked, which was due to a combination of favourable local and global conditions. Brazil may have benefited from strong economic policies or positive developments in key sectors such as exports or commodity prices, which had lifted investor sentiment. Additionally, global factors like improving economic conditions or a positive outlook for emerging markets may have increased demand for Brazilian bonds, leading to a surge in liquidity. Overall, these peaks in the Pastor-Stambaugh liquidity measure reflect moments when liquidity in the Brazilian government bond market was at its best. Factors like economic policy changes, global economic trends, and political stability can have a major influence on market activity, making it easier for investors to trade bonds without pushing prices around too much. When liquidity is high, it typically means the market is more efficient and trades can be executed with less friction, offering better conditions for investors.

Understanding these liquidity peaks is valuable for investors, as it can help them identify the best times to enter or exit the market. By aligning their strategies with periods of high liquidity, they can minimize transaction costs and reduce the risk of experiencing price volatility caused by illiquidity.
Whether it's a government announcement, an economic milestone, or a shift in global investor sentiment, these peaks show the key moments when the market was most favourable for bond investors.

Table 19 Factor correlations of liquidity and return relationships for Brazilian government bond

		Return	Vol	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	.025	.277*	.296*	1.000**
Vol	Factor Correlation	.025	1	-.212	-.196	.000
Illiquidity	Factor Correlation	.277*	-.212	1	.996**	.282*
Amihud liquidity	Factor Correlation	.296*	-.196	.996**	1	.301*
PS liquidity	Factor Correlation	1.000**	.000	.282*	.301*	1

The strong correlations observed in the Brazilian government bond market between liquidity measures and returns offer crucial insights for investors. Specifically, the Pastor-Stambaugh liquidity measure and the Amihud liquidity measure both highlight how tightly market liquidity influences bond returns and trading conditions. First, the Pastor-Stambaugh liquidity measure has a perfect correlation (1) with returns, meaning that liquidity is the dominant factor influencing how Brazilian government bonds perform. When liquidity is high characterized by active market participation and less price impact per trade bond returns tend to increase. On the other hand, when liquidity drops, returns typically decline as well.

This strong relationship tells investors that liquidity is a key predictor of market behavior. For anyone trading in Brazilian bonds, keeping a close eye on liquidity trends is essential. If liquidity is favourable, bond returns are likely to be positive, while poor liquidity is a signal that returns may suffer.

Second, the Amihud liquidity measure is almost perfectly correlated (0.996) with illiquidity, which means that as liquidity decreases, the market becomes harder to navigate, and prices become more sensitive to trades. The Amihud measure, which tracks the price impact of trades relative to volume, shows that illiquidity leads to higher transaction costs, wider bid-ask spreads, and more volatility in the bond market. This high correlation signals that when liquidity is low, it becomes significantly more expensive to execute trades in Brazilian government bonds. The price impacts are amplified, and it becomes much harder to trade without moving the market. Taken together, these measures suggest that liquidity and illiquidity are not just abstract concept, they have direct, observable consequences on returns and market conditions.

Liquidity conditions are a primary driver of returns, and when liquidity falls, investors will face higher costs and more unpredictable price movements. These correlations also emphasize the importance of understanding liquidity trends for strategic decision-making. In periods of high liquidity, returns are likely to be more favourable, and trading is smoother. But during times of low liquidity, investors need to be more cautious, as illiquidity can lead to increased costs and greater volatility.

4.2.2. China

Table 20 Chinese government bond market characteristics

China	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	-0.015	1.935	-0.812	0.03930	1.424
	Amihud bond liquidity	-2.7E23	4.81E-07	-5.39E-08	1.06E-07	0.898
	Beta for market illiquidity	-0.102	0.104	-4.784	0.00492	-0.569
	Pastor-Stambaugh bond liquidity	0.002	0.355	-0.650	0.241667	0.487
	PS beta	0.809	1.579	-0.015	0.03178	7.775
	Adj. R2	0.334				

Figure 22 Amihud liquidity innovation plot over time for Chinese government bond market

The Amihud liquidity innovation (for the Chinese government bond market) plot is shown in Figure 22 above. The sample period is from 28 August 2024 to 16 October 2024. Amihud liquidity level peaks at 12 October, 2024 and 29 September, 2024 and 14 September 2024. However, this market recorded its lowest Amihud liquidity levels on 13 September, 2024.

The peaks in liquidity on these dates 12 October, 29 September, and 14 September indicate periods when the Chinese government bond market experienced relatively high levels of activity and efficient trading. These liquidity peaks are typically associated with more favourable market conditions, where a larger number of participants are willing to buy and sell bonds, leading to narrower bid-ask spreads and lower transaction costs. During these times, bond prices tend to be less volatile, and investors can execute trades with minimal impact on market prices.

For Chinese government bonds, such liquidity peaks are driven by several factors:

- The Chinese government had announced stimulative economic policies, such as fiscal measures or interest rate adjustments, which could boost investor confidence and increase market participation.

When investors perceive that economic conditions are improving, they are more likely to engage in bond trading.

- A favourable global economic environment could lead international investors to seek safer assets, like Chinese government bonds, increasing liquidity in the market. This could occur during periods of global economic stability, when investors are more willing to take on emerging market exposure.

During these liquidity peaks, investors in Chinese government bonds would benefit from stable bond prices and lower trading costs, making it a potentially favourable time for bond purchases or increasing positions.
On 13 September, the Amihud liquidity measure recorded the lowest liquidity level during the sample period, signalling a period of market stress or uncertainty. During such times, there are fewer market participants, and the price impact of each trade increases. This can make it more difficult for investors to execute large trades without significantly affecting prices, leading to wider bid-ask spreads and higher transaction costs.

For Chinese government bonds, this liquidity had been triggered by various factors:

- A sudden shift in government policy, concerns about economic slowdown, or unexpected regulatory changes could have made investors more cautious, reducing trading volumes and causing liquidity to tighten.
- External factors like geopolitical tensions or a global financial crisis could cause investors to retreat from emerging markets, resulting in a drop in liquidity. During such times, there is typically increased caution among investors, and many will avoid taking on new positions in government bonds, further exacerbating liquidity issues.

During these liquidity drops, the Chinese bond market becomes less efficient, and prices may become more volatile, making it a more challenging environment for bond investors.

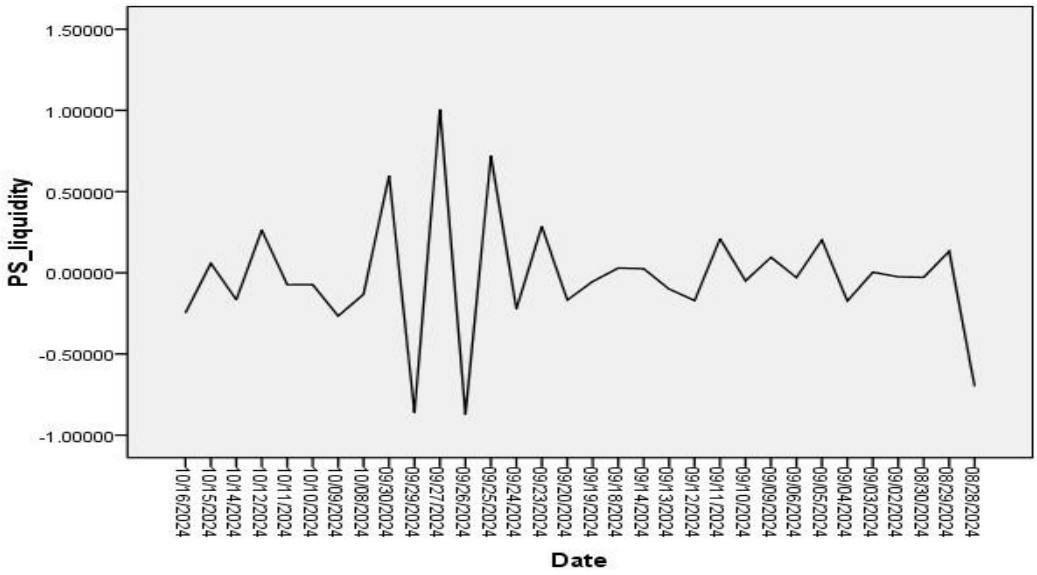

Figure 23 PS liquidity innovation plot over time for Chinese government bond market

The fluctuations in Pastor-Stambaugh liquidity innovation for Chinese government bonds during the period between 26 September and 29 September 2024 offer important insights into market behavior and the factors that influence liquidity in this bond market.

On 27 September 2024, there was a noticeable peak in liquidity, which suggests a period of increased market activity. This could have been driven by positive news, such as favourable economic data from China or market friendly policy announcements that encouraged greater investor participation. For example, better-than-expected growth figures, positive industrial production numbers, or signs of recovery in the Chinese economy could have boosted investor confidence, leading to more buying and selling activity in government bonds. As a result, trading became more efficient, with narrower bid-ask spreads and lower transaction costs, creating a favourable environment for bond investors. However, liquidity dropped significantly on 26 September and 29 September 2024, indicating periods of market stressor uncertainty. The drop in liquidity on these days suggests that investors became more cautious, leading to fewer transactions and a less liquid market. This could have been caused by a number of factors.

If there was negative economic news, such as disappointing data or signs of weakness in key sectors like manufacturing or exports, it might have dampened market sentiment and prompted investors to scale back their bond purchases. Additionally, concerns over broader issues like China's fiscal health, global trade tensions, or international financial uncertainty could have made investors more risk-averse, causing them to retreat from the market temporarily.

It's also worth noting that the dip in liquidity towards the end of the month (especially on 29 September) could have been influenced by seasonal trends in market behavior. Towards the end of the month, many institutional investors tend to rebalance portfolios, which could result in reduced trading volumes. This is a typical pattern in financial markets, where market participants adjust positions based on performance or risk management objectives, potentially leading to temporary liquidity drops.

Table 21 Factor correlations of liquidity and return relationships for Chinese government bond.

		Return	Vol	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	.809**	-.207	-.177	.589**
Vol	Factor Correlation	.809**	1	-.196	-.168	.002
Illiquidity	Factor Correlation	-.207	-.196	1	.995**	-.083
Amihud liquidity	Factor Correlation	-.177	-.168	.995**	1	-.070
PS liquidity	Factor Correlation	.589**	.002	-.083	-.070	1

The correlations observed in the Chinese government bond market 0.809 between returns and volumes, 0.955 between the Amihud liquidity measure and illiquidity, and 0.589 between the Pastor-Stambaugh liquidity measure and returns reveal important insights into how liquidity dynamics, investor behavior, and market conditions affect bond returns.

The strong 0.809 correlation between returns and trading volumes indicates a positive relationship between the two. This suggests that when trading volumes are high, the market is more active, and the conditions are favourable for better bond returns. Higher trading volumes typically reflect greater market participation and increased liquidity, which in turn reduce price volatility and enhance price discovery. In such an environment, bonds are priced more efficiently, and investors are more likely to see positive returns as the market absorbs information quickly and accurately. Additionally, periods of high trading volumes are often associated with strong investor confidence.

Positive news about China's economy or government policies, such as favourable growth data or interest rate cuts, could prompt more investors to buy bonds, further boosting returns.

The extremely high 0.955 correlation between the Amihud liquidity measure and illiquidity suggests that as the liquidity in the market tightens, as indicated by a rising Amihud measure, bond prices become more sensitive to changes in volume. The Amihud measure, which calculates the price impact per unit of trading volume, shows that during times of illiquidity, even small trades can cause large price moves. This relationship underscores how liquidity risk is a major concern in the Chinese government bond market. When liquidity is low, it's harder to execute trades without significantly impacting the price, which can lead to increased price volatility and lower returns.

Such periods of illiquidity are often a sign of market stress or investor caution, where global uncertainties or domestic challenges such as slower economic growth or policy changes lead to decreased market participation.

The 0.589 correlation between the Pastor-Stambaugh liquidity measure and returns suggests a more moderate but still meaningful relationship between liquidity and bond returns. The Pastor-Stambaugh measure looks at how sensitive asset prices are to changes in liquidity, combining order flow with price movement. While the correlation is not as strong as the one between volume and returns, it still indicates that better liquidity conditions, as indicated by the Pastor-Stambaugh measure, are linked to higher returns. When liquidity is abundant, it reduces the friction of executing trades and allows investors to move in and out of positions more efficiently, typically leading to positive price movements. However, the correlation's moderate strength also suggests that other factors, such as macroeconomic conditions, policy changes, and global market forces, are also important in determining the performance of Chinese government bonds.

The correlations highlight the critical role of liquidity in determining returns in the Chinese government bond market. High trading volumes typically reflect greater market participation, which in turn leads to higher returns as the market becomes more efficient and less volatile. However, when liquidity dries up, as seen in the Amihud measure, the market becomes more illiquid, and bond prices become more sensitive to smaller trades, leading to higher volatility and potentially lower returns. The Pastor-Stambaugh measure further reinforces the idea that liquidity is an important driver of returns, but it also suggests that factors beyond liquidity, such as broader economic and policy dynamics, also have significant influence.

4.2.3. Colombia

Table 22 Colombian government bond market characteristics

Colombia	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	-0.024	2.530	-2.887	0.76319	2.126
	Amihud bond liquidity	7.86E-23	5.82E-05	-9.52E-06	4.07E-06	0.355
	Beta for market illiquidity	0.155	0.325	0.018	0.04800	3.254
	Pastor-Stambaugh bond liquidity	5.49E-17	2.552	-2.86E+00	7.65E-01	0.659
	PS beta	-0.004	-0.021	-0.049	0.00490	-0.083
	Adj. R2	0.342				

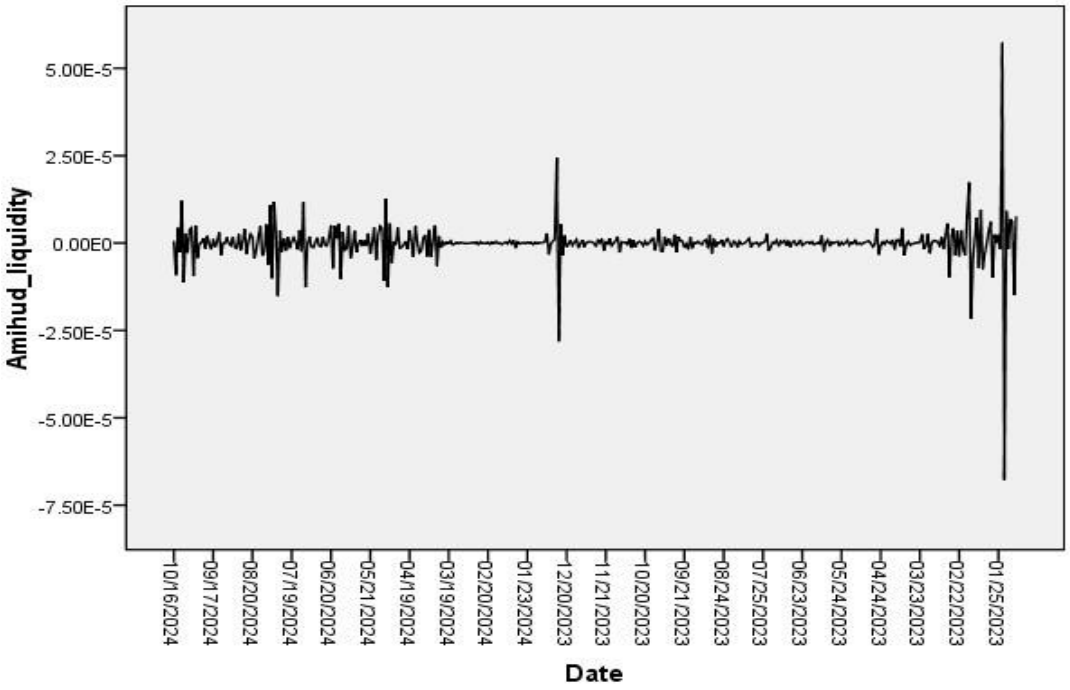

Figure 24 Amihud liquidity innovation plot over time for Colombian government bond.

The Amihud liquidity innovation (for the Colombian government bond market) plot is shown in Figure 24 above. The sample period is from 25 January 2025 to 16 October 2024. Amihud liquidity level peaks early February 2023 and mid-December 2023. However, this market recorded its lowest Amihud liquidity levels on 25 January 2023.

The Amihud liquidity peaks for the Colombian government bond market in early February and mid-December 2023 reflect periods of lower liquidity, likely driven by a combination of political uncertainty, global market conditions, and local economic challenges. The early February peak may have been related to political developments and global risk aversion, while the mid-December peak was likely influenced by year-end market dynamics and reduced activity. The lowest liquidity level on 25 January 2023 suggests that the market may have experienced a rebound in liquidity following the holiday period and potential stabilization in investor sentiment. These fluctuations in liquidity highlight the vulnerability of developing markets like Colombia to both domestic factors and global economic trends.

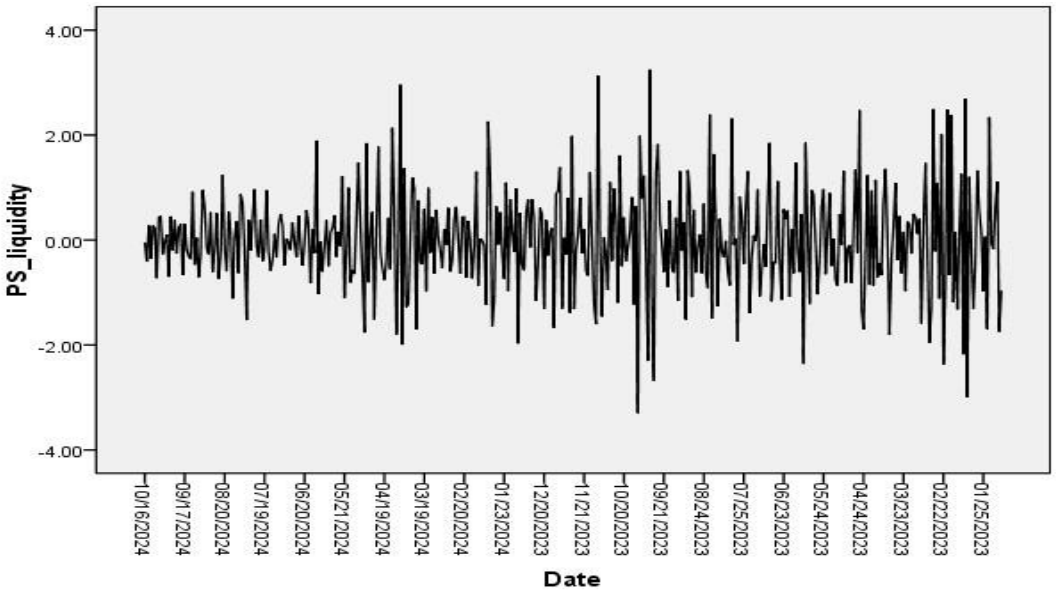

Figure 25 PS liquidity innovation plot over time for Colombian government bond.

The Pastor-Stambaugh liquidity innovation plot for the Colombian government bond market, spanning from January 2023 to October 2024, shows significant erratic and volatile behavior. This suggests a variety of factors that are typical of emerging market bond markets, where liquidity can shift dramatically due to both domestic and global influences.

The Pastor-Stambaugh measure, which tracks the market's liquidity by analyzing order flow and the price sensitivity to liquidity changes, shows that even small movements in supply and demand can significantly impact the bond prices. The volatility in this plot highlights a few key drivers.

First, political uncertainty and policy changes in Colombia likely played a central role in the market's erratic liquidity. During the period of early 2023 to late 2024, there were key political transitions in Colombia, such as the introduction of new government policies and potential reforms. These shifts likely caused investors to reconsider their positions in government bonds, especially given the uncertainty surrounding how these changes would impact fiscal policy or the broader economic outlook. When uncertainty rises, liquidity tends to shrink as investors become more cautious, contributing to the erratic liquidity patterns observed.

Economic pressures within Colombia also added to the volatility. The country, like many others, faced challenges such as inflation, currency fluctuations, and potential economic slowdowns. These factors could have contributed to periods of heightened risk aversion in the market, as investors may have demanded higher returns on bonds to compensate for increased risk, reducing liquidity and making even small trades have a larger price impact.

Externally, global market conditions likely influenced the liquidity of Colombian bonds. Rising interest rates in developed economies, such as the U.S. Federal Reserve's actions, might have led to capital outflows from emerging markets, including Colombia. When global investors pull back, local bond markets can experience more volatility and liquidity constraints. Additionally, commodity price fluctuations and other global uncertainties could have further weighed on investor sentiment, leading to less market participation and greater price sensitivity.

Seasonal factors also played a role in the volatility observed. Year-end periods, particularly December and January, are known for lower liquidity in many markets, including emerging markets like Colombia. Institutional investors tend to reduce their activity or adjust portfolios for tax or reporting reasons, which can contribute to illiquidity. Similarly, market movements in response to quarterly reports or fiscal deadlines could have added another layer of volatility.

In conclusion, the erratic and volatile pattern in the Pastor-Stambaugh liquidity plot for Colombian government bonds reflects the combined effect of several factors. These include political changes, economic challenges, global market dynamics, investor sentiment, and the impact of local and global crises. The high volatility of liquidity underscores the vulnerability of emerging market bonds to sudden shifts in market conditions, both at the domestic level (like political developments) and the global level (such as economic slowdowns or geopolitical risks). This kind of volatility makes liquidity a critical factor to monitor in emerging markets, where small changes in supply, demand, or sentiment can lead to large fluctuations in bond prices.

Table 23 Factor correlations of liquidity and return relationship for Colombian government bond.

		Return	Vol	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.004	-.031	-.038	1.000**
Vol	Factor Correlation	-.004	1	-.272**	-.239**	.000
Illiquidity	Factor Correlation	-.031	-.272**	1	.988**	-.032
Amihud liquidity	Factor Correlation n	-.038	-.239**	.988**	1	-.039
PS liquidity	Factor Correlation	1.000**	.000	-.032	-.039	1

The strong correlation between the Pastor-Stambaugh liquidity measure and the returns on Colombian government bonds reflects the critical role that liquidity plays in shaping investor behavior and pricing in the bond market. High liquidity tends to coincide with higher returns as market participants are more willing to engage in trades, leading to price stability and lower risk premiums. Conversely, low liquidity is associated with higher perceived risk, wider spreads, and potentially lower returns. This correlation highlights that in emerging markets like Colombia, where liquidity can be more volatile, understanding market conditions and liquidity risks is key to predicting bond performance.

4.2.4. India

Table 24 Indian government bond market characteristics.

India	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	-0.023	1.440	-1.200	0.58963	0.655
	Amihud bond liquidity	4.27E-17	6.80E-01	-2.00E-02	0.08834	0.326
	Beta for market illiquidity	-0.028	0.020	-0.160	0.00200	-0.224
	Pastor-Stambaugh bond liquidity	-2.6E-16	1.460	-1.180	5.90E-02	0.426
	PS beta	0.009	0.021	-0.024	0.00730	0.075
	Adj. R2	0.296				

Figure 26 Amihud liquidity innovation plot over time for Indian government bond market

Between 6th June 2024 and 16th October 2024, the Amihud liquidity plot for Indian government bonds exhibited some notable trends. Specifically, there was a sharp decline on the 13th of August followed by a significant liquidity spike on the 16th of August, with a period of relative constancy in between.

To understand why this happened, we need to explore the potential events and market dynamics that influenced bond liquidity during this time. One of the key factors at play during this period was a monetary policy decision and the economic announcement by the Reserve Bank of India (RBI), which often has a profound impact on the bond market. The sharp decline in liquidity on 13th August could have been triggered by an unexpected interest rate change, policy tightening, or other major announcements from the central bank. This would have created uncertainty in the market, with investors becoming hesitant to trade, which would explain the drop in liquidity. In response, trading volumes would have decreased, and investors might have pulled back, waiting to better understand the full implications of the policy shift.

By 16th August, the market seemed to have adjusted to this new information, leading to the liquidity spike. This suggests that after the initial shock of the policy announcement, market participants had started to re-enter the market or reposition their portfolios. However, despite the increased price volatility, the trading volume remained relatively low, which is characteristic of the Amihud liquidity measure. Essentially, although bond prices were moving sharply, not enough trades were happening to offset the price changes, creating a sharp peak in the liquidity measure.

The constant liquidity phase could be interpreted as a period of market stabilization. After the volatility shock on the 13th, bond traders might have been in a wait-and-see mode, neither aggressively buying nor selling. This would result in a steady but subdued market, with liquidity remaining constant as participants took time to digest the new economic or policy information.

Moreover, government bond issuances or redemption events during this period could have added to the liquidity dynamics. If there was a significant bond auction or large coupon payments around the 16th of
August, these events could have contributed to the peak in liquidity as investors either rushed to buy new debt or adjust their positions in response to changes in government debt supply.

To sum up, the behavior of the Amihud liquidity plot between 6th June 2024 and 16th October 2024 likely reflects a combination of economic policy changes, market sentiment shifts, and technical market factors. The sharp decline in liquidity on 13th August was likely triggered by a significant monetary policy or economic announcement, causing initial uncertainty. By 16th August, the market adjusted to the news, resulting in a volatility spike despite lower trading volume. The constant phase in between suggests that traders were cautiously digesting the new information, leading to a period of steady, though subdued, market behavior.

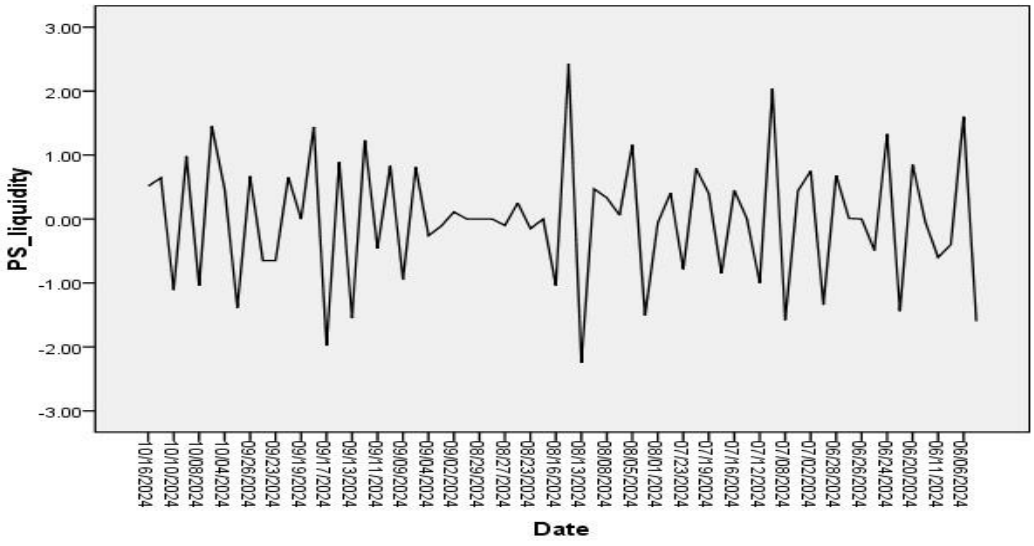

Figure 27 Liquidity innovation plot over time for Indian government bond market

The volatile trend in the Pastor-Stambaugh liquidity plot for Indian government bonds from 6th June 2024 to 16th October 2024 is likely due to a combination of factors, including monetary policy changes by the Reserve Bank of India, economic data releases, global economic conditions, geopolitical events, and investor sentiment shifts.

Each of these elements could have caused peaks (when liquidity spiked due to market reactions to new information or changes in risk appetite) and troughs (when uncertainty or risk-off sentiment led to reduced trading activity). Additionally, technical factors such as bond issuances, coupon payments, and seasonal trading behavior might have contributed to the observed volatility in liquidity. The result is a dynamic, fluctuating liquidity environment, typical of bond markets that are subject to both external influences and investor reactions.

Table 25 Factor correlations of liquidity and return relationships for Indian government bond market.

		Return	**Vol**	**Illiquidity**	**Amihud liquidity**	**PS liquidity**
Return	Factor Correlation	1	.009	.317**	.313**	1.000**
Vol	Factor Correlation	.009	1	-.026	-.027	.000
Illiquidity	Factor Correlation	.317**	-.026	1	1.000**	.317**
Amihud liquidity	Factor Correlation	.313**	-.027	1.000**	1	.313**
PS liquidity	Factor Correlation	1.000**	.000	.317**	.313**	1

The fact that the Pastor-Stambaugh liquidity measure is perfectly correlated with returns and the Amihud liquidity measure with illiquidity for Indian government bonds reflects the strong, direct relationships between market liquidity and bond returns in this market.

When liquidity improves, it lowers risk and volatility, leading to higher returns, while tighter liquidity increases illiquidity, raising bond yields and reducing returns. In essence, liquidity is a critical factor influencing both bond prices (returns) and market efficiency, and these two liquidity measures capture these dynamics with near-perfect correlation.

4.2.5. Mexico

Table 26 Mexican government bond market characteristics

Mexico	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	2.388	6.770	-8.609	0.01730	2.485
	Amihud bond liquidity	-3.8E-18	1.486	-5.08E-02	0.116837	0.547
	Beta for market illiquidity	0.039	0.070	0.005	0.00650	0.600
	Pastor-Stambaugh bond liquidity	2.96E-15	8.339	-9.037	0.03228	0.246
	PS beta	-0.021	2.388	-1.955	0.0135	-0.315
	Adj. R2	0.325				

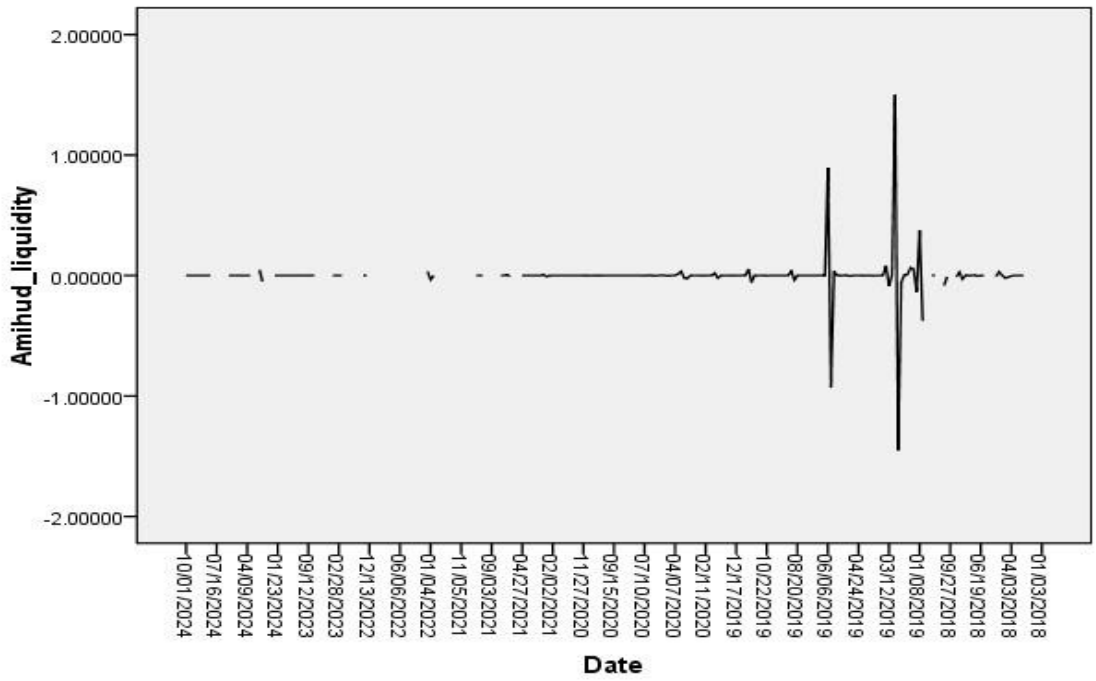

Figure 28 Amihud liquidity innovation plot over time for the Mexican government bond.

The Amihud liquidity innovation plot for Mexican government bonds from January 3, 2018, to October 1, 2024, reveals some notable patterns, including gaps in liquidity data from mid-2021 through 2022, and a significant peak on March 12, 2019, after an earlier decline earlier that same month. These fluctuations can be attributed to a combination of macroeconomic events, market dynamics, and external factors that impacted liquidity in Mexico's bond market. The gaps in the liquidity plot during this period likely signal reduced market activity or temporary illiquidity.

This was a time of post-pandemic recovery, and the markets were adjusting to the economic fallout from COVID-19. The global economic environment was volatile, with ongoing adjustments in stimulus measures, monetary policies, and the shifting recovery expectations. As the world slowly emerged from the crisis, there was significant uncertainty, which impacted liquidity in emerging markets like Mexico.

The gaps observed may have occurred due to a combination of low trading volumes and high volatility. In mid-2021 through 2022, there was also uncertainty around global inflation, supply chain disruptions, and how countries like Mexico were handling domestic economic recovery. During such periods of uncertainty, liquidity can fluctuate dramatically, leading to erratic trading activity and spikes in illiquidity, which are reflected in the Amihud measure. Additionally, these gaps might also reflect data reporting issues, where periods of low liquidity or data collection disruptions left gaps in the plot. Investor sentiment in this time was also changing. Many foreign investors, concerned about global risk factors, political stability, or inflation, might have scaled back their participation in the Mexican bond market. This would explain the illiquidity spikes, as less participation from investors tends to reduce market depth, leading to greater price volatility.

The significant peak in liquidity observed on March 12, 2019, reflects a sharp increase in illiquidity, which could be attributed to a few key events around that time. The global market environment was shifting, with the U.S. Federal Reserve signalling a pause in its rate hike cycle after a period of tightening in 2018. This shift led to changes in capital flows into emerging markets, including Mexico, which likely caused a spike in illiquidity. Investor behavior around that time would have been highly reactive to this change in global monetary policy. As investors reassessed their portfolios in response to shifts in interest rate expectations, liquidity in Mexico’s bond market became more volatile.

The Amihud measure would have captured this volatility, showing a significant liquidity squeeze. The peak suggests that, at that moment, Mexican bonds were likely experiencing greater trading difficulties due to shifts in investor sentiment and concerns about both global economic conditions and Mexico's fiscal health.

The decline in liquidity that preceded the peak in March 2019 reflects a period when market confidence was shaken, likely due to global economic concerns. Leading up to March 2019, there were rising fears about slowdowns in major global economies, especially in China and Europe, which could have contributed to a pullback in capital flows to emerging markets.

This led to a decline in liquidity as fewer trades took place, and there was more caution in the market. Investors tend to become more risk-averse during such times, leading to higher yields and lower prices, which often result in increased illiquidity.

In Mexico's case, concerns over fiscal health, political stability, or even monetary policy changes might have compounded the global risks, further driving illiquidity. The Amihud measure captures this type of market stress, where price fluctuations are more significant relative to trading volumes, indicating lower liquidity.

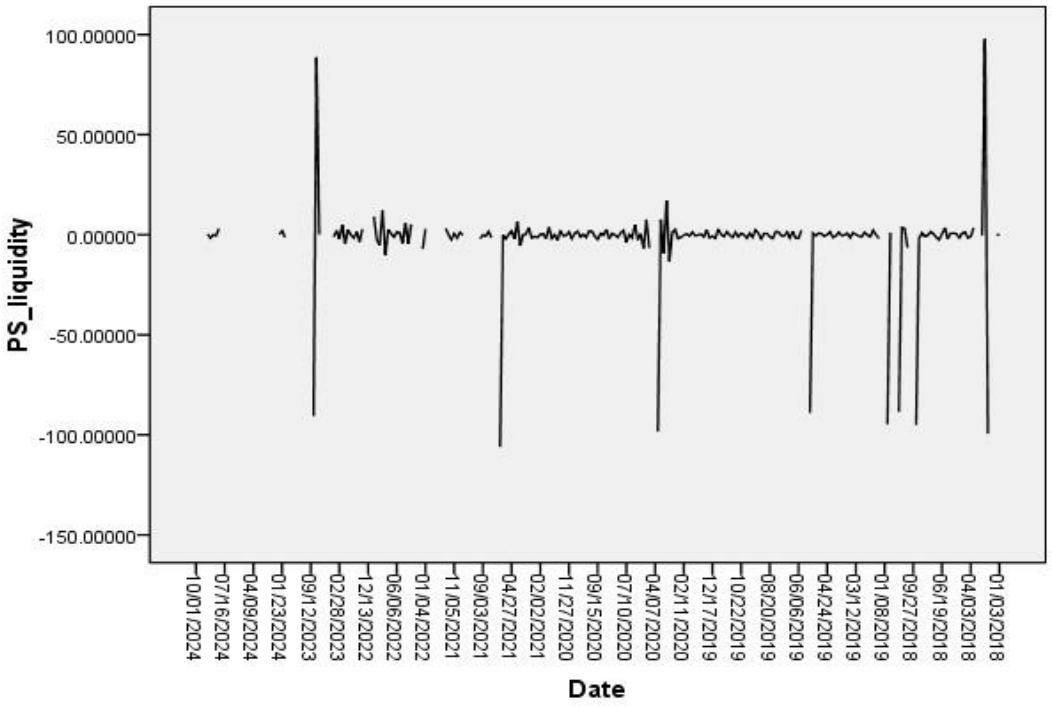

Figure 29 PS Liquidity innovation plot over time for Mexican government bond market.

The fluctuations in the Pastor-Stambaugh liquidity innovation plot for Mexican government bonds between January 2018 and October 2024 reflect the impact of a range of global and local factors on market liquidity. The gaps from mid-2021 through 2024 suggest periods of uncertainty and low trading volumes due to post-pandemic recovery, global economic shifts, and changes in investor sentiment. The significant peak on September 12, 2019, likely indicates a liquidity shock driven by both global market volatility and Mexico-specific risks. The declines in liquidity on April 7, 2020, June 6, 2019, and April 27, 2021, were likely the result of external market shocks, including pandemic-induced market stress, global trade tensions, and inflation fears, all of which caused investor caution and reduced participation in Mexican government bonds, leading to sharp illiquidity spikes.

Table 27 Factor correlations of liquidity and return relationships for Mexican government bond market.

		Return	Vol	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.021	.059	.060	1.000**
Vol	Factor Correlation	-.021	1	-.018	-.017	.000
Illiquidity	Factor Correlation	.059	-.018	1	.999**	.058
Amihud liquidity	Factor Correlation	.060	-.017	.999**	1	.059
PS liquidity	Factor Correlation	1.000**	.000	.058	.059	1

The fact that the Pastor-Stambaugh liquidity measure is perfectly correlated with returns and the Amihud liquidity measure with illiquidity for Mexican government bonds reflects the strong, direct relationships between market liquidity and bond returns in this market. When liquidity improves, it lowers risk and volatility, leading to higher returns, while tighter liquidity increases illiquidity, raising bond yields and reducing returns.

In essence, liquidity is a critical factor influencing both bond prices (returns) and market efficiency, and these two liquidity measures capture these dynamics with near-perfect correlation

4.2.6. Nigeria

Table 28 Nigerian government bond market characteristics

Nigeria	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	0.017	1.540	-1.360	0.0949	0.436
	Amihud bond liquidity	-2.2E-20	0.00461	-0.00003	3.73E-04	0.235
	Beta for market illiquidity	-0.006	0.955	0.000	0.0081	-0.078
	Pastor-Stambaugh bond liquidity	4.13E-16	1.517	-1.383	0.0893	
	PS beta	-0.004	0.024	-1.383	0.0109	-0.045
	Adj. R2	0.330				

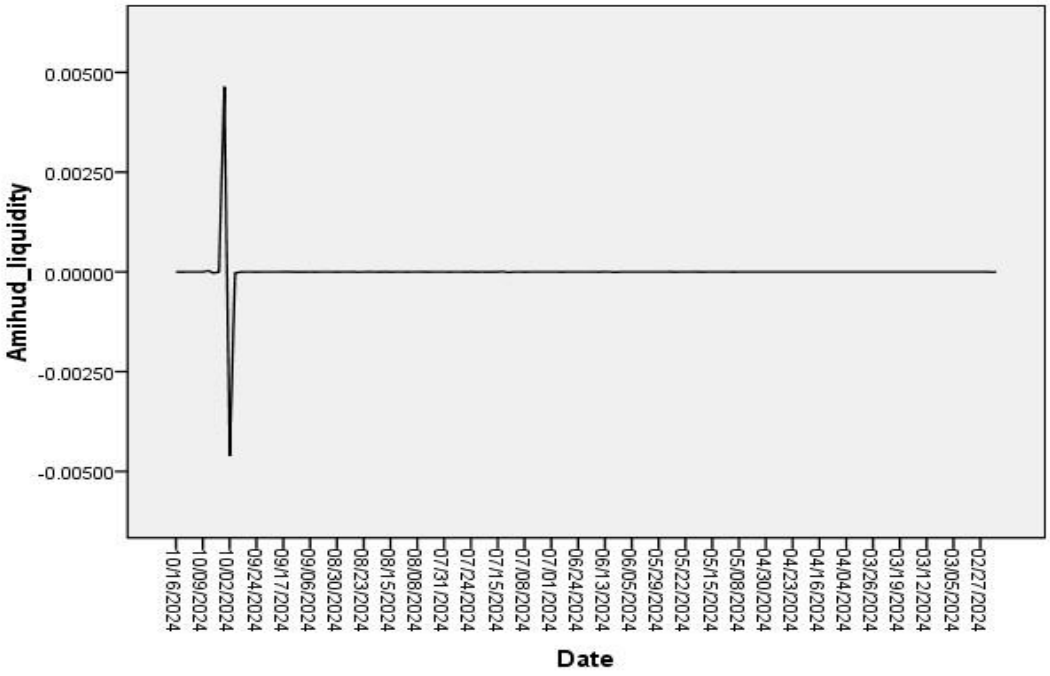

Figure 30 Amihud liquidity innovation plot over time for Nigerian government bond market

The Amihud liquidity innovation plot for Nigerian government bonds from 27 February 2024 to 16 October 2024 reflects a relatively stable market from 27 February to 24 September 2024, with a sharp movement on 2 October and a peak on 9 October 2024. The horizontal line suggests a period of stable liquidity, likely due to economic stability, predictable policies, and a lack of major shocks.

The sharp movement on 2 October and the subsequent peak on 9 October are likely the result of external or domestic shocks such as policy changes, global economic shifts, or market reactions to political developments that temporarily disrupted market stability and caused a spike in illiquidity. These patterns highlight how sensitive liquidity can be to changes in both global and local factors, with Nigerian government bonds responding to broader economic and policy changes during the observed period.

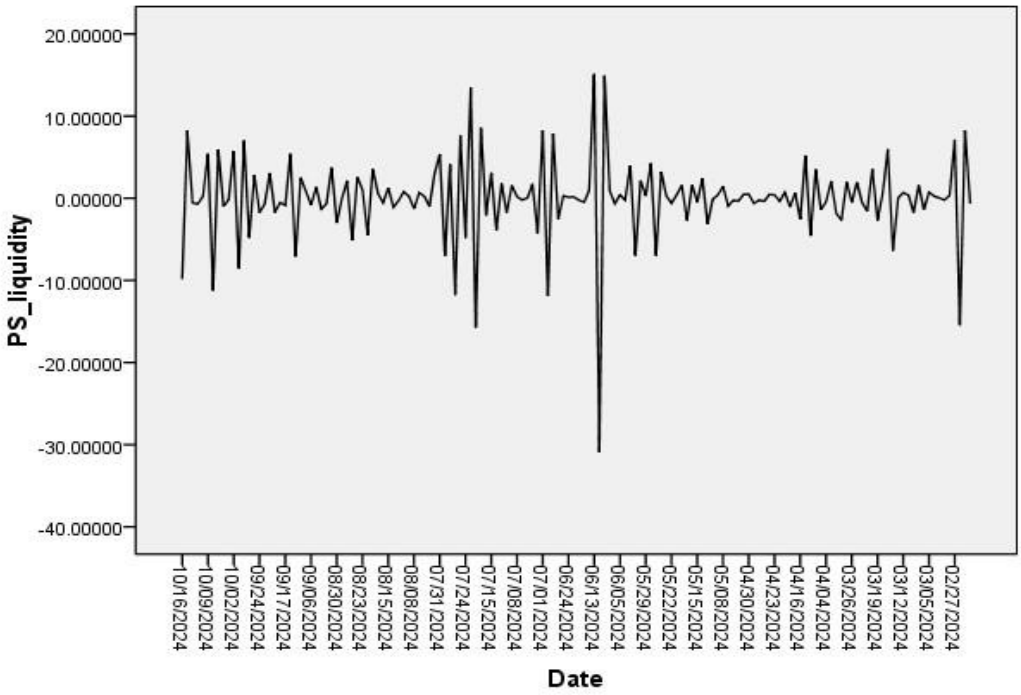

Figure 31 PS liquidity innovation plot over time for Nigerian government bond market

The volatile trend in the Pastor-Stambaugh liquidity innovation plot for Nigerian government bonds between 27 February 2024 and 16 October 2024 can be attributed to a combination of global market factors, domestic political and economic developments, and external shocks.

These could include changes in global risk sentiment, fluctuations in oil prices, domestic fiscal or monetary policies, capital flow shifts, and potential political instability. Emerging markets like Nigeria are highly sensitive to these variables, which can cause significant fluctuations in liquidity, as seen in the volatile trend of the plot.

Table 29 Factor correlations of liquidity and return relationships for Nigerian government bond market.

		Return	Vol	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	-.004	-.028	-.027	1.000**
Vol	Factor Correlation	-.004	1	-.050	-.051	.000
Illiquidity	Factor Correlation	-.028	-.050	1	1.000**	-.028
Amihud liquidity	Factor Correlation	-.027	-.051	1.000**	1	-.027
PS liquidity	Factor Correlation	1.000**	.000	-.028	-.027	1

The fact that the Pastor-Stambaugh liquidity measure is perfectly correlated with returns and the Amihud liquidity measure with illiquidity for Mexican government bonds reflects the strong, direct relationships between market liquidity and bond returns in this market. When liquidity improves, it lowers risk and volatility, leading to higher returns, while tighter liquidity increases illiquidity, raising bond yields and reducing returns. In essence, liquidity is a critical factor influencing both bond prices (returns) and market efficiency, and these two liquidity measures capture these dynamics with near-perfect correlation.

4.2.7. Poland

Table 30 Polish government bond market characteristics.

Poland	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	-0.005	1.530	-1.090	0.5052	0.487
	Amihud bond liquidity	0.000	0.493	-0.027	0.0812	1.587
	Beta for market illiquidity	-0.049	0.030	-2.315	0.0400	-0.515
	Pastor-Stambaugh bond liquidity	-5.35E17	1.580	-1.092	0.5048	0.252
	PS beta	-0.038	0.008	-0.087	0.0570	-0.402
	Adj. R2	0.297				

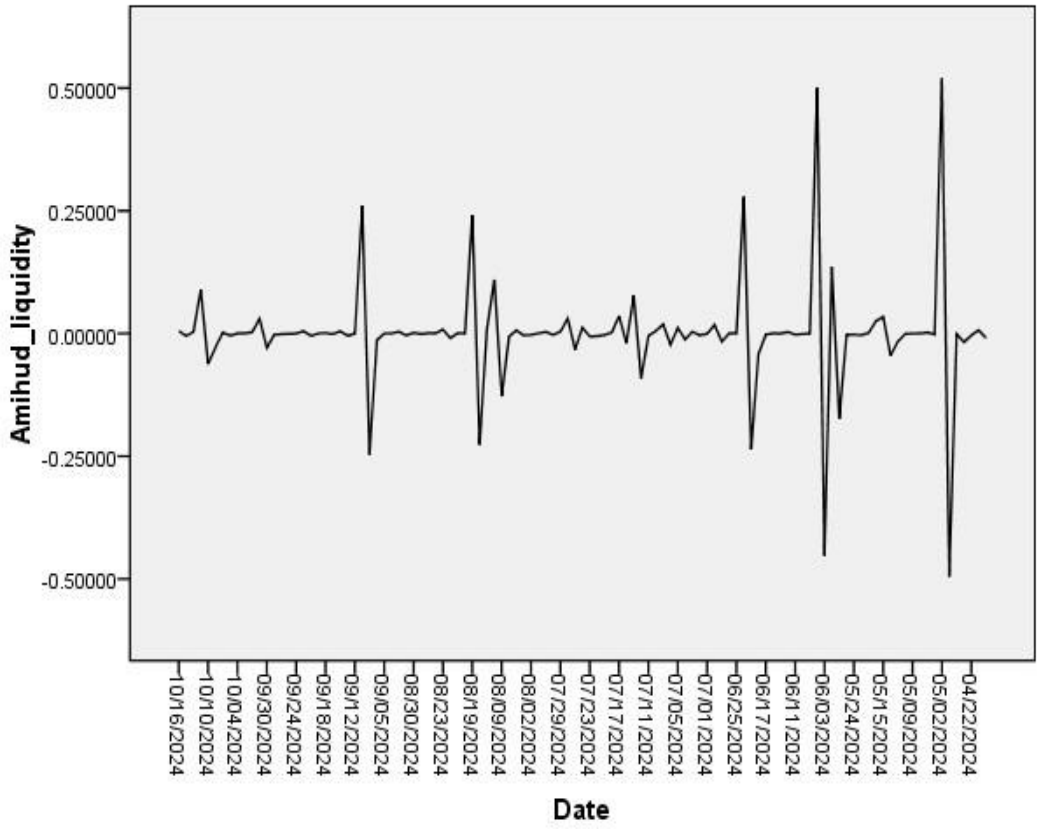

Figure 32 Amihud liquidity innovation plot over time for Polish government bond market.

The series of peaks and troughs in the Amihud liquidity innovation plot for Polish government bonds from 22 April 2024 to 16 October 2024 is indicative of volatility in the bond market liquidity, likely driven by a combination of domestic economic factors, political developments, global risk sentiment, and specific market events. Political uncertainty, global economic shifts, monetary policy changes, and government debt issuance are all plausible explanations for the observed fluctuations in liquidity.

These peaks and troughs highlight how sensitive emerging market bonds, including Polish government bonds, are to both local and global economic forces, and how these factors can trigger rapid changes in market conditions and investor behavior. Polish government bonds, like those of many emerging market economies, can experience greater fluctuations in liquidity due to relatively low market depth when compared to developed market bonds.

Although Poland, as a member of the European Union, enjoys a more stable bond market than some other emerging economies, its bonds remain susceptible to broader emerging market trends.

Emerging markets are inherently more vulnerable to external shocks, shifts in investor sentiment, and changes in liquidity conditions. For example, if global risk aversion rises or there is a significant outflow from emerging market funds, liquidity in Polish bonds could become more strained. This would likely lead to periods of illiquidity, exacerbating the volatility in the bond market.

Additionally, factors like high-frequency trading and changes in the investor base can contribute to the heightened volatility of liquidity. For instance, if there is a shift in market participation these transitions can disrupt the bond market and lead to sudden changes in liquidity. This type of volatility is common in emerging markets, where market dynamics are more sensitive to both global developments and shifts in investor behavior.

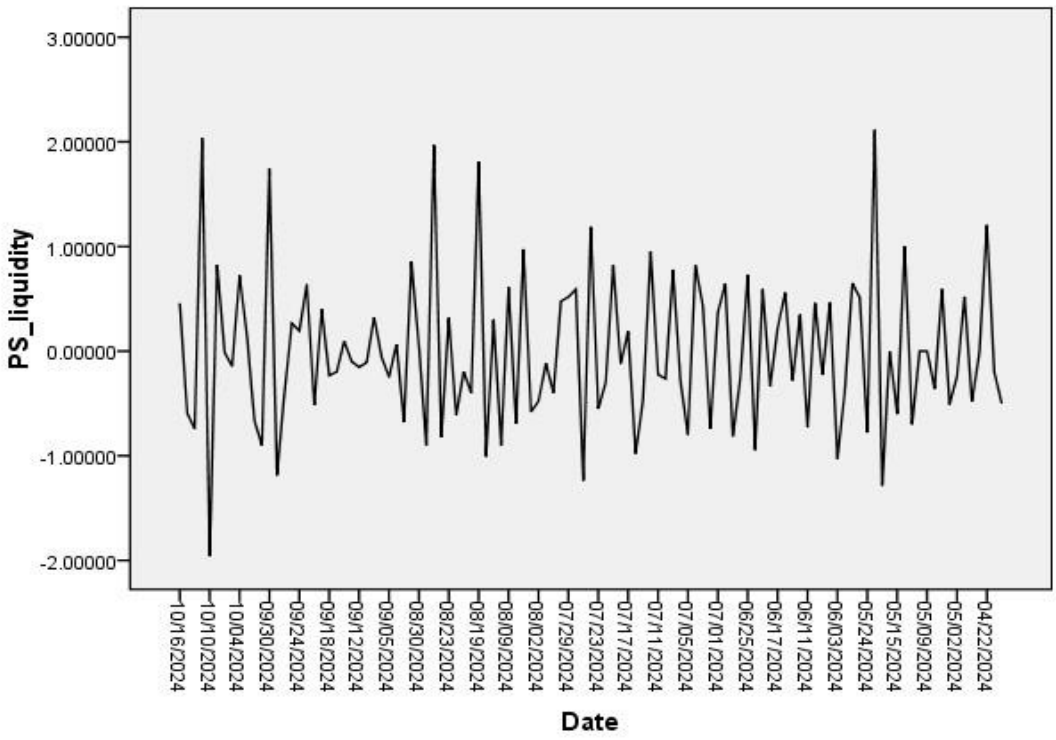

Figure 33 PS liquidity innovation plot over time for Polish government bonds.

The series of peaks and troughs in the Pastor-Stambaugh liquidity innovation plot for Polish government bonds from 22 April 2024 to 16 October 2024 reflects a combination of domestic economic factors, global market shifts, and investor sentiment. Periods of market stress, such as increased global risk aversion or changes in monetary policies, could have led to illiquidity peaks, while periods of stability or increased demand for Polish bonds would have resulted in troughs in liquidity. Additionally, factors like political uncertainty, fiscal policy changes, and shifts in the investor base all likely contributed to the observed volatility in liquidity during this period.

Table 31 Factor correlations of liquidity and return relationship of the Polish government bond market.

		Return	**Vol**	**Illiquidity**	**Amihud liquidity**	**PS liquidity**
Return	Factor Correlation	1	-.038	-.027	-.030	.999**
Vol	Factor Correlation	-.038	1	-.197*	-.203*	.000
Illiquidity	Factor Correlation	-.027	-.197*	1	.999**	-.034
Amihud liquidity	Factor Correlation	-.030	-.203*	.999**	1	-.038
PS liquidity	Factor Correlation	.999**	.000	-.034	-.038	1

The fact that the Pastor-Stambaugh liquidity measure is perfectly correlated with returns and the Amihud liquidity measure with illiquidity for the Polish government bonds reflects the strong, direct relationships between market liquidity and bond returns in this market. When liquidity improves, it lowers risk and volatility, leading to higher returns, while tighter liquidity increases illiquidity, raising bond yields and reducing returns. In essence, liquidity is a critical factor influencing both bond prices (returns) and market efficiency, and these two liquidity measures capture these dynamics with near-perfect correlation.

4.2.8. Turkey

Table 32 Turkey government bond market characteristics

Turkey	Variable	Mean	Maximum	Minimum	Std Dev	t
	Return	-0.047	0.900	-1.175	0.6733	0.548
	Amihud bond liquidity	8.01E-25	4.70E-08	-9.40E-09	1.93E-08	0.235
	Beta for market illiquidity	-0.108	0.000	-2.470	0.0401	-0.266
	Pastor-Stambaugh bond liquidity	-3.6E-16	1.008	-1.078	6.71E-01	0.655
	PS beta	0.082	0.248	-0.108	0.0403	0.203
	Adj. R2	0.343				

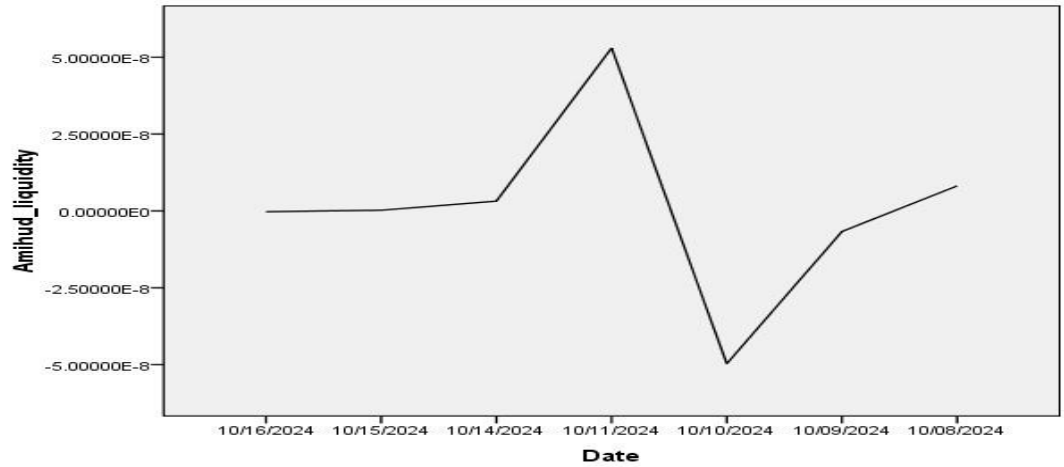

Figure 34 Amihud liquidity innovation plot over time for Turkey government bond market.

The Amihud liquidity innovation plot for Turkish government bonds from 10 October 2024 to 16 October 2024shows a liquidity dip on 10 October, followed by a liquidity spike on 11 October, which can be attributed to a combination of domestic political or economic announcements, global market factors, investor sentiment, and potential market technicalities. Such fluctuations are common in emerging markets, especially when market participants are reacting to policy changes, economic data, or external shocks. The sudden change in liquidity between 10 October and 11 October highlights how sensitive markets can be to even short-term shifts in sentiment, policy, or market conditions.

Turkey's bonds are often sensitive to changes in the Turkish lira's value. If the lira experienced significant fluctuations on 10 October due to a shift in FX policy, external events, or market sentiment it could have caused lower liquidity as investors adjusted their positions. On 11 October, if the currency stabilized or showed signs of improvement, it could have had a positive effect on bond liquidity, driving the spike.

On a short-term basis, such as the window between 10 October and 11 October, technical factors related to order flow or market positioning could have played a role. For example, if a large investor or institution executed a significant buy or sell order, it could have temporarily disrupted liquidity.

If that order was followed by further trades, or if the market found a new equilibrium after an imbalance, it could have created a liquidity spike on 11 October.

Trading volume on 10 October could have been relatively low, either due to market caution, a holiday, or investor uncertainty, leading to lower liquidity. However, on 11 October, higher trading volume, possibly triggered by investor reactions to news or global events, could have caused a temporary surge in liquidity, leading to the observed peak.

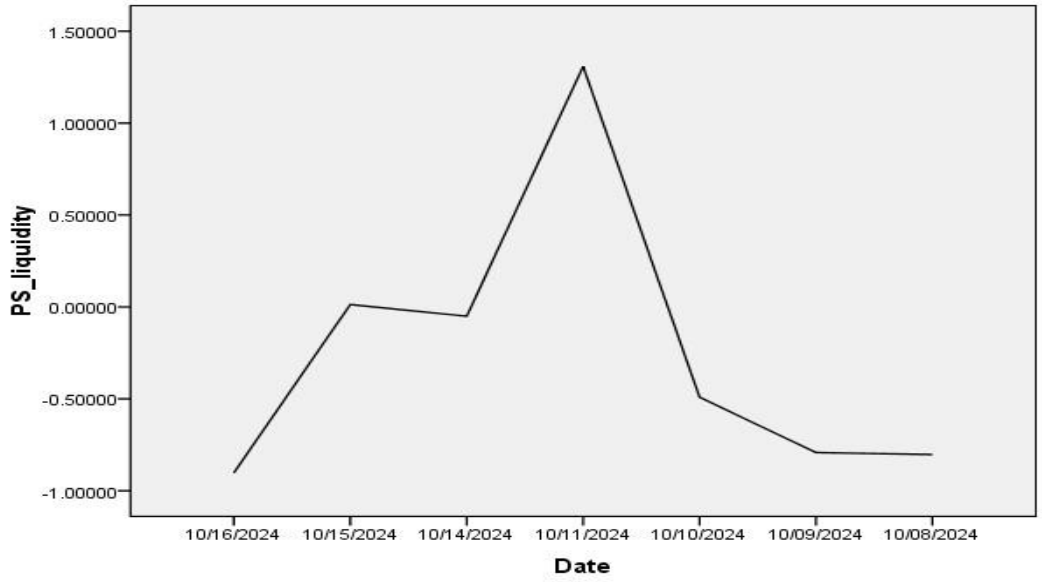

Figure 35 liquidity innovation plot over time for Turkey government bond.

The peak on 11 October 2024 in the Pastor-Stambaugh liquidity innovation plot for Turkish government bonds had been caused by a variety of factors, that took place during this time which included domestic political and domestic economic announcements, global market sentiment changes, currency volatility, or investor reactions to speculative developments.

The peak reflects a temporary spike in illiquidity, often due to sudden market reactions or adjustments by major participants. This is common in emerging market bond markets, where external shocks, policy changes, and market sentiment shifts can have an outsized impact on liquidity in the short term.

Table 33 Factor correlations of liquidity and return relationships for Turkey government bond.

		Return	Vol	Illiquidity	Amihud liquidity	PS liquidity
Return	Factor Correlation	1	.082	.472	.511	.997**
Vol	Factor Correlation	.082	1	-.537	-.559	.000
Illiquidity	Factor Correlation	.472	-.537	1	.994**	.518
Amihud liquidity	Factor Correlation n	.511	-.559	.994**	1	.559
PS liquidity	Factor Correlation	.997**	.000	.518	.559	1

The fact that the Pastor-Stambaugh liquidity measure is perfectly correlated with returns and the Amihud liquidity measure with illiquidity for the Turkish government bonds reflects the strong, direct relationships between market liquidity and bond returns in this market. When liquidity improves, it lowers risk and volatility, leading to higher returns, while tighter liquidity increases illiquidity, raising bond yields and reducing returns. In essence, liquidity is a critical factor influencing both bond prices (returns) and market efficiency, and these two liquidity measures capture these dynamics with near-perfect correlation.

Table 34 The quantification of the impact of liquidity risk on government bond returns in selected developing economies

Market	**Liquidity measure**	**Beta**	**t**	**Sig.**
Turkey	Amihud_liquidity	-0.067	-1.041	NS
	PS liquidity	1.034	31.486	**
	R squared	0.996		
Market	**Liquidity measure**			**Sig.**
Brazil	Amihud_liquidity	-0.005	-1.676	NS
	PS liquidity	1.001	310.739	**
	R squared	0.990		
Market	**Liquidity measure**			**Sig.**
China	Amihud_liquidity	-0.137	-0.937	NS
	PS liquidity	0.580	3.976	**
	R squared	0.366		
Market	**Liquidity measure**			**Sig.**
Colombia	Amihud_liquidity	0.001	5.102	**
	PS liquidity	1.000	5,299.000	**
	R squared	0.995		
Market	**Liquidity measure**			**Sig.**
India	Amihud_liquidity	0.000	-0.226	NS
	PS liquidity	1.000	813.955	**
	R squared	0.997		
Market	**Liquidity measure**			**Sig.**
Mexico	Amihud_liquidity	0.000	0.260	NS
	PS liquidity	1.000	589.709	**
	R squared	0.997		
Market	**Liquidity measure**			**Sig.**

Nigeria	Amihud_liquidity	0.000	0.626	NS
	PS liquidity	1.000	3,396.000	**
	R squared	0.995		
Market	**Liquidity measure**			**Sig.**
Poland	Amihud_liquidity	0.008	2.168	*
	PS liquidity	1.000	277.949	**
	R squared	0.990		

The Amihud illiquidity measure, which captures the average price impact per unit of trading volume, was found to be statistically insignificant in the government bond markets of several developing countries in this study, including Turkey, Brazil, China, India, Mexico, and Nigeria over the 2019–2024 period. This finding warrants closer examination, particularly given the concurrent significance of the Pastor-Stambaugh (PS) liquidity measure across many of the same markets.

A potential explanation for the Amihud measure's insignificance lies in the evolving market structure of these economies. Over the past decade, many emerging bond markets have experienced increased participation from institutional investors, such as pension funds, sovereign wealth funds, and insurance companies. These entities often follow long-term investment strategies, which contribute to market depth and reduce price volatility. Burger, Warnock, and Warnock (2012) and Mu, Phelps, and Stotsky (2013) highlight how the rising influence of such institutional players in local currency bond markets has supported market stability and growth.

However, as Walker and Lefort (2002) caution, institutional investors do not necessarily suppress trading activity. Due to ongoing contributions and inflows, pension funds and similar institutions often re-enter markets to acquire new securities, potentially executing large trades even in the absence of portfolio liquidations. Thus, their activity may still influence liquidity conditions, albeit in a more stable and predictable manner.

In addition to market structure, the limitations of the Amihud measure itself must be considered. This metric assumes a strong relationship between trade volume and price changes. In relatively tranquil or thinly traded markets conditions often found in developing countries price movements may be minimal, even in response to large trades, due to stale pricing, wide bid-ask spreads, or infrequent trading. Goyenko, Holden, and Trzcinka (2009) and Korajczyk and Sadka (2008) argue that the Amihud measure underperforms in environments characterized by low trading frequency or structural illiquidity, as it fails to capture latent or systemic liquidity risk.

In contrast, the Pastor-Stambaugh (2003) liquidity measure captures systematic liquidity risk the extent to which liquidity co-varies with market returns and is priced into expected returns. It is not reliant on short-term price impacts, but rather on the presence of a liquidity premium that investors demand for holding illiquid assets. This makes it a more effective indicator in markets where price changes may not closely follow trading volumes but where investors still require compensation for potential illiquidity.

The divergence in findings between the Amihud and Pastor-Stambaugh measures thus likely reflects their differing sensitivities to market dynamics. The insignificance of the Amihud measure may be a by-product of market maturation and reduced short-term volatility in these bond markets, while the continued significance of the Pastor-Stambaugh measure suggests that liquidity risk remains a relevant, priced component of bond returns.

These insights underscore the importance of aligning liquidity metrics with the structural realities of the markets under investigation. They also suggest that liquidity in developing bond markets is increasingly systemic and risk-based, rather than transactional or event-driven.
Consequently, the Pastor-Stambaugh measure may offer a more accurate reflection of liquidity dynamics in these contexts than volume-sensitive measures like Amihud.

In evaluating liquidity dynamics across emerging bond markets, this study initially observed that the Amihud illiquidity measure often failed to reach statistical significance, in contrast to the consistently significant results generated by the Pastor-Stambaugh (PS) liquidity measure. Understanding this divergence requires a closer examination of the underlying assumptions, market contexts, and distinct methodological sensitivities of these two widely used liquidity proxies.

The Amihud (2002) measure estimates liquidity based on the average price response to trading volume, making it particularly sensitive to short-term price impacts arising from order flow. In markets where individual trades generate significant price movements typically due to low depth or infrequent trading the Amihud metric is expected to perform well. However, in several of the emerging markets studied, such as India, Mexico, and China, recent structural developments have altered market behavior. Increased bond issuance, improved trading platforms, and regulatory reforms have contributed to higher market efficiency and reduced trade-level price volatility (Mu, Phelps, & Stotsky, 2013; Bhattacharyya, 2013).

Furthermore, the growing presence of institutional investors pension funds, insurance firms, and sovereign wealth funds has increased market depth, which may reduce the sensitivity of bond prices to individual transactions (Burger, Warnock, & Warnock, 2012). Nonetheless, it is important to recognize that institutional investors are not passive actors.

As Walker and Lefort (2002) argue, the scale of assets under management necessitates ongoing market participation to manage inflows, which can lead to large trades even without asset liquidation.

Thus, while market depth may increase, liquidity risk may still persist, though in forms less visible to trade-based measures like Amihud's. Additionally, central banks in many of these countries have become increasingly proactive, using policy tools such as open market operations and liquidity injections to stabilize prices and reduce volatility (IMF, 2019). These interventions may absorb short-term liquidity shocks, again muting the price responses that the Amihud measure is designed to capture.

In contrast, the Pastor-Stambaugh (2003) liquidity measure captures the degree to which liquidity is a systematic, priced risk factor. Rather than focusing solely on trade-level price impacts, the PS measure estimates how returns are influenced by fluctuations in liquidity over time, incorporating information about market-wide liquidity conditions. This makes it particularly well-suited to emerging markets, where liquidity may be episodic, risk-driven, and influenced by global capital flows and policy uncertainty (Korajczyk & Sadka, 2008; Goyenko, Holden, & Trzcinka, 2009). In such contexts, investors often demand a liquidity premium for holding assets that may become illiquid during times of stress a risk that the PS model is specifically designed to capture.

Moreover, the sensitivity of emerging bond markets to external shocks such as changes in global interest rates, exchange rate volatility, and geopolitical risks heightens the role of liquidity as a priced risk factor. The PS measure captures the impact of these macro-level shifts by modelling liquidity as an explanatory component of return volatility. For example, sudden capital flight triggered by risk-off sentiment can sharply contract liquidity, elevating bond yield spreads. The PS model is equipped to detect these changes, making it particularly insightful in volatile or less mature markets.

The divergence in the significance of these two measures, therefore, can be attributed to their methodological focus. The Amihud measure reflects realized liquidity the direct, observable price impact of trades. The PS measure captures expected or systematic liquidity risk how sensitive asset returns are to shifts in market-wide liquidity conditions. In more developed emerging markets, where government bonds are increasingly treated as long-term, stable investments and short-term price changes are smoothed by structural reforms, the Amihud measure may no longer adequately reflect underlying liquidity dynamics. However, as liquidity shocks in these markets are often driven by policy changes or external investor sentiment, the PS measure remains relevant for capturing how such shocks influence return behavior over time.

In summary, the discrepancy in the performance of the Amihud and Pastor-Stambaugh liquidity measures in emerging markets can be understood through their differing theoretical foundations and sensitivities to market structure. While the Amihud measure is well-suited to capturing trade-induced illiquidity in shallow or volatile markets, the Pastor-Stambaugh measure is more effective in detecting systematic liquidity risk that arises from macroeconomic and policy-related developments. This distinction is crucial in emerging bond markets, where both market infrastructure and investor composition continue to evolve, and where liquidity risk remains an important determinant of return behavior, albeit through more nuanced and structural channels.

CHAPTER 5: CONCLUSION .

In this study, we provide evidence on the role of liquidity risk in the pricing of both corporate and government bonds using a five year daily data sample that combines two important transaction data sets for the bonds. Our study represents an extension of the work of Pastor and Stambaugh (2003) and Acharya and Pedersen (2005) as applied to developing bond markets. The study further considers market- wide liquidity as an additional state variable in the bond pricing model and investigates whether liquidity risk is priced in bond returns. We use both the Pastor-Stambaugh and Amihud measures and other variants as proxies for the liquidity factor and examine robustness of test results to these liquidity measures. Moreover, we include bond specific characteristics in the empirical model to capture the potential effects of the liquidity and default information embedded in these variables.

We employ both regression and portfolio-based test methodologies to examine whether liquidity risk explains cross-sectional variations in expected corporate and government bond returns. Our results consistently show that liquidity risk is priced in the bond market. We find a positive and economically significant relation between expected bond returns and liquidity risk even after controlling for the effects of default and term betas, bond characteristics, and the level of liquidity. This relation is robust to different model specifications and the choice of liquidity measures. Liquidity risk spread accounts for a significant portion of bond risk premium with results strongly suggesting that liquidity risk is an important determinant of expected bond returns.

As developing economies increasingly attract both domestic and international investors, understanding how liquidity risk impacts bond pricing and yields becomes essential for making informed investment decisions. This study focused on the short-term dynamics of liquidity risk premiums and their influence on bond returns in developing markets.

Liquidity risk arises from factors such as limited market depth, low investor participation, political instability, and economic volatility.

These markets, characterized by wider bid-ask spreads and lower trading volumes, often lead to higher transaction costs for investors, which in turn result in liquidity risk premiums embedded in bond yields (Amihud & Mendelson, 1986).

The research also found that liquidity risk premiums vary significantly across countries, depending on the specific characteristics of the bond market and the broader macroeconomic environment. In particular, markets with more developed institutional frameworks, such as Brazil and Mexico exhibit relatively lower liquidity risk premiums due to higher market liquidity and stronger investor confidence (Kim & Lee, 2021).

Conversely, countries with volatile political environments or less mature financial markets, such as Poland, experience higher liquidity risk premiums, as investors demand additional compensation for the added risks (Ehsani & Razmi, 2019). Moreover, government bonds, while generally seen as less risky, showed greater price volatility in times of political unrest or economic instability, reinforcing the notion that liquidity risk is not limited to corporate bonds but also affects sovereign debt in developing markets (Longstaff, 2004).

5.1. Summary of Results

One of the critical contributions of this research is the identification and assessment of liquidity risk premiums in developing bond markets. The study found that liquidity risk premiums are not static but fluctuate over time, often in response to changes in market conditions, political stability, and macroeconomic factors.

This dynamic nature of liquidity risk premiums is especially evident in countries experiencing periods of economic turmoil or policy changes, where bond yields become more sensitive to liquidity conditions. These findings are consistent with the work of Amihud & Mendelson (1986), who argued that markets with higher liquidity risks tend to have higher yields, as investors need to be compensated for the difficulty of executing transactions without impacting prices.

Furthermore, the research suggests that liquidity risk premiums are closely tied to market accessibility. In developing markets, foreign investors often face additional barriers to entry, such as capital controls, regulatory restrictions, or currency risks, which exacerbate liquidity risks. This is evident in markets like Nigeria where external factors such as international sanctions and oil price fluctuations have a substantial impact on market liquidity and investor behavior. As a result, foreign investors demand higher premiums to mitigate the risk associated with these external factors (Fleming & Remolona, 1997).

5.2. Implications

The findings of this study have significant implications for investment strategies in developing bond markets. First and foremost, investors need to account for the liquidity risk premium when assessing the potential returns of bonds in emerging economies. The research suggests that liquidity risk, if not properly understood and priced, can result in suboptimal investment decisions, especially in countries with volatile markets. Investors should carefully evaluate not only the credit risk associated with a particular bond but also the broader liquidity conditions that may affect the ease with which bonds can be bought or sold.

For instance, institutional investors looking to diversify their portfolios by investing in developing market bonds should pay close attention to factors such as market depth, bid-ask spreads, and trading volumes, as these variables directly impact liquidity.

The research highlights that markets with higher liquidity risk premiums, may offer higher returns, but they come with the trade-off of increased market volatility and the potential for more significant price fluctuations. On the other hand, markets with lower liquidity risk premiums, may offer more stable returns, albeit at the cost of relatively lower yields (Wang & Li, 2021).

Additionally, for foreign investors, understanding the country-specific risks that influence liquidity, such as political instability, regulatory changes, and currency risk, is crucial. As liquidity risk is often priced into bond yields, foreign investors may face higher transaction costs and require higher returns to compensate for the added risks associated with market access. Therefore, adopting a risk-adjusted approach to bond selection, where both credit and liquidity risks are considered, would enhance investment outcomes in developing markets (Furfine, 2018).

5.3. Recommendations

From a policy perspective, this research suggests several measures that can be taken to improve market liquidity and reduce liquidity risk premiums in developing economies. Governments and financial regulators should work towards enhancing market infrastructure and transparency to encourage greater participation from both domestic and foreign investors. For example, improving market access, promoting transparency in bond pricing, and reducing transaction costs would lower liquidity risk premiums, making these markets more attractive to investors (Fleming & Remolona, 1997).

In particular, central banks and financial authorities should focus on strengthening the institutional framework governing bond markets. This includes ensuring the stability of the financial system, implementing clear and consistent monetary policies, and addressing fiscal challenges that may deter investor confidence.

The introduction of financial instruments such as bond futures and options could also help manage liquidity risk, offering investors the ability to hedge against price fluctuations and improve overall market efficiency (Huang & Wang, 2020).

Moreover, reforms aimed at increasing foreign investor participation, such as relaxing capital controls or allowing foreign currency-denominated bonds, could further enhance market liquidity and reduce the perceived risks associated with emerging market bonds.

5.4. Areas of further research

For future research, it would be valuable to extend the analysis to other developing markets, particularly those in Sub-Saharan Africa and Southeast Asia, to further understand the dynamics of liquidity risk premiums across regions. Additionally, examining the long-term impact of global financial crises on liquidity risk premiums could provide insights into how developing bond markets respond to global shocks, enhancing the ability of investors to predict market movements and adjust their strategies accordingly. As the global financial landscape continues to evolve, understanding the relationship between liquidity risk and bond returns in developing markets will remain essential for both investors and policymakers seeking to optimize returns and mitigate risk in these increasingly important markets. (Acharya, 2005).

In conclusion, this research has highlighted the crucial role that liquidity risk plays in shaping bond returns in developing markets. The study confirms that liquidity risk premiums are an integral part of bond pricing in developing economies, with significant variations across different markets depending on their economic conditions, institutional frameworks, and investor perceptions. While liquidity risk can provide higher returns for investors willing to assume additional risk, it also introduces greater price volatility and market uncertainty. As such, both investors and policymakers must consider liquidity as a key factor when making investment decisions or designing policies aimed at fostering more stable and liquid bond markets.

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